Relationships between Unusual Antarctic Ozone Hole in 2019 and Dynamical Fields

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Extreme ozone depletion occurs during early austral spring in the lower strarosphere over Antarctica, i.e., the Antarctic ozone hole, showing large interannual changes in its area as well as its ozone depletion amount. In 2019 a minor Antarctic sudden stratospheric warming (SSW) was observed in September and a smaller ozone hole was developed over Antarctica. Before this year, a small Antarctic ozone hole was also formed in 2017, even though there occurred no pronounced sudden stratospheric warmings. Hence, in this study, we use the Aura Microwave Limb Sounder (MLS) observations and the Japanese 55-year Reanalysis (JRA-55) data to try to find plausible mechanisms to bring about such small ozone holes in the two years. Resultantly, our ozone volume mixing ratio analyses show that positive volume mixing ratio anomalies from the climatological seasonal march appeared in the polar lower and middle stratosphere throughout the spring in both two years, which corresponds to the insufficient ozone hole development. We examined dynamical analyses based on Eliassen-Palm (E-P) flux and the residual mean meridional circulation and found that the wave activity of zonal wavenumber 1 was extremely strong in 2019 to cause the minor SSW while that of zonal wavenumbers 1 and 2 became strong intermittently in 2017; thus, the enhanced wave activity induced downward advection of ozone-rich air to bring about the small ozone holes.

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