*Geophysical Research Letters*

Supporting Information for

# Stratospheric chlorine processing after the unprecedented Hunga Tonga eruption

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**Introduction**

Supporting information includes text and figures to support the discussion in the main article.

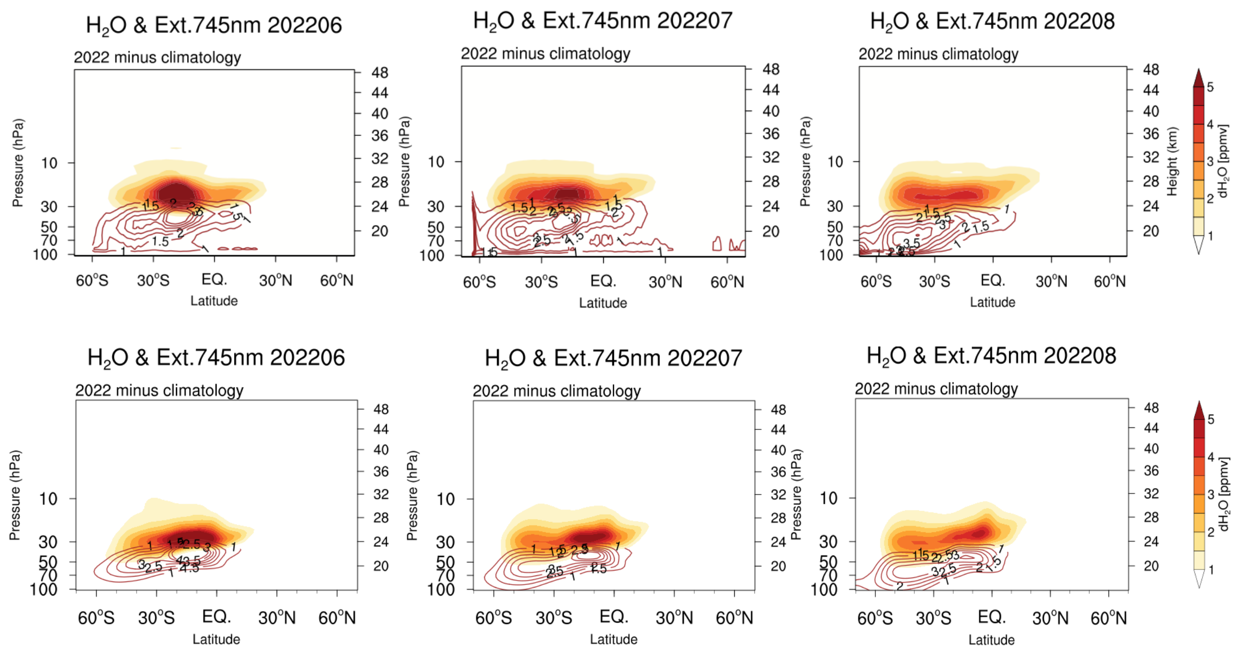


**Figure S1**. Observed and simulated $H_2O$ and aerosol perturbations after the HTHH eruption in JJA 2022. Top: observed $H_2O$ from MLS overlayed with OMPS aerosol extinction. Bottom: WACCM simulated $H_2O$ and aerosol extinction.

**Table S1.** Heterogeneous Reaction Probabilities for sulfate aerosol used in WACCM.

| Reactions | Reaction probability |
|---|---|
| $HCl+ClONO_2 \rightarrow Cl_2 + HNO_3$ | Shi et al. (2001) |
| $ClONO_2 + H_2O \rightarrow HOCl + HNO_3$ | Shi et al. (2001) |
| $BrONO_2 + H_2O \rightarrow HOBr + HNO_3$ | Hanson et al. (1996) |
| $HOCl + HCl \rightarrow Cl_2 + H_2O$ | Shi et al. (2001) |
| $HOBr + HCl \rightarrow BrCl + H_2O$ | Hanson (2003) |

**Table S2.** Full list of HCl reactions examined in this study.

Gas-phase production:

Cl + $CH_2O$ -> HCl + $HO_2$ + CO
Cl + $CH_4$ -> $CH_3O_2$ + HCl
Cl + $H_2$ -> HCl + H
Cl + $H_2O_2$ -> HCl + $HO_2$
Cl + $HO_2$ -> HCl + $O_2$
ClO + OH -> HCl + $O_2$
HOCl + Cl -> HCl + ClO
$CH_2Br_2$ + Cl -> 2*Br + HCl
$CH_3Br$ + Cl -> HCl + $HO_2$ + Br
$CH_3Cl$ + Cl -> $HO_2$ + CO + 2*HCl
$CHBr_3$ + Cl -> 3*Br + HCl
$C_2H_6$ + Cl -> HCl + $C_2H_5O_2$

Gas-phase loss:

HCl + hv -> H + Cl
HCl + O -> Cl + OH
HCl + OH -> $H_2O$ + Cl
O1D + HCl -> Cl + OH
O1D + HCl -> ClO + H

Heterogeneous loss:

| | |
|---|---|
| [het4] | $ClONO_2$ + HCl -> $Cl_2$ + $HNO_3$ |
| [het5] | HOCl + HCl -> $Cl_2$ + $H_2O$ |
| [het6] | HOBr + HCl -> BRCl + $H_2O$ |
| [het9] | $ClONO_2$ + HCl -> $Cl_2$ + $HNO_3$ |
| [het10] | HOCl + HCl -> $Cl_2$ + $H_2O$ |
| [het15] | $ClONO_2$ + HCl -> $Cl_2$ + $HNO_3$ |
| [het16] | HOCl + HCl -> $Cl_2$ + $H_2O$ |
| [het17] | HOBr + HCl -> BrCl + $H_2O$ |

Het 4,5,6 are reactions on sulfate aerosol;
Het 9,10 are reactions on nitric acid trihydrate;
Het 15,16,17 are reactions on ice.

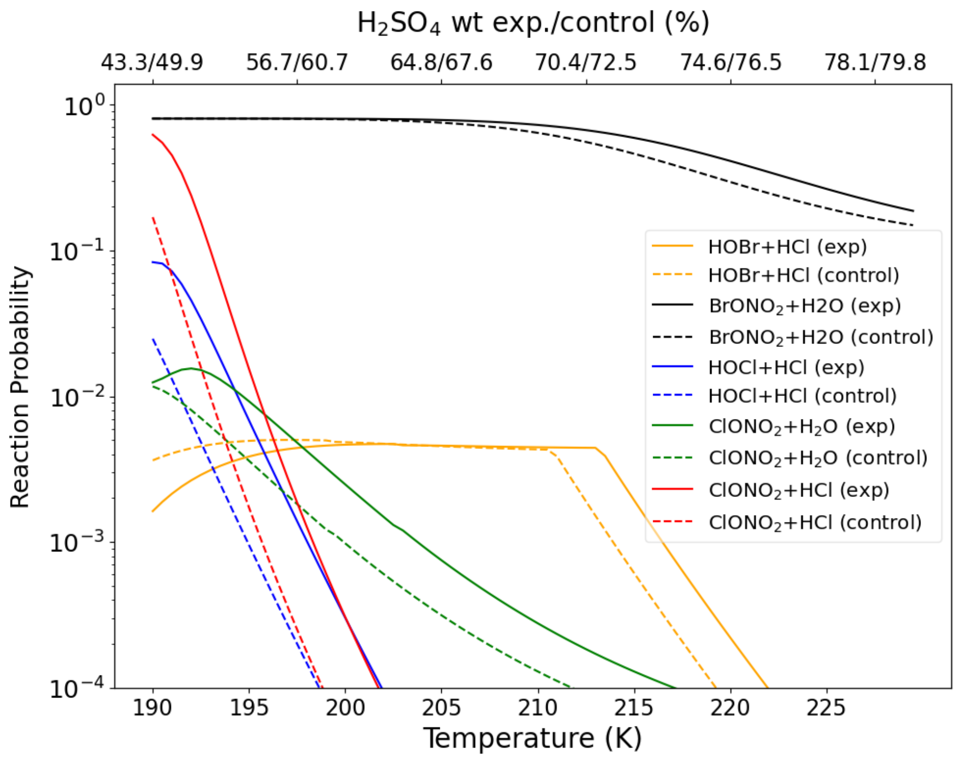


**Figure S2**. Reaction probability as a function of temperature for key stratospheric heterogeneous processes on sulfuric acid aerosols from the volcano (solid lines) and control (dashed lines) case in June 2022 at 40°S and 30 hPa. The $H_2SO_4$ wt.% is shown at the top of the graph for volcano and control case respectively.