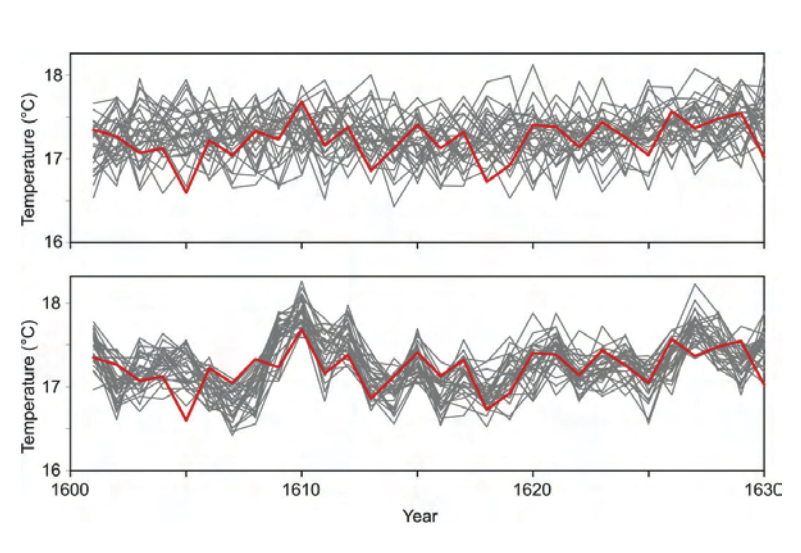
Towards a paleoreanalysis?

Background information on NCCR publications

In paleoclimatology, numerical models have long been used side-by-side with empirical data. In recent years, new approaches have been emerging that combine the evidence from proxies and historical data with the power of statistics and the physical consistency of models to obtain better estimations of past climate. The broad expertise required for this task puts NCCR Climate in a good position – a model analog approach to climate reconstruction has already been developed within NCCR Climate. In the framework of PALVAREX III, in collaboration with DETREE and HyClim, we now go a step further and combine an ensemble of model simulations with historical data and proxies using Ensemble Kalman filtering.

Thirty climate model simulations are run continuously for the period 1600-2011. Their only difference lies in the initial conditions. Each simulation sees the same, time-varying forcings (including sea-surface temperatures), but each member also has its individual variability, which allows estimating a hypothetical «variability structure for a particular time». Climate proxies and historical observations are then used to correct each simulation at each time step (monthly or seasonal). The estimated variability structure controls how the correction is propagated in space and across model variables. The result is a new set of 30 estimations of past climate, which together give a measure of uncertainty.

The approach was tested in the climate model world by retaining one of the 30 simulations as «observations», extracting from it seasonal temperature at 45 selected locations and adding a large amount of noise to these series to mimick the quality of climate proxies. Using only this information, each of the 29 other simulations was corrected. How well do they reproduce the 30th simulation? The example of summer temperature averages over Europe (a case where proxy information is available) shows that the correction (bottom) brings the simulations relatively close to the target. For regions without proxies or for other variables results are worse, but skilful reconstructions are also found for important large-scale circulation features, even for the polar vortex in the northern stratosphere.



European summer temperature average for the years 1601-1631 for the uncorrected (top) and the corrected model simulations (bottom). The red line represents the 30th simulation that was retained as «observations», the grey lines represent the 29 other simulations.

The way towards a paleoreanalysis is still long. The approach needs to stand the test in the real world. If that is the case, however, it will allow more comprehensive studies of past climate that address, e.g., changes in the jet streams or in the Hadley circulation since the Little Ice Age. Despite the promising new techniques, it should be kept in mind that accurate reconstructions depend upon high-quality underlying proxy data – another key focus within the multi-disciplinary NCCR framework.

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www.nccr-climate.unibe.ch/projects/project_en.html?acronym=PALVAREX

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