Wave Activity Budget and the Onset of Sudden Stratospheric Warming

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Sudden stratospheric warming (SSW) is arguably the greatest manifestation of wave breaking in the Earth's atmosphere. Although it is well established that the main driving of SSW is the planetary-scale wave forcing of the tropospheric origin, accurate prediction of SSWs still remains a challenging problem (Tripathi et al. 2016). Main difficulty is that our mechanistic understanding of finite-amplitude (and threshold) behaviors of Rossby waves is rather limited. In this study, we attempt to advance theory from the observed budget of finite-amplitude wave activity (FAWA, Nakamura and Zhu 2010) during the lifecycles of SSWs (and other stratospheric wave events). Of particular interest is the relationship between the vertical flux of wave activity (or the meridional eddy heat flux) and FAWA. Our analysis shows that the vertical wave activity flux at the edge of the polar vortex (say 60N 10hPa) maximizes at an intermediate (critical) FAWA, which defines the *capacity of the jet stream* with respect to the vertically travelling waves packets. Wave breaking and SSWs tend to occur once this capacity is reached: they are characterized by large (supercritical) FAWA and weak (stalled) vertical wave activity flux. However, the capacity of the jet stream is a strong function of the zonal wind; weak jet reduces the capacity, making it more susceptible to wave breaking for the same wave forcing. The FAWA perspective allows one to mesh the early theoretical work of Wang and Fyfe (2000) and observed data and unravel the relative roles of mean flow and wave forcing in the onset of SSW/wave breaking.

Key words: sudden stratospheric warming, finite-amplitude wave activity, wave breaking, wave flux capacity of jet stream

References

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