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Is stratospheric variability completely determined by tropospheric forcing?

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Recently, the authors showed that coherent, internal modes of stratospheric variability, observed previously in highly truncated models, persist also in relatively high resolution models that provide a more realistic representation of stratospheric dynamical processes. These internal modes of variability consist of downward propagating patterns of zonal wind anomalies that closely resemble those found recently in observational data sets. The modeled internal variability is associated with large variability in the upward EP fluxes into the stratosphere, which occurs despite the fact that the troposphere has no variability of its own; here, the stratosphere essentially controls the amount of wave flux that can enter into it. This begs the question to what extent is the observed stratospheric variability controlled by its own internal variability, and to what extent is it simply forced by large tropospheric variability.

This question is addressed using a simple variation of the model configuration used to identify the original, internal modes of stratospheric variability. Instead of being time independent, the tropospheric wave forcing is now allowed to vary in a prescribed manner as a simple, controlled representation of natural tropospheric variability. Comparing the characteristics of the stratospheric variability obtained with and without tropospheric variability provides an estimate of the importance of the latter. We consider both periodic and random modulations of the tropospheric wave forcing, with the modulation period and amplitude as external control parameters, and use a frequency decomposition to illustrate the character of the stratospheric response. For periodic modulation, although the response typically becomes frequency locked, the character of the variability strongly resembles the internal variability found with no modulation. For random modulation, significant power persists at the internal frequency, even for large modulation amplitudes. The results suggest that, even under strongly time-dependent external forcing, internal dynamical modes play a fundamental role in

determining the total stratospheric variability.