What causes the double peak in upwelling in the tropical lower stratosphere?

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The upwelling in the Brewer-Dobson circulation in the lower stratosphere (~70 hPa) has a double-peak structure, with the maximum upward velocity at about 20 N and 20 S and a minimum over the equator. This structure is evident in diabatic heating rates and vertical velocities calculated from ERA -Interim data and also in many model simulations. We analyse the different contributions to the localized maxima in diabatic heating rates and find an important contribution to the double peak from ozone absorption, with secondary contributions from temperature structure and from latitudinal variations in upper tropospheric clouds. As required by the angular momentum balance, the double-peak structure in upwelling corresponds to a certain latitudinal structure in wave driving. However we argue that the structure in the wave driving cannot be considered to be the primary cause of the double peak and that the cause is instead some component of the diabatic heating field. We study the response to an imposed double peak structure in the heating in an idealized general circulation model and identify a regime in which the imposed heating is primarily balanced by upwelling, with the wave driving changing accordingly as part of the response. Broader dynamical implications, including the dynamics of 'compensation' in wave driving of the Brewer-Dobson circulation, are discussed.

Key words: Brewer-Dobson circulation, ozone, angular momentum balance