Geophysical Research Abstracts
Vol. 15, EGU2013-12251, 2013
EGU General Assembly 2013

Isentropic constraints by midlatitude surface warming on the Arctic midtroposphere

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Observed warming of the Arctic free troposphere has been linked to intensified atmospheric energy transport within the storm tracks, but the mechanisms by which this occurs are poorly understood. Here, we show that aspects of the Arctic midtropospheric warming can be obtained by a simple theory in which midlatitude near-surface warming is propagated upward and poleward along climatological zonal mean isentropes. The effect is most clearly seen in the greenhouse warming response in the CMIP5 climate models but consistency of this theory with historical observed trends is also seen.
In most models, it is observed that the Arctic midtropospheric warming can be obtained from the propagation of midlatitude near-surface warming anomalies according to a dynamic that is intermediate between dry and moist adiabatic theories. While many models follow more closely the moist theory, few follow more closely the dry theory. The analysis suggests that the Arctic midtropospheric warming can be partly described in terms of enhanced latent heat transport by synoptic eddies along slanted moist isentropes. Thus, as for the tropical atmosphere, theories of high latitude midtropospheric warming based on changes in poleward heat fluxes should include a moist component.