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Multilevel drought reanalysis over France with Safran-Isba-Modcou hydrometeorological suite

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From a physics point of view, droughts can be defined as a water deficit in at least one component of the land surface hydrological cycle. The reliance of different activity domains (water supply, irrigation, hydropower, etc.) on specific components of this cycle prevent one from deriving a universal drought index. Drought monitoring thus requires having indices related to meteorological, agricultural, and hydrological droughts.

This paper proposes a high-resolution retrospective analysis of such droughts in France over the last fifty years, based on Safran-Isba-Modcou (SIM) hydrometeorological suite. First, a high-resolution (hourly, 8km) gridded atmospheric reanalysis based on both ground observations and large-scale ECMWF atmospheric model archives was performed with Safran mesoscale analysis system for the period August 1958-July 2008. Analysed near-surface variables were then used to force the Isba land surface scheme which computes the surface water and energy budgets. The evolution of aquifers and river flows was furthermore simulated by Modcou hydrogeological model.

Meteorological droughts are characterized by computing a Standardized Precipitation Index (SPI) at time scales varying from 1 to 24 months. Agricultural and hydrological droughts are identified by applying a similar standardizing method to Soil Wetness Index (SWI) and streamflow respectively. Such an approach provides a consistent way to assess the propagation of droughts through the land surface hydrological cycle, by considering normally distributed indices derived from water contents in each component.

Similarities and differences between different types of drought are highlighted by examining the severity, duration and areal extension of drought events, from multi-year precipitation deficits (1989-1990) to short hot and dry periods (2003). This multilevel drought climatology will serve as a basis for assessing the impacts of climate change on droughts in France.