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A data assimilation approach to reconstruct climate changes over the past centuries

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A data assimilation approach with applications in paleoclimatology is quite recent, but the interest in it is growing, e.g. [1]. As in meteorology, given the observations it assists in estimating the probability distribution function of the model state as well as uncertain model parameters. This results in a better reconstruction of the past climate states consistent with the model physics and proxy data (indirect reconstructions based on tree rings, ice cores, sediments). However, there are some specifics associated with applications in paleoclimatology: the observations have a sparse spatial distribution; the time resolution of proxies becomes lower as the record goes further back in time; there are non-climatic uncertainties associated with the reconstructions based on proxies. On the other hand, a description of the state of the system in paleoclimatology does not need to be as detailed as in meteorology--in many cases large-scale averages on seasonal to annual means give already very valuable information. In [1], we have implemented a particle filter in the three-dimensional Earth system model of intermediate complexity LOVECLIM [2] to reconstruct the annual temperature anomalies over the past 150 years in a twin experiment and using the HADCRUT3 dataset [3]. The results show a good agreement between simulations with the particle filter and the observations. Moreover, they demonstrate that it is possible to reproduce large-scale features over a wide region with a number of particles of the order of 100. However, if a more detailed reconstruction of the state of the system is needed, either a more sophisticated implementation of the particle filter or another data-assimilation method should be used. We chose Ensemble Kalman Filter as an alternative method aiming to complement the particle filter, and the initial results of its implementation will be presented.
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