Geophysical Research Abstracts
Vol. 12, EGU2010-4734, 2010
EGU General Assembly 2010

Past climate variability inferred from statistical processing of documentary data: a case study on extreme meteorological events in western central France from 1500 to 2000 AD

Clément Poirier (1), Eric Chaumillon (1), and Jean-Luc Audé (2)

(1) Littoral Environnement Sociétés, UMR 6250 CNRS-ULR, La Rochelle, France (clement.poirier@univ-lr.fr), (2) private address

Recent human-induced climate changes are expected to have an impact on extreme events including shifts in storm tracks, heavier precipitations and more severe droughts (Planton, 2008). Although climate models successfully describe the past mean climate variability, they often fail to correctly reproduce such extreme events, mainly because of a low spatial and temporal resolution (Sánchez et al., 2004). Reports of extreme meteorological events gathered from documentary archives are be useful to fill this gap, and would also provide insights into local climatic variations (Leijonhufvud et al., 2008; Rodrigo, 2008; Wheeler, 2006). In this study, a local text book published by Audé (2006) was used as a source of climatic data. It consists of a list of extreme meteorological events recorded in historical archives (diaries mainly) in western central France, along the Bay of Biscay. From the book, 284 extreme meteorological events that occurred between 1500 and 2000 were selected. A presence-absence matrix was built, the events being classified in 7 distinct categories by Audé. A preliminary multivariate analysis (Principal Component Analysis) was used to group these categories into 4 classes of events. First axis (22.3% of explained variance) discriminated the events related to temperature, with frosts and snowfalls on one side, versus gales and storms on the other side. Second axis (18.5% of explained variance) discriminated the events related to precipitation, with floods and rainfalls on one side (humid), versus droughts on the other (dry). For each class, a 29-year running mean was computed to convert binary qualitative data to semi-quantitative curves. A spectral analysis was also performed on the same binary data to detect potential climatic cycles. Despite the randomness of the historical records reported in this book, that much relies on the subjective perception of meteorological events by past witnesses, the results obtained are consistent with existing data about past climate changes since 1500 AD. Temperature-related events show a significant negative correlation ($R2 = -0.49$, $p = 0$) with 14C curve (Reimer et al., 2004), whereas precipitation-related events show a significant positive correlation ($R2 = 0.66$, $p = 0$) with the same curve. As an example, recurrent flood and rainfall events occurred from 1630 to 1720 and from 1800 to 1830, which corresponds to the Maunder and Dalton periods of minimum solar activity respectively. Spectral analysis carried out on the 4 classes of events revealed several cycles in the data, in particular a 11 year cycle that corresponds to the Schwabe cycle, and a 85 year cycle that might be related to Gleissberg cycle. The last 150 years display unusual conditions with increasing storms, gales and droughts. The documentary data analysed in the present study might provide interesting information about the consequences of human-induced global warming on extreme meteorological events. They would also be useful as a source of information about local climate variations.

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