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Missing stratospheric ozone depletion at Southern Hemisphere midlatitudes after Mt. Pinatubo

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Although the volcanic eruption of Mt. Pinatubo in 1991 caused a global-scale increase in stratospheric aerosol abundance, column ozone in the Southern Hemisphere midlatitudes did not show a pronounced decrease comparable to that in the Northern Hemisphere. To study this missing ozone depletion, a multiple linear regression was applied to the total ozone data set CATO (Candidoz Assimilated Three-dimensional Ozone) including the solar cycle, the Quasi-Biennial Oscillation (QBO), the effect of volcanic eruptions, the lower stratospheric (LS) Eliassen-Palm (EP) flux to describe the Brewer-Dobson circulation, and the stratospheric chlorine increase as explanatory variables. Volcanic induced ozone depletion was overcompensated partly by the QBO and by a pronounced EP flux anomaly, indicative of planetary wave activity emanating from the troposphere. Using NCEP-NCAR reanalysis data, it is found that the anomalous wave activity consisted of several significant wave events (SWEs) from austral spring 1991 through 1992 that lead to, together with aerosol heating, a significantly enhanced Brewer-Dobson circulation. It is therefore suggested that more ozone was transported from the tropics to the extratropics shifting the onset of the volcanic ozone loss into 1992 and reducing the strength of the volcanic signal. Using the eddy heat flux as diagnostic for vertical wave propagation we show that the majority of the SWEs can be traced back to the troposphere, and that a significant fraction was associated with atmospheric blocking patterns preceding the SWEs. In 1991/92, the Southern Annular Mode was in a negative and the El Niño-Southern Oscillation in a warm phase. We suggest that these atmospheric conditions favored a flow preconditioning toward quasi-stationary features including blocking, which was significantly enhanced in 1991/92. In JJA 1992, blocking occurred preferably over the southeast Pacific pointing to a major ENSO influence on LS wave activity in this season.