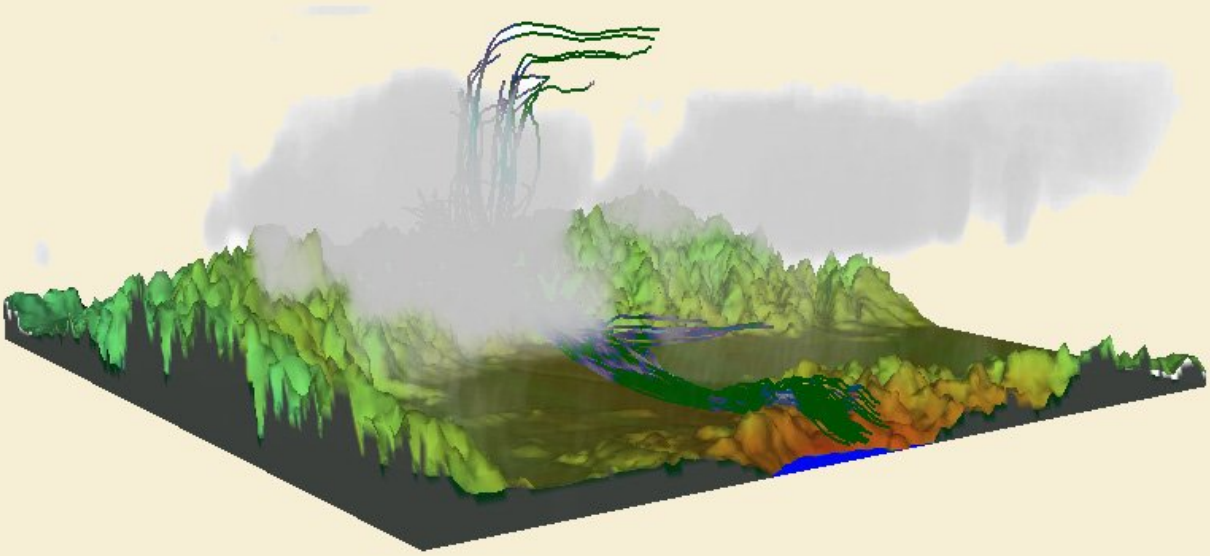
9th EGU Plinius Conference
Mediterranean Storms



PROGRAMME AND ABSTRACTS

Varenna, Italy
10-13 September 2007

International Congress Centre "Villa Monastero"

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GENERAL INFORMATION

Location and Conference Address

The 9th EGU Plinius Conference on Mediterranean Storms is held at the International Congress Centre "Villa Monastero", Varenna, Italy, from 10–13 September 2007. It is organized by the European Geosciences Union (EGU) and three Italian research Institutes active in the field of natural hazards evaluation and prediction: the Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR); the CNR Institute for Hydrogeological Research and Prevention (IRPI); and the Inter-university Research Center for Environmental Monitoring (CIMA) of the Universities of Genoa and Basilicata. The conference is open to the scientists of all nations.

Villa Monastero, ancient monastery and patrician abode, is today an international Congress Centre that offers corporate bodies, associations and institutes the possibility of holding conferences, seminars, courses and workshops in extremely suggestive surroundings.

Villa Monastero is one of the most interesting examples of an eclectic style residence on Lake Como; here the interventions from the end of XIX and the beginning of XX century have added functional and decorative elements without damaging the traces of the building's history.

The enchantment of the gardens, which extend up to Fiumelatte, and the peace and quiet of the place makes the Villa an ideal environment for high level cultural and scientific meetings. Internationally known literates, historians, artists, scientists, even Nobel Prize winners, have honoured Villa Monastero since 1953 when this prestigious abode became a Congress Centre for high level studies.

The Villa is located in Varenna, a picturesque medieval village, rich in artistic monuments on the east coast of Lake Como, and a tourist destination traditionally appreciated also for its stupendous nature and landscape.

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Eric A. Smith (NASA-GSFC, USA)
Jacques Testud (NOVIMET, France)
Gregory J. Tripoli (University of Wisconsin, USA)
Judith Wolf (POL, U.K.)

Local Organizing Committee

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Francesco Cardillo (CNR-ISAC)
Luisella Colla (CIMA)
Luca Ferraris (CIMA)
Fausto Guzzetti (CNR-IRPI)
Alberto Mugnai (CNR-ISAC)
Giorgio Roth (CIMA)

Invited Speakers

Chandrasekar V. Chandra (Colorado State University, USA)
Giovanni Battista Crosta (University of Milano - Bicocca, Italy)
Bernardo De Bernardinis (National Civil Protection, Italy)
Dara Entekhabi (MIT, USA)
Efi Foufoula-Georgiou (University of Minnesota, USA)
Bruce D. Malamud (King's College London, U.K.)
Richard Rotunno (NCAR, USA)
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Registration & Information Desk

On-site registration at on-site rates will be possible at the registration desk which is located at the ground floor of the International Congress Centre "Villa Monastero" at:

Opening Hours

Sunday, 09 September 2007, 15:00–20:00

Monday–Wednesday, 10–12 September 2007
during the session times

Oral Sessions

Monday, 10 September 2007	
Timeblock 1	09:00–11:00
Coffee Break	11:00–11:30
Timeblock 2	11:30–13:15
Lunch	13:15–14:30
Timeblock 3	14:30–16:00
Coffee Break	16:00–16:30
Timeblock 4	16:30–19:30

Tuesday, 11 September 2007	
Timeblock 1	09:00–11:00
Coffee Break	11:00–11:30
Timeblock 2	11:30–13:30
Lunch	13:30–14:30
Timeblock 3	14:30–16:00
Coffee Break	16:00–16:30
Timeblock 4	16:30–19:50

Wednesday, 12 September 2007	
Timeblock 1	09:00–10:45
Coffee Break	10:45–11:15
Timeblock 2	11:15–13:15
Lunch	13:15–14:30
Timeblock 3	14:30–15:30
Coffee Break	15:30–16:00
Timeblock 4	16:00–19:30

Poster Sessions

Monday, 10 September 2007, 09:00–19:30
Tuesday, 11 September 2007, 09:00–19:50
Wednesday, 12 September 2007, 09:00–19:20

The posters are located in the Poster Area near Fermi Conference Room. Double sided tape is available at the registration & information desk.

Special Events

All registered participants of the 9th EGU Plinius Conference are invited to join the following social events:

Buffet Dinner, Monday, 10 September 2007

Buffet Dinner, Tuesday, 11 September 2007

Conference Dinner, Wednesday, 12 September 2007

Optional Conference Boat Tour of Como Lake, Thursday, 13 September 2007

The Med-Storm Prize for Young Researchers

During the Conference, two prizes of 1000 Euro will be assigned to the two best contributions (either oral or poster) presented by young researchers. The goal of these prizes is to foster innovative research on the understanding and prediction of Mediterranean storms and their ground effects.

The two prizes are kindly sponsored by Elsag Datamat, the Italian company of Finmeccanica Group which has been recently established to act as a centre of excellence for the design and production of systems, services and solutions in automation, security, transport, defence & space, information technology (www.elsagdatamat.com/EN/Home).

The selection will be made during the conference and will be based on the originality and relevance of the contribution and the quality of the presentation. Conditions for eligibility are: being the first and presenting author of a contribution; being no more than 33 years old; being either a student or a Post-Doc.

Contributions including co-authors who are members of the Prize Selection Committee are excluded from the competition.

Proceedings

Authors whose papers have been accepted for presentation at the 9^{th} EGU Plinius Conference on Mediterranean Storms are invited to prepare a short but self-contained manuscript (4–6 pages) for publication in the Conference Proceedings. Selected contributions will be invited for submission in form of regular length articles to NHESS (Natural Hazards and Earth System Sciences) http://www.copernicus.org/EGU/nhess/nhess.html.

TIME TABLE

MONDAY, 10 SEPTEMBER 2007

9:00 – 10:00	10:00 – 11:00	11:00 – 11:30	11:30 – 12:30	12:30 – 13:15	13:15 – 14:30	14:30 – 16:00	16:00 – 16:30	16:30 – 18:00	18:00 – 18:15	18:15 – 19:30	20:00
INTRODUCTION	PLC13	C.B.	PLC2	PLC6	L.B.	PLC1	C.B.	PLC4	B.	PLC11	BUFFET DINNER

TUESDAY, 11 SEPTEMBER 2007

9:00 – 11:00	11:00 – 11:30	11:30 – 12:30	12:30 – 13:30	13:30 – 14:30	14:30 – 16:00	16:00 – 16:30	16:30 – 19:50	20:00
PLC0	C.B.	PLC5	PLC7	L.B. (STEERING COMMITTEE)	PLC3	C.B.	PARALLEL SESSIONS 1 = PLC1 + PLC2 + PLC5 2 = PLC13 + PLC7 + PLC11 + PLC12	BUFFET DINNER

WEDNESDAY, 12 SEPTEMBER 2007

9:00 – 10:45	10:45 – 11:15	11:15 – 12:30	12:30 – 13:30	13:30 – 14:30	14:30 – 15:30	15:30 – 16:00	16:00 – 19:30	20:30
PLC9	C.B.	PLC8	PLC10	L.B.	PLC12	C.B.	PARALLEL SESSIONS 3 = PLC4 + PLC3 + PLC1 4 = PLC9 + PLC8 + PLC10	CONFERENCE DINNER

THURSDAY, 13 SEPTEMBER 2007

9:00 – 13:30	13:30 – 14:30	14:30 – 19:00
BOAT TOUR OF LAKE COMO	L.B.	MEDEX MEETING (FERMI CONFERENCE ROOM) RISKMED MEETING (POLVANI MEETING ROOM)

PROGRAMME

MONDAY – 10 September 2007

Fermi Conference Room

Introduction

Chairperson: MUGNAI, A.

9:00–9:15 Welcome

9:15–9:45; PLINIUS9-A-00162
Malamud, B. D.
Tails of natural hazards: Implications for ecology, erosion, and risk (invited)

9:45–10:00; PLINIUS9-A-00161
Tripoli, G. J.
A Numerical Investigation of the 26-28 June 1997 Lake Como Heavy Precipitation Event (solicited)

PLC13 Societal Impacts & Responses (1)

Conveners: Llasat, M.; Siccardi, F.

Chairperson: LLASAT, M.C.

10:00–10:30; PLINIUS9-A-00140
Llasat, M.C.; **Siccardi, F.**
Social and technological aspects in managing natural hazards (solicited)

10:30–10:45; PLINIUS9-A-00149
Porcu', F.; Carrassi, A.
Economic impact of cyclonic structures in Europe

10:45–11:00; PLINIUS9-A-00058
Nicolaides, K.A.; Photiou, G.; Savvidou, K.; Orphanou, A.; Michaelides, S.C.; Karacostas, T.S.; Kannaouros, C.
Synoptic and dynamic characteristics of selected hailstorms over the area of Cyprus and their impact on the agricultural economy

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11:00 COFFEE BREAK

PLC2 Storm Processes (1)

Conveners: Tripoli, G.; Prodi, F.

Chairperson: TRIPOLI, G.

11:30–12:00; PLINIUS9-A-00019
Rotunno, R.
Moist Convection and Mesoscale Predictability (invited)

12:00–12:15; PLINIUS9-A-00057
Jansa, A.; Martinez, C.; Campins, J.; Genoves, A.
Atmospheric patterns for Mediterranean heavy rain

12:15–12:30; PLINIUS9-A-00159
McBride, J.L.
Conceptual frameworks for understanding Mediterranean cyclones

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PLC6 Operational Meteorological Forecasting

Conveners: Jansa, A.; Lagouvardos, K.

Chairperson: JANSA, A.

12:30–12:45; PLINIUS9-A-00002
Garcia-Moya, J. A.; Callado, A.; Santos, C.; Santos-Muñoz, D.; Simarro, J.
Multimodel Ensemble for Operational Short-Range Forecast

12:45–13:00; PLINIUS9-A-00022
Vich, M.; Romero, R.; Homar, V.
Sensitivity areas of Mediterranean cyclones derived from the MM5 adjoint model: Application to mesoscale ensemble forecasts

13:00–13:15; PLINIUS9-A-00087
Picornell, M.A.; Genovés, A.; Santos, C.; García-Moya, J.A.; Campins, J.; Jansà, A.
Extratropical cyclone tracks forecast from the INM-SREPS

13:15 LUNCH BREAK

PLC1 Climate Change & Extreme Events (1)

Conveners: Alpert, P.; Levizzani, V.

Chairperson: LEVIZZANI, V.

14:30–15:00; PLINIUS9-A-00118
Chaboureau, J.-P.; Claud, C.; Funatsu, B.; Söhne, N.; Argence, S.; Lambert, D.; Richard, E.
From climate to weather: Mediterranean storms as seen from satellite-based climatology and mesoscale simulations (solicited)

15:00–15:15; PLINIUS9-A-00011
Saaroni, H.; Halfon, N.; Ziv, B.; Alpert, P.; Kutiel, H.
The Role of East-Mediterranean Synoptic Systems in Controlling the Rainfall in Israel

15:15–15:30; PLINIUS9-A-00088
Nuissier, O.; Joly, B.; Somot, S.; Ducrocq, V.; Joly, A.
Heavy Precipitating Events (HPEs) over Southern France in a climate change scenario: a dynamical downscaling approach

15:30–15:45; PLINIUS9-A-00089
Genovés, A.; Campins, J.; Picornell, M.A.; Jansà, A.
A comparison between Mediterranean cyclone climatologies

15:45–16:00; PLINIUS9-A-00121
Lionello, P.
A joint analysis of cyclone and precipitation trends in the Mediterranean region

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16:00 COFFEE BREAK

PLC4 Remote Sensing (1)

Conveners: Smith, E.A.; Testud, J.

Chairperson: SMITH, E.A.

16:30–17:00; PLINIUS9-A-00130
Stephens, G.; L'Ecuyer, T.; Haynes, J.
New A-Train Satellite Observations of Mediterranean Storm (invited)

17:00–17:15; PLINIUS9-A-00158
Smith, E.A.
Contrasts between precipitation over Mediterranean Sea and adjacent continental areas based on decadal scale satellite estimates

17:15–17:30; PLINIUS9-A-00155
Haddad, Z.; Park, K.-W.
Vertical structure contrasts between precipitation and latent heating over southeastern Mediterranean Sea and surrounding continental areas

17:30–17:45; PLINIUS9-A-00156
Mehta, A.; Yang, S.
Propagation of precipitation over southeastern Mediterranean basin produced by mesoscale storms based on TRMM PR measurements

17:45–18:00; PLINIUS9-A-00157
Mugnai, A.; Casella, D.; Formenton, M.; Leung, W.Y.; Mehta, A.; Sanò, P.; Smith, E.A.; Tripoli, G.J.; Yang, S.
Investigating contrasts between continental and maritime precipitation over Mediterranean basin based on CDRD Algorithm methodology

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18:00 BREAK

PLC11 Prediction & Effects of Rainfall-Induced Landslides (1)

Convener: Guzzetti, F.

Chairperson: GUZZETTI, F.

18:15–18:45; PLINIUS9-A-00165
Crosta, G.B.; Frattini, P.
New approaches for the assessment of the return period of shallow landslides (invited)

18:45–19:00; PLINIUS9-A-00017
Guzzetti, F.; Peruccacci, S.; Rossi, M.; Stark, C.P.
Rainfall conditions that have resulted in landslides: a global analysis

19:00–19:15; PLINIUS9-A-00109
Benedetti, A.I.; Catani, F.; Falorni, G.; Gabellani, S.; **Leoni, L.**; Righini, G.; Rudari, R.; Segoni, S.
PREVIEW Service 2: Forecasting Shallow Rapid Landslides

19:15–19:30; PLINIUS9-A-00030
Underwood, J.
Cloud-to-ground lightning characteristics of storms that trigger debris-flows in complex terrain of the Mediterranean region

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19:30 END OF SESSION

Poster Session 1

Display Time: Monday, 09:00–19:30

Poster Area

Chairperson: MUGNAI, A.

P0001; PLINIUS9-A-00051
Funatsu, B.; Claud, C.; Chaboureau, J.-P.
A climatology of Mediterranean severe weather events using the Advanced Microwave Sounding Unit (AMSU)

P0002; PLINIUS9-A-00101
Claud, C.; **Funatsu, B.**; Gauthier, N.; Montoux, N.; Hauchecorne, A.; Lambert, D.; Argence, S.; Chaboureau, J.P.
A case of severe weather over the western Mediterranean: satellite observation and numerical simulations

P0003; PLINIUS9-A-00097
Horvath, K.; Lin, Y.-L.; **Ivanèan-Picek, B.**
Classification of Cyclogenesis over the Apennine Mountains and Adriatic Sea

P0004; PLINIUS9-A-00139
Bloom, A.; Kotroni, V.; Lagouvardos, K.
Climate change impact of wind energy availability in the Eastern Mediterranean using the regional climate model PRECIS

P0005; PLINIUS9-A-00148
Caporali, E.; Fatichi, F.
Detecting trends and long term persistency in precipitation indexes in Tuscany

P0006; PLINIUS9-A-00080
Barnolas, M.; Atencia, A.; Llasat, M.C.; Rigo, T.
Characterization of a Mediterranean flash flood event using raingauges, radar, GIS and lightning data

P0007; PLINIUS9-A-00137
Formenton, M.; Adamo, C.; Casella, D.; Mugnai, A.; Sanò, P.
Development of an algorithm for convection detection by means of IR observations from geosynchronous satellites and lightning data from VLF ground-based networks: Application to the FLASH Project case studies over Italy

P0008; PLINIUS9-A-00061
Grecu, M.; **Anagnostou, E.**
Ensemble-based data assimilation of satellite observations into a cloud resolving model

P0009; PLINIUS9-A-00023
Garcies, L.; Homar, V.
Ensemble sensitivities of the real atmosphere: Application to Mediterranean Intense Cyclones

P0010; PLINIUS9-A-00082
Davolio, S.; Buzzi, A.; Malguzzi, P.
High resolution operational forecasting with MOLOCH for MAP-DPHASE

P0011; PLINIUS9-A-00150
Santorelli, E.; Dietrich, S.; Di Paola, F.; Porcù, F.
Damages and social impact of Italian severe storms: focus on regional differences

P0012; PLINIUS9-A-00020
Aran, M.; Sairouni, A.; Miro, J.; Moré, J.; Toda, J.; Cunillera, J.
The impact of two assimilation techniques in two tornadoes cases

P0013; PLINIUS9-A-00052
Rigo, T.; Bech, J.; Pineda, N.; Trapero, L.
A remote sensing analysis of the 25 August 2006 event in Catalonia (NE Spain)

PROGRAMME

TUESDAY – 11 September 2007

Fermi Conference Room

PLC0 Advanced Technologies for Measuring Rainfall and Cloud Properties

Convener: Mugnai, A.

Chairperson: MUGNAI, A.

9:00–9:25; PLINIUS9-A-00152
Chandrasekar, V.; McLaughlin, D.; Brotzge, J.; Zink, M.; Phillips, B.; Wang, Y.
Distributed Collaborative Adaptive Radar Network: The CASA IP-1 Network and relevance to the Mediterranean region (invited)

9:25–9:45; PLINIUS9-A-00167
Weinman, J.A.; Marzano, F.S.; Mugnai, A.; Pierdicca, N.
Exploitation of X-band space-borne synthetic aperture radar for highly-resolved precipitation retrieval over land within GPM (invited)

9:45–10:00; PLINIUS9-A-00128
Baldini, L.; Gorguci, E.; Romaniello, V.
C-band procedure for rainfall estimation using polarimetric measurements

10:00–10:15; PLINIUS9-A-00046
Betz, H. D.; Schmidt, K.; Oettinger, W. P.; Fuchs, B.
Lightning Detection in Europe

10:15–10:30; PLINIUS9-A-00168
Price, C.
Use of real time lightning observations for early warning of meteorological hazards

10:30–10:45; PLINIUS9-A-00163
Alpert, P.; Rayitsfeld, A.; Firsten, A.; David, N.; Goldshtein, O.; Messer, H.; Zinevich, A.
Study of precipitation by cellular networks with focus on heavy rainfall events

10:45–11:00; PLINIUS9-A-00062
Anagnostou, M.; Nystuen, J.; Anagnostou, E.; Nikolopoulos, E.
Evaluation of underwater rainfall estimation through comparison with dual polarization radar rainfall measurements in the Ionian Sea Rainfall Experiment

11:00 COFFEE BREAK

PLC5 Nowcasting (1)

Conveners: Michaelides, S.; Price, C.

Chairperson: MICHAELIDES, S.

11:30–11:45; PLINIUS9-A-00029
Metta, S.; Ferraris, L.; von Hardenberg, J.; Provenzale, A.; Rebora, N.
PHAST: a phase-diffusion model for stochastic nowcasting

11:45–12:00; PLINIUS9-A-00041
Bonelli, P.; Marcacci, P.
Thunderstorm nowcasting by means of lightning and radar data: algorithms and applications in Northern Italy

12:00–12:15; PLINIUS9-A-00103
Zinner, T.; Mannstein, H.; **Tafferner, A.**; Forster, C.
Cb-TRAM: Tracking and monitoring severe convection from onset over rapid development to mature phase using multi-channel Meteosat-8 SEVIRI data

12:15–12:30; PLINIUS9-A-00154
Dietrich, S.; Di Paola, F.; Santorelli, E.
On using lightning for temporal propagation and cloud-life adjustment of MW-estimated severe precipitation fields

PLC7 Rainfall Downscaling (1)

Conveners: Deidda, R.; Foufoula-Georgiou, E.

Chairperson: DEIDDA, R.

12:30–12:50; PLINIUS9-A-00007
Provenzale, A.; Brussolo, E.; Ferraris, L.; von Hardenberg, J.; Metta, S.; Rebora, N.
RainFARM, stochastic rainfall downscaling, and beyond (solicited)

12:50–13:10; PLINIUS9-A-00132
Deidda, R.
Space-time rainfall downscaling with multifractal models

13:10–13:30; PLINIUS9-A-00151
Fienberg, K.; Foufoula-Georgiou, E.
Multi-Scale Variability of Orographic Precipitation and Topographic Attributes: Application to Rainfall Downscaling

13:30 LUNCH BREAK

PLC3 Mesoscale Modeling (1)

Conveners: Kotroni, V.; Buzzi, A.

Chairperson: KOTRONI, V.

14:30–15:00; PLINIUS9-A-00005
Ducrocq, V.; Drobinski, P.; et al.
Hydrological cycle in the Mediterranean experiment (HyMeX): The mesoscale modeling facets (solicited)

15:00–15:15; PLINIUS9-A-00010
Miglietta, M.M.; Rotunno, R.
High-resolution 3D numerical simulations of conditionally unstable flows over a ridge

15:15–15:30; PLINIUS9-A-00086
Fita, L.; Romero, R.; Luque, A.; Ramis, C.
Improvements of numerical simulations of tropical-like Mediterranean storms through the assimilation of satellite and lightning data

15:30–15:45; PLINIUS9-A-00027
Yan, X.; Ducrocq, V.; Poli, P.; Jaubert, G.
Ground-GPS data assimilation and its impact on Mediterranean heavy rainfall prediction

15:45–16:00; PLINIUS9-A-00069
Fantini, M.; Malguzzi, P.
Two-dimensional non-hydrostatic numerical study of conditional symmetric instability

16:00 COFFEE BREAK

Parallel Session 1

Fermi Conference Room

PLC1 Climate Change & Extreme Events (2)

Conveners: Alpert, P.; Levizzani, V.

Chairperson: ALPERT, P.

16:30–16:42; PLINIUS9-A-00164
Alpert, P.; Shafir, H.; Krichak, S.O.; Osetinsky, I.; Dayan, M.; Haim, D.
Climatic trends to extremes employing regional modeling and statistical interpretation over the Eastern Mediterranean

16:42–16:54; PLINIUS9-A-00003
Ziv, B.; Saaroni, H.; Romem, M.; Heifetz, E.; Harnik, N.; Baharad, A.
Warm and Cold Conveyor Belts: Which Is the Main Rainfall Contributor in the Mediterranean?

16:54–17:06; PLINIUS9-A-00028
Levizzani, V.; Ginnetti, R.; Masotti, M.; Melani, S.; Antonini, A.; Pasqui, M.; Ortolani, A.; Laing, A. G.; Carbone, R. E.
Variability of warm season convective clouds over Europe and the Mediterranean

17:06–17:18; PLINIUS9-A-00059
Morin, E.; Karklinsky, M.; Tamari, H.
Spatial characteristics of radar-derived convective rain cells over dry climate regimes and their hydrological impacts

17:18–17:30; PLINIUS9-A-00054
Loukas, A.; Vasiliades, L.; Jabiras, J.
Climate change impacts on drought severity

17:30 BREAK

PLC2 Storm Processes (2)

Conveners: Tripoli, G.J.; Prodi, F.

Chairperson: SAARONI, H.

17:40–17:52; PLINIUS9-A-00040
De Sanctis, K.; Ferretti, R.; Marzano, F.; Molini, L.; Montopoli, M.; Parodi, A.; Siccardi, F.
High-resolution numerical forecast of an hailstorm event in the Po Valley: sensitivity analysis to microphysical parameterization using COSMO-LAMI and MM5

17:52–18:04; PLINIUS9-A-00009
Gilet, J.-B.; Plu, M.; Joly, A.
The relation between dynamical and humidity synoptic structures: an examination of some Mediterranean extreme weather events

18:04–18:16; PLINIUS9-A-00119
Joly, B.; Nuissier, O.; Ducrocq, V.; Joly, A.
Statistical downscaling of synoptic environments for High Precipitations Events over southern France: an objective method of selection

18:16–18:28; PLINIUS9-A-00035
Wang, D.; Wang, G.; **Anagnostou, E.N.**
Impact of sub-grid variability of precipitation and canopy water storage on hydrological processes in a coupled land-atmosphere model

18:28–18:40; PLINIUS9-A-00123
Conteduca, C.; **Molinié, G.**; Girard, S.; Gardes, L.
Severe storms in a mountainous Mediterranean regions: Uncertainties on extreme rainfall estimations

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18:40 BREAK

PLC5 Nowcasting (2)

Conveners: Michaelides, S.; Price, C.

Chairperson: PRICE, C.

18:50–19:02; PLINIUS9-A-00001
Yair, Y.; Aviv, R.; Ravid, G.; Asfur, M.; Price, C.
Transient synchronization and coupling of lightning activity in severe Mediterranean winter thunderstorms

19:02–19:14; PLINIUS9-A-00160
Hashino, T.
Microphysical effects of Saharan dusts on an orogenic thunderstorm

19:14–19:26; PLINIUS9-A-00013
Michel, Y.; Bouttier, F.
Case studies of 4D-var assimilation of potential vorticity observations derived from image processing

19:26–19:38; PLINIUS9-A-00131
Price, C.; Kohn, M.; Lagouvardos, K.; Kotroni, V.
Nowcasting lightning activity over the Mediterranean Sea

19:38–19:50; PLINIUS9-A-00114
Nicolaides, K.A.; Michaelides, S.C.; Savvidou, K.; Orphanou, A.; Constantinides, P.; Charalambous, M.
Case studies of selected Project "Flash" events

19:50 END OF SESSION

Parallel Session 2

Polvani Meeting Room

PLC13 Societal Impacts & Responses (2)

Conveners: Llasat, M.; Siccardi, F.

Chairperson: SICCARDI, F.

16:30–16:45; PLINIUS9-A-00075
Llasat, M.C.; López, L.; Barnolas, M.; Llasat-Botija, M.
Flash-floods in Catalonia: the social perception in a context of changing vulnerability

16:45–17:00; PLINIUS9-A-00065
Zak, M.; Kveton, V.
Flood in Prague in August 2002 and what has been learned from its impacts

17:00–17:15; PLINIUS9-A-00136
Lomazzi, M.; Bee, M.; Benedetti, R.; Espa, G.; Ghizzoni, T.; Roth, G.; Rudari, R.; Taramasso, A. C.; Terpessi, C.
A conditional probability approach to spatially distributed flood scenarios simulation

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PLC7 Rainfall Downscaling (2)

Conveners: Deidda, R.; Foufoula-Georgiou, E.

Chairperson: FOUFOULA-GEORGIOU, E.

17:15–17:30; PLINIUS9-A-00021
Brussolo, E.; Ferraris, L.; von Hardenberg, J.; Provenzale, A.; Rebora, N.
Rainfall downscaling, LAM predictions and rain gauge data

17:30–17:45; PLINIUS9-A-00141
Tomassetti, B.; Verdecchia, M.
A Neural Network approach for the downscaling of precipitation fields

17:45–18:00; PLINIUS9-A-00066
Mascaro, G.; Deidda, R.; Vivoni, E.R.
Use of Rank Histogram to verify consistency of ensemble precipitation fields simulated by downscaling models

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18:00 BREAK

PLC11 Prediction & Effects of Rainfall-Induced Landslides (2)

Convener: Guzzetti, F.

Chairperson: GUZZETTI, F.

18:15–18:30; PLINIUS9-A-00071
Martina, M.L.V; Pignone, S.; Ferroni, E.; Todini, E.
A Bayesian approach to determine the rainfall thresholds for shallow landslides triggering

18:30–18:45; PLINIUS9-A-00014
Rossi, M.; Peruccacci, S.; Witt, A.; Guzzetti, F.; Malamud, B.D.
Correlations between rainfall and landslides in 3 Provinces of the Emilia-Romagna Region, northern Italy

18:45–19:00; PLINIUS9-A-00100
Perekhodtseva, E.V.
Hydrodynamic-statistical method of forecast of dangerous precipitation and incurred floods and landslides over the Central and East Europe

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PLC12 Sea Waves & Coastal Hazards (1)

Conveners: Cavaleri, L.; Wolf, J.

Chairperson: WOLF, J.

19:00–19:15; PLINIUS9-A-00076
Sanchez-Arcilla, A.; Bolaños, R.; Gonzalez-Marco, D.; Gomez, J.
Wave climate and prediction of the Spanish Mediterranean coast

19:15–19:30; PLINIUS9-A-00120
Lionello, P.; Galati, M.B.
Changes of wave climate inferred from scenario simulations

19:30 END OF SESSION

Poster Session 2

Display Time: Tuesday, 09:00–19:50

Poster Area

Chairperson: GUZZETTI, F.

P0009; PLINIUS9-A-00116
Milelli, M.; Sanna, A.; Cane, D.; Oberto, E.; Turco, M.
Pseudo-observations assimilation in numerical weather forecasting

P0001; PLINIUS9-A-00015
Rossi, M.; Peruccacci, S.; Guzzetti, F.; Stark, C.P.
New global rainfall intensity - rainfall duration thresholds for the initiation of shallow landslides and debris flows

P0002; PLINIUS9-A-00016
Peruccacci, S.; **Rossi, M.**; Balducci, V.; Guzzetti, F.
A catalogue and web site of rainfall thresholds for the initiation of precipitation-induced landslides

P0003; PLINIUS9-A-00037
Tiranti, D.; **Rabuffetti, D.**
The empirical model SMART - Shallow landslides movements announced trough rainfall thresholds

P0004; PLINIUS9-A-00117
Munachen, S.E.
The effects of rainfall-induced seepage on slope stability

P0005; PLINIUS9-A-00113
Munachen, S.E.
Landslide monitoring using reactive sensor networks with high-speed local positioning

P0006; PLINIUS9-A-00063
Ogorodnikov, V.; **Ukhinova, O.**; Makarova, S.
Stochastic models of time series and fields of daily precipitation sums

P0007; PLINIUS9-A-00024
Greco, M.; Martino, G.; Squicciarino, G.
A methodology for the vegetational stress assessment in mediterranean areas

P0008; PLINIUS9-A-00018
Miglietta, M.M.; Regano, A.; Moscatello, A.
An observational and numerical analysis of a heavy rain event over south-eastern Italy

P0010; PLINIUS9-A-00091
Drofa, O.; Malguzzi, P.; Buzzi, A.
Verification of Numerical Weather Prediction limited area models by remote sensing observations

P0011; PLINIUS9-A-00095
Horvath, K.; Lin, Y.-L.; Ivanèan-Picek, B.
A Numerical Study of an in-situ Adriatic Mesocyclone: Formation and Development

P0012; PLINIUS9-A-00144
Katsanos, D.; Kotroni, V.; Lagouvardos, K.
Relationship between cloud-to-ground lightning activity and cloud ice distribution profiles produced by MM5 model over the eastern Mediterranean

P0013; PLINIUS9-A-00145
Koletsis, I.; Lagouvardos, K.; Kotroni, V.; Bartzokas, A.
Study cases of downslope windstorms in Northwestern Greece

P0014; PLINIUS9-A-00147
Mazarakis, N.; Kotroni, V.; Lagouvardos, K.; Argiriou, A.
Evaluation of convective precipitation schemes during the warm season of the year 2006–2007 over Greece

PROGRAMME

WEDNESDAY – 12 September 2007

Fermi Conference Room

PLC9 Hydrological Processes (1)

Conveners: Roth, G.; Claps, P.

Chairperson: ROTH, G.

9:00–9:30; PLINIUS9-A-00146
Foufoula-Georgiou, E.
Landscape organization and bio-physical transport (invited)

9:30–9:45; PLINIUS9-A-00038
Di Domenico, A.; Laguardia, G.; Fiorentino, M.
Exploiting the scale invariance feature of the critical behaviour of soil moisture dynamics

9:45–10:00; PLINIUS9-A-00056
Braud, I.; Manus, C.; Viallet, P.; **Anquetin, S.**
Hydrological response with respect to soil characteristics in a context of Mediterranean extreme events

10:00–10:15; PLINIUS9-A-00070
Martina, M.L.V; Todini, E.; Liu, Z.
On the preservation of the physical representation of the hydrological processes in omdel lumping

10:15–10:30; PLINIUS9-A-00135
Di Baldassarre, G.; Laio, F.; Montanari, A.
Model selection techniques for flood frequency analysis

10:30–10:45; PLINIUS9-A-00045
Borga, M.; Norbiato, D.; Sangati, M.; Zanon, F.
Flash floods: innovative observation concepts for hydrometeorological process understanding and risk mitigation

10:45 COFFEE BREAK

PLC8 Soil-Vegetation-Atmosphere Interactions (1)

Conveners: Boni, G.; Fiorentino, M.

Chairperson: BONI, G.

11:15–11:45; PLINIUS9-A-00134
Entekhabi, D.
Role of evaporation pathways in surface energy balance and atmospheric boundary layer diurnal cycles (invited)

11:45–12:00; PLINIUS9-A-00084
Kunstmann, H.; Heckl, A.; Suppan, P.; Rimmer, A.
Joint high resolution climate - hydrology simulations for the Upper Jordan Catchment

12:00–12:15; PLINIUS9-A-00049
von Hardenberg, J.; Kletter, A.; Meron, E.; Provenzale, A.
Rainfall intermittency and vegetation patterns

12:15–12:30; PLINIUS9-A-00085
Serio, C.; Grieco, G.; Masiello, G.
Surface emissivity characterization from modern hyperspectral infrared sensors

PLC10 Operational Hydrological Forecasting (1)

Convener: Ferraris, L.

Chairperson: FERRARIS, L.

12:30–12:45; PLINIUS9-A-00094
Castelli, F.; Caparrini, F.; Manzella, F.
The MOBIDIC model in the hydrological forecast system of Tuscany Region

12:45–13:00; PLINIUS9-A-00105
Gabellani, S.; Ferraris, L.; Rudari, R.; Silvestro, F.; Ratto, S.; Collé, F.; Stevenin, H.
An ad-hoc hydrological model for operative warning system in Valle d'Aosta Region

13:00–13:15; PLINIUS9-A-00034
Moulin, L.; Gaume, E.; Bernardara, P.; Obled, C.
Are the uncertainties on mean areal precipitation decisive for flood hydrograph simulations with lumped rainfall-runoff models?

13:15–13:30
De Bernardinis, B.
The Hydro-geological Civil Protection System in Italy (invited)

13:30 LUNCH BREAK

PLC12 Sea Waves & Coastal Hazards (2)

Conveners: Cavaleri, L.; Wolf, J.

Chairperson: CAVALERI, L.

14:30–14:50; PLINIUS9-A-00077
Cavaleri, L.
Large or freak waves?

14:50–15:10; PLINIUS9-A-00072
Wolf, J.
Coupled wave and surge modelling and implications for coastal flooding

15:10–15:30; PLINIUS9-A-00074
van Vledder, G.
Wind wave modelling in a tidal inlet (solicited)

15:30 COFFEE BREAK

Parallel Session 3

Fermi Conference Room

PLC4 Remote Sensing (2)

Conveners: Smith, E.A.; Testud, J.

Chairperson: SMITH, E.A.

16:00–16:12; PLINIUS9-A-00026
Torricella, F.; Cattani, E.; Levizzani, V.
Rain areas delineation by means of SEVIRI: Eploitation of the multispectral cloud characterization in a blended MW-IR precipitation technique

16:12–16:24; PLINIUS9-A-00055
Pineda, N.; **Rigo, T.**; Bech, J.; Trapero, L.
Life cycle study of convective structures using an object oriented methodology for total lightning and radar data

16:24–16:36; PLINIUS9-A-00068
Bechini, R.; Cremonini, R.; Campana, V.; Gorgucci, E.; Baldini, L.; Chandrasekar, V.
A new transportable polarimetric X-band radar for accurate rainfall measurement in Alpine basins

16:36–16:48; PLINIUS9-A-00042
Molini, L.; De Sanctis, K.; Ferretti, R.; Marzano, F.; Montopoli, M.; Parodi, A.; Siccardi, F.
Characterization of rainfall C-band radar response and dual-polarized measurement for an hailstorm event

16:48–17:00; PLINIUS9-A-00169
Marzano, F.S.; Scaranari, D.; Vulpiani, G.; Montopoli, M.; Celano, M.; Alberoni, P.P.
Supervised classification and estimation of hydrometeors from dual-polarized C-band weather radar

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17:00 BREAK

PLC3 Mesoscale Modeling (2)

Conveners: Kotroni, V.; Buzzi, A.

Chairperson: BUZZI, A.

17:10–17:22; PLINIUS9-A-00036
Papadopoulos, A.; Serpetzoglou, E.; Anagnostou, E.N.
The Influence of Assimilating Land Surface Parameters on the Simulation Performance of Warm Season Convective Systems

17:22–17:34; PLINIUS9-A-00079
Davolio, S.; Miglietta, M.M.; Moscatello, A.; Pacifico, F.; Rotunno, R.
A tropical-like cyclone over southern Italy: observational and numerical analysis

17:34–17:46; PLINIUS9-A-00081
Buzzi, A.; Davolio, S.; Malguzzi, P.
Numerical study of orographic influence on convection initiation

17:46–18:58; PLINIUS9-A-00110
Lambert, D.; Argence, S.
Intense rainfall episode in Corsica: sensitivity study using a mesoscale model

17:58–18:10; PLINIUS9-A-00112
Argence, S.; Lambert, D.; Richard, E.; Chaboureau, J.-P.; Söhne, N.
Impact of initial condition uncertainties on the predictability of heavy rainfall in the Mediterranean: a case study

18:10–18:22; PLINIUS9-A-00126
Federico, S.; Avolio, E.; Bellecci, C.; Lavagnini, A.; Walko, R.L.
Sensitivity of a Central Mediterranan moderate storm to the upper-level forcing: a LEPS appoach

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18:22 BREAK

PLC1 Climate Change & Extreme Events (3)

Conveners: Alpert, P.; Levizzani, V.

Chairperson: BARTZOKAS, A.

18:30–18:42; PLINIUS9-A-00043
Houssos, E.E.; Lolis, C.J.; Bartzokas, A.
Atmospheric circulation patterns associated with extreme precipitation amounts in Greece

18:42–18:54; PLINIUS9-A-00106
Durao, R.; Costa, A.; Pereira, M.; Soares, A.
Indices of precipitation extremes in Southern Portugal – a geostatistical approach

18:54–19:06; PLINIUS9-A-00111
Costa, A.C.; Durão, R.; Pereira, M.J.; Soares, A.
Geostatistical Stochastic Mapping of Extreme Precipitation in Southern Portugal

19:06–19:18; PLINIUS9-A-00125
de Lima, M.I.P.; de Lima, J.L.M.P.; Coelho, M.F.E.S.
Trends in extreme precipitation events in Portugal

19:18–19:30; PLINIUS9-A-00127
La Rocca, T.
Some considerations concernig most likely circulation types over Mediterranean in the future

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19:30 END OF SESSION

Parallel Session 4

Polvani Meeting Room

PLC9 Hydrological Processes (2)

Conveners: Roth, G.; Claps, P.

Chairperson: CLAPS, P.

16:00–16:12; PLINIUS9-A-00006
Vincendon, B.; Bouilloud, L.; Chancibault, K.; Saulnier, G.M.; Ducrocq, V.; Habets, F.; Martin, E.; Noilhan, J.
Flash flood forecasting with the SURFEX/TOPMODEL coupled system

16:12–16:24; PLINIUS9-A-00073
Delogu, F.; Gabellani, S.; Rudari, R.; Boni, G.
A Continuous hydrological model for operational flood forecast exploiting satellite observations

16:24–16:36; PLINIUS9-A-00090
Vasiliades, L.; Loukas, A.
Evaluation of drought forecasting models in Pinios river basin, Greece

16:36–16:48; PLINIUS9-A-00122
Horta, A.; Durão, R.; Pereira, M.; Soares, A.
Characterization of Main Spatial Patterns of Biophysical Factors of Desertification

16:48–17:00; PLINIUS9-A-00098
Lastoria, B.; Miserocchi, F.; Lanciani, A.; Monacelli, G.
An estimated erosion map for the Aterno-Pescara river basin

17:00 BREAK

PLC8 Soil-Vegetation-Atmosphere Interactions (2)

Conveners: Boni, G.; Fiorentino, M.

Chairperson: FIORENTINO, M.

17:10–17:22; PLINIUS9-A-00083
Manfreda, S.; Fiorentino, M.
A Stochastic Approach for the Description of the Water Balance Dynamics in a River Basin

17:22–17:34; PLINIUS9-A-00008
Baudena, M.; D'Andrea, F.; Provenzale, A.
Soil-vegetation-atmosphere interactions and midlatitude summer droughts

17:34–17:46; PLINIUS9-A-00032
Cervarolo, G.; Mendicino, G.; **Senatore, A.**
A coupled SVAT-3D unsaturated flow model for the assessment of soil-vegetation-atmosphere exchanges

17:46–17:58; PLINIUS9-A-00102
Caparrini, F.; Manzella, F.
Hydrometeorological and vegetation indices for the Drought monitoring system in Tuscany Region, Italy

17:58–18:10; PLINIUS9-A-00142
Gigante, V.; Milella, P.; Iacobellis, V.; Manfreda, S.; Portoghese, I.
Influences of Leaf Area Index estimations on the soil water balance predictions in Mediterranean regions

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18:10 BREAK

PLC10 Operational Hydrological Forecasting (2)

Convener: Ferraris, L.

Chairperson: FERRARIS, L.

18:20–18:32; PLINIUS9-A-00053
Rabuffetti, D.; Ravazzani, G.; Barbero, S.; Mancini, M.
Operational flood-forecasting in the Piemonte region: development and verification of a fully distributed phisically-oriented hydrological model

18:32–18:44; PLINIUS9-A-00031
Thielen, J.; **Anquetin, S.**; Younis, J.
Exploring High-Resolution operational weather Forecasts for Flash-Flood Prediction

18:44–18:56; PLINIUS9-A-00039
Gabellani, S.; Giordano, V.; **Sini, F.**; Ferraris, L.; Ferretti, M.
Parsimonious distributed model applied to the Aspio urbanized small catchment

18:56–19:08; PLINIUS9-A-00067
Mediero, L.; Garrote, L.; Llasat, M.C.
Calibration of a distributed rainfall-runoff model for the validation of rainfall forecasts based on lightning data

19:08–19:20; PLINIUS9-A-00033
Giudici, I.; Ravazzani, G.; Mancini, M.; Amadio, P.
Effects of soil moisture parameterization on a real- time flood forecasting system based on rainfall thresholds

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19:20 END OF SESSION

Poster Session 3

Display Time: Wednesday, 09:00–19:20

Poster Area

Chairperson: ROTH, G.

P0001; PLINIUS9-A-00104
Anagnostou, M.; Kalogiros, J.; Anagnostou, E.
Evaluation of quantitative rainfall estimation by X-band dual-polarization radar observations
P0002; PLINIUS9-A-00004
Bechini, R.; Zanon, F.; Borga, M.; Campana, V.; Cremonini, R.
Using C-band radar differential phase measurements for extreme rainfall estimation: comparison with estimates based on horizontal reflectivity
P0003; PLINIUS9-A-00044
Molini, L.; Parodi, A.; Siccardi, F.
Severe precipitation processes in complex orography:meteorological modelling and comparison of observed and simulated radar data
P0004; PLINIUS9-A-00096
Alfieri, L.; Claps, P.; Laio, F.
Continuous-time calibration of the Z-R relationship for estimating rainfall fields from radar measurements
P0005; PLINIUS9-A-00133
Sanò, P.; Casella, D.; Formanton, M.; Mugnai, A.; Smith, E.; Tripoli, G.; Yang, S.
Bayesian estimation of precipitating cloud parameters: Application to case studies of FLASH and RISKMED projects
P0006; PLINIUS9-A-00138
Casella, D.; Mugnai, A.; Sanò, P.; Formenton, M.
Microwave single-scattering quantities of randomly oriented soft ice hydrometeors
P0007; PLINIUS9-A-00115
Napolitano, F.; Duni, L.; Miserocchi, F.
A fractional infiltration model for the simulation of the wetting front in non-saturated soils
P0008; PLINIUS9-A-00124
Grankina, T.
Numerical modeling of the ice-snow cover forming process in water body of different mineralization
P0009; PLINIUS9-A-00107
Carriero, D.; Fiorentino, M.; Romano, N.
Spatial distribution of soil moisture at different soil depth
P0010; PLINIUS9-A-00108
Carriero, D.; Fiorentino, M.
Snowmelt simulation in the experimental basin of "Fiumarella of Corleto" (Southern Italy)
P0011; PLINIUS9-A-00092
Di Rosario, R.; Guida, D.; **Longobardi, A.**; Siervo, V.; Villani, P.
Water resources and sediment prediction in poorly monitored basins: the Mingardo river basin case study
P0012; PLINIUS9-A-00129
Calvo, B.; Savi, F.
Conceptual model for real time flood forecasting of Tiber river in Rome
P0013; PLINIUS9-A-00093
Lombardo, F.; Montesarchio, V.; Napolitano, F.
Rainfall thresholds and flood warning: an operative methodology
P0014; PLINIUS9-A-00170
Wang, X.; Li, X.; Berndtsson, R.; Pan, Y.
Evolution characteristics of the restoration desert ecosystem and its influence on water cycling in the Tengger Desert, Northern China

PROGRAMME

THURSDAY – 13 September 2007

09:00–13:30

Boat tour of Como Lake

13:30 LUNCH BREAK

14:30–19:00

MEDEX Meeting (Fermi Conference Room)

RISKMED Meeting (Polvani Meeting Room)

ABSTRACTS

MONDAY

Tails of natural hazards: Implications for ecology, erosion, and risk

Bruce D. Malamud

Hazards, Vulnerability, and Risk Research Unit; Department of Geography; King's College London, UK (bruce.malamud@kcl.ac.uk)

There is increasing evidence that the extremes of many natural hazards satisfy power-law or other heavy-tailed frequency-size statistics. Examples include earthquakes, volcanic eruptions, landslides, snow avalanches, forest and wildfires, meteorite impacts, and possibly floods. Although power-law distributions are commonly associated with the frequency-size distribution of small to large earthquakes, the frequency-size statistics of many other natural hazards are frequently associated with distributions that are more thin-tailed. The occurrence for large and very-large events using power-law frequency-size distributions is often much more conservative, with a greater chance of a large event occurring in a given period of time, compared to thinner tail distributions. The choice of the statistical distribution used or assumed has many implications to Earth Sciences research. In this paper we will present the frequency-size distributions for wildfires and landslides, both found to be robustly power-law for the medium and large events, and the implications of these statistics to erosion, ecology, and risk.

From climate to weather: Mediterranean storms as seen from satellite-based climatology and mesoscale simulations

J.-P. Chaboureau (1), C. Claud (2), B. Funatsu (2), N. Söhne (1), S. Argence (1), D. Lambert (1), and E. Richard (1)

(1) Laboratoire d'Aerologie, University of Toulouse, France, (2) Laboratoire de Meteorologie Dynamique/IPSL, Palaiseau, France

Mediterranean storms are mesoscale cyclones that can evolve to high-impact weathers events such as heavy precipitation and flash flooding. They result from the interaction of different processes at spatial scales ranging from the large-scale to the mesoscale. Two main ingredients favour the enhancement of precipitation: a warm sea surface temperature (in late summer and autumn) and the presence of an upper-level trough. The former provides strong heat flux that feed the storm while the latter acts to destabilize the atmosphere. Climatology of Mediterranean cyclones built from satellite observations affords us information on cloud and precipitation fields of the storms and their environment. Based on a long series of NOAA/TOVS observations, a cloud system typology has revealed the frequent occurrence of an upper-level anomaly during cold season. Cloud systems are also more frequent during negative North Atlantic Oscillation phase when the north Atlantic storm track takes its southernmost position. When focusing on severe precipitation events over the Alpine region, the rain events are found preferentially in summer and autumn and are more intense downstream an upper level trough. Such upper-level forcing is also crucial on the quantitative precipitation forecast as shown from a set of mesoscale simulations verified against satellite observations. This stresses the importance of scale interactions for intense Mediterranean storms and their predictability.

The Role of East-Mediterranean Synoptic Systems in Controlling the Rainfall in Israel

H. Saaroni (1), N. Halfon (2), B. Ziv (3), P. Alpert (4), H. Kutiel (2)

(1) Department of Geography and the Human Environment, Tel Aviv University, Israel (2) Department of Geography and Environmental Studies, University of Haifa, Israel (3) Department of Natural Sciences, The Open University of Israel (4) Department of Geophysics and Planetary Sciences, Tel Aviv University, Israel (saaroni@post.tau.ac.il/Fax: +972-3-6406243)

The inter-annual variations and the spatial distribution of the rainfall in Israel are analyzed with respect to the variations in the occurrence of the synoptic types of the Eastern Mediterranean. The synoptic analysis is based on the daily, semi-objective synoptic classification (Alpert et al., 2004). The study covers the months November-March, in which 90% of the annual rainfall, mostly resulting from Cyprus Lows, is obtained. The study area covers the northern half of the country, having Mediterranean and semi-arid climate (Cs and BS, according to Köppen classification), down to the 300 mm isohyet and excludes the arid southern half. It was found that the inter-annual variation of the rainfall is highly correlated with the number of days in which Cyprus Low prevails. The correlation varies around +0.7 and decreases toward the south, dropping to +0.55 in the semi-arid part. Similar analysis, including only the deep lows, shows the same spatial trend, but the north - south gradient is considerably sharper. The location of the cyclone relative to Israel and its depth determine the spatial distribution of the rain it produces. The cyclones located east of the country were found productive mainly in the south part of the study region, while those located to the west and north of Israel - to the northern part of the country. This is explained by the differences in the moisture transport. A deep low was found to produce considerably more daily rainfall, especially in the mountain regions. The latter may be explained by the stronger winds it causes, which enhance the orographic effect. In spite of the drying trend that

has been observed in the central and western Mediterranean, no significant trend was found in the annual rainfall in Israel. This can be explained by the absence of a significant trend in the occurrence of Cyprus Lows.

Heavy Precipitating Events (HPEs) over Southern France in a climate change scenario: a dynamical downscaling approach.

O. Nuissier, B. Joly, S. Somot, V. Ducrocq and A. Joly

National Center for Meteorological Research (CNRM), Meteo-France, Toulouse, France. (olivier.nuissier@meteo.fr / Fax: (33)561-079-626)

Climate simulations have been performed at CNRM / Météo-France, with the Atmospheric Oceanic Regional Climate Model (AORCM) with the GICC A2 scenario, in the CYPRIM framework. The theme 3 of CYPRIM aims at assessing the frequency evolution of the synoptic environments associated with Heavy Precipitating Events (HPEs) over Southern France in a future climate scenario. A methodology of selection (already described in a companion contribution for the Plinius conference) has permitted to finger out in the climate simulations outputs statistical classes of synoptic patterns propitious to heavy precipitation, similar than those identified in the ERA40 reanalysis. The results show weak inner-core variations for the both classes representative of the main part of HPEs, between the present and future climate. However, one of these two classes ("cut-off" patterns) seems to include much more HPEs in the future climate scenario, at the other classes' expense. Furthermore, the first preliminary tests have shown the capability of initializing the Meso-NH non-hydrostatic mesoscale numerical model from the AORCM outputs, and obtaining realistic finer-scale features of HPEs over Southern France. Although at this time this study cannot conclude on the possible changes in structure and rainfall distribution of these events, a future work would be to apply dynamical downscaling to a few cases of HPEs in the future climate scenario and draw the possible evolution of the phenomana in term of fine-scale rainfall structure and even hydrological consequences.

A comparison between Mediterranean cyclone climatologies

A. Genovés, J. Campins, M.A. Picornell, and A. Jansà

CMT en Illes Balears, INM, Spain (genoves@inm.es)

The climatological knowledge concerning weather systems, in particular cyclones, are nowadays important both in a climatic change and a short range weather forecast frameworks of research. The detection and tracking procedures developed for those purposes are usually automatic and applied on objective analyses or on model outputs. In such a way, the deficiences or limitations of the numerical models for describing the cyclones directly influence the conclusions obtained from the results of the climatology. In this paper, the differences between two climatologies on Mediterranean cyclones, developed in the framework of MEDEX and obtained both from the ECMWF ERA-40 re-analysis and the operational ECMWF analysis system, are studied for the common period 1998-2002.

A joint analysis of cyclone and precipitation trends in the Mediterranean region

P.Lionello (1)

(1) Univ. of Salento

This study analyses in parallel the precipitation and cyclone activity in the Mediterranean region during the second half of the 20th century. Reanalysis data show a weak but statistically significant reduction of monthly synoptic activity in the Mediterranean region, more pronounced in winter and autumn, then in the remaining season. For the same period precipitation climatology and station time series show a large reduction of monthly precipitation in winter and very little change in summer, except for a reduction in the western Mediterranean areas. This study shows that, though, in general, the pattern of change is less strong and has finer structure and higher spatial variability in winter precipitation than in synoptic activity, the changes in the two fields are consistent. In fact, changes of synoptic activity in the North-Eastern Atlantic affect precipitation in the western Mediterranean regions and changes inside the Mediterranean region itself and over Europe affect precipitation in the eastern Mediterranean. Details of the trends and links between precipitation and cyclone activity are discussed (also in comparison with previous studies) and regional features are highlighted. The analysis is extended also to extreme precipitation events and to the weather systems associated with their occurrence.

Moist convection and mesoscale predictability

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Soon after the beginning of numerical weather prediction, the following question presented itself: "What degree of improvement in the prediction can be expected from a given improvement of the initial condition?" If only small improvements were to be obtained for a much more accurate initial condition, then there would be an effective limit on the ability to predict the weather (i.e. a limit on predictability). A consensus has formed behind the idea of Lorenz that predictability is limited for flows with many scales of motion in which errors in small scales grow faster than and spread to errors in larger scales. This idea is supported by numerical experiments using turbulence models under varying degrees of idealization and approximation. However, as complicated as the latter models are, they are considerably simpler than numerical weather prediction models as they do not take into account moist convection, cloud microphysics, complex orography and physiography, etc. In this talk, results will be presented from recent studies examining error growth in relatively high-resolution numerical weather prediction models initialized with idealized (but meteorologically relevant) initial conditions. These studies indicate the critical importance of moist convection in the initial rapid error growth at small scales which, consistent with the Lorenz idea, eventually transition to more slowly growing larger-scale errors in the forecast. Although the latter supports the

idea of a predictability limit, there remains the very practical question of whether error transfers slowly enough from convective scales to the mesoscale for the latter to retain useable information in short-term ($\sim$1 day) forecasts. Results will be presented from real-time high-resolution numerical weather forecasts in convective-weather situations showing that skill in predicting the mesoscale can translate into skill of forecasting aspects of convective weather such as its structure (e.g. squall lines, supercells, etc.), and areal coverage (if not the exact placement and timing of convective cells).

Atmospheric patterns for Mediterranean heavy rain

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The Mediterranean heavy rain events are probable related to mesoscale structures, but these mesoscale structures are framed in some kinds of larger scale atmospheric patterns. In order to explore in a systematic way the kind of large scale atmospheric patterns that are associated with heavy rain, a global classification of the atmospheric situations simultaneous and preliminary to 472 heavy rain events in the Mediterranean zones of Spain and France has been undertaken, by using statistical methods. The result is a series of eight atmospheric patterns, every one of them associated with heavy rain in different regions of the whole area. Although in some of these patterns a clear cyclonic structure is identified, the cyclonic structure is, perhaps, only an embedded weak depression or through, not very clear in the average charts. In both cases, the heavy rain would generally be organised by a warm (and wet) cyclonic low layer inflow. A few particular examples of different kind of situations help to clarify the panorama given for the average atmospheric patterns.

Conceptual frameworks for understanding Mediterranean cyclones

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What do we learn by following the research literature and investigating case studies of weather systems from other parts of the world? The tropical cyclone forecast community carries a conceptual framework for families of cyclones. The major demarcation is between baroclinic cyclones, whose characteristics include an upper level cold core and an association with a jet stream (either polar or frontal). Tropical cyclones in contrast are characterised by a vertically stacked structure, restriction to the troposphere, a first tropospheric internal mode vertical structure consistent with forcing by cumulonimbus heating, and a warm core in the upper troposphere. This framework serves forecasters well, as it allows interpretation of transitions from tropical to baroclinic (or extratropical structure) and even allows hybrid systems which are usually referred to as extratropical lows. In midlatitude Southern Hemisphere forecasting, the common framework is of two families of baroclinic systems. The first of these are the baroclinic systems associated with the polar front or polar jet stream. These are the constituents of the major Southern Hemisphere circumpolar storm track and have a structure and lifecycle consistent with classical baroclinic instability studies. The second class of system is the cutoff low, which is essentially always associated with the subtropical jet stream (and so has no initial baroclinicty at low levels) and is the system causing most major widespread heavy rainfall events affecting the three Southern hemisphere continents. Severe storm events including heavy rainfall and severe convective and wind are almost always associated with the interactions between this second family and orographic and coastal features. Moving to a different part of the world (the Mediterranean), the research and forecast communities base their work on different conceptual frameworks, including the Mediterranean lower tropospheric storm-track, potential vorticity streamers and the Browning slopwise convection model. In the oral presentation, case studies will be used from these three worlds (Southern Hemisphere forecasting, tropical cyclones forecasting, Mediterranean research literature) to illustrate how the same underlying physics is present in all sets of conceptual framework. The purpose is to find commonality and a conceptual framework that aids understanding of the dynamics of all extratropical weather systems.

New A-Train Satellite Observations of Mediterranean Storms

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On April 28, 2006 a millimeter radar system, designed expressly for vertically profiling of hydrometeors, was launched from Vandenburg Air Force Base. Both Cloudsat, carrying the Cloud Profiling Radar (CPR), and the lidar satellite CALIPSO, were inserted into nearly identical orbits each approximately 1 minute behind the NASA Earth Observing System (EOS) Aqua satellite and in formation with the French PARASOL satellite and the EOS Aura satellite.This created the A-Train satellite constellation. This talk will review several new findings from analysis of CloudSat data after more than a year of operation. The performance of the radar, comparison to other A-Train observations and the value of synergy of the different observations available for studying clouds and precipitation will be underscored in the talk which will focus primarily on the nature of storms observed over the Mediterranean region. New insights on the structure of these storms will be revealed and these results will be contrasted against weather forecast results.

Contrasts between precipitation over Mediterranean Sea and adjacent continental areas based on decadal scale satellite estimates

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Most knowledge concerning the last century's climatology and climate dynamics of precipitation over the Mediterranean Sea basin is based on observations taken from rain gauges surrounding the sea itself. In turn, most of the observations come from Southern Europe, with many fewer measurements taken from widely scattered sites situated over North Africa, the Middle East, and the Balkans. This aspect of research on the Mediterranean Sea basin is apparent in a recent compilation of studies presented in book form concerning climate variability of the Mediterranean region [Lionello, P., P. Malanotte-Rizzoli, and R. Boscolo (eds.), 2006: *Mediterranean Climate Variability*. Elsevier, Amsterdam, 9 chapters.] In light of this missing link to over-water observations, this study (in conjunction with four companion studies by Z. Haddad, A. Mugnai, A. Mehta, and G. Stephens) will contrast the nature of precipitation variability directly over the Mediterranean Sea to precipitation variability over the surrounding land areas based on three decades of satellite-based precipitation estimates which have stood up well to validation scrutiny. The satellite observations are drawn from the Global Precipitation Climatology Project (GPCP) dataset extending back to 1979 and the TRMM Merged Algorithm 3b42 dataset extending back to 1998. Both datasets are mostly produced from microwave measurements, excepting the period from 1979 to mid-1987 when only infrared satellite measurements were available for the GPCP estimates. The purpose of this study is to emphasize how the salient properties of precipitation variability over land and sea across a hierarchy of space and time scales, and the salient differences in these properties, might be used in guiding short-term climate models to better predictions of future climate states under different regional temperature-change scenarios.

Vertical structure contrasts between precipitation and latent heating over southeastern Mediterranean Sea and surrounding continental areas

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The TRMM Precipitation Radar (PR) observes the southeastern Mediterranean basin over which there is active precipitation activity during the Autumn-Winter wet season. Because there has been little emphasis on understanding precipitation structures directly over the Mediterranean Sea itself (virtually all studies have focused on land-based radar and rain gauge datasets), this talk will focus on contrasting the vertical structures of precipitation, found within storm episodes, between land and sea environments. We also compare the passive microwave signatures of precipitation systems and their correlations with the vertical radar observations over the Mediterranean with those of systems over 4 other mid-latitude regions: the Atlantic coast of the Maghreb, the Eastern Seaboard of the South-Eastern United States, frontal and pineapple-express systems off Southern California, and the Yellow Sea between China and Japan.

Propagation of precipitation over southeastern Mediterranean basin produced by mesoscale storms based on TRMM PR measurements

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The TRMM Precipitation Radar (PR) provides an excellent view of the southeastern Mediterranean basin over which there is a good deal of mesoscale storm activity during the Autumn-Winter wet season. The focus of this talk is describing the propagation properties of mesoscale precipitation features over the southeastern Mediterranean basin with an emphasis on highlighting the contrast(s) between continental and maritime propagation processes. Once mesoscale storms develop in the Mediterranean basin, they move under the influence of various external forces that lead to propagation, generally, but not always, eastward – and with differing advection and/or propagation controls depending on whether they develop within continental areas or maritime areas. This study examines these differences using the TRMM PR precipitation retrievals, with the eventual goal of explaining the difference in propagation properties through CRM modeling.

Investigating contrasts between continental and maritime precipitation over Mediterranean basin based on CDRD Algorithm methodology

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Almost all published research concerning the climatological properties of precipitation over the Mediterranean basin has been based on use of rain gauge and radar data taken

from continental sites surrounding the Mediterranean Sea, and then used to represent precipitation processes over the entire basin. Observations obtained from satellite taken directly over the Mediterranean Sea have not yet seriously impacted the climatological literature [see Lionello, P., P. Malanotte-Rizzoli, and R. Boscolo (eds.), 2006: *Mediterranean Climate Variability*. Elsevier, Amsterdam, 9 chapters.]. This talk addresses retrieval of precipitation over the entire Mediterranean basin – continent and sea – based on use of passive microwave satellite observations used within a physically-based Bayesian algorithm in which a cloud resolving model (CRM) run over a regional domain (i.e. the Mediterranean basin) is used to provide microphysical, hydrometeorological, thermodynamical, and dynamical information to the Bayesian database underpinning the algorithm. The methodology is referred to as the Cloud-Dynamics-Radiation-Database (CDRD) technique – highlighting an improvement to our previous methodology which we referred to as the Cloud-Radiation-Database (CRD) technique because we had not yet incorporated information from the full range of variable provided by the CRM into the Bayesian database. This presentation briefly reviews the main design features of the CDRD algorithm, and then proceeds to describe some of the similarities and contrasts between precipitation processes over land and sea environments. The implications of these differences are then examined in light of developing a representative precipitation climatology over the entire Mediterranean basin.

Multimodel Ensemble for Operational Short-Range Forecast

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The forecast of severe mesoscale events has a growing interest for the general public. Mesoscale models have already several problems to deal with such events because their predictability is very low even in the short-range. In such environment, probabilistic forecast can help to address the issue. Multi-model ensemble prediction systems are showing to be very useful to add some probabilistic value to the mesoscale deterministic models. A multi-model ensemble prediction system focused on weather forecast up to 72 hours has been developed at the Spanish Weather Service (INM). The presentation will show the current status of the system and results of the operational verification from April to June 2006 using ECMWF analysis, synoptic observations and precipitation from the climate networks of Spain, France, Germany, UK and Northern Italy. These results show very good scores even for large precipitation thresholds.

Sensitivity areas of Mediterranean cyclones derived from the MM5 adjoint model: Application to mesoscale ensemble forecasts

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Many of the cyclones developed over the western Mediterranean region are associated with high impact weather phenomena that affect the society of its coastal countries. In order to improve the short and mid-range numerical forecasts of this kind of events, ensemble prediction systems based on perturbed initial and boundary conditions are being tested in the context of the Spanish project PRECIOSO. In this study, a Potential Vorticity (PV) Inversion Technique operating on the MM5 mesoscale model fields is applied to generate the ensemble members. The simulations are performed for a two-day period with a 22.5 km resolution domain (Domain 1 in http://mm5forecasts.uib.es) nested in the ECMWF large-scale forecast fields. The method uses the PV sensitivity areas calculated by the MM5 adjoint model under a response function given by the low-level vorticity predicted over the western Mediterranean region. Perturbations of the PV field are introduced in these areas closely following the spatial and intensity pattern of the sensitivity field. The difference between the inverted mass-wind fields from perturbed and unperturbed PV distributions define the modifications introduced in the MM5 initial and boundary conditions. A PV error climatology (PVEC) was found in an earlier work in order to introduce perturbations of realistic magnitude in the ensemble prediction system. Preliminary results showing the potential of this methodology will be presented for selected MEDEX cyclones, with special attention to forecast precipitation and sea level pressure fields. It seems that perturbing according to PV sensitivity patterns instead of randomly, produces higher spread and more realistic results.

Extratropical cyclone tracks forecast from the INM-SREPS

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In previous works a procedure to detect, characterize and monitoring the evolution of the extratropical cyclones from numerical model analyses was developed and some climatologies of these cyclones were obtained. At present a Short Range Ensemble Prediction System (SREPS) is available in the INM and it has made possible the probabilistic forecast of cyclones. In this work the tracking algorithm has been applied on the INM-SREPS. The most probable evolution of cyclones, their displacement, growth and decay and some features have been forecasted. The comparison between the evolutions from the forecast and from the ECMWF operational analyses can be used for verification purposes.

New approaches for the assessment of the return period of shallow landslides

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Rainfall–induced shallow landslides have been recognized as important sources of risk in mountain areas. In order to study these phenomena in the framework of natural hazards, it is important to assess both the potential location of landslide-prone areas, and the return period of the landslides. Different GIS-based models have been developed to deal with the first issue. These analyses have been favoured by the development of simplified 1D hydrological models (Montgomery and Dietrich, 1994; Iverson, 2000) and the availability of new high resolution DTMs. The assessment of return period of rainfall-induced landslides has been normally performed by associating rainfall I-D frequency curves (IDF) with landslide-triggering rainfall thresholds (Iida, 2004; Rosso et al, 2006; D'Odorico and Fagherazzi, 2003). This is a strong simplification because, in general, the same rainfall I-D leads to different landslide probabilities according to different initial water content. In this contribution, we develop a method that allows to calculate rainfall I-D frequency curves (IDF) accounting for the antecedent rainfall conditions. The corrected IDF are then used to assign return periods to probabilistic landslide-triggering rainfall thresholds developed using two different approaches. First, we apply a logistical regression model to discriminate between rainfall events that triggered or not landslides, and we obtain a set of thresholds, that express the I-D needed to trigger landslides with different levels of probability. Then, we develop a stochastic simulation of rainfall-induced landslide triggering by using a diffusive transient physically based model (Iverson, 2000), and we derive a set of thresholds, that express the I-D responsible to destabilize different percentages of the area with different probabilities of failure. By assigning a return period to the triggering thresholds, we develop exceedence probability-intensity functions for shallow landslides, where the intensity of landsliding is expressed as the percentage of the area that can be destabilized during a single event. These curves, coupled with maps of landslide susceptibility, can be finally used for a rigorous assessment of landslide hazard. We applied this approach in a study area located on the eastern side of Lake of Como (Lombardy Region, Northern Italy). The area includes the Pioverna and Esino river basins, 180 km2 in size, and is situated between 200 m and 2600 m a.s.l.. This area has been selected because of the availability of pre-existing hydrological, physical, and mechanical soil data needed for model calibration (Crosta and Frattini, 2003; Bathurst et al., 2005).

Rainfall conditions that have resulted in landslides: a global analysis

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Rainfall is a recognized trigger of landslides, and investigators have long attempted to determine the amount of precipitation needed to trigger slope failures, a problem of scientific and societal interest. We review the literature on rainfall thresholds for the initiation of landslides, and we present a catalogue of 125 empirical rainfall thresholds for the possible occurrence of landslides proposed in the literature in the period from 1970 to 2006. Next, we present a world-wide catalogue of rainfall conditions that have resulted or have not resulted in slope failures, and we exploit this information to establish new minimum global intensity-duration and normalized intensity-duration thresholds for the possible occurrence of landslides. We compare the new thresholds with existing thresholds, including global, regional and local thresholds. We conclude discussing the results obtained, with emphasis on the possible application of the new thresholds in a world-wide operational landslide warning system.

PREVIEW Service 2: Forecasting Shallow Rapid Landslides

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PREVIEW (Prevention, Information and Early Warning, pre-operational services to support the management of risks) is an European Commission FP6 Integrated Project with the aim of developing, at a European level, innovative geo-information services for atmospheric, geophysical and man made risks. Within this framework, Service 2 (Prediction of shallow rapid slope movements) of the Landslides Platform has the objective of developing an integrated procedure for the forecasting and warning of distributed shallow landsliding to be used for civil protection purposes. The service will blend advanced techniques from different fields and involving different tools: meteorology, hydrology, geologic modelling, remote sensing and GIS. The service is being developed in two pilot test sites in Italy, the Armea river basin, located in the Province of Imperia, Liguria, in NE Italy, and the entire Ischia Island, in the Gulf of Naples. Two field campaigns on each test site have been carried out for collecting data for the development and calibration of the models that will be applied within the service. A distinctive feature of the service being developed is the use of an innovated soil depth model for predicting the distributed thickness of the soil (depth-to-bedrock) within

the basin, one of the most important parameters controlling shallow landslide triggering. Data from a probabilistic downscaled short term rainfall forecast will be used to estimate soil saturation and meteorological radar outputs will be employed to determine overall system evolution in the very short term (less than 6 hours lead time). The final step regards the use of hydrogeological modelling to calculate the distributed factor of safety on a pixel-by-pixel basis. The infinite slope model of Skempton and Delory is used for this purpose. On the Armea valley, the topographic base that will be used for the modelling is a DEM with a cell size of 5 m specifically created for this purpose by digitizing a large scale raster contour map. The area is characterised by calcareous and arenaceous terrains, with colluvial deposits of variable thickness. Calibration of the service will be performed with two rainfall events: one that occurred in 2000, which triggered numerous superficial landslides but for which the rainfall data is less well-known and a smaller, more recent event (2006) that caused fewer landslides but for which more information is available, including a high-resolution optical satellite image. For the Ischia Island is available a very detailed topographic base in vectorial format and a DEM with the same resolution (5 m) of the Armea valley has been created. The entire island is a volcanic complex, with many different terrains, as ashes, pumices and lavas. The calibration will make use of the 30 April 2006 event data, when an exceptional precipitation triggered few landslides in the Monte Vezzi area, with catastrophic consequences (four people were killed in their home). In this case hourly rainfall data are available and a lot of terrain parameters (topographic, geological and geotechnical) have been collected during the fieldwork. Once fully developed the entire service will run within a real-time updated WebGIS system so that end-users involved in PREVIEW can interactively access, query and download data.

Cloud-to-ground lightning characteristics of storms that trigger debris-flows in complex terrain in the Mediterranean region

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It is very common for summer season convective storms in the Mediterranean region to produce copious rainfall totals. A small population of these storms produce short lived, but very intense rainfall in the region. These intense rainfall episodes can produce devastating hydrological responses in complex terrain where vegetation cover has been disturbed or where slope material is unconsolidated. Debris flows and flash floods are among the hydrological hazards associated with these types of storms (Tecca et al. 2003; Cannon and Reneau 2000). This study investigates the morphology of convective storms that produce short, but intense periods of rainfall over complex terrain in northeastern Italy. One objective of this research is to develop cloud-to-ground (CG) lightning flash parameters that when combined with measures of convective instability and storm motion can be used to identify storms with potential to produce short bursts of intense rainfall in regions of complex terrain in the Mediterranean area. For the study two dates were identified where convective rainfall produced debris flows in the study region. The storm date 12 June 1997 corresponds to debris flow observations near Cortina d'Ampezzo (Berti et al. 1999). The storm date of 7 August 1996 corresponds to debris flow observations at Cancia and reported by Bacchini and Zannoni (2003). Both of the debris flows were triggered by intense convective rainfall in the region. Data collected at both sites provides the rainfall chronology and the time of debris flow initiation. Upper-air data and thermodynamic parameters from Udine (LIPD) and Milano (LIML) were obtained from the NOAA Integrated Global Radiosonde Archive (NOAA 2007). CG flash data for the storm events were purchased from CESI-SIRF. A number of CG lightning flash parameters were calculated for a period beginning 90-minutes prior to the intense rainfall episodes. These parameters included: flash location and spatial patterns, time of flashes relative to rainfall initiation, polarity of flash population, spatial and temporal sequence of polarity shifts, peak current of flash population, 1-minute, 5-minute, and 10-minute flash rates. Multiple spatial and temporal scales of analysis were employed in the analysis. Convective storms produced peak rainfall rates as great as 1.0mm/min at both debris flow sites. The 12 June 1997 storm dumped more than 22mm of rainfall in 35 minutes in the late afternoon. A smaller convective rainfall episode in the early afternoon on that date may have played a role in intensifying the later storm by entraining moisture in a layer from 750hPa to 550hPa. Preliminary results suggest that peak CG flash rate (5-min) and time of CG flash peak are the best of the prognostic parameters tested to this point. **References:** Berti, M., R. Genevois, A. Simoni, and P.R. Tecca (1999). Field observations of a debris flow event in the Dolomites. *Geomorphology*, 29, 265-274. Bracchini M. and A. Zonnoni (2003). Relations between rainfall and triggering of debris flows: case study of Cancia (Dolomites, Northeastern Italy). *Natural Hazards and Earth Systems Sciences*, 3, 71-79. Cannon , S.H, and S.L.Reneau (2000). Conditions for generation of fire-related debris flows, Capulin Canyon, New Mexico. E*arth Surface Processes Landforms*, 25, 1103-1121. NOAA Satellite and Information Service and the National Climatic Data Center, US Dept of Commerce (website accessed: May 2007) http://lwf.ncdc.noaa.gov/oa/climate/igra/index.ph Tecca, R.R., A. Galgaro, R. Genevois, adn A.M. Deganutti (2003). Development of a remotely controlled debris flow monitoring system in the Dolomites. *Hydrological Processes*, 17, 1771-1784.

Social and technological aspects in managing natural hazards

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The natural catastrophe that have produced the major economic loss, before the Katrina event, was an earthquake

[Munich Re Group, 2004] recorded on January 17, 1995, in Japan, that produced more than 6 000 casualties and economic losses exceeding 100.000 US$ millions. The major number of casualties was also produced by an earthquake in Japan, on September 1, 1923, that produced more than 140 000 victims. Going back through time, the earthquake recorded in China in 1556 produced 830000 casualties, quantity that was exceeded by the flood recorded in that country in 1887, with 900000 casualties. Although individual earthquakes and hurricanes are the hazards that usually produce the greatest losses, floods occur with such a frequency throughout the world that, in total, they are the disasters responsible of the major economic and human losses in the world. However, in the perception of the population at large, the idea of disaster is usually associated to earthquakes, hurricanes and so on; they have a poor perception about the danger due to floods. As a consequence of such a social drawback, subjective judgements of personal exposure to floods depend on age, education and social role. That's the reason why most flood prone areas around the planet still increase in population density and change the land use into urban, affecting the flood regime and flood risk. The social response to such disasters by more conscious countries has been to build up Civil Protection organizations: the need of the citizens to be protected, from natural and industrial disasters, made, in Europe, US and Japan, the Civil Protection organizations to be established during the last decades of the past century. UE DG XVI makes efforts, presently, to comply with the rapid development of the Civil Protection in the countries of Southern Europe, trying to have the remaining ones keeping the pace of the leaders. FEMA failing to manage Katrina in New Orleans it's pushing United States to redesign their approach to both the prediction of ground effects and to the organization of the relief. Even Latin America countries are presently developing their state organizations, although with more accent on the relief then to the prediction and forecast. Asian and African countries do not presently perceive the need: emergency relief of the population affected by a disaster is there organized, if the term organization would apply, case by case, mainly with the help of international relief agencies. It seems to us that the right of a person to be protected from the extremes, of climate, of day by day weather, of ground motions, of infrastructures management, of industrial failures, is characteristic of a given level of development of the society: in our countries the right of the citizen to safely stay home, to safely work and travel everywhere in its country is presently acknowledged by the common law. In less developed countries, where the human life is still threatened by the insufficient satisfaction of basic needs, where diseases, malnutrition and limited access to safe water and air reduce sensibly the life expectancy, Civil Protection has no meaning, in the sense we understand it. A modern Civil Protection, in a modern, post-industrial society, has two major tasks: the first one is sociological, in the sense that the new organization has to deeply intermingle with the existing social institutions of the country in order to get consensus on the restrictions of land use and other limitations; the second one is technological, in the sense that Civil Protection must make use of the most advanced and efficient tools to predict, forecast and observe the ground effects affecting people and its properties, in order to be perceived as much reliable as possible. Getting, also by this way, consensus on restrictions. We will attempt to clearly discuss, in the following, not only successes but also failures, showing why, in some cases, the sociological task failed, and why, in some other cases, it failed the technological one.

Economic impact of cyclonic structures in Europe

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Cyclonic systems play a crucial rule in the European and Mediterranean region meteorology in particular between the late summer and the early winter. Cyclonic systems often induce severe weather condition in terms of heavy and/or long-lasting precipitation with related phenomena such as strong winds and lightning. Recent studies have shown that cyclonic structures confined in the mid-upper troposphere, among which the so-called cut-off low, are responsible of the set-up of instability up to at the lower levels sometimes leading to convective precipitation. On the other hand, the eventual rain pattern associated to a lower levels cyclone it is seen to be related to its vertical structure and to the presence of a driving upper levels low pressure. In this work the occurrence of cyclonic events (both surface and upper air) is estimated and matched with an economic losses database to derive a relation between the atmospheric structure and their impact on the economic and social environment. Based on the ERA40 Reanalysis, a 10 years database of surface and upper air low pressure systems has been constructed by means of an automatic pattern recognition algorithm, evidencing typical structure, lifetime, path and sources. The economic losses are estimated from insurance company records, with indication of location, date and type of events, and related losses in terms of damages and casualties. Results show the relative high impact of cyclonic structures of human life in Europe, especially if coupled with the physiography of the ground (e.g. coastlines and orography), evidencing the need of further studies on both modeling and observations.

Synoptic and dynamic characteristics of selected hail-storms over the area of Cyprus and their impact on the agricultural economy

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Hail is a hazardous weather element always resulting from thunderstorm activity. The development of a thunderstorm

is a consequence of thermal instability; alternatively, thunderstorms occur in the presence of a frontal depression. Thunderstorms do not always produce hail of adequate size to reach the ground. However, in the cases of hail reaching the ground, a variety of problems can be anticipated, spanning over a large range of human activities. Many of these problems are directly connected to the agricultural economy of a region, since hailstorms can straightforwardly destroy crops and plantations. In the present study, the hail events which have resulted in compensations by the Agricultural Insurance Organization of Cyprus during a ten-year period, from 1996 until 2005, are examined. These hail events are grouped into two clusters, the "instability cluster" and the "frontal depression cluster". For the "instability cluster" several thermodynamic indices were calculated, using the 1200UTC data from Athalassa radiosonde station in Cyprus. For the "frontal depression cluster" the characteristics of the associated synoptic situation were examined and the fields of a lower tropospheric stability index, relative vorticity and divergence of the horizontal wind vector were calculated. The NCEP/NCAR global analyses for 0000UTC, with a grid of 2.5 x 2.5 degrees were used in order to perform the necessary mathematical calculations. The calculations cover the area bounded by the meridians 20 degrees West and 50 degrees East and the parallel circles 20 degrees and 65 degrees North. Frequencies of hail events were also calculated in order to identify geographical areas which are often hit by hail storms, while an attempt was made to relate the impact on the agricultural economy and the type of hailstorm. The above synoptic and dynamic characteristics and the thermodynamic instability indices of the day before, the day of occurrence of the hail event and those of the day after were listed, in order to create a useful forecasting tool for local weather forecasters and for further research.

A climatology of Mediterranean severe weather events using the Advanced Microwave Sounding Unit (AMSU)

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The Mediterranean basin is an area of frequent cyclonic activity, where both local effects and large scale dynamics have significant contribution to the extent and severity of weather events. Synoptic-scale perturbations such as southward stratospheric intrusions are often precursors of surface cyclogenesis and occurrence of extreme events. AMSU-A and AMSU-B microwave instruments, both onboard NOAA satellites, are able to detect upper-level intrusions and to locate heavily precipitating areas, respectively. Such diagnostics using AMSU channels are used to perform a climatology of severe weather events in the Mediterranean basin, for the period of 2001-2006, to form a typology of precipitating systems and upper level intrusions, based on their relative positions, frequency, and size. By forming such climatology we are able to determine whether whenever an intrusion is detected there is precipitation and/or heavy rainfall. We also investigate the importance of the shape, axis of orientation and amplitude of such intrusions for the occurrence of storms, and whether there is a geographical preference for its occurrence. Moreover, the analysis of monthly, seasonal and annual climatologies allows to investigate the seasonal and/or interannual variability of these systems.

A case of severe weather over the western Mediterranean: satellite observation and numerical simulations

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On 26 September 2006, a strong mesoscale storm, with some resemblance to a polar low, hit Italy. This event is investigated from an observational and numerical point of view. AMSU (Advanced Microwave Sounding Unit) satellite observations show strong precipitation over eastern Italy early in the day that followed the reinforcement of a strastospheric intrusion upstream. A more detailed description of the intrusion is provided by fine scale PV fields obtained by the MIMOSA ('Modele Isentropique de transport Mesoechelle de l'Ozone Stratosphérique par Advection') model. Besides, a numerical simulation is conducted with the French research model Méso-NH. Two initial and coupling fields set (ECMWF and ARPEGE analyses) are used to run Méso-NH to investigate the case study. Three interactively 2-way nested domains are used with horizontal mesh sizes of 32 and 8 km by a mass-flux convection scheme, whereas for the inner grid with mesh size of 2 km, convection is assumed to be explicitly resolved. The case is validated against both infrared and microwave satellite observations by using the so-called model-to-satellite approach.

Classification of Cyclogenesis over the Apennine Mountains and Adriatic Sea

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Cyclones that appear in the basin of Adriatic Sea strongly influence the climate and weather conditions in the area. In particular, apart from the usually mild climate, cyclonic activity in the Adriatic and Central Mediterranean provide the main hydrological forcing as well as trigger mechanisms for a range of extreme weather phenomena. Therefore, a basic understanding of the cyclogenesis over the Adriatic Sea is essential. In particular, the classification of different types of cyclogenesis in the area is fundamental since it

will help the understanding and prediction of the relevant weather phenomena. In this study, based on the analysis of four year (2002 – 2005) operational ECMWF T511 dataset, we classify various types of cyclone tracks as well as isolate the mesocyclogenesis areas in the vicinity of Adriatic basin. Our analysis indicates that four types of cyclogenesis over the Adriatic Sea can be identified: (1) Type A: cyclones connected with pre-existing Genoa cyclones. Two subcategories are found: (I) continuous track: Genoa cyclones crossing over the Apennines to the Adriatic Sea and (II) discontinuous track: new surface cyclones generated over the Adriatic Sea under the influence of a parent cyclone generated in the Gulf of Genoa (Genoa cyclones) and moving towards Adriatic but blocked by the Apennines; (2) Type B: cyclones developed in situ over the Adriatic Sea without any connections with other pre-existing cyclones in the surrounding area; (3) Type AB: mixed types A and B cyclones. In this type of cyclones, two cyclones co-exist and stride over the Apennines (twin or eyeglass cyclones); and (4) Type C: cyclones moving from Mediterranean Sea, but not from the Gulf of Genoa (non-Genoa cyclones). Two subcategories are found: (I) continuous track: a non-Genoa cyclone is able to cross over the Apennines to the Adriatic Sea continuously and (II) discontinuous track: a non-Genoa cyclone is blocked by the Apennines and a new surface cyclone is generated over the Adriatic Sea. The relevant dynamics of the above types of cyclones are discussed along with characteristics of the cyclones and their synoptic situations at lower and upper troposphere.

Climate change impact of wind energy availability in the Eastern Mediterranean using the regional climate model PRECIS

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Renewable energy resources - and among them wind energy availability - are of great interest in view of the efforts to mitigate the impact of climate change. Within this framework the high-resolution regional climate simulations performed with the PRECIS climate model over the Eastern Mediterranean area are evaluated. The PRECIS model was developed at the Hadley Centre (UK Meteorological Office) and is based on the latest version of the global climate model HadCM3. A 25km horizontal resolution was chosen for the application of the PRECIS model at NOA. The objectives of the work are to determine (a) whether the PRECIS model-simulated 10-m winds reproduce realistic features when compared to the ERA40 reanalysis at a 1.125˚x1.125˚ resolution during the 1961-1990 reference period and (b) whether there are substantial differences between the current climatic wind speed distribution and wind energy density and those projected for the period 2071-2100 for the IPCC A2 emission scenario.

Detecting trends and long term persistency in precipitation indexes in Tuscany

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The issues related to droughts and to water resources management are going to became more and more important, especially in the framework of the climate change discussion. Citizens, stakeholders and managers have to know if the amount and the distribution of the available water could be different in the future. The analysis of climatic events like long periods of water shortage is made more difficult by the general lack of long sequences of data. Here the authors analyzed 5 indexes of precipitation regime: the annual precipitation, the number of wet days (precipitation > 1 *mm*), the Precipitation Concentration Index – PCI, the number of days with more than 10 *mm* of precipitation and the maximum number of consecutive dry days (precipitation < 1 *mm*). The region analyzed is the Tuscany region, with a dataset of 785 rain gauges covering the period 1903-2003. A methodology, to use more data than usual, including the gauges with very short time series, i.e. only 1 year, based on time variable spatial interpolation techniques, is here proposed. Both a distributed and lumped trends analysis of the indexes calculated have been performed by means of the Mann-Kendall test. The 5 time series of regional value of the indexes have been detected to present long memory, i.e. to reveal the presence of a not negligible dependence between distant observations in the time series. The implication of Long Term Persistency – LTP can lead to a remarkable increase of uncertainty in statistical estimation. The results do not show any evident signals of changes in the amount of water precipitated in Tuscany during the last century even in the more restrictive hypothesis of absence of long term persistency.

Characterization of a Mediterranean flash flood event using raingauges, radar, GIS and lightning data.

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Flash flood events are very common in Catalonia, generating hight impacts and losses nearly every year. They are produced by the overflowing of non-permanent rivers in little and steep basins close to the sea. This kind of floods are associated with very convective rainfall events reaching high rainfall intensities. The aim of the present study is to analyse the 12-14th September 2006 flash flood event within the framework of the characteristics of flood events in the Internal Basins of Catalonia (IBC). To achieve this purpose all flood events occurred between 1996 and 2005 have been analysed. Rainfall and radar data have been introduced into a GIS, and a classification of the events has been done.

A distinction of episodes has been made considering the spatial coverage of cummulated rainfall in 24 hours, and the degree of the convective precipitation registered. The study case can be considered as a highly convective one, with rainfalls covering all the IBC on the 13th September. In that day 215.9mm/24h were recorded with maximum 5-minutal intensities above 130mm/h. Together with the convective precipitation, other severe phenomena were observed like two tornadoes on the 13th. A complete meteorological study of this event is also presented. In addition, as it was an episode with a high lightning activity it has been chosen to be studied into the framework of the FLASH project. Near 184000 flashes, of which 58052 were cloud-to-ground, were recorded during the whole event. In this way, a comparision between this information and raingauge data have been developed. All with the goal in mind of finding a relation between lightning density, radar echoes and amounts of precipitation. Furthermore, these studies improve our knowledge about thunderstorms systems.

Development of an algorithm for convection detection by means of IR observations from geosynchronous satellites and lightning data from VLF ground-based networks: Application to the FLASH Project case studies over Italy.

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In this study, we present an algorithm for monitoring cloud convection, which is obtained by enhancing the GCD (Global Convective Diagnostic) technique (Mosher 2001) by means of lightning data information provided the ZEUS VLF ground network. We first investigate how the dual band GCD algorithm (WV – IR) can be improved using other SEVIRI (Spinning Enhanced Visible and Infrared Imager) bands to obtain additional cloud information from the MSG geosynchronous satellite. Then we discuss its enhancement using lightning data. To this end, we use five recent case studies over Italy, that have been selected within the FP6 FLASH project, and validate the results with available ground radar data. Finally, the one-dimensional cloud electrification model EMTM (Explicit Microphysics Thunderstorm Model) is used to simulate the non-inductive cloud electrification, so as to help us understanding the microphysical/electrification processes of the selected precipitating systems.

Ensemble-based data assimilation of satellite observations into a cloud resolving model

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In this study, we investigate a strategy to directly assimilate brightness temperatures into a cloud-resolving-model. The assimilation is based on an Ensemble Kalman Filter methodology. The cloud resolving model used in the study is the Advanced Regional Prediction System (ARPS) developed at the University of Oklahoma. The model features several microphysical schemes, turbulent parameterizations, and surface sub-models. In spite of its advanced physics packages, the model is deemed to over-predict the amount of solid phase hydrometeors. This has a negative impact on the assimilation of brightness temperatures because over-prediction of scattering may result in underestimation of surface rainrates. To mitigate this potential deficiency an "a priori" covariance term, based on independent radar-radiometer observations, is included in functional form associated with the assimilation process. This "a priori" covariance term constrains the model state variables to values consistent with independent observations. The methodology is evaluated using radar and radiometer observations. That is coincident real radar and radiometer data are assimilated into the model. Assimilations of radiometer only observations with and without the "a priori" covariance term are performed. The retrieved/forecasted state variables are compared to those derived in from the combined radar and radiometer observations, and the impact of the "a priori" covariance term on the assimilation is thus assessed. The radar observations are collected by an X-POL radar over Crete, while the associated radiometer observations are simulated from the radar retrievals in this semi-idealized study.

Ensemble sensitivities of the real atmosphere: Application to Mediterranean Intense Cyclones

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The sensitivity patterns of a certain feature of interest to precursing states and processes involved in its evolution is an important information used in many disciplines of sciences as it provides cause-effect bonding links. Classical sensitivity studies analyze the effect of one factor by comparing a control experiment with one where the factor is removed. This approach allows to easily track all effects of one cause on the system. After the adoption of adjoint models by the atmospheric numerical community, the inverse approach is also possible: estimating the set of causes that are related to an effect. Adjoint models provide a tangent linear estimate of the sensitivities of a forecast aspect to the initial and boundary conditions fields. Another approach, that has been recently proposed, is to use ensembles of simulations of one episode to estimate the sensitivity fields. The estimate is obtained by correlating the ensemble initial conditions perturbations to the dispersion of the ensemble of forecasts. In this study we use this approach to compute sensitivities of intense Mediterranean cyclones. Intense cyclones from the ECMWF ERA-40 database are objectively classified in 24 classes based on both cyclone position at its mature stage and precursing atmospheric conditions 24 and 48 h before that time. Sensitivities are derived using the ensemble method with each cluster providing the initial conditions and "forecast" dispersion in which the original method is based on. Thus, this technique is not based on numerical modeling

but just on the ERA-40 analysis fields. Results from the application of this technique on intense Mediterranean cyclones are provided. The North-Atlantic, western Europe and north Africa are the areas persistently highlighted by the sensitivity fields. A comparison of the estimates obtained using the ensemble method and adjoint techniques are shown. Differences among them are highlighted and further discussed.

High resolution operational forecasting with MOLOCH for MAP-DPHASE

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The MAP DPHASE (Mesoscale Alpine Programme, Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region) is a Forecast Demonstration Project (FDP) of the WWRP (World Weather Research Programme of WMO), aimed at demonstrating the ability of forecasting heavy precipitation and related flooding events over complex terrain, as gained from state-of-the-art atmospheric and hydrological models, new technologies and improved knowledge acquired during the MAP project. High resolution, convection resolving models are a component of the end-to-end forecasting system that will be run operationally for six months, starting from 1st June 2007, over the Alpine region. At ISAC-CNR, two weather prediction chains for producing real-time, high resolution simulations in the range 0-48 hours have been recently implemented. They will run once a day during the six months period of MAP DPHASE experiment (1st June – 30th November 2007). The chains comprise the hydrostatic model BOLAM, which is driven directly by the global model, and the non-hydrostatic model MOLOCH, which is nested in cascade, using a 1-way nesting procedure. For BOLAM simulations the horizontal resolution is 0.11 degree in rotated coordinate (about 12 km); for MOLOCH is 0.02, corresponding to about 2.2 km. The two forecasting chains employ different initial and boundary conditions: one is based on the 00 UTC, GFS-NCEP global model forecasts at 0.5 degree horizontal resolution, while the second is based on the 18 UTC, ECMWF forecasts at 0.25 degree horizontal resolution. MOLOCH graphical products are collected by the MAP DPHASE Visualization Platform. Output data in grib format, stored in the MAP DPHASE data archive, provide rainfall input for hydrological model forecasts.

Damages and social impact of Italian severe storms: focus on regional differences

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(1) Institute of Atmospheric Science and Climate – National Council of Researches ISAC – CNR, Rome, Italy (2) Department of Physics, University of Ferrara, Ferrara, Italy (e.santorelli@isac.cnr.it) It is generally well known that social impact of precipitation extreme events is very hard, especially for agricultural industry. In many cases, an event that in certain environmental conditions does not cause damages in itself, the same intensity being equal can damage with consequences most serious for environment and infrastructure. In the present work, these aspects will be discussed referring to some Italian severe storms, for which immediate and indirect damages have been analysed. The events are also the object of modelling and remote sensing analysis, and represent the focus for other works in Plinius conference. Moreover concerning damages, data and information gathered through different kind of sources have been connected with characteristic of regions and people.

The impact of two assimilation techniques in two tornadoes cases

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The improvement of relative humidity, precipitation patterns and the quantitative precipitation forecast (QPF) in short-range forecast is one of the main priorities of mesoscale model researches. Several studies have been carried out at Meteorological Service of Catalonia (Meteocat) in order to optimize the ingestion of radar and satellite data, as well as automatic weather station data, in the operational mesoscale models (MASS and MM5). In this way, two different techniques are tested: the Local Analysis and Prediction System (LAPS) developed by NOAA and the Incremental Analysis Updating (IAU) developed by NASA. The IAU was implemented at Meteocat in 2003, and LAPS during this year. As a part of the verification process these techniques are also applied to two tornadoes events (autumn of 2006). In both cases, there was precipitation associated with the pass of a squall line. However, the interaction between the frontal gust of the storms and local winds, determined by topography and synoptic conditions, might have played an important role in the initial state of development of the tornadic storms. Consequently, the main features at low levels (wind, temperature and humidity fields) are analysed to verify if there is any improvement in the forecasted variables with these two techniques such as it has already been observed in the QPF. In both cases, the operational models are initialized with data from global models and observational data. A coarse and nested domain of 36 and 12 km of horizontal resolution respectively have been used. Concerning to the assimilation techniques, LAPS has been applied in MM5 model and IAU in MASS model, both run twelve hours before the event occurs.

A remote sensing analysis of the 25 August 2006 event in Catalonia (NE Spain).

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On the afternoon of 25 August 2006 a thunderstorm caused important damage in the small coastal village of Calella (40 km at NE of Barcelona). The intense rainfall produced a flash-flood that affected a great number of cars. The Meteorological Service of Catalonia warned about the situation some minutes before, in spite of the difficulty to determine the risk of danger of the thunderstorm. Even though the

thunderstorm moved very fast (the mean speed was 46 km per hour), the features observed with remote sensing tools (especially radar and lightning detectors) allowed issuing the warning. Regarding radar reflectivity, the maximum values were elevated (Z = 54 dBZ, TOP = 14.3 km, and VIL = 28.5 mm), but typical of normal summer thunderstorms in the area. However, some other characteristics were observed in the imagery (hook echo, bounded weak echo region), which indicated the potential severity of the thunderstorm. However, it was the lightning data which confirmed the severity of the convective structure. In the 30 minutes previous to the arrival of the storm to the affected region, more than 2000 IC and near of 650 CG flashes were detected by the lightning network. The presented study is centred in the analysis of the background and the evolution of the thunderstorm from the point of view of the remote sensing tools, in order to improve the knowledge about life cycle of thunderstorms. These models will be implemented in nowcasting tools.

ABSTRACTS

TUESDAY

Distributed Collaborative Adaptive Radar Network: The CASA IP-1 Network and relevance to the Mediterranean region.

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Current weather radar observation networks are based upon conventional sensing paradigm of widely-separated, standalone radar systems. These radar systems, such as the WSR-88D Next Generation Doppler Radar (NEXRAD) system in the USA, sample the atmosphere in "sit-and-spin" mode over the same regions according to predefined volume coverage patterns (VCP). NEXRAD radars are neither adaptive nor collaborative by design and suffer from 'earth curvature problem' – namely, the inability to see low at far off distances from the radar. The Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) is founded on the transforming paradigm of Distributed Collaborative Adaptive Sensing (DCAS) networks designed to overcome these fundamental scientific, technological, and organizational limitations of current approaches to observing, understanding, predicting, and responding to atmospheric hazards. CASA paradigm of short range radar networks provide observations at better resolution compared to the state of the art while at the same time mitigating the Earth curvature problem of long range radars. The CASA enterprise designs, develops, and deploys system-level test beds to integrate underlying scientific and technical breakthroughs and demonstrate the potential to observe, understand, predict and respond to hazardous atmospheric phenomena – with end users involved from the outset. The IP-1 test bed is the first one of such test beds that was completed in 2006, designed for adaptively sampling severe convective storms. The IP1 radar network consists of four radar nodes and a cluster of computers known as System Operation and Control Center (SOCC) for processing and disseminating data in real-time to a pilot group of National Weather Service forecasters and emergency managers with jurisdictional authority in the IP1 network; and Meteorological Command and Control (MC&C) algorithms that determine the optimal scanning strategy for the radar network based on user needs for data. The radar nodes are installed in Southwest Oklahoma, and are under the coverage of the KFDR and KTLX WSR-88D radar units. The four radar nodes are located in or near the towns of Chickasha, Rush Springs, Cyril and Lawton, OK, and each radar node is approximately 30 km apart with overlapping coverage. Redundant radio links provide Internet connectivity to the radar node sites with a maximum guaranteed bandwidth of 4 MBps. The IP-1 network of radars operate at X band and make measurements close to the ground. This poses whole set of technical challenges to clutter suppression, range/ velocity ambiguity mitigation and attenuation correction. The CASA solution to all these problems is discussed. This paper presents some of the early examples of the implementation of the observations from CASA radar network, using data collected over the Spring experiment period. In addition, observations from the CASA spring experiment are used to highlight the need and relevance of this concept for the Mediterranean flood monitoring.

Exploitation of X-band space-borne synthetic aperture radar for highly-resolved precipitation retrieval over land within GPM

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Numerous studies, conducted as part of the Tropical Rainfall Measurement Mission (TRMM) program, have demonstrated the benefits of space-borne precipitation measurements. The NASA Global Precipitation Measurement (GPM) mission is an outgrowth of TRMM that will provide improved precipitation measurements and it will extend those measurements to higher latitudes. The forthcoming GPM will seek data from a constellation of satellites to provide measurements of precipitation that expand the coverage provided by the well-instrumented core satellite. The analysis of X-band Synthetic Aperture Radar (SAR) data is aimed to explore the advantage of resources that will already be placed in orbit by European and other space agencies for other purposes. The TerraSAR-X (TSX) will be launched by the Deutsches Zentrum f. Luft u. Raumfahrt (DLR) and the Constellation of Small Satellites for Mediterranean basin Observations (COSMO-SkyMed, CSM) will be launched by the Agenzia Spaziale Italiana (ASI). Both have been launched in June 2007 and both will operate in the X-band. Additional X-band SARs will be launched in the coming decade. C-band and L-band SARs have a long heritage of Earth observation. Recent studies showed that X-band SARs are more sensitive to rainfall effects than SARs operating at longer wavelengths because the rainfall reflectivity at X-band is enhanced by $\sim$ 12 dB and the attenuation increases

by $\sim$ 4 dB compared to C-band reflectivities and attenuation. The main scientific benefit that will accrue from the use of X-band SARs will be the measurement of precipitation over land where microwave radiometers have had limited success. X-band SAR precipitation retrievals will be especially valuable over mountainous terrain where ground based radars are obstructed. The high spatial ($\sim$100m) resolution of those radars will provide new insights into the structure of precipitating clouds. Beam filling has introduced ambiguities in precipitation estimates derived from microwave radiometry. The spatial resolution of X-band SARs is better than about 100m; much smaller rain cells can thus be observed from space-borne observations. Combining X-band SAR and microwave radiometric data enables such beam filling problems to be addressed. Unlike the TRMM Precipitation Radar (PR), which provides highly resolved vertical precipitation profiles, TSX and CSM will mainly measure the slant-path integrated scattering and attenuation of precipitation. These satellites will also measure the differentially-polarized phase shift produced by precipitation in the slant path. However unlike microwave radiometers, contrast between rain and land background signals will be sufficient to measure terrestrial rainfall. Marine precipitation has been observed by previous space-borne X-band SARs. Because it appears to be difficult to separate the effects of downbursts, wind roughening and rain impact on the sea surfaces from signals produced by hydrometeors, we have deferred the retrieval of maritime rainfall until we have demonstrated the utility of terrestrial precipitation retrievals. In this work we illustrate a model-based investigation on the potentials of X-band space-borne SARs to detect and retrieve rainfall over land. In order to show this, a vertically-inhomogeneous horizontally-finite rain cloud model is set up coupled with an electromagnetic surface and volume scattering model. The effect of the slant-view geometry is taken into account in order to deal with possible overlay phenomena. The rain-cloud model is varied to evaluate the sensitivity of the normalized radar cross section (NRCS), measured from satellite SARs, to snowfall and rainfall intensity. Dual-polarized horizontal and vertical absorption and scattering are also considered. The bounded random variation of cloud parameterizations is accomplished to generate a training data set for an inversion algorithm. Both a semi-empirical and statistical retrieval schemes have been formulated and tested in order to give a rough estimate of rainfall accuracy. Mission constraints, derived from nominal specifications of both TSX and CSM, will be discussed and some case studies, obtained from 1994 Shuttle missions, will be also analyzed.

C-band procedure for rainfall estimation using polarimetric measurements

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Due to orographical complex contexts, conventional and polarimetric C-band radar systems are widely used in Italy for meteorological applications. In fact, C-band is a suitable compromise between S- and X-band in terms of non-Rayleigh effects, maximum sensitivity with minimum attenuation of reflectivity and influence of the backscattering phase shift as well as the overall cost. Actually, the Italian weather radar network of the Civil Protection Department will be made up of C-band Doppler radars, some of them with polarimetric capability. Since 1980, in Italy the weather radar polarimetric techniques have been widely studied in order to improve radar rainfall estimation for hydrological purposes and to infer on the microphysical characteristic of cloud and precipitation. This paper presents an integrated methodology which, starting from polarimetric radar measurements, allows to obtain the best rainfall estimation. The procedure takes into account key radar meteorology issues such as: real time calibration check, ground clutter identification, and attenuation correction. The method takes advantage of the synergy between radar measurements of reflectivity factor (Zh), differential reflectivity (Zdr) and specific differential phase (Kdp), as expressed by the self-consistency principle. The methodology is applied to a case study analyzed by means of the ISAC-CNR Polar 55C radar during an intense rainfall event which occurred on 25 September 2006 over the Lazio region (central Italy). A comparison analysis of the method is also performed using rainfall data collected by the Hydrographic regional Office telemetered network.

Lightning Detection in Europe

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A new lightning detection network (LINET) has been developed at the University of Munich which exhibits a number of advantageous features: it measures very weak lightning events, reports discharges in clouds, and locates cloud-to-ground strokes with an average accuracy of about 200 m (the statistical error is $\sim$100 m)provided that site errors are compensated. Tests of the system have been carried out in four continents (Germany, Brazil, Australia, Africa) along with scientific campaigns of DLR (Institute of Atmospheric Physics, Oberpfaffenhofen, Germany). Since May 2006, European lightning data is delivered to the German Weather Service on an operational basis (powered by NowCast mobile GmbH, Germany). Using 65 lightning sensors in 12 countries, an area from longitude 7°W - 26°E to latitude 40° - 59° is covered. Another 20 sensors are deployed during 2007 in order to enhance pick-up of weak signals. Further expansion is in the planning stage involving new LINET sensors in Italy, Spain, Croatia, and other (near-) Mediterranean countries, to be set up in 2008, so that high efficiency can be reached in the southern part of the network. A number of scientific co-operations are carried out and are intended to combine lightning with other meteorological data sources and, thus, to exploit the potential of high-quality lightning data. For example, LINET will be used together with data from the DLR radar (POLDIRAD) for the development of improved nowcasting of thunderstorms,

especially of severe weather conditions. A particular study of this type is aimed at the improvement of nowcasting for airports. Another international campaign concerns COPS (convective and orographically-induced precipitation study), under way in the South-West of Germany and East of France. In these and further studies it is helpful to have reports not only on ground strokes, but also on the electrical activity in the clouds; the latter data source has not been available in large networks and may provide useful information about the development of severe weather and supercells. LINET allows studies of lightning occurrence in large geographical areas without the necessity to collect data from different countries and different detection networks. Thus, it becomes feasible to correlate lightning with all other data sources, which are available in large areas, including data from global networks, and to trace Mediterranean storms over very long paths.

Use of real time lightning observations for early warning of meteorological hazards

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Today many countries around the world have ground-based lightning detection networks that supply real time lightning data with high spatial and temporal resolution. In addition, global networks are sprouting up based on the detection of very low frequency (VLF) radiation emitted by lightning discharges. Lightning intensity is strongly connected to convective precipitation processes, and hence can possibly be used to estimate regions of heavy rainfall, with possible nowcasting capabilities for flash floods. Furthermore, severe weather storms (producing tornados, derechos, hailstorms, etc.) appear to exhibit specific lightning signatures, particularly in the polarity of the lightning discharges. Finally, lightning may also supply important information related to tropical hurricane genesis. In the presentation a few examples will be presented of how lightning information may help in the early warning of meteorological hazards.

Study of precipitation by cellular networks with focus on heavy rainfall events

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We will demonstrate how a severe rainfall storm is analyzed with high-resolution (1 minute time interval) data from a cellular network. New insight into the dynamics of precipitation is given by the new source of data and compared to classical understanding based on raingauges and radar. Global spread of wireless networks brings a great opportunity for their use in environmental studies. Weather, atmospheric conditions and constituents cause propagation impairments on radio links. As such, wireless communication systems provide built-in monitoring capabilities, and can be considered as a widespread distributed, high-resolution atmospheric observation network, operating in real time, with minimum supervision and with almost no additional cost. Here, we demonstrate how standard measurements of the received signal level, made in a cellular network, provide reliable measurements for surface rainfall. We compare the estimated rainfall intensity with the radar and rain gauge measurements. The skill of our method (correlation with rain gauges) is 0.86 for 15-min interval rain intensity and 0.9 for hourly interval, versus 0.85 and 0.81 respectively for radar, when evaluated from the maximal value over a 3X7 km^2 area.

Evaluation of Underwater Rainfall Estimation through Comparison with Dual Polarization Radar Rainfall Measurements in the Ionian Sea Rainfall Experiment

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Rainfall on the sea surface generates a loud and distinctive sound underwater. This sound propagates downward and attenuates, producing an effective listening area, or an equivalent "catchment basin" for a listening device that is a function of depth and frequency. Acoustical measurements of rainfall are reported from four Passive Acoustic Listeners (PALs) at 60, 200, 1000 and 2000 m depths from a mooring in the Ionian Sea off the southwestern coast of Greece (37N, 21.5E) from January to April 2004. These measurements are compared with co-located high-resolution dual-polarization X-band radar (XPOL) rainfall measurements. The XPOL, which is calibrated by a 2-Dimensional Video Disdrometer located at the coast some 10km from XPOL, reports the spatial distribution of rainfall variability over the listening areas of the PALs. Six quality controlled rainfall events, including drizzle, squall line, and heavy localized rainfall were recorded. The XPOL rainfall fields are spatially averaged over the mooring and compared with the four different acoustic measurements at depths. To understand the issue of spatial averaging quantitative comparisons is presented showing a high correlation between the acoustic measurements and area averaged radar estimates at corresponding resolutions. The study will present a number of XPOL-PAL rainfall comparison statistics at the matching radar averaging scales to demonstrate the ability to measure area averaged rainfall at depth.

Climatic trends to extremes employing regional modeling and statistical interpretation over the Eastern Mediterranean

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Regional climate models were run and analyzed for the Eastern Mediterranean. It was found that the average temperature over the Mediterranean area has increased by 1.5-4°C in the last 100 years. The temperature in the years 2071-2100 according to the A2 and B2 scenarios are predicted to increase by about 4°C and 6°C respectively over Northern Israel in comparison with the control run for 1961-1990. The precipitation above most of Mediterranean shows a dominant negative trend in the last 50 years. A large negative trend in the A2 scenario was found over Northern Israel, while B2 scenario shows no significant trend. There is a tendency toward extreme events. It was found that the extreme precipitation over Northern Israel shows significant increasing trends for the A2 and B2 scenarios with respect to the present climate. Also, the standard deviation of the average annual precipitation is higher in the A2 and B2 scenarios showing a trend toward both drier as well as wetter years in the future. Over Israel the tendency to more extreme years can be related to the increase of the specific "Red-Sea trough" synoptic system whose frequency has doubled in recent 50 years.

Warm and Cold Conveyor Belts: Which Is the Main Rainfall Contributor in the Mediterranean?

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The conveyor belt approach of extra-tropical cyclones regards the warm conveyor belt (WCB) as the main rainfall contributor. This is attributed to the high moisture content of the warm air and its considerable ascent while approaching the cyclone. In contrast, the cold conveyor belt (CCB) has only minor rainfall contribution, due to the small moisture content of the cold, and typically continental, air mass and the absence of upward motion within this conveyor belt. Satellite imagery indicates that over the Mediterranean, the cloudiness associated with WCBs is less extensive and thinner than is common, and that thick convective clouds are typical for the CCBs and within the cyclones' cores. A 3-D thermodynamic analysis of the Mediterranean Cyclones was done in order to evaluate the potential rainfall contribution of these two types of conveyor belts. The analysis is based on vertical cross-sections of relative humidity, potential temperature (θ) and equivalent potential temperature (θ_e). In order to investigate the source and evolution of the air-masses involved we incorporated air trajectories, derived by the HYSPLIT Model of NOAA. The results show that the WCBs contains dry air, originating from the Sahara, which points at low rainfall expected in this belt over the Mediterranean. This contradicts the classical conveyor belt model. As for the CCB, while the air-stream flows over the Mediterranean Sea it becomes warmer (along-stream increase in θ) and moist near the surface and becomes unstable, till it develops convection of several kilometers deep, expressed in vertically homogeneous θ_e.

Variability of warm season convective clouds over Europe and the Mediterranean

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A dataset consisting of 5 years of Meteosat IR data every half hour has been exploited to investigate the span and duration of convective systems over Europe and the Mediterranean during summer months (May-August). The European domain spans a latitude belt 30 - 54 N and a longitude domain 15 W – 40 E to capture the North Atlantic jet and the circulation from North Africa which interests the western and central Mediterranean. May to August data were considered. Hovmöller longitude-time diagrams are used to retrieve the span, duration and phase speed of the convective systems. A Fourier power spectrum analysis is used to identify daily cycles and propagation features of the systems. The role of orography in determining the convection strength and propagation comes out quite evident. The Atlas, Pyrenees, Alps and Carpathians heavily influence the circulation and convective cloud development. Sea-land effects appear also responsible of convective development along the Atlantic French coast and over the Black Sea. At the same time, the propagation and convective re-generation component of the mesoscale systems is observed. NCEP reanalysis data for the period are also used to identify the relevant mesoscale features. These results show a potential for the improvement of NWP models and for a regional climate characterization in the Mediterranean area, which is a clear hot spot in a changing climate scenario.

Spatial characteristics of radar-derived convective rain cells over dry climate regimes and their hydrological impacts

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Weather radar data contain detailed information about the spatial structures of rain fields previously unavailable

from conventional rain gauge networks. This information is of major importance for enhancing our understanding of precipitation and hydrometeorological systems. This study focuses on spatial features of convective rain cells in southern Israel where the climate ranges from Mediterranean to hyper-arid. Extensive data bases from two study areas covered by radar systems were analyzed. Rain cell features were extracted such as center location, area, maximal rain intensity, spatial integral of rain intensity, major radius length, minor radius length, ellipticity, and orientation. Rain cells in the two study areas were compared in terms of feature distributions and the functional relationships between cell area and cell magnitude, represented by maximal rain intensity and spatial integral of rain intensity. Analytical distribution functions were fitted to the empirical distributions and the log-normal function was found to fit well the distributions of cell area, maximal rain intensity and major and minor radius lengths. The normal distribution fits well ellipticity empirical distribution, and orientation distribution was well-represented by the normal or uniform distribution functions. The effect of distance from the Mediterranean coastline on cell features was assessed. A maximum of cell rain intensity at the coastline and maximum cell density 15 km inland from the coastline were found. In addition, a gradual change of cell orientation was observed with a northwest-southeast orientation 30 km from the coastline at the Mediterranean Sea and to almost a west-east orientation 30 km from the coastline inland. The effect of the derived spatial rain cell features on the hydrological response of a drainage basin is examined by utilizing a hydrological model for a case study of an extreme storm in a semi-arid basin. The storm rainfall is fed into the model by a set of convective rain cells according to the derived characteristics. The computed runoff data are analyzed and associated with the convective rain cell properties.

Climate change impacts on drought severity

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Potential future climate change will have significant impact on local and regional meteorological and hydrological regimes, which will in turn affect ecological, social and economical systems. However, climate-change impact studies on hydrologic regime and especially on droughts have been relatively limited until recently, mainly because of the limitations of Global Circulation Models, which are widely used to simulate future climate scenarios. The major problem of the current generation of GCMs is the limitation of their spatial resolution and the resolution of the output. Various statistical downscaling methods and downscaling through coupling of GCM output and regional meteorological models have been used to overcome the spatial resolution limitation of the GCMs. The Canadian Centre for Climate Modeling Analysis General Circulation Model (CGCMa2) has been used to estimate the precipitation changes for the periods 2020-2050 and 2070-2100 and for two future socioeconomic scenarios (SRES A2, SRES B2). This study investigates and applies two statistical downscaling techniques to generate the possible future monthly values of precipitation for the region of Thessaly, Greece. The downscaled monthly rainfall data are used for the estimation of the Standardized Precipitation Index (SPI) computed at various time scales to assess drought characteristics (intensity, duration, and severity) for present and future climate conditions. The downscaling methods are validated using historical data for the period 1960-2002. Comparison of the drought characteristics for the historical base period (1960-1990) and the two future periods indicates that the drought intensity, duration and severity increases for the examined climate change scenarios.

High-resolution numerical forecast of an hailstorm event in the Po Valley: sensitivity analysis to microphysical parameterization using COSMO-MODEL and MM5

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High resolution numerical forecast of severe weather has received an increasing attention in the hydro-meteorological community. In this work two non hydrostatic models, COSMO-LAMI and MM5,have been used to simulate, at fine resolution (3 and 1 km), a severe hailstorm event occured on May 20, 2003 in the Po Valley area(Italy). Two C-band radars simultaneously measured that event from two different locations, S.Pietro Capofiume and Gattatico, revealing strongly localized convective cells. The mesoscale models have been run in the same physical and numerical configuration and particular attention has been paid to the study of convective processes uncertainty due to variations in graupel and hail related particle parameters. Several sensitivity tests have been carried out using different microphysical hail and graupel setting (intercept parameter, mass-size relationship, velocity size relationship) to the aim of investigating the different hydrometeors production processes and to compare them with the available radar data and hydrometeors classification from the dual-polarized weather radars. Finally, further comparison have been performed with pluviometric network and the analysis of the results for this case study will be presented and discussed.

The relation between dynamical and humidity synoptic structures: an examination of some Mediterranean extreme weather events.

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Synoptic-scale dynamics is often described through the single field of potential vorticity. If a balance is assumed between mass and temperature fields, the distribution of potential vorticity may be inverted to give all the other dynamical fields. Aside from the dry properties of the flow, moist processes may play a significant role that is not taken into account through the potential-vorticity inversion. High-impact weather events in the Mediterranean region often

have signatures in both parts of this description: dynamical (tropopause foldings, troughs, surface pressure lows) and humidity structures (quasi-saturated tropospheric air) can trigger and sustain wind storms and precipitation events. The objective of the present study is to give some insights into the characteristics of potential-vorticity and moisture fields, and to investigate the relation between them.\\ An innovative algorithm implemented by Plu et al (2006) has been applied to ERA-40 data on some Mediterranean high wind and rainfall cases. This tool is based on a bidimensional discrete orthogonal wavelet transform and allows the detection and extraction of coherent structures from meteorological fields. First, a model-to-observation approach will test the relevance and the accuracy of the ERA-40 humidity fields for this study: simulated brightness temperatures will be compared with satellite observations. Then, the application of the wavelet algorithm to a moisture field will help to prove the existence of humidity coherent structures and to document them. In this context, the use of an alternative moisture variable based on a comparison with a 42-year climatology will also be presented. Plu, M., P. Arbogast, A. Joly, 2006. A wavelet representation of potential-vorticity coherent structures. Second Thorpex International Science Symposium, Landshut, Extended Abstract, 2 pp.

Detecting severe storms using MSG data

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An objective method to detect events of severe storms is presented. We use data from the European geostationary satellite Meteosat Second Generation to retrieve cloud top parameters, cloud microphysical structure, and to extract a number of parameters that give indication on potential severe storms events. Few case studies over the Mediterranean Sea and Israel are presented together with meteorological radar data for validation.

Impact of sub-grid variability of precipitation and canopy water storage on hydrological processes in a coupled land-atmosphere model

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The impact of sub-grid variability of precipitation and water storage canopy is investigated by applying a new canopy interception scheme into the Community Atmosphere Model version 3 (CAM3) coupled with the Community Land Model version 3 (CLM3). Including such sub-grid variability alters the partitioning of net radiation between sensible heat flux and latent heat flux on land surface, which leads to change in precipitation through various pathways/mechanisms. The areas with most substantial changes are Amazonia and tropical Africa where convective rain is dominant and vegetation is very dense. In these areas, precipitation during December-January-February is increased by up to 2 mm/day. The enhanced large-scale circulation and atmospheric stability by including the sub-grid variability contribute to the increased precipitation. The cloud feedback plays an important role in modifying the large-scale circulation and atmospheric instability. Turning off the cloud feedback mitigates the changes in surface convergence and boundary layer height caused by inclusion of sub-grid variability of precipitation and water storage canopy, which reduces the difference in precipitation between the simulation with such sub-grid variability and the one without.

Severe storms in a mountainous Mediterranean regions: Uncertainties on extreme rainfall estimations

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In a recent study, Molinié et al. (xxxx) analyzed extreme rainfall in a Mediterranean and mountainous region ($200 \times 150\ km^2$), the Cévennes-Vivarais region (CéVi). It is shown that extreme rainfall in CéVi is associated to two different precipitation regimes. Extreme rainfall cumulated over 24 hours results from stratiform clouds on which the relief forcing is of primary importance (Yates (2006) and Anquetin et al. (2003) among others). At shorter accumulation periods, typically 1 hour, three specific regions of several 100 km^2 are stroke by the highest extreme rainfall rates. Extreme rainfall rates are defined as rainfall rates with low probability of occurrence, typically with higher mean return-periods than data lengths. It is then of primary importance to explore the extreme rainfall sensitivity to the estimation methods (tail fitting i.e. TF or excess fitting i.e. EF). Maps of TF- and EF-estimated extreme rainfall display similar patterns but different intensities. The “measured” rainfall rate quantiles exhibit different patterns than those of the estimated extreme rainfall rates. This shows that: (1) an extreme value analysis is required in order to find out the most sensitive regions to highest rainfall rates; (2) Estimated Extreme rainfall intensities highly depend on the estimation method; Using criteria on the location and intensity, rainy events yielding intensities comparable to the estimated extreme ones have been found out in the databases. A geostatistical analysis of the rainfall fields allows to characterize their spatio-temporal structures. It is discussed in terms of storm organizations.

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Hydrological cycle in the Mediterranean experiment (HyMeX): The mesoscale modelling facets

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The Mediterranean basin has quite a unique character that results both from physiographic conditions and historical and societal development. The region features a near closed sea surrounded by very urbanized littorals and mountains from which numerous rivers originate. This results in a lot of interactions and feedbacks between oceanic-atmospheric-hydrological processes that play a predominant role on climate and its ecosystems. These processes frequently cause extreme events that produce heavy damages and human losses; heavy precipitation and flash-flooding during the fall season, severe cyclogeneses associated with strong winds and large swell or droughts accompanied by forest fires during summer are examples of Mediterranean high-impact weather events. The capability to predict such dramatic events remains weak because of the contribution of very fine-scale processes and their non-linear interactions with the larger scale processes. Progress in the understanding of the Mediterranean climate has thus important environmental, societal and economical implications.
There is a clear lack of an experimental project relying on up-to-date innovative instrumentation in order to go one step further in the understanding and predictability of the Mediterranean climate and associated weather events. The hydrological cycle in the Mediterranean region has been identified as a key scientific, environmental and socio-economic issue that has to be addressed within such experimental project. The HyMeX (HYdrological cycle in the Mediterranean EXperiment, http://www.cnrm.meteo.fr/hymex/) project aims at a better quantification and understanding of the hydrological cycle and related processes in the Mediterranean, with emphases put on high-impact weather events and regional impacts of the global change including that on ecosystems and the human activities. A 10-year Long Observation Period (LOP), starting in 2010 is envisaged to cover the whole Mediterranean basin. Within it, several Special Observation Periods (SOP) will be dedicated more specifically to heavy precipitation events and flash-flooding, intense air-sea exchanges during high-wind and dense water formation episode. A phasing of a special observing period with a THORPEX European Regional Campaign in 2011 in connection with the Medex Phase 2 is looked for.
Mesoscale numerical atmospheric modeling (including data assimilation) is: i) a necessary component during the preparatory phase of a field campaign to analyze representative meteorological situations, ii) during the field phase to forecast weather events and to plan the deployment of specific instrumentation (incl. targeting "sensible" areas), iii) during the analysis phase to put different high resoltution observations in their context. Coupled processes play a particularly significant role in Mediterranean high-impact events and ask for mesoscale coupled hydrometeorological and ocean-atmosphere modeling systems to study these processes. This point will be more specifically discussed at the conference through examples of mesoscale modeling of air-sea and atmosphere-hydrological interactions occuring during Mediterranean high-impact events.

High-resolution 3D numerical simulations of conditionally unstable flows over a ridge

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Numerical simulations of conditionally unstable flows impinging on a mesoscale mountain ridge have been performed with an explicitly resolving cloud model (Bryan and Fritsch, 2002) in order to investigate orographic precipitation in this regime.. The environmental conditions are the same used in a previous study but with increased horizontal resolution (grid interval = 250 m) and extended to a 3D domain in order to resolve properly the cellular-scale features. Even with the simplified atmospheric profile we considered, several external parameters come into play, so that only a limited portion of the state space has been explored. First, the solutions have been analyzed for different uniform-wind profiles impinging on a bell-shaped ridge 2000 m high. In the experiments with weaker environmental wind speeds ($U = 2.5\ m/s$), the cold-air outflow, caused by the evaporative cooling of rain from storm cells, is the main mechanism for cell redevelopment and movement: The outflow produces convective cells near the head of the up- and down-stream density currents, which rapidly propagate far from the ridge, so that no rainfall is produced close to the mountain at later times. For a larger wind speed ($U = 10\ m/s$), the evaporation is effective in generating a cold pool only on the downstream side of the mountain , in a region where the air is unsaturated; for even larger wind speeds ($U = 20\ m/s$), the air beneath the thunderstorm over the mountain remains saturated, so that rain cannot evaporate and cool the sub-cloud layer. No cold pools form in this case. Another set of experiments considers the effects of different mountain heights h. From the limited tests we have done, the height of the mountain with respect to the LCL (or LFC) turns out to be a more relevant parameter (as compared with the Froude number).

Improvements of numerical simulations of tropical-like Mediterranean storms through the assimilation of satellite and lightning data

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The scarcity of meteorological observations in maritime areas is a well know problem that could be an important limitation in the study of different phenomena. Tropical-like storms or medicanes developed over the Mediterranean sea are strong storms with some similarities with the tropical ones. Although they do not reach the hurricane intensity,

its potential for damage is very high due to the densely populated Mediterranean coastal regions. The capability of simulation of such phenomena by mesoscale numerical models has been previously shown. However, numerical simulations many times present clear spatial and temporal shifts in comparison with the satellite-observed storms. With the aim of improving the numerical results, an adjustment of the vertical profile of the humidity in MM5 simulations is performed by means of satellite derived precipitation. Convective or stratiform precipitation types obtained from satellite images are used to individually adjust the profiles. Lightning hits are employed to identify convective grid points. The adjustment of the vertical humidity profile is carried out in the ECMWF analyses used as global conditions of the simulations. It has also been applied the analyses nudging with ECMWF analyses and ECMWF analyses with corrections of humidity through the satellite-based profiles. The adjustment is also applied as observation nudging at each time step when the satellite image is available. The obtained improvements in the simulations and the degree of sensitivity to the adjusted vertical moisture profiles are discussed.

Ground-GPS data assimilation and its impact on Mediterranean heavy rainfall prediction

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During 5-9 September 2005, a convective system has hit the region of south France where there exists a high density network of ground-GPS stations from the OHMCV campaign. This event gives us a good chance to evaluate the impact of assimilation of high spatial resolution GPS Zenith Total delay(ZTD) observations on the prediction of rainfall with the mesoscale model MesoNH. ZTD observations have been assimilated with the 3D-Var data assimilation system based on the ALADIN limited area model. Two 6-h cycle assimilation experiments (with and without ZTD observations) using this mesoscale data assimilation system were conducted for a duration of 1 month including the heavy rainfall period. Conventional observations as well as METEOSAT clear air radiances were also assimilated in both experiments. A pre-processing of ZTD observations was carried out before their assimilation in order to apply a quality check on the observations and remove bias. To evaluate the impact of GPS data assimilation on the high-resolution forecast of the heavy rainfall event, two forecast trials with the non hydrostatic modeląłMesoNH (2.5km) were realized using the analysis of the cycle assimilation experiments as the initial conditions and boundary limit conditions. These two forecast trials were conducted every 12 hours from 00 UTC, 5 September 2005 to 00 UTC, 9 September. Each run lasted 18 hours. We found that assimilating GPS ZTD observations has some certain impact on the statistics of background humidity and wind field used in the assimilation cycle experiments while for other parameters, the impact is almost neutral. And the results of the two high-resolution forecast trials suggests that the GPS data helps recover slightly better the distribution and intensity of this rainfall events.

Two-dimensional non-hydrostatic numerical study of conditional symmetric instability

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The presence of conditional symmetric instability in the saturated core of severe marine storms determines their internal structure, and it is a pre-requisite for the occurrence of a stronger baroclinic development. The assumption of a slantwise convective adjustment taking place on shorter time and space scales strongly influences the modeling of larger scale circulations. We use a 2-D version (MOLON) of the full non-hydrostatic model MOLOCH, developed at ISAC-CNR, to study the whole life-cycle of moist symmetric instabilities in idealized conditions representing the environment of severe Mediterranean storms. It has been shown in previous analytical and numerical studies that the most unstable "symmetric" mode is not aligned with the shear vector. We approach this problem with the use of a rotated basic state and obtain indications for the subsequent use of the full 3D model.

PHAST: a phase-diffusion model for stochastic nowcasting

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Stochastic nowcasting methods generate ensemble forecasts of precipitation intensities, where individual ensemble members can be considered as different possible realizations of the precipitation process. Here we discuss an ensemble rainfall nowcasting technique based on the extrapolation of radar observations by a diffusive process in Fourier space, where power spectral amplitudes are kept constant and Fourier phases evolve by a Ornstein-Uhlenbeck stochastic process.

Thunderstorm nowcasting by means of lightning and radar data: algorithms and applications in Northern Italy

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Thunderstorms and their effects, as flash flood, hail, lightning, strong wind and tornado, are responsible of most of the weather damages in Northern Italy, especially in the warm season from May to September. The area interested by a single thunderstorm may be large only a few kilometers and its related phenomena at ground may last for half an hour, but often the associated convective system moves horizontally for several tens of kilometers and being dangerous for

some hours. These space-time dimensions result in a strong impact of T-storms on a densely populated region as the Po Valley, or even more as the boundary between the plain and the Alpine Chain, where the frequency and the intensity of these events are very high. For this reason a nowcasting and warning system focused on severe thunderstorm events would be useful to reduce risks for people involved in outside activities and for electric, telecommunication and sensitive industrial business. C-band radar and Lighting Location System (LLS) provides useful fast and high resolution data to the purpose of detecting and following the dynamics of convective systems. Some areas in Italy, and in particular the whole of Northern Italy, are covered by radars with a resolution of 1 km and the whole of Italy is covered by the CESI-SIRF LLS with a mean accuracy of 0.5 km on the single point of impact. In order to follow the horizontal cell movement, it is necessary to develop and run real time automatic algorithms that assimilate remote-sensing data, identify cells in space and time, track their paths and finally extrapolate their future position untill an hour in advance. One important matter about tracking algorithms is the verification of the computed path for a thunderstorm cell. In fact, due to the continuous individual evolution of the cell and the possible split and merge between different cells during their life cycle, it is extremely difficult to decide which is the real path of a single cell and the right algorithm. Sometimes a subjective definition of a path may rise from the hand observation of animated images, but this method cannot be used on a regular basis. Authors present some case studies in which trajectories are computed both with radar and lightning data separately, using different algorithm and parameters. The data used come from the Monte Lema Swiss Met-Service Radar and CESI SIRF LLS. Radar data consist in 15 minutes rainfall intensity maps with a grid mesh of 1 km. Cloud to ground lightning data have a continuous detection rate, calculating each flash instantly (time accuracy less than 10^{-7} sec.); the lightning peak current and polarity is also available. Case studies come both from strong perturbed situations and light instability ones. Authors emphasize the importance of the tracking algorithm as a tool for studying convective storm from a lagrangian point of view. In other words the identification of a convective cell during its whole life cycle is the first step to study the relation among different measurements related to the cell, for example the relation between lightning and rainfall. This topic is shown with some case studies. The work has been financed by the Italian Ministry of Economic Development with the Research Fund for the Italian Electrical System.

Cb-TRAM: Tracking and monitoring severe convection from onset over rapid development to mature phase using multi-channel Meteosat-8 SEVIRI data

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Cb-TRAM is a new fully automated tracking and nowcasting algorithm. Intense convective cells are detected, tracked and discriminated with respect to onset, rapid development, and mature phase. Finally, short range forecasts are provided. The detection is based on Meteosat-8 SEVIRI (Spinning Enhanced Visible and Infra-Red Imager) data from the broad band high resolution visible, infra-red 6.2 micrometer (water vapour), and the infra-red 10.8 micrometer channels. Areas of convection initiation, of rapid vertical development, and mature thunderstorm cells (cumulonimbus Cb) are identified. For the latter, tropopause temperature data from ECMWF operational model analyses is utilised as an adaptive detection criterion. The tracking is based on geographical overlap between current detections and first guess patterns of cells detected in preceeding time steps. The first guess patterns as well as the short range forecasts are obtained with the aid of a new image matching algorithm providing complete fields of approximate differential cloud motion. Based on the so called pyramid matcher an interpolation and extrapolation technique is presented which can also be used to generate synthetic intermediate data fields between two known fields as well as nowcasts of motion and development of detected areas. Examples of application are presented for thunderstorm tracks over the Mediterranean. Reference: Zinner, T., H. Mannstein, A. Tafferner, 2006: Cb-TRAM: Tracking and monitoring severe convection from onset over rapid development to mature phase using multi-channel Meteosat-8 SEVIRI data. Subm. to. Meteor. Atmos. Phys.

On using lightning for temporal propagation and cloud-life adjustment of MW-estimated severe precipitation fields

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The close connection between lightning occurrences and convection makes them interesting for nowcasting applications. As a matter of fact, there are weak statistics supporting their widespread use for quantitative precipitation estimation, while the usefulness of information related with the position and frequency of lightning strokes arises forcefully by the visual inspection of maps. On the contrary, microwave-based precipitation retrieval techniques, recognized as good tools to quantify the instantaneous rainfall amount, suffers from low spatial and most low temporal resolution related to the orbital characteristics of the low earth observation (LEO) satellites accommodating MW sensors. Within the frame of the definition of a Mediterranean real time precipitation monitoring and nowcasting system, the paper will show some preliminary considerations and results derivable by the combined use of those data sources. In particular, here the focus is on the potential to extrapolate the evolution of the AMSU-based instantaneous rainfall maps by applying physical assessments concerning the electrical properties of evolving convective systems derived by available lightning ground network data.

Transient synchronization and coupling of lightning activity in severe Mediterranean winter thunderstorms

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Analysis of space-shuttle video footage of 6 storm systems with different flash rates, obtained during the STS-107 mission in January 2003, showed that when the storm flash rate is high, lightning activity in separate thunderclouds becomes clustered, with bursts of nearly simultaneous activity separated by quiet periods [Yair et al., *JASTP*, 2006]. The analysis was expanded to sequences of lightning flashes in Mediterranean winter thunderstorm, based on data obtained during the 2004/5 and 2005/6 seasons from ground-based lightning location systems. We found similar patterns of clustering and synchronicity of flashes in individual clouds, separated by tens to hundreds of kilometers, hinting at a possible mutual electromagnetic coupling of remote thunderstorms. We developed a theoretical model that is based on the "fire and integrate" concept of Mirrolo and Strogatz [1990], in order to simulate the flashing behavior of a weakly coupled network of thunderstorm cells. In this type of coupling, the intensity of the electric field in a thunderstorm (i) grows with time, reaches the critical breakdown value, generates a lightning flash and its field drops to zero, while adding a ΔE to the intensity of the internal electric field in all thunderclouds (j) that are linked to it. The value of ΔE is inversely proportional to the distance between clouds i and j. Several topologies of the thunderstorm network were tested with varying degrees of coupling, assuming a fixed probability of links between active cells. The results suggest that when a critical value of coupling is surpassed, all thunderstorm cells will flash in a synchronized manner. The physical mechanisms that are possibly interacting will be discussed.

Microphysical effects of Saharan dusts on an orogenic thunderstorm

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Saharan dusts are usually transported into the Mediterranean by southerly wind associated with cyclones. They modulate radiative budget by the absorption and scattering of solar and thermal radiation. Another aspect of Saharan dust is its microphysical impact as cloud condensation nuclei and ice nuclei. It is known that the dry elevated mixed layer (ELM) from North Africa can cap the moist marine boundary layer, and set up "loaded-gun sounding" in the Mediterranean. The Saharan dust tends to be abundant in the EML. In addition, aerosols of salt particles from the Mediterranean Sea also are brought into the storms. The resulting mixture of mineral dust and sea salt has a strong impact on the precipitation process occurring in Mediterranean storms. This study investigates the sensitivity of an orogenic thunderstorm modeled for the Genoa 1992 flood event to the concentration and solubility of nucleating aerosols. The relative roles of the heterogeneous freezing nucleation process, the deposition-condensation nucleation processes of ice particles, and the activation of liquid hydrometeors are evaluated through the explicit numerical simulation of the storm using the University of Wisconsin Nonhydrostatic Modeling System (UW-NMS) and the newly developed Advanced Microphysical Prediction System (AMPS). The AMPS features the Hashino and Tripoli (Hashino and Tripoli, JAS, 2007) Spectral Habit Ice Prediction System (SHIPS), which is the first microphysics model to explicitly simulate the growth of ice habit characteristics beginning with the nucleating aerosol. The system also features the Hashino and Tripoli (2007) Spectral Liquid Prediction System (SLIPS) which predicts the evolution of the liquid drop spectrum from aerosol origins. These models provide the first explicit multidimensional simulations of the precipitation formation process and the explicit chain of events set off by the interaction between evolving droplets containing immersed aerosols, aerosols in the air parcel and evolving crystals, some nucleated by aerosols directly having varying habits, sizes and origins. This talk will feature a fascinating first look at these processes in the context of a complex dynamical storm and how they directly and indirectly affect the resultant precipitation produced. The results suggest a strong sensitivity of the precipitation process to the chemical properties of the aerosols involved.

Case studies of 4D-Var assimilation of potential vorticity observations derived from image processing

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Short-range forecasts errors occurring in numerical weather prediction are often diagnosed by forecasters as being displacement errors: forecast locations of meteorological structures are displaced from their observations, and this displacement can be evaluated through inspection of satellite images. However, current representation of background error are based on Gaussian assumptions, and linear or weakly non-linear data assimilation schemes are used to correct errors. This hypothesis is more and more critical as resolution increases and as the meteorological situation evolves more and more non-linearly. Therefore, high resolution forecasts models of strongly non-linear processes need a different, more realistic initialization especially when the background quality is poor or when few observations are available. Some methods have already been developed to identify and correct the position and amplitude of storm-scale thunderstorms and of tropical cyclones, including bogussing practices and variational assimilation of simulated observations. Despite the growing number of radiance data being assimilated, global models sometimes fail to predict

mid-latitude cyclogenesis, even if the upper or lower level precursors are visible in the images from geostationary satellites. Different operational procedures, often based on potential vorticity inversion, have been developed to exploit the link between water vapour images and the initial state of the upper level of the troposphere. The mediterranean region involves shorter scale; high impact cyclogenesis that require a precise initialisation of the coherent structures such as dynamical dry intrusions or convective cells. Our goal is to build observations of potential vorticity that correct the displacement and amplitude error of the dry intrusions using a image satellite processing technique. An objective algorithm developed for the identification and tracking of dry intrusions in water vapour imageries is used to define potential vorticity pseudo-observations in the upper troposphere. A simple object-based methodology produces observations that are built to locally correct the amplitude and displacement errors as diagnosed from the comparison of the trajectories in the image processing tool. An approximate form of Ertel potential vorticity operator is used to incorporate the pseudo-observations inside a 4D-var assimilation scheme. It is applied to real cases of cyclogenesis forecasts and within an operational data assimilation scheme, the high resolution (20 km over Europe) global model ARPEGE. Experiments on several cases studies highlight the ability of the algorithm to correct locally the tropopause and to partially improve the forecasts of the cyclogenesis. Advantages and drawbacks of this procedure are finally discussed.

Nowcasting lightning activity over the Mediterranean Sea

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As part of the EU FP6 FLASH project, we plan to develop nowcasting techniques to improve our short term estimates of heavy precipitation and possibly flash floods. As part of this effort the ZEUS lightning data were used to study to characteristics of lightning storms over the Mediterranean region. The ZEUS ground network is a very low frequency (VLF) lightning detection network run by the National Observatory of Athens (NOA). We have looked at the statistics of thunderstorms (lifetime, size, motion vectors, etc.) to better understand the characteristics of these thunderstorms. Using these statistics we have started to develop nowcasting algorithms that estimate the lightning activity in the next few hours. Initial results will be presented, while connections to heavy precipitation will be addressed in future research. Initial results are promising, showing that simple algorithms can give a useful estimate of the location of thunderstorms in the coming hours.

Case studies of selected Project "Flash" events

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Flooding is a consequence of the prevailing meteorological situation, the intensity and duration of precipitation, geomorphology, human activities over a geographical region and other factors. Floods result in damage and destruction of infrastructure and private property and, in some cases, in fatalities. Flash floods are sudden and quite localized in extend, characterized by excessive amounts of rainfall within a short period of time and are distinguished from other floods by the degree of severity. In the present study, selected Cyprus events submitted to Project “Flash” are investigated in detail. The meteorological situation and specifically the synoptic and dynamic characteristics and the thermodynamic instability indices one the day before, on the day of occurrence and one day after the flash flood event were accrued. Several thermodynamic indices were calculated, using the 1200UTC data from the representative radiosonde station at Athalassa. Also, the characteristics of the respective synoptic situation were examined and the fields of a lower tropospheric stability index, relative vorticity and divergence of the horizontal wind vector were calculated. The NCEP/NCAR global analyses for 0000UTC, with a grid of 2.5 x 2.5 degrees, were used in order to perform the necessary mathematical calculations. The calculations refer to an area bounded by the meridians 20 degrees West and 50 degrees East and the parallel circles 20 degrees and 65 degrees N. The above approach is a demonstration of the analysis that will be adopted for all the Project “Flash” events. The broader knowledge concerning flash floods is useful for the better understanding of the underlying thermodynamic and dynamic mechanisms as well as the associated physical processes. The wider understanding of flash floods that the above analysis provides, can form part of an integrated system for short and very short forecasting of these events.

RainFARM, stochastic rainfall downscaling, and beyond

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In the past two years we have spent some efforts in developing a practical tool for stochastic rainfall downscaling, which we called RainFARM: Rainfall downscaling by a Filtered AutoRegressive Model. In this contribution we briefly review the characteristics of RainFARM and the place it holds in the universe of rainfall stochastic models. We shall then spend some time in discussing how the stochastic models are practically nested into operational meteorological forecasts, and how the possible errors of LAM predictions can affect the whole downscaling procedure. Time allowing, we shall conclude with a perspective on physically-based models for rainfall downscaling, where one attempts at including in the model at least some of the dynamical properties of rainfall fields.

Space-time rainfall downscaling with multifractal models

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It is well know that rainfall fields display fluctuations in space and time that increase as the scale of observation decreases. Multifractal theory represents a solid base to characterize scale-invariance properties observed in rainfall fields as well as to develop downscaling models able to reproduce observed statistics. The availability of such downscaling tools allows forecasting of floods in small basins by coupling meteorological and hydrological models working on different space-time grid resolution. In this talk multifractal theory will be reviewed highlighting the most relevant aspects for rainfall downscaling (e.g., the concept of scale-invariance in rainfall fields displaying space-time self-similarity or self-affinity, the role of orography). The main results of the scale-invariance analysis of rainfall retrieved by remote sensors will be discussed. Finally the application of multifractal models for rainfall downscaling will be presented and some new ideas for ensemble verification will be argued.

Multi-Scale Variability of Orographic Precipitation and Topographic Attributes: Application to Rainfall Downscaling

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Precipitation downscaling requires a priori knowledge of the way rainfall statistics vary across scales in space and time. For orographic rainfall, these statistics are influenced by the interaction of the larger scale meteorological forcing with the underlying terrain. In this study we use wavelet-based multiresolution analysis to determine the signature that topography leaves on the multiscale structure of rainfall fields. We propose that at spatial scales on the order of 10 km and larger, rainfall variability can be resolved by a convolution with topography, where the convolution filter is parameterizable in terms of a suite of location- and storm-dependent meteorological variables. At scales less than 10 km, rainfall variability is explained statistically using an almost universal multiscale filter that operates on topography gradients. The proposed approach is tested using both observed orographic rainfall with ground-based radars and simulated rainfall from high resolution cloud resolving models over the Appalachian mountains. The challenge of temporal downscaling is also addressed.

Statistical downscaling of synoptic environments for High Precipitations Events over southern France: an objective method of selection.

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The Cevennol precipitations events can bring on flash floods with serious societal impact over the french southern coast. Some studies have reported theses situations often match with strong synoptic forcing. This study aims at determining over long periods whether these synoptic conditions are necessary or not, and whether they reciprocally could help detect objectively these events even their analogues in future climate simulations. This study has been carried out by the french CYPRIM project. As a preliminary step, we looked for the large scale patterns that usually come with the High Precipitations Events (HPE) over the present period. The data comes from the ERA40 reanalysis for the synoptic parameters (the 500hPa geopotential height (Z500) has been chosen for the classification), and the precipitations from the Meteo France rainfall gauges network, the period is between 1958 and 2001 for autumn seasons (September to December). From the rainfall data, a set of 220 HPEs is selected to characterize the extreme part of the precipitations. However, a larger set of a thousand significant precipitations days must be used to apply the dynamical clustering method that produced a 4 Z500 clusters classification. For the two classes representative of the major part of the HPEs, the composite analysis shows the existence of a strong cyclonic activity over the Atlantic forwarding effects over Spain and western Mediteranean, and also a strong ridge over central Europe that could point convergent lower level flows over the concerned region. The reciprocal standpoint is evaluated by selecting among all the whole period Z500 fields, the ones that are spatially correlated to the rainfall centroids. The result shows that the Z500 is discriminating 20 percent of the extreme situations, which is significant but not enough to build a criterion. Then, the lower level 925hPa moisture flux is sequentially added and brought the detecting potential of the algorithm up to 80 percent. This algorithm has been applied in climate simulations to identify synoptic environments favoring the HPEs (this study is described in the Nuissier, Joly contribution).

Rainfall downscaling, LAM predictions and rain gauge data

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We compare the precipitation forecasts obtained from operational Limited Area Models (LAM) with the direct observations of a regional network of rain gauges. A major problem in this exercise is the inconsistency of the scales reliably resolved by the meteorological models, say at

most a few tens of kilometers, and those sampled by the individual rain gauges. To overcome this difficulty, we use the RainFARM approach and we stochastically downscale LAM predictions to small spatial and temporal scales comparable to those sampled by the rain gauges. In this way, we obtain mixed deterministic-stochastic predictions that exactly preserve the LAM field above a given reliability scale (which we vary between 7 and about 100 km) and are represented by an ensemble of RainFARM downscaling fields at smaller scales. We apply this procedure to a large study area covering North-Western Italy, and address the following (related) questions: (1) what is the overall skill of the prediction, i.e., does the operational chain that includes the LAM and RainFARM correctly predict the observed rainfall, and (2) what is the choice of the reliability scale that optimizes the prediction skill.

A Neural Network based approach for the downscaling of precipitation fields.

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A collection of one year daily forecast with MM5 mesoscale model has been used to investigate the possibility to downscale at an horizontal resolution of 3 kilometres the precipitation fields obtained with MM5 simulation carried out with an horizontal resolution of 27 kilometres. The input pattern of the multi-layer Neural Network is built with information of terrain, landuse and predicted precipitation in 4 adjacent grid points of MM5 grid. The preliminary results obtained for a domain of complex orography show as the proposed technique is suitable to obtain a realistic downscaled precipitation field. Emphasis is given to the possible application of the methodology for the coupling of hydrological and meteorological model or for the downscaling of precipitation fields simulated by GCM climatic model to investigate the effects at hydrological scale of climate change.

Use of Rank Histogram to verify consistency of ensemble precipitation fields simulated by downscaling models

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Multifractal models for precipitation downscaling are used in hydrometeorological forecasting chain in order to bridge the spatial and temporal scale gap between meteorological and hydrological models, since they are able to reproduce the statistical behavior of precipitation at high resolution starting from information at coarse scale. Their operative use within such forecasting chain is usually achieved by means of calibration relation between their few parameters and meteorological observable at coarse scale predicted with low uncertainty by meteorological models. In this study, we propose a method to test the consistency hypothesis (i.e. observed and ensemble members are drawn from the same distribution) for the spatiotemporal precipitation fields outputted by downscaling models. The verification procedure is based on a generalization of the Rank Histogram, a graphical device currently adopted in applied meteorology to test consistency of univariate variable. In particular, the variable used to build the histograms in the method here proposed is the exceedance probability of fixed precipitation thresholds at the fine scale. The verification method has been applied and tested by means of three numerical experiment using a multifractal downscaling model based on a Log-Poisson generator with two parameters (c and b)p. The strategy adopted to carry out the experiments is to first use the multifractal model to synthetically generate set of events that are considered as "observed events". Then model parameters are estimated on these "observed events" and interpreted according to different calibration modes. Finally, the "observed events" are hindcasted applying these calibration modes and Rank Histograms are built for different precipitation thresholds. Results of the three experiments allow us to show that the adoption of calibration relations between model parameter and coarse meteorological observable can be able to reproduce the sampling variability leading to consistent ensemble members.

A Bayesian approach to determine the rainfall thresholds for shallow landslides triggering

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The rainfall thresholds are, in this work, defined as the critical value for the combination of two controlling variables: a variable expressing the soil moisture conditions antecedent a storm event and a variable describing the magnitude of the storm event (e.g. rainfall intensity, total rainfall volume of the event). We used a statistical Bayesian approach in order to estimate the rainfall thresholds by choosing a critical value for the exceedance probability of the landslides given the two controlling variables. The study is based on the available data of the Emilia-Romagna for the landslides occurred in the last 70 years and specifically those located within the Reno catchment. The joint probability distribution function of the controlling variables conditional to a landslide does not show indication of critical threshold as it has been shown by previous works. We think that is not the correct way to analyze the data. As a matter of fact the comparison of the marginal and conditional pdfs of the controlling variables shows evident differences. By applying the Bayes's theorem, it has been possible to estimate the probability of a landslides event conditional to the controlling variables and confirm the intuitive dependence of the shallow landslides from the triggering factors.

Correlations between rainfall and landslides in 3 Provinces of the Emilia-Romagna Region, northern Italy

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Rainfall is a major trigger of landslides. In this work, we attempt to determine correlations between historical landslides and rainfall in the 51-year period from 1951 to 2002, in the Reggio Emilia, Modena and Bologna Provinces of the Emilia-Romagna Region, Northern Italy. We investigate the relationship between the cumulative rainfall for different periods and the abundance of the triggered landslides. We examine the correlation between measures of the antecedent precipitation and the abundance of the triggered landslides. Adopting a Peak-Over-Threshold (POT) technique, we analyse the correlation between extreme values of daily rainfall and the abundance of the triggered historical landslides. We use daily precipitation measurements for selected rain gauges, and we exploit a catalogue of 2253 historical landslides. The 2253 individual landslides reported in the historical catalogue, corresponding to 1057 days with landslides (DL), were further grouped into 596 different landslide events (Sevent), consisting of 1 to 129 landslides each. Grouping was performed by considering the successive landslides over time; during the winter (summer) a period of four (two) days without landslides was considered a separate event. We examine the correlation between the cumulated rainfall amount for different rainfall periods, from 1 to 30 days, and: (i) the number of triggered landslides in a day, DL, and (ii) the number of triggered landslides in during a landslide events, Sevent. We find that for short periods of antecedent rainfall the minimum amount of rainfall necessary to trigger landslides varies considerably with Sevent (the magnitude of the event), and that for long antecedent period Sevent is largely independent of the cumulative amount of rainfall. However, the largest landslide events are always preceded by abundant rainfall. Next, we compare measures of precipitation with the occurrence (or lack of occurrence) of landslide events. We experiment with trend corrected and weighted trend corrected measures of precipitation, and we find that no clear relationship exists between the trend of precipitation and the occurrence and magnitude of landslide events (Sevent). We take this as indication that climate and its decadal variation were not significant for the initiation of large landslide events in the three studied provinces of northern Italy during the considered period. An improved correlation exists for the medium-term trend of precipitation, indicating that seasonal variations in rainfall were significant for the initiation of medium to large landslide events. Lastly, we analyse the correlation between extreme values of daily rainfall and extreme values of landslide magnitude, measured by DL and Sevent, and we find that this correlation is larger for Sevent and much reduced for DL. This justifies the use of Sevent to model the historical distribution of landslides in the investigated area.

Hydrodynamic-statistical method of forecast of dangerous precipitation and incurred floods and landslides over the Central and East Europe

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This report presents the results of application of a short-term (up to 12-24-36 hours) automated method of forecast of dangerous precipitation in different seasons over the Central and Eastern Europe. The method is based on statistical interpretation of output hydrodynamic forecast of the hemispherical model. The statistical decisive rules for diagnosis and prognosis of dangerous precipitation for the warm and cold seasons were calculated separately using the data samples of objective analysis in accordance with the data on precipitation over the Central and East Europe. The problem of choose of informative vector-predictor is decided by method of diagonalization of correlation matrix and choosing of factors from blocks of connection predictors. The probabilities of two grades of precipitation, connected with discriminant function, are calculated in the nodes of the grid of 150x150km, covering the territory of Central and East Europe. The conditional probability of floods and landslides is also calculated automatically in the nodes of the grid according to the duration of forecasted dangerous precipitation of different grades. The paper presents the examples of the forecast of floods and landslides at the territory of the Northern Italy and in Central East and Southern Europe.

Wave climate and prediction of the Spanish Mediterranean coast

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Waves conditions of the Northern Spanish Mediterranean coast reflect the variability of meteo-oceanographic patterns. They are conditioned by the presence of sharp gradients in orography and by the relatively small sized low pressure centres which may travel in any direction or even recirculate in the North-western Mediterranean. This leads to a sort of "torrential" like wave climate difficult to characterize both in physical and statistical terms. The paper will discuss both aspects in terms of i) Statistical distributions, particularly those of extreme values ii) Wave forecasting, particularly for the short duration wave storms commonly encounter in this part of the Mediterranean. The paper will use results and also present the XIOM network of buoys deployed along the catalan coast. It will also use results from the operational predictions carried out jointly by the Catalan meteorological

service (Servei Meteorològic de Catalunya) and CIIRC (International Centre for Coastal Resources Research). This predictions can be seen at http://www.boiescat.org . The talk will end with some conclusions on the difficulties to analyse wave forecasting and climate in semi-enclosed sea domains.

Changes of wave climate inferred from scenario simulations

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This study is based on 30-year long simulations of the wind-wave field in the Mediterranean Sea carried out with the WAM model for the A2, B2 emission scenarios and a control CTR simulation based on the 1960-1990 emission level. Changes of wave climate are linked to those of the weather systems generating them. The wave model is forced by the wind field computed by a regional climate model simulation with a 50km resolution. The monthly mean SWH (Significant Wave Height) field of the A2 scenario is lower over large fraction of the Mediterranean sea in winter, spring and Autumn. In summer the SWH is reduced in the central part of the basin and increased in the eastern and western parts. All these changes are smaller or less significant in the B2 scenario, but in winter when average SWH is higher in the B2 scenario and in the western basin. The SWH reduction is valid also for extreme values and is larger for the A2 than for the B2 scenario. The only exception in a significant increase of the SWH extremes in the central Mediterranean during summer. In general results shows a milder wave climate in future scenarios than in the present climate, with changes that are consistent with those of the atmospheric circulation and cyclone activity.

Flash-floods in Catalonia: the social perception in a context of changing vulnerability

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In the Iberian Peninsula, Catalonia is one of the areas that is most affected by floods. Every year, during the summer or at the beginning of autumn, flash floods affect the littoral mountains or the Pyrenees region, although sometimes they can also occur in spring. Usually, the maximum accumulated rainfall is less than 100 mm, with instantaneous intensities above 3 mm/min, but sometimes more than 200 mm can be recorded 24 hours. This has been the case of the flash flood events recorded on 10th June 2000, 31-1st July 2002, 11th April 2002, 18th October 2003 and 12-14 th September 2006. However, other events with less precipitation, like 8-9th October 2002, 2nd August 2005, 11-13th October 2005 and 13-15th November 2005, can have a major social impact. This contribution, developed in the framework of the European Project FLASH and the WMO project MEDEX, analyzes the different social perception of those events. The contribution takes into account that a number of perception studies in connection to floods have been already carried out. Indeed, the studies on floods were the first to include the psychological aspects accompanying flood events. Some authors distinguished three groups of factors influencing amplification of the perceived risk: personal characteristics, situational factors and risk characteristics. Situational factors are very important, in particular media attention. The media is one of the most important sources of disaster information and it significantly influences or shapes how the population and the government view, perceive, and respond to hazards and disasters. Others authors goes even further and claims that the perception of risk is reflected by the media's coverage of these events. All the studies suggest that the power of the mass media in the perception of a natural disaster, like for example floods, is essential. This study will assess the perception of flood risk in the population of Catalonia on the basis of information provided by the mass media, in particular by the press, since it has been demonstrated that the mass media are a key element in constructing social perception.

Flood in Prague in August 2002 and what has been learned from its Impacts

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In August 2002, the largest flood ever recorded occurred in Prague and over many parts of the Czech Republic. This flood was caused by intensive long-lasting rains that were brought by slowly moving cyclone. This cyclone was formed in the Mediterranean region. In our presentation we give analysis of this extraordinary event and its impacts on the inhabitants and property of Prague with respect to it historical parts. We give also overview of system of warning that was used to warn and protect the people. Finally, we describe what has been learned and what arrangements have been done since that for better possibilities of protection in such next floods.

A conditional probability approach to spatially distributed flood scenarios simulation

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The flooding risk impact on society cannot be understated: it influences land use and territorial planning and development both at the physical and regulatory levels. To cope with it, a variety of mitigation actions can be put in place, from the improvement of monitoring systems to the development

of hydraulic structures, throughout land use restrictions and civil protection plans, involving multidisciplinary competences. All of those viable options present social and economic impacts, either positive or negative, whose proper estimate should rely on the assumption of appropriate – present and future – scenarios, i.e. quantitative event descriptions in terms of $i)$ the flood hazard, with its probability of occurrence, extension, intensity, and duration, *ii)* the exposed values and *iii)* their vulnerability. At present, initial attention has been devoted to the design of flood scenarios, or ensembles of them, and to the evaluation of their frequency of occurrence. Instead, maps which represent the union of all flood prone areas for assigned return times, are used to direct structural and non structural mitigation actions. In the present work, a spatial model for flood scenario frequency assessment is proposed, and applied to the Italian territory. First, the study area has been divided into homogeneous regions according to their hydrologic, orographical and meteo-climatic characteristics. Then, a statistical model for flood scenarios simulation has been implemented throughout a conditional approach by using $i)$ a historical flood events dataset; *ii)* a homogeneous regions correlation matrix; and *iii)* an auxiliary variables data set.

Pseudo-observations assimilation in numerical weather forecasting

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The Multimodel SuperEnsemble technique (Krishnamurti et al., J. Climate, 13, 2000) is a powerful post-processing method for the estimation of weather forecast parameters. Several model outputs are combined, using weights calculated during a training period. This technique has been already tested and implemented in many works on limited-area models in order to obtain good parameter forecasts in complex orography regions (Cane and Milelli, Meteorologische Zeitschrift, 15, 2, 2006). On the other hand, it has been demonstrated (Sanna et al., ICAM 2007) that the assimilation of non-GTS stations from the ARPA Piemonte very high-resolution network into a limited-area model is of crucial importance in the forecast. The purpose of this work is to join the two approaches by assimilating the forecast given by the Multimodel SuperEnsemble technique into the COSMO-LAMI, the Italian implementation of the COSMO model, developed by the COnsortium for Small-scale Modelling, an over-national consortium coordinating the cooperation of the national and regional weather services of Germany, Italy, Switzerland, Greece, Poland and Romania (see http://www.cosmo-model.org/ for a more comprehensive description). In details, we assimilated into the model the 2 m temperature, the 2 m dew point temperature and the sea level pressure forecasts given by the Multimodel SuperEnsemble technique in all the available stations of the ARPA Piemonte network as if they were observations. The selected test case is the 1-2 May 2007, when a cold front, associated to a deep low, affected Piemonte region determining great instability and strong precipitation especially in the northern part. The forecast given 24 hours before the event was affected by an error in the localization of the main precipitation pattern. Therefore the considered run starts the 20070501 at 12UTC for 36 hours, during which the model assimilates the Multimodel SuperEnsemble technique forecast obtained by using the previous runs (20070501 00UTC and 20070430 12UTC, respectively) of IFS model, COSMO-LAMI and other two implementations of the COSMO model which are available at ARPA Piemonte for research purposes: the COSMO-LM from Deutscher Wetterdienst (DWD) and COSMO-aLMo from MeteoSwiss. The results, although preliminary, showed an improvement of the precipitation and of the surface parameters in a statistically significant way compared to the operational run, according to the bootstrap method.

New global rainfall intensity - rainfall duration thresholds for the initiation of shallow landslides and debris flows

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New minimum thresholds of rainfall duration and intensity likely to result in shallow landslides and debris flows are obtained from a global catalogue of 2626 rainfall events that have resulted in shallow hill slope failures. Rainfall intensity - rainfall duration (ID) values are plotted in logarithmic coordinates to establish that with increasing rainfall duration the minimum average intensity likely to trigger landslides decreases linearly. Based on this observation, minimum intensity - duration conditions for the possible initiation of shallow landslides and debris flows are established. The new global thresholds are significantly lower than the global threshold proposed by Caine in 1980, and lower than other global thresholds proposed in the literature. To cope with differences in the intensity and duration of rainfall likely to result in landslides in different climatic regions, the rainfall information is normalized to the mean annual precipitation and the rainy-day-normal. To further investigate the role of climate in the initiation of shallow failures, the available rainfall data are subdivided in climate subsets, and the minimum ID thresholds for the likely occurrence of shallow landslides and debris flows in six different climates are established.

A catalogue and web site of rainfall thresholds for the initiation of precipitation-induced landslides

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Rainfall is a recognized trigger of landslides, and investigators have long attempted to determine the amount of precipitation needed to trigger slope failures. Through an extensive search of the international, national and local literature, we have recently compiled a world-wide catalogue of rainfall thresholds for the possible occurrence of rainfall-induced landslides, including global, regional, and local thresholds. The catalogue currently lists 125 thresholds proposed in the literature in the period from 1970 to 2006, in five continents. In the catalogue, rainfall thresholds are classified based on the type of threshold, the geographical extent of the area for which the threshold is applicable, and the type of landslides predicted by the threshold. We designed a specific web site (http://rainfallthresholds.irpi.cnr.it/) to disseminate the collected information on rainfall thresholds for the initiation of landslides. Through the web site, interested users can search the catalogue based on the type of the threshold (in 16 classes), the type of landslide (in 8 classes), the geographic area, and the extent of the area for which the threshold is defined. In addition, the web site lists more than one hundred papers and reports on rainfall induced landslides.

The empirical model SMART - Shallow landslides Movements Announced trough Rainfall Thresholds

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The Arpa Piemonte Regional Warning System Service is based on an advanced meteo-hydrological automatic monitoring system and it is integrated with forecasting activities of severe weather related natural hazards. At present, a hydro-meteological chain is operationally run to provide flood forecasting on the main river network. The development of a forecasting tool for shallow landslides triggering by heavy rainfall is here presented. Due to the difficulties in modelling shallow landslides triggering in a large and complex area like Piemonte region, an empirical model is developed on the basis of the correlation between rainfall and landslide movements in historical information. The research focused on establishing rainfall thresholds for landslides triggering, differentiating the critical rainfall values through an 'a priori' geological characterisation of the different territories. The rainfall events responsible for widespread shallow landslide movements that involved the Piemonte region in a period between 1990 and 2004 are considered. A total number of 20 rainfall events and 200 landslides with precise information about triggering time are used to calibrate the system. As a first outcome, two different zones have been identified: 1) includes zones that require higher values of critical rainfall and are principally characterized by a bedrock composed of metamorphic rocks, igneous rocks, dolostones or limestones in alpine environment; 2) includes zones that require lower values of critical rainfall and are principally characterized by sedimentary bedrock in hilly environment. Verification has been performed on the whole 15 years rainfall data set. The results show a good reliability of the model with no missed alarms and a very little number of false alarms, thus suggesting an effective operational implementation.

The effects of rainfall-induced seepage on slope stability

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The tacit assumption made in the majority of liquefaction analyses is that no change in volume occurs prior to the initiation of pre-failure instability. However, evidence from geotechnical case studies and physical model tests suggest that granular slopes, because of their high permeability, can undergo localised dilation, even during relatively brief rainstorms. The potential for the development of instability under partially drained conditions is therefore of considerable practical importance, particularly when it may have consequences that are more severe than those occurring under undrained conditions. An experimental investigation of the effects of pore-water migration on the initiation of pre-failure instability in a saturated sand is presented. The domain of stress space in which instability develops is identified under various strain-paths, and its relationship to the zone of instability observed during undrained shear is explored. Results demonstrate that water content redistribution may render a sand unstable that would otherwise stabilise at the quasi steady state during undrained deformation, implying that the presumption of undrained conditions cannot always be regarded as conservative. Thus, partially drained conditions that result in even very small dilative volumetric strains can trigger instability at constant shear stress that would not develop if conditions remained undrained without some initial increase in shear stress. Pre-failure instability is affected not only by the initial state of the sand but also by the strain increment ratio imposed during shear. The response is controlled mainly by the difference between the imposed strain increment ratio and the maximum strain increment ratio obtained from a drained test conducted under the same initial effective stresses. In very loose sands, for example, the maximum strain increment ratio is typically greater or equal to zero and instability tends to occur under undrained conditions. However, in dense sands with a negative maximum strain increment ratio instability is possible only when the imposed strain increment ratio is more negative. The relevance of the insitu stress conditions, the preloading history and the kinematic constraints on the collapse mode are discussed.

Landslide monitoring using reactive sensor networks with high-speed local positioning

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High infiltration capacities associated with the residual soil mantle of steep, humid hillslopes and the presence of less permeable bedrock at depth create conditions that favour the mobilisation of shallow landslides. Typically, rainwater and snowmelt permeate the subsoil under gravity and capillary forces to an underlying low conductivity layer. The permeability contrast leads to the development of a perched water table, and downslope saturated flow ensues. In regions where shallow subsurface storm flow is the dominant means by which water reaches the channel all incident precipitation must pass through a largely unsaturated soil profile before contributing to runoff. Hence unsaturated zone processes may directly control the timing and magnitude of positive pore pressure development and slope instability. This paper presents the results from a series of field experiments designed to investigate the mechanisms by which rainfall signals propagate through an unsaturated soil profile and ultimately trigger slope failure. The behaviour of a small unchannelled headwater basin, driven to quasi-steady state by sprinkler-irrigation, was monitored by a network of wireless probes with high-speed local positioning embedded within the regolith. A novel sprinkler programme was devised to produce a long period of steady flow conditions, during which tracer studies were conducted to verify subsurface flow paths and effluent geochemistry, followed by high-intensity storm simulations. Analysis of the hydrologic response reveals that unsaturated zone dynamics play a primary role in dictating the spatio-temporal evolution of pore pressures and discharge from the hillslope. Runoff is controlled by a dynamic subsurface region just upslope from the channel head where there is interplay between exfiltrating bedrock flow and vertical percolation through the mantle. Owing to the steep characteristic curve for these soils, even relatively light rainfall tends to drive pressure heads to zero whilst remaining far from saturation. With the onset of steady discharge the vadose zone, saturated zone, and groundwater flux became delicately linked, such that a rapid increase in rainfall intensity led to a saturated zone response and peak discharge which occurred much faster than could have happened through advection alone. The precipitation spike produced a transient pressure wave that travelled relatively rapidly through the unsaturated zone, inducing a large change in hydraulic conductivity and the rapid effusion of stored pore-water. This groundwater redistribution was sufficient to induce localised dilation within the colluvium, triggering a translational landslide which mobilised rapidly into a debris flow. Infiltration tests on intact soil cores show that momentum dissipation dominates flow in soils with highly non-linear soil-water retention properties when input rates and antecedent soil-water contents are high. A slight pressure head increase in the near-zero pressure head range can lead to the release of stored soil-water into larger macropores, setting up conditions that favour the initiation of preferential flow. Hence, minor rainstorms which fall on nearly-saturated hillslopes can produce small variations in pressure head that are accompanied by correspondingly large changes in water content, giving rise to the transmission of pressure waves in response to increased rainfall intensity and a relatively rapid response in the vadose zone. Such a coupled dynamic process is believed to be the underlying mechanism that enables short bursts of rainfall to induce slope instability, and supports the hypothesis that storm sequencing may have a greater effect on pore pressure development than cumulative rainfall.

Stochastic models of time series and fields of daily precipitation sums

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In the work some questions associated with stochastic simulation of time series, spatial and time-spatial fields of daily precipitation sums for uniform grid and for not uniform grid with regards to observation data are considered. Some different models are considered. For example for not uniform grid or for weather-station system models are constructed taking into account the heterogeneousness of fields. For uniform grid the approximation by homogeneous field are considered. Models are based on nonlinear transforms of Gaussian series and field. In parameters of models are univariate distributions of precipitation sums, correlation matrixes and correlation functions of indicator processes and fields and also spatial correlations of precipitation sums under condition of their fall out. The accuracy of estimates and reproduction accuracy required input characteristics in models are investigated. As approximation for univariate distributions of precipitation sums the cubic polynomials are used in combination with spatial functions for approximation for tail of distribution. The model verification are carried out for test characteristics which are not in parameters of model. These characteristics are estimated with the help of real data and with the help of modeling realizations. Becoming results of comparison of these estimations are presented in the work. On basis of the models some statistical properties of precipitation extremes are investigated.

A methodology for the vegetational stress assessment in Mediterranean areas

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The study deals some aspects concerning the desertification risk assessment through the study of the climatic evolution effects on the vegetational species. A Vegetational Stress Index (VSI) has been developed and applied to a test case area located in the south-east part of Basilicata Region territory,

southern Italy. VSI depends on the existing cultures characteristics, the amounts of really absorbed rainfalls by the vegetation and the cultural evapotranspiration. Index and of the deficit in irrigation temporal maps have been produced in order to describe the stress level in different seasons and its evolution over the period from 2002 up to 2006. The results show that natural bushes and Mediterranean scrub are the most easy-fitting species to the characteristics of large part of analysed territory, while medium levels of vulnerability especially refer to olive tree and cereals cultivations. Stress value scale does not match to the water demand in irrigation, due to the different needs for the existing vegetational species. Thus planning actions must taking into account the necessary equilibrium from water quantity and product quality, including in this way socio-economical aspects for both large scale and local policies. The proposed methodology addresses a key value of a Decision Support System aiming sustainable development strategies for the mitigation and the prevention of scenarios related to environmental risks, such as land cover changes and productivity loss of the soil, generally. This methodology could support planners in the definitions of the actions on territorial systems with respect to agricultural resources, soil characteristics, irrigation water demand in a global view of sustainable use of water resources.

An observational and numerical analysis of a heavy rain event over south-eastern Italy.

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A flash flood episode affecting a small area in Apulia region (south-eastern Italy) has been documented on 22 October 2005. A rainfall of 160 mm has been recorded in a 6-hour interval in the central part of the region, producing severe damages and causing six fatalities. Synoptic maps, observations from surface stations and remote sensing data are used to describe the evolution of the system. The analysis of the vertical profiles suggests that the small hills in the centre of the region play an important role in the release of the instability and the localisation of the rain. Numerical simulations have been performed to understand the mechanisms responsible for the heavy rain event. The Weather Research and Forecasting Model (WRF) has been setup in a 2-way nesting configuration including two domains. Model results show that the model is able to realistically simulate the evolution of the system and to capture pretty well the localisation, the amount and the timing of the rainfall, although a strong sensitivity to the specification of the initial conditions is apparent. Finally, some sensitivity experiments have been performed to evaluate the role the surface sensible and latent heat fluxes for the development of the system.

Verification of Numerical Weather Prediction limited area models by remote sensing observations

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Two NWP models are currently developed by the Dynamic Meteorology group of the Institute of Atmospheric Sciences and Climate (ISAC-CNR): the hydrostatic model BOLAM and the non-hydrostatic convection resolving model MOLOCH. Both models are successfully employed in operational forecast by various meteorological services. A many-sided verification is an important component of this development. Two case-studies, characterised by the presence of intense weather systems in the North Mediterranean region, are simulated by both models. The analysis is based on the comparison between satellite observations taken from the Meteosat-7 and their simulated analogues obtained by the RTTOV software, developed in the context of the EC project SAF. This technique turns out to be very useful for the evaluation of the model dynamical and physical scheme performance. In addition, data from the meteorological radar of the Ligurian Meteorological Centre (ARPAL-CFMI) are being compared to simulated radar reflectivity derived from the 3-D precipitation field of the MOLOCH model. This work demonstrates the benefit of atmospheric remote sensing observations for the verification of NWP models. This effort has been carried out as part of EC project AMPHORE.

A Numerical Study of an in-situ Adriatic Mesocyclone: Formation and Development

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The Eastern Adriatic coast is often subject to the severe weather events, including heavy precipitation and strong winds, associated with land-falling cyclones. Most of these cyclones originate over the western Mediterranean Sea, northern Italy or northern Adriatic Sea. In this research, a class of meso-β scale cyclones has been identified that forms over the middle Adriatic, to the lee of the Apennine mountains of Italy. These cyclones may trigger severe weather along the eastern Adriatic coastal region but because of their small size and the complexity of the terrain in the region they are often poorly resolved by numerical weather prediction models. Herein, in this study we investigate the life-cycle of one of these meso-β systems by a series of numerical simulations. The numerical analysis is aimed at isolating the effects of the mechanical forcing associated with the surrounding complex topography as well as the upper-level dynamical factors and surface sensible and latent heat fluxes on the formation and development of the mesocyclone. Our preliminary sensitivity experiments indicate that the cyclone is strongly modulated by both the Apennines and the Dinaric Alps and that the upper-level shortwave trough is the

essential contributor to the cyclone deepening. Furthermore, sensitivity experiments that isolate the effects of surface sensible and latent heat fluxes over the Adriatic Sea on the initiation and deepening of this mesocyclone are also discussed.

Relationship between cloud-to-ground lightning activity and cloud ice distribution profiles produced by MM5 model over the eastern Mediterranean

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In this study we examine the possible connection between cloud ice and cloud-to-ground lightning activity. In order to investigate the presence of such a relationship, a number of cases with significant lightning activity over the region of the eastern Mediterranean are selected. The lightning data are provided by the ZEUS lighting detection system, operated by the National Observatory of Athens. For the same cases, simulations with the non-hydrostatic MM5 model are performed with the aim to reproduce the cloud ice profiles within the clouds of the systems related with the lightning activity. As lightning is related with presence of ice, at a first stage comparison of the simulated ice content with observed lightning provides an additional verification tool of the model performance. At a second stage, the simulated ice fields could be further used as a proxy for the presence of electrical activity.

Study cases of downslope windstorms in Northwestern Greece

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This study describes the leeside wind events of 25-26 March 1998 and 16-17 March 2003, the most intense wind events of the last decade at the region of Ioannina city, in Northwestern Greece. The waves that developed over the lake of Ioannina produced flooding in the areas around the lake coast. The topography that surrounds the city of Ioannina and particularly the mountain Mitsikeli seems to play an important role in the modification of the wind field during these wind events; however this modification can hardly be defined due to the lack of several observing stations at the area. For this reason, a non-hydrostatic model (MM5) is used in order to identify the regions over Ioannina basin where the wind reaches its maximum intensity, and to assess the influence of mountain Mitsikeli on the wind field, using high resolution simulations at 2 Km grid increment. Moreover, the aim of this study is to determine whether the model can successfully simulate strong downslope winds in the lee of the mountain Mitsikeli.

Evaluation of Convective Precipitation Schemes during the Warm Season of the year 2006 – 2007 over Greece.

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This study is devoted to the evaluation of the role of various convective parameterization schemes on the quantitative precipitation forecasts during the warm season of the year at regional scale. For this reason the non-hydrostatic model MM5 is used. Namely the schemes proposed by Kain – Fritch, Betts – Miller and Grell are evaluated. The analysis is based on the simulation of 16 cases of heavy precipitation that occurred over Greece during the warm season (May – September) of 2006-2007. Precipitation forecasts provided by MM5 model at 8-Km grid increment are verified against the observational data from the local rain gauges network. Further, as warm season precipitation is often convective and localized a further verification of the model performance is made using lightning observations provided by the Zeus Lightning Network generated by the National Observatory of Athens.

ABSTRACTS

WEDNESDAY

Atmospheric circulation patterns associated with extreme precipitation amounts in Greece

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The main synoptic conditions associated with extreme precipitation amounts in Greece are examined by using a multivariate statistical methodology comprising S-mode Factor Analysis and k-means Cluster Analysis. The data used consists of: i) daily precipitation amounts (measured at 6UTC) for the meteorological stations of Hellenikon (Athens), Thessaloniki (northern Greece) and Ioannina (western Greece) and ii) daily (18UTC) 2.5x2.5 grid point values of 500hPa geopotential height, sea-level pressure and 1000-500hPa thickness at 273 grid points over Europe (10W to 40E and 30N to 60N), for the period 1970-2002. The dates corresponding to the upper quintile (5%) of the frequency distribution of precipitation are selected for each one of the three stations. In total 369 dates are used, some of them being common among the stations. The corresponding 369x273 data matrices of 500hPa geopotential height, sea-level pressure and 1000-500hPa thickness are constructed. The rows refer to the 369 extreme precipitation cases and the columns refer to the 273 grid points. The three matrices are unified into one 369x819 matrix. In order to reduce the dimensionality of the data set, S-mode Factor Analysis is applied to the unified matrix, revealing 7 factors accounting for 85% of the total variance. Finally, k-means Cluster Analysis is applied to the factor scores matrix, classifying the 369 cases into 9 clusters. For each one of the 9 clusters revealed, the mean 18UTC patterns of the above parameters are constructed and presented. These patterns correspond to the main distinct atmospheric circulation structures favoring extreme precipitation amounts in Greece. Most of the patterns are characterized by enhanced cyclonic activity over or near the Greek area. The differences among the 9 circulation structures refer mainly to the position and the intensity of the surface and the upper air synoptic systems involved. Some of the 9 synoptic conditions favor extreme precipitation amounts mainly at one or two of the three stations while the rest of them equally affect the three stations.

Indices of Precipitation Extremes in Southern Portugal – a geostatistical approach.

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Most studies and previews of future rainfall patterns, based on past observed records for Mediterranean climate areas, point to a decline of the rainfall amounts throughout the year, and to an increase of the frequency of heavy/intense rainfall events particularly in the winter season. These changes in heavy rainfall events may have severe implications and impacts on soil erosion and the respective associated soil degradation's risks. The focus of the present paper is to evaluate the spatial distribution of extreme precipitation events in Southern Portugal, using a geostatistical approach to assess the relationships between spatial and temporal extreme rainfall patterns. The dataset used in this work comprises a set of 105 station records of daily precipitation observations within the period 1960-2000. Two indices of extreme precipitation were selected - one representing extremely heavy precipitation events and the other one representing flood events. For each one, yearly trends and decadal space-time patterns were also evaluated.
The preliminary results of the geostatistical analysis although showing no significant temporal trends in the regional extreme indices it indicates that the spatial patterns are more continuous in the last two decades than the previous ones. Keywords: Indices of Precipitation Extremes, Southern Portugal, Geostatistical approach

Geostatistical Stochastic Mapping of Extreme Precipitation in Southern Portugal

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As other Southern European regions, the rainfall regime in Southern Portugal is highly variable in both the spatial and temporal dimensions, being clearly Mediterranean. Geostatistical techniques, known as kriging, provide statistically unbiased estimates of surface values from a set of observations at recorded locations, using the estimated spatial and temporal covariance structure of the observed data. Several geostatistical procedures also allow incorporating auxiliary information into the spatial prediction. However, traditional

geostatistical techniques may not be appropriate for mapping precipitation patterns in Mediterranean climate regions, because of the well known smoothing effect of kriging. To overcome this weakness, a stochastic geostatistical approach is proposed for mapping extreme precipitation in Southern Portugal. Moreover, this approach has the advantage of allowing the uncertainty assessment of the generated maps. It is recognized that topography and other geographical factors are responsible for considerable spatial heterogeneity of the precipitation distribution at the sub-regional scale. For precipitation mapping we explore the application of the direct sequential cosimulation which allows incorporating covariates, such as altitude or distance to the coastline. The stochastic simulations were developed for extreme precipitation series in a 800x800m grid. The technique is illustrated using high quality daily precipitation observations measured at 105 monitoring stations located in Southern Portugal, within the period 1970-2000. The rainfall patterns are analysed in the spatial and temporal components, and uncertainty is assessed.

Trends in extreme precipitation events in Portugal

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Mainland Portugal is located in the transitional region between the sub-tropical anticyclone and the sub-polar depression zones. The spatial distribution of precipitation over the territory and its seasonal variability are the result of the characteristics of the global circulation (specifically the Atlantic origin of many synoptic disturbances; e.g. seasonal movements of the Azores high pressure system) in the context of the regional geography (e.g. latitude, orography, oceanic and continental influences). Although the variation in climate factors is rather small, it is sufficient to justify significant variations in precipitation. Although mainland Portugal is not located in the Mediterranean basin, it is characterized by mild Mediterranean climate, with a warm and dry summer period, more pronounced in the southern regions, but with well known vulnerability to climate variability. The understanding of the precipitation regime and variability in this part of the Iberian Peninsula contributes to clarify the behaviour observed in neighbouring Mediterranean regions (and vice-versa). Two storm types dominate the occurrence of precipitation in mainland Portugal: convective storms and frontal storms. Convective storms are frequent during the summer season and the early and mid autumn, and are more frequent in the southern regions; frontal storms occur principally in the winter season, and affect more the northern regions. Usually, both types of storms are pooled for the analysis and characterization of intense rain events, regardless of their respective statistical signature. In this work we analyse daily and hourly rain from several locations in mainland Portugal aiming at investigating increased variability in the rain process, traduced by trends in the temporal structure of rain. The seasonality of rain is accounted for by investigating changes in the distribution and structure of rain within the year. This study complements previous studies of trends in annual and monthly rain amounts in the region and clarifies the small scale behaviour and statistics.

Some considerations concernig most likely circulation types over Mediterranean in the future

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In the perspective of a climatic change over Mediterranean, the most probable weather regimes which will became usual in the future, are analyzed; specifically, the synoptic subjects bringing about hazaurdous weather events are described and their predictions by means of climatic maps interpretation are attempted.

The Influence of Assimilating Land Surface Parameters on the Simulation Performance of Warm Season Convective Systems

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In this study, we examine the impact of data forced land surface conditions (soil moisture and temperature) on the simulation of thunderstorm development in warm-season environment over Continental USA. The study is facilitated by the POSEIDON weather forecasting system that uses a modified version of the NCEP/Eta model. We consider two modes of atmospheric model operations: coupled and uncoupled with the land surface model (LSM). In the coupled mode, for the definition of the initial soil state (soil moisture and temperature distributions) we use (a) the global ECMWF analysis dataset and (b) the output obtained from a land surface data assimilation system. The system uses hourly gauge-calibrated radar rainfall fields, satellite radiation forcing fields, and other near surface atmospheric parameters (winds, temperature, pressure and relative humidity) obtained from the global ECMWF analysis dataset to force the NCAR Community Land Model version 3.0 (CLM3) for simulating the evolution of land surface parameters. In the uncoupled mode, the CLM3 soil moisture and temperature fields are used to dynamically update the Eta land surface boundary conditions during model simulations. Results from the numerical experiments are evaluated against measured radar rainfall fields and in-situ observations of soil moisture from two continental regions (US and Central Europe).

A tropical-like cyclone over southern Italy: observational and numerical analysis

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In the framework of RISKMED - INTERREG IIIB project, whose overall objective is the weather risk reduction in the central and eastern Mediterranean area, a forecasting system has been implemented for operational weather prediction over south-eastern Italy. The system comprises two different forecasting chains. One is based on the hydrostatic model BOLAM and the non hydrostatic model MOLOCH, using a 1-way nesting procedure. The second is based on the Weather Research and Forecasting Model (WRF), set up with two domains, in a 2-way nesting configuration. On 26 September 2006, a subsynoptic-scale vortex developed over the Mediterranean Sea and affected south-eastern Italy. The cyclone has been documented by radar maps, Meteosat Second Generation satellite images and surface stations, as well as by numerical weather prediction model (NWP) forecasts. Both the modelling and observational analyses agree in identifying in this small scale cyclone the typical characteristics of a Mediterranean tropical-like cyclone, such as, for example, eye-like features, intense convection around the centre, strong wind, a warm core and high vorticity values. Model forecasts are able to properly capture timing and intensity of the small-scale cyclone development, although the results show strong sensitivity to the specification of the initial and boundary conditions. Finally, sensitivity experiments have been performed to analyse the mechanisms responsible for the development and the maintenance of the cyclone over the sea. They show the orographic origin of the vortex on the lee side of the Atlas Mountains. Also, the role of the surface fluxes and of the latent heat release have been investigated.

Numerical study of orographic influence on convection initiation

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Orographically induced convection can produce intense local floods, especially when the orography favours the persistence of mesoscale convective systems (MCS) in a restricted area. In one of the most severe floods that inspired this work (Gard basin, 8-9 Sept. 2002), the orography of the Massif Central favoured the onset and maintenance of the MCS at some distance upstream of the main orographic slope. In this study based on numerical experimentation using the MOLOCH convection-resolving model, the initial atmospheric conditions have been largely idealized, taking horizontally uniform conditions for wind, temperature and humidity profiles. Isolated orography of different shapes and height has been introduced in the model. Convective systems are initiated embedded in a quasi-stationary solution of flow over the orography. The numerical experiments have been designed in order to better understand the complex mechanisms of upstream orographic influence on the convective life cycle, as a function of the environmental profiles and, in particular, of the orography characteristics. The triggering of convection occurs preferably near or within the convergence area upstream of the orographic obstacle, when the height of the mountain is sufficiently large. The intensity and movement of the MCS also depend on the topography properties.

Intense rainfall episode in Corsica: sensitivity study using a mesoscale model

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On September 14 2006, a heavy rainfall episode reached the eastern part of Corsica with accumulated precipitation higher than 400 mm which caused impressive material damage. This rainfall episode was quite well forecasted at large scale but neither the intensity nor the fine scale location of the heaviest rainfall were captured by operational numerical models. In this study, two initial and coupling fields set (ECMWF and ARPEGE analyses) are used to run the French Méso-NH model so as to investigate the case study. Three interactively 2-way nested domains are used with horizontal mesh sizes of 50 and 10 km using a mass-flux convection scheme, whereas for the inner grid with mesh size of 2 km centred on Corsica, convection is assumed to be explicitely resolved. If the increase of the simulation resolution and a better description of the synoptic environment of the situation allow a better forecast of the rainfall quantity, the localization of the most intense precipitation seems to be related to the precision of the description of the craggy relief. Sensitivity tests are presented to understand how the relief, the surface conditions and the high level dynamics are involved in this intense rainfall episode.

Impact of initial condition uncertainties on the predictability of heavy rainfall in the Mediterranean: a case study

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This study explores the predictability of a heavy rainfall event which struck North Africa the 9 and 10 November 2001. During these two days, the meteorological situation was dominated by the presence of a deep upper-level trough associated with an intense cyclone which developed over the western Mediterranean basin. Using the French non-hydrostatic mesoscale model MESO-NH, numerical experiments starting from various initial atmospheric states have been conducted so as to assess the impact of initial condition uncertainties on the precipitation and the cloud cover forecast along Algerian and Moroccan coasts. In order to generate a set of perturbed atmospheric states, a simple date-shifting initialization method has been used.

Two sets of simulations have been performed, using lateral boundaries and initial conditions derived from both the French operational global assimilation system ARPEGE (Action de Recherche Petite Echelle Grande Echelle) and the European Centre for Medium Range Weather Forecasting (ECMWF). Initial perturbations of the upper-level trough propagate and intensify throughout the simulation leading to some discrepancy on the low-level cyclone forecast. While it is found that the upper-level trough and the low-level cyclone control the position of the overall rainfall pattern and of the main convective areas, the predicatbility of smaller-scale features such as heavy rainfall is directly related to specific mesoscale structures. The convergence zone between the easterly flow and the low-level jet as well as coastal orography are shown to be involved in the triggering and sustainement of the convective cells. As a consequence, small-scale perturbations of these features lead to large errors on the precipitation forecast, especially in Algiers' area. These findings suggest that, even if numerical prediction modelling is continually prone to improvements, the deterministic prediction of heavy rainfall remains a difficult task, strongly limited by the level of predictability characterizing mesoscale features associated with convection.

Sensitivity of a Central Mediterranan moderate storm to the upper-level forcing: a LEPS appoach.

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This study investigates the sensitivity of a moderate-intense storm that occurred over Calabria, southern Italy, to the upper-tropospheric forcing through a Potential Vorticity (PV) perspective. A prominent mid-troposheric trough can be identified for this event, which occurred between 22-24 May 2002, and serves as the precursor agent for the moderate-intense precipitation recorded. The working hypothesis is that the uncertainty in the representation of the upper-level disturbance has a major impact on the precipitation forecast and we cope with this issue by selecting five different scenarios in a Limited area model Ensemble Prediction System (LEPS) framework which utilizes the height of the dynamical tropopause as the discriminating variable. Pseudo water vapour images of different scenarios are compared to the corresponding METEOSAT 7 water vapour image at a specific time, antecedent to the rain occurrence over Calabria, in order to evaluate the reliability of the different precipitation scenarios simulated by the LEPS. The working hypothesis is then verified in the second part of the paper where the impact of the upper-tropospheric forcing for this event is discussed using the PV inversion property.

Rain areas delineation by means of SEVIRI: exploitation of the multispectral cloud characterization in a blended MW-IR precipitation technique

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The identification of precipitation areas by microwave based rain algorithms can be improved by means of cloud classification schemes based on multispectral observations. Several recent studies have demonstrated the potential of cloud microphysical and optical characterization for the improvement of passive microwave rain estimates, especially in detecting likely precipitating pixels over land. The multispectral sensing capabilities of SEVIRI onboard METEOSAT-8 are thus exploited to characterize the cloudy scenario, using a twofold approach: a) an RGB technique to qualitatively identify the different cloud systems on the basis of the combination of radiances measured in three selected channels, and b) a retrieval algorithm to obtain a quantitative description of cloud top in terms of optical thickness (τ), effective radius (Re) and top temperature (Tc). The approach has proved especially effective for over-land severe convective events. The multispectral analysis tools are exploited in conjunction with the blended precipitation technique (Torricella et al. 2007) originally developed at the Naval Research Laboratory in Monterey (CA). Key to the blended satellite technique is a real time, underlying collection of time and space-intersecting pixels from operational geostationary infrared imagers and microwave sensors onboard polar, low orbiting platforms. The rain intensity maps derived from microwave measurements are used to create global, geo-located rain intensity vs brightness temperature relationships that are renewed as soon as new co-located data are available. The information gathered by the multispectral analysis of the cloud field is conveyed to the blended rainfall algorithm and the results are compared to reference rain data for selected Mediterranean storm cases. Whenever possible, the TRMM precipitation radar data will be used as reference rain information. Torricella, F., V. Levizzani and F. J. Turk, 2007: "Application of a blended MW-IR rainfall algorithm to the Mediterranean" in "Measuring precipitation from space - EURAINSAT and the future" (pp 407-507). Levizzani, V., P. Bauer, and F. J. Turk (Eds.), Springer, Dordrecht, Advances in Global Change Research, 28, 722 pages.

Life cycle study of convective structures using an object oriented methodology for total lightning and radar data

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The main objective of the present study is to obtain a life cycle model for convective structures, with the purpose to improve the operational nowcasting and weather surveillance at the Meteorological Service of Catalonia (SMC). Lightning data was collected by the SMC SAFIR

system, composed of three stations that combine a VHF interferometer with an LF antenna, allowing the detection of both intra-cloud (IC) and cloud-to-ground (CG) lightning. In the other hand, the SMC radar network (XRAD) is formed by three C-band Doppler radars, which generate complete volumes (14 elevations) every 6 minutes. The product used in this study is the composition of the maximum reflectivity in each pixel of a grid, which has a resolution of 2x2 km2, and 10 CAPPIs in the vertical separated by 1 km. The 2D radar structures (XRAD2D) are areas that verify the following conditions: Z $>$ 12 dBZ, and area $>$ 24 km2. The XRAD2D structures are characterized by the position and area, reflectivity (max and mean), top (max and mean), and the percentage of convective precipitation. The 3D radar structures (XRAD3D) are volumes which exceed one of the defined reflectivity thresholds (30, 35, 40, 45, 50, 55, 60, or 65 dBZ) in different levels, and are characterized by their position, volume, reflectivity, and echo top height. Besides radar structures, lightning structures are also considered. First of all, all IC and CG flashes identified in the same time period of the radar volume (six minutes) are selected. Next, for each IC flash detected, a circle with a radius of 5 km is defined. All the circles connected are considered in the same structure (XDDEIC). CG flash structures (XDDECG) are calculated using the same methodology. Afterwards, some parameters are defined for each IC and CG structure: number of flashes, density (maximum and mean), position, and area. Once the XRAD and XDDE structures are identified, the methodology for combining both is applied: identification of areas where at least one type of structure (XRAD2D, XRAD3D, XDDEIC, or XDDECG) has been identified for every pixel; determination of the complete area of lightning/radar activity; at last, a small growing of the structures is done in order to join closed structures and avoid merging or splitting. Once the structure is identified, the characterization is made considering: the area, number of structures of each type, position, etc. Finally, the tracking in time of the structure has been done in order to obtain the evolution of all the parameters in summer thunderstorms, from 1st July 2006 to 30th September 2006.

A new transportable polarimetric X-band radar for accurate rainfall measurement in Alpine basins

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Rainfall estimation in alpine areas using classical C-band weather radar is often limited by several factors such as beam blockage, poor visibility, strong ground clutter contamination. Measurements using compact X-band radars have been strongly limited in the past due to relevant attenuation by rain. Nowadays, the use of the differential phase shift ΦDP to correct for attenuation and its range derivative KDP, which is less sensitive then radar reflectivity to Drop Size Distribution variability, can significantly improve accuracy in rainfall estimation. This work aims at characterizing the first measurements collected by a new transportable X-band radar with polarimetric capabilities, managed by Arpa Piemonte.

Characterization of rainfall C-band radar response and dual-polarized measurement for an hailstorm event

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In the last few years, the polarimetric upgrading of weather radars has allowed to improve considerably the accuracy related to the estimation of precipitation rate intensity and to the hydrometeors classification, mainly in deep convective events. Recently, the need to deepen the analyses on such issues has been tackled by means of the development of modelling chains composed by high resolution numerical weather prediction models able to generate atmospheric scenarios with desired characteristics and radar simulation modules feeded with the 3-D output fields of the aforementioned atmospheric models. This work focuses primarily on the evaluation of the effects of different microphysical parameterizations embedded into two atmospheric limited area model (COSMO-LAMI and MM5) on the simulated co-polar and differential reflectivity datasets computed by a radar simulation software (RSM). Since the latter is able to provide C-band polarimetric signatures of different hydrometeors, a second important task is constituted by the intercomparison of both simulated and the available observed reflectivity fields so as to assess the reliability of both models in reproducing deep convective weather conditions with a particular attention on the dynamics of the precipitation processes. Particularly, a severe event occurred over Northern Italy on 20/05/2003 has been simulated through the above mentioned numerical models and results concerning the polarimetric RSM measurements will be presented and discussed.

Supervised classification and estimation of hydrometeors from dual-polarized C-band weather radar

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New generation of dual-polarized weather radar systems may offer the opportunity to detect and identify different classes of hydrometeors present in stratiform and convective storms. This important feature depends on the fact that polarimetric radar measurements are highly sensitive to

physical properties of hydrometeors like composition, size, shape and orientation (Bringi and Chandrasekar, 2001). Hydrometeor classification may facilitate to study rain-cloud microphysics, to detect hailstorms and to choose the correct algorithm for precipitation rate retrieval. Last but not least, hydrometeor identification may also be useful for flight assistance and weather nowcasting. Polarimetric signatures depend also on the frequency used by the radar system. The consequence is that S-band signals differ substantially from C-band signals, especially as far as differential reflectivity and specific differential phase are concerned. As a matter of fact, most scientific literature about hydrometeor classification describes classification techniques designed for S-band radar data (Vivekanadan et al., 1999; Zrnic et al., 2001; Liu et al., 2005). Only recently some works related to C-band measurements have been presented (Baldini et al., 2004; Galletti et al., 2005; Marzano et al., 2006). The interest of assessing C-band hydrometeor classification may also emerge from the consideration that most mid-to-high latitude weather radars operate and are planned at C-band. Generally speaking, C-band radar systems may offer some advantages such as higher sensitivity, reduced antenna size and overall lower cost with respect to that of an S-band system with similar characteristics. On the other hand, rainfall path attenuation cannot be disregarded when inverting radar measurements at C-band frequencies and above (e.g., Testud et al., 2001; Vulpiani et al., 2005). Dual-polarized weather radars may offer the advantage of polarization diversity and differential phase shift measurements to correct for precipitation path attenuation effects in a fairly effective way. In this work, a model-based fuzzy-logic classification method for C-band polarimetric radar data is presented. Membership functions (MBFs) are designed for best fitting simulation data at C-band and they are derived for ten different hydrometeor classes by means of a radar scattering model, based on T-Matrix numerical method. The fuzzy logic classification technique, named Fuzzy Radar Algorithm for Hydrometeor Classification at C band (FRAHCC), uses here a reduced set of polarimetric observables, i.e. Zhh and Zdr, and it is finally applied to data coming from radar sites located in Gattatico and S. Pietro Capofiume in Northern Italy. Numerical and experimental results clearly show the improvements of hydrometeor classification, obtained by using FRAHCC with respect to the direct use of fuzzy-logic based algorithms specifically tuned for S-band radar data. Moreover, the bistatic mode of available C-band rainfall observations allows to implement a path-integrated attenuation correction procedure based either on a composite radar field approach or, more rigorously, on a bistatically-constrained algorithm for attenuation compensation. Impact of these correction procedures on hydrometeor classification is qualitatively discussed within the considered case study.

Role of evaporation pathways in surface energy balance and atmospheric boundary layer diurnal cycles

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Evaporation from exposed soil medium and evaporation through vegetation transpiration have distinct impacts on the dirunal amplitude and phase response of the surface and the atmospheric boundary layer to daytime solar forcing. In this paper field observations and numerical experiment data are used to establish some of the major distinctions. The implications for the interpretation of remote sensing measurements will be also addressed.

Joint high resolution climate-hydrology simulations for the Upper Jordan Catchment

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Sufficient freshwater availability is a central prerequisite for agricultural and industrial development in the water scarce environment of the Eastern Mediterranean and Middle East. Political peace in the region is strongly linked to the satisfactory compliance of increasing water demands. Sustainable management of water resources requires scientific sound decisions on future freshwater availability, in particular under global climate change and increasing greenhouse gas emissions. Facing these grand challenges, the impact of climate change on water availability in the Upper Jordan River catchment (UJC) is investigated within the framework of the GLOWA-Jordan river project (http://www.glowa-jordan-river.de). A focus is set on the Upper Jordan in this study as it provides $1/3^{rd}$ of freshwater resources in Israel. This is achieved by high resolution coupled regional climate – hydrology simulations. Two 30 year time slices (1960-1990 and 2070-2100) of the global climate model ECHAM4 (emission scenario B2) were dynamically downscaled using the non-hydrostatic meteorological model MM5 in nesting steps with resolutions of 54 km and 18 km. The meteorological fields in turn are used to drive the hydrological model WaSiM applied to the UJC which has an area of about 850 km^2. The hydrological model computes in detail the surface and subsurface water flow and water balance in a horizontal resolution of 90 m and dynamically couples to a 2-dim numerical groundwater model. The ability of the hydrological model to describe the observed river discharges in this hydrogeologically extremely complex region is discussed. The impact of predicted atmospheric change on terrestrial water availability (flow components, evapotranspiration, groundwater recharge, etc.) is shown. Results of the joint regional climate-hydrology simulations indicate mean annual temperature increases up to 4.5˚C and 25%

decreases in mean annual precipitation in the mountainous part of the UJC. Total runoff at the outlet of the catchment is predicted to decrease by 23%, and is accompanied by significant decreasing groundwater recharge. An additional focus will be on the analysis of changes in dry spells and drought risks in the region.

Rainfall intermittency and vegetation patterns

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Temporal rainfall intermittency has a deep impact on ecosystem functioning in water-limited areas. In particular vegetation persistence has been suggested to be positively affected by rainfall intermittency. This problem has been explored in the literature using ecohydrological, spatially integrated, approaches. Here we present the inclusion of precipitation intermittency in a spatially extended model of water-vegetation interaction in drylands. We compare different water uptake strategies by the vegetation and we study the existence range of vegetation and the regularity of vegetation patterns as a function of the statistical properties of the precipitation forcing. Finally we compare these results with a simple spatially implicit, ecohydrological model.

Suraface emissivity characterization from modern hyperspectral infrared observations

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New generation meteorological satellites carry infrared sensors able to sense the earth emission spectrum at very high spectral resolution. High spectral resolution infrared sensors on operational meteorological polar orbiters include the Infraed Atmospheric Sounding Interferometer (IASI) on the European Meteorological Operational Satellite (METOP) launched in October 2006 and the Cross Track Infrared Sounder (CrIS) on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) preparatory project (NPP) satellite. High spectral resolution radiance data are also available for instruments that are part of a National Aeronautics and Space Administration (NASA) research mission, i.e. the Atmospheric Infrared Sounder (AIRS) on the second Earth Observing System (EOS) polar orbiting platform, EOS-Aqua (launched in April 2002), and the Tropospheric Emission Spectrometer (TES) on the AURA satellite (launched in 2004). All these sensors are characterized by a wide band spectral coverage (3.7 to 15.5 μm) and a spectral sampling rate in the range 0.25 to 2 cm^{-1}. The high spectral-resolution of new advanced infrared sensors should provide temperature and constituent profiles at a higher accuracy and with more vertical resolution than the existing filter wheel radiometers. However, the full exploitation of these new sensors requires more accurate radiative transfer calculations, and, in general, new data processing algorithms, which, in turns, need to be validated. In particular, these new sensors should also allow us to estimate surface parameters, such as emissivity with unprecedented accuracy and reliability. Surface emissivity is one of the most critical parameters when dealing with the use and interpretation of high spectral resolution observations in the infrared. The spectral signature of the surface becomes relevant in the range with higher transmittance and, therefore, an incorrect model for the surface emissivity could sensitively bias, e.g., the retrieval of geophysical parameters in the lower part of the atmosphere, such as surface temperature and lower level moisture. In this work, while reviewing the characteristics of modern sensors and the related mathematical tools (both forward and inverse methodology), we illustrate a technique which can be validly applied to characterize the surface emissivity. Examples will be shown by using observations from the NAST-I instrument (NAST-I is the NPOESS Aircraft Sounder Testbed Interferometer) recorded during the EAQUATE (European Aqua Thermodynamic experiment) campaign which took place in Italy in September 2004. Emissivity will be derived for an area covered by a forest. For this kind of vegetation (plant canopy), the surface emissivity is typically modeled with that of a black-body (emissivity equal to 1 and no dependence on the field of view angle). Our results show that this is, indeed, not the case and the above straightforward model can produce highly biased retrieval for temperature and water vapor. The presentation will include:. 1) an account of the modern infared sensors; 2) the description and discussion of the forward/inverse methodology; 3) the fitting technique used for the surface emissivity, including comparison of the results with laboratory measurements and the use of the estimated emissivity to input the physical inverse scheme, for the retrieval of temperature and water vapor profiles.

A Stochastic Approach for the Description of the Water Balance Dynamics in a River Basin

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The present paper introduces an analytical approach for the description of the soil water balance dynamics over a schematic river basin. The model is based on a stochastic differential equation where the rainfall forcing is interpreted as an additive noise in the soil water balance. This equation can be solved assuming known the spatial distribution of the soil moisture over the basin. This assumption is particularly true in the case of humid and semihumid environments, where spatial redistribution of soil moisture becomes dominant producing a well defined pattern. The model allowed to derive the probability density function of the saturated portion of a basin and of its relative saturation. Furthermore, it was possible to characterize the cumulative probability distribution of the produced runoff. This theory is based on the assumption that the water storage capacity varies across

the basin following a parabolic distribution and the basin has homogeneous soil texture and vegetation cover. The methodology outlined the role played by the basin shape and slope in the soil water balance dynamics.

Soil-vegetation-atmosphere interactions and midlatitude summer droughts

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In a recent work, we introduced a model for the coupled dynamics of the soil and the atmosphere, focussing on the phenomenon of summer droughts at continental midlatitudes. In another work, we focussed on the relevance of rainfall intermittency in arid regions, introducing a model for the dynamics of soil and vegetation. In this contribution we discuss a new conceptual model for the coupled dynamics of the system soil-vegetation-atmosphere and we focus on the active role of vegetation in the development and control of summer droughts.

A coupled SVAT-3D unsaturated flow model for the assessment of soil-vegetation-atmosphere exchanges

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A fully-coupled model for evaluating soil-vegetation-atmosphere mass and energy exchanges is presented, using a discrete approach based on an extension of the original Cellular Automata (CA) computational paradigm. The model is composed of two interacting modules, a soil-vegetation-atmosphere transfer scheme (SVAT) and a three-dimensional model for unsaturated flow. It requires as input common meteorological data (precipitation, air temperature and humidity, wind speed, atmospheric pressure, downward shortwave radiation and albedo) together with parameters characterizing the hydraulic soil properties, and provides in output the estimate of the main energy balance components (net radiation, soil heat flux, latent and sensible heat flux), evapotranspiration, surface temperature, three-dimensional distribution of soil water content, runoff excess, as well as some additional parameters like drag coefficients and the atmospheric stability parameters. The model has been tested by means of ground ET measurements, carried out through eddy covariance systems in summer periods of the years 2005 and 2006 on two different areas in southern Italy, characterized by different physiographic and vegetative conditions (sparse vegetation and semi-arid climate in the former site, alfalfa field and sub-humid climate in the latter). In both sites the model showed good estimates of the numerous variables considered, proving to be a reliable tool for the estimate of energy and mass fluxes, as well as the space-time distribution of soil moisture. From a computational point of view, the CA structure on which the model is developed permits to achieve high efficiency values running it on a parallel architecture, allowing the proposed model to be used on wide areas with a very high detail.

Hydrometeorological and vegetation indices for the Drought monitoring system in Tuscany Region, Italy

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It is known that drought is a complex phenomenon whose impacts have different time scales. For this reason, the computation of precipitation deficit alone is not sufficient for the evaluation of possible drought conditions. Vegetation stress and soil moisture status have to be considered, as well as effects on surface water bodies and groundwater. We present here an integrated system that is under development for drought monitoring in Tuscany Region in Central Italy. The system is based on the cross-evaluation of meteorological indices (SPI, standardized precipitation index), vegetation indices from remote sensing (from SEVIRI-MSG), and outputs from the distributed hydrological model MOBIDIC, that is used in real-time for water balance evaluation and hydrological forecast in the major basins of Tuscany. Furthermore, a telemetric network of aquifer levels is near completion in the region, and data from more than 50 stations are already available in real-time for the drought monitoring system. Drought indices over Tuscany in the period 2006- 2007 are shown, and correlation between patterns of crop water stress, precipitation deficit and groundwater conditions are discussed.

Influences of Leaf Area Index estimations on the soil water balance predictions in Mediterranean regions

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In semi-arid and sub-humid areas of the Mediterranean region, the development of hydrological models able to describe the seasonal dynamics of vegetation cover becomes crucial in SVAT applications. A simple approach to describe the heterogeneity of vegetation cover was introduced by Eagleson (1982) who derived the fractional vegetation cover M of a grid cell as a function of the Leaf Area Index (LAI). In most of the cases, the LAI values are determined from satellite data using vegetation indices such as the NDVI. The inherent problem is that the vegetation heterogeneity of Mediterranean region - including soil disturbances - has a large influence on the spectral bands and so the relation between LAI and NDVI is not unambiguous. In the present work, the soil water balance and the hydrological losses (e.g., evapotranspiration) are estimated in a medium-sized river basin in Southern Italy using distributed approach where the vegetation status is characterised through a data-set of multi-temporal NDVI images. Adopting a process-based model (DREAM) with a distributed parameterisation, the influence of different NDVI-LAI regression models on main features of water balance predictions is investigated. The

results show a limited influence in the prediction of flood dynamics while sensible differences in the soil water regime and evapotranspiration are determined as a consequence of the alternative LAI estimations. The proposed method for the local calibration of the non-linear NDVI-LAI regression is based on the comparison between NDVI values, obtained by satellite data, and local LAI estimations of the vegetation cover in recognized landscape elements of the catchment. Results show that the accurate estimation of LAI may significantly improve the model performances especially in the simulated groundwater contribution to the streamflow.

Landscape organization and bio-physical transport

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High resolution topography (1m LIDAR) offers new opportunities for hydrologic research. Of special interest is the long-standing problem of exploring linkages between the underlying physical processes that sculpture the landscape and the statistical signature and organized patterns they imprint on it. If these linkages are understood and quantified they can be useful in guiding field work, e.g, by suggesting physically-distinct regimes from statistically-distinct regimes; in improving modeling, e.g., by suggesting what transport laws might apply in different parts of the watershed; in providing detailed information for hypothesis testing; and in allowing prediction in ungauged basins. Here we report results along three main directions: (1) explicit and objective extraction of river networks from LIDAR data, to replace the current implicit methods that use threshold area or slope-area threshold relationships requiring field work, (2) quantifying the horizontal organization of hillslope drainage paths and river networks and the vertical organization of hillslopes and valleys with implications for water and sediment transport, and (3) exploring stream organization for upscaling biomass from a point to a stream reach by combining local dimensionless relationships with geomorphic scaling laws. All of the above are discussed in the light of improving hydrologic and biophysical predictions by detailed knowledge of topography and space-time rainfall.

Exploiting the scale invariance feature of the critical behaviour of soil moisture dynamics

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Recently we have proposed a novel approach dealing with soil moisture organization on the basis of concepts of the percolation theory and the renormalization group method (Di Domenico et al., 2007). When in a physical system a geometrical phase transition occurs showing a critical behaviour, it is possible to observe the onset of scale-invariance. The soil moisture spatial patterns show a behaviour similar to phase transition processes when changing, in their seasonal time dynamics, from spatially random to spatially connected appearances as conditions become wetter. Such phenomenon is driven by the onset of lateral redistribution, which provides the conditions for the growth of the contributing areas. Working on the Agri catchment (southern Italy), we demonstrated that such phase change shows critical point behaviour. In addition, the value of the critical probability seems to be an intrinsic characteristic of a catchment, being insensitive to renormalization (rescaling), as well as to model parameterization. The aim of this work can be summarized into three goals:

1. to evaluate the generality of the methodology by considering other soil moisture data sources;
2. to explore the relationship between geomorphologic indices and critical point;
3. to assess the role of renormalization in problems of optimal monitoring scales.

In order to assess the generality of the methodology we decided to perform further applications on other river basins. Indeed, we considered the soil moisture data provided by the hydrological model TOPMODEL-based land-surface-atmosphere transfer scheme (TOPLATS) on the Red and Arkansas basins in the south-central United States (Crow and Wood, 2002). From the 1 km grid covering the entire 575000 km^2 Red and Arkansas basins, we selected several sub-basins, then we processed one year of daily soil moisture maps. We verified the critical behaviour and we determined the critical probability for each sub-basin. With respect to point 2, it is worth to believe two different processes driven by the morphology of the catchment and experiencing scale invariant behaviour being related. Thus the relationship between critical point and morphologic features of drainage basin, such as bifurcation and elongation ratio, fractal dimension and informational entropy has been investigated. Critical point tends to be lower for basins with more organized morphological structures. Finally, we investigated the possibility of taking advantage of the scale invariance feature in the definition of the monitoring scale of soil moisture. The maximum pixel size at which rescaled soil moisture maps show the same critical point should be the upper limit of monitoring (or ensemble scheming) scale. References Crow, W. T. and Wood, E. F., The value of coarse-scale soil moisture observations for regional surface energy balance modelling, Journal of Hydrometeorology, 3, pp. 467–482, 2002. Di Domenico A., Laguardia G., Fiorentino M., Capturing critical behaviour in soil moisture spatio-temporal dynamics, Advances in Water Resources, 30, pp. 543–554, 2007.

Hydrological response with respect to soil characteristics in a context of Mediterranean extreme events

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I. Introduction In September 2002 a flash flood killed 23 human lives and generated 1.2 billion Euros of damages in less than 24 hours over an area of 20000 km^2 located in the south of France. The Gard river basin was hit by a storm that locally received more than 600 mm in one day (Huet et al., 2003). The Mesoscale Convective System firstly remained stationary for 14 hours then moved West, and finally interacted with a cold front moving East (Delrieu et al., 2005). This storm triggered catastrophic flash floods on many upstream tributaries as well as the most important flood ever reported of the major rivers (Gard, Ceze and Vidourle). Post-event hydrological investigation using interviews of witnesses and river cross-sections surveys allowed estimation of specific peak discharges of 17 watersheds, the size of which ranged from 10 to 100 km2. It was noticeable that most of the estimations gave specific peak discharges of at least 5 m3.s-1.km2 whereas the 10 years return period discharge, in this region, is about 2 m3.s-1.km2 for such catchment sizes. Below the 600 mm rain area, peak discharges even exceed 20 m3.s-1.km2, which was the most important value ever reported for watersheds of similar areas (Delrieu et al., 2005). The prediction of such extreme events remains an open question due to scarcity of observations and the unknown individual hydrological behavior of very small basins. The aggregation of small basins contributions along the river network remains also largely unknown. In order to study runoff generation on these small catchments, we implemented a physically based hydrological model developed under the numerical LIQUID platform (Viallet et al., 2006) on the Cévennes - Vivarais region. The study focused on the variability of the hydrological response with respect to soil properties in order to propose an observation strategy to enhance our understanding of the corresponding hydrological processes. II. Results and Conclusions Soil characteristics, including soil depths and hydraulic properties, were described using a regional soil data base and pedo-transfer functions. Using a 1D soil water transfer module (Varado et al., 2006), we performed sensitivity tests in order to highlight the role of soil properties and the soil depth on the hydrological response of the catchments (maximum ponding and time of beginning of runoff in response to a given rainfall). The results present a regional overview of the main soil properties that favor the flood propagation and of the type of active process (saturation excess or infiltration excess). From the first estimation of the infiltration properties of the soil, the simulations allow to highlight the impact of initial soil moisture and the nature of the soil on the hydrological behavior within the studied catchments. The impact of the pedotransfer function has been studied on the simulated saturation rate profile within the soil. The signature of the structure on the simulated soil moisture profile is visible during a long time after the rainfall event has ceased. Therefore, the simulated amount of water available for runoff will lead to very different hydrological impact. III. References Delrieu G., V. Ducrocq, E. Gaume, J. Nicol, O. Payrastre, E. Yates, P.E. Kirstetter, H. Andrieu, P.-A. Ayral, C. Bouvier, J.-D. Creutin, M. Livet, S. Anquetin, M. Lang, L. Neppel, C. Obled, J. Parent-du-Châtelet, G.-M. Saulnier, A. Walpersdorf and W. Wobrock, 2005, The catastrophic flash-flood event of 8-9 September 2002 in the Gard region, France: a first case study for the Cévennes-Vivarais Mediterranean Hydro-meteorological Observatory, J. Hydrometeorology, 6, 34-52. Huet P., X. Martin, J.-L. Prime, P. Foin, C. Laurain and P. Cannard, 2003, Retour d'expérience des crues de septembre 2002 dans les departments du Gard, de l'Hérault, du Vaucluse, des Bouches-du-Rhône, de l'Ardèche et de la Drôme. Technical report, Ministère de l'Ecologie et du Développement Durable, Republique Française, 133pp. Varado, N., Ross, P.J., Braud, I., Haverkamp, R., 2006. Assessment of an efficient numerical solution of the Richards' equation for bare soil, J. Hydrology, 323 (1-4), 244-257. Viallet, P., S. Debionne, I. Braud, J. Dehotin, R. Haverkamp, Z. Saâdi, S. Anquetin, F. Branger, N. Varado, 2006, Towards multi-scale integrated hydrological models using the LIQUID framework, 7th International Conference on Hydroinformatics 2006, 4-8 September, Nice, France, Vol I, 542-549.

On the preservation of the physical representation of the hydrological processes in model lumping

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Presently, physically based distributed models are recognized to be the most successful and fertile way of simulating and investigating hydrological processes. Nevertheless the power of synthesis of the lumped models makes them scientifically very attractive. The interest in lumped models not only lays in the practical aim of using simpler models but even more in the theoretical implications involved in finding the "dominant processes", namely the essential hydrological features, to be preserved in the lumping process. Historically, the evolution of hydrological models proceeded from the simple conceptual models to the more complex physically based ones, gradually introducing more complicated and comprehensive equations in the efforts of better reproducing reality. An interesting question is whether or not it is possible to directly set up a lumped hydrological model encapsulating the physical meanings and processes, without the need of setting up a distributed model. This would allow the direct transfer of the model to ungauged catchments. Starting from a distributed model, the present work follows two lumping procedures: (1) a "structural lumping" of the catchment, (2) an "empirical lumping" of the dominant processes. The first structural lumping aims

at aggregating all the grid cells composing the catchment in just one single cell with equivalent hydrological properties. This requires a “non trivial” aggregation, of the distributed model parameters, defined in each single cell, into a unique lumped parameter value. The empirical lumping exploits the diagnostic skills of the distributed model to infer internal relations (such as the water volume - saturated area relationship or the exfiltration) representing the dominant processes that are now based on average quantities. This empirical lumping, which allows to correctly preserve the description of the internal dynamics at the lumped scale, is achieved by deriving a set of functions via simulation with distributed model. An interesting phenomenon highlighted by this lumping gives is the hysteretic dependency of the saturated area on the mean soil water volume, which was also found by other authors. Following this approach one has to realize that only the distributed model can be exported on physical grounds to ungauged catchments, while its lumped version will again be derived with the proposed approach. An example of application to a real catchment will complement the theoretical description.

Model selection techniques for flood frequency analysis

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One of the main goals of flood frequency analysis is to estimate the design flood, namely, the discharge value corresponding to an assigned return period. Usually this problem is solved by fitting a suitable probability distribution to the observed peak flow data. However, the choice of the probabilistic model is often a relevant issue. This study aims at identifying an objective criterion for the selection of the most appropriate extreme value probability distribution. A relevant contribution to the subject of model identification is in the work by Akaike (1973), who proposes the use of the principle of maximum entropy for model selection. Later, Schwartz (1978) developed a similar idea in a Bayesian context, therefore formulating the Bayesian Information Criterion. Applications of model selection techniques within flood frequency analysis are rare.. The objective of this study is to verify whether the model selection techniques proposed by Akaike and Schwartz work correctly when they are applied for identifying the probability distribution of extreme events. A comparison of these and others model selection techniques is carried out trough an extensive numerical analysis in order to check the performances of the considered methods when dealing with small sample sizes and highly asymmetric distributions.

Flash floods: innovative observation concepts for hydrometeorological process understanding and risk mitigation

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The management of flash flood hazards and risks is a critical component of public safety and quality of life. Flash-floods develop at space and time scales that conventional observation systems are not able to monitor for rainfall and river discharge. Consequently, the atmospheric and hydrological generating mechanisms of flash-floods are poorly understood, leading to highly uncertain forecasts of these events. An innovative flash flood observation methodology, coupling analysis of radar rainfall estimates and post-flood surveys, allows to derive unique observations concerning rainfall-runoff dynamics during flash flood events. Observations related to the 2003 Fella basin flood in the Eastern Italian Alps are examined in this paper. Results are presented concerning the impact of space-time precipitation variability, antecedent soil moisture conditions, soil/bed rock types on flood response and triggering of landslides and debris flows.

Flash flood forecasting with the SURFEX/TOPMODEL coupled system

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Within the European Commission FP6 Integrated Project PREVIEW (**PREV**ention, **I**nformation and **E**arly **W**arning), a specific action (WP4340) is dedicated to the improvement of the Mediterranean flash-flood forecasting. Its general aim is to improve the very short-range forecast of Mediterranean flash-floods over medium basins, based on the next generation European high-resolution Numerical Weather Prediction (NWP) models. One cornerstone of the project is the development of hydro-meteorological coupled systems based on kilometric scale atmospheric models and hydrological models adapted to the fast hydrological response of Mediterranean catchments. In particular, a full 2-way coupling between the hydrological model TOPMODEL and the surface scheme (SURFEX) of the MESON-NH model has been developed. The hydrological model performs the lateral soil water distribution over the catchments and diagnosed saturated areas, from which the surface model relying on the ISBA scheme for natural land cover simulates the surface run-off. Then, surface runoff and deep drainage are routed on the hillslopes and in the river

to the catchment's outlet. So total discharges are simulated. Moreover, more realistic soil moistures are expected for the meteorological simulations. To test the ability of the SURFEX/TOPMODEL coupled system to reproduce severe flash-flooding, it has been applied to an heavy precipitation episode that occurred over Southeastern France, on 5 to 10 September 2005. Horizontal resolution of SURFEX and TOPMODEL models are 1 km and 50 m respectively. As a first step, the coupled system has been driven by observed rainfall (radar data and spatially interpolated raingauge observations) for the three main watersheds affected by the heavy precipitation. The best simulation of discharges is obtained when the coupled system is driven by raingauge observations. Moreover, the soil water contents distribution is notably improved when comparing to the SURFEX scheme alone : the top of the catchments become drier whereas the soil is wetter near the hydrologic network. Sensitivity experiments varying parameters of the water routing to the outlet and the initial soil moisture have been also carried out . Then, high-resolution rainfall forecasts have been used as input to the coupled model. Hourly precipitation forecasts from MESO-NH 2.5 km simulations with different initial conditions have been supplied as input to SURFEX/TOPMODEL. Better scores are obtained when the 2-way system uses as input the MESO-NH simulation starting from a mesoscale data assimilation instead of a large scale analysis. As a matter of fact, even though errors in location and in intensity in the forecast rainfall fields exist, it seems that there are some relevant information in the hydrological responses considering not too small catchments and a regional approach.

A Continuous hydrological model for operational flood forecast exploiting satellite observations

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When operational hydrologic forecast is of concern, models should have some important characteristics in order to obtain timely and reliable results for civil protection purposes. In particular, it should be continuous, distributed, robust and computationally fast. This work describes the implementation of the hydrologic model C-DriFt (Continuous Discharge River Forecast) that summarizes all previous properties. In the model are represented the most important soil processes such as infiltration, subflow, evapotranspiration and runoff routing. The peculiarity of the formulation is that the model has, among its state variables, Land Surface Temperature (LST). This is obtained evaluating Evapotranspiration through the evolution of LST as a response to the surface energy balance, modelled via the Force-Restore Equation, an approximation of heat diffusion in the soil. Coupling mass balance and energy balance via the force-restore equation allow the use of forcings, such as long and short wave radiations, available as operational satellite products. The introduction of LST as state variable makes the model suitable for implementation in data assimilation procedures (e.g. assimilation of observed LST). In this study, forcings are estimated using two different sources of information. Operational products of the LSA SAF (Land Surface Analysis - Satellite Applications Facility) data archive are used to describe the energy forcing. Ground observed data are used to describe meteo-hydrological forcings. The model is applied to the Casentino River using data recorded during the six-months period, from June to December 2005.

Evaluation of drought forecasting models in Pinios river basin, Greece

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Droughts are the world's costliest natural disasters that occur virtually in all landscapes causing significant damage both in natural environment and in human lives. Early indication of possible drought can help to set out drought mitigation strategies and proactive measures. Drought forecasting plays an important role in the planning and management of natural resources and water resource systems of a river basin. Due to the random nature of contributing factors, occurrence and severity of droughts can be treated as stochastic in nature. This study uses linear stochastic models eg. Autoregressive Integrated Moving Average (ARIMA), multiplicative Seasonal ARIMA (SARIMA)models, and nonlinear artificial neural network models to forecast droughts based on the procedure of model development. The models are applied to forecast droughts using standardized precipitation index (SPI) timeseries at multiple timescales in the Pinios river basin in Thessaly, which lies in the central district of Greece. The results obtained from the study models and their potential to forecast drought over different lead times are presented and compared with the observed SPI timeseries. The predicted results show reasonably good agreement with the actual data for short lead times and the forecasting accuracy decreases with increase in lead-time. Hence, the models could be operationally used to forecast droughts for civil protection services.

Characterization of Main Spatial Patterns of Biophysical Factors of Desertification

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Extreme climate events act as a main driving force for desertification. Soil degradation, vegetation and land use can be directly associated with extreme events of precipitation in areas of high susceptibility to the desertification. This paper will focus in the assessment of the spatial local relationship between extreme precipitation events and the relevant biophysical factors of desertification - soil quality, vegetation

indexes and land use classes. Hence, to ascertain the spatial patterns of main relationships between soil and vegetation in the context of desertification, artificial neural networks (ANN) models will be applied with spatial dispersion maps of different variables: soil quality variables, which comprise certain properties related with land degradation (total organic carbon and pH), obtained with geostatistical simulation methods; vegetation indexes (NDVI) derived from remote sensing data; and land use cartography resulting from classification of remote sensing data. The resulting mapping of the areas with critical values of the relationship between climatic events and desertification can be used as a fundamental tool for the planning and control of local impacts of climate in the desertification dynamic. This methodology was applied to an area in the South-East of Portugal, the left margin of the Guadiana river, classified with an high susceptibility index to the desertification phenomenon. Keywords: Extreme Climate Events, Desertification, ANN models, Geostatistics.

An estimated erosion map for the Aterno-Pescara river basin

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Soil erosion is responsible for the continuous modification of the shape and elevation of the natural ground surface. In fact, due to the erosive actions associated with rain, wind, frost and melting snow, soil particles are detached from either outcropping rock deposits or from soil like deposits. Then, the particles removed from the parent formations are transported to lower elevations. Hence, the characteristics of a natural or geological erosive process are governed by the climatic characteristics of the area and also by the resistance of the parent formation, which in turn depends on soil erodibility, area topography and vegetation cover. In order to design and test an efficient coastal management procedure it is necessary to know at least approximately the mass of eroded soil and the solid transport quantity in the basin of the rivers that “feed” the coast. In this study, performed in the framework of the INTERREG IIIB CADSEALAND project, we have used the USLE model to obtain a first guess of the erosion in the Aterno-Pescara catchment. The Aterno-Pescara river, which is situated in the eastern Italian region of Abruzzo and empties in the central Adriatic Sea, was chosen as representative of the Mediterranean basin typology. Our final result is an estimated erosion map for the catchment that allowed us to identify five ordinal classes of quantitative output of predicted soil. For each major land use we calculated the area percentage of different potential erosion classes to find which land use entails the highest potential erosion. However, the USLE model, as any other empirical model, needs to be fine tuned to a location before its results can be trusted. In view of this, our study also suggests the deployment of a gauging network in the catchment based on that first guess.

The MOBIDIC model in the hydrological forecast system of Tuscany Region

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The model MOBIDIC (MOdello di Bilancio Idrologico DIstribuito e Continuo - Distributed and Continuous Model for the Hydrological Balance) is used for the hydrological forecast and monitoring at the Centro Funzionale Regione Toscana. MOBIDIC is a physically-based model that allows the estimation of the components of the hydrologic balance in the subsurface layer, the soil-vegetation system and surface water bodies. In the representation of physical processes, the main innovations with respect to existing models concern the coupling of the water balance in soil and vegetation with surface energy balance (to the benefit of evapotranspiration computation and use of remotely sensed maps of Land Surface Temperature for calibration and validation) and the detailed interaction between groundwater and surface water bodies. In the real-time operational version for hydrological forecast at Centro Funzionale Regione Toscana, new modeling schemes and algorithms have been added, as well as specific modules for the integration of MOBIDIC into the Centro Funzionale data flow system (i.e. processing of Quantitative Precipitation Forecasts from four different meteorological models, real-time assimilation of data from the hydrometeorological network). Current research activities regarding the model include a new parameterization of soil hydraulic properties and experiments on advanced assimilation techniques.

An ad-hoc hydrological model for operative warning system in Valle d’Aosta Region

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Non-structural policies for flooding defence have established themselves as an absolute necessity in the Mediterranean where the orography is particularly high near the coast and in the alpine environment and where complex urban areas do not allow vulnerability reduction by restructuring the urban settlements. Moreover the morphology of the basins and the very short times of the watershed response limit the use of alarm systems entirely based on measurements of both flow and rainfall rates. An early alert, useful for the implementation of civil protection measures on a given territory, becomes, consequently, the only possibility. It is essential the use of meteorological rainfall forecast as input for hydrological models. Hydrological watershed modelling should be able to reproduce basin response accounting for both its morphoclimatic features and hydraulics structures (e.g. dams, barrages and weirs). To these cases has been

required to implement an appropriate model for Valle d'Aosta alpine region that accounts for snow, dams and manoeuvre effect operated for hydroelectric production. Actually the model is in a pre-operative testing phase for warning procedure in the Functional Centre of Valle d'Aosta Region. It has shown good capability to reproduce observed discharge for different historical events.

Are the uncertainties on mean areal precipitation decisive for flood hydrograph simulations with lumped rainfall-runoff models?

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The efficiency of flood forecasts on small watersheds appears to be limited, in particular by the accuracy of Rainfall-Runoff (RR) simulations. In fact, many flood forecasting services do not consider hydrological models to be reliable enough for use in a real-time operational context. Many authors suggest that the uncertainties associated with spatial rainfall estimation are probably one of the major factors limiting the accuracy of the RR simulations. Most of the previous studies on the assessment of the impact of rainfall estimation uncertainties consisted of propagating into RR models either empirical rainfall estimation errors (obtained through under-samplings of rain gauges in an existing network) or purely theoretical errors (use of uncalibrated rainfall error models). The originality here is the proposal of a rainfall estimation error model calibrated on observed rainfall data. The proposed model is composed of two components: (i) an error model for the hourly point and mean areal rainfall estimates based on geostatistics (kriging), (ii) an autoregressive model to account for the temporal dependence of the estimation errors. The proposed approach is developed and applied to a given case study: the application of lumped conceptual RR models for the simulation of the floods in eleven watersheds exposed to flash floods, located in the upper Loire region (France) with areas ranging from 20 to 3230 km2. First, the proposed error model and results of its validation will be presented. A cross-validation procedure has been used: the statistical distributions of empirical spatial interpolation errors and modelled interpolation errors have been compared for various rain gages of the network and various rainfall durations. Second, Monte Carlo simulations have been used to generate corrupted rainfall scenarii which were propagated into two lumped hydrological models (TOPMODEL and GR4). The obtained results confirm the major impact of the areal rainfall estimation uncertainties on RR simulation results despite a relatively dense hourly rain gage network (1/80 km2 on average over the region). For the smallest watersheds the observed discharges generally lie in the uncertainty range of the simulated discharges: i.e. the rainfall estimation errors alone can explain the differences between simulated and observed discharges. This is not the case for the largest tested watershed, where the spatial pattern of the rainfall events appears to play an important role and the use of at least semi-distributed RR models seems to be necessary. In any case, the awareness of the uncertainty level associated to any RR simulation, which probably will remain non-negligible even if the rainfall observation networks and techniques are improved, should lead to the use of ensemble rather than the standard deterministic RR simulations. The proposed procedure can be used to produce such ensemble simulations.

Operational flood-forecasting in the Piemonte region: development and verification of a fully distributed phisically-oriented hydrological model.

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As far as the operational implementation of real time flood forecasting systems to Civil Protection is concerned, the hydrological model main requirements are: reliability and rapidity. The present computational capabilities offer the chance to overcome the rapidity needs even adopting a fully distributed hydrological model for a large river catchment as the Upper Po river basin closed at Ponte Becca (nearly 40000 km2). This approach allows simulating the whole area obtaining the responses of large as well as of medium and little sized sub-catchments. The FEST-WB hydrological model (Mancini, 1990; Mancini et al., 2000, Rabuffetti et al., 2007) is implemented. The model mainly focuses on the flood processes, such as infiltration and run-off and hypodermic flow propagation, but accounts also for a continuous water-budget, by a simplified scheme for percolation and evapotranspiration calculations, to obtain a reliable estimate of the initial soil-water conditions. The calibration and verification activities are based on more than 100 of flood events, occurred along the main tributaries of the Po river in the period 2000-2003. More then 300 meteorological stations are used to obtain the forcing fields, 15 cross section with discharge time series are used for calibration while verification is performed on about 40 monitored cross sections. Furthermore, since it is important to have a forecast horizon as long as possible to allow effective action by the Civil protection structures, meteorological models are coupled with the hydrological simulations, i.e. the hydrological model is forced with rain observations till the time of forecast and with Quantitative Precipitation Forecasts (QPFs) for the 36 hour successive time interval. The use of the FEST-WB model is then analysed in operational set experiments. Particular care is devoted to understanding how the reliability of QPF affects the accuracy of the Quantitative Discharge Forecasts (QDFs) and to assessing how QDF uncertainty can affect the warning system reliability. Result are presented either in terms of reliability of QDF either in terms of alert issues.

Exploring high-resolution operational weather forecasts for flash-flood prediction

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1. INTRODUCTION In Mediterranean Europe, flash flooding is one of the most devastating hazards in terms of human life loss and infrastructures. Over the last two decades, flash floods brought losses of a billion Euros of damage in France alone. The objective of this study is to investigate if operationally available short-range numerical weather forecasts together with a rainfall-runoff model can be used as early indication for the occurrence of flash floods. The study is focussed on the Cévennes-Vivarais region, Southeast of the Massif Central, France, which is often prone to flash flood. The main objective aims at evaluating the hydrometeorological chain for the forecasting of one of the main flash flood event that took place in this region in September 2002 (Delrieu et al., 2005). During the 8 and 9 September, more than 700 mm were recorded; the flash flood took 24 lives and the economical damages were evaluated at 1.2 billions euros (Huet et al., 2003). The short range weather forecasts are derived from the Lokalmodell of the Deutscher Wetterdienst, the German national weather service, and is available twice a day, at 00:00 and at 12:00 on a grid spacing of 7 km and an hourly temporal resolution. The outputs are driving the hydrological rainfall-runoff model LISFLOOD (van der Knijff, 2007, de Roo et al., 2000). It is set-up for the whole study area comprising several smaller river basins on a grid spacing of 1 km and runs with an hourly time step for the flood predictions. One of the challenges in flash flood forecasting is that the watersheds are typically small and good observational networks of both rainfall and discharge are rare. Therefore, hydrological models are difficult to calibrate and the simulated river discharges cannot always be compared with ground truth. The miss of observation in most flash flood prone basins, therefore, leads to develop a method where the excess of the simulated discharge above a critical threshold can provide the forecast. A model consistent approach is then proposed based on the evaluation of discharge threshold values obtained with the simulation of long-time series. Then, the forecasted discharges, for a given event, are compared against these thresholds, available at every pixel. The major advantage of this approach is that any systematic over- or under-prediction of the model is compensated for. If the model tends to overestimate discharges in a given river reach, either because of a non-optimised parameterization or lack of processes such irrigation or reservoir operations, this would be reflected in the thresholds as well as in the forecasts. 2. RESULTS AND CONCLUSIONS For this study, the long time series simulations are based on observed daily meteorological data derived from observed meteorological stations for the time period 1990-2003. From the daily hydrological simulations critical thresholds have been derived as well as the starting conditions for the flood forecasts. The flood forecasts were driven by the 48h DWD weather forecasts starting on 20020906 00:00 and then in 12h intervals the next weather forecasts until 20020910 12:00 o'clock forecast. The initial conditions were always taken from the 00:00 forecasts. Both the 00:00 and 12:00 forecasts from the same day start with the same initial conditions. From the obtained results, it appears that the forecast from the 7th at 12:00 exceeds in fact the severe and high flood thresholds, indicating a possibility for a severe flood within the coming 2 days. This time is required for the civil protection to organize the warning of the territory and to prepare the eventual rescues. The later forecasts confirm the severity of the flood. Moreover, the simulated flood alert highlights the severity of the event at the regional scale and in particularly, the area around the Gard and Virdourle is at particular risk. 3. REFERENCES De Roo, A., Wesseling, C. G. & Van Deurssen, W. P. A. (2000). Physically based river basin modelling within a GIS: the LISFLOOD model. Hydrological Processes, Vol. 4, Issues 11-12, p.1981-1992. Delrieu G., V. Ducrocq, E. Gaume, J. Nicol, O. Payrastre, E. Yates, P.E. Kirstetter, H. Andrieu, P.-A. Ayral, C. Bouvier, J.-D. Creutin, M. Livet, S. Anquetin, M. Lang, L. Neppel, C. Obled, J. Parent-du-Châtelet, G.-M. Saulnier, A. Walpersdorf and W. 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Parsimonious distributed model applied to the Aspio urbanized small catchment

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A parsimonious distributed model for event discharge simulation is used inside the operational chain of Marche Civil Protection, Italy. The regional forecast centre is part of the national network of warning system. Hydrological model is currently implemented on three regional basins, different for size, land use and topography. It is calibrated on reliable hydro-pluviometric data over case studies. DEM and land use maps are the distributed basin information. LAM precipitation fields are used as input for flash flood forecast. Applications over Aspio catchment are presented and analyzed. The severe storm event of 16th September

2006 is in details described. A Mesoscale Convective System insisted over a densely urbanized area of about 150 km2 for 24 hours. The heavy precipitation caused severe damages on factories and cultivated land fields. Study is focused on warning system procedure and real time event management, analyzing limits and future improvements.

Calibration of a distributed rainfall-runoff model for the validation of rainfall forecasts based on lightning data

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FLASH project propose the use of lightning data to improve nowcasts and forecasts of intense rainfall events in the Mediterranean region. These rainfall forecasts can improve real-time forecasts of flash floods and supply short term warnings of the risk of flash floods. The final objective of FLASH project is the validation of improved rainfall forecasts, developed by different algorithms, procedures and products, by the use of hydrological models. A physically-based rainfall-runoff model can be used to encode all the available information through the calibration process, which is critical to represent the basin behaviour correctly. This calibrated model can be used to quantify the improvement of a rainfall forecast based on lightning data. There are many uncertainties linked to the result of a deterministic rainfall-runoff model, which can not be taken into account by traditional calibration and its fixed set of model parameter values. Otherwise, a probabilistic calibration methodology has been developed to achieve the probability density functions that best represent the variability of each model parameter. A set of synthetic hydrographs have been calculated by repetitive simulations of the rainfall-runoff model from Monte Carlo simulations over the feasible space of each parameter. Objective functions have quantified errors between synthetic and observed hydrographs. Probability density functions for every parameter have been estimated from the solutions that minimize all the selected objective functions at the same time. This probabilistic calibration takes into account the uncertainties in the estimation of initial basin state, measurements of rainfall and discharge and forecast of future rainfall. The proposed probabilistic calibration methodology has been applied to the RIBS distributed rainfall-runoff model, and will be applied to different Mediterranean river basins in Catalonia to validate the results of FLASH project.

Effects of soil moisture parameterization on a real- time flood forecasting system based on rainfall thresholds

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The rainfall threshold is the cumulated rainfall depth required to cause flooding flow at the basin outlet. Thresholds are used in operational flood forecasting systems as a means to provide flood warnings based on the comparison with rainfall amounts (either observed or forecasted). This approach results in a simple system that can also be used by non expert technicians; it is a complementary tool to "classical" rainfall-runoff modelling systems. Despite the simple usage, a flood forecasting system based on thresholds requires great accuracy in definition of the critical rainfall. Special attention is required in modelling the basin moisture condition. The aim of this paper is to assess a reliability analysis of a framework for the definition of rainfall thresholds using the distributed hydrological model FEST. The AMC value (antecedent moisture condition) of the conventional SCS-CN method is employed to describe the soil moisture initial condition. The case study is the Arno River basin located in Italy. A detailed investigation of the most recent flood events shows that precise accounting of the watershed wetness based on analysis of actual soil moisture can improve the prediction accuracy of flood forecasting systems.

Large or freak waves?

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Freak waves are anomalously large waves that reportedly appear in the middle of a group of otherwise relatively smaller waves. They are a permanent danger to the navigation and are believed to be responsible for the loss of many ships. The difficulties of having an instrument at the right time and position adds speculation on their reality and nature. In February 2006, while it was crossing the Mediterranean Sea from the African coast towards Barcelona, the cruise ship Voyager was reportedly hit by one or more big waves and suffered substantial damage. The ship survived, but had strong difficulties in limping towards the closest harbour with only one engine at work. I analyse the physics of freak waves and report about some documented episodes and experimental data. In particular I analyse the wind and wave conditions present in the Mediterranean Sea at the time and location of the Voyager accident. The analysis is done using wind and wave modelling supported by satellite and buoy wind and wave data. Granted the hindcast of the storm, I also analyse the local conditions for the possibility of freak waves.

Coupled wave and surge modelling and implications for coastal flooding

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Wave modelling at POL has always focussed on the application to extreme waves, sea level and coastal flooding. In order to investigate the interaction between waves and mean flow (water levels and currents) we are using the 3D baroclinic hydrodynamic model, POLCOMS, coupled with the 3^{rd} generation WAM and SWAN wave models. The main focus is on the NW European shelf but within the ongoing EU MARIE project we have implemented POLCOMS-WAM for the Catalan Shelf of the Mediterranean Sea. Some recent results are presented for the NE Atlantic, NW European shelf and the Irish Sea, which is the site for the POL Coastal Observatory, with an intensive real-time measurement programme. We examine wave climate and extreme storm events.

Wind wave modelling in a tidal inlet

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The northern part of the Netherlands is protected from the North Sea by a series of barrier islands. Between these islands are tidal inlets that allow the penetration of waves into the shallow Waddensea. The amount of penetration under storm conditions is important for the determination of the dikes protecting the lower parts of the Netherlands. The wave conditions in the tidal inlet and the amount of wave penetration are modelled by numerical wind wave models to determine these wave conditions. In this lecture attention will be given to the physical processes playing a role in the tidal inlet under storm conditions, followed by a discussion of the numerical model setup. Important aspects are the role of the wind, shallow water wave breaking, wave-current interactions and the set-up of the computational grid. In addition, the interplay between numerical aspects and the modelling of physical processes will be addressed. Examples will be given of the hindcast of historical events and a comparison with measured wave data.

Severe precipitation processes in complex orography:meteorological modelling and comparison of observed and simulated radar data.

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The last decades have experienced considerable improvements in numerical weather prediction models due to the enhanced performances of the computing systems. Nevertheless,forecast verification is a still a long-standing and open problem in applied meteorology though great efforts had been spent to develop reliable methods for assessing forecast skill. This study proposes a twofold approach employing rain gauges Ligurian network) and radar data (Mt. Settepani), through both observed and simulated datasets. In the first part, observed rain gauges are put into comparison with the corresponding measures simulated by means of the high resolution numerical model COSMO-LAMI, using a set of statistical variables as the temporal correlation coefficient, the frequency distribution, the dicotomic indexes and the deviation between the gauged accumulated precipitation and the estimated one. Then, in order to conduct a distributed analysis with a higher spatio-temporal resolution, the same technique is applied both to real radar data and the ones generated with the COSMO-LAMI/RSM-POL modelling chain. The severe event occurred over western Liguria on 13-14-15 September 2006 was selected as the case study so as to evaluate the degree of reliability of two different 13/09/2006 COSMO-LAMI forecast run initialized at 00.00 GMT and at 12.00 GMT, respectively.

Evaluation of Quantitative Rainfall Estimation by X-band Dual-Polarization Radar Observations

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Over the years operational weather networks have been based on S- and C- bands radar units and recently on the more advanced Dual-polarization Doppler technology. The advancement to dual-polarization has shown considerable improvements on the quantitative estimation of rainfall rates and the estimation of the rainfall drop size distribution (DSD). However, operational weather radars have demonstrated limitations (1) due to low spatial resolution effects in the quantification of localized convective storms that can cause flash floods in small scale basins, and (2) over complex terrain environment introducing marginal gaps and the need for vertical profile corrections due to the higher elevation scans. Recent research has demonstrated that cost-effective low-power Dual-polarization X-band weather radar systems could be used as ‘fill gapers’ of large operational radar networks and for small scale hydrological applications (including flood forecasting of urban catchments). These systems offer an increased sensitivity in the differential phase shift compared to the lower frequencies (S and C-band), but they are associated with increased rain-path attenuation. This work examines the use of X-band dual polarization measurements in quantitative rainfall estimation for a number of convective storms, radar ranges, and scales of aggregation. We will investigate all existing polarimetric retrieval algorithms applied on attenuation-corrected X-band radar parameters. The algorithms are evaluated based on localized intense convective storms measured by a dense network of rain gauges during an experiment in Crete over the period December 2006 to April 2007.

Using C-band radar differential phase measurements for extreme rainfall estimation: comparison with estimates based on horizontal reflectivity

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Polarimetric radar capabilities are increasingly spreading from research to operational systems. Arpa Piemonte manages two polarimetric operational radar in North-Western Italy: Bric della Croce and Monte Settepani. This work focuses on the analysis of two flash flood events occurred during the summer of 2006. Rainfall rate at the ground is estimated by using KDP, the range derivative of the differential phase ΦDP. The accuracy of these estimates is evaluated by using raingauge measurements as a reference. KDP- based estimates are compared with concurrent estimates based on horizontal reflectivity measurements and processed by applying correction of partial beam blocking, attenuation and vertical profile of reflectivity. This comparative study aims at assessing the reliability of rainfall estimates from polarimetric measurements and quantifying the benefit deriving from the operational use of differential phase measurements for hydrological applications.

Continuous-time calibration of the Z-R relationship for estimating rainfall fields from radar measurements

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The operational use of weather radar has become a widespread and useful tool for estimating rainfall fields as well as for now-casting applications. The radar-gauge adjustment is a commonly adopted technique which allows one to reduce bias and dispersion between radar rainfall estimates and the corresponding ground measurements provided by rain gauges. Nevertheless, rainfall fields estimated through radar data are known for being scarcely-reliable at reproducing a quantitative assessment of the total areal rainfall, though they provide an accurate qualitative description of the spatial evolution of the rainfall intensities throughout the event. Because of that, radar products still find scarce use into distributed hydrologic models. The goal of this work is to identify a methodology for estimating rainfall fields based on a radar-gauge adjustment, in order to minimize the related error. The study region is located in the north-west of Italy, where ARPA Piemonte operates a C-band radar near the city of Turin. We consider 19 rainfall events between 2003 and 2006, with available measures of radar reflectivity and rainfall intensity from 20 rain gages with a 10 minutes temporal resolution. For each hourly time step, we estimate several Z-R relationships in the form of power laws, with parameters estimated on moving windows of different durations, between 1 and 24 hours. Three further methods are then applied, based on power law relationships: (1) the one which is currently adopted at ARPA Piemonte, $Z = 300\ R^{1.5}$, (2) one which minimizes the squared sum of the residuals from all the available Z-R pairs, and finally (3) a method similar to (2) which evaluate a relationship for each rainfall event. We apply a cross-validation procedure in order to assess the error characteristics as a function of the calibration period. Our results suggest that a 14% reduction of the standard error is obtained by recalibrating the power law parameters on all the available Z-R pairs. The use of Z-R relations calibrated on shorter durations allows one to achieve further substantial improvements, which we found to be about 27% for a calibration windows of three to five hours.

Bayesian estimation of precipitating cloud parameters: Application to case studies of FLASH and RISKMED projects.

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The retrieval of precipitation profiles from spaceborne microwave radiometers has received, in recent years, several improvements in terms of ground resolution, number of microwave channels, sensor reliability, and computer algorithms for the processing of experimental data. This paper describes recent developments of a Bayesian technique (BAMPR – Bayesian Algorithm for Microwave Precipitation Retrieval) that has been implemented at the CNR ISAC of Rome to produce precipitation estimates from observed multi-channel brightness temperatures. In detail, we will present a general description of the Bayesian inversion algorithm, with particular emphasis on some improvements in the screening procedures, obtained using the polarization-corrected temperature and aimed at reducing the effect of background surface emissivity. These changes have been tested on some case studies of heavy precipitation over the Italian region that were observed by the SSM/I and SSMIS sensors. The results show a considerable improvement of the retrieval algorithm, especially for the rainfall over coastal areas where the different emissivities of the sea and land surfaces usually represent a problem. The cloud radiation database (CRD) that has been utilized for the tests, consist of about 200000 precipitating cloud profiles and of the associated brightness temperatures. The experimental data were obtained from SSM/I sensors (7 channels) of the Defense Meteorological Satellite Program (DMSP).

Microwave single-scattering quantities of randomly oriented soft ice hydrometeors

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Large ice hydrometeors are usually present in intense convective clouds. Many operating satellite-borne passive microwave radiometers (i.e. SSMI/S and AMSU-B) measure radiances up to 183 GHz of frequency, that are strongly affected by ice scattering. Thus, retrieval of precipitation from these measurements requires an accurate method to compute the single scattering parameters of ice particles. On the other hand, shape and internal structure of ice particle (especially, the larger ones) is very complex and variable. Thus, it is necessary to resort to simplifying assumptions in order to compute their single-scattering parameters. In this study, we compute the absorption and scattering efficiencies and the asymmetry factor of two species of non-spherical and non-homogeneous soft-ice particles. The first kind of particles are modelled as quasi-spherical ice particles having randomly distributed spherical air inclusions. The second kind are modelled as random aggregates of ice spheres of random radius. In both cases, particle densities and dimensions are coherent with two UW-NMS's ice categories- i.e., graupel and snow. For our scattering calculations, we use the discrete dipole approximation (DDA) in a range of frequency from 50 to 183 GHz. Then, our results for randomly-oriented soft-ice hydrometeors are compared to the corresponding ones that make use of: a) homogeneous-medium theories, b) equivalent solid spheres, and c) cylinder-shaped snow particles.

A fractional infiltration model for the simulation of the wetting front in non-saturated soils

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In this work the possibility of making use of fractional calculus in hydrology is considered. In the light of the application of non integer order derivatives to various systems in engineering, a fractional infiltration model has been analyzed. The present work is an attempt to ascertain whether fractional calculus is suitable as a tool for the simulation of the wetting front in partially saturated porous media. The model is based on the non linear Richards diffusion equation, therefore the substitution of the derivative with respect to time with a fractional derivative of order smaller than one is considered and the fractional Richards equation is solved by the use of a numerical algorithm (i.e.: Adams-Bashforth-Moulton method). The behavior of the saturation front as a function of time, space and fractional order and the influence of soil diffusivity on the volumetric moisture content are analyzed in order to create a complete description of many phenomena involved in superficial soil layers (as in any porous media) during extreme rain events. Finally some preliminary results based on connection between fractional order and hydrologic parameters are presented.

Numerical modeling of the ice-snow cover forming process in water body of different mineralization

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One-dimensional model describing ice cover growth in mineralized water body is developed. As a result of salt-free ice increasing before a crystallization front a layer with higher mineralization is formed. The last phenomenon affects of the freezing-point. The mathematical statement based on Stefan's problem comes to the solution of the equations of heat conductivity for temperature conditions and diffusion for distribution of mineralization in three conjugated areas with three desired moving boundaries and conjugating conditions. The conditions of heat and mass balances as well as freezing-point changing are taken into account. The front rectification method allowing to setting the equations in a regular domain is used. The problem is numerically realized by the so called contradirectional sweep method (Voevodin A.F. at all. Thermodiffusion task of sphere crystallizations//Dinamika sploshnoi sredy, 1982, N5, pp 118-123).

Spatial distribution of soil moisture at different soil depth

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The study of the soil moisture variability represents an important tool for understanding the dominant flow dynamics on the basis of the runoff mechanism generation during the flood events. Soil moisture data were collected during a period of 10 months using the Time Domain Reflectometry (TDR) technique. The study area is located on a hillslope of the Fiumarella of Corleto River catchment, monitored since different years by three hydro-meteorological stations and a stage-discharge apparatus. Soil moisture is measured along a transect of 11 sample site at two depths (30 and 60 cm), with a total of 22 probe that covered a length of about 60 m. The datalogger acquires in continuous at hourly scale and transmits the data in real time by GSM network. The purpose of this study is to analyze, from a statistical point of view, the acquired data highlighting the different behaviour between the temporal variations of the water contents measurements at 30 cm and 60 cm of depth. The

precipitation registered from a raingauge, sited near the TDR station, were taken in consideration to define the site wetness condition. Further investigations were conducted on the soil moisture spatial variability with particular emphasis to the morphological parameters influence: the topographic attributes, in fact, show their influence on the soil moisture spatial distribution in different way according to the wetter or drier climate conditions.

Snowmelt simulation in the experimental basin of "Fiumarella of Corleto" (Southern Italy)

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The AD3n rainfall-runoff model was applied to the experimental basin of Fiumarella of Corleto to analyze the importance of the snow accumulation end melt processes in the streamflow simulation. The "Fiumarella of Corleto" river is located in Basilicata region (Southern Italy), with an area of about 33 km2, a mean altitude of 1050 m (ranging from 650 to 1500m), characterized by a mean annual precipitation 720 mm with conspicuous snowfalls during winter periods. The snowy precipitation is quantified by means of a raingauge provided of a heat resistance, installed on a hillslope at the mean altitude. The adopted snowmelt module is based on a degree-day method. The snow cover spatial distribution, result of the mass balance between snow accumulation and melt, was compared with NDSI (Normalized Difference Snow Index) obtained by reflectance data from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the NASA Earth Observing System (EOS) Terra spacecraft. Such index allows a reduction of cloud obscuration producing a good description of snow cover. The DREAM model application have been validated producing good results both in terms of snowmelt runoff, highlighting a delayed response in the streamflow during a flood event, and in terms of basin snow cover distribution: in this way the model shows a good capability to reproduce not only the outlet streamflow but also the physical processes on the basis of snowpack generation and melting.

Water resources and sediment prediction in poorly monitored basins: the Mingardo river basin case study

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Water resources and sediment prediction represent a present key issue in hydrology. From this point of view, hydrological models, generating streamflow components time series which are statistically equivalent to the recorded time series, coupled with soil erosion models, simulating water erosion operated by surface runoff, become useful tools. A great number of coupled hydrological - erosion models can be used to this aim, spanning from traditionally conceptual approaches to fully distributed physically based approaches. But is their application feasible and reliable for very poorly monitored basins? The case study we propose is represented by the Mingardo river basin, a 224 kmq catchment, located in southern Italy, Campania region. Data consist in ten years historical precipitation time series recorded at two gauging stations, monthly streamflow measurements recorded within a two years campaign, land cover and geological maps. Streamflow and sediment production are modelled by the SWAT (Soil and Water Assessment Tool) model, a river basin scale physically based model developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time. SWAT is a semi-distributed model using landscape parameters such as topography, land use, soil and geology besides climatic data to simulate streamflow and sediment transport at the catchment or sub-catchment scale. Most of the required data to describe the case study hydrological processes are only available in a coarse spatial resolution and some of these are not even available making the calibration and validation procedures not feasible in this case. To make up for the lack of data we propose an innovative approach, joining all together hydraulic, hydrological geological and geomorphologic features, to capture space-time variability of hydrological processes with a major reduction in predictive uncertainty.

Conceptual model for real time flood forecasting of Tiber river in Rome

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In the present work an application of a conceptual semi-distributed model to real time flood forecasting in Tiber river in Rome is proposed. The model, originally developed to evaluate the probability of inundation of Rome using a Monte Carlo analysis, was slightly modified to calibrate the parameters for ungauged sub-basins and to enable an easy on-line calibration. The catchment area of Tiber river at Ripetta gauging station, in Rome, is more than 16000 km^2. In the upper part of the watershed is located Corbara dam, a reservoir encompassing an active storage of 165 hm^3. The catchment area downstream the Corbara dam is about 10000 km^2. A complete hydrologic and hydraulic physically based model (TEVERE) was applied: the hydrologic module perform rainfall-runoff analysis on 38 ungauged catchements for a total area of 3000 km^2 (which constitutes one third of the watershed area downstream Corbara dam), the hydraulic module simulates flood wave propagation in a looped network of 8 reaches that represent the hydrographic network of Tiber river from Corbara dam to Tyrrhenian Sea. The hydrologic model was modified in order to perform real time flood forecasting: the parameters that characterized both surface and subsurface flow were correlated to area and average elevation of the gauged sub-basins by linear regressions, the remaining parameters, all of which refer

to infiltration and subsurface flow, were correlated to SCS curve number CN_e of the event. On the whole 120 floods on 11 gauged sub-basins available were used to off-line calibration of the rainfall-runoff model and to define the regression equations that allows to reduce the number of the hydrologic parameters at 38, i.e. the value of CN_e of the storm for each sub-basin. In real time application, the ratio r=CN_e/CN_{II} is introduced for each sub-basin. In order to reduce the number of the on-line calibration parameters the values of r are kept constant in areas covering several sub-basins. The hydraulic model was considered as a deterministic component of the system (no parameter calibration). To improve the forecasting accuracy, to support the decision maker, and reduce the possibility of false or missed alarms is necessary provide a usable quantification of the forecasting uncertainty. In the present work the prediction error is calculated in different ways and the confidence intervals of the predicted stages are estimated. The model is applied to simulate the forecasting of historical flood occurred in November 2005. The computation show the possibility to develop a flood forecast model with a lead time of 12 hours, which is useful for civil protection actions.

Rainfall thresholds and flood warning: an operative methodology

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An operative methodology for rainfall thresholds definition is illustrated, in order to provide at critical river section optimal flood warnings. The procedure for the definition of critical rainfall threshold values is based both on the quantitative precipitation observed and forecasted and the hydrological response of the basin. After a statistical analysis in order to define return period of critical discharge of considered hydraulic cross section, a semi-distributed rainfall runoff model is used combined with a spatial-temporal rainfall field simulator, based on stochastic point processes. Thresholds values are estimated for different hydrological scenarios (e.g.: soil moisture conditions); the sensibility of the values is performed considering also different down scaling scenarios of total forecasted rainfall amount over the region. Some preliminary results and a case study of Mignone River are presented.

Evolution characteristics of the restoration desert ecosystem and its influence on water cycling in the Tengger Desert, Northern China

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The rainfed sand-binding vegetation for stabilizing the migrating desert dunes in the Shapotou area at the southeastern edge of the Tengger Desert, initiated in 1956, using shrubs consisting predominantly of *Caragana korshinskii, Hedysarum scoparium and Artemisia ordosica*, has established a desert shrub ecosystem with a dwarf-shrub and biological soil crust cover on the stabilized sand dunes. Some of the effects of recovery from desertification and ecological restoration on soil properties are manifested by the increase of distribution of fine soil particle size, organic matter and nutrients. The physical surface structure of the stabilized sand dunes, and inorganic soil crusts formed by atmospheric dust has gradually formed biological soil crusts. There is a significant positive correlation between fractal dimension of soil particle size distribution and the clay content of the shallow soil profile in the desert shrub ecosystem, the longer the dune being stabilized, the greater the soil clay content in the shallow soil profiles, and the greater the fractal dimension of soil particle size distribution. This reflects the fact that during the re-vegetation processes, the soil structure is better developed especially in the upper profile. Hence, the migrating sand dune becomes more stabilized. During the growing seasons, the average shrub community interception loss is 6.9% and 11.7% of the simultaneous overall precipitation, for *A. ordosica* and *C. korshinskii*, respectively. Taking into account the observed rainfall conditions and vegetation cover characteristics, it was concluded that the interception loss was 2.7% of the total annual precipitation verified in the period for the *A. ordosica* community with an average cover of 30%, canopy projection area of 0.8 m^2 and canopy storage capacity of 0.75 mm. It was 3.8% for the *C. korshinskii* community with an average cover of 46%, canopy projection area of 3.8 m^2 and canopy storage capacity of 0.71 mm. The redistribution of infiltrated moisture through percolation, root extraction, evapotranspiration pathways indicates that the infiltration varied greatly from 7.5 to more than 45 cm depending upon rainfall quantity and soil surface conditions. In the shrub community area without biological soil crust cover, infiltration increased due to preferential flow associated with root tunnels. The biological soil crust cover had a significant negative influence on the infiltration for small rainfall event, it restricted the infiltration depth to less than 20 cm, and increased soil moisture content just beneath the soil profile of 10 cm, while it was not as strong or clear for larger rainfall events. For small rainfall events, the wetting front depth for the three kinds of surface cover was as follows: shrub community without biological soil crust $>$ bare area $>$ shrub community with biological soil crust. In contrast, for large rainfall events, infiltration was similar in shrub communities with and without biological soil crust cover, but significantly higher than measured in the bare area. Soil water extraction by roots associated with evapotranspiration restricted the wetting front penetration after one to three hours of rainfall. Keywords: desert ecosystem; infiltration; dwarf-shrub stabilized sand dune; Shapotou

AUTHOR INDEX

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