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The Medieval Climate (A)nomaly over Europe

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We present a new gridded (5°x5°) European summer (JJA) temperature reconstruction back to 750 C.E. and compare it to an ensemble of millennium length forced transient climate model (general circulation models, GCMs) runs, focusing on warmer periods during the last 1500 years.

The reconstruction is based on ten long, high quality tree ring records and one composite documentary record, all of them annually resolved. The spatial coverage spans the area 41°N-68°N and 1°E-25°E. Instrumental data used are the seasonal summer (JJA) means from grid cells of the CRUTEM4v dataset in the area 35°N-70°N and 10°W-40°W. Since the climate archives are on land only, we limited the analysis to land mass grid cells, omitting small islands and Iceland. The climate field reconstruction was then performed using Bayesian inference on a localized stochastic description of the underlying processes (Tingley and Huybers 2010a,b; Werner et al. 2012). Using chains with different initial conditions as well as subsets of the data, we arrive at estimates for the posterior distributions. These were then used in a predictive experiment, keeping the model parameters fixed and only updating the temperatures. Here, the full proxy data were used while ommitting the intrumental data. This results in a multivariate distribution of temperature reconstructions from 750 – 2003 CE. The mean of this distribution can be considered an optimal estimate of the gridded annual summer temperature anomalies, the width delivers impartial reconstruction uncertainties. The derived reconstruction is compared with independent long instrumental and proxy data on decadal-to-centennial time scales, showing in general very good agreement on the magnitude and timing of cooler and warmer years.

The simulations are grouped in two categories depending on the magnitude of change in solar forcing used to drive the model. We then compare the new gridded reconstruction with the GCM results, focusing on two key periods over the last one and a half millennia: the Little Ice Age (LIA) and the Medieval Climate Anomaly (MCA). While the reconstructions and the ensembles of simulations show higher medieval temperatures and cooler temperatures during the LIA, the spatial distribution of anomalies and the range of values differ. The warm episodes from 7th to 12th century compare well to the warm summer temeratures in the late 20th century and early 21st century, both in spatial extent and magnitude. However, the warm summer of 2003 still remains to be the warmest year in the considered time span, both at the grid cell scale but also when considering the European averages.

Tingley M.P. and Huybers P. JClim 10, 2759-2781, 2782-2800 (2010a,b)
Werner J.P. et al. JClim accepted (2012)