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Influence of the stratospheric potential vorticity distribution on planetary wave breaking and the Brewer-Dobson circulation

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Propagation of planetary-scale Rossby waves within the stratosphere, and hence the location of wave-induced zonal mean momentum forcing and the resulting Brewer-Dobson circulation, is dynamically determined by the distribution of zonal mean potential vorticity. Steep potential vorticity gradients at the vortex edge act both as a wave-guide for upward propagating waves, as well as increasing the resilience of the vortex edge to wave breaking. Further, the potential vorticity distribution imposes a dynamical constraint on the possible latitudinal extent of wavebreaking, and suggests the importance of breaking planetary-scale waves in the stratospheric surf zone for the driving of tropical upwelling in the lowermost stratosphere. Using simple numerical experiments we examine the effect of the potential vorticity distribution on planetary wave propagation and breaking. In these experiments, the potential vorticity distribution may either be varied directly or implicitly through the effect of finite horizontal resolution, which acts to limit the extent to which wave breaking may steepen potential vorticity gradients at the vortex edge. Details of individual wave breaking events and the secondary circulations they induce are highly sensitive to the potential vorticity distribution, and, in particular, to horizontal resolution. However, in long, forced-dissipative integrations, bulk quantities such as the total time-average tropical upwelling in the lowermost stratosphere appear relatively insensitive to horizontal resolution.