Downscaling and hydrological uncertainties in 20th century hydrometeorological reconstructions over France

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The record length of streamflow observations is generally limited to the last 50 years, which is not enough to properly explore the natural hydrometeorological variability, a key to better understand the effects of anthropogenic climate change. This work proposes a comparison of different hydrometeorological reconstruction datasets over France built on the downscaling of the NOAA 20th century global extended reanalysis. It aims at assessing the uncertainties related to these reconstructions and improving our knowledge of the multi-decadal hydrometeorological variability over the 20th century.

Sparse and scarce hydrometeorological data before the 1960s

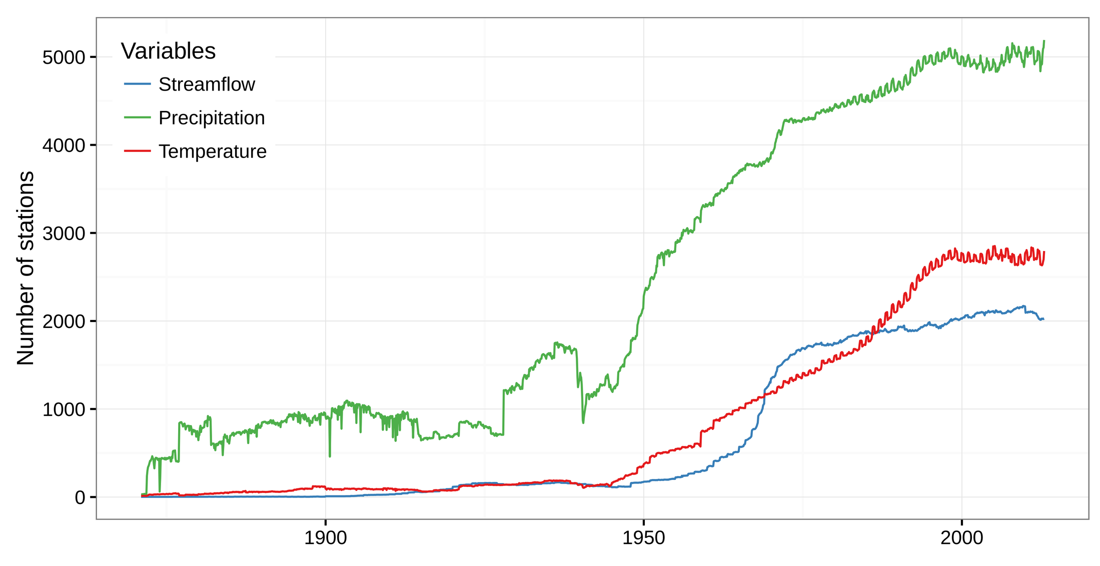

Figure 1: Number of stations recording precipitation, temperature, and streamflow over France since 1871.

- Issue for studying long-term hydrological trends and multidecadal variability at the country scale

Hydrometeorological reconstructions

- Meteorological forcings:
  1. 1958-now: **SAFRAN** high-resolution near-surface reanalysis (Vidal et al., 2010)
  2. 1871-2012: **20CR** global extended large-scale Twentieth Century Reanalysis (Compo et al., 2011) downscaled by 2 statistical downscaling methods to derive catchment-scale weather:
     - **ANALOG**: deterministic method for the whole France (Dayon et al., 2015)
     - **SCOPE**: ensemble method (25 members) calibrated locally (Caillouet et al., 2016a,b)
- Hydrological models:
  - **SIM2.0**: land surface model + distributed hydrogeological model (Habets et al., 2008; Decharme et al., 2013)
  - **GR6J**: calibrated lumped conceptual model (Pushpalatha et al., 2011; Valéry et al., 2014)

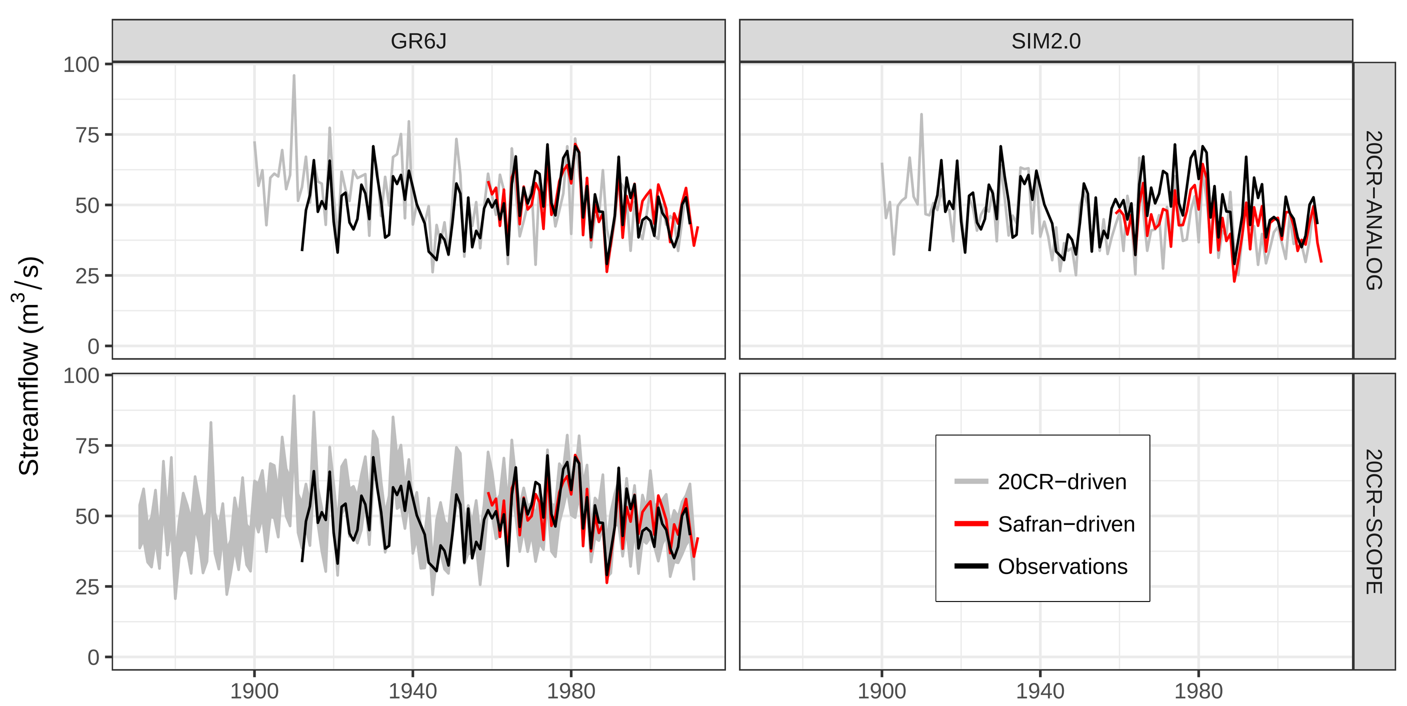

Figure 2: Evolution of streamflow observations and reconstructions for the Gave d'Oloron@Oloron-Sainte-Marie (South-West France).

- Daily reconstructions on a subsample of 68 stations from the French reference hydrological network (Giuntoli et al., 2013)

Multidecadal streamflow variability over France

MDV: multidecadal variability taken as the ratio between the standard deviation of smoothed annual series and the standard deviation of raw annual series

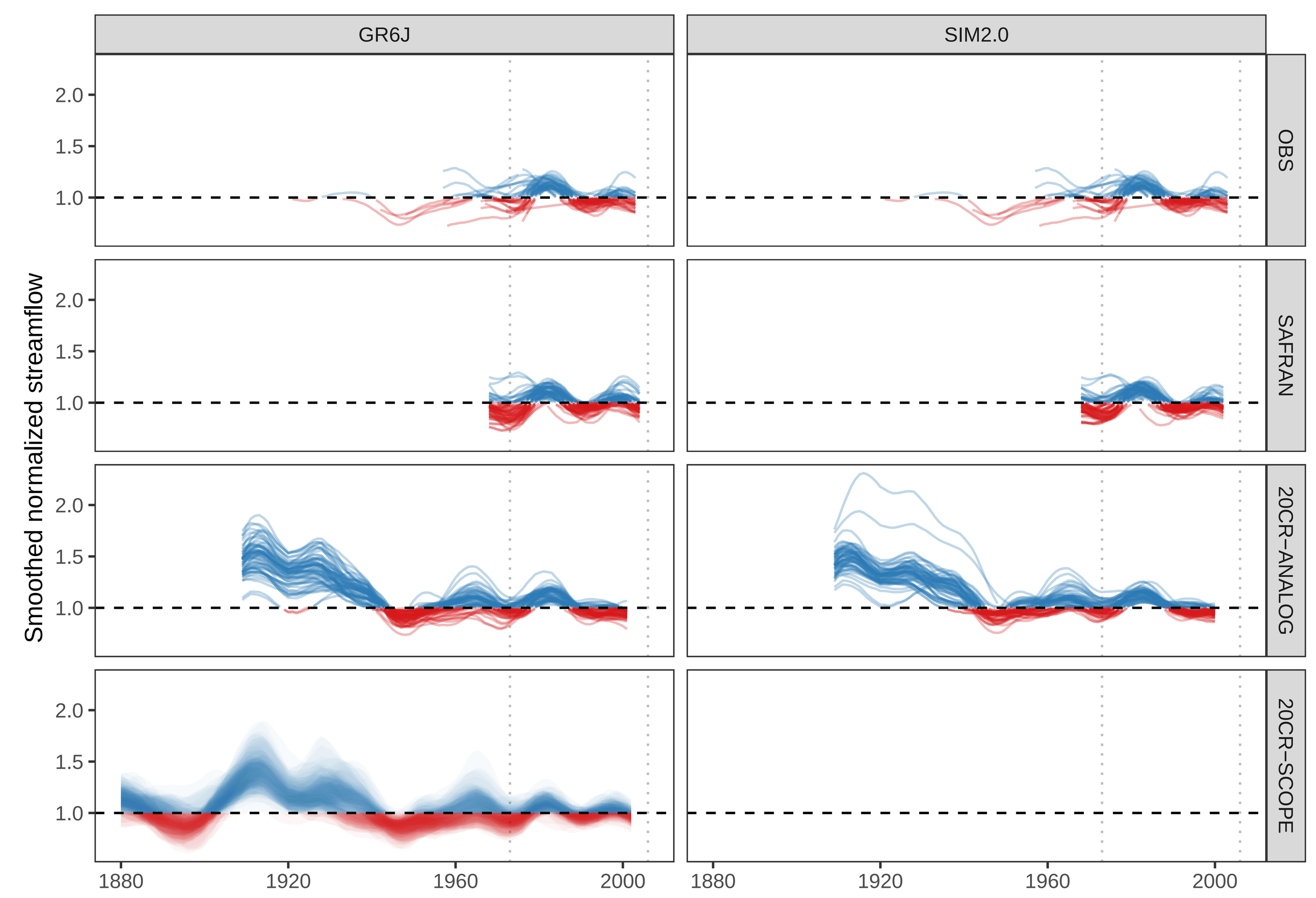

Figure 3: Smoothed normalized annual streamflow for observations and hydrometeorological reconstructions over individual stations, with hydrological models over the columns and meteorological forcings over the rows. Streamflow are normalized with respect to the 1973-2006 average. Smoothing follows a Hamming filter with 19 weights.

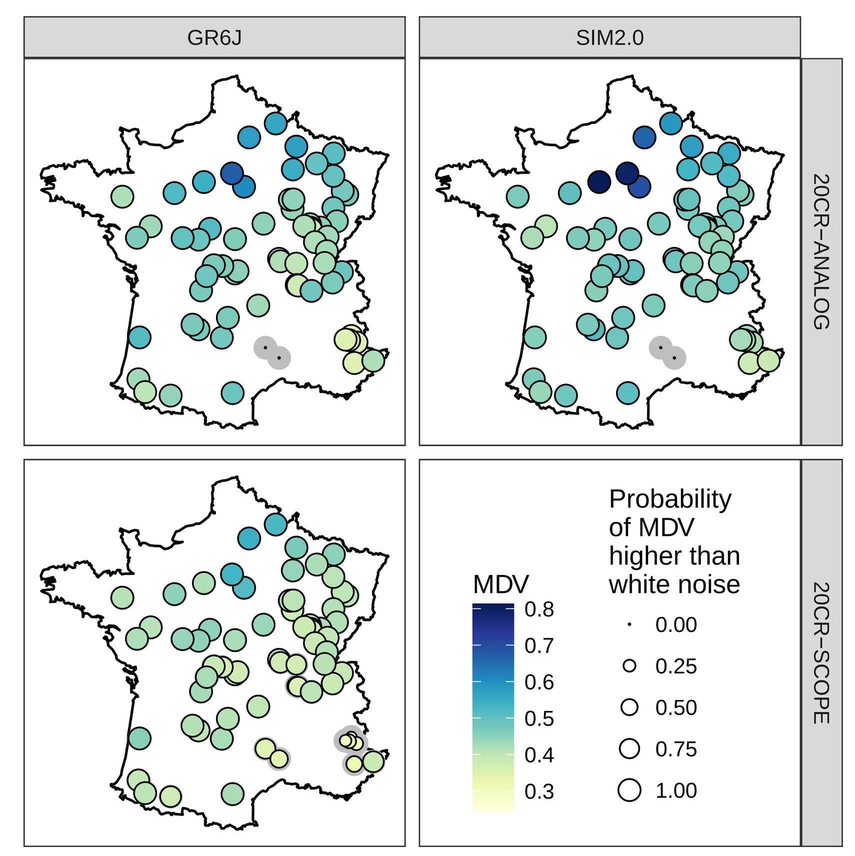

Figure 4: Multidecadal variability for 20CR-driven hydrological centennial reconstructions.

- Large multidecadal variability in 20CR-driven reconstructions between 1871 and 2012
- Relatively coherent over France
- Consistent with findings on observations (Boé and Habets, 2014)

Downscaling and hydrological uncertainties in streamflow reconstructions

SDM: uncertainty in the structure of the statistical downscaling method
- Absolute difference between:
  - 20CR-ANALOG × GR6J
  - median value of 20CR-SCOPE × GR6J

SSIV: small-scale internal variability (Vidal et al., 2016)
- Mean absolute difference across 20CR-SCOPE × GR6J ensemble members

HM: uncertainty in the structure of the hydrological model
- Absolute difference between:
  - 20CR-ANALOG × GR6J
  - 20CR-ANALOG × SIM 2.0

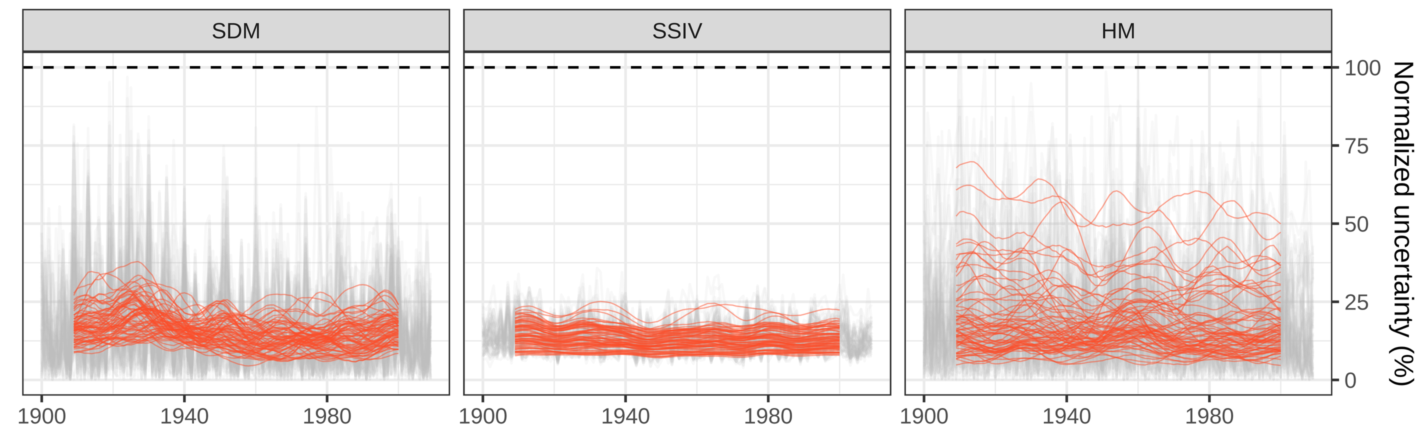

Figure 5: Evolution of uncertainty types for individual stations over 1900-2010, in percent of the mean interannual streamflow. Smoothed versions with a Hamming filter similar than Fig. 3 are shown in black.

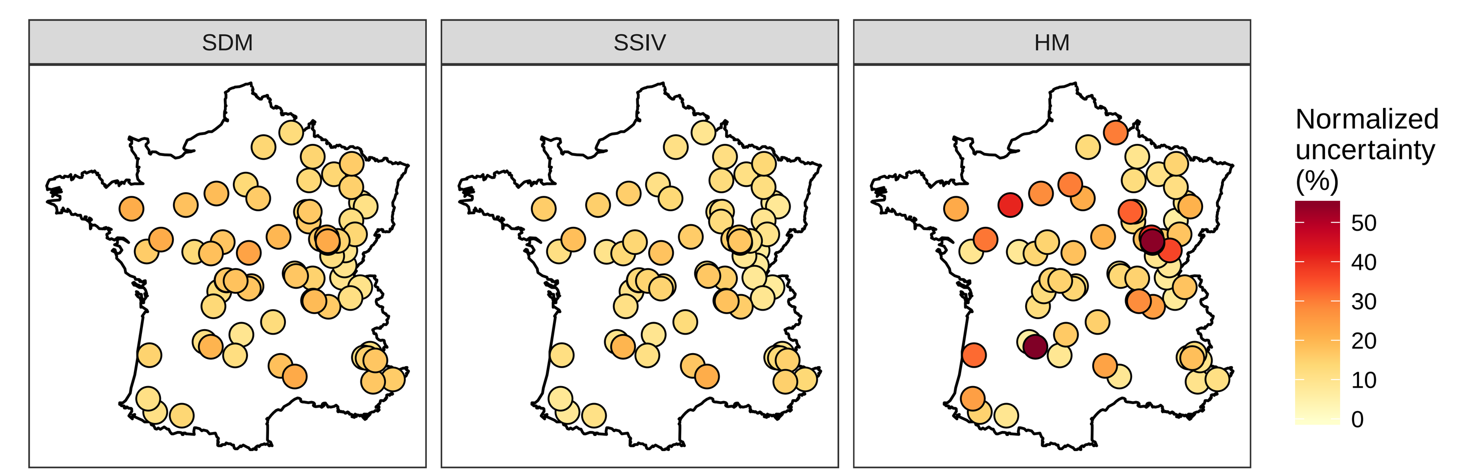

Figure 6: Temporal average of uncertainty types, in percent of the mean interannual streamflow.

- Same order of magnitude for all 3 uncertainty types
- Values around 20% of the interannual mean, locally larger for HM

Perspectives

- Analysing multidecadal variability on downscaled precipitation and temperature, and at finer time scales
- Comparing SDM, SSIV, and HM uncertainty with uncertainty related to the choice of the driving reanalysis, by integrating experiments driven by ERA-20C reanalysis (Poli et al., 2016)
- Reducing reconstruction uncertainty by assimilating historical meteorological station data

See poster "Reanalysis of the 1893 heat wave in France through offline data assimilation in a downscaled ensemble meteorological reconstruction" by A. Devers et al., Hall X5 at board number X5.20 (Wed. 17:30-19:00)

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