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What Controls the Frequency of SSWs in a Dry Dynamical Core?

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It is well known that pulses of upward propagating planetary waves from the troposphere and also a relatively weak polar vortex provide favorable conditions for stratospheric sudden warmings (SSWs). However, in a climatological sense, the relationship between the magnitude of the stratospheric wave driving, the strength of the vortex, and the frequency of SSWs is not well understood. To study this relationship, we employ GFDL's dry dynamical core with realistic topography and zonally asymmetric equilibrium temperatures. We conduct a series of parameter sweep experiments by systematically varying the magnitude of the surface drag, which controls the tropospheric zonal wind and the synoptic eddy activity. Zonal wind and synoptic eddy activity have direct influences on the strength of the polar vortex and the stratospheric wave driving, and thus on the SSW frequency. We find that the frequency of SSWs depends non-linearly on the strength of the surface drag. We propose a conceptual model that explains this relationship, using parameters derived from the experiments with the dynamical model. The conceptual model describes how the surface drag modifies the tropospheric and stratospheric physical quantities, and provides an explanation for the interaction between these quantities. The conceptual model successfully predicts the complicated non-linear dependence of the frequency of SSWs on the surface drag.