Session: B12 Oral presentation

Anthropogenic forcing and feedback of the Earth system

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When climate models are forced with a constant radiative agent, such as doubled CO2 concentration, they exhibit a linear relationship between the net heat flux into the climate system and the global-mean surface air temperature change ΔT. This relationship provides a means to evaluate the radiative forcing F and the climate feedback parameter, which determine the equilibrium climate sensitivity. In CMIP3 rapid adjustment of the troposphere and surface state causes some model spread in the CO2 forcing. When radiative forcing is increasing with time, there may still be a linear relationship with ΔT, provided ocean heat uptake efficiency is constant. Observations of the 20th century and AOGCM simulations support such a linear relationship, which can be used to estimate that the real-world TCR is 1.3-2.3 K (5--95% uncertainty range) from the data for 1970--2006. In the model average of CMIP3, climate feedback is about twice as important as ocean heat uptake in determining the TCR. Although the CO2 concentration can be prescribed in models, the real-world system is forced by anthropogenic CO2 emissions, and itself determines the CO2 concentration. Perturbations to the carbon cycle could therefore give large feedbacks on changes in CO2 concentration and climate. Carbon-cycle feedback can be expressed in formally similar ways to climate feedback, allowing us to compare their magnitudes. In the C4MIP Earth system models, the net carbon-cycle feedback is of comparable size and uncertainty to the non-carbon climate response measured by the TCR. This framework can be further extended to express other Earth system forcings and feedbacks in the same terms, in order to compare their magnitude and uncertainty with physical climate and carbon-cycle responses.