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EDITORIAL

Studies with the EC-Earth seamless earth system prediction model

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EC-Earth is a new Earth System Model (ESM) based on the operational seasonal forecast system of the European Centre for Medium-Range Weather Forecasts (ECMWF). Climate and weather forecasting applications share a common ancestry and are build on the same physical principles. The emerging concept of "seamless prediction" forges weather forecasting and climate change studies into a single framework. Employing this concept, EC-Earth benefits greatly from the advances in Numerical Weather Prediction (NWP) modeling. Even though ESMs like EC-Earth are used for different purposes and time scales compared to NWP models, the quality of long-term predictions relies heavily on accurate simulations of slow components of the Earth system, on precise incorporation of the many interactions between fast and slow processes in the Earth system, and on initialization procedures.

The EC-Earth consortium is a grouping of meteorologists and Earth system scientists from ten European countries, put together to face the challenges mentioned above. The consortium consists of scientists from national meteorological services, academia, and high-performance computing centers, designed to bridge the gap between NWP and Earth system modeling. In a consortium-wide effort, the EC-Earth ESM has been thoroughly devised, tested, and tuned (Hazeleger et al. 2010), and new modules concerning atmospheric composition and the land surface have been developed. Additionally, decadal predictions and long climate simulations have jointly been carried out (e.g. in the framework of the CMIP5 initiative; Taylor et al. 2012), and climate feedbacks have been examined (e.g. Bintanja et al. 2011).

This special issue contains a collection of 7 papers that use EC-Earth (1 paper was already published earlier), providing a broad (however necessarily incomplete) overview of the topics that are currently being addressed within the EC-Earth consortium.

Three papers determine EC-Earth's performance in relation to observations of the current climate. The paper of Hazeleger et al. (this issue) closely examines the general performance of EC-Earth version 2.2. They find that EC-Earth performs well in simulating tropospheric fields and dynamic variables, whereas simulated surface temperature and fluxes compare less favorably. It is concluded that a coupled model based on an operational seasonal prediction system can be used for climate studies, supporting seamless prediction strategies. Sterl et al. (this issue) evaluate the performance of the ocean component of EC-Earth within the coupled system and conclude that, overall, modeled ocean characteristics are within the range of observational estimates. They also find that simulated inter-annual variability of key variables and correlations

This paper is a contribution to the special issue on EC-Earth, a global climate and earth system model based on the seasonal forecast system of the European Centre for Medium-Range Weather Forecasts, and developed by the international EC-Earth consortium. This special issue is coordinated by Wilco Hazeleger (chair of the EC-Earth consortium) and Richard Bintanja.

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between them are realistic in terms of their size and pattern. Johnston et al. (this issue) use EC-Earth to evaluate tropical upper tropospheric humidity, clouds, and ice water content, as well as outgoing longwave radiation with the aid of satellite retrievals. EC-Earth is found to overestimate cloud fraction above 200 hPa and underestimate it below that level, whereas the model underestimates the impact of clouds on OLR.

Two papers address the predictability of the climate system. The earlier published contribution of Du et al. (2012) investigates the impact of initial perturbation methods on the behavior of an ensemble of decadal re-forecasts by using EC-Earth in various initial-condition perturbation strategies. It is found that the skill in terms of correlation is not significantly affected by the particular perturbation method employed. Weiss et al. (this issue) use EC-Earth to analyze the impact of observed short-term temporal variability of vegetation phenology (leaf-area index and albedo) on potential predictability of evaporation and temperature, as well as on model skill. It is found that a realistic representation of vegetation positively influences the simulation of evaporation and its potential predictability.

Finally, three papers focus on specific climate mechanisms and feedbacks. The paper of Wouters et al. (this issue) examines the causes behind natural inter-decadal variability in a control simulation made with EC-Earth. They find that the strength and depth of the Atlantic meridional overturning circulation vary with a timescale of 50–60 years part of a delayed response of the ocean to the North Atlantic Oscillation with a pattern and timescale resembling the real-world Atlantic Multi-decadal Variability. Bintanja et al. (this issue) employ idealized climate change experiments with EC-Earth to show that the near-surface inversion governs Arctic warming through the efficiency by which boundary-layer mixing 'dilutes' the surface warming signal to higher levels. They estimate that the reduced Arctic inversion has slowed down global warming by about 5 % over the past 2 decades. The paper of Semmler et al. (this issue) use EC-Earth to investigate the influence of reduced/removed Arctic sea ice cover on the climate of the Northern mid-latitudes. Even though simulated changes are most pronounced over the Arctic, where the reduced or removed sea ice leads to strongly increased upward heat/radiation fluxes and precipitation in winter, the authors also find a weaker pressure gradient, less extreme cold events and less precipitation in the Northern mid-latitudes in winter.

The results presented in this special issue convincingly demonstrate that EC-Earth, the new Earth System Model based on ECMWF's operational seasonal forecasting system, can be used for a variety of climate studies, thereby implicitly supporting emerging seamless prediction strategies. For more information, please visit ecearth.knmi.nl.

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