A flexible forecast system for decadal climate predictions (FLEXFORDEC)

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Abstract

On timescales of several years to several decades, weather and climate patterns depend not only on the anthropogenic rise of greenhouse gas concentrations in the atmosphere, but also on natural climate variability. Natural climate variability is both internal – ultimately induced by weather in both atmosphere and ocean – and forced – caused by solar variability and volcanic eruptions. Owing to the chaotic nature of the internal variability, its predictability horizon is limited. But the clear signal of decadal-timescale variability in almost all climate records suggests that, if we are able to observe the phase and amplitude of the current decadal variability "event", we can exploit the memory of the climate system to predict the further evolution of this event. How to turn this potential for decadal climate prediction into realised predictive skill is the grand challenge of the BMBF-funded project MiKlip.

Strategically, FLEXFORDEC stands out as a pivotal project within MiKlip: it is the key project for the MiKlip Module D "Synthesis", one of the five cornerstones of MiKlip; it comprises the development of the central prediction system, one of the key objectives of MiKlip; and it includes the overall coordination of MIKlip. The scientific synthesis of the MiKlip project has both prediction research and infrastructure components. Decadal climate prediction research is an emergent field of climate science, so substantial research progress is required to improve prediction skill. Because we show by construction which elements of the climate system are predictable, we build the most state-of-the-art prediction system. The prediction system will continuously be improved by incorporating the research progress across all of MiKlip, according to the development stages (DS) 1-3, where during DS1 we employ the prediction system currently being used for the WCRP CMIP5/IPCC AR5 simulations. Effective incorporation into the prediction system used in DS2 and DS3 requires an infrastructure that gives us a large degree of flexibility, so that we can test various suggestions arising from other MiKlip Modules for improving decadal climate predictions.

FLEXFORDEC establishes a central decadal climate prediction system, based on the experience previously gained at MPI-M. The essential characteristic of the central prediction system is its flexibility – the system enables us efficiently to test and, if successful, incorporate into the central prediction setup whatever research progress has been made within MiKlip. Specifically we successively form an ensemble prediction system (EPS) for global-scale decadal climate variability. This system considers a technically complex data assimilation architecture comparable to the one provided by NWP and by seasonal climate prediction. This system also considers scientifically complex questions such as the inclusion of relevant climate system components (e.g., land surface and sea-ice), and the generation of a sufficiently large ensemble. For these reasons we embed the EPS in a well-designed prediction system and model environment infrastructure.

Further during the course of MiKlip a succession of central prediction systems will be developed (one in each of the development stages DS1 to DS3), employing successively more sophisticated process representation. For each system we will perform sets of hindcasts and forecasts, control runs and 20th-century experiments with the model of highest possible resolution (for example, T63L95/TP04 during DS1). Integrating novel

work into the system will naturally occur predominantly in DS2 and DS3.

And also an integrated system for the standardised evaluation of experiment output will be implemented, that allows comparability of forecast skills and systems performance for different configurations of the prediction system. Data and prediction results are finally disseminated to all participants in MiKlip and to potential users.