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Probabilistic forecast of long-term climate changes under different RCP scenarios.

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Long-term response of the climate system to anthropogenic forcing was investigated with the MIT Earth System Model of intermediate complexity version 2.2 (MESM2.2). The MESM2.2 consists of a 2D (zonally averaged) atmospheric model coupled to an anomaly diffusing ocean model. Climate sensitivity of the MESM can be varied using a cloud adjustment technique and rate of oceanic heat uptake can be varied by changing effective diffusion coefficient.

An ensemble of four hundred simulations was carried out for the period 1860-2005 using historical forcing. Values of climate sensitivity, rate of ocean heat uptake, and the strength of the aerosol forcing were drawn from the Libardoni and Forest (2013) distribution presented in the IPCC AR5.

A 400-member ensemble was carried out for each of four different RCP scenarios from the year 2006 to the year 2500. By the end of the 21st century (2081-2100), the ensemble mean of surface air temperature increases, relative to 1986-2005 period, by 1.2, 1.8, 2.2 and 3.3oC for RCP26, RCP4.5, RCP6.0 and RCP8.5, respectively. Corresponding numbers for the ensemble of the CMPI5 models are 1.0, 1.8, 2.2 and 3.7oC.

In spite of the forcing being fixed beyond year 2150 for RCP4.5 and RCP6.0 and beyond 2250 for RCP8.5, surface air temperature keeps rising until the end of 25th century under these scenarios. The upper bound of the 90% probability interval increases significantly more than the mean. For the RCP4.5 scenario, the mean value of possible SAT change increases by 1.6oC from the end of the 21st century to the end of the 25th century, while the value of the 95th percentile increases by 3.2oC. Corresponding numbers for RCP6.0 and RCP8.5 are 3.6 and 10.2oC for the medians and 7.0 and 14.5oC for the 95th percentiles, respectively. Such changes in the shape of probability distributions with time indicate an increase in the probability that surface warming will exceed a given value. For example, the probability of exceeding 3oC warming under the RCP4.5 scenario increases from 2.5% at the end of 21st century to 32% and 50% at the end of 23rd and 25th centuries, respectively. For the RCP2.6 scenario, in which radiative forcing peaks in the year 2070 before decreasing back to the 1990s level by the year 2300, the ensemble mean surface air temperature is still about 0.5oC above present at the end of the simulation.

Obtained results show that in spite of large differences in radiative forcing between different RCP scenarios, uncertainties in the climate system characteristics defining climate system response make a significant contribution into overall uncertainty in possible climate change during the next few centuries.

Comparison with simulations carried under SRES scenarios also will be presented.