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Assimilation of palaeoclimate proxy data into GCMs using ensemble member selection

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Reconstructing the climate of the past and understanding the natural climate variability over long periods are key factors to the understanding of the natural and anthropogenic climatic changes of the 20th and 21st century, as well as to predicting the future climate. Having in mind that the available instrumental meteorological records are too short to estimate this variability on long time scales, scientists can either use climate proxy data, or numerical simulations, for this purpose. However, both of these sources of information exhibit important weaknesses. Hence, one of the emerging topics in palaeoclimate modelling is the combination of the empirical information from proxies with numerical simulations, an approach known in meteorology as data assimilation. Adapting it to palaeoclimatic applications is challenging and not straightforward (e.g. Widmann et al., 2010).

The aim of this project is to develop a data assimilation method to reconstruct the climate of the last millennium. We propose to employ ensemble simulations with a low-resolution General Circulation Model (GCM) and to select the ensemble members that are the closest to the palaeoclimate proxy data, in order to obtain a simulation for the last millennium that is both consistent with the model physics and the empirical knowledge. The approach has already been successful with Earth System Models of Intermediate Complexity (e.g. Goosse et al. 2006). The increase in computing power now allows attempting this using more complex models, namely GCMs, and a simplified (off-line) version has already been used by Bhend et al. (2012). We will be using the Max Planck Institute for Meteorology's state-of-the-art Earth System Model, MPI-ESM.