Dynamical impact of the warming pattern

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It is well established that an increase in greenhouse gas concentration does not lead to a homogeneous tropospheric warming, but a warming pattern characterized by a stronger warming in the upper tropical troposphere and near the surface at the northern high-latitudes than elsewhere in the troposphere (Fig.10.7 in Meehl et al. 2007). Such a warming pattern can significantly impact the dynamical state of the atmosphere. But what exactly is this dynamical impact? Does the warming pattern imply a more energetic atmosphere with enhanced storm activity?

The questions are difficult to answer, mainly because the warming pattern reveals various counteracting effects. For instance, the tropical warming favors not only an increase in meridional temperature gradient but also a decrease in static stability. While the former tends to enhance baroclinic activity, the latter acts to suppress it. Held (1993) pointed out another pair of competing effects involving the increase in meridional temperature gradient in the upper troposphere due to the upper tropical warming and the decrease in temperature gradient near the surface due to the high-latitude surface warming. In general, the effect of temperature-gradient change has been perceived as being more important than that of the static-stability change.

In the present paper, we discuss a new approach used to assess the dynamical impact of the warming pattern. The approach is based on specially designed experiments with coupled atmosphere-ocean GCM. We will demonstrate that that it is the changes in static stability, not those in temperature gradient, that control the response of the dynamical state to the warming pattern.