Geophysical Research Abstracts
Vol. 12, EGU2010-2283, 2010
EGU General Assembly 2010

Aerosol-induced Changes in Boreal Winter Extratropical Circulation

Yi Ming and V. Ramaswamy
NOAA/Geophysical Fluid Dynamics Laboratory, Princeton, United States (Yi.Ming@noaa.gov)

We examine some key aspects of the boreal winter extratropical circulation changes in response to aerosols, simulated with a coupled atmosphere-slab ocean general circulation model. The zonal-mean response features a pronounced equatorward shift of the North Hemisphere subtropical jet owing to the mid-latitude aerosol cooling. The circulation changes are also characteristic of strong zonal asymmetry. In particular, the cooling is more concentrated over North Pacific than over North Atlantic in spite of similar forcings. With the help of an idealized model, we show that the zonally asymmetric response is tightly linked to the stationary Rossby waves excited by the anomalous diabatic heating over Tropical Indian Ocean and West Pacific. The wave pattern leads to a southeastward shift of the Aleutian low (and associated changes in winds and precipitation), while leaving the Atlantic circulation relatively unchanged.

Despite the rich circulation changes, the change in the extratropical meridional latent heat transport is controlled strongly by the dependence of tropospheric water vapor on temperature, as in the global warming case. An important implication of this finding is that one can understand/predict reliably the variations in zonal-mean extratropical precipitation solely from global-mean temperature change, even without a highly confident knowledge of the detailed circulation changes caused by aerosols. On the other hand, such a knowledge is indispensable for understanding zonally asymmetric (regional) precipitation change. Finally, we offer an explanation of the nonlinearity in the low and mid-latitude temperature response based on a baroclinic instability view of the Hadley circulation.