Atmospheric Precursors to Floods in Switzerland

Paul Froidevaux*, Olivia Romppainen-Martius*, Rolf Weingartner*

*Oeschger Centre for Climate Change Research and Institute of Geography, University of Bern, Hallerstrasse 12, CH-3012 Bern (paul.froidevaux@giub.unibe.ch)

It is important to learn more about flood triggering weather patterns in Switzerland for two reasons: (i) projections of flood frequencies in a warmer climate are strongly limited by the ability of climate models to represent the complex small-scale processes associated with typical flood triggers like heavy precipitation and snow melt. Information about flood triggering weather situations can be used in a more indirect approach to estimate changes in future flood frequencies.

(ii) Flood frequencies in Switzerland show significant decadal variability, suggesting that decadal variations in the synoptic atmospheric flow might influence flood probabilities (Schmocker-Fackel & Naef, 2010). However, links to temperature trends or large-scale climate indices are complex and ambiguous and Schmocker-Fackel & Naef expressed the need for a better understanding of the synoptic-scale atmospheric flood triggers.

We used weather types classifications to group the Swiss rivers based on their specific flood-associated synoptic situations. The classification algorithm grouped the rivers into distinct classes, each reacting to a different synoptic flow pattern. We aim to determine for each class a set of typical synoptic- and meso-scale flood ingredients by combining atmospheric reanalysis from the ECMWF with dense networks of rain gauges and river discharge measurements.

We performed a series of case study analyses that showed promising results. For the case studies four catchments have been selected, each representing a preferred hydrological flood type (e.g. shower, long lasting rain, rain on snow, pure melt). For each of these catchments many of the annual maximum floods share a common triggering weather situation and these flood triggering weather situations vary substantially between the different catchments.

An example is shown in Figure 1. On 21 December 1991 an atmospheric river brought very moist air to North-Western Europe. This atmospheric river triggered, together with other factors, a record flood in the Suze river in Switzerland.

We will use the best set of atmospheric flood precursors to build up an ingredient-based flood forecasting model. We will separate 50 years of discharge and reanalysis data into a validation and calibration period to test the skills of our flood forecasting model. In case of sufficient skill, this model will be applied to future climate projections to derive future flood probabilities for each Swiss region.

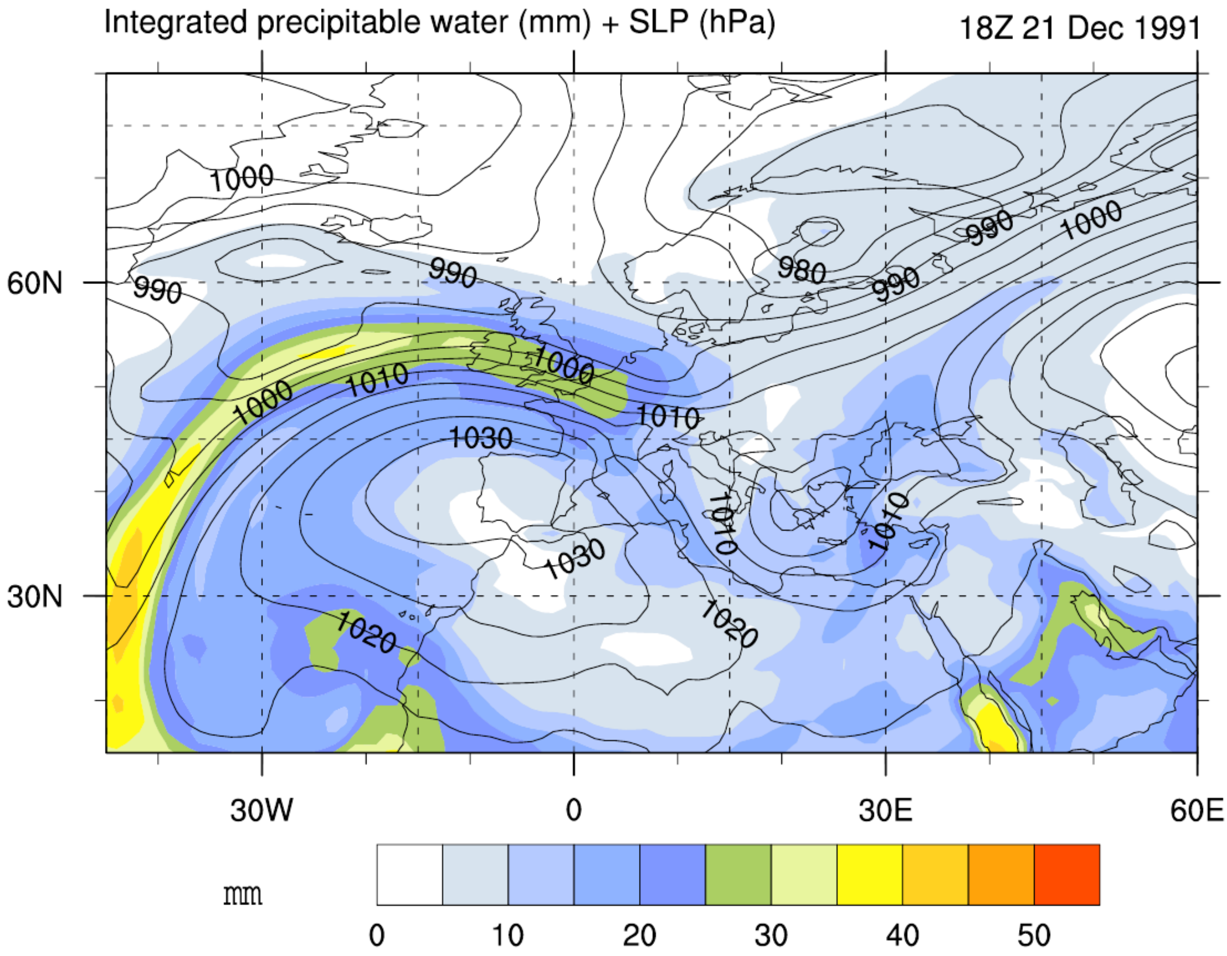

Figure 1: Precipitable water (shaded, mm) and sea level pressure (contour lines) on 18 UTC December 21 1991.

REFERENCES

Schmocker-Fackel, P. and Naef F. 2010: More frequent flooding? Changes in flood frequency in Switzerland since 1850, Journal of hydrology, 381, 1-8

Heavy Precipitation Events in Northern Switzerland

Paraskevi Giannakaki, Olivia Martius

Institute of Geography, Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Heavy precipitation events in the Alpine region often cause floods, rock-falls and mud slides with severe consequences for population and economy. Breaking synoptic Rossby waves located over western Europe, play a central role in triggering such heavy rain events in southern Switzerland (e.g. Massacand et al. 1998). In contrast, synoptic scale structures triggering heavy precipitation on the north side of the Swiss Alps and orographic effects have so far not been studied comprehensively.

An observation based high resolution precipitation data set for Switzerland and the Alps (MeteoSwiss) is used to identify heavy precipitation events affecting the north side of the Swiss Alps for the time period 1961-2010. For these events a detailed statistical and dynamical analysis of the upper level flow is conducted using ECMWFs ERA-40 and ERA-Interim reanalysis data sets. For the analysis north side of the Swiss Alps is divided in two investigation areas north-eastern and western Switzerland following the Swiss climate change scenarios (Bey et al. 2011). A subjective classification of upper level structures triggering heavy precipitation events in the areas of interest is presented. Four classes are defined based on synoptic-scale structures of the dynamical tropopause over Europe during extreme events in the northern part of Switzerland and its sub-regions. The analysis is extended by a climatology of breaking waves and cut-offs following the method of Wernli and Sprenger (2007) to examine their presence and location. In a next step the potential for an upper-level Rossby wave upstream precursor is investigated.

References

Bey I., Croci-Maspoli M., Fuhrer J., Kull C, Appenzeller C., Knutti R. and Schär C. Swiss Climate Change Scenarios CH2011, C2SM, MeteoSwiss, ETH, NCCR Climate, OcCC (2011), http://dx.doi.org/10.3929/ethz-a-006720559

Massacand A., H. Wernli, and H.C. Davies, 1998. Heavy precipitation on the Alpine South side: An upper-level precursor. Geophys. Res. Lett., **25**, 1435-1438.

MeteoSwiss 2011. Documentation of Meteoswiss grid-data products, daily precipitation (final analysis): Rhiresd. Available at: http://www.meteosuisse.admin.ch/web/en/services/data_portal/gridded_datasets/precip.html

Wernli. H., and M. Sprenger, 2007. Identification and ERA-15 climatology of potential vorticity streamers and cutoffs near the extratropical tropopause. *J. Atmos. Sci.*, **64**, 1569-1586.