EMS7/ECAM8 Abstracts,
Vol. 4, EMS2007-A-00272, 2007
7th EMS Annual Meeting / 8th ECAM

An evaluation study of the MM5 solar radiation estimates in a complex-topography area in southeastern Spain

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The solar radiation plays a major role in the energy exchange process between the atmosphere and the earth surface and is, therefore, a key parameter in a wide range of studies related to agriculture, hydrology, ecosystem modelling or renewable energy. It is known that complex topography significantly modifies radiation fluxes at the earth's surface. Nevertheless, terrain effects on radiation fluxes induced by aspect, slope, sky view factor and shadowing are normally neglected in numerical models when horizontal resolution is lower than 10 km. As spatial resolutions of mesoscales models increase (1-2 Km) the topographic effect on the solar radiation might be considerable, especially at low solar-height angles. Fine-scale non-hydrostatic numerical models, such as PSU/NCAR MM5, are able to include the effects of the slope and aspect on the solar radiation estimates.

In this work we analyze the reliability of solar radiation estimates provided by the MM5 in complex topography. Particularly, hourly global solar radiation values for clear-sky days were obtained based on several MM5 simulations. The experiment was carried out for an area located within the Sierra-Magina Natural Park (Jaén, Southeastern Spain). This area is characterized by a relatively complex topography, with elevations ranging from 600 to 2100 m. MM5 estimates were tested against field data measured at 12 radiometric station located in an area of 20 km x 20 km inside the Park . The location of these radiometric stations covers a wide range of elevations, aspects and slopes. The experiment was conducted for three winter and three summer

clear-sky days collected along the year 2006. Two 1 km resolution simulations were carried out for each set of days: one including the MM5 topographic parameterization and one without including these effects. The comparative analysis of the results allows both knowing the effect of topography on MM5 high-resolution solar radiation estimates and how the slope and aspect parameterization of the MM5 deals with this problem. Finally, the results were analyzed on the light of the different topographic characteristics of the 12 stations.

Results showed, firstly that, compared to observations, an important improvement is obtained both for temperature and radiation when including the topographic effects in the MM5 simulations. Additionally, the model tends to underestimate the solar radiation in morning day hours and to overestimate the values in the central day hours. Finally, results showed, that the difference between the estimated and measured solar radiation increases when the topographic complexity increases.