STORM: High-resolution community climate change simulations

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Summary

Climate change experiments summarized in the IPCC AR4 report were performed at a resolution that is too low to resolve regional phenomena such as high-impact weather events, hurricanes, intense mid-latitude cyclones, coastal dynamics, and topographically constrained oceanic circulation features. Moreover, the AR4 simulations could not represent two classes of variability, namely internal gravity waves in the atmosphere and meso-scale eddies in the ocean. The former represents an important member in the chain relating atmospheric variability on a vast range of scales that is crucial for the interaction between the troposphere and the stratosphere. The latter represents the bulk of oceanic variability on intra-seasonal time scales that is essential for the turbulent motions in the oceanic interior and consequently for the ocean general circulation, including the global meridional overturning circulation. Both classes of variability and other small-scale high-impact phenomena can interact with global-scale processes, such as meridional and vertical energy and water transports in the atmosphere and ocean, and from that alter the climate sensitivity to increases in GHG concentration.

The STORM project proposes long climate change simulations (i.e. over several centuries) at a horizontal and vertical resolution that is high enough to allow the development of gravity waves in the atmosphere, meso-scale eddies in the ocean, and other small-scale high-impact phenomena. By doing so, new types of scale-coupling and scale-interactions are introduced into the climate simulation. The model will be the latest version of the COSMOS model including ECHAM and MPIOM, but without biogeochemistry modules. The horizontal resolution in the atmosphere will be around T250. To resolve gravity waves and to allow the coupling between the troposphere and the stratosphere through these waves, the ECHAM model will be extended vertically to the height of the middle atmosphere at about 80 km (MAECHAM) with a vertical resolution of about 500-600 meters (i.e. with about 150 layers). To adequately represent inertial currents, resolve important topographic features, and simulate the meso-scale eddies in the ocean, a horizontal ocean resolution of at least 0.1° will be used. The ocean model will have at least 40 (most likely 80) vertical levels. Following a control run of about 50 to 100 years with constant pre-industrial levels of greenhouse gases, a simulation of the 20th century from year 1890 to 2005 using the observed anthropogenic and natural forcing, and a climate change projection using one of the IPCC AR5 scenarios (RCP4.5) from 2005 to 2100 will be performed.