



Visual exploration of ensemble variability at the example of decadal climate predictions

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In this work, we apply combined clustering and visualization techniques in order to analyze the temporal behavior of small to medium sized climate simulation ensembles. Ensemble simulations have become a standard method to explore uncertainty in numerical simulations. In climate research, ensemble techniques are often applied for capturing the internal variability of the climate system, which then allows estimating the robustness of certain results. The analysis of such ensembles, however, is often confined to computing the mean and standard deviation by aggregating data from the complete ensemble. In such a process, outliers may be overlooked as well as several distinct trends that may exist in the data.

We have developed a tool that allows a more fine-grained inspection of time-dependent 2D scalar fields stemming from ensemble simulations. We show how ensemble members can be clustered (possibly differently for each simulation time step) and we present an interactive visualization of the resulting time-dependent clustering. The spatial patterns found by the clustering can be visualized along with the interactive clustering timeline display that allows temporally tracking the cluster membership of selected ensemble members or groups of members. By reducing the ensemble dimension to a few clusters instead of one global mean only, we allow analyzing the most probable patterns and – by the respective cluster size – their occurrence probability.

This is linked with color-mapped visualizations of the field data and a heatmap view of the pairwise similarity of the ensemble members for selected time steps. This methodology is applied to decadal climate predictions carried out within the MiKlip project (<http://www.fona-miklip.de/>).