



Identification of spring weather patterns causing floods in the East of Brittany (France)

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Brittany and northwestern France was seriously affected by several hydrological crisis since the last decades of the XXth century. Hydrological events due to the remarkably wet winters were thoroughly studied (e.g. winter 1994-1995 and 2000-2001), but serious floods occurred in spring too, e.g. in May 1981 or in April 1998. The aim of this paper is to identify the weather patterns causing heavy rainfall and floods in spring and to analyse these occurrences, using the Hess-Brezowsky classification of circulation patterns. In order to acquire knowledge of rainy circulation types, the Hess-Brezowsky classification was applied to the months of April, May and June between 1958 and 2002. The precipitation ratio was calculated for each major (zonal, mixed and meridional) circulation type and for each group of circulation type (*Grosswettertypen*) at the weather station of Rennes for these three months, in order to identify the rainiest circulation types. The ratio of days receiving a rainfall amount of more than 10 mm and 20 mm for each GWT was calculated too. More detailed observations and analysis using the Hess-Brezowsky classification were made in order to study the connection between the GWT and the daily precipitation during remarkable spring months.

The floods of the Vilaine river in eastern Brittany were identified in spring (April, May and June) during the period of 1958-2002: 44 events were identified and succeeded rainfall events, which sometimes reach more than 20 mm / 24 h. Ten flood events succeeded daily rainfall of at least 20 mm at the weather station of Rennes. Among the three days preceding the flood events, 57.6% of these days were subjected to meridional circulation types, 21.2% were subjected to zonal-westerly circulation

types and 21.2% were subjected to mixed circulation types (including 50% of southwest cyclonic type). More precisely, 43.2% of the days preceding the flood events were subjected to south circulation types, 21.2% were subjected to west circulation types and 15.2% were subjected to northwest and north circulation types. At the weather station of Rennes, during the period of 1958-2002 (April, May and June) 37.4% of the rainfall were associated with south circulation types, 20.3% with west circulation types, 17.2% with northwest and north circulation types and 13.8% with northeast and east circulations types. The occurrence of daily rainfall of at least 20 mm confirmed the importance of the south circulations (33.3% of the events) as first rain-producing circulation types in spring in Brittany.

While the strong westerlies induce heavy precipitation in winter, (zonal-westerly southwesterly circulations occur throughout the year but more especially in autumn and winter), Heavy rainfall in spring are especially associated with meridional circulation patterns: the highest occurrence of the meridional circulations recorded in April and May allows the development of low geopotential heights at mid-latitudes which have strong effects on cyclogenesis and precipitation. The circulation type with a trough located west of the Greenwich meridian produces heavy precipitation in the Atlantic western Europe (especially in spring and summer), due to a negative surface pressure anomaly located over or close to the British Isles, which involves a southerly or southwesterly flow over western Europe. Most of the daily rainfall of at least 20 mm (73%) were associated with weather patterns characterized by a low located from case to case between the British Isles and Portugal. The unusual recurrence of weather patterns with troughs between the eastern Atlantic Ocean and the Central Europe longitude in May during the 80s involved positive precipitation anomalies in most of western Europe.

Distinctive features of daily timescale heavy precipitation events are shown with the rainfall amounts and ratios for the characteristic month of May 1981. In May 1981, the meridional circulation types represented 74.2% of all circulation types and caused 72.4% of the monthly rainfall. The heaviest rainfall of May 1981 occurred during the two periods subjected to meridional circulation types. The highest rainfall amount was recorded during the second period: the meridional-southerly circulation type of May 30th (*South Anticyclonic* circulation type) caused the highest daily rainfall of the month in Rennes (35.1 mm) and involved a flood of the Vilaine river on June 1st. The flood hydrograph from the Meu river on May 1981 proved a short time riser and a rapid runoff. The prevailing weather pattern of May 1981 was a trough over the eastern Atlantic Ocean associated with a surface low durably located close to the British Isles. The highest positive precipitation anomalies in western Europe were recorded in western France between 100% and more than 200% above the 1961-1990

average.