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# Improved climate simulation using a new earth system model MRI-ESM2 focusing on middle atmosphere

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Toward CMIP6 we have developed a new version of earth system model MRI-ESM2, by improving previous models MRI-CGCM3/MRI-ESM1. MRI-ESM2 couples model components of the atmosphere, ocean, sea ice, aerosol, atmospheric chemistry, and land surface. In this presentation, we present general performance of MRI-ESM2 and model features focusing on middle atmosphere. For the atmospheric model MRI-AGCM3.5 including land surface process, horizontal resolution is about 110 km ($T_L159$) and vertical levels are 80 (model top: 0.01 hPa). Cloud microphysics and radiative process related to cloud and aerosol are also improved. For the ocean model MRI.COM4.4 including sea ice module, vertical resolution is enhanced to 61 layers, and horizontal resolution is primarily 0.5° latitude/1° longitude with meridional refinement near the equator down to 0.3°. For the aerosol model MASINGAR-mk2r4, treatments of both black carbon and sulfate are refined. For the chemistry climate module MRI-CCM2.2, ionization process related to the energetic particle precipitation is parameterized.

As a trial, we performed preliminary historical and some control experiments based on CMIP5 protocol. Realistic QBO is driven by implementing both enhanced vertical resolution and nonorographic gravity wave drag parameterization. Rapid ozone reduction related to a high energetic particle precipitation event is reproduced. During 1986-2005, surface air temperature, precipitation rate, sea level pressure, sea ice distribution, and cloud radiative effect show largely realistic structure. Total cloud amount in the Southern Ocean is also improved, so that bias of cloud-radiative effect reduces. Additionally due to improvement of mixed layer treatment of MRI.COM4.4, excessive extent of sea ice reduces in the Northern Hemisphere. Equilibrium climate sensitivity related to doubling $CO_2$ is estimated by 3.0 K. In actual presentation, we plan to introduce results of CMIP6 setting experiments.