

Supplement to the paper “Polar-night O₃, NO₂ and NO₃ distributions during sudden stratospheric warmings in 2003-2008 as seen by GOMOS/Envisat”

In this supplement, we present horizontal distributions of temperature, ozone, NO₂ and NO₃ at several altitudes in four winters 2002-2008 when sudden stratospheric warmings (SSW) occur. In all figures, black crosses indicate locations of GOMOS measurements and black dashed line indicate 70°N. The color plots show representative phases of SSWs: before warming, the first warming, the period shortly after the first warming, then the second warming etc. The dates of the warming events, as well as the vertical distributions of temperature and the considered trace gases during the considered SSWs at latitudes 70°-90°N are presented in Figure 3 of the main paper.

1 Stratospheric distributions at 40 km

The horizontal distributions of temperature ozone, NO₂ and NO₃ in the 3-km layer centered at 40 km are presented in Figures 1-4. At ~40 km, NO₂ and NO₃ mixing ratios are close to maximum. Note, that at this altitude temperature and ozone are expected to be negatively correlated (Figures 6 and 7 of the main paper), opposite to their positive correlation in the lower stratosphere.

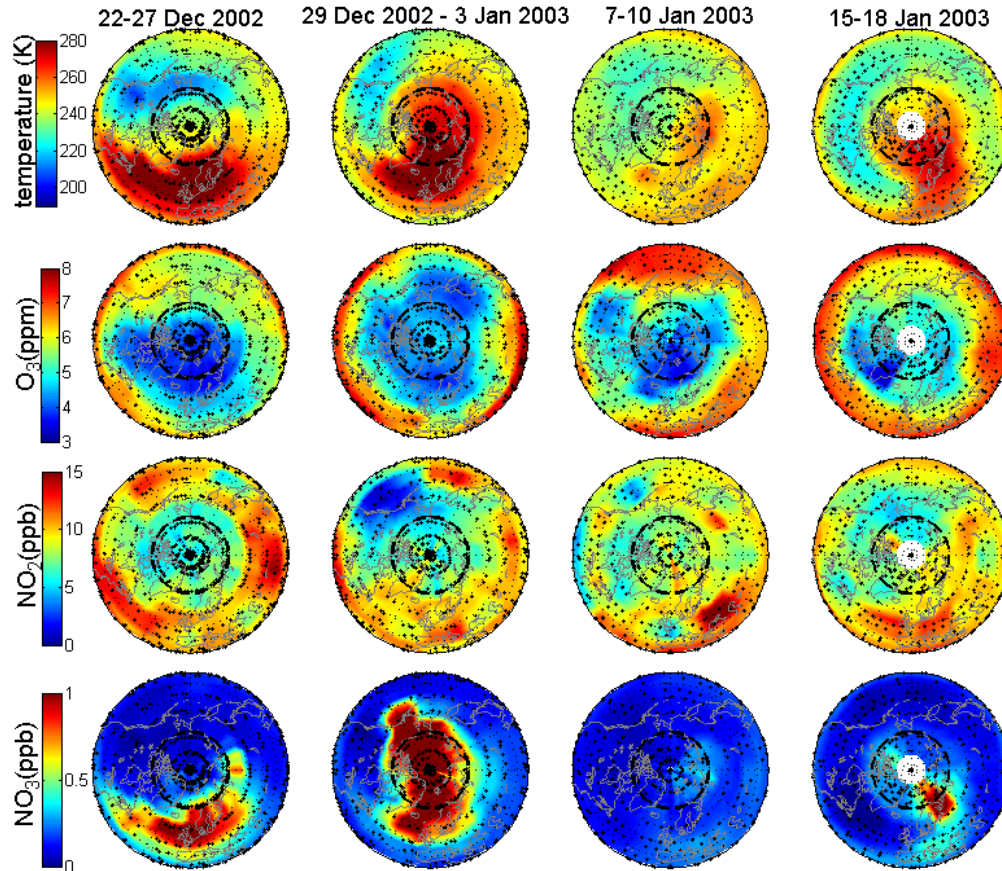


Figure 1. Temperature, ozone, NO₂ and NO₃ distributions at ~40 km during SSWs in January 2003. Temperature is ECMWF data at the locations of GOMOS occultations (averaged in the same way as GOMOS data). Latitudes 35°-90° N.

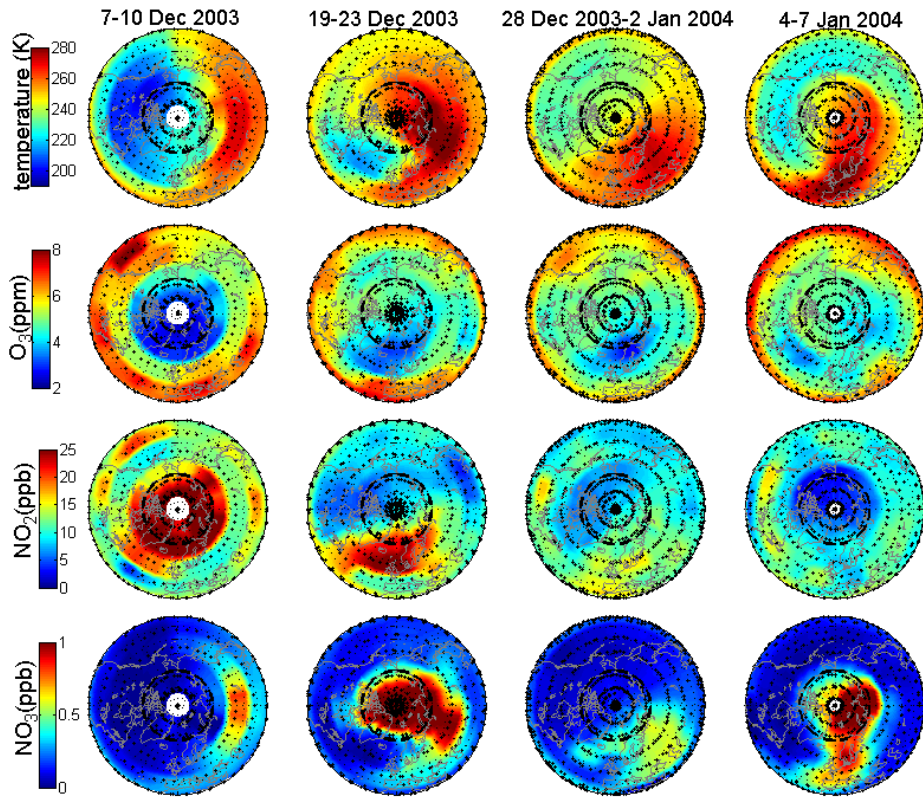


Figure 2 As Figure 1, but for SSWs in December 2003- January 2004. Latitudes 35°-90° N.

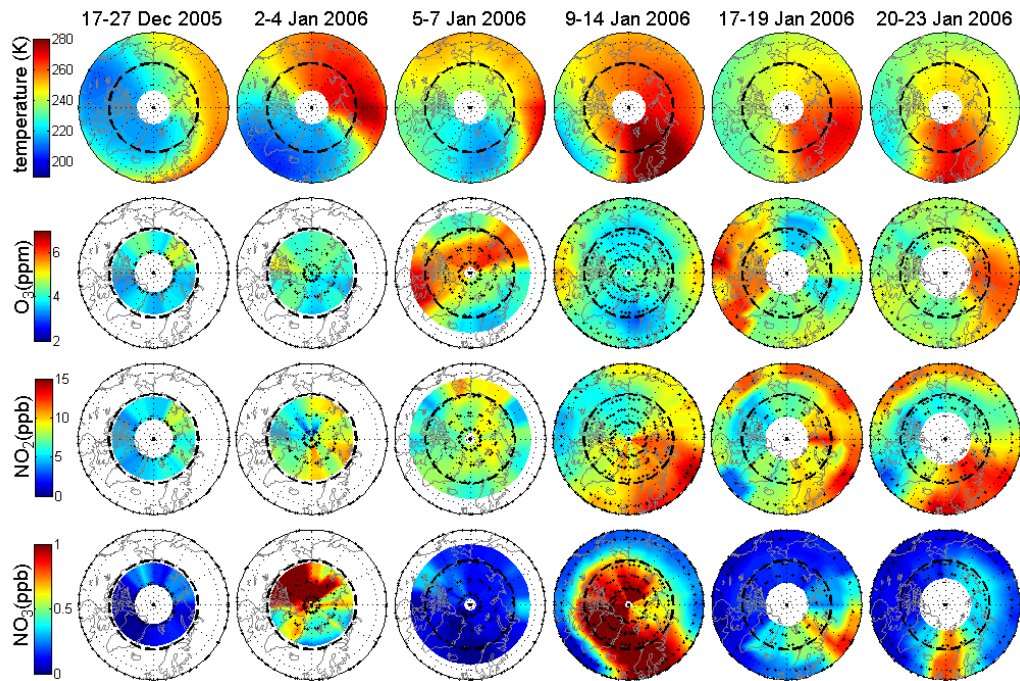


Figure 3 As Figure 1, but for SSWs in January 2006. Temperature data are from MLS measurements. Latitudes 55°-90° N.

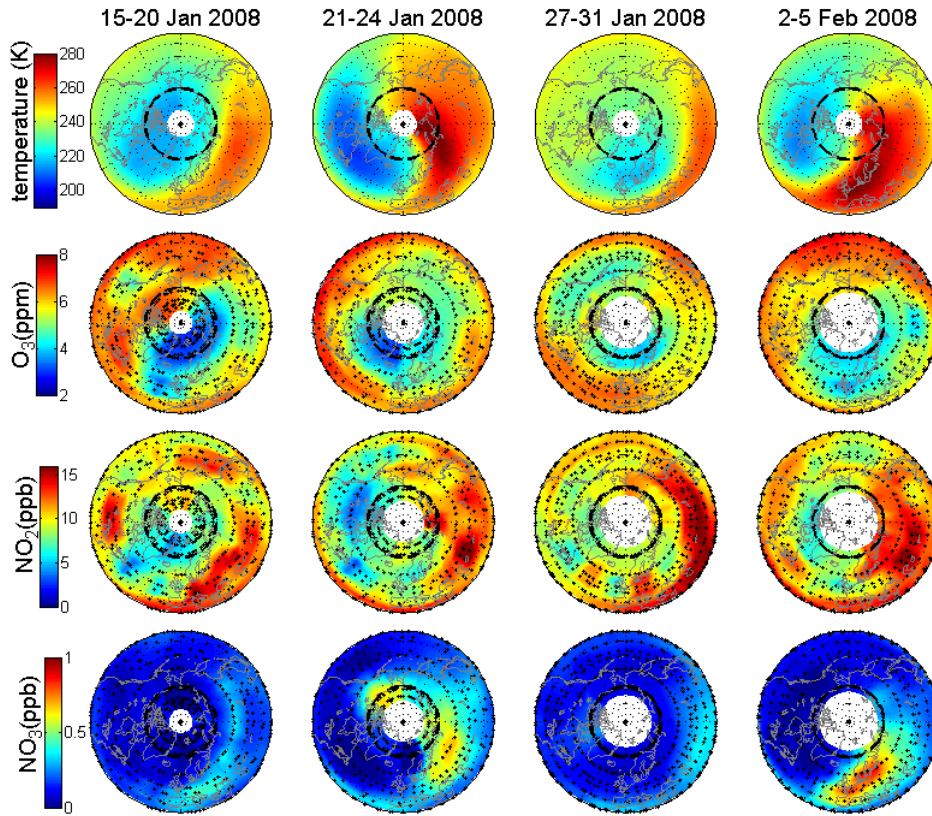


Figure 4 As Figure 3, but for SSWs in January-February 2008. Latitudes 35°-90° N.

2 Tertiary ozone maximum

Figures 5-8 present horizontal distributions of GOMOS ozone and MLS temperature (when available) in the 3-km layer centered at 72 km, the typical altitude for location of the tertiary ozone maximum (TOM) close to the polar night terminator.

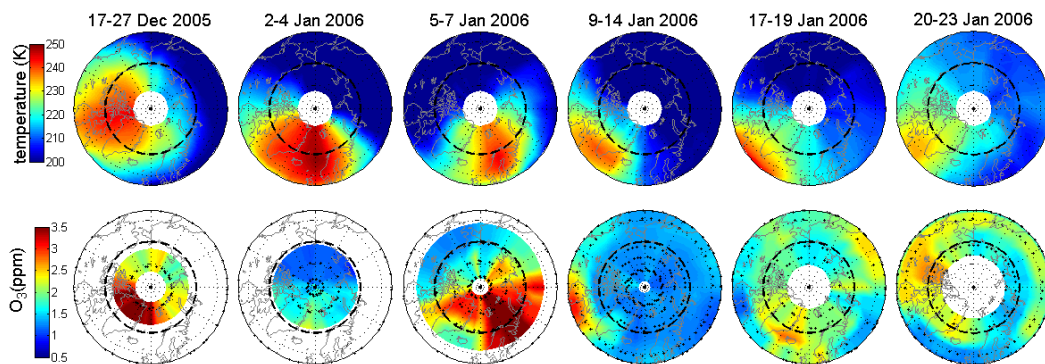


Figure 5. MLS observations of temperature and GOMOS observations of TOM during SSWs in January 2006. Latitudes 55°-90° N.

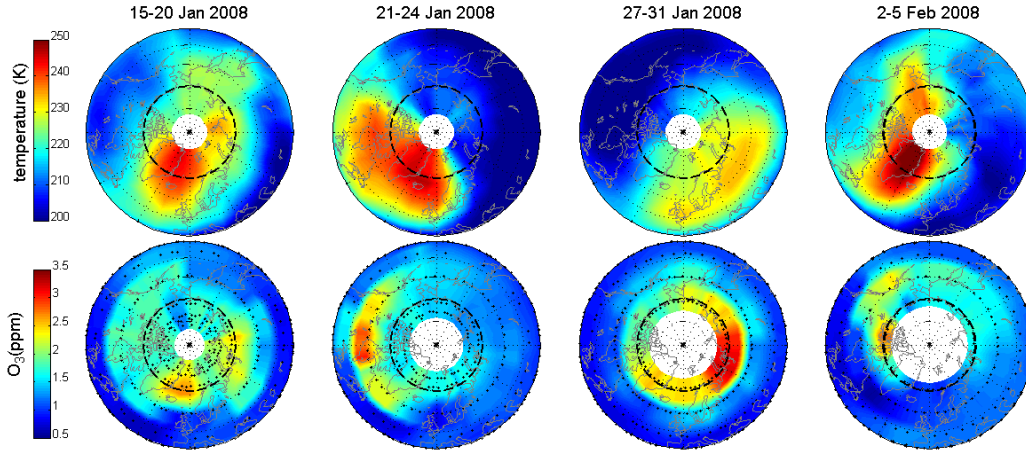


Figure 6 As Figure 5 but for SSWs in 2008. Latitudes 40°-90° N.

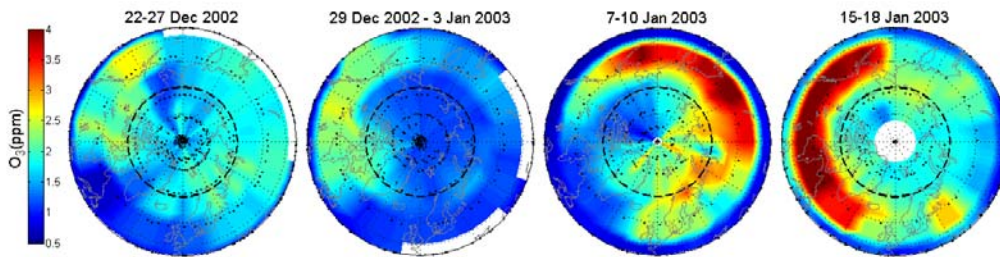


Figure 7. GOMOS observations of the tertiary ozone maximum during SSW in January 2003. Latitudes 40°-90° N. Note that large enhancement at ~58°N (location of GOMOS measurements) for 7-10 Jan 2003 and 15-18 Jan 2003 are smeared due to spatial averaging.

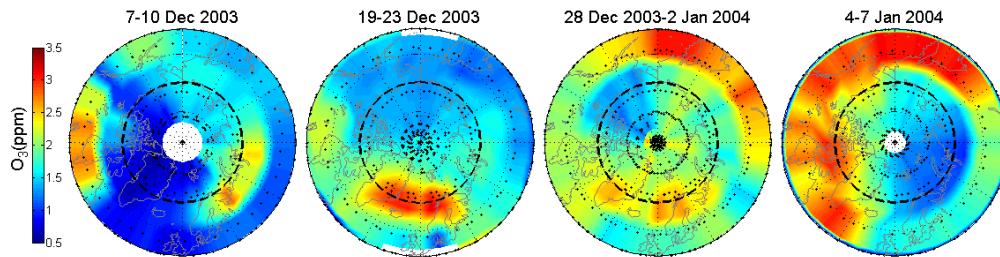


Figure 8. As Figure 7, but for the SSWs in Dec 2003- Jan 2004. Latitudes 50°-90° N.

3 Ozone at ~95 km

Figures 9-12 present GOMOS horizontal distributions of ozone mixing ratio in the 3-km altitude layer centered at 95 km, the typical altitude of the lower-thermosphere maximum of ozone mixing ratio.

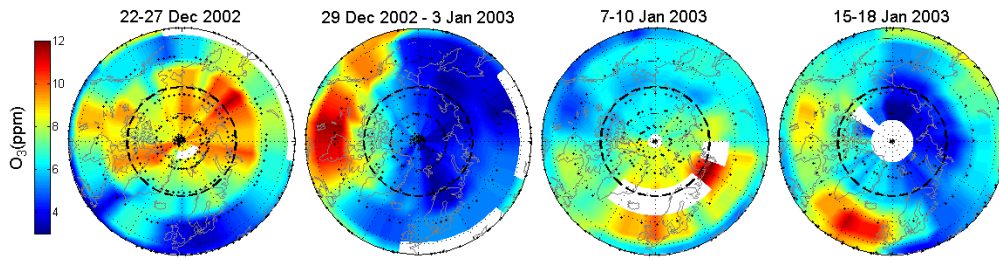


Figure 9 GOMOS observations of secondary ozone maximum during the SSW in January 2003. Latitudes 45°-90°N.

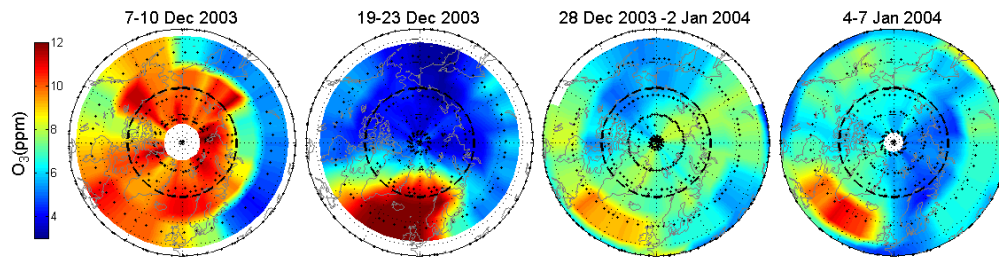


Figure 10 As Figure 9, but for the SSW in Dec 2003-Jan 2004. Latitudes 45°-90°N.

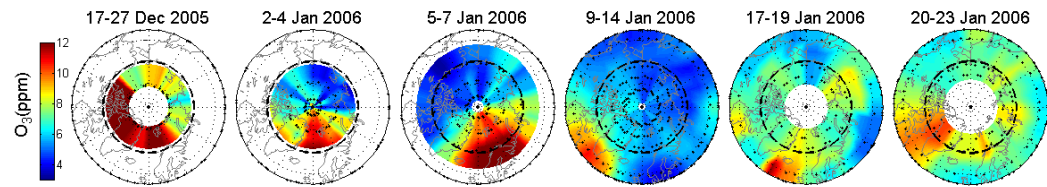


Figure 11. As Figure 9, but for the SSW in January 2006. Latitudes 55°-90°N.

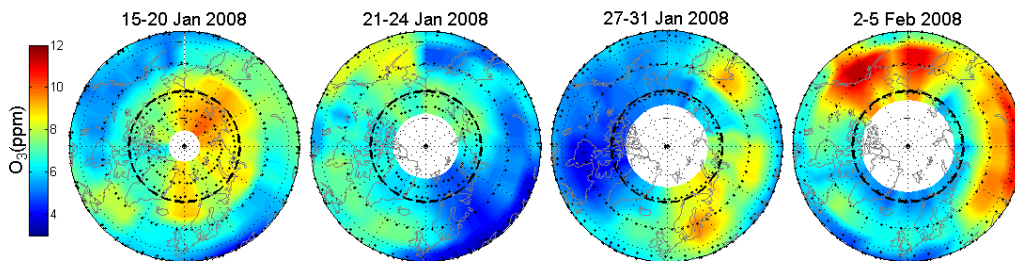


Figure 12. As Figure 9, but for the SSW in 2008. Latitudes 45°-90°N.