Supplementary Material for

Short-Lived Halogen Sources and Chemistry in the Community Earth System Model v2 (CESM2-SLH)

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This file contains:

- Supplementary Charts S1 and S2
- Supplementary Figures S1 to S6
- Supplementary Tables S1 to S3

./$PATH/components/cam/src/

```
chemistry
      bulk_aero
            aerosol_depvel.F90
      modal_aero
            aero_model.F90
      mozart
            chemistry.F90
            clybryiy_fam.F90
            gas_wetdep_opts.F90
            iodine_emissions.F90
            mo_chemini.F90
            mo_chm_diags.F90
            mo_drydep.F90
            mo_gas_phase_chemdr.F90
            mo_neu_wetdep.F90
            mo_photo.F90
            mo_sad.F90
            mo_sad_trop.F90
            mo_sethet.F90
            mo_slh_routines.F90
            mo_srf_emissions.F90
            mo_strato_rates.F90
            mo_usrrxt.F90
      pp_trop_strat_mam4_slh
      pp_waccm_tsmlt_mam4_slh
phisics
      cam
            physpkg.F90
```

(Bold in original: **clybryiy_fam.F90**, **iodine_emissions.F90**, **mo_sad_trop.F90**, **mo_slh_routines.F90**, **pp_trop_strat_mam4_slh**, **pp_waccm_tsmlt_mam4_slh**)

Chart S1: Individual Fortran routines that have been updated within the CESM2-SLH CAM6-Cham folders. The individual files highlighted in bold are new files included in the model.

```
&cam_initfiles_nl
   ncdata = '$PATH/FC.f19_f19_mg17.L32.cesm2.2-
asdbranch_slh_released.FCHIST_slh.Historical_SLH.cam.i.1980-01-01-00000.nc'
/
&chem_inparm
   srf_emis_specifier = 'BENZENE  -> $PATH/emissions-cmip6-ScenarioMIP_IAMC-AIM-ssp370-1-
1_BENZENE_anthro_surface_mol_175001-210101_0.9x1.25_c20190222.nc',
...
   'CHBR3  -> $PATH/emissions_CHBr3_chlorophyll_surface_Ordonez2012_flx1p15_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2BR2 -> $PATH/emissions_CH2Br2_chlorophyll_surface_Ordonez2012_flx1p15_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2BRCL-> $PATH/emissions_CH2BrCl_chlorophyll_surface_Ordonez2012_flx1p15_cyclical_1850-
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   'CHBR2CL-> $PATH/emissions_CHBr2Cl_chlorophyll_surface_Ordonez2012_flx1p15_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CHBRCL2-> $PATH/emissions_CHBrCl2_chlorophyll_surface_Ordonez2012_flx1p15_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH3I   -> $PATH/emissions_CH3I_chlorophyll_surface_Ordonez2012_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2I2  -> $PATH/emissions_CH2I2_chlorophyll_surface_Ordonez2012_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2IBR -> $PATH/emissions_CH2IBr_chlorophyll_surface_Ordonez2012_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2ICL -> $PATH/emissions_CH2ICl_chlorophyll_surface_Ordonez2012_cyclical_1850-
2100_1.9x2.5_c240804.nc',
   'CH2CL2 -> $PATH/emissions_CH2Cl2_NoNeg_surface_Claxton2020_flx1p15_serial_1850-
2100_1.9x2.5_c240722.nc',
   'C2CL4  -> $PATH/emissions_C2Cl4_NoNeg_surface_Claxton2020_flx1p15_serial_1850-
2100_1.9x2.5_c240722.nc',
   'I2     -> $PATH/emissions_I2_ocean_surface_PradosRoman2015_online_1850-2100_1.9x2.5_c240804.nc',
   'HOI    -> $PATH/emissions_HOI_ocean_surface_PradosRoman2015_online_1850-2100_1.9x2.5_c240804.nc'
/
&chem_surfvals_nl
 flbc_file = '$PATH/LBC_1750-
2100_CMIP6_0p5degLat_HIST_c170126_SSP370_c180905_VSL_Cl_CHCL3x1p15_C2H4CL2x1p15_c20240731.nc'
 flbc_list = 'CCL4', 'CF2CLBR', 'CF3BR', 'CFC11', 'CFC113', 'CFC12', 'CH3BR', 'CH3CCL3', 'CH3CL', 'CH4',
'CO2', 'H2', 'HCFC22', 'N2O', 'CFC114', 'CFC115', 'HCFC141B', 'HCFC142B', 'H2402', 'OCS', 'SF6',
'CHCL3', 'C2H4CL2'
/
&prescribed_strataero_nl
 prescribed_strataero_file          = 'CESM_1949_2100_sad_V2_c130627.nc'
/
&wetdep_inparm
 gas_wetdep_ice_uptake_list = 'HNO3','CLONO2','HCL','HOCL','BRNO2','CLNO2','I2O2','I2O3','I2O4'
 gas_wetdep_list = 'ALKNIT', 'ALKOOH', ... , 'XYLOL', 'XYLOLOOH', 'CLNO2', 'BRNO2', 'BR2', 'BRCL',
                   'IONO2', 'INO2', 'HI', 'IO', 'OIO', 'ICL',
                   'IBR', 'I2O2', 'I2O3', 'I2O4', 'CHCL2O2', 'COCL2'
/
&drydep_inparm
  drydep_list = 'ALKNIT', 'ALKOOH', ... , 'XYLOL', 'XYLOLOOH',
                'CLONO2', 'HCL', 'HOCL', 'CLNO2', 'BRONO2', 'HBR', 'HOBR', 'BRNO2', 'BR2',
                'IONO2',  'HI',  'HOI',  'INO2',  'I2O2', 'I2O3', 'I2O4', 'CHCL2O2', 'COCL2'
/
&slh_nl
 SSAdehal_ScalingFactor = 1.40; SSAhno3_ScalingFactor = 1.00; SSAn2o5_ScalingFactor = 1.00
 LIQfraprx_ScalingFactor_I = 1.50; ICEfraprx_ScalingFactor_I = 1.30; ICEfraprx_ScalingFactor_Br = 1.00
/
```

Chart S2: User defined variables and parameters that must be updated in user_nl_cam to properly configure CESM2-SLH compsets. Example changes for the reccomended *FCnudged_slh* compset wit (2°×2°) resolution.

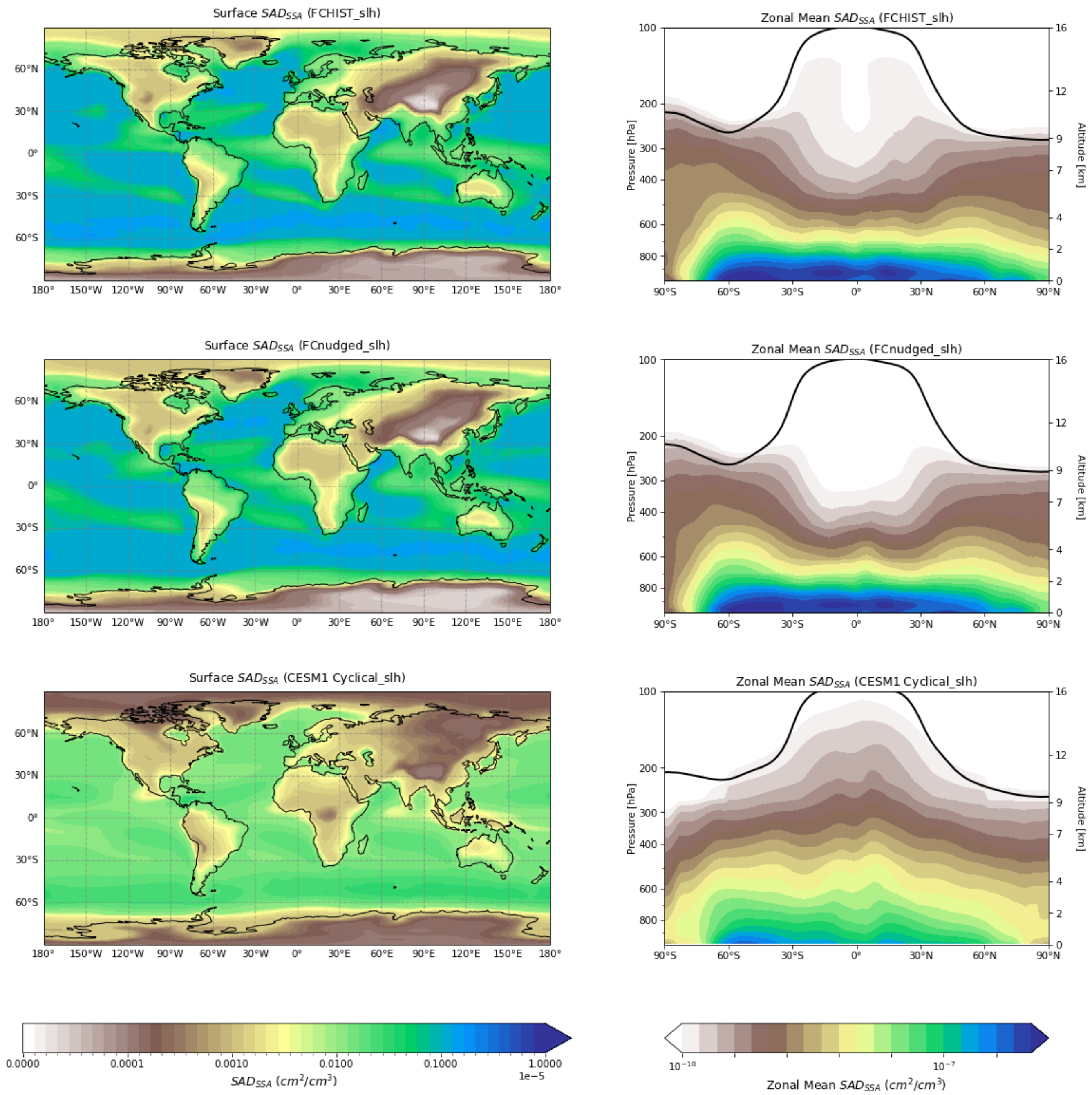

Figure S1: Annual mean distribution of surface area density for sea-salt aerosol (*SAD_{SSA}*) during present-day (2015-2020) for the *FCHIST_slh* (top row), *FCnudged_slh* (middle row) and CESM1 *Cyclical_slh* (bottom row) configurations. Left panels show the geographical variability within the model surface, while right columns show the tropospheric zonal average.

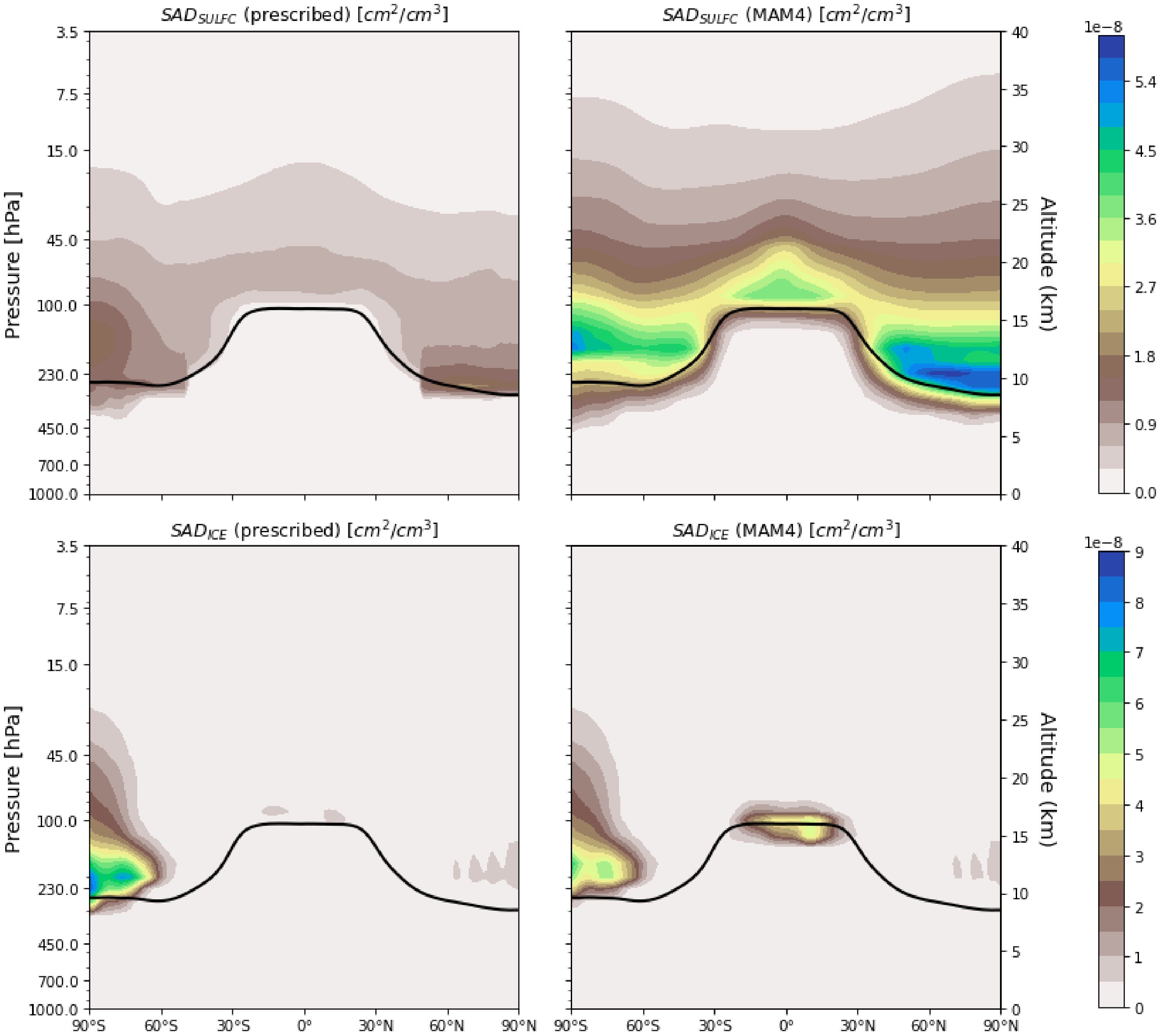

Figure S2: Present-day (2015-2020) zonal average of the Surface Area Density (SAD) for stratospheric sulphate (*SAD_{SULFC}*, top row) and stratospheric ice (*SAD_{ICE}*, bottom row) for different model configurations: (left) prescribed configuration and (right) online computation within the MAM4 aerosol scheme.

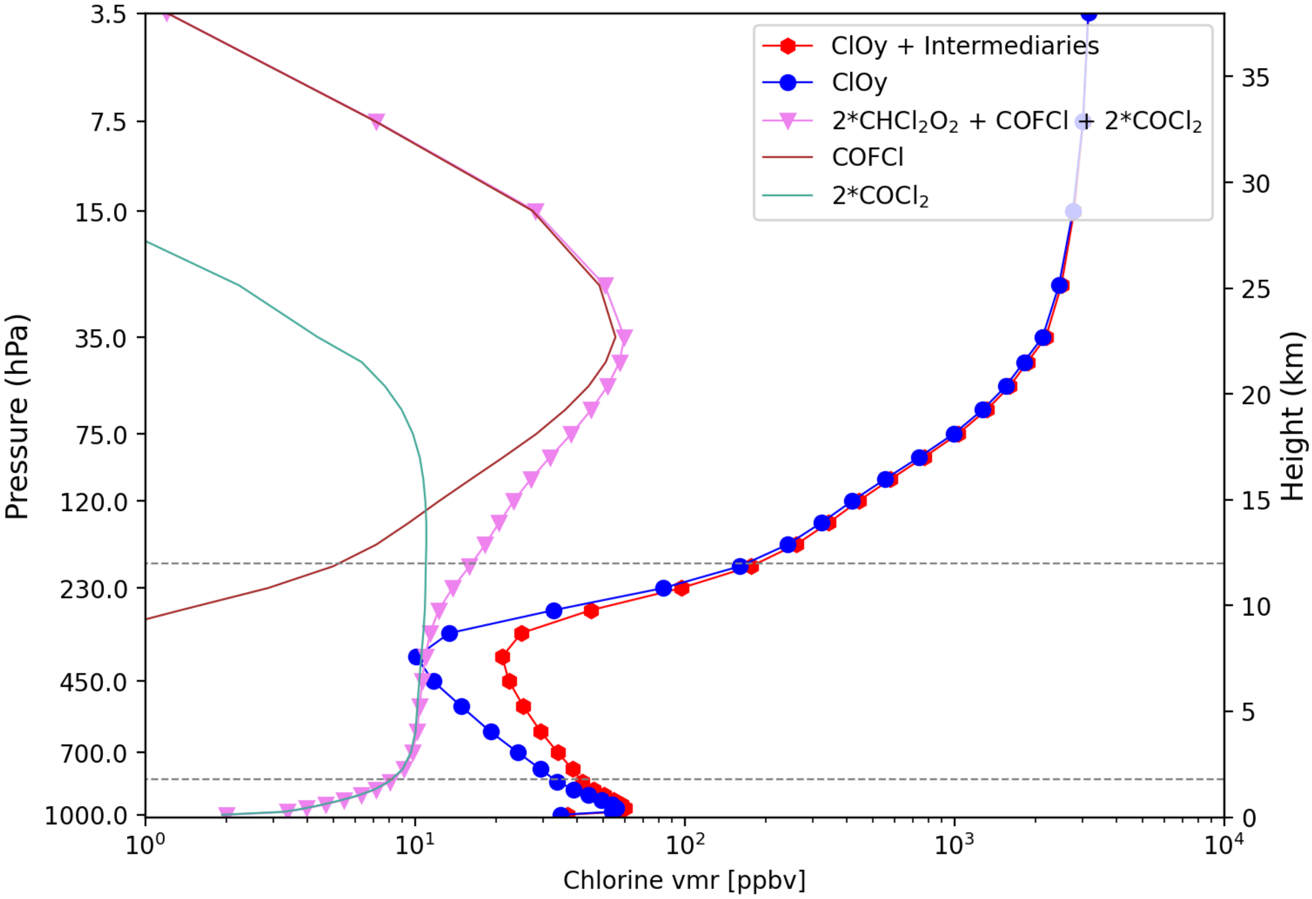

Figure S3: Global vertical profile of the contribution of intermediate chlorine species $COCl_2$, COFCl and $CHCl_2O_2$ to the total Cl_y budget within the FCnudged_slh compset during present-day (2015-2020).

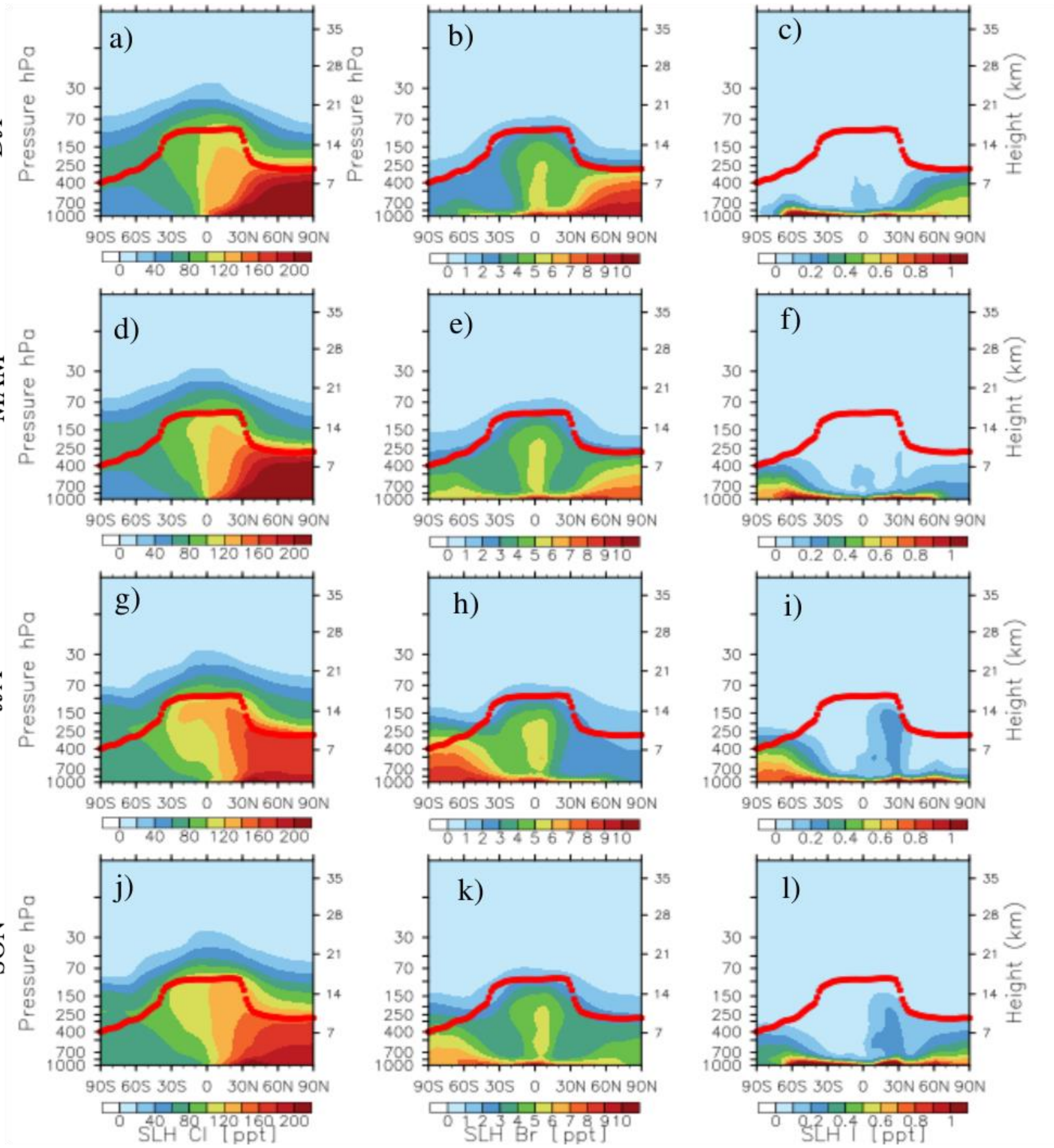

Figure S4: Seasonality zonal average distribution of the very short-lived (VSL) organic (carbon bonded) halogen fraction during present-day (2015-2020) for the *FCnudged_slh* compset. Left column shows chlorine (VSL_{Cl}), the center column shows bromine (VSL_{Br}) and the right column shows iodine (VSL_{I}). The rows correspond to the different seasons, first row to december, january and february 'DJF', second row to march, april and may 'MAM', third row to june, july and august 'JJA', and the fourth row to september, october and november 'SON'. The red-dotted line shows the mean model tropopause. See annual mean in Figure 4 (d, e, f).

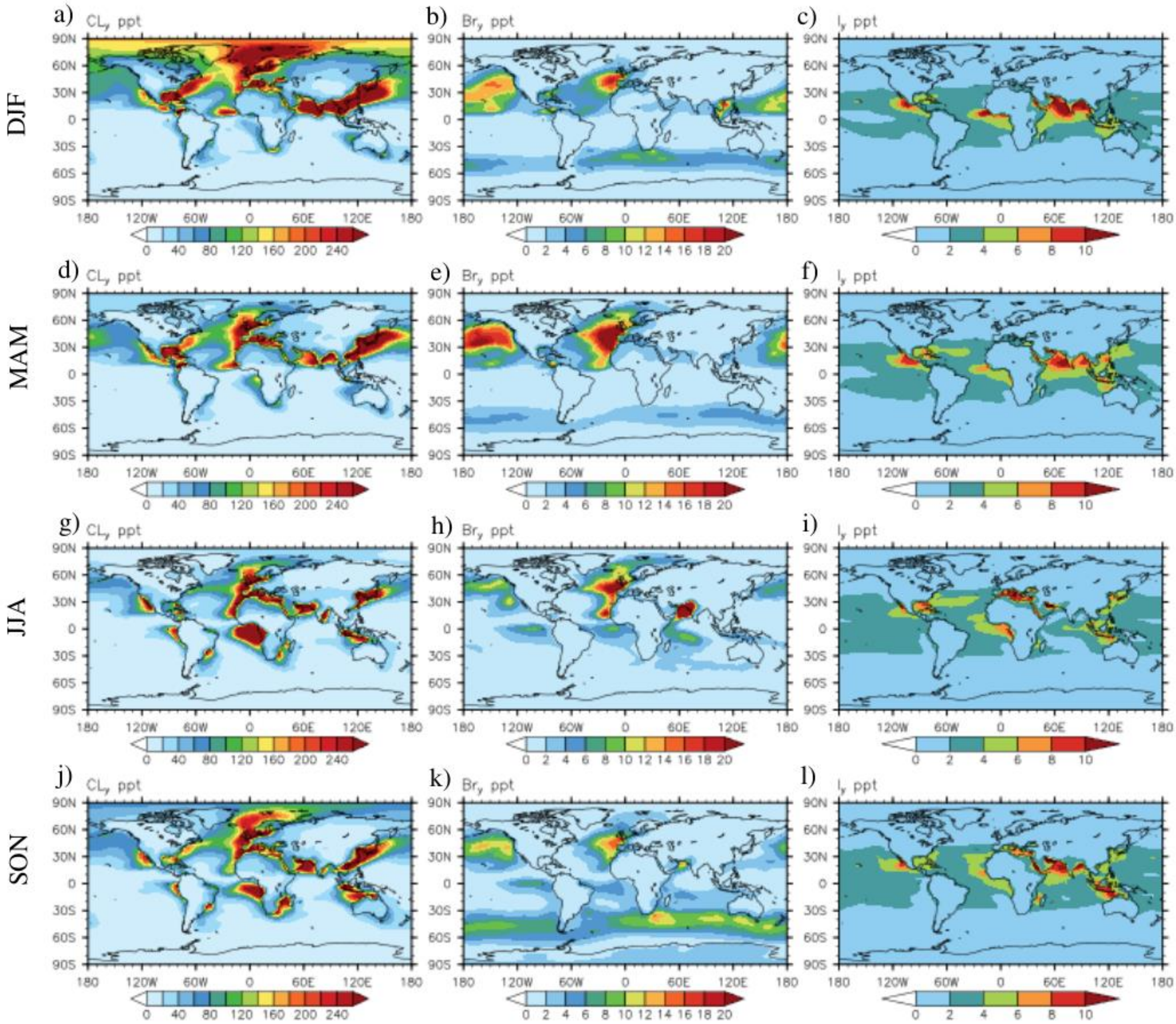

Figure S5: Geographical seasonal cycle of total inorganic halogen content during present-day (PD = 2015-2020) for the *FCnudged_slh* compset. Left column shows chlorine (Cl_y), center column shows bromine (Br_y) and right column shows iodine (I_y). The rows correspond to the different seasons, first row to 'DJF', second row to 'MAM', third row to 'JJA' and fourth row to 'SON'. All magnitudes have been averaged within the boundary layer (from the model surface up to ~850 hPa). See annual mean in Figure 10 (d, e, f).

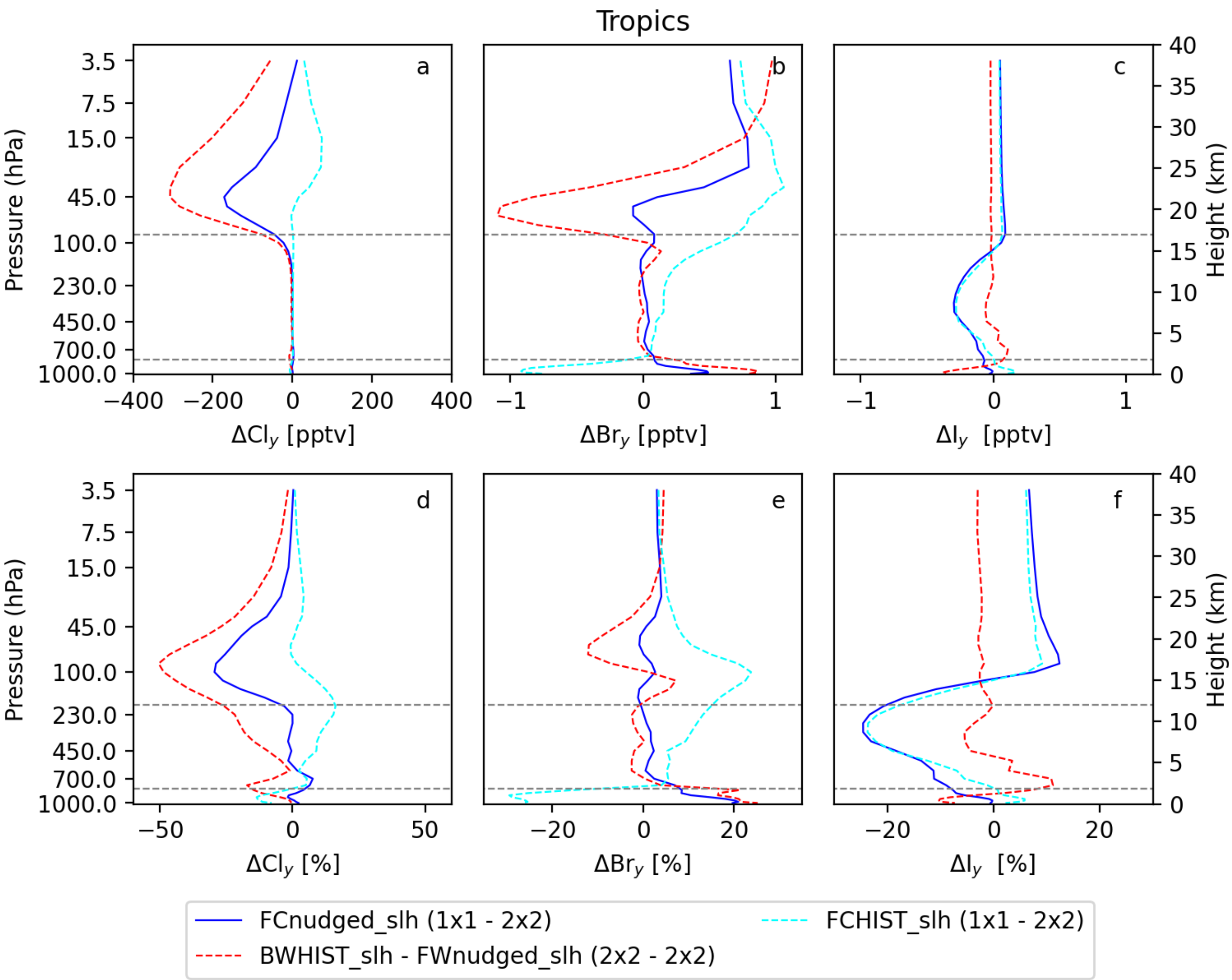

Figure S6. Percentage and Absolute differences of Vertical Profiles for the different compsets evaluated for the period 2000-2005 in Tropics. Top row shows the absolute differences in pptv while bottom-row shows the corresponding percentage between the compsets *FCnudged_slh* and *FCnudged_1X1_slh* in blue, between *FCHIST_slh* and *FCHIST_1x1_slh* compsets in light blue, and between BW*HIST_slh* and *FWnudged_slh* compsets in dashed red for (a, d) chlorine (Cl_y), (b, e) bromine (Br_y) and (c, f) iodine.

Table S1: Photochemical Reactions separated by halogen family

Photolysis Reactions
$CH_2BrCl + hv \rightarrow Br + Cl$
$CHBr_2Cl + hv \rightarrow 2{*}Br + Cl$
$CHBrCl_2 + hv \rightarrow Br + 2{*}Cl$
$CH_2ICl + hv \rightarrow I + Cl$
$ICl + hv \rightarrow I + Cl$
$Cl_2 + hv \rightarrow 2{*}Cl$
$ClO + hv \rightarrow Cl + O$
$OClO + hv \rightarrow O + ClO$
$Cl_2O_2 + hv \rightarrow 2{*}Cl$
$HOCl + hv \rightarrow OH + Cl$
$HCl + hv \rightarrow H + Cl$
$ClONO_2 + hv \rightarrow Cl + NO_3$
$ClONO_2 + hv \rightarrow ClO + NO_2$
$ClNO_2 + hv \rightarrow Cl + NO_2$
$BrCl + hv \rightarrow Br + Cl$
$C_2Cl_4 + hv \rightarrow 4{*}Cl$
$C_2H_4Cl_2 + hv \rightarrow 2{*}Cl$
$CH_2Cl_2 + hv \rightarrow 2{*}Cl$
$CH_3Cl + hv \rightarrow Cl + CH_3O_2$
$CHCl_3 + hv \rightarrow CHCl_2O_2 + Cl$
$ClNO_2 + hv \rightarrow Cl + NO_2$
$COCl_2 + hv \rightarrow 2{*}Cl + CO$
$COFCl + hv \rightarrow F + Cl$
$CCl_4 + hv \rightarrow 4{*}Cl$
$CH_3CCl_3 + hv \rightarrow 3{*}Cl$
CFC11 + hv $\rightarrow$ 3*Cl
CFC12 + hv $\rightarrow$ 2*Cl
CFC113 + hv $\rightarrow$ 3*Cl
HCFC23 + hv $\rightarrow$ Cl
$CH_3Br + hv \rightarrow Br + CH_3O_2$
$CF_3Br + hv \rightarrow Br$
$CF_2ClBr + hv \rightarrow Br + Cl$
CFC114 + hv $\rightarrow$ 2*Cl
CFC115 + hv $\rightarrow$ Cl
HCFC141B + hv $\rightarrow$ 2*Cl
HCFC142B + hv $\rightarrow$ Cl
$IBr + hv \rightarrow I + Br$
$CH_2IBr + hv \rightarrow I + Br$
$CHBr_3 + hv \rightarrow 3{*}Br$
$CH_2Br_2 + hv \rightarrow 2{*}Br$
$BrO + hv \rightarrow Br + O$
$HOBr + hv \rightarrow Br + OH$
$HBr + hv \rightarrow Br + H$
$BrONO_2 + hv \rightarrow Br + NO_3$
$BrONO_2 + hv \rightarrow BrO + NO_2$
$BrNO_2 + hv \rightarrow Br + NO_2$
$BrNO_2 + hv \rightarrow BrO + NO$
$Br_2 + hv \rightarrow 2{*}Br$
$H_{2402} + hv \rightarrow 2{*}Br$
$CH_3I + hv \rightarrow I + CH_3O_2$
$CH_2I_2 + hv \rightarrow 2{*}I$
$I_2 + hv \rightarrow 2{*}I$
$IO + hv \rightarrow I + O$
$OIO + hv \rightarrow I + O_2$

$INO + h\nu \rightarrow I + NO$
$INO_2 + h\nu \rightarrow I + NO_2$
$INO_2 + h\nu \rightarrow IO + NO$
$IONO_2 + h\nu \rightarrow I + NO_3$
$HOI + h\nu \rightarrow I + OH$
$HI + h\nu \rightarrow I + H$
$I_2O_2 + h\nu \rightarrow OIO + I$
$I_2O_3 + h\nu \rightarrow OIO + IO$
$I_2O_4 + h\nu \rightarrow OIO + OIO$

Table S2: Arrhenius type Reactions separated by halogen family

Odd-Oxygen Reactions	**Rate**
$O^1D + HCl \rightarrow Cl + OH$	9.90×10^{-11}
$O^1D + HCl \rightarrow ClO + H$	3.30×10^{-12}
$O^1D + HBr \rightarrow Br + OH$	9×10^{-11}
$O^1D + HBr \rightarrow BrO + H$	3×10^{-11}
$O^1D + HCN \rightarrow OH$	$7.70\times10^{-11}e^{(100/T)}$
$O^1D + CFC11 \rightarrow 2*Cl + COFCl$	2.07×10^{-10}
$O^1D + CFC12 \rightarrow 2*Cl + COF_2$	1.17×10^{-10}
$O^1D + CFC113 \rightarrow 2*Cl + COFCl + COF_2$	2.088×10^{-10}
$O^1D + CFC114 \rightarrow 2*CL + 2*COF_2$	1.17×10^{-10}
$O^1D + CFC115 \rightarrow Cl + F + 2*COF_2$	4.644×10^{-11}
$O^1D + HCFC22 \rightarrow Cl + COF_2$	7.65×10^{-11}
$O^1D + HCFC141B \rightarrow Cl + COFCl$	1.794×10^{-10}
$O^1D + HCFC142B \rightarrow Cl + COF_2$	1.3×10^{-10}
$O^1D + CCl_4 \rightarrow 4*Cl$	2.84×10^{-10}
$O^1D + COFCl \rightarrow F + Cl$	1.90×10^{-10}
$O^1D + CH_3Br \rightarrow Br$	1.8×10^{-10}
$O^1D + CF_2ClBr \rightarrow Cl + Br$	9.60×10^{-11}
$O^1D + CF_3Br \rightarrow Br + F + COF_2$	4.50×10^{-11}
$O^1D + H2402 \rightarrow 2*Br + 2*COF_2$	1.20×10^{-10}
$O^1D + CHBr_3 \rightarrow 3*Br$	4.62×10^{-10}
$O^1D + CH_2Br_2 \rightarrow 2*Br$	2.57×10^{-10}
Odd-Chlorine Reactions	**Rate**
$Cl + CH_2O \rightarrow HCl + HO_2 + CO$	$8.10\times10^{-11}e^{(-30/T)}$
$Cl + H_2 \rightarrow HCl + H$	$3.05\times10^{-11}e^{(-2270/T)}$
$Cl + H_2O_2 \rightarrow HCl + HO_2$	$1.10\times10^{-11}e^{(-980/T)}$
$Cl + HO_2 \rightarrow HCl + O_2$	$1.40\times10^{-11}e^{(270/T)}$
$Cl + HO_2 \rightarrow OH + ClO$	$3.60\times10^{-11}e^{(-375/T)}$
$ClNO_2 + OH \rightarrow HOCl + NO_2$	$2.40\times10^{-12}e^{(-1250/T)}$
$Cl + O_3 \rightarrow ClO + O_2$	$2.30\times10^{-11}e^{(-200/T)}$
$ClO + CH_3O_2 \rightarrow Cl + HO_2 + CH_2O$	$3.3\times10^{-12}e^{(-115/T)}$
$ClO + ClO \rightarrow 2*Cl + O_2$	$3.00\times10^{-11}e^{(-2450/T)}$
$ClO + ClO \rightarrow Cl_2 + O_2$	$1.00\times10^{-12}e^{(-1590/T)}$
$ClO + ClO \rightarrow Cl + OClO$	$3.50\times10^{-13}e^{(-1370/T)}$
$ClO + HO_2 \rightarrow O_2 + HOCl$	$2.60\times10^{-12}e^{(290/T)}$
$ClO + NO \rightarrow NO_2 + Cl$	$6.40\times10^{-12}e^{(290/T)}$
$ClONO_2 + Cl \rightarrow Cl_2 + NO_3$	$6.50\times10^{-12}e^{(135/T)}$
$ClONO_2 + O \rightarrow ClO + NO_3$	$3.60\times10^{-12}e^{(-840/T)}$
$ClONO_2 + OH \rightarrow HOCl + NO_3$	$1.20\times10^{-12}e^{(-330/T)}$
$ClO + O \rightarrow Cl + O_2$	$2.80\times10^{-11}e^{(85/T)}$
$ClO + OH \rightarrow Cl + HO_2$	$7.40\times10^{-12}e^{(270/T)}$
$ClO + OH \rightarrow HCl + O_2$	$6.00\times10^{-13}e^{(230/T)}$
$HCl + O \rightarrow Cl + OH$	$1.00\times10^{-11}e^{(-3300/T)}$
$HCl + OH \rightarrow H_2O + Cl$	$1.80\times10^{-12}e^{(-250/T)}$
$HOCl + Cl \rightarrow HCl + ClO$	$3.40\times10^{-12}e^{(-130/T)}$
$HOCl + O \rightarrow ClO + OH$	1.70×10^{-13}
$HOCl + OH \rightarrow H_2O + ClO$	$3.00\times10^{-12}e^{(-500/T)}$
Odd bromine reactions	**Rate**
$Br_2 + OH \rightarrow HOBr + Br$	$2.10\times10^{-11}e^{(240/T)}$
$Br + O_3 \rightarrow BrO + O_2$	$1.60\times10^{-11}e^{(-780/T)}$
$Br + HO_2 \rightarrow HBr + O_2$	$4.80\times10^{-12}e^{(-310/T)}$
$Br + CH_2O \rightarrow HBr + HO_2 + CO$	$1.70\times10^{-11}e^{(-800/T)}$
$BrO + BrO \rightarrow 2*Br + O_2$	$1.50\times10^{-12}e^{(230/T)}$
$BrO + ClO \rightarrow Br + OClO$	$9.50\times10^{-13}e^{(550/T)}$
$BrO + ClO \rightarrow Br + Cl + O_2$	$2.30\times10^{-12}e^{(260/T)}$
$BrO + ClO \rightarrow BrCl + O_2$	$4.10\times10^{-13}e^{(290/T)}$
$BrO + NO \rightarrow Br + NO_2$	$8.80\times10^{-12}e^{(260/T)}$

$BrONO_2 + Br \rightarrow Br_2 + NO_3$	$1.78\times10^{-11}e^{(365/T)}$
$BrONO_2 + Cl \rightarrow BrCl + NO_3$	$6.28\times10^{-11}e^{(215/T)}$
$BrONO_2 + O \rightarrow BrO + NO_3$	$1.90\times10^{-11}e^{(215/T)}$
$BrO + O \rightarrow Br + O_2$	$1.90\times10^{-11}e^{(230/T)}$
$BrO + OH \rightarrow Br + HO_2$	$1.70\times10^{-11}e^{(250/T)}$
$HBr + OH \rightarrow Br + H2O$	$5.50\times10^{-12}e^{(200/T)}$
$HBr + O \rightarrow Br + OH$	$5.80\times10^{-12}e^{(-1500/T)}$
$HOBr + O \rightarrow BrO + OH$	$1.20\times10^{-10}e^{(-430/T)}$
Odd iodine reaction	**Rate**
$HI + NO_3 \rightarrow I + HNO_3$	$1.30\times10^{-12}e^{(-1830/T)}$
$HOI + OH \rightarrow IO + H_2O$	2.00×10^{-13}
$I_2 + NO_3 \rightarrow I + IONO_2$	1.50×10^{-12}
$I_2 + O \rightarrow IO + I$	1.25×10^{-10}
$I_2 + OH \rightarrow HOI + I$	1.80×10^{-10}
$I + BrO \rightarrow IO + Br$	1.44×10^{-11}
$I + HO_2 \rightarrow HI + O_2$	$1.50\times10^{-11}e^{(-1090/T)}$
$I + IONO_2 \rightarrow I_2 + NO_3$	$9.10\times10^{-11}e^{(-146/T)}$
$INO_2 + INO_2 \rightarrow I_2 + 2*NO_2$	$4.70\times10^{-13}e^{(-1670/T)}$
$INO_2 \rightarrow I + NO_2$	$1.008\times10^{18}e^{(-13670/T)}$
$I + NO_3 \rightarrow IO + NO_2$	1.00×10^{-10}
$INO + INO \rightarrow I_2 + 2*NO$	$8.40\times10^{-11}e^{(-2620/T)}$
$I + O_3 \rightarrow IO + O_2$	$2.10\times10^{-11}e^{(-830/T)}$
$IO + Br \rightarrow I + BrO$	2.49×10^{-11}
$IO + BrO \rightarrow Br + I + O_2$	$0.30\times10^{-11}e^{(510/T)}$
$IO + BrO \rightarrow Br + OIO$	$1.20\times10^{-11}e^{(510/T)}$
$IO + ClO \rightarrow I + OClO$	$2.585\times10^{-12}e^{(280/T)}$
$IO + ClO \rightarrow I + Cl + O_2$	$1.175\times10^{-12}e^{(280/T)}$
$IO + ClO \rightarrow ICl + O_2$	$0.940\times10^{-12}e^{(280/T)}$
$IO + NO \rightarrow I + NO_2$	$7.15\times10^{-12}e^{(300/T)}$
$IO + HO_2 \rightarrow HOI + O_2$	$1.30\times10^{-11}e^{(570/T)}$
$IO + NO_3 \rightarrow OIO + NO_2$	9.00×10^{-12}
$IO + O \rightarrow I + O_2$	1.40×10^{-10}
$IO + O_3 \rightarrow OIO + O_2$	3.60×10^{-16}
$IO + OH \rightarrow HO_2 + I$	1.00×10^{-10}
$OH + HI \rightarrow I + H_2O$	$1.60\times10^{-11}e^{(440/T)}$
$OIO + NO \rightarrow IO + NO_2$	$1.10\times10^{-12}e^{(542/T)}$
$HOI + NO_3 \rightarrow IO + HNO_3$	
$I_2O_2 \rightarrow OIO + I$	
$I_2O_3 \rightarrow IO + IO$	
$I_2O_4 \rightarrow 2*OIO$	
$IO + IO \rightarrow OIO + I$	
$IO + IO \rightarrow I_2O_2$	
$IO + OIO \rightarrow I_2O_3$	
$OIO + OIO \rightarrow I_2O_4$	
VSL halocarbon degradation	**Rate**
$C_2Cl_4 + OH \rightarrow 0.47* COCl_2 + 3.06*Cl$	$4.7\times10^{-12}e^{(-990/T)}$
$C_2H_4Cl_2 + Cl \rightarrow 2*Cl + HCl$	1.30×10^{-12}
$C_2H_4Cl_2 + OH \rightarrow 2*Cl + H_2O$	$1.14\times10^{-11}e^{(-1150/T)}$
$CH_2Br_2 + Cl \rightarrow 2*Br + HCl$	$6.30\times10^{-12}e^{(-800/T)}$
$CH_2Br_2 + OH \rightarrow 2*Br + H_2O$	$2.00\times10^{-12}e^{(-840/T)}$
$CH_2BrCl + OH \rightarrow Br + Cl$	$2.10\times10^{-12}e^{(-880/T)}$
$CH_2Cl_2 + Cl \rightarrow CHCl_2O_2 + HCl$	$7.40\times10^{-12}e^{(-910/T)}$
$CH_2Cl_2 + OH \rightarrow CHCl_2O_2 + H_2O$	$1.90\times10^{-12}e^{(-880/T)}$
$CH_3Br + Cl \rightarrow HCl + HO_2 + Br$	$1.46\times10^{-11}e^{(-1040/T)}$
$CH_3Br + OH \rightarrow Br + H_2O + HO_2$	$1.42\times10^{-12}e^{(-1150/T)}$
$CH_3CCl_3 + OH \rightarrow H_2O + 3*Cl$	$1.64\times10^{-12}e^{(-1520/T)}$
$CH_3Cl + Cl \rightarrow HO_2 + CO + 2*HCl$	$2.03\times10^{-11}e^{(-1110/T)}$
$CH_3Cl + Cl \rightarrow HO_2 + CO + 2*HCl$	$2.03\times10^{-11}e^{(-1200/T)}$
$CH_3I + Cl \rightarrow I + HCl + HO_2$	$2.90\times10^{-11}e^{(-1000/T)}$
$CH_3I + OH \rightarrow I + H_2O + HO_2$	$2.90\times10^{-12}e^{(-1100/T)}$

$CHBr_2Cl + OH \rightarrow 2*Br + Cl$	$9.00\times10^{-13}e^{(-420/T)}$
$CHBr_3 + Cl \rightarrow 3*Br + HCl$	$4.85\times10^{-12}e^{(-850/T)}$
$CHBr_3 + OH \rightarrow 3*Br$	$9.00\times10^{-13}e^{(-360/T)}$
$CHBrCl_2 + OH \rightarrow Br + 2*Cl$	$9.40\times10^{-13}e^{(-510/T)}$
$CHCl_2O_2 + CH_3O_2 \rightarrow 2*Cl + 2*HO_2 + CH_2O + CO$	1.20×10^{-12}
$CHCl_2O_2 + CH_3O_2 \rightarrow COCl_2 + CO + H_2O$	8.00×10^{-13}
$CHCl_2O_2 + HO_2 \rightarrow COCl_2 + H_2O + O_2$	$3.92\times10^{-13}e^{(700/T)}$
$CHCl_2O_2 + HO_2 \rightarrow H_2O + CO + Cl + HOCl$	$1.68\times10^{-13}e^{(700/T)}$
$CHCl_2O_2 + NO \rightarrow H_2O + 2*Cl + NO_2 + CO$	$4.05\times10^{-12}e^{(360/T)}$
$CHCl_2O_2 + NO_3 \rightarrow H_2O + 2*Cl + NO_2 + CO$	2.30×10^{-12}
$CHCl_3 + Cl \rightarrow COCl_2 + Cl + HCl$	$3.30\times10^{-12}e^{(-990/T)}$
$CHCl_2O_2 + OH \rightarrow COCl_2 + Cl + H_2O$	$2.20\times10^{-12}e^{(-920/T)}$
HCFC141B + OH → Cl + COFCl	$1.25\times10^{-12}e^{(-1600/T)}$
HCFC142B + OH → Cl + 2*COF_2	$1.30\times10^{-12}e^{(-1770/T)}$
HCFC22 + OH → H_2O + Cl + COF_2	$1.05\times10^{-12}e^{(-1600/T)}$
Sulphur and Carbon	
DMS + BrO → SO_2 + Br	$1.00\times10^{-14}e^{(950/T)}$
DMS + Cl → sink	3.30×10^{-10}
DMS + Cl → SO_2 + HCl	$9.40\times10^{-11}e^{(190/T)}$
DMS + IO → SO_2 + I	$3.20\times10^{-13}e^{(-925/T)}$
C2	
$C_2H_6 + Cl \rightarrow HCl + C_2H_55O_2$	$7.20\times10^{-11}e^{(-70/T)}$
$CH_4 + Cl \rightarrow CH_3O_2 + HCl$	$7.10\times10^{-12}e^{(-1270/T)}$

Temperature (T) is expressed in K.

Table S3: Termolecular Reactions separated by halogen family

Odd-Chlorine Reactions	**Rate**
$Cl + NO_2 + M \rightarrow ClNO_2 + M$	troe:
	$k_0=1.80\times10^{-31}\times(300/T)^{2.0}$
	$k_i=1.0\times10^{-10}\times(300/T)^{1.0}$, f=0.6
	$2.40\times10^{-12}e^{(-1250/T)}$
$ClO + NO_2 + M \rightarrow ClONO_2 + M$	troe:
	$k_0=1.80\times10^{-31}\times(300/T)^{3.4}$
	$k_i=1.5\times10^{-11}\times(300/T)^{1.9}$, f=0.6
$ClO + ClO + M \rightarrow Cl_2O_2 + M$	troe:
	$k_0=1.90\times10^{-32}\times(300/T)^{3.6}$
	$k_i=3.7\times10^{-12}\times(300/T)^{1.6}$, f=0.6
Odd bromine reactions	**Rate**
$Br + NO_2 + M \rightarrow BrNO_2 + M$	troe:
	$k_0=4.20\times10^{-31}\times(300/T)^{2.4}$
	$k_i=2.7\times10^{-11}$, f=0.6
$BrO + NO_2 + M \rightarrow BrONO_2 + M$	troe:
	$k_0=5.20\times10^{-31}\times(300/T)^{3.2}$
	$k_i=6.9\times10^{-12}\times(300/T)^{2.9}$, f=0.6
Odd iodine reaction	**Rate**
$I + NO_2 + M \rightarrow INO_2 + M$	troe:
	$k_0=3.00\times10^{-31}\times(300/T)$
	$k_i=6.6\times10^{-11}$, f=0.6
$I + NO + M \rightarrow INO + M$	troe:
	$k_0=1.80\times10^{-32}\times(300/T)^{1.0}$
	$k_i=1.7\times10^{-11}$, f=0.6
$IO + NO_2 + M \rightarrow IONO_2 + M$	troe:
	$k_0=6.50\times10^{-31}\times(300/T)^{3.5}$
	$K_i=7.6\times10^{-12}\times(300/T)^{1.5}$,f=0.6
Organic halogen reaction with Cl, OH	**Rate**
$C_2Cl_4 + Cl + M \rightarrow 5*Cl$	troe:
	$k_0=1.40\times10^{-28}\times(300/T)^{8.5}$
	$K_i=4.0\times10^{-11}\times(300/T)^{1.2}$,f=0.6
$C_2H_4 + Cl + M \rightarrow Cl + M$	troe:
	$k_0=1.60\times10^{-29}\times(300/T)^{3.3}$
	$k_i=3.1\times10^{-10}\times(300/T)^{1.0}$, f=0.6

Temperature (T) is expressed in K, air density (M) in molecules/cm^3, k_i and k_0 in cm3/molec/s.