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Improved climate field reconstruction techniques: Application to Europe

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Paleoclimate field reconstructions started off with the climatologic interpretation of some of the fundamental approaches in linear algebra and classical multivariate statistics. The practice of these techniques and the lack of agreement on the past temperature variability over certain periods made clear, that there is a special need for further investigations. A better understanding of the uncertainties inherent to the statistical models is a necessary requirement. In order to improve the reconstruction skill, the limiting factors have to be taken into account by careful testing and evaluating the techniques in respect to the temporal resolution and the spatial scale they are used for.

RegEM (Regularized expectation maximization, e.g. Schneider et al. 2001, J. Climate; Rutherford et al. 2005, J. Climate), not yet applied on the European scale, is based on the idea to model the relationship between the missing values and the available values also taking into account ill-posed or under-determined settings and is opposed to principal component (PC) regression, which has been recently used (e.g. Luterbacher et al. 2004, Science; Xoplaki et al. 2005, Geophy. Res. Lett.).

We present primarily test results and the comparison of the two techniques applied to reconstruct European seasonal temperature variability covering the last millennium. The reconstructions are performed with the NCAR CSM 1.4 climate model data and exemplarily with 'real-world' proxy information. We further show how and to what extent the errors-in-variables approach improves the reconstruction skill of the above-mentioned PC-regression technique. On the one hand RegEM seems to clearly perform better for summer temperature reconstructions than for winter estimates. On the other hand, incorporating the errors in the predictors with errors-in-variables in the PC-regression considerably improves the overall reconstruction skill of this method.