

Supplement

An improved observation-based tropopause-relative coordinate system based on tracer climatologies

S1 Dynamic tropopause (3.5 PVU) profile irregularities

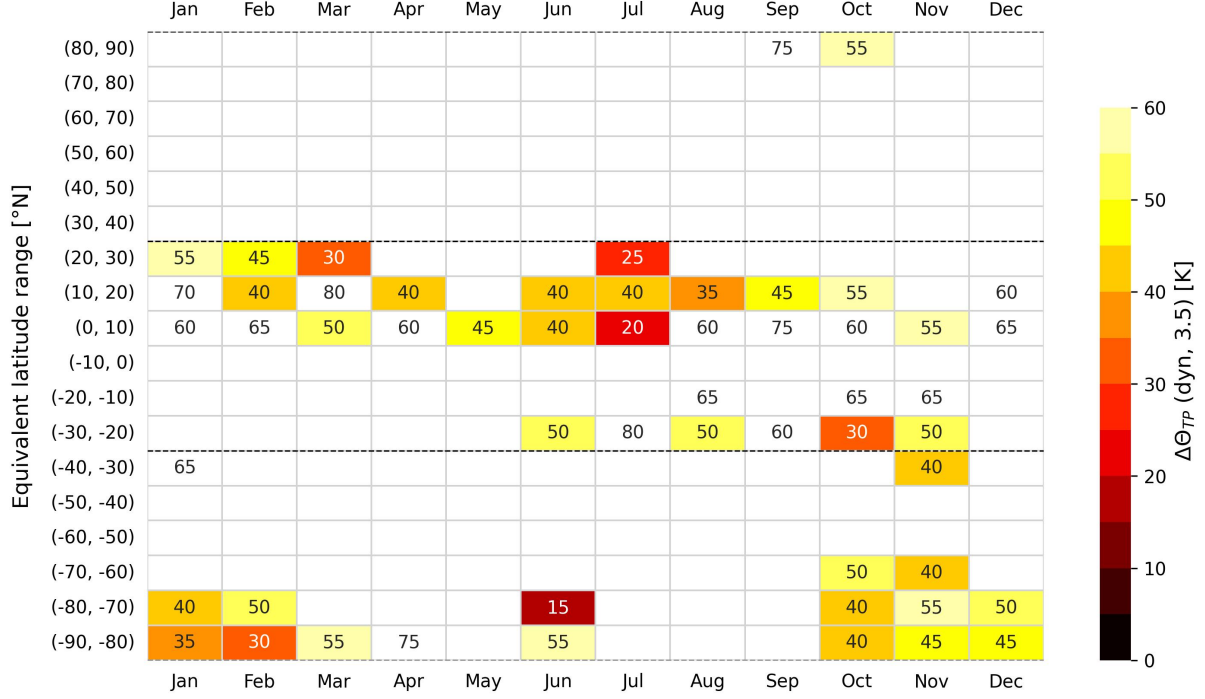


Figure S1: First occurrence of a decreasing value in the climatological profiles of O_3 versus potential temperature relative to the dynamical 3.5 PVU tropopause. Data is binned into month $\times$ 10° equivalent latitude $\times$ 5 K in $\Delta\Theta_{TP}$. Grid cells without a value are strictly monotonically increasing across the full vertical range (up to 80 K above the tropopause). Highlighted in colour are fields with non-monotonic behaviour below 60 K above the tropopause and values indicate the midpoint of the corresponding bin ± 2.5 K. In the tropics, the procedure outlined by Sprenger et al. (2003) is used to evaluate a dynamical tropopause in regions where the dynamic tropopause is not well defined / above the 380 K isentrope. Fewer stations contribute to tropical than extratropical bins due to geographical distribution of regular ozone soundings. Areas around the northern hemispheric subtropical jet show increases in irregular behaviour.

S2 Thermal tropopause O₃ profile irregularities

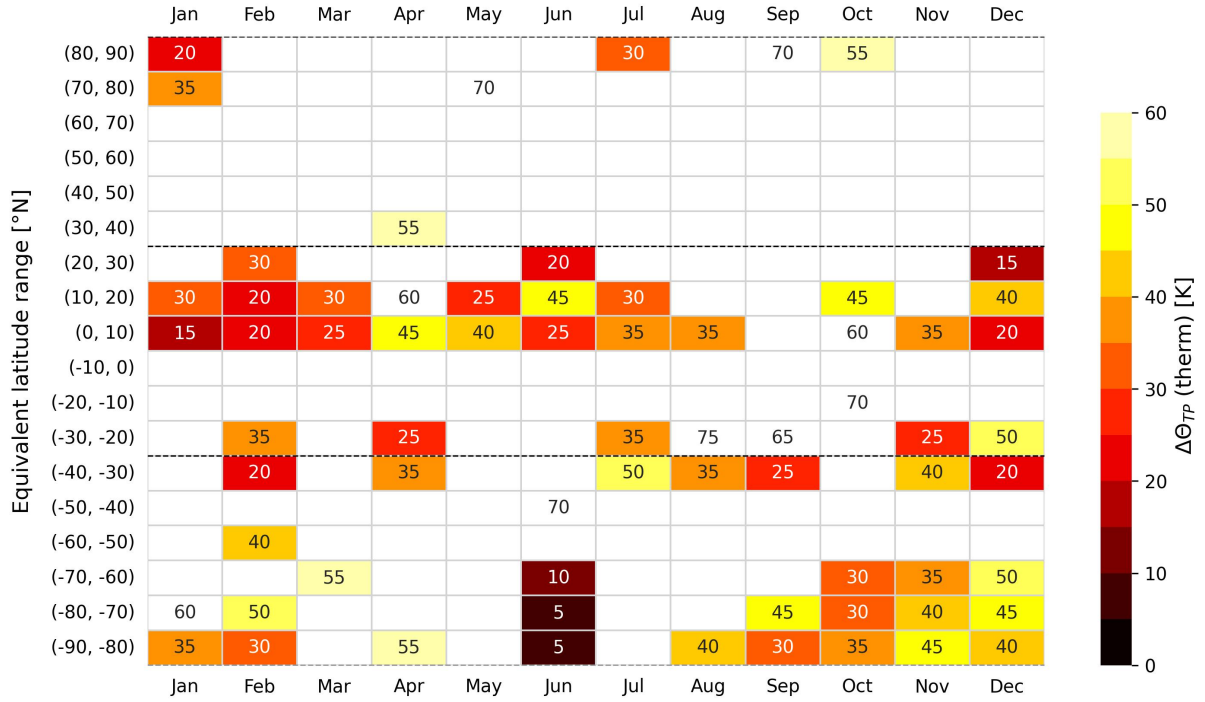


Figure S2: First occurrence of a decreasing value in the climatological profiles of O₃ versus potential temperature relative to the thermal tropopause. Data is binned into month $\times$ 10° equivalent latitude $\times$ 5 K in $\Delta\Theta_{TP}$. Grid cells without a value are strictly monotonically increasing across the full vertical range (up to 80 K above the tropopause). Highlighted in colour are fields with non-monotonic behaviour below 60 K above the tropopause. In comparison to Fig. S1 one can see that profiles referencing the dynamic 3.5 PVU tropopause tend to be less irregular in the mid-latitudes and decreasing parts of the profile happen at greater $\Delta\Theta(dyn)$ than $\Delta\Theta(therm)$.

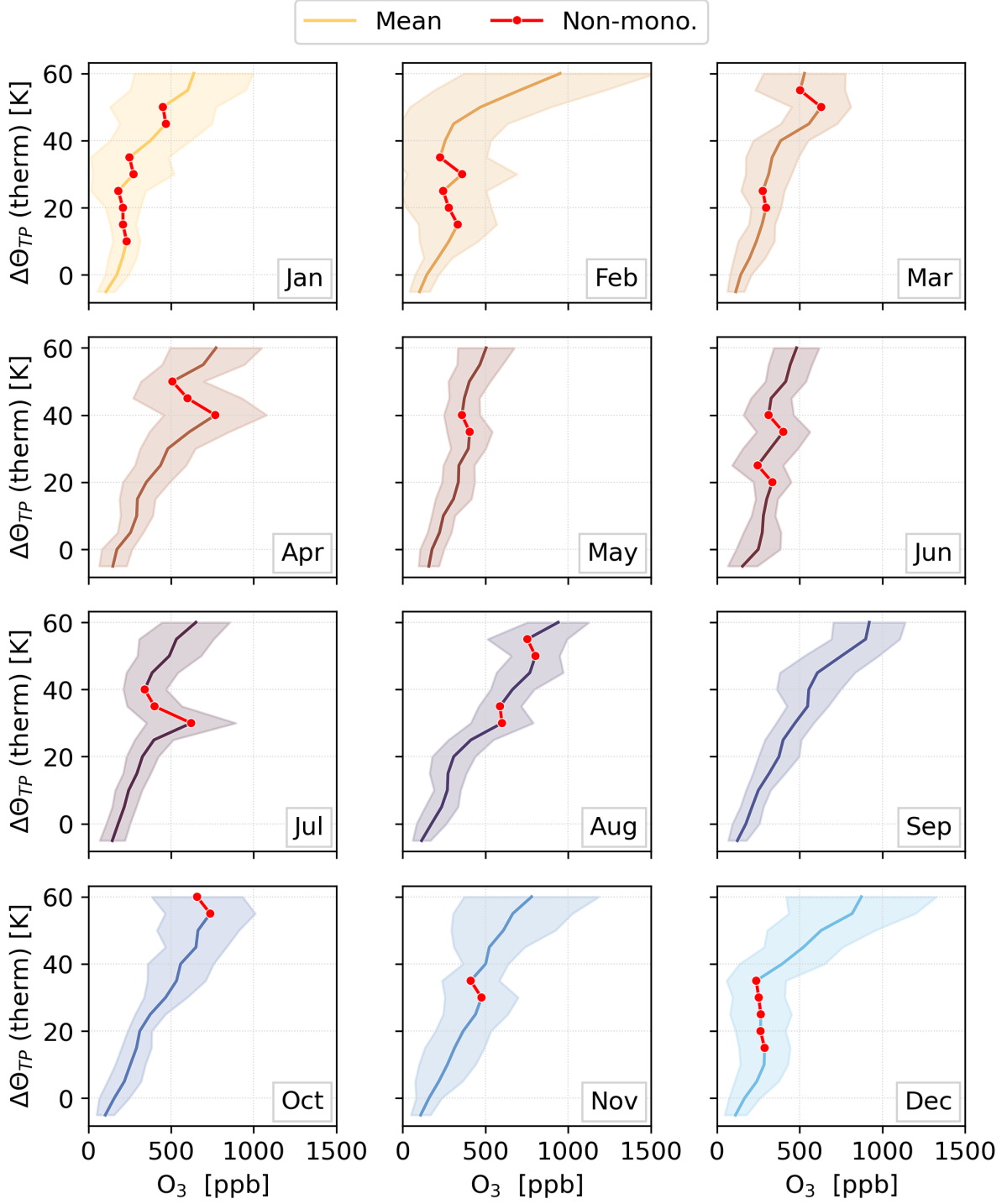


Figure S3: Monthly mean profiles of O_3 in potential temperature relative to the thermal tropopause in the (0,10) $^{\circ}$ N equivalent latitude range. Parts of the profile that are not monotonically increasing are highlighted in red. The lower range of the decreasing bins is indicated in Fig. S2 for each month.

References

Sprenger, M., Croci Maspoli, M., and Wernli, H.: Tropopause folds and cross-tropopause exchange: A global investigation based upon ECMWF analyses for the time period March 2000 to February 2001, *Journal of Geophysical Research: Atmospheres*, 108, <https://doi.org/10.1029/2002JD002587>, 2003.