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WAVE FORCING ESTIMATED FROM MIPAS STRATOSPHERIC TEMPERATURE AND OZONE MEASUREMENTS DURING THE SOUTHERN POLAR VORTEX SPLIT-UP EVENT OF 2002

Abstract

The temperature and ozone volume mixing ratio (VMR) profiles observed by MIPAS on ENVISAT in the southern hemisphere during the winter of 2002 provide evidence for an unprecedented stratospheric major warming. Here presented is an analysis of the measurements retrieved using the IMK data analysis processor.

Evidence of Major Warming

The zonal mean temperatures show rapid poleward increase with a maximum of 50 K or more, and remarkable reversal of the latitudinal gradients at 35 km or below in several days. The zonal mean ozone VMR also increase poleward, and have maximum value of 7 ppmv in a wide region between 20-40 km at latitudes south of 40S.

Longitudinal Variations

The variations are dominated by wave 1 at the onset of the warming. The wave 1 amplitudes drastically increase at 60S-80S, reaching maxima of 2-3 ppmv and 30-40 K in the region of 20 and 35 km for ozone VMR and temperature, respectively. The large-amplitude wave 1 disturbances break down in one or two days, and the amplitudes of wave 1 and 2 become comparable, resulting in an apparent wave 2 pattern with the temperature and ozone VMR peaked around longitudes of 30E and 100W.

Possible Mechanism

The forcing from near-stationary gravity waves is estimated at +/- 500 m/s/day. It plays a key role to reverse the mean temperature gradient and the zonal wind direction and to enhance the planetary wave activity in the middle atmosphere. Once the process initiates, there is strong positive feedback and so it develops rapidly. As the zonal eastward flow become weaker, more planetary waves can penetrate into a region of wider latitudes and upper altitudes, and their phase speeds tend to be westward due to filtering of the changing background flow. When these waves break, the zonal flows further decelerate. This reaches the stage of the process where the planetary waves are in effect together with small-scale gravity waves.

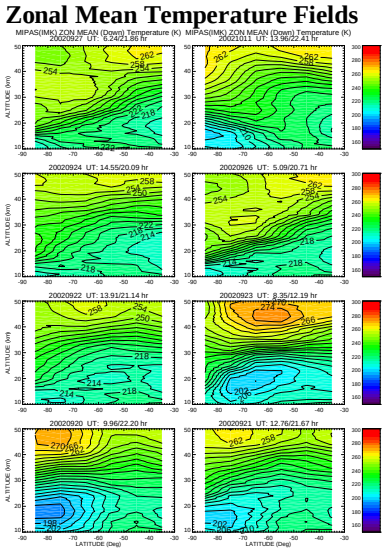

Figure 1. Daily zonally averaged temperature in Kelvin. The data were measured by MIPAS in the descending node for the eight days of late September and early October of 2002. The local time varies from 6:00 AM at 85S to 10:00 AM at 35S.

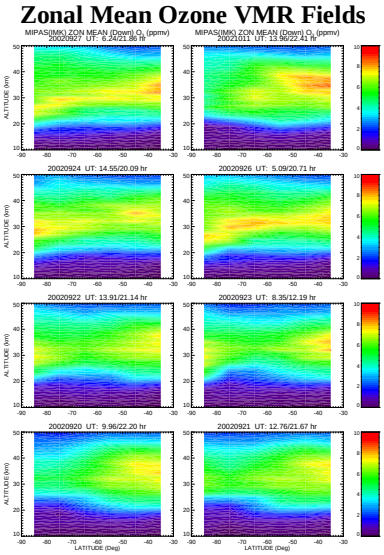

Figure 2 Same as Figure 1, but for ozone mixing ratio in ppmv (parts per million by volume).

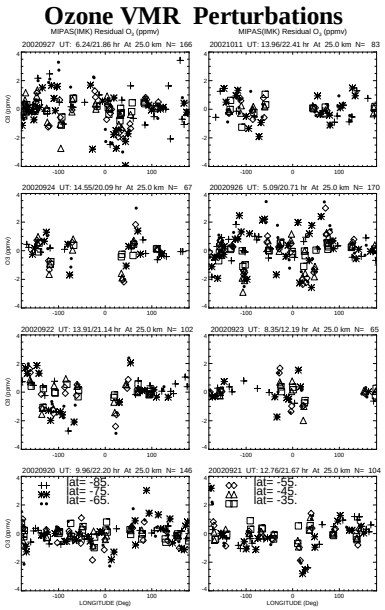

Figure 4. Same as Figure 3, but for the residual ozone mixing ratio in ppmv at 25 km altitude.

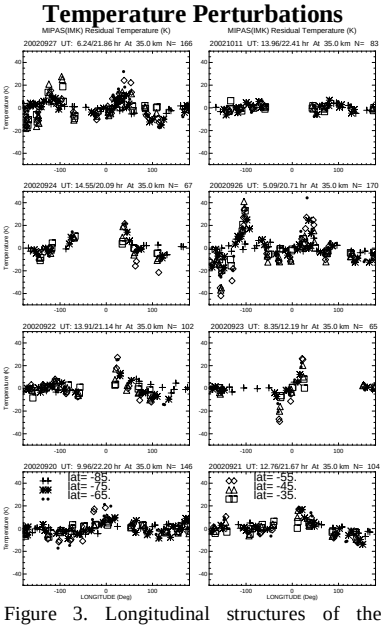

Figure 3. Longitudinal structures of the residual temperatures (in Kelvin) at 35 km altitude for the eight days of September and October 2002. The residuals are obtained from the observed values of individual datapoints subtracted by the daily zonal means of their corresponding leg. The data from both descending and ascending nodes are combined and binned into six latitude bands.