Geophysical Research Abstracts, Vol. 8, 02284, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02284

Polar Amplification of Climate Change

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Most modeling studies show climate warming to be most pronounced at high latitudes. This effect is called polar amplification and is the focus of this study in which a general circulation model (GCM) of the atmosphere is employed in a series of simplified studies of the effect. Polar amplification is discussed chiefly in terms of the system's linearized dynamics. A method based on the fluctuation-dissipation theorem is used to extract the linear stability and sensitivity characteristics of the model climate and the polar amplification is seen to arise as an excitation of the slowest decaying stable eigenmode of the system's linear operator. Relaxation of perturbations is shown to follow the linear expectations. It is demonstrated that the polar amplified shape of the slowest decaying mode is due to a communication of tropical temperature perturbations to high latitudes through changes in the poleward energy transport. From the linear operator we estimate the worst-case forcing, which optimizes warming per unit forcing. This worst-case forcing is found also to have a polar amplified structure.