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Reconstruction of the Greenland ice sheet dynamics in a fully coupled Earth System Model

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Earth system models (ESMs) are undoubtedly effective tools for studying climate dynamics. Incorporation of evolving ice sheets to ESMs is a challenging task because response times of the climate system and of ice sheets differ by several orders of magnitude. Besides, AO GCMs operate on spatial and temporal resolutions substantially differing from those of ice sheet models (ICMs). Therefore elaboration of an effective coupling methodology of an AO GCM and an ICM is the key problem of an ESM construction and utilization. Several downscaling strategies of varying complexity exist now of data exchange between modeled climate system and ice sheets. Application of a particular strategy depends on the research objectives. In our view, the optimum approach for model studying of significant environmental changes (e.g. glacial/interglacial transitions) when ice sheets undergo substantial evolution of geometry and volume would be an asynchronous coupling. The latter allows simulation in the interactive way of growth and decay of ice sheets in the changing climatic conditions.
In the focus of the presentation, is the overview of coupling aspects of an AO GCM INMCM32 elaborated in the Institute of Numerical Mathematics (Moscow, Russia) to the Greenland ice sheet model (GrISM, Vrije Uninersiteit Brussel, Belgium). To provide interactive coupling of INMCM32 (spatial resolution $5^{\circ}\times4^{\circ}$, 21 vertical layers and temporal resolution 6 min. in the atmospheric block) and GrISM (spatial resolution 20×20 km, 51 vertical layers and 1 yr temporal resolution), we employ a special energy- and water balance model (EWBM-G), which serves as a buffer providing effective data exchange between INMCM32 and GrISM. EWBM-G operates in a rectangle domain including Greenland. Transfer of daily meanings of simulated climatic variables (air surface temperature and specific humidity) is provided on the lateral boundarias of the domain and inside the domain (sea level air pressure, wind speed and total cloudiness) after applying spline interpolation. EWBM-G calculates annual surface mass balance, SMB, (further transferred as an external forcing to the GrISM) and fresh water flux (transferred to the oceanic block of the INMCM32). After receiving SMB, GrIS is integrated and returns update surface topography back to the INMCM32. The aim of the current research is to establish equilibration time of climate and GrIS in the transient coupled run and to elaborate optimum methodology for performing numerical experiments simulating glacial/interglacial transitions.