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Search for synoptic precursors to extreme precipitation events in the Swiss Alps

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Heavy precipitation events result in one of the most expensive natural disasters in Switzerland. Those events induce mainly landslides, floods and debris flows. Three major precipitation events occurred recently (August 1987, September 1993 and October 2000) in the Swiss Alps, more specifically in the Rhone valley, with extensive flood events. All these inclement weather took place under a southerly circulation, but this meteorological situation does not always lead to heavy precipitations. A lack of knowledge exists in their formation. In consequence, nowadays extreme events are still difficult to forecast, especially in an alpine environment. The numerical models struggle to take into account the complexity of this environment with many local-scale specific behaviours. Therefore, this work aims to identify simple synoptic precursors to such events throughout backward trajectories of the air masses.

Backward trajectories can be modeled with different methods and along two or three dimensions. The 2D trajectories are calculated and projected on an invariant parameter such as the pressure or the temperature, while the 3D trajectories indicate the height position of the air masses. Three-dimensional trajectories tend to be more complex, which will add uncertainties and errors to our models. Various existing tools are used to run the trajectories. Among them, we tested tools such as Hysplit, Flextra or Metex in order to analyze the trajectory properties. The implemented methods in these models are quite similar, but the results may be slightly different.

The tools also offer the possibility to use the reanalysis dataset source of our choice. Therefore, trajectories are run with different datasets such as the NCEP/NCAR reanalysis or the ERA reanalysis. We preliminary observed that the accuracy of the model highly depends on the spatial density and the temporal availability of the dataset.

Then, backward trajectories are run for several extreme events and non-extreme events in order to analyze and compare their properties and differences. They are run from weather stations that often measure big amount of rain during those events, such as the Binn station. An identification of synoptic precursors is attempted throughout those analyses.