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Towards a reanalysis covering the last millennia

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The reanalysis, extending over several decades or longer, provide a comprehensive record of the recent variability and changes of the climate system by objectively combining observations and a numerical model. They are now considered as an essential source of information on the state of the ocean and the atmosphere used, among many other applications, to study the dynamics of the system and the interactions between its different components, to analyze the characteristics of the recent changes as well as the interannual climate variability.

However, in order to study processes with a characteristic period from some decades to several centuries, the period covered by the presently available reanalysis is too short. It is therefore necessary to use paleoclimatic proxy data, which provide longer time series, in order to extent the period covered by reanalyses . Those paleoclimatic data, however, are much less numerous, more noisy, and have a lower spatial and temporal resolution than the ones available for the reanalyses over the 20th century.

In order to obtain reanalyses covering the last millennia, several steps are thus still required. It is first necessary to develop data assimilation methods adapted to this specific problem. Some data synthesis for this period are available but a reanalysis requires a comprehensive evaluation of the quality of existing data, in all the regions and for all the proxies. Reanalyses are very demanding in computer time, the model selected in the procedure must thus be efficient enough but should also include the right dynamics in order to reproduce the teleconnections between areas where data are available and to extrapolate the information towards regions with no data. Finally, proxies and models do not provide the same variables and comparing them requires a sophisticated approach, ideally implying the inclusion of forward proxy models in the data assimilation system.

Here, we propose to review the present status of the field and to identify how significant steps can be made in the way towards a reanalysis over the last millennia. This is illustrated by examples from recent studies in which data assimilation is applied over the last millennia using reconstructions at continental and nearly hemispheric-scale as well as grid-scale temperatures derived directly from the local calibration of proxies.