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Extreme heat and runoff extremes in the Swiss Alps

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This study focuses on the response of Swiss rivers to 2003 heatwave by combining an analysis of discharge records with specific application of distributed hydrological modelling. Data from 42 stream flow gauges are adopted for describing the occurrence of opposite monthly runoff extremes. The spatially distributed hydrological model PREVAH is then applied to three basins for analyzing the mechanisms triggering the different regional impacts on discharge.

Following main topics are discussed: a) Local and regional characterization 2003 flow rates in Switzerland with respect to the historical data. b) Analysis of the differential impacts of the 2003 heatwave by mean of distributed hydrological modelling. c) Quantify the particular contribution of icemelt to the discharge. d) Evaluation of capabilities of the adopted distributed hydrological model to cope with unprecedented climate conditions which are close to the generally proposed climate change scenarios.

In summer 2003 the discharge from headwater streams of the Swiss Central Plateau was only 40%-60% of the long term average. For alpine basins runoff was about 60%-80% of the average. Glacierized basins showed opposite behavior. According to the degree of glacierization the average summer runoff was close or even above average. The hydrological model PREVAH has been applied for the period 1982-2005. Even if the model has not been calibrated for such meteorological conditions, it was well able to simulate the particular hydrological responses of three basins. The aridity index ϕ describes feedbacks between hydrological and meteorological anomalies. ϕ was adopted as indicator for hydrological drought. The anomalies of ϕ and temperature in summer 2003 exceeded the 1982-2005 mean by more than 2 standard deviations. Catchments without glaciers showed negative correlation between ϕ and the dis-

charge R. In basins with about 15% glacierization ϕ and R were not correlated. Rivers with higher glacier portion showed a positive correlation between ϕ and R. Icemelt was positively correlated with ϕ and reduced the variability of discharge with larger amounts of meltwater. Runoff generation from the non-glaciated sub-areas was limited by high evapotranspiration and reduced precipitation. Summer 2003 could have been a precursor of similar events in the near future. Hydrological models and further data analysis will allow identifying the most sensitive regions where heatwaves may become a recurrent natural hazard with large environmental, social and economical impacts.