Understanding the distribution of CI-VSLS and their interhemispheric transport based on global model simulation and measurement data
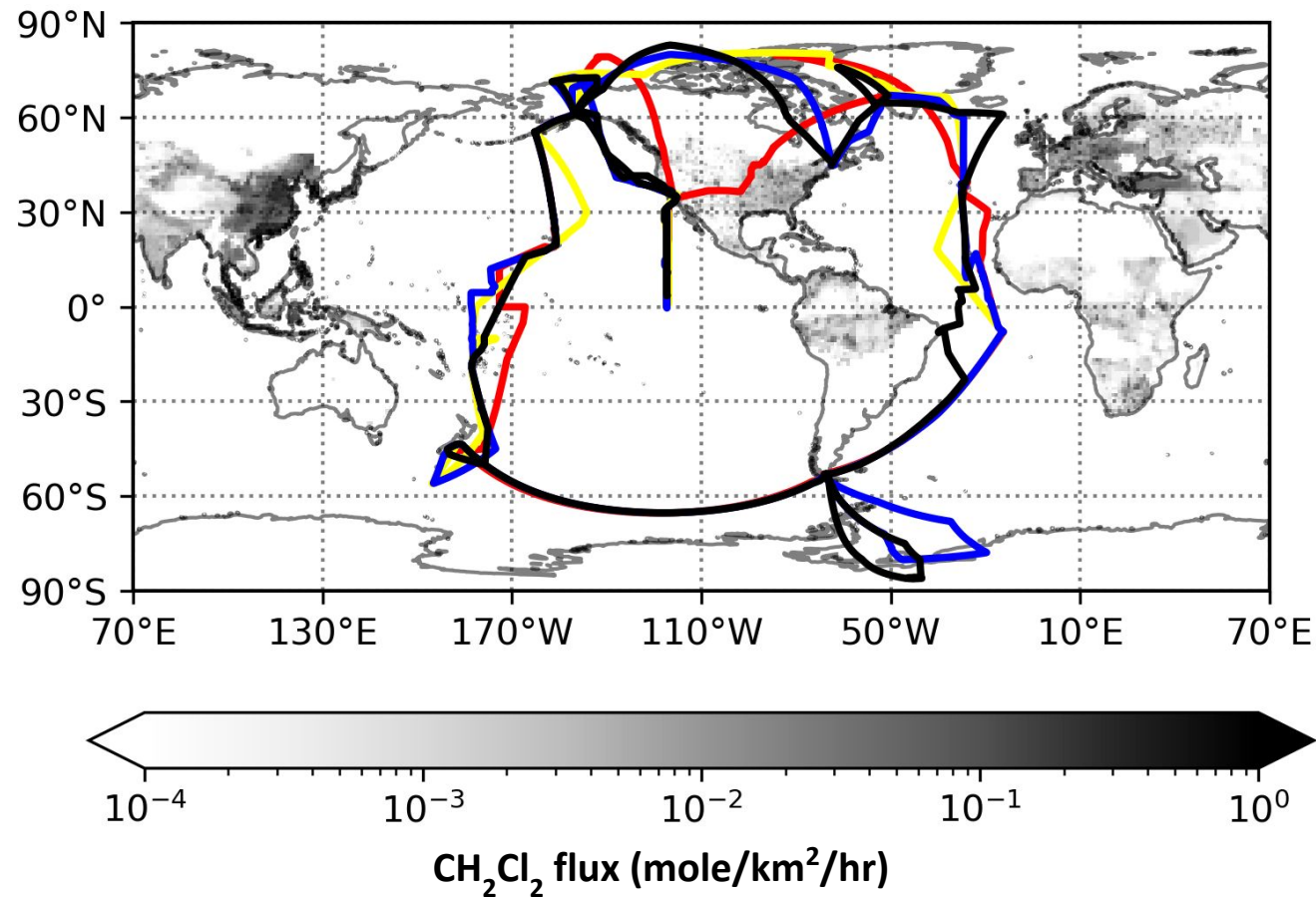
Behrooz Roozitalab,

Eric C. Apel, Rebecca S. Hornbrook, Louisa Emmons, Douglas E. Kinnison, Rafael Fernandez, Qinyi Li, Alfonso Saiz-Lopez

The NASA Atmospheric Tomography (ATom) mission provides a comprehensive dataset to characterize the chemistry and transport of Cl-VSLS.

Cl-VSLS in this talk:
- CH_2Cl_2 ~1200 Gg/yr
- C_2Cl_4 ~120 Gg/yr

ATom1 – August 2016
ATom2 – February 2017
ATom3 – October 2017
ATom4 – May 2018

CH_2Cl_2 flux (mole/km^2/hr)

Cl-VSLS: Chlorinated Very Short Lived Substances

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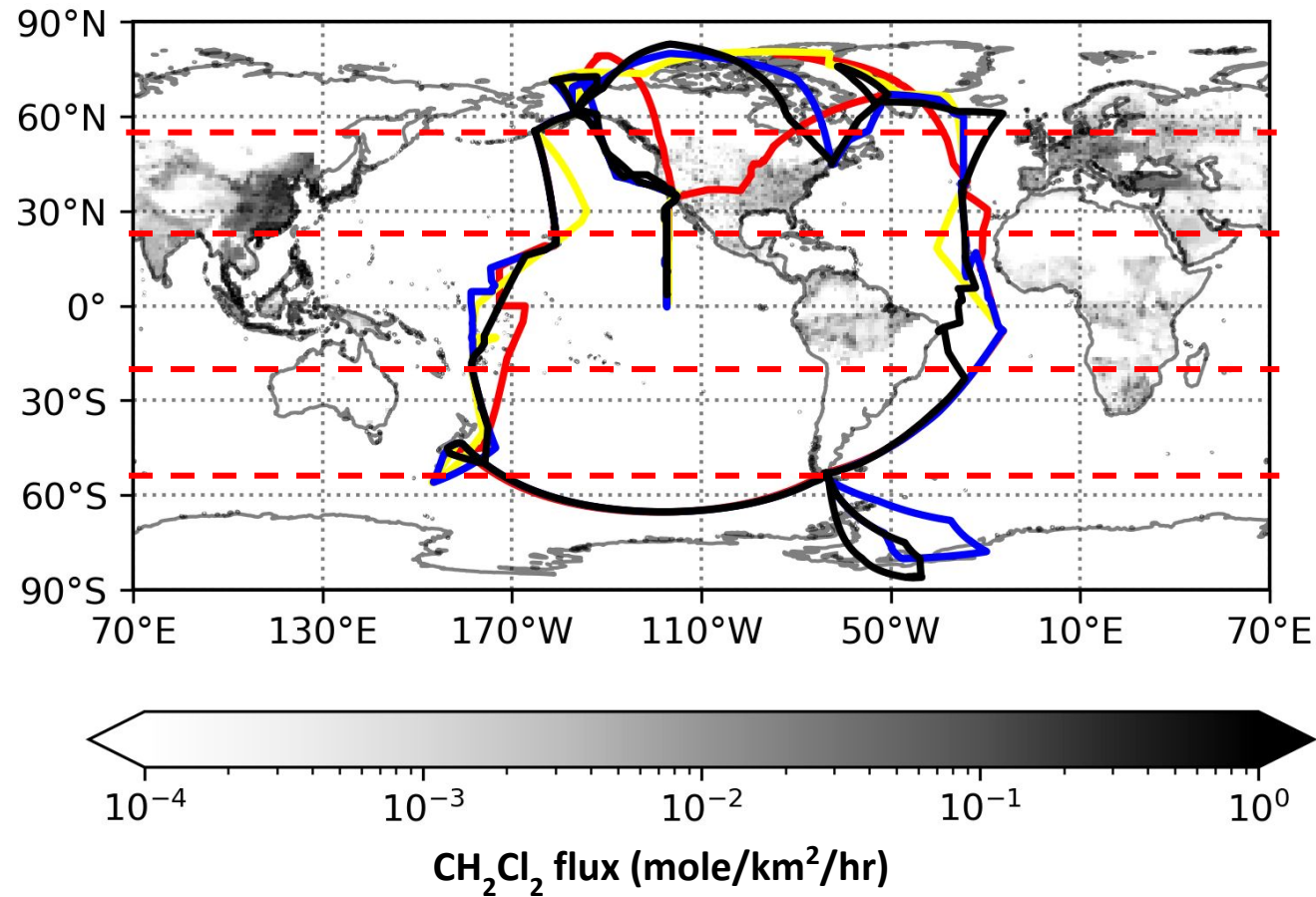
Cl-VSLS have large vertical and inter-hemispheric variation.
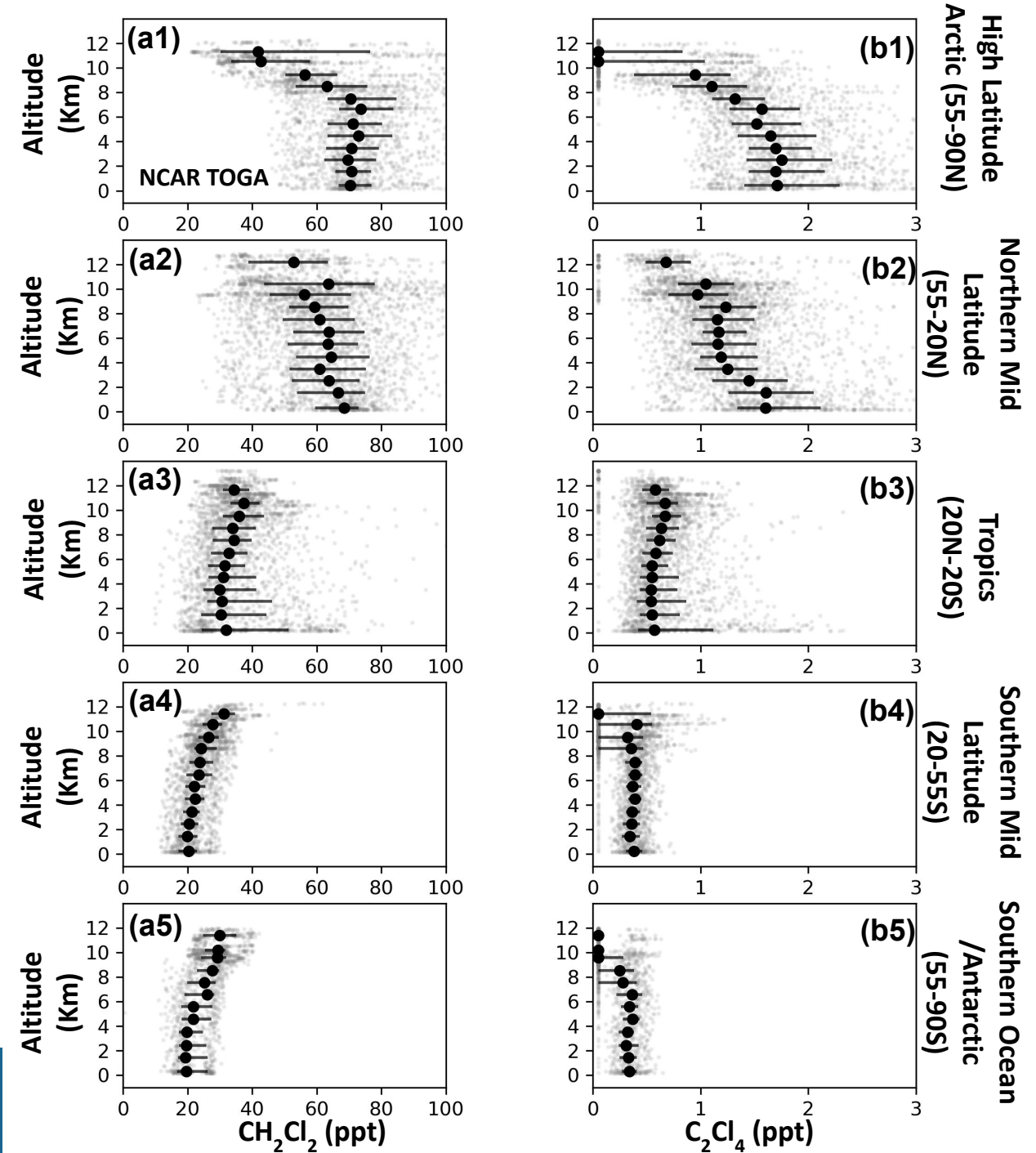
TOGA: Trace Organic Gas Analyzer

CESM CCWG Meeting

The model captures the overall vertical and inter-hemispheric gradients, while being biased low.
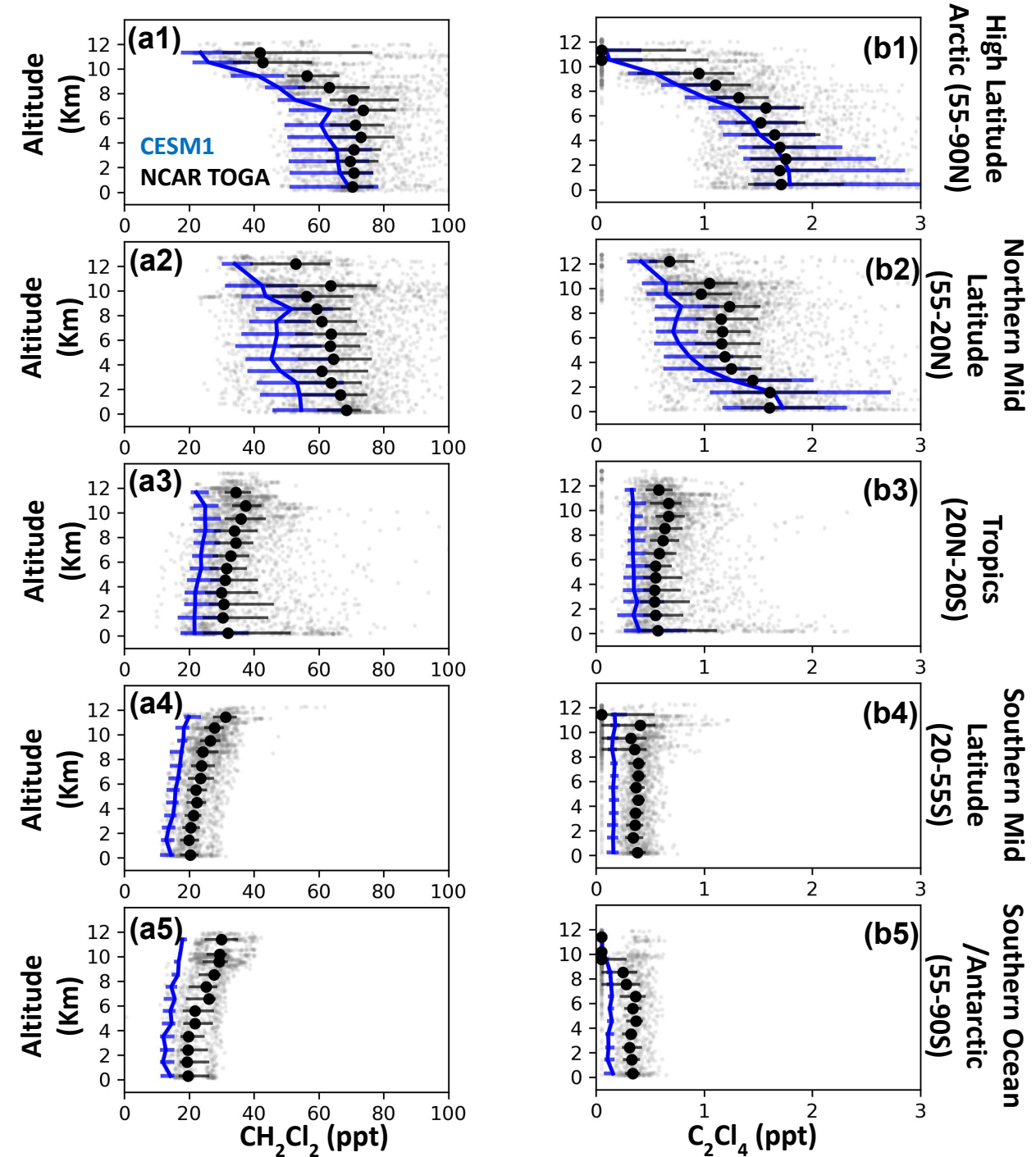
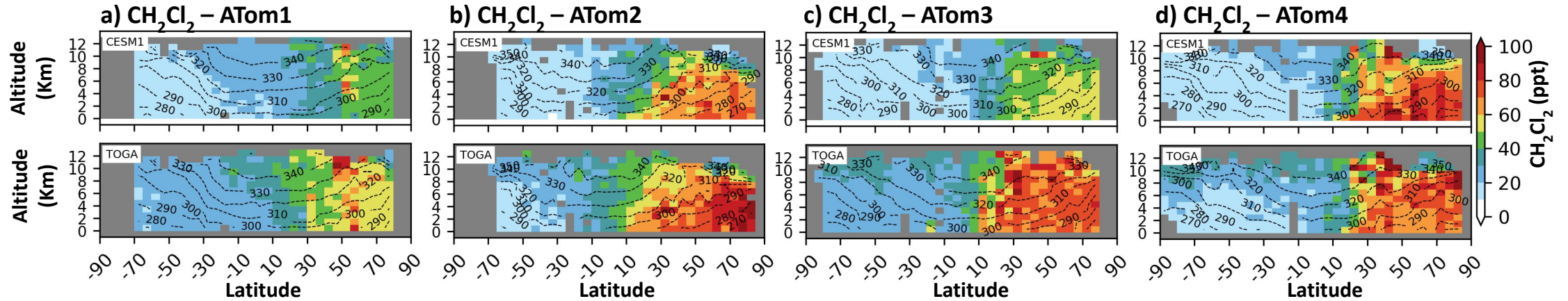# The model captures the seasonal differences but misses some features!
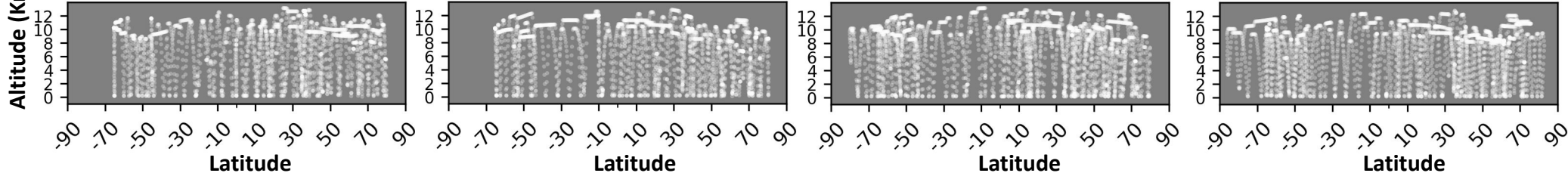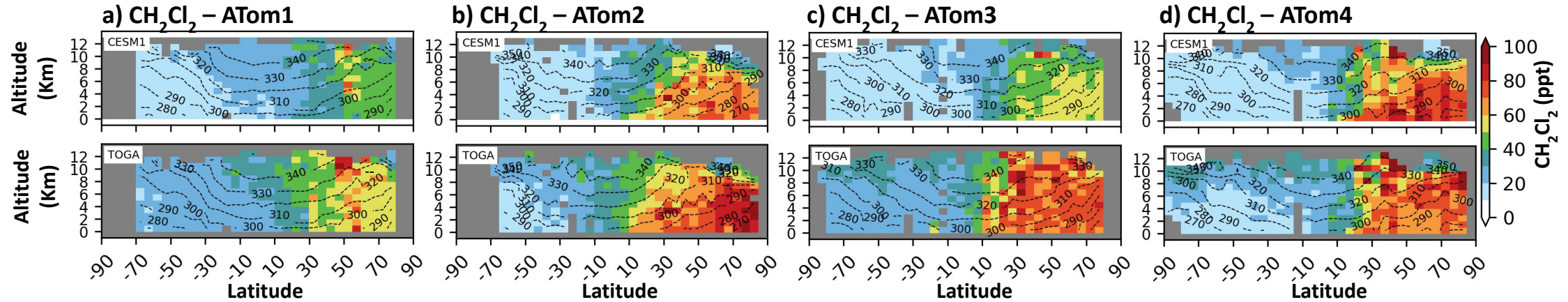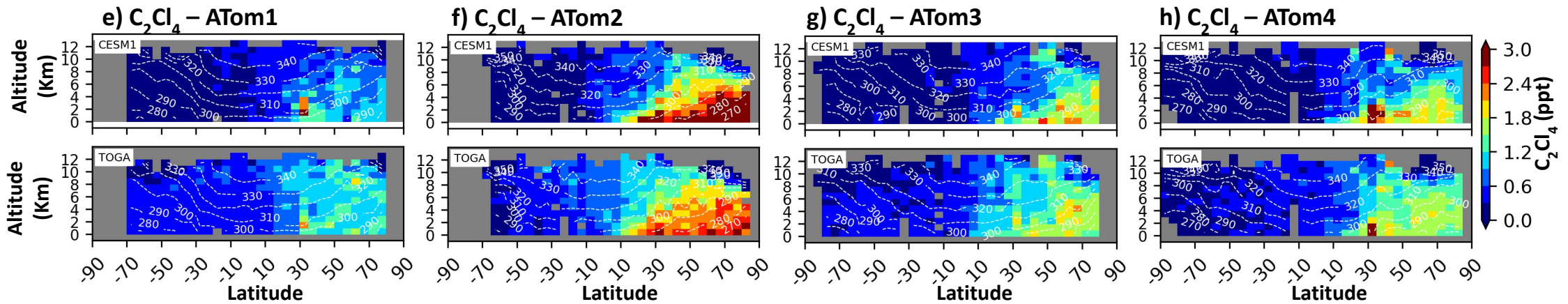
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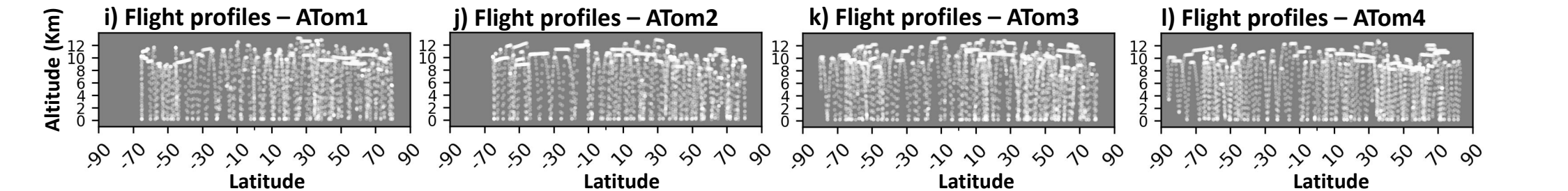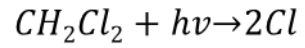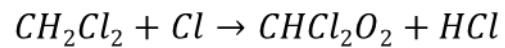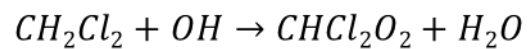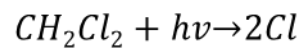
OH oxidation is the major removal pathway of Ch$_2$Cl$_2$.

CH$_2$Cl$_2$ removal reactions in the model:

$$CH_2Cl_2 + hv \rightarrow 2Cl$$
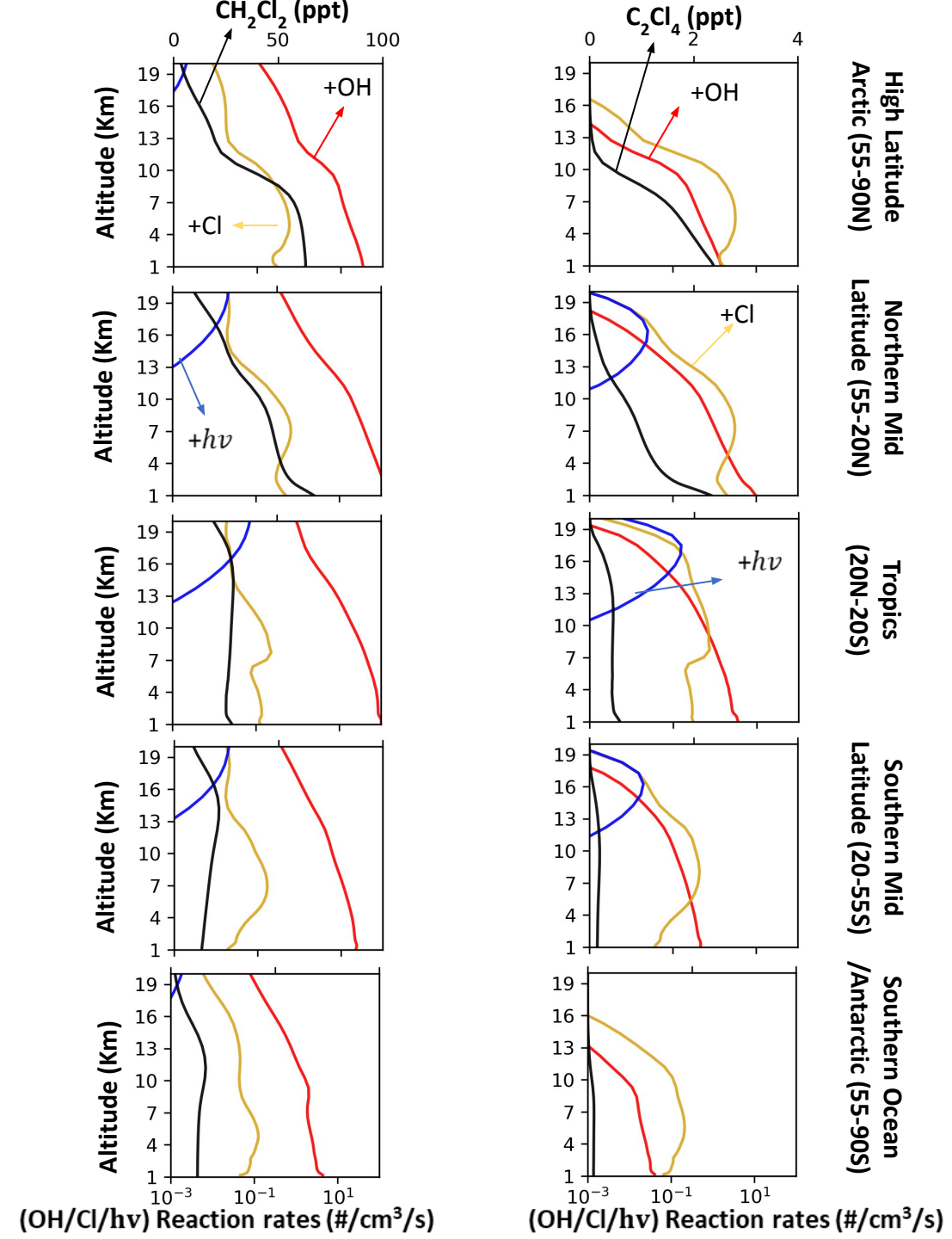
$$CH_2Cl_2 + OH \rightarrow CHCl_2O_2 + H_2O$$

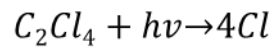$$CH_2Cl_2 + Cl \rightarrow CHCl_2O_2 + HCl$$
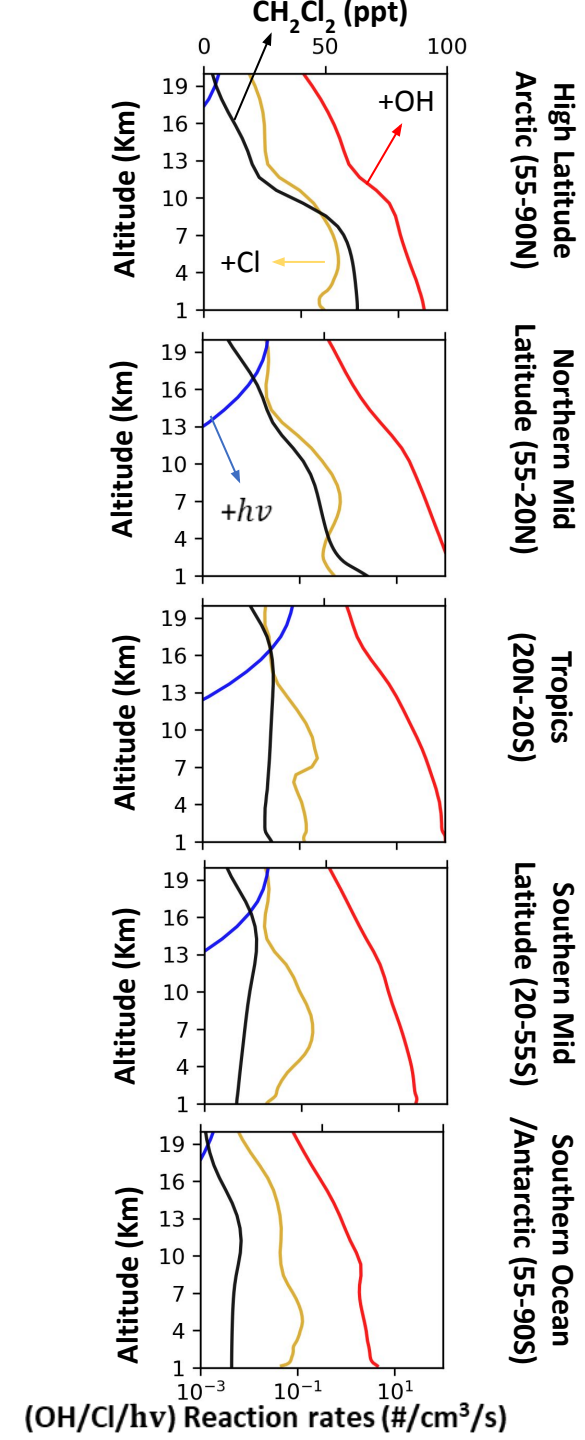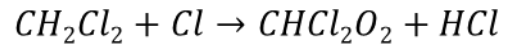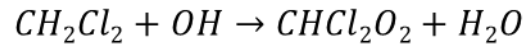
OH and Cl compete to remove C$_2$Cl$_4$!

CH$_2$Cl$_2$ removal reactions in the model:

$CH_2Cl_2 + hv \rightarrow 2Cl$

$CH_2Cl_2 + OH \rightarrow CHCl_2O_2 + H_2O$

$CH_2Cl_2 + Cl \rightarrow CHCl_2O_2 + HCl$

C$_2$Cl$_4$ removal reactions in the model:

$C_2Cl_4 + hv \rightarrow 4Cl$

$C_2Cl_4 + OH \rightarrow 0.47COCl_2 + 3.06Cl$

$C_2Cl_4 + Cl + M \rightarrow 5Cl$
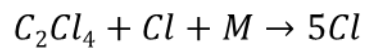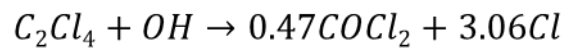
Cl pathway majorly affects the C$_2$Cl$_4$ local lifetime!
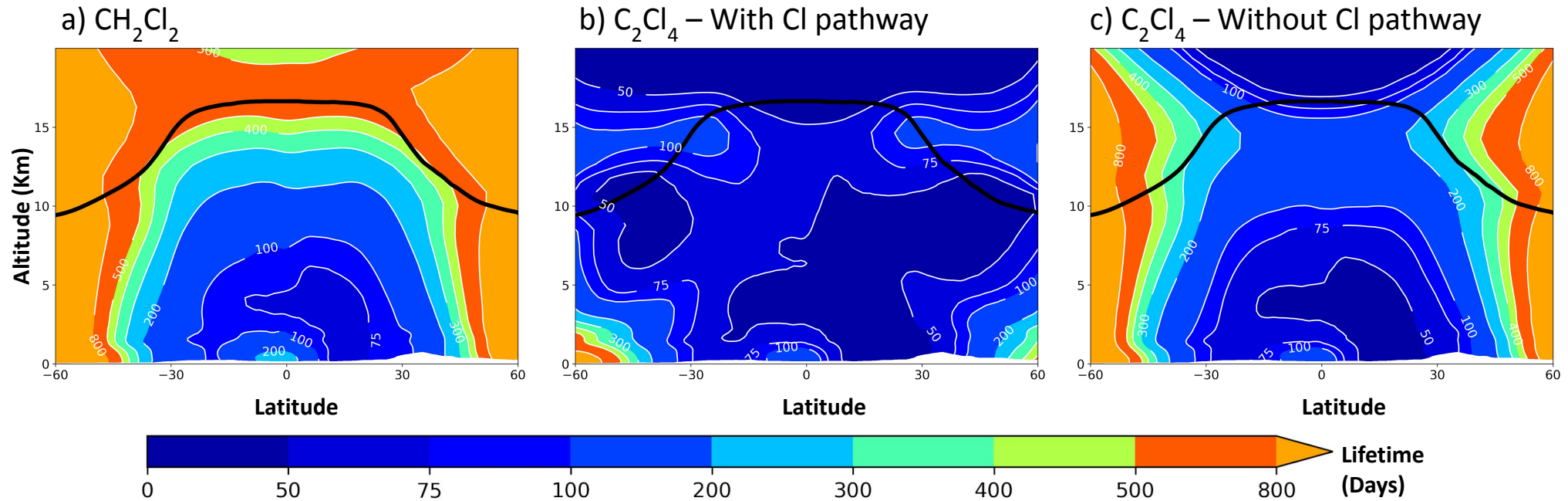
a) CH$_2$Cl$_2$

b) C$_2$Cl$_4$ – With Cl pathway

c) C$_2$Cl$_4$ – Without Cl pathway

The model Cl$_2$ results do not match the ATom measurements.

a) Cl - #/cm3

$$CL_2 + OH \rightarrow HOCL + CL$$
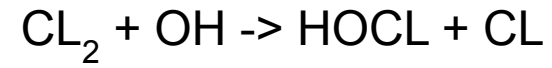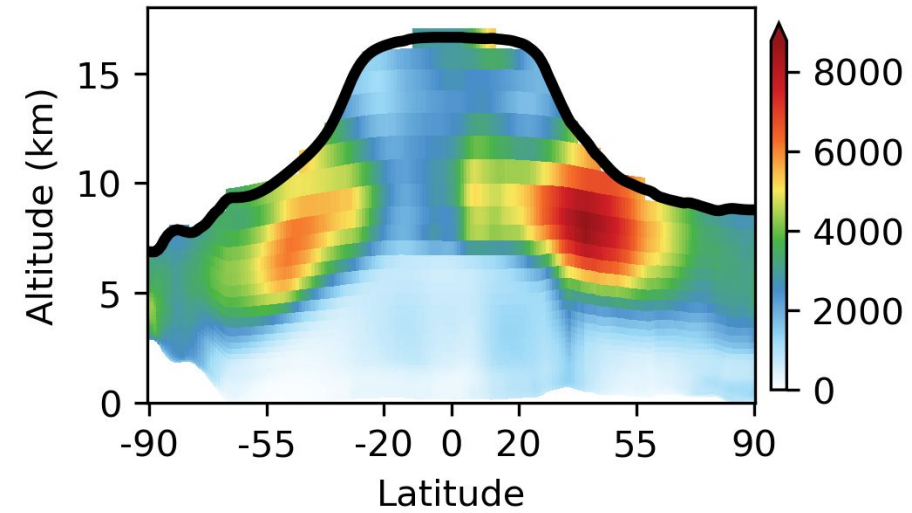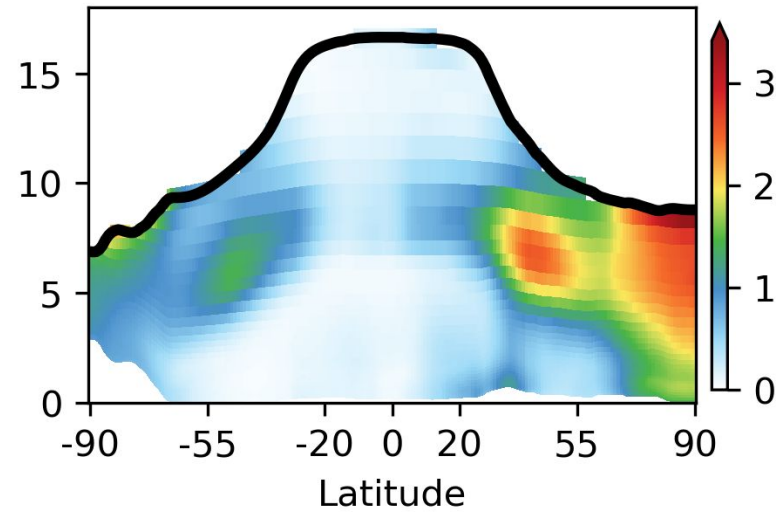
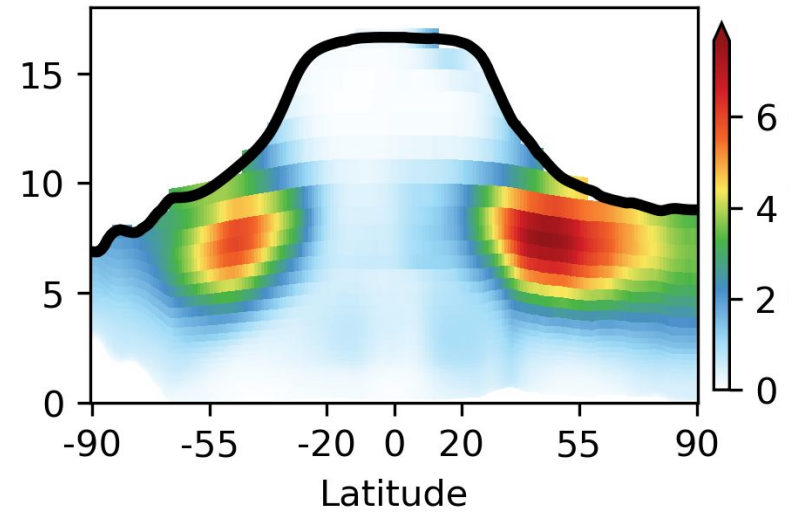# The model Cl$_2$ results do not match the ATom measurements.
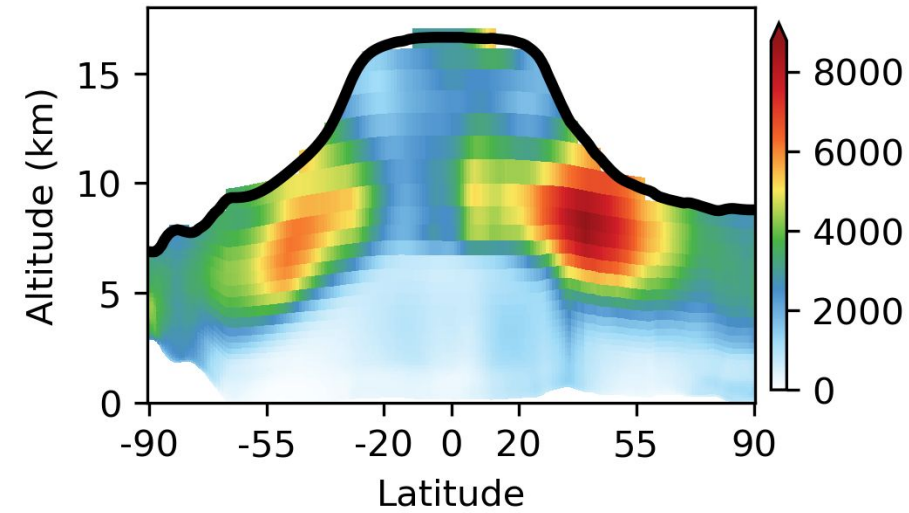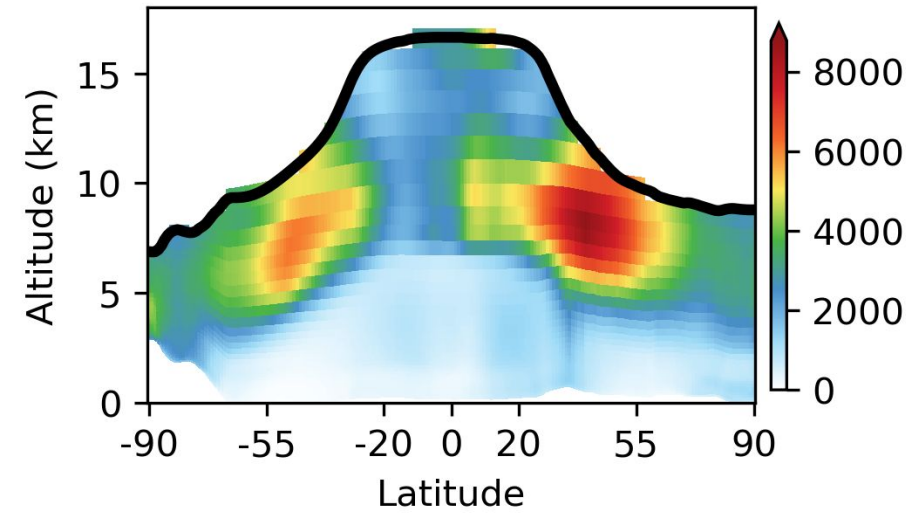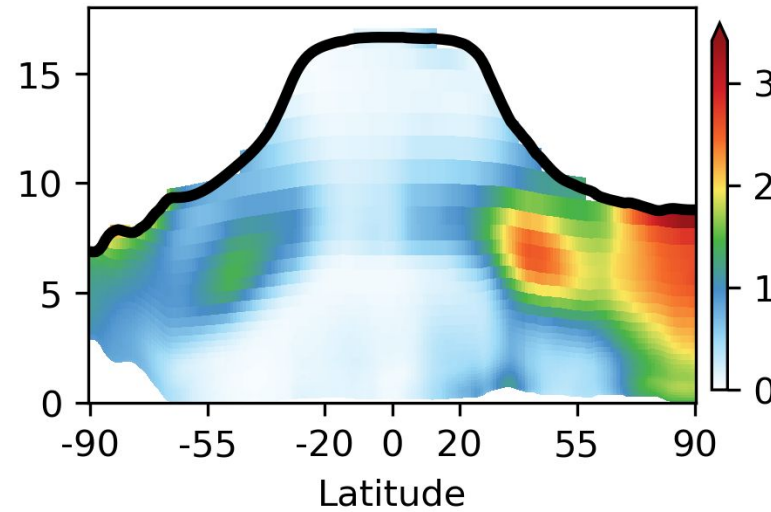

a) Cl - #/cm3

b) Cl$_2$ - ppt

c) HOCl - ppt

The model Cl$_2$ results do not match the ATom measurements.

a) Cl - #/cm3

b) Cl$_2$ - ppt

c) HOCl - ppt
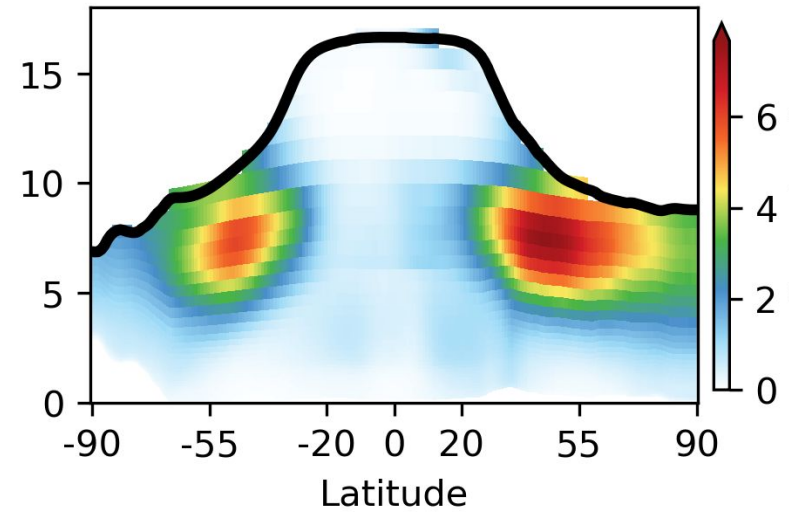
CL$_2$- ATom 3 – October 2017

CL$_2$ ATom 4 – May 2018

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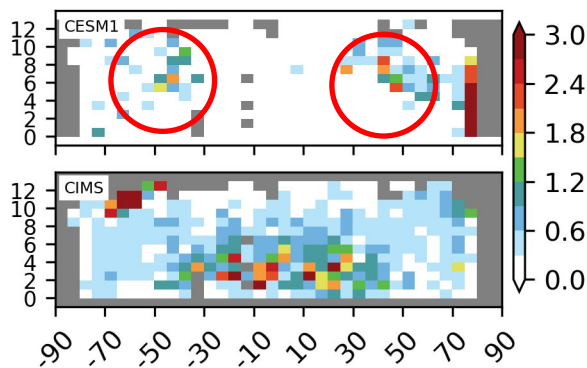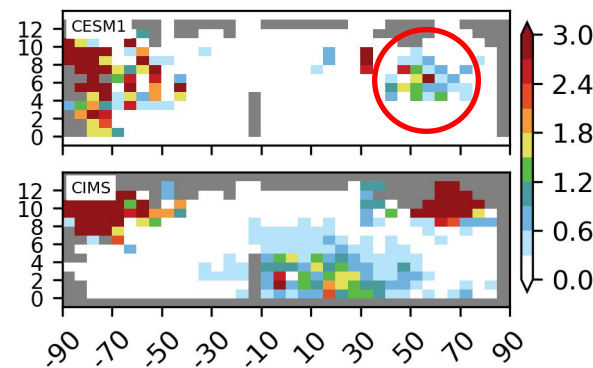
Summary:

- Cl-VSLS distribution has large vertical and horizontal variability.

- CESM captures the trends pretty well but is biased low.

- CH_2Cl_2 bias could be due to the models high OH.

- Model has too much Cl atoms in high altitudes; inorganic chlorines should be investigated.

Thank you for your time