Geophysical Research Abstracts
Vol. 18, EGU2016-3525, 2016
EGU General Assembly 2016

Implication of radiative forcing distribution for energy transport

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Radiative forcing of a homogeneous greenhouse gas can be very inhomogeneous because the forcing is dependent on other atmospheric and surface variables. In the case of doubling CO_2, the mean instantaneous forcing at the top of the atmosphere is found to vary geographically and temporally from positive to negative values, with the range being more than three times the magnitude of the global mean value. The vertical temperature change across the atmospheric column (temperature lapse rate) is found to be the best single predictor for explaining forcing variation. In addition, the masking effects of clouds and water vapor also contribute to forcing inhomogeneity. A regression model that predicts forcing from geophysical variables is constructed. This model can explain more than 90% of the variance of the forcing. Applying this model to analyzing the forcing variation in the CMIP5 models, we find that inter-model discrepancy in CO_2 forcing caused by model climatology leads to considerable discrepancy in their projected change in poleward energy transport.