Geophysical Research Abstracts
Vol. 14, EGU2012-12610, 2012
EGU General Assembly 2012

Global energy budget changes and the role of tropical SSTs in the southward ITCZ shifts

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In this study we first examine the tropical response to North Atlantic high latitude cooling by focusing on two questions: 1. what is the role of tropical SSTs and 2. what are the local and remote feedbacks that act to alter the top-of-the-atmosphere energy (TOA) budget and atmospheric energy transport. Following this, we expand our consideration by additional two scenarios of southward ITCZ shifts, namely the high latitude Southern Ocean warming and the oceanic bipolar seesaw.

With regards to the role of tropical SST anomalies in the southward ITCZ shifts due to high latitude North Atlantic cooling, we show (using idealized simulations with the fixed tropical SSTs) that the ITCZ shifts are not possible without the tropical SST changes. Following this, we examine the effects of dominant feedbacks using the radiative kernel technique by Soden et al. 2006 and Shell et. al. 2008. The results show partial local energy flux compensation to the initial perturbation in the high latitudes, due to the negative temperature feedback. Main energy gain comes from the southern tropics, where the positive TOA changes originate from the cloud radiative feedbacks, temperature and longwave water vapor feedbacks, making the overall TOA flux changes in this experiment positive. Southern warming and bipolar seesaw experiments support these findings, by showing the largest energy gain in the southern tropics and loss in the northern tropics. But as the TOA energy budget changes act to cancel the imposed surface forcing, the overall TOA flux changes are not anymore positive. We analyze the radiative feedbacks that enable the overall negative and neutral TOA flux changes following the southward ITCZ shifts in the southern warming and bipolar seesaw experiments, respectively.