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Summer North Atlantic Oscillation and flood variability in Switzerland

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The study analyses the possible links between flood frequency in Switzerland and the North Atlantic dynamics over the last two centuries.

Given the intricate topography of Switzerland, it will generate a territorial division to retain main physiographic and environmental dissimilarities between different regions. The flood variability in Switzerland over the period 1800-2010 has been determined from a flood damage index for July and August months. The index considers very severe and catastrophic floods from existing flood inventories, summarizing both the severity of these events, their spatial extent and the regional differences. Special attention will be focused on the disparities between flood dynamics at northern and southern slopes of the Alps.

The analysis of the possible links between floods and North Atlantic dynamics is focused on the low-frequency atmospheric circulation patterns. Summer climate in the North Atlantic-European sector shows a principal pattern of year-to-year variability, although this pattern is weaker than the North Atlantic Oscillation (NAO) in winter and is confined to northern latitudes. By analogy the climatology community refers to this pattern as the Summer North Atlantic Oscillation (SNAO), which is defined as the main empirical orthogonal function of the standardized anomalies of the European mean sea level pressure during July and August.

The flood damage index provides evidences of floods clusters in: 1830-1851, 1881-1927, 1977-1990 and 2005 to present. These clusters coincide with those reported from Switzerland and from some areas of the European continent such as the Czech Republic, Italy and the eastern half of the Iberian Peninsula. This link is not so close when compared with the flood occurrences in Germany. The analysis of the principal mode of low-frequency atmospheric variability shows that the Swiss river catchments situated on the center and southern flank of the Alps are affected by atmospherically unstable areas defined by the positive phase of the SNAO pattern, while those basins located in the northern slope of the Alps are predominantly associated with the negative phase of the pattern. Furthermore, a change in the low-frequency atmospheric circulation pattern related to the major floods occurred over the period from 1800 to 2010: the Summer North Atlantic Oscillation persists in negative phase during the last cool pulses of the Little Ice Age (1817-1851 and 1881-1927 flood clusters), whereas the positive phases of SNAO prevail during warmer climate of the last four decades (flood clusters from 1977-1990 and 2005 to present).