Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06570, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06570
EGU General Assembly 2008

Rain high in atmosphere over midlatitude ocean front

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The coupling of the small and slow processes of the ocean to the transient and large-scale processes of the atmosphere in the extra-tropical latitudes and for long time periods has been controversial. Most studies using atmospheric general circulation models fail to generate systematic response to prescribed midlatitude sea surface temperature anomalies. The lapse rate is believed to be too weak to support deep convection and the ocean effect is confined to the atmospheric boundary layer. With the large scale gradient removed by a two dimensional mean filter, we found that the magnitude of surface stress measured by the scatterometer is spatially coherent with not only sea surface temperature, but also with cloud top temperature and cloud optical thickness provided by the International Satellite Cloud Climatology Project, over the Agulhas, Gulf Stream, and Kuroshio Extensions. Atmospheric Infrared Sounder (AIRS) temperature profiles show that the high and low temperatures penetrate from the ocean all the way up to 300 mb. The surface and cloud top temperatures are also spatially coherent with surface precipitation from Tropical Rainfall Measuring Mission (TRMM) over the southern branch of the Kuroshio Extension, and TRMM radar confirms that rainfall anomalies up to 5 km, way above the top of the atmospheric boundary layer. The agreement is also a validation to the rain profile measured by TRMM radar in its most poleward extent (36ºN latitude). Present numerical models of atmosphere circulation in the midlatitudes do not vertically propagate ocean SST signals much beyond the atmospheric boundary layer. The AIRS and TRMM data contradict the prevailing notion among atmospheric modeling community and present a challenge to model dynamic and the spatial versus temporal scale parameterization.