

S 1 Vortex and mid-latitude profiles

The profiles for the vortex and the mid-latitudes were generated by using measurements of nitrous oxide (N₂O) and potential temperature (Θ) or rather potential temperature difference to the local tropopause (ΔΘ). The following describes the several stages to determine the profiles and profile functions in order to assign measurements to the corresponding regions during the campaign.

For the vortex profile, only flights which had contact to the vortex core are taken into account. During these flights, only measurements polewards of 60° equivalent latitude and 20 Kelvin above the local tropopause are used. For the mid-latitudes profile, all flights are taken into account, but only measurements between -40° and -60° equivalent latitude and 20 Kelvin above the local tropopause.

For the remaining measurements, a filter procedure was used to get the lower envelope for the vortex profile and the upper envelope for the mid-latitude profile. Figure S 1 displays the procedure for the task using ΔΘ as the vertical coordinate. The process is initialized by binning the N₂O measurements into intervals of ΔΘ. For every bin, the mean value, standard deviation and relative standard deviation is calculated. This is necessary as the condition for the filter needs a binned profile to begin with. While the maximum relative standard deviation is bigger than the pre-settled outlier limit, the measurements, which are not flagged as outliers are binned in intervals of ΔΘ (this is done twice in the first iteration step, due to the fact that the binned profile is already needed for the initialization and no outliers are set for the beginning of the filtering process). Every bin is checked, whether the relative standard deviation is greater than the outlier limit. Is this the case, all measurements of N₂O which are greater (or lower, if the upper envelope is requested) than the mean of the respective bin are flagged as outliers. If this is not the case, the measurements above (below) the one sigma environment are cut off and marked as outliers. After each iteration step the outlier number is increased by one. The iteration process stops when the maximum relative standard deviation is below the pre-settled outlier limit. Figure S 2 and S 3 shows the measurements for the vortex and mid-latitude profiles. For the vortex profile, bin size was set to 5 Kelvin and the outlier limit to 3 %. Four iterations were done to get the lower envelope (grey samples). For the mid-latitude profile, the bin size was set to 2 Kelvin and the outlier limit to 10 %, resulting in two iteration-steps for the remaining measurements. For the profiles only those measurements are used which are not marked as outlier. As an intermediate step to the final profiles they are binned in 5 Kelvin intervals of ΔΘ (see Figure S 4 and S 5). Due to the low data density between 70 and 85 K of ΔΘ these bins are not considered for the profile. Mean values of the binned profiles are then used to generate a polynomial fit function for the vortex profile and the mid-latitude profile (see Figure S 6 and S 7).

S 2 Correlations between CFC-12 and the other organic source gases

For up-sampling the GhOST-MS measurements, pre-required are good correlations between CFC-12 and the other organic source gases, which are used for the calculation of inorganic chlorine. Figure S 8 displays the correlations with the respective polynomial or linear fit.

S 3 Vortex and mid-latitude profile during second phase of PGS

For the comparison of Arctic and Antarctic polar Cl_y, the vortex and the mid-latitude profile during PGS is needed. To generate these profiles, only the flights of the second main Phase of PGS were used, as this is the comparable time domain to the SouthTRAC campaign. Reference profiles can be seen in Fig. S 9.

S 4 Correlations function for the time period of the PGS campaign

$$\chi_{Cl_y} = c_0 + c_1 \chi_{ref} + c_2 (\chi_{ref})^2 \quad (1)$$

Table S 1. Coefficients of the correlation function to derive Cl_y with the respective reference substance for the time of the PGS campaign. Calculation of Cl_y with CFC-12 or N_2O and coefficients based on the balloon observations in 2009 and 2011 (Balloon).

Data source	χ_{ref}	c_0 [ppt]	c_1	c_2 [ppt ⁻¹]
Balloon	CFC-12	3011.05	-2.77406	$-5.88360 \cdot 10^{-3}$
Balloon	N_2O	3034.75	-2.11561	$-2.12169 \cdot 10^{-2}$

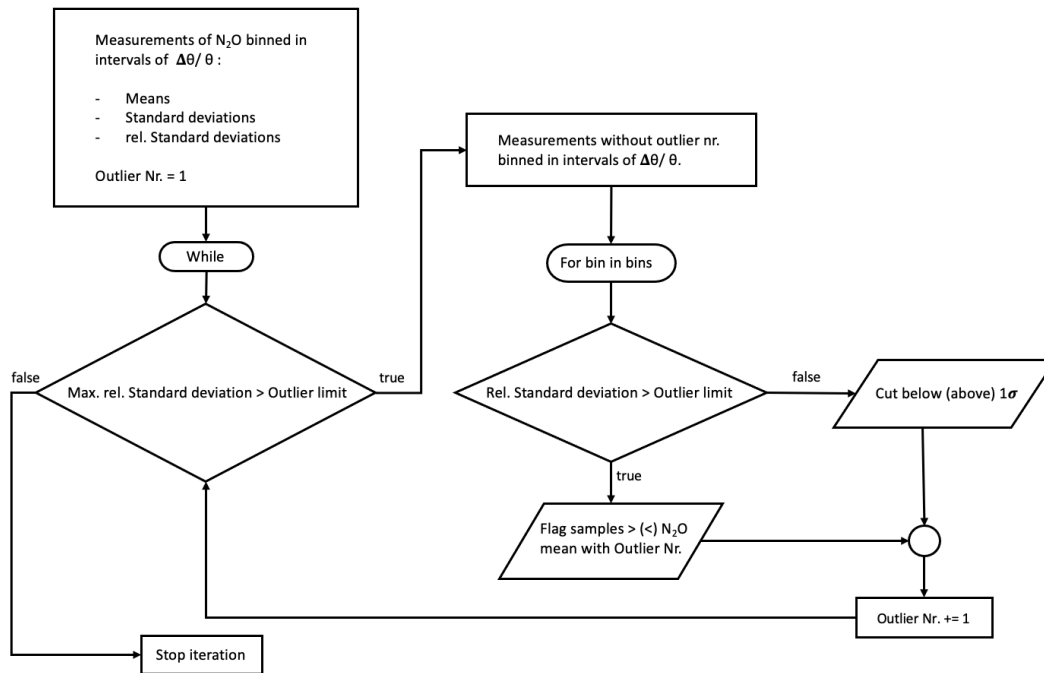


Figure S 1. Flowchart for the outlier identification to generate the vortex profile and mid-latitude profile

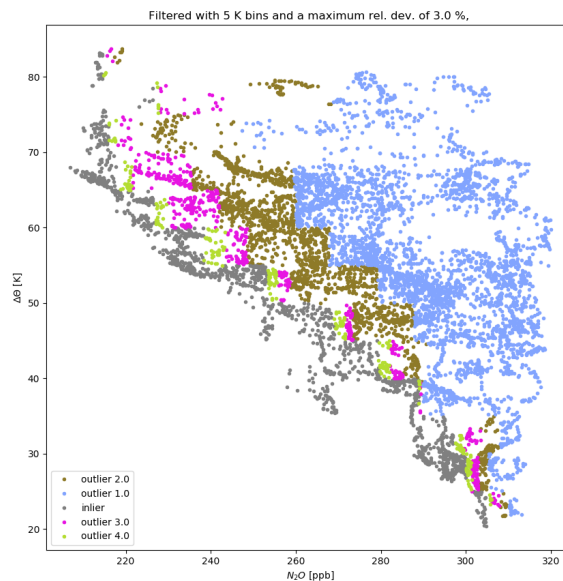


Figure S 2. Measurements included for generating the vortex profile during the SouthTRAC campaign. Colors indicate the iteration over the measurement data to get left over data for the final lower left envelope.

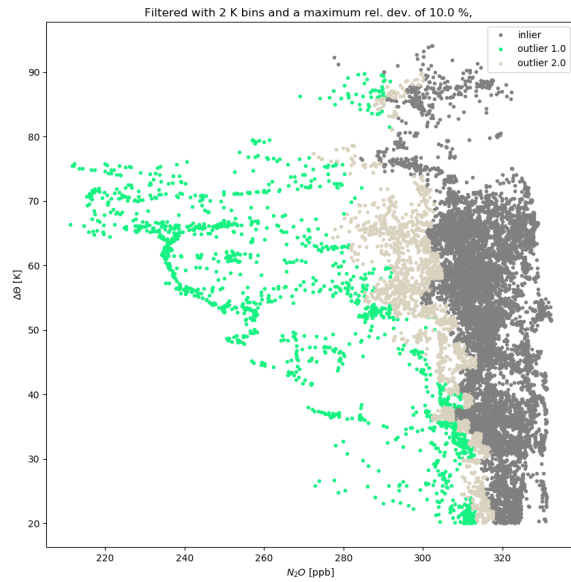


Figure S 3. Measurements included for generating the mid-latitude profile during the SouthTRAC campaign. Colors indicate the iteration over the measurement data to get left over data for the final upper right envelope.

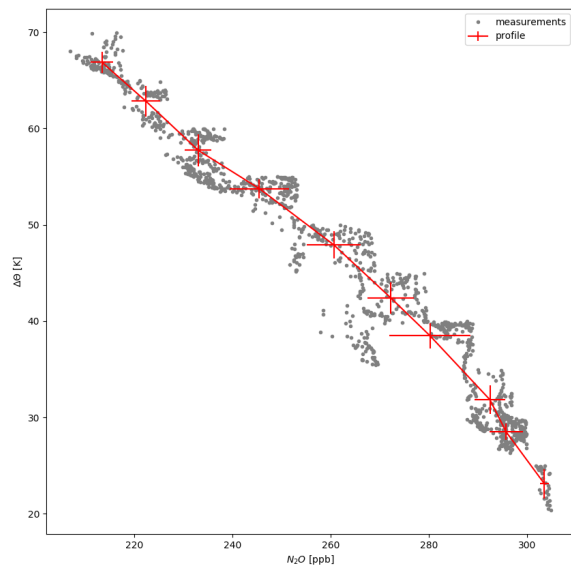


Figure S 4. Remaining measurements after filtering for the vortex profile, binned in 5 K intervals of $\Delta\Theta$.

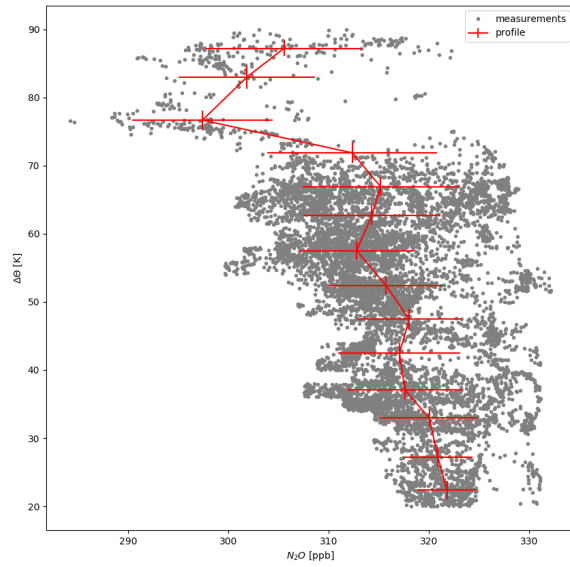


Figure S 5. Remaining measurements after filtering for the mid-latitude profile, binned in 5 K intervals of $\Delta\Theta$.

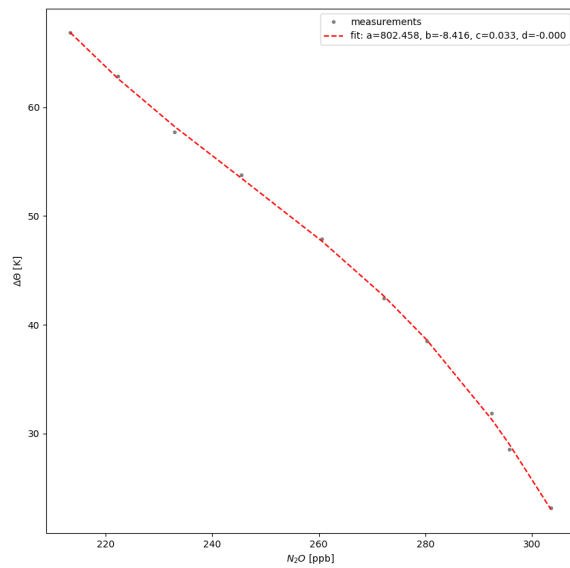


Figure S 6. Mean values of the binned profile and the fit function for the vortex profile.

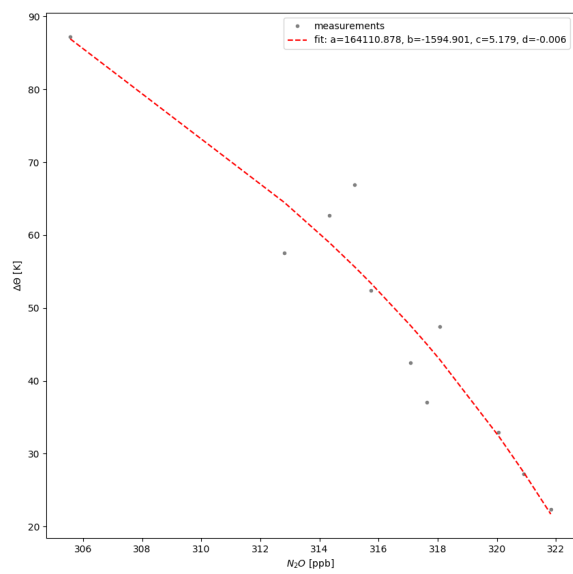


Figure S 7. Mean values of the binned profile and the fit function for the mid-latitude profile.

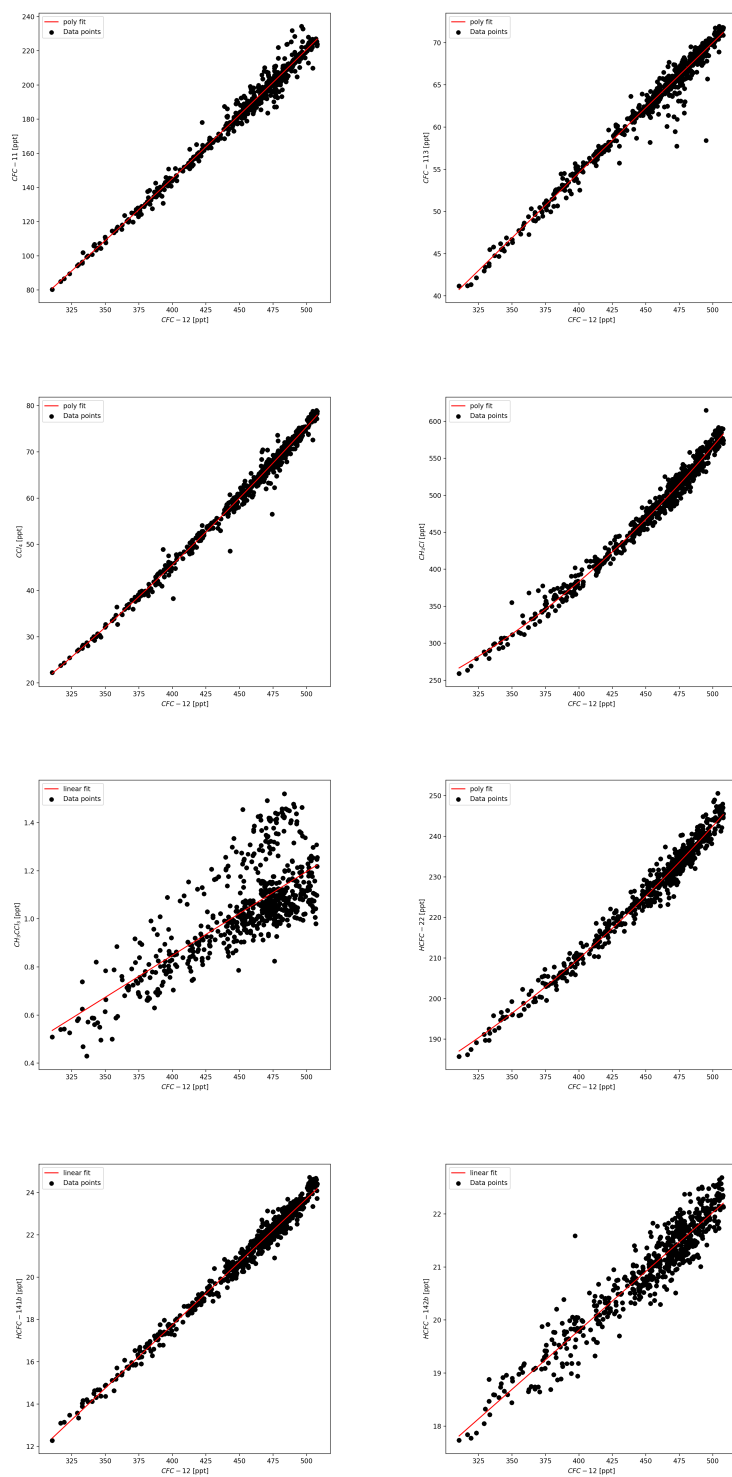


Figure S 8. Correlations between CFC-12 and the other major organic source gases, which are used for the calculation of inorganic chlorine.

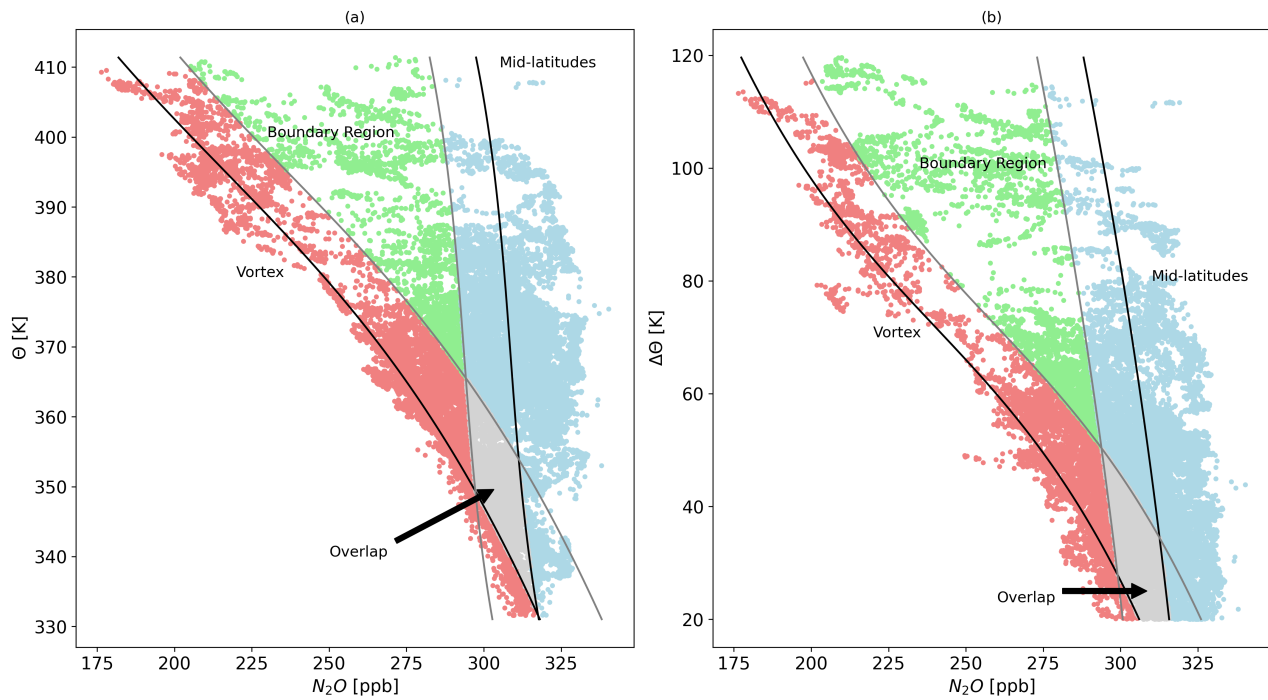


Figure S 9. Vortex and mid-latitude reference profiles during the second main phase of PGS.