Geophysical Research Abstracts
Vol. 13, EGU2011-13183, 2011
EGU General Assembly 2011

Why can't climate models capture the observed connection between seasonal snow cover and the Northern Annular Mode?

Karen L. Smith (1), Paul J. Kushner (1), Judah Cohen (2), and Christopher G. Fletcher (3)

(1) Department of Physics, University of Toronto, Canada (paul.kushner@utoronto.ca), (2) AER, Lexington MA, USA (jcohen@aer.com), (3) Department of Geography, University of Waterloo, Canada (chris.fletcher@uwaterloo.ca)

The suite of general circulation models (GCMs) in the Coupled Model Intercomparison Project (CMIP3) fail to reproduce the observed negative lag correlation between interannual variations in October Eurasian snow cover anomalies and the tropospheric Northern Annular Mode (NAM) in the subsequent winter. This deficiency is directly related to the fact that models fail to reproduce the observed *positive* lag correlation between October Eurasian snow cover anomalies and wintertime Rossby wave activity fluxes from the troposphere to the stratosphere. This issue is analyzed here in the context of the following hypothesis about the snow-circulation connection: in order to achieve amplification of the wave activity, the vertically propagating Rossby wave train associated with the snow cover anomaly must reinforce the climatological stationary wave, which corresponds to *constructive linear interference* between the anomalous wave and the climatological wave. It is shown that the lag in peak wave activity flux arises because the Rossby wave train associated with the snow cover is in quadrature or out of phase with the climatological stationary wave from October to mid-November. Beginning in mid-November the associated wave anomaly migrates into a position that is in phase with the climatological wave, leading to constructive interference and anomalously positive upward wave activity fluxes until mid-January. (This linear interference effect is not only associated with stratospheric warming due to Eurasian snow cover anomalies but is a general feature of Northern Hemisphere troposphere-stratosphere interactions, and in particular dominated the negative NAM events of the fall-winter of 2009-2010.) By contrast, the CMIP3 GCMs typically show a negative correlation between October Eurasian snow cover and December wave activity flux, which is related to destructive interference between the wave train associated with the snow and the background stationary wave. This work clarifies why it might be so challenging for models to simulate connections between the NAM and snow cover or other tropospheric sources of NAM variability: in order to capture these connections, both the structure of the forced wave anomalies and the climatological stationary waves must be accurately captured.