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Dynamics of stratosphere troposphere singular vectors

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Stratospheric conditions affect the tropospheric circulation on a variety of temporal and spatial scales. We address two issues relevant for stratosphere troposphere interaction at short time scales: the basic growth mechanisms involved with the interaction and the role of the stratospheric shear of the basic state. Idealized simulations are conducted of initially stratospheric perturbations that maximize tropospheric total disturbance energy with a lead time of 5 days, assuming linear quasi-geostrophic dynamics and simplified zonal flow. The evolution is analysed in terms of the basic interactions between three Rossby-wave components. On the f-plane (constant Coriolis parameter) the three-component analysis is very accurate (the error stays within one percent of vertically integrated total energy) because all available growth mechanisms are captured. Energy growth occurs initially through the Orr mechanism, subsequently through resonance and finally through (normal-mode) shear instability. On the beta-plane (Coriolis parameter varying linearly with latitude) errors increase because westward retrogression of the untilting potential vorticity structure is neglected by the three-component model. Further study reveals that the tropospheric energy growth strongly depends on the value of the stratospheric shear.