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Supplement of

Impact of chlorine ion chemistry on ozone loss in the middle atmosphere during very large solar proton events

Monali Borthakur et al.

Correspondence to: Monali Borthakur (monali.borthakur@kit.edu)

Supplement

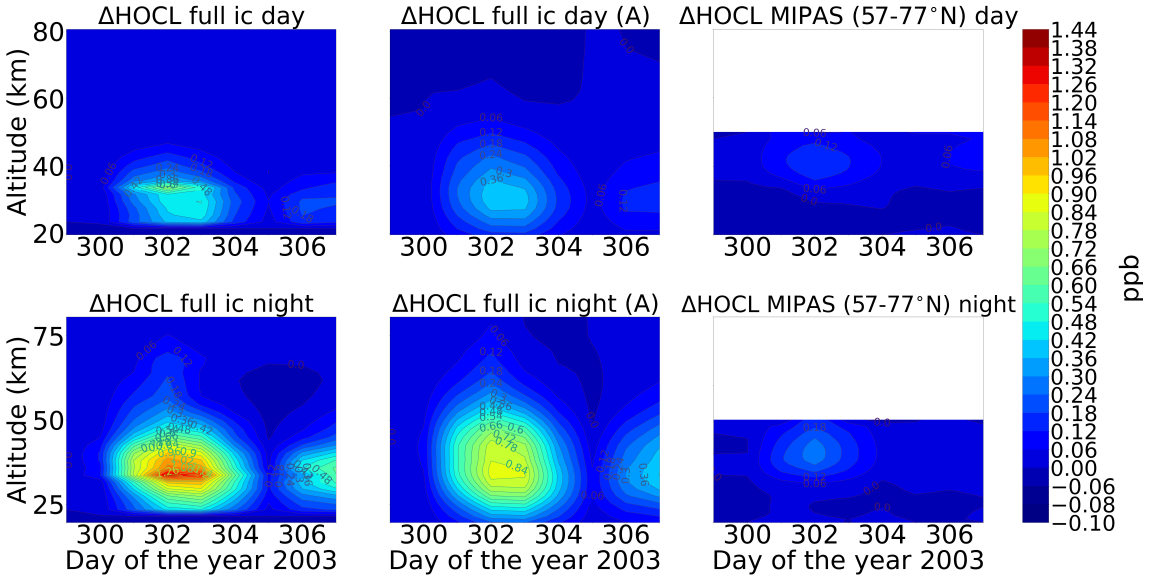

Figure S1. Absolute differences of HOCl full ion-chemistry w.r.t. 26$^{\text{th}}$ October for day-time (sza <= 90°) and night-time (sza > 98°). Column-wise: Full ion-chemistry, full ion-chemistry (with Averaging kernel) and MIPAS 57-77°N zonal averages.

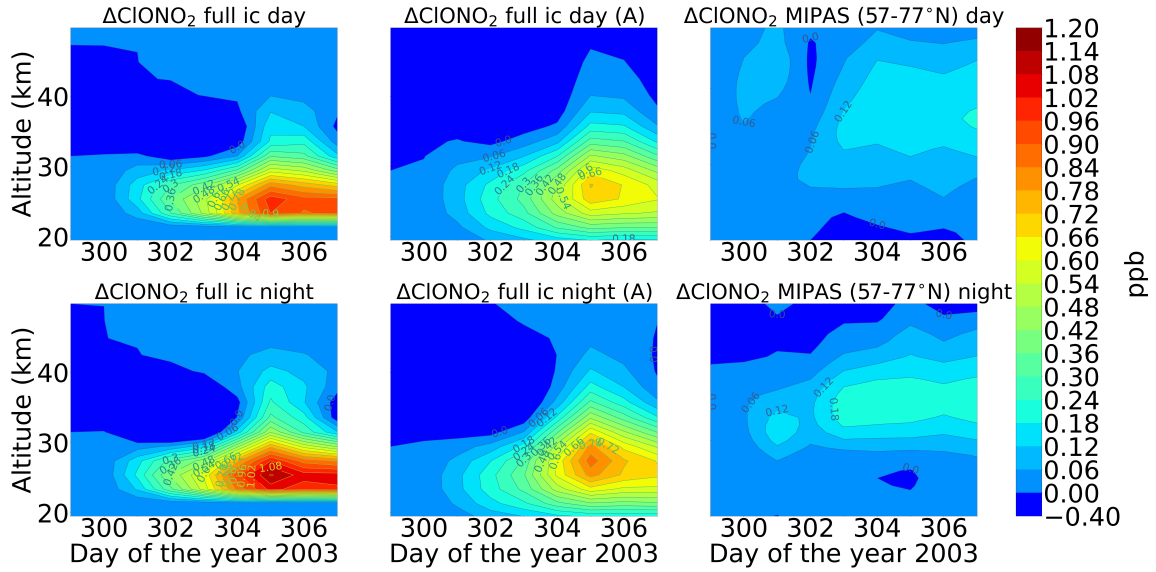

Figure S2. Same as figure S1 but for $ClONO_2$

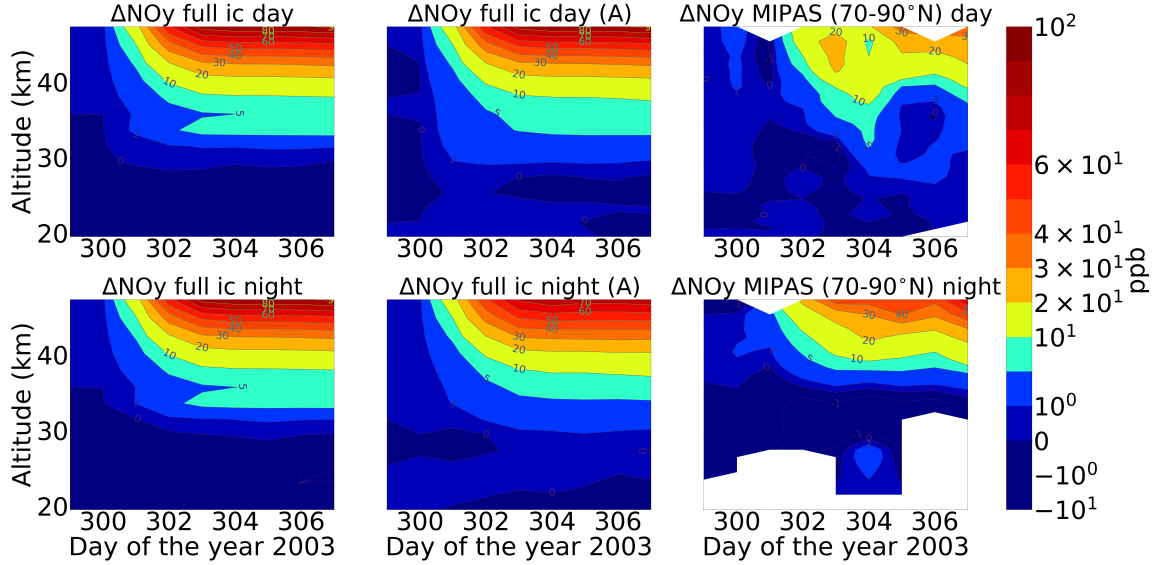

Figure S3. Same as figure S1 but for NO_y

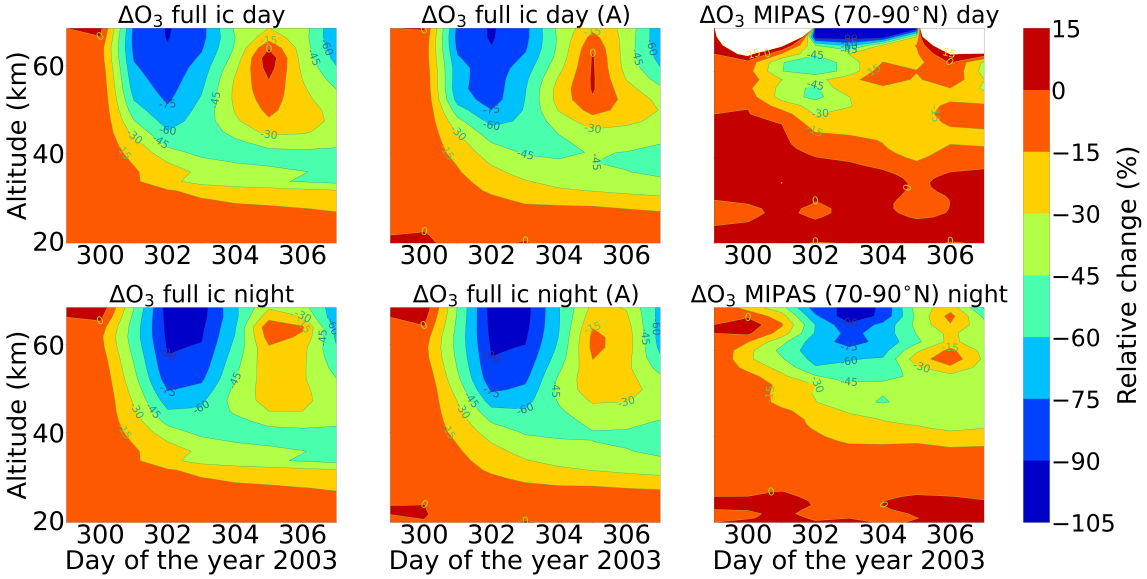

Figure S4. Relative differences of O_3 w.r.t. 26^{th} October. Rest is the same as figure S1

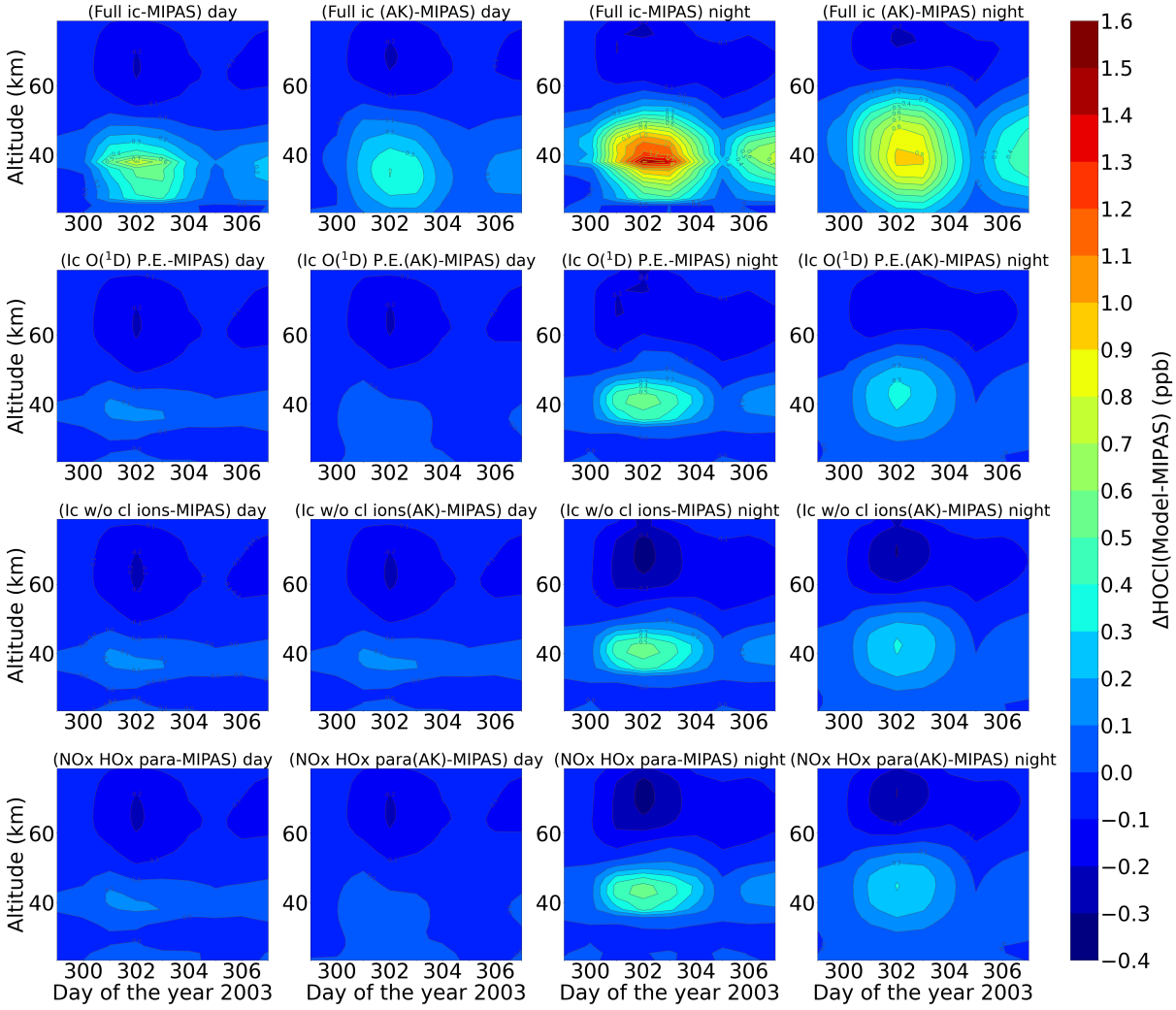

Figure S5. (Model-MIPAS) for day-time (sza <= 90°) and night-time (sza > 98°). Row-wise: Differences w.r.t. MIPAS zonal averages for: Full ion-chemistry, full ion-chemistry with O(^{1}D) in photo-chemical equilibrium, sensitivity tests without chlorine ion-chemistry and parameterised NO_x and HO_x model. Column-wise: Daytime, daythime (model with averaging kernel applied), nighttime, nighttime (model with averaging kernel applied).

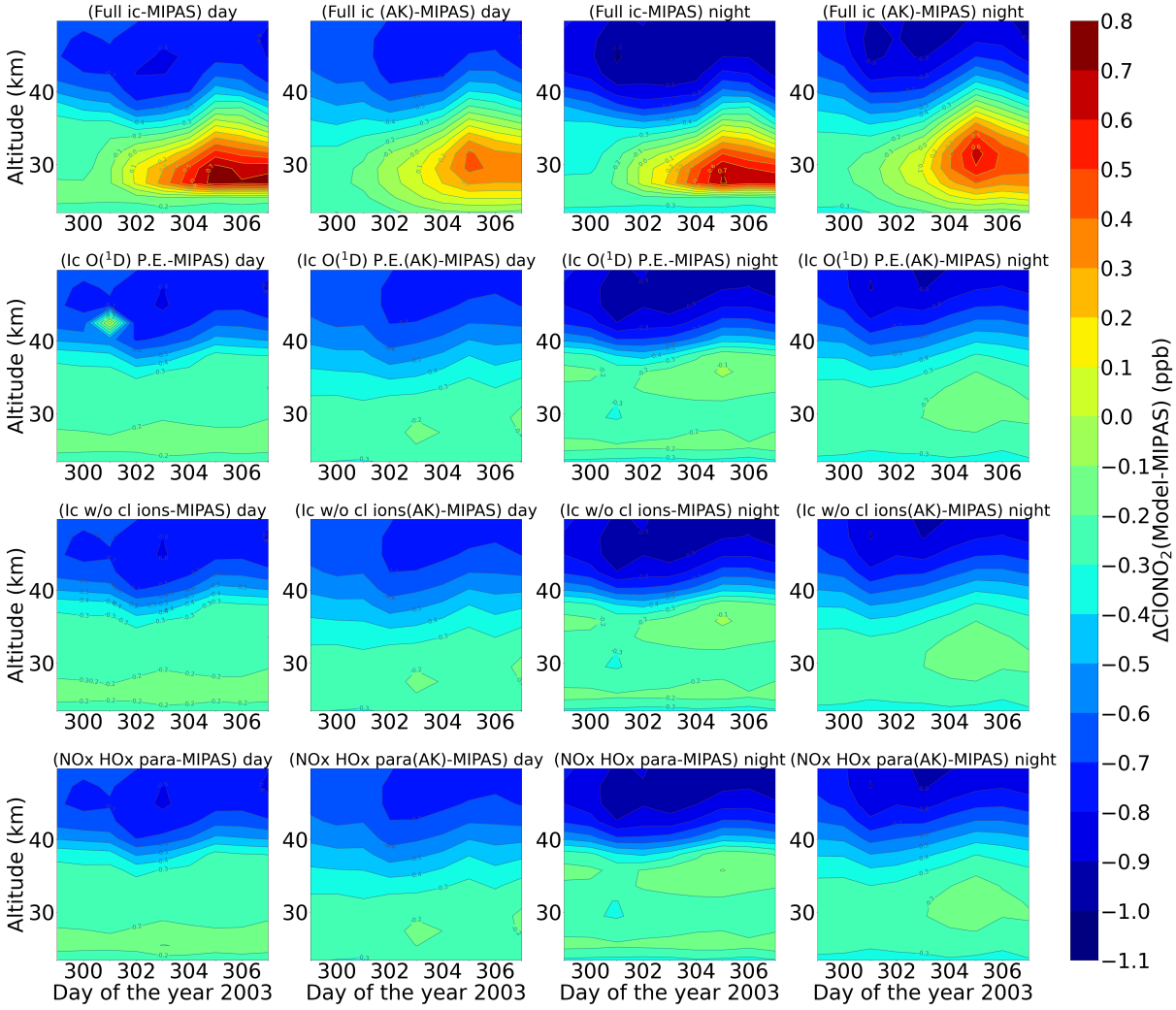

Figure S6. Same as figure S5 but for $ClONO_2$

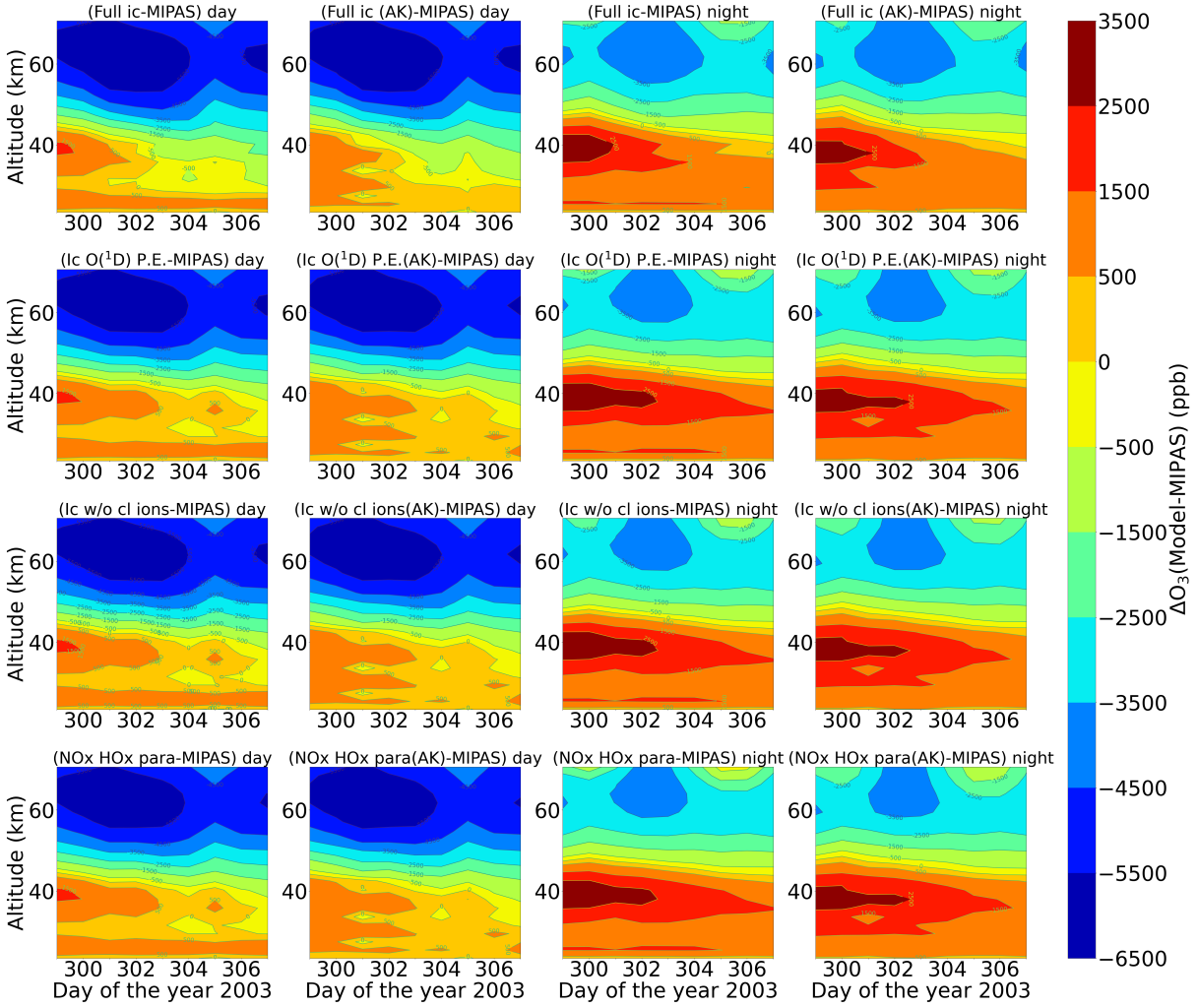

Figure S7. Same as figure S5 but for O_3

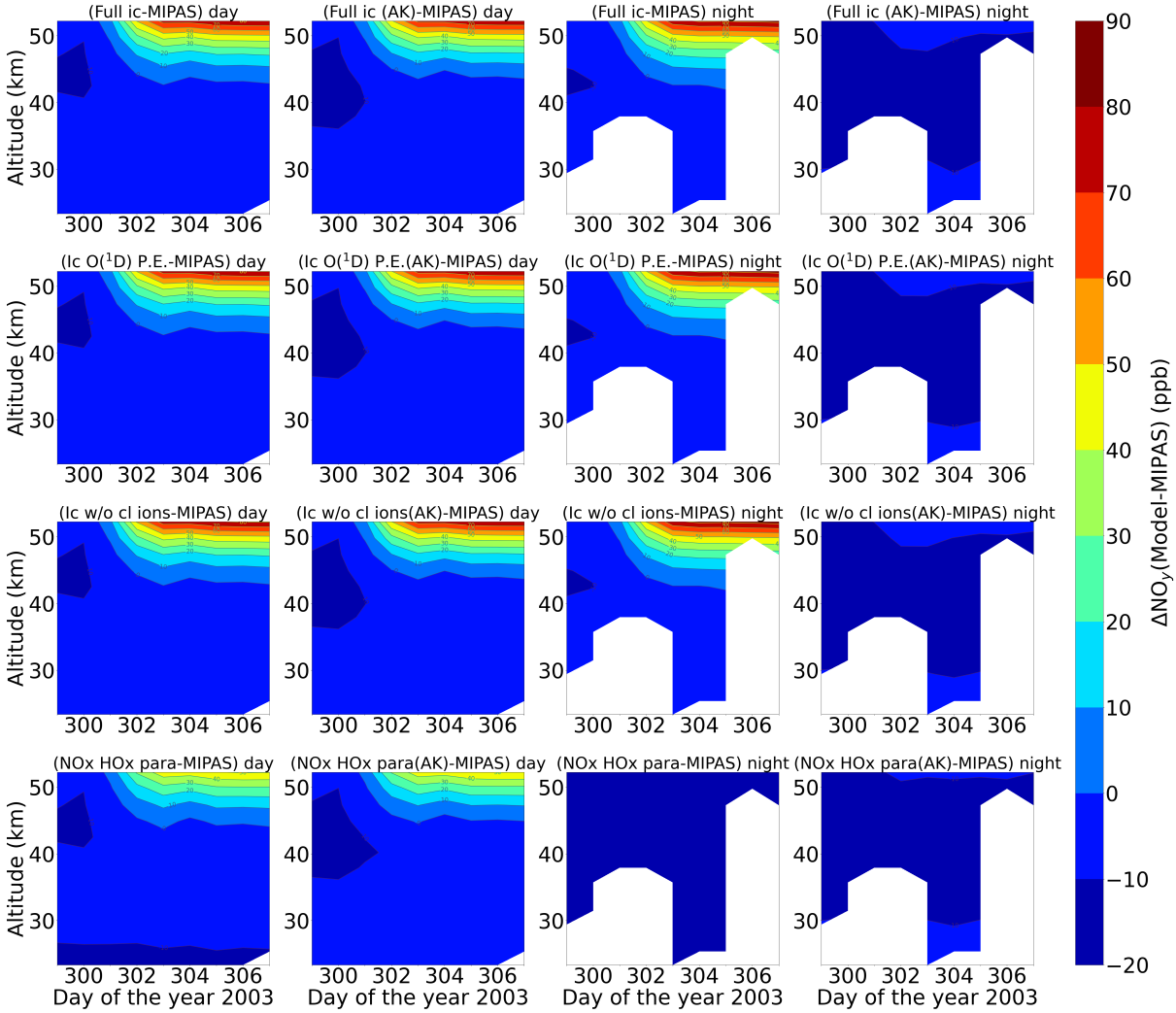

Figure S8. Same as figure S5 but for NO_y

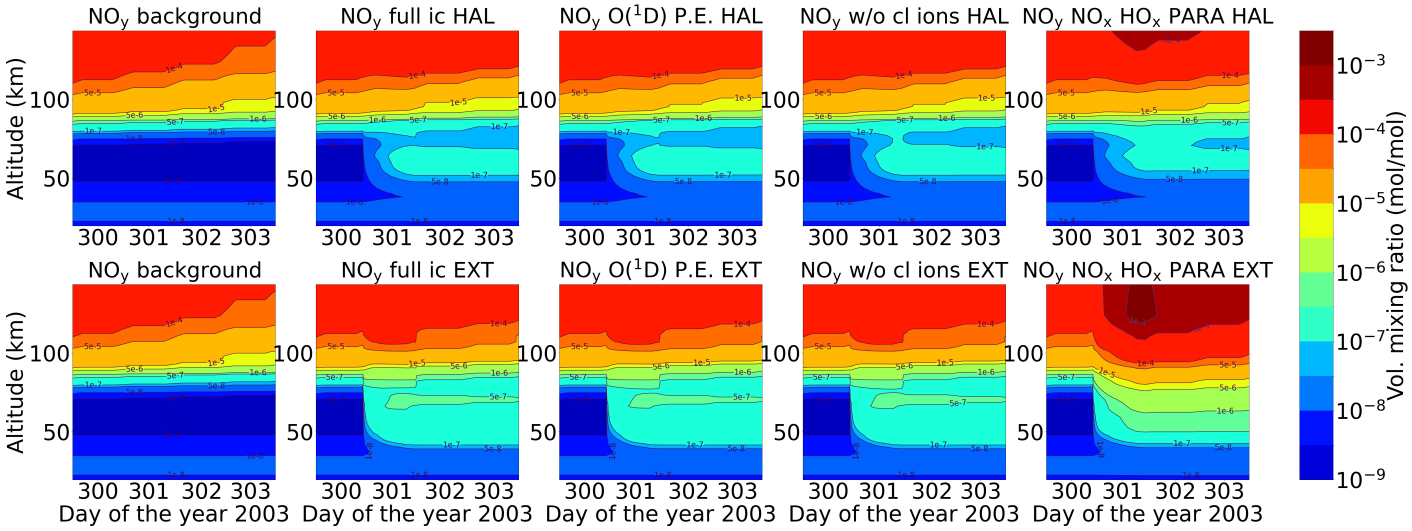

Figure S9. Comparison of the Halloween SPE and the extreme scenario (row-wise) for $N\tilde{O}_y$ and column wise: reference run (background atmosphere), full ion-chemistry, full ion-chemistry with $O(^1D)$ set to photo-chemical equilibrium, without chlorine ions and parameterised NO_x and HO_x model for the high latitude of 67.5°N.

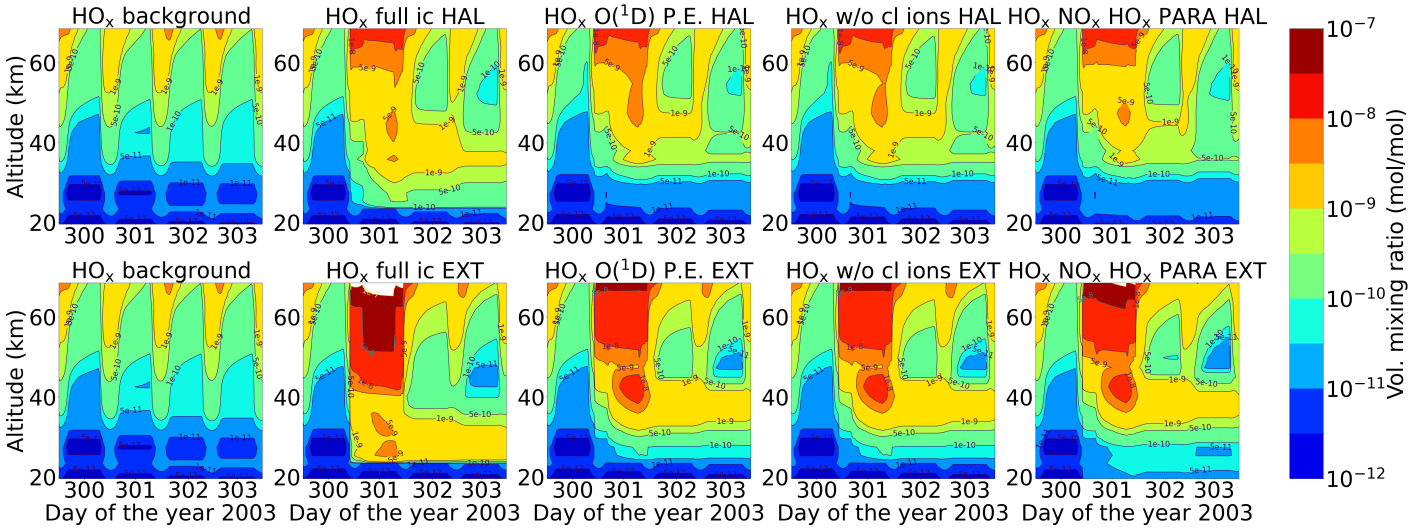

Figure S10. Same as figure S9 but for HO_x

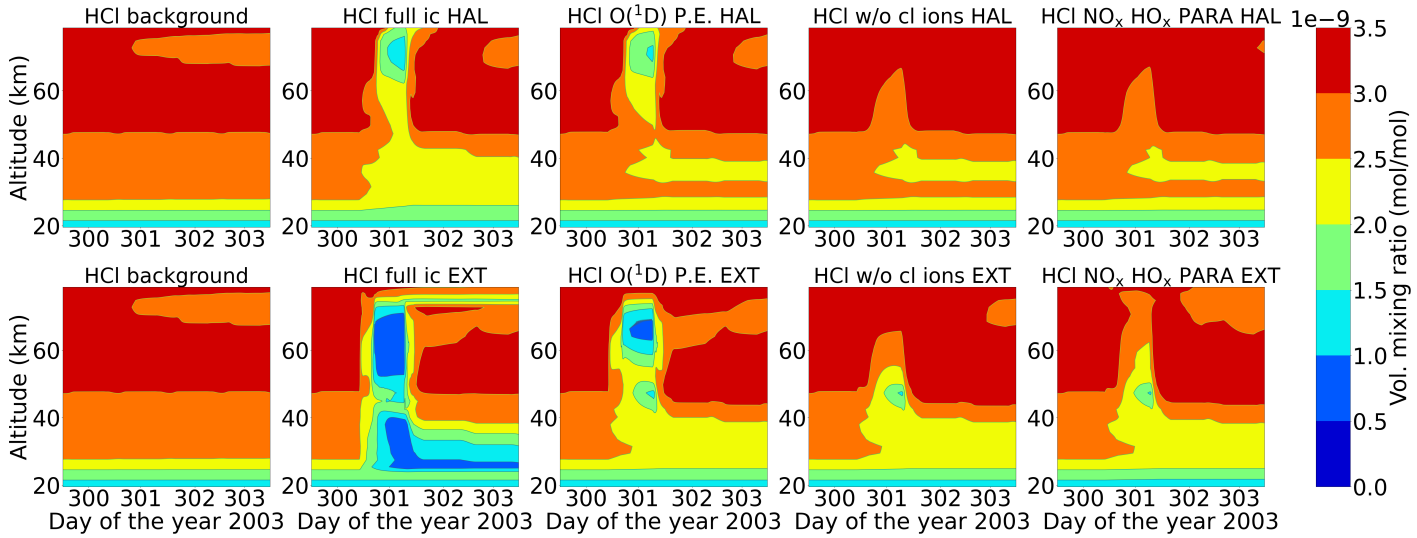

Figure S11. Same as figure S9 but for HCl

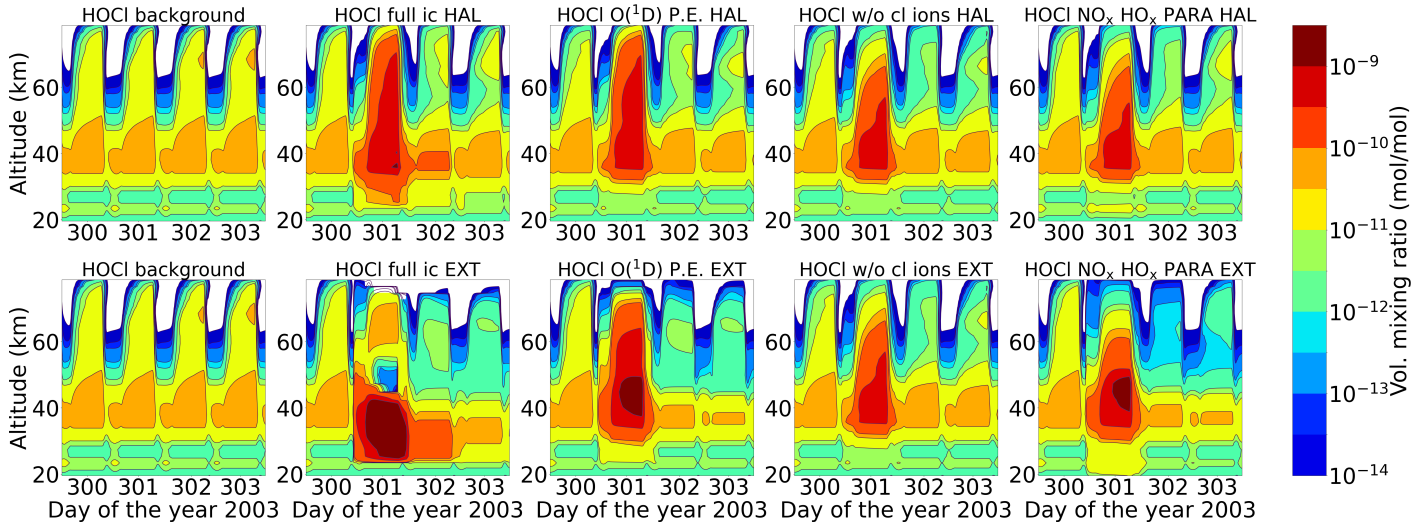

Figure S12. Same as figure S9 but for HOCl

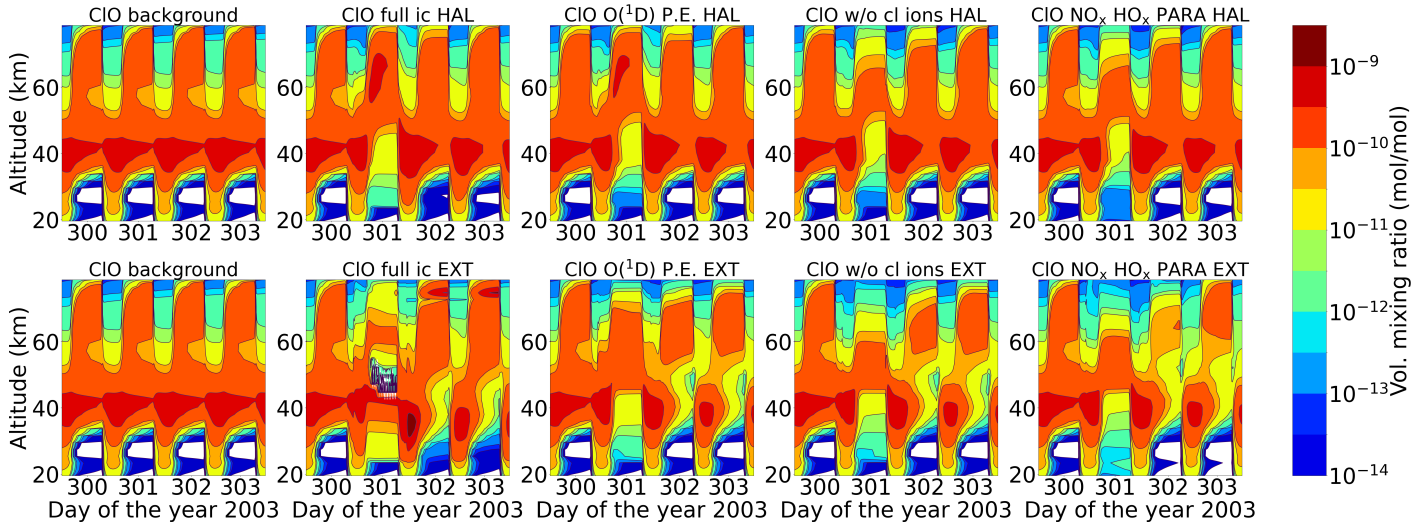

Figure S13. Same as figure S9 but for ClO

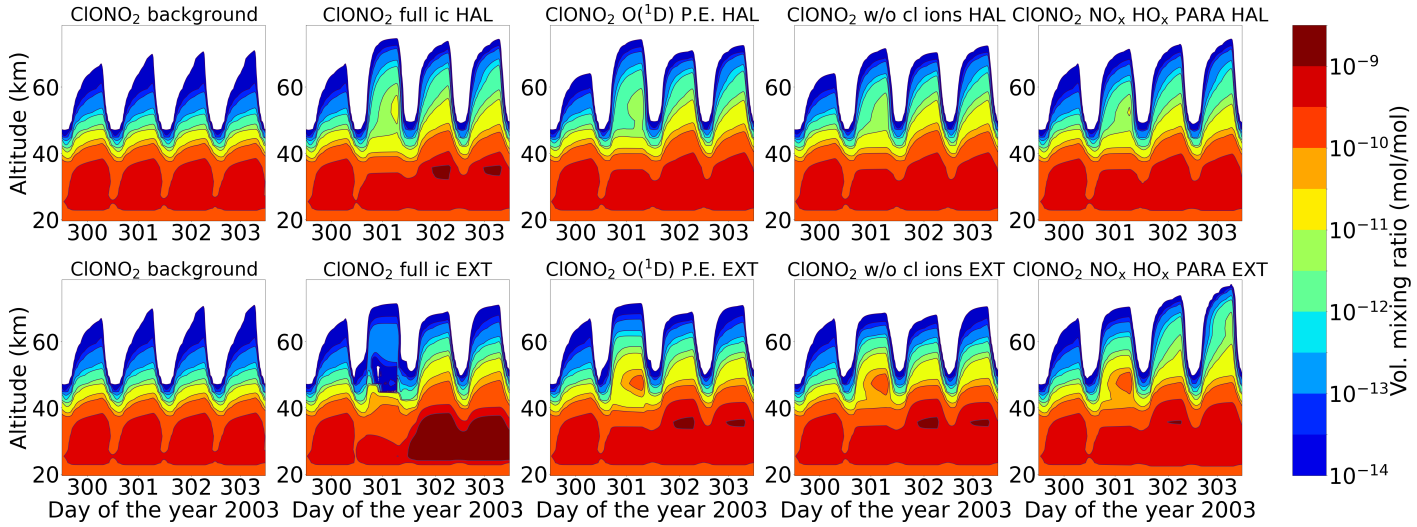

Figure S14. Same as figure S9 but for $ClONO_2$

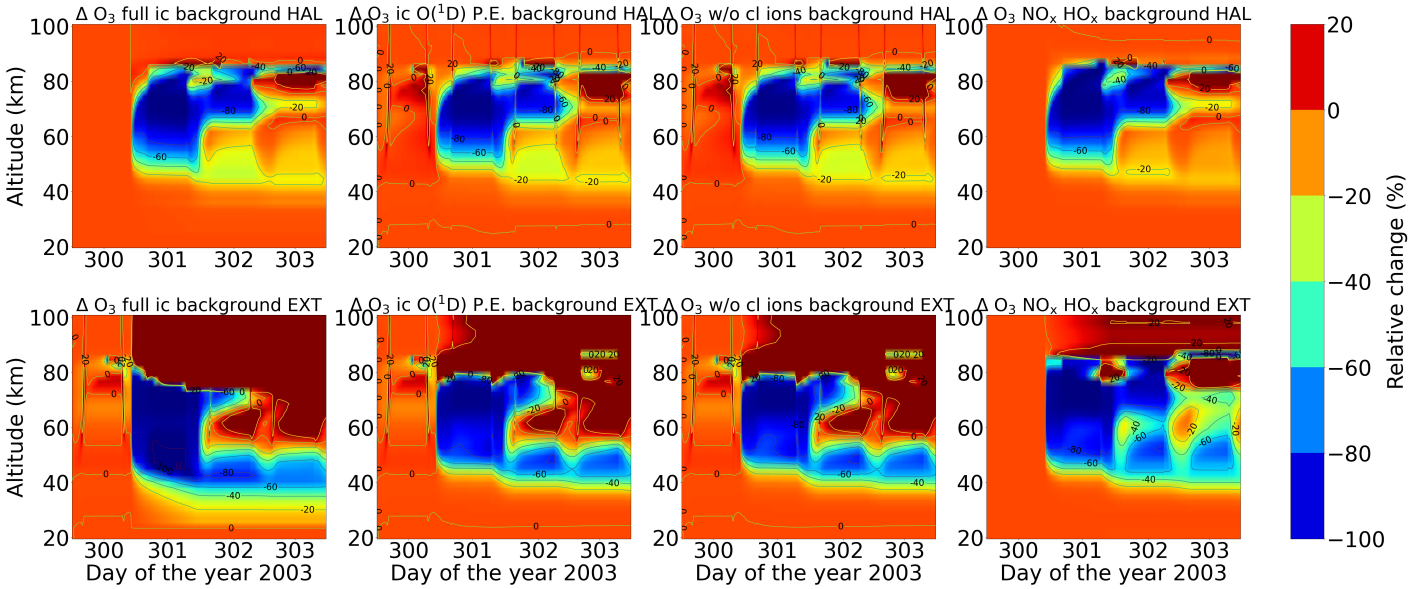

Figure S15. Same as figure S9 but for O_3

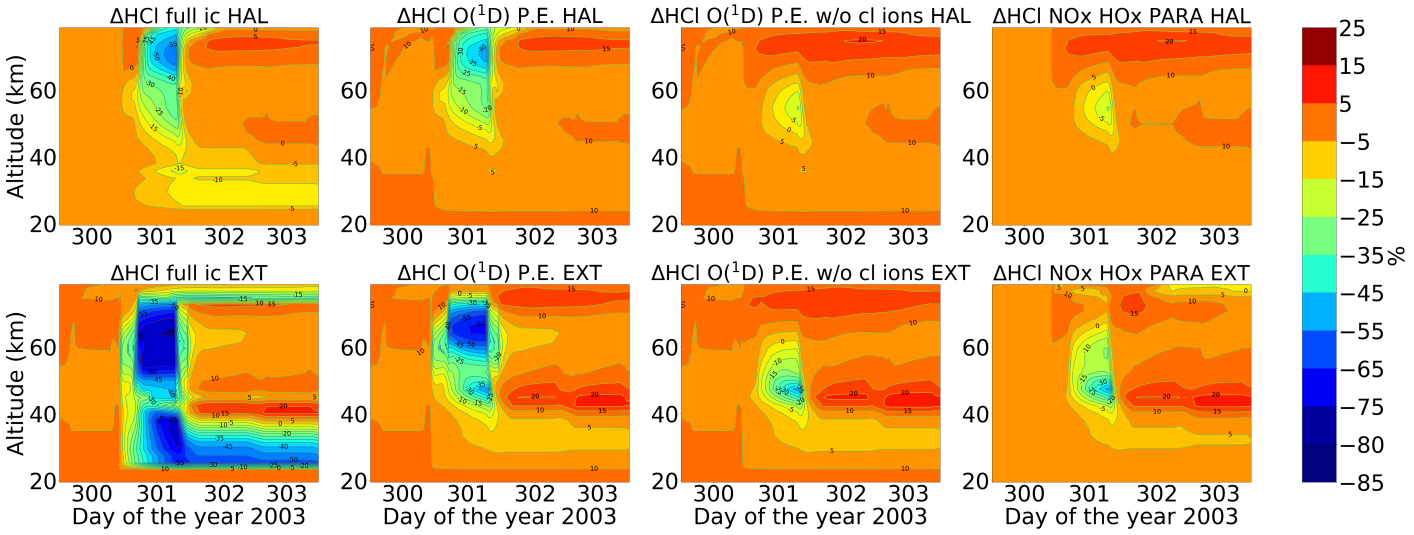

Figure S16. Relative change of the different sensitivity runs for HCl w.r.t. the reference run.

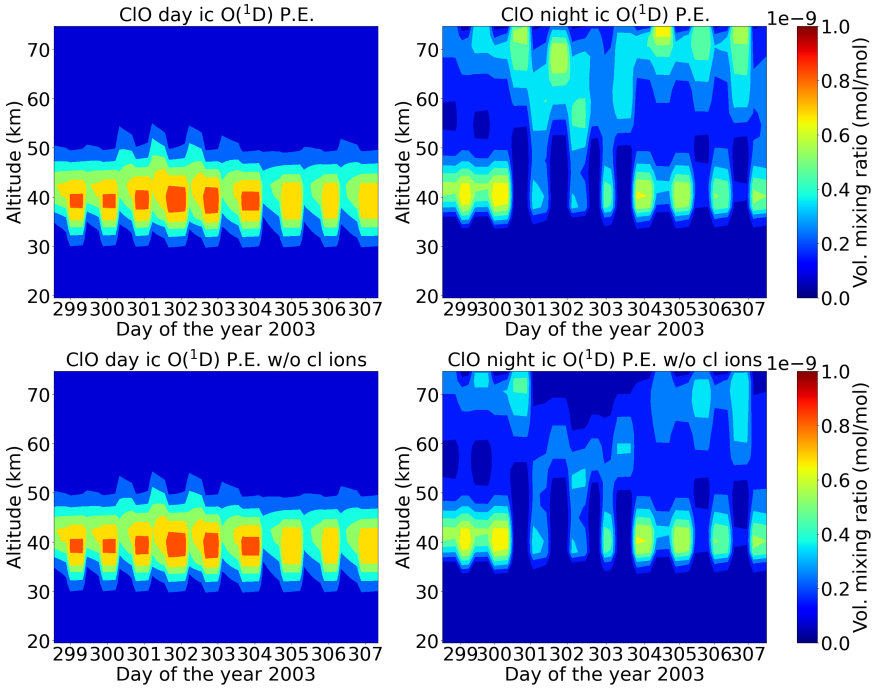

Figure S17. Diurnal cycle of ClO with temporal ionisation rates for the Halloween SPE for the sensitivity studies of ion-chemistry with O(^{1}D) in photo-chemical equilibrium and the one without chlorine ions.