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SCOPE Climate: a high-resolution ensemble meteorological downscaling of the Twentieth Century Reanalysis over France from 1871 to 2012

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This work presents SCOPE Climate, a daily high-resolution ensemble reconstruction of precipitation and temperature fields in France over the 1871-2012 period. The objective is to fill in the spatial and temporal data gaps in surface observations in order to improve our knowledge on the local-scale climate variability from the late nineteenth century onwards. This high-resolution daily dataset allows for the first time detailed long-term analyses of meteorological trends in a comprehensive way over the whole country. It provided forcings for the GR6J-CemaNeige rainfall-runoff model to derive a daily 140-year ensemble reconstruction streamflow dataset for a reference network of more than 600 near-natural catchments – the SCOPE Hydro dataset –, used to study historical extreme low flow events in France (Caillouet et al., 2017).

Sparse and scarce meteorological data before the 1950s

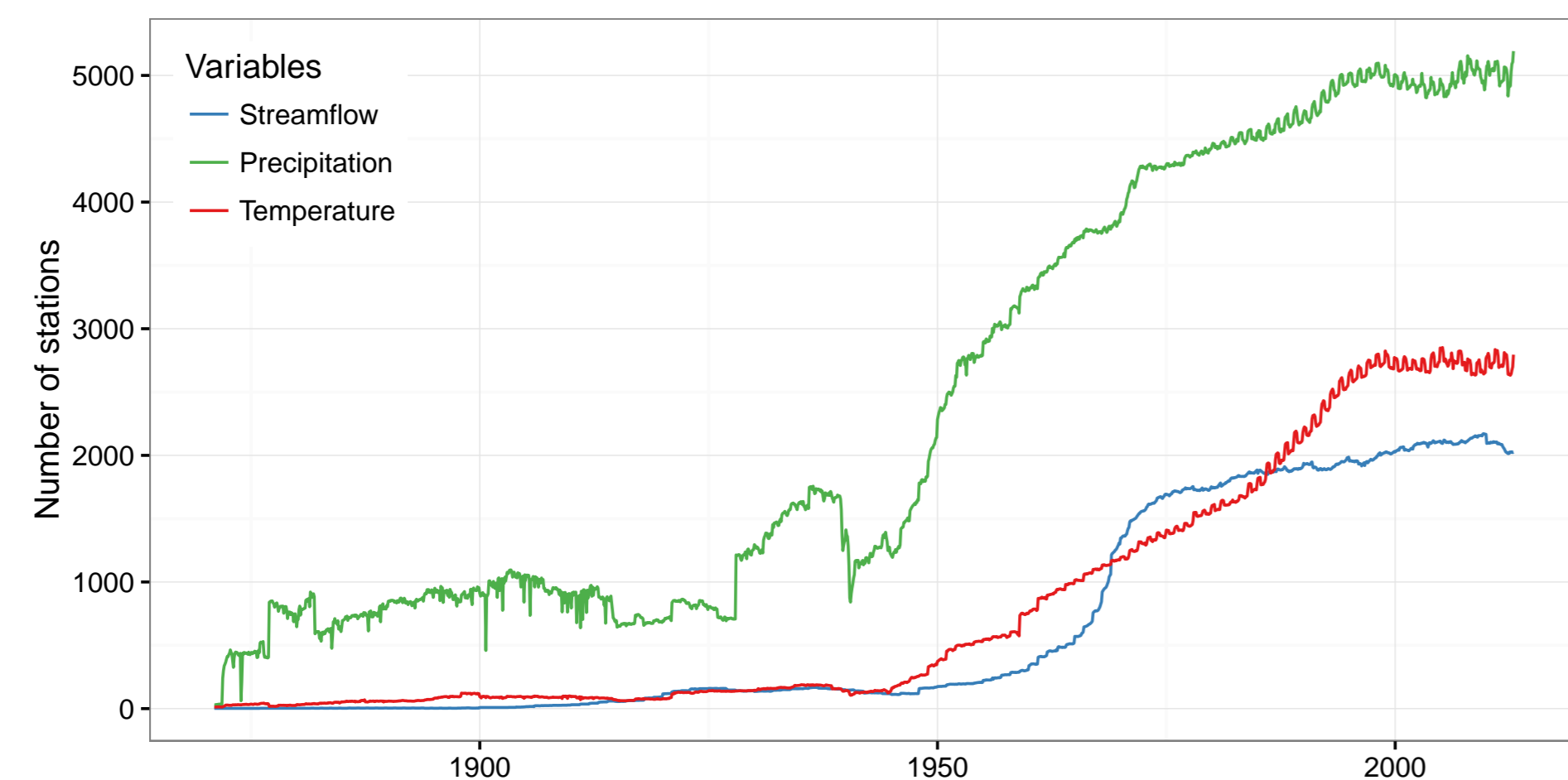


Figure 1: Number of stations recording precipitation, temperature (and streamflow) over France since 1871.

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

Multivariate spatial downscaling chain

1. **SANDHY**: Stepwise ANalogue Downscaling Method for HYdrology (Ben Daoud et al., 2011; Radanovics et al., 2013; Ben Daoud et al., 2016)

- Dedicated to precipitation as predictand
- Stepwise refinement of the pool of analogues
- Local optimisation of geopotential spatial domains: 5 best ones retained

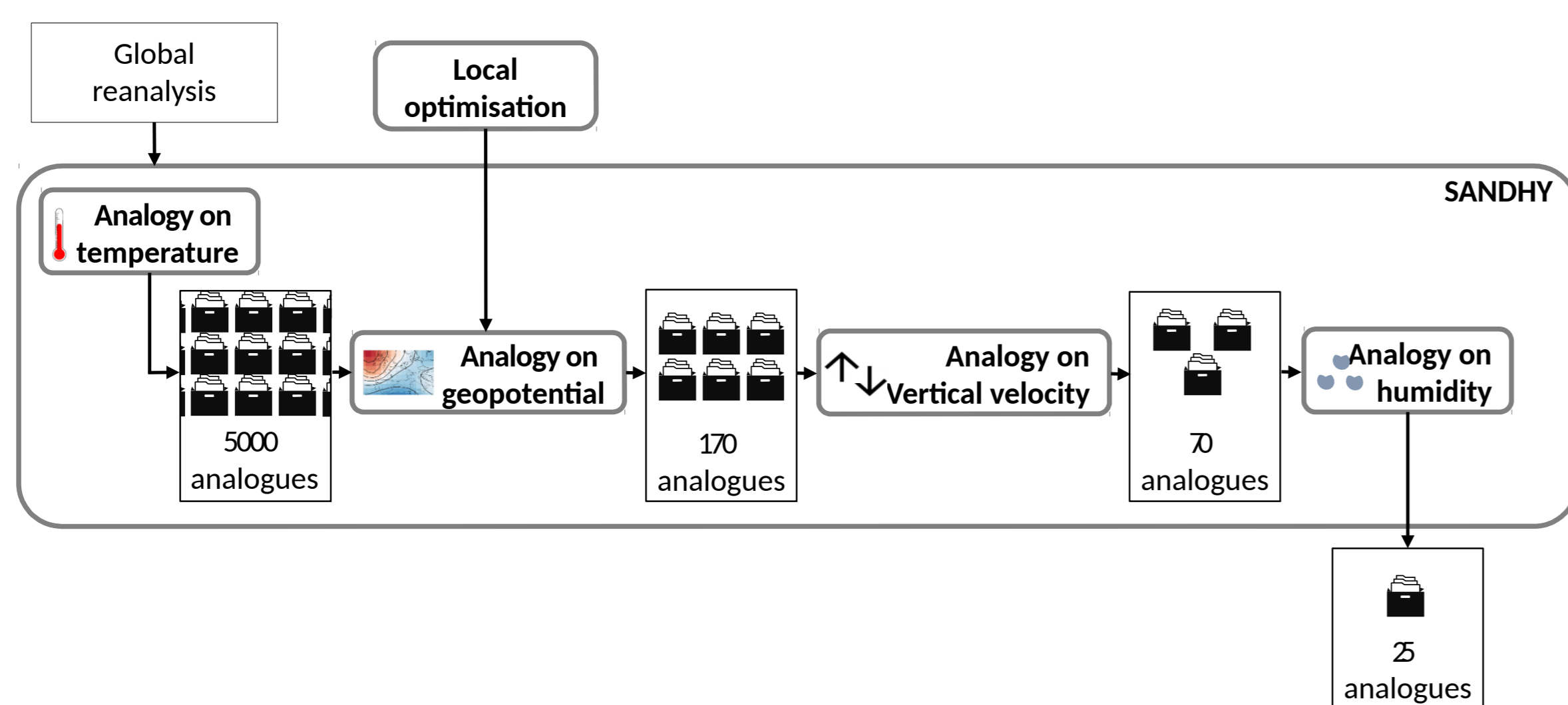


Figure 2: The SANDHY method.

2. **Additional analogy steps** ("Stepwise", Caillouet et al., 2016)

- Adaptation to both precipitation and temperature as predictands
- Subselection of 80 analogues on Sea Surface Temperature
- Subselection of 25 analogues on large-scale 2m temperature

3. **Correction of dry bias** (Caillouet et al., 2017)

- Remove 1 to 3 dates (depending on the zone) with the lowest precipitation amounts
- Resample remaining dates to preserve the 25-member ensemble size

4. **Spatial coherence**: Schaake Shuffle (Clark et al., 2004)

- Reorganisation of ensemble members across France based on observed climatological spatial coherence (Caillouet et al., 2017)

SCOPE: Spatially COherent Probabilistic Extension method

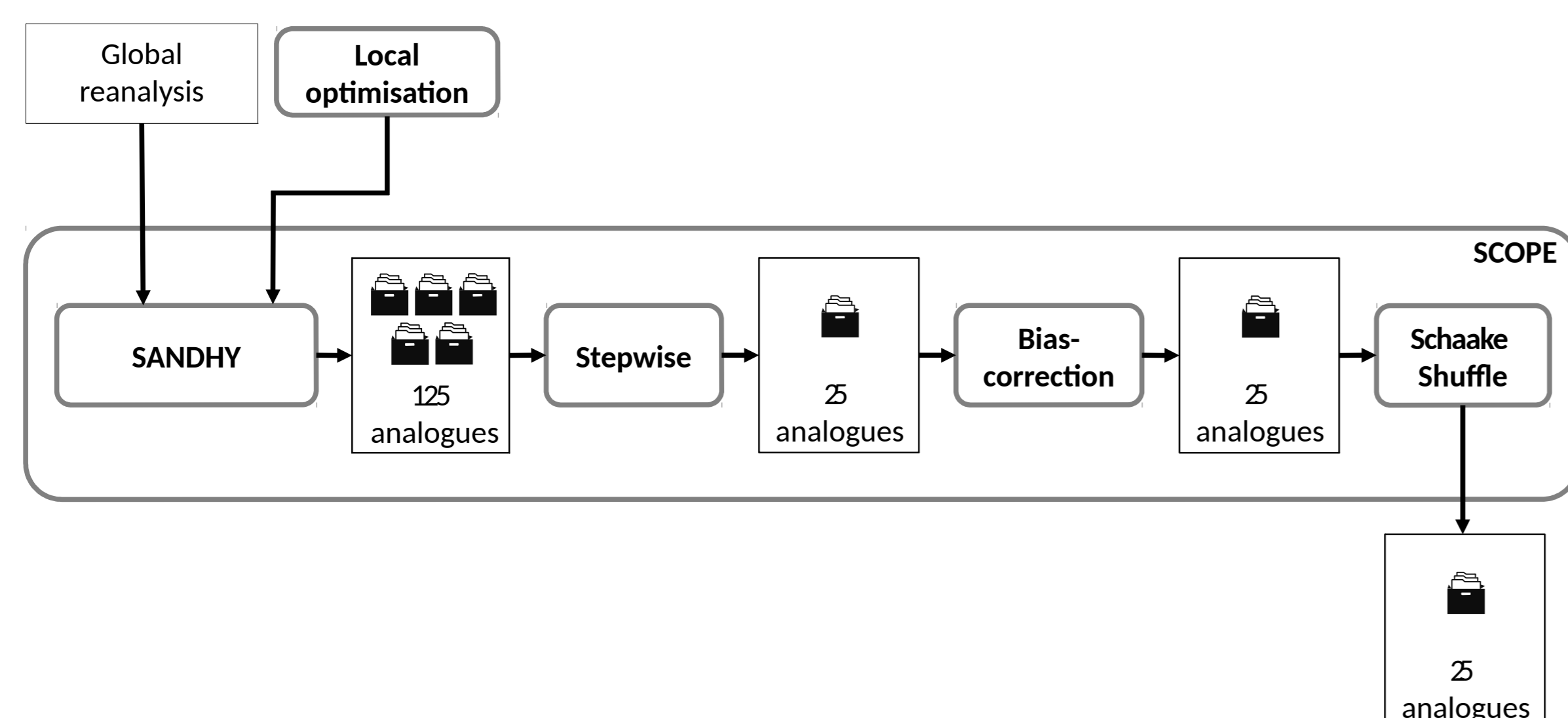


Figure 3: The entire SCOPE method (Caillouet et al., 2016, 2017).

► Application to downscale the Twentieth Century Reanalysis (Compo et al., 2011) over France

- SCOPE Climate dataset:**
- Daily time scale, 1871-2012
 - 8-km spatial resolution
 - 25-member ensemble

SCOPE Climate: precipitation

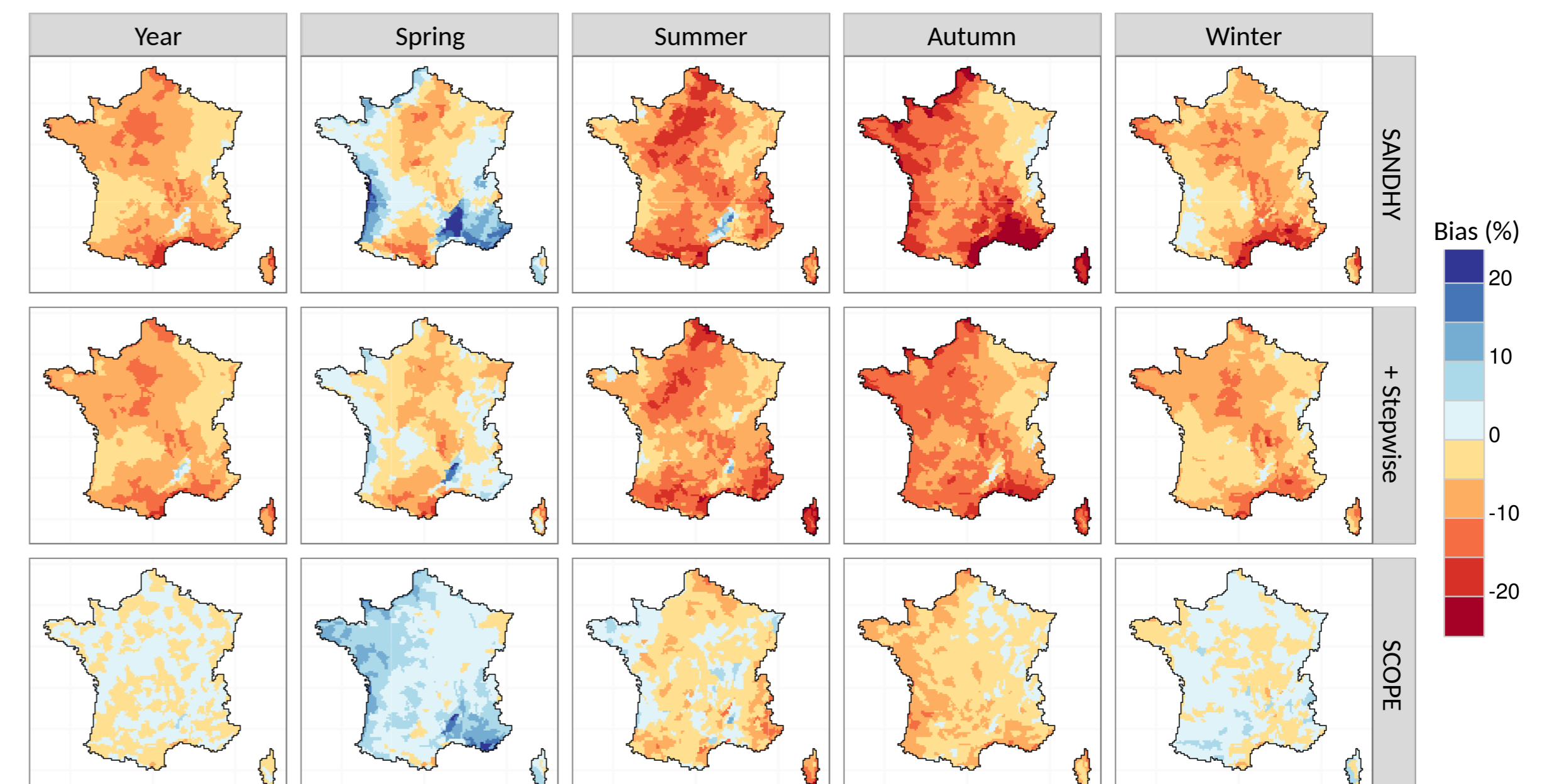


Figure 4: Precipitation bias 1958-2008

SCOPE Climate: temperature

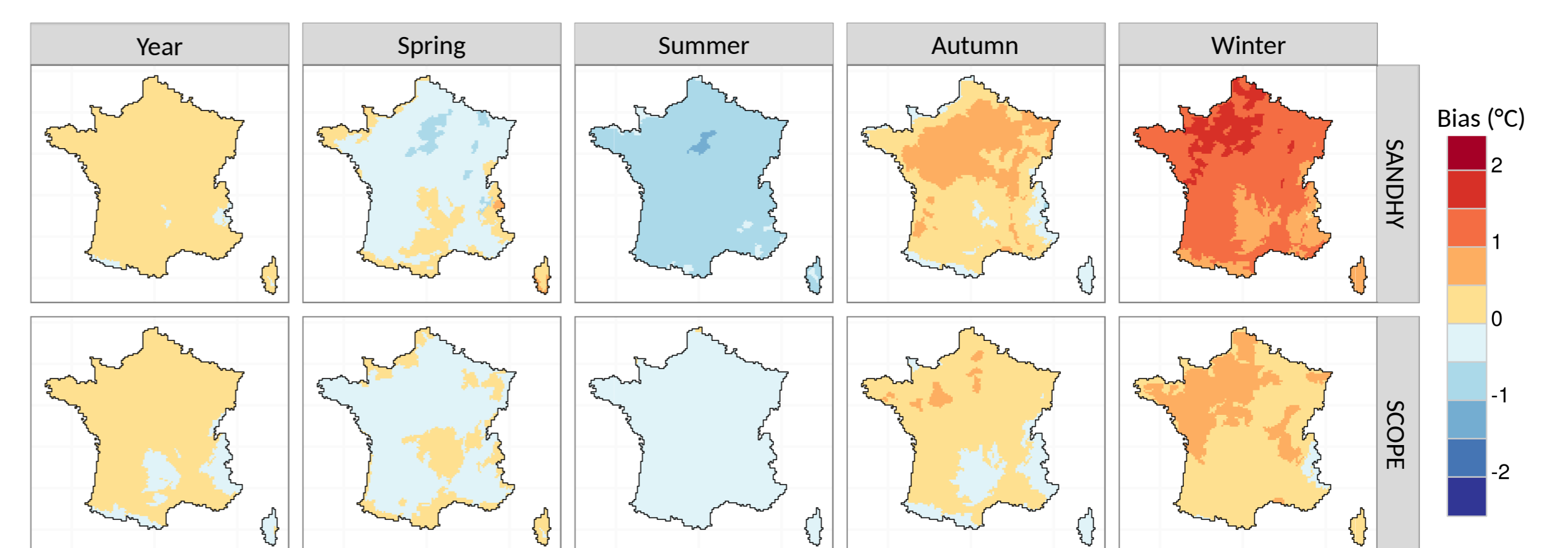


Figure 5: Temperature bias 1958-2008

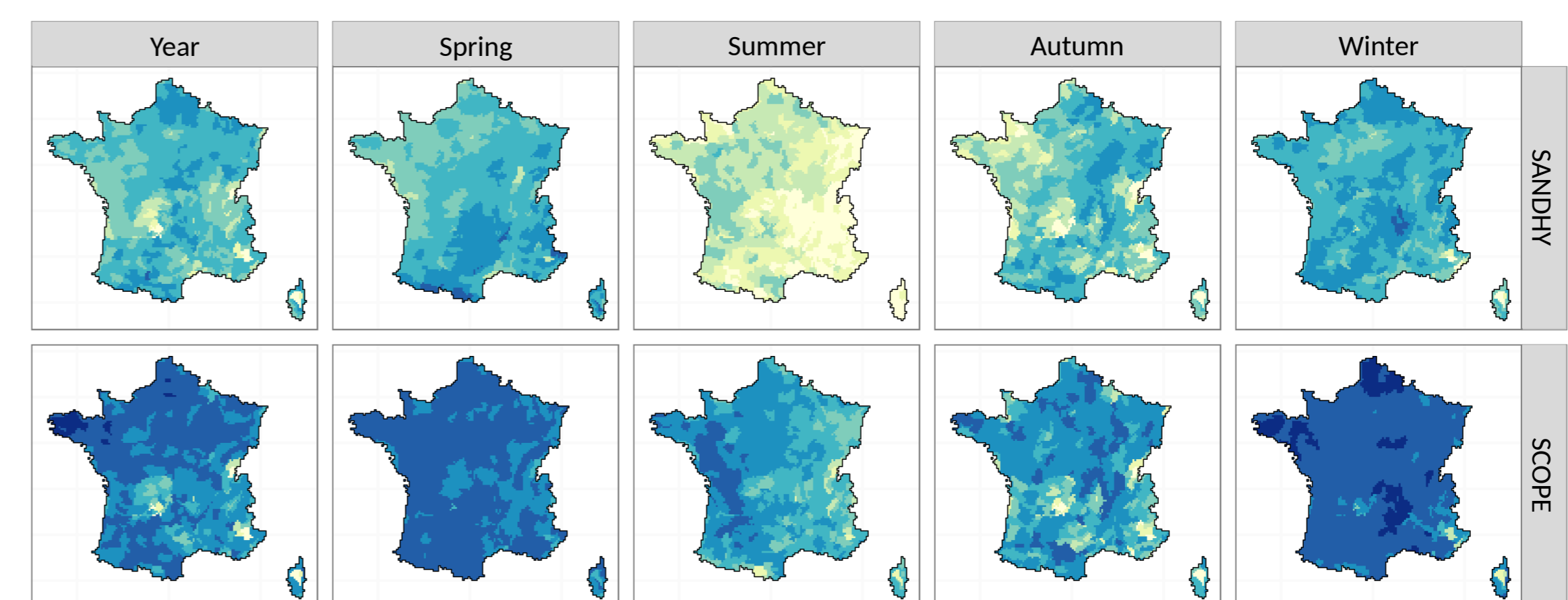


Figure 6: Temperature interannual correlation 1958-2008

Example of a daily SCOPE climate field



Figure 7: Precipitation on 21 September 1890 in the south-east of France: strong convective event that led to record flood in the Ardèche catchment.

Perspectives

- **Data paper** in preparation for **open dissemination** under a Creative Commons licence
- On-going **assimilation of historical surface meteorological observations** to derive a 140-year daily 8-km resolution reanalysis over France (Devers et al., 2017)

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