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Team MIROC: MIROC4h - a new high-resolution atmosphere-ocean coupled general circulation model

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A new high-resolution atmosphere-ocean coupled general circulation model named MIROC4h has been developed, and its performance in a control experiment under conditions present in 1950 is examined and compared with simulations of preindustrial conditions carried out by the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4) using the previous high- and medium-resolution versions of the model, called MIROC3h and MIROC3m, respectively. A major change in MIROC4h is a doubling of the resolution of the atmospheric component to 0.5625^{o}, compared to 1.125^{o} for MIROC3h. The oceanic components of MIROC4h and MIROC3h are eddy-permitting, with a horizontal resolution of 0.28125^{o} (zonal) x 0.1875^{o} (meridional). In MIROC3m, the horizontal resolution is 1.40625^{o} (zonal) x 0.56-1.4^{o} (meridional). Compared with MIROC3h and MIROC3m, many improvements have been achieved; for example, errors in the surface air temperature and sea surface temperature are smaller, there is less drift of the ocean water temperature in the subsurface-deep ocean, and the frequency of heavy rain is comparable to observations. The fine horizontal resolution in the atmosphere makes orographic wind and its effects on the ocean more realistic than those of the former models, and the treatment of coastal upwelling motion in the ocean has been improved. Phenomena in the atmosphere and ocean related to the El Niño and southern oscillation are now closer to observations than was obtained by MIROC3h and MIROC3m. The effective climate sensitivity for CO2 doubling is calculated to be about 5.7 K, which is much larger than the value obtained using the IPCC AR4 models, and this is mainly due to a decrease in the low-level clouds at low latitudes.