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Steric and Dynamic Sea-Level Change in Response to the A1B Scenario Integration in the ECHAM5/MPI-OM Coupled Climate Model

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Sea-level change is an important consequence of climate change - a warming of the ocean will increase the specific volume and thus raise sea-level. Additionally, ocean circulation changes cause the sea surface height (SSH) gradient to adjust geographically nonuniformly according to the momentum balance between pressure gradients, wind stress and Coriolis forces. Here, we analyze simulations of the 20th century climate performed with the ECHAM5/MPI-OM coupled atmosphere-ocean model, and projections for the 21st century following the A1B scenario of the Intergovernmental Panel on Climate Change (IPCC).

With ocean mass being conserved in the model, global sea-level rise from thermo-steric expansion does not commence until the end of the 20th century. Projected global mean sea-level rise reaches 0.28m by 2100, with a linear increase in the rate of sea-level rise to 4mm/year by 2100. At the same time, the North Atlantic thermohaline circulation (THC) has weakened by about 25%. We find that under the A1B scenario, the dynamic adjustment of the sea surface height shows a complex pattern in the Northern Atlantic: whereas the interior of the subtropical gyre experiences negative SSH changes, the subpolar gyre partly responds with a strong positive SSH change of up to 0.4m by 2100 along the Gulf Stream axis. The individual contribution of salinity and temperature to the dynamic sea surface height field are evaluated with reference to an unperturbed control integration. The enhanced interbasin atmospheric freshwater transport from the Atlantic to the Pacific basin increases the salinity of the subtropical Atlantic, which partly compensates for thermo-steric expansion from global warming. Increased fresh water input from melting sea ice, precipitation and river run-off into the Artic Ocean causes a halo-steric sea-level rise of up to 0.6m by the end of

the 21st century, contributing almost 50% in the Artic Ocean. Additional experiments with individual forcing fields (e.g. wind, fresh water) switched on or off suggest that the response of the SSH field to changing buoyancy and momentum fluxes and ocean circulation is regionally very different: whereas in the Southern Ocean wind stress changes dominate, sea-level response in the North Atlantic and Artic is determined mainly by buoyancy fluxes.