Geophysical Research Abstracts
Vol. 20, EGU2018-6, 2018
EGU General Assembly 2018

Atmospheric dynamics feedback: concept, simulations and climate implications

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The regional climate response to radiative forcing is largely controlled by changes in the atmospheric circulation. It has also been suggested that global climate sensitivity depends on the circulation response, an effect we call the "atmospheric dynamics feedback". Using a technique to isolate the effect of changes in atmospheric circulation on top-of-atmosphere (TOA) radiation, we calculate the atmospheric dynamics feedback in coupled climate models. Large-scale circulation changes shape clear-sky and particularly cloud feedbacks in the tropics but are relatively less important at higher latitudes. Globally averaged, the dynamics feedback is small and positive and contributes to model uncertainty in the near-surface temperature response to climate change. A fundamental constraint related to the atmospheric mass budget results in the global dynamics feedback being negligible relative to feedbacks associated with thermodynamic processes. Idealized forcing simulations suggest that circulation changes at high latitudes are more effective at influencing global temperature than circulation changes at low latitudes, and the implications for past and future climate change are discussed.