

2. Scientific Objectives

2.1 Background

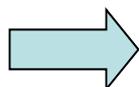
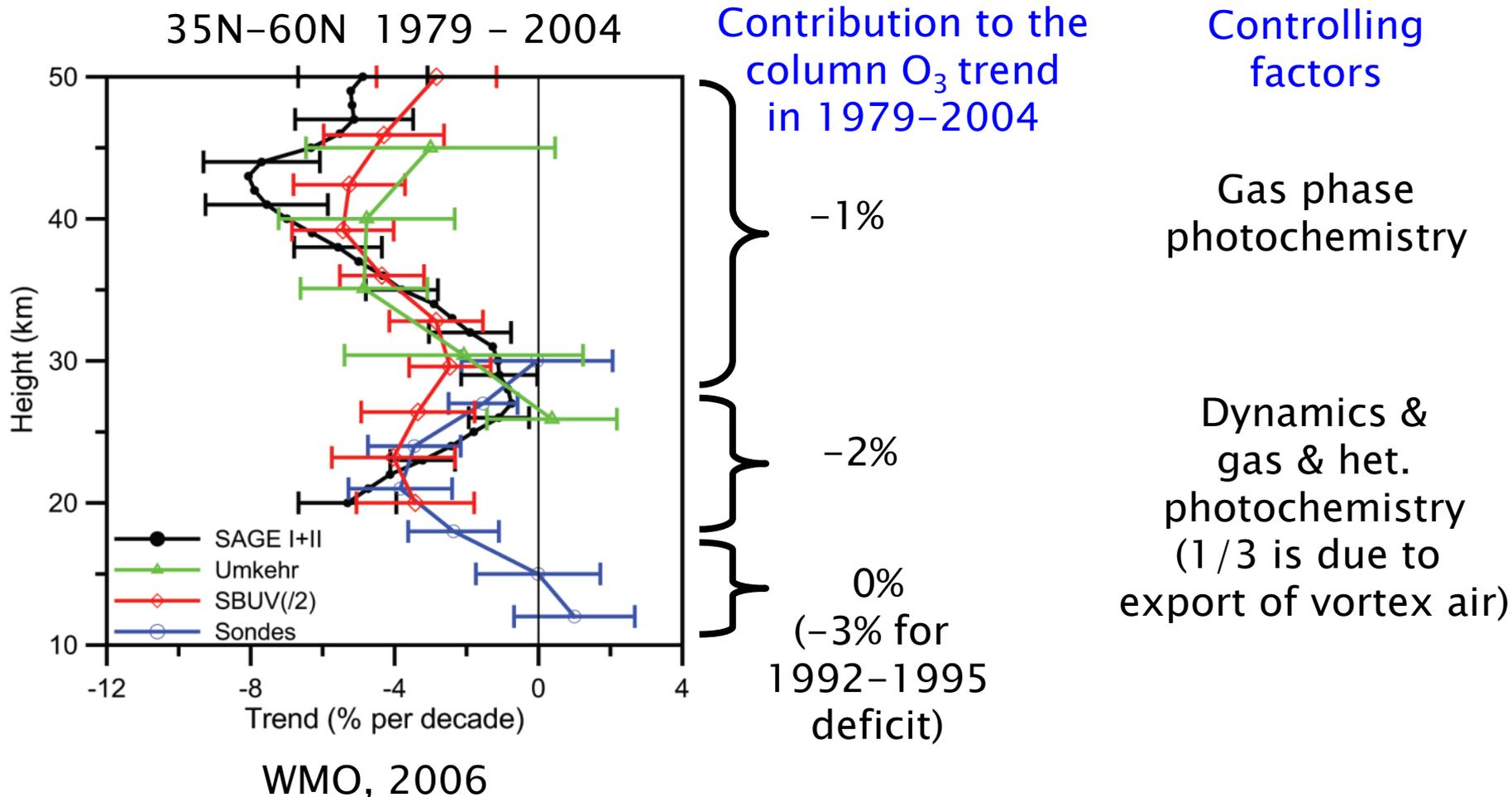
2.2 Inorganic Chlorine chemistry

2.3 Bromine budget

2.4 HO_x budget

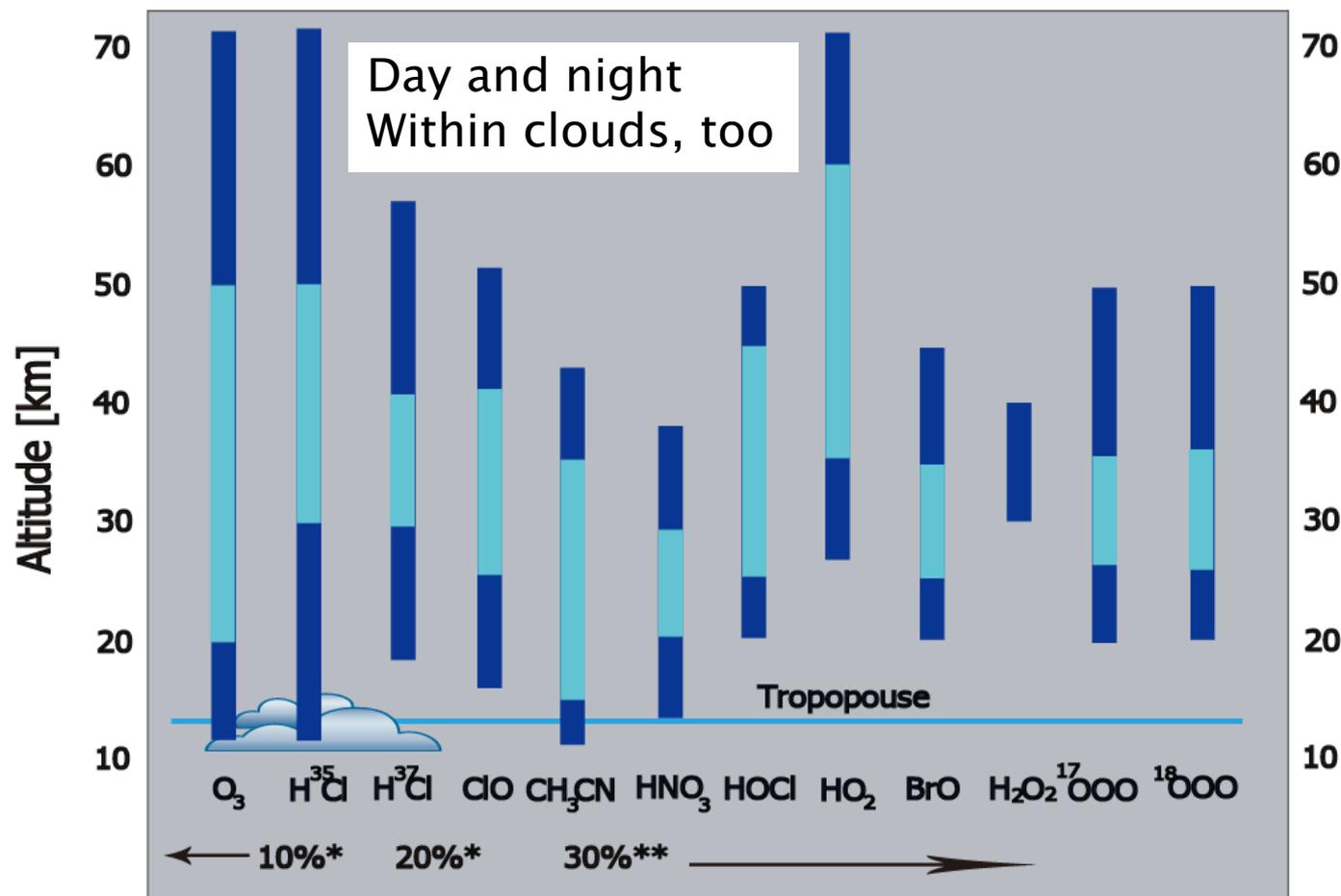
2.5 Cirrus clouds

Stratospheric ozone trend



Further needs of systematic understandings of O₃ chemistry and transport processes

Species and altitude range of SMILES measurement



* Single scan with 3 km altitude resolution.

** Zonal mean average with 5 km altitude resolution

Scientific targets of SMILES

1. Inorganic Chlorine chemistry

- ClO to HCl ratio (O₃ trend in the US)
- HOCl production (O₃ trend in the LS)
- Global ClO (background ClO)

2. Bromine budget (very short-lived source gas)

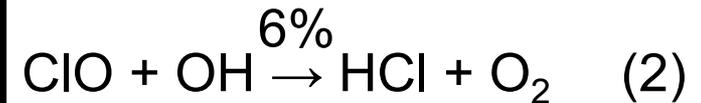
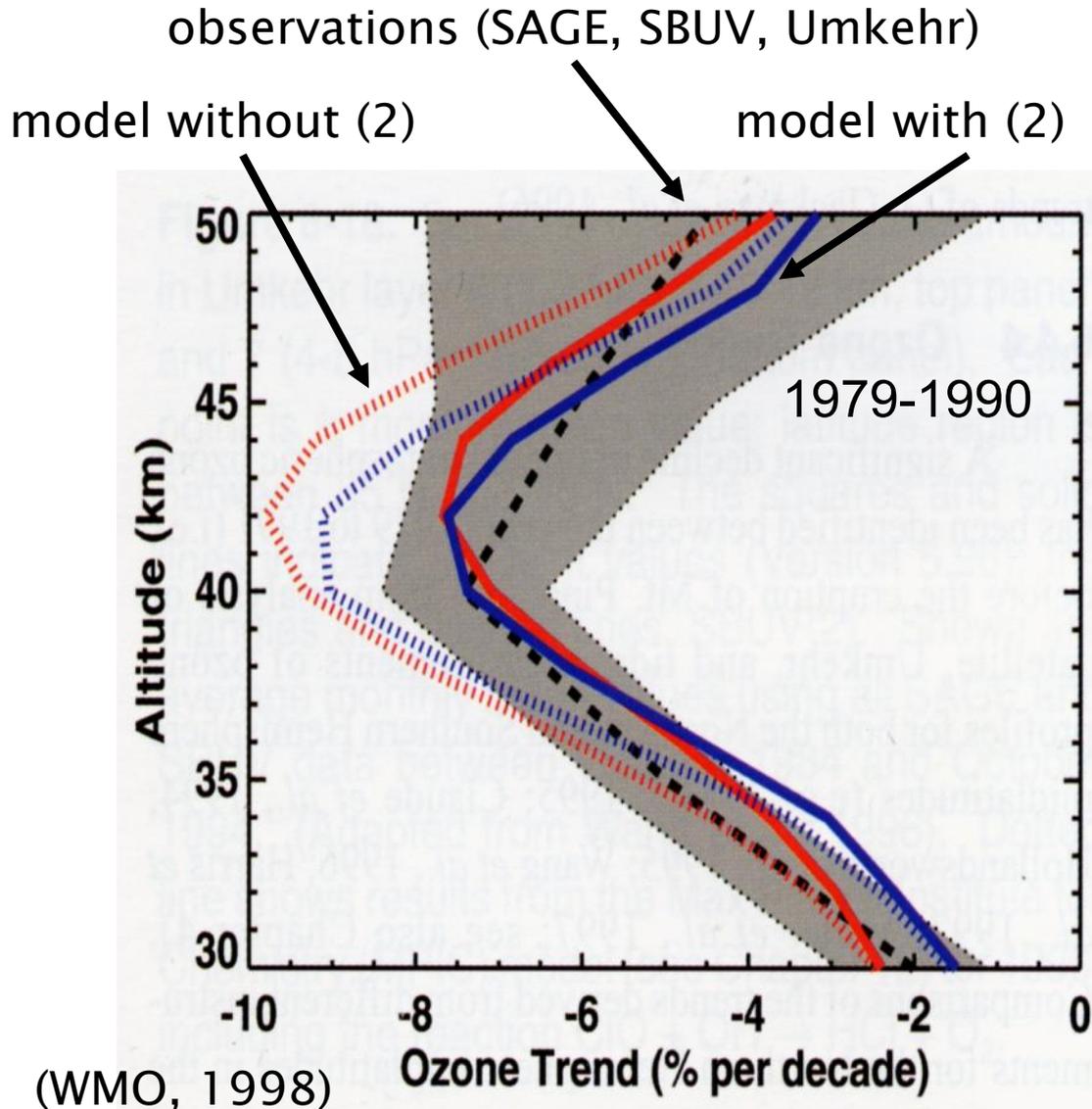
3. HO_x budget (HO_x dilemma)

4. Cirrus clouds (Het. reactions & Rad. budget)

5. O₃ isotope (mass independent chemistry)

(6. UT/LS mixing (O₃ flux))

Partitioning within Cl_y in US

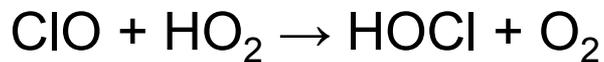
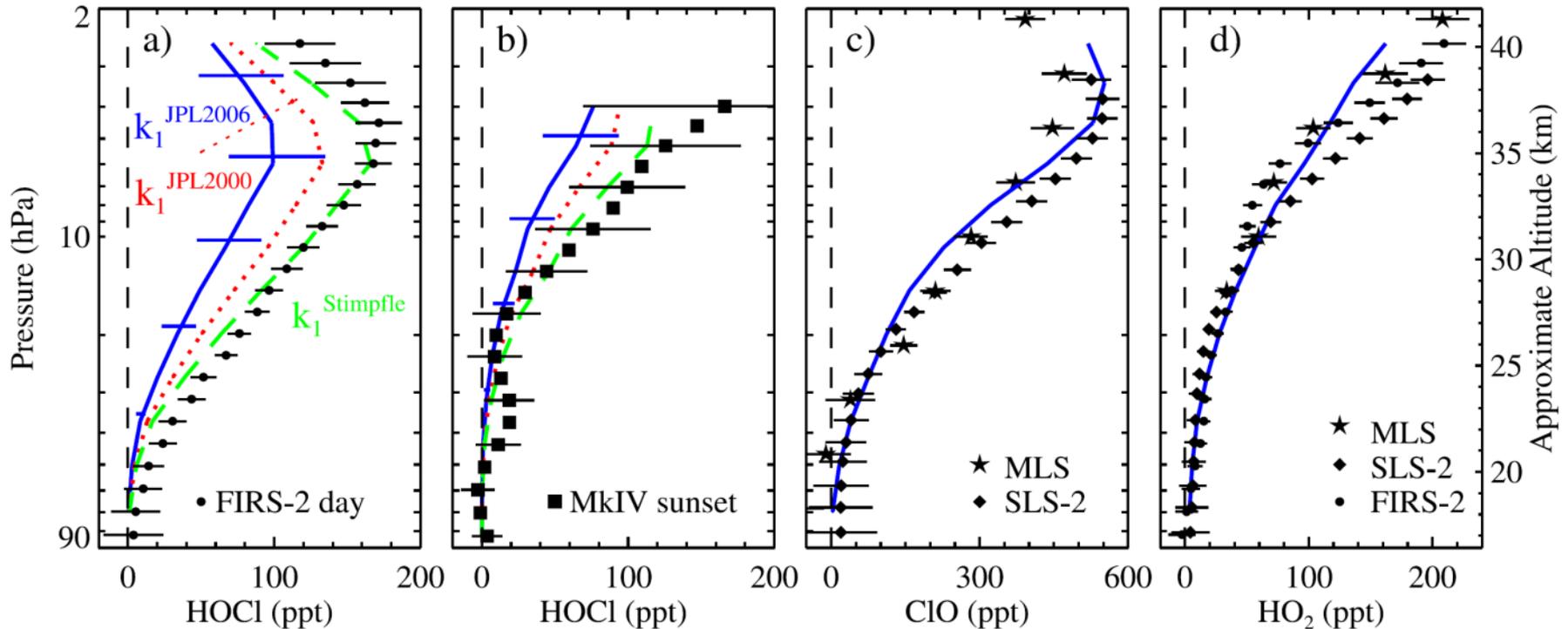


Inclusion of the reaction (2) results in a better agreement with observed $[ClO]/[HCl]$ ratio (balloon) and O_3 trend in the upper stratosphere.



SMILES $[ClO]/[HCl]$ measurements can be utilized further systematic test on Cl_y partitioning.

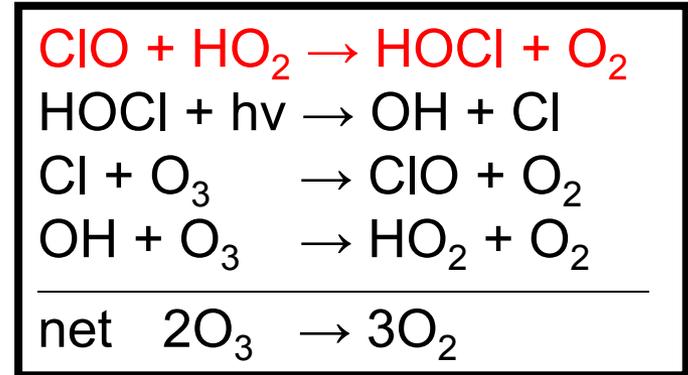
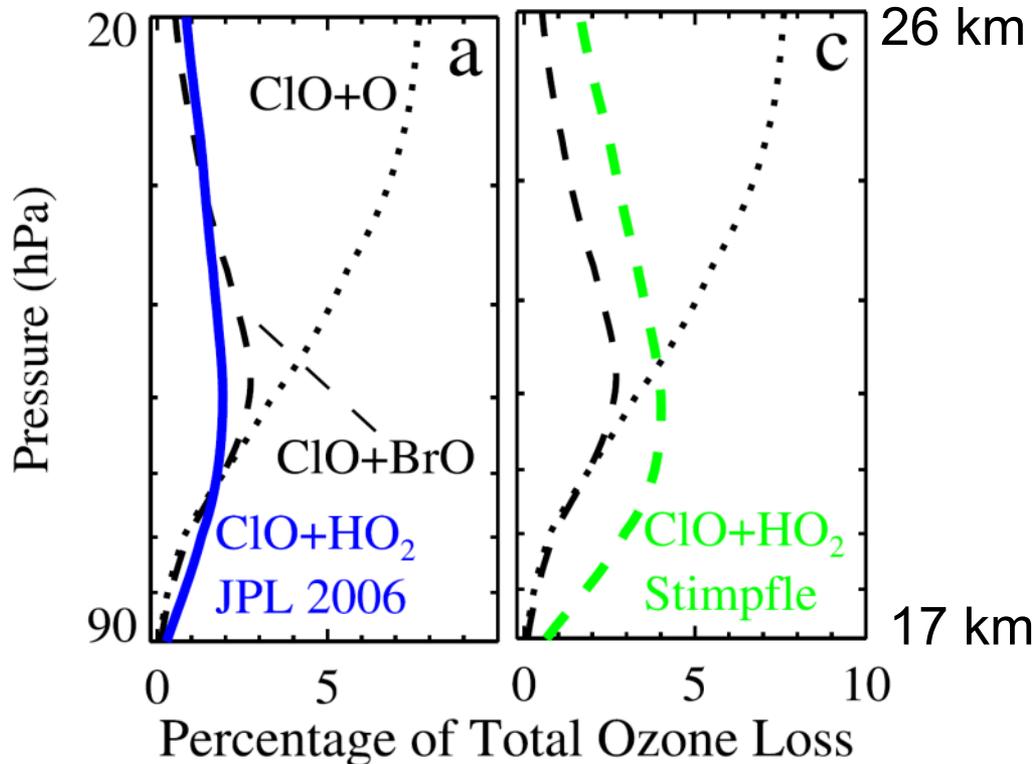
HOCl production



(Kovalenko et al, 2007)

There is a factor of 2 uncertainty in the rate constant for this reaction. It directly affects HOCl levels, while it does not affect ClO and HO₂ levels.

HOCl production



(Kovalenko et al, 2007)

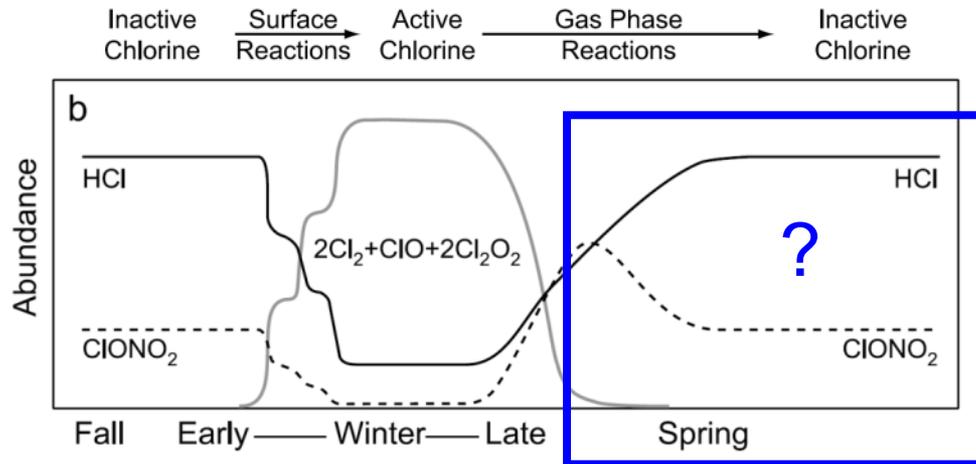
ClO+HO₂ cycle can be the most efficient O₃ loss processes within the cycles involving ClO in the LS, and therefore important for O₃ trend.



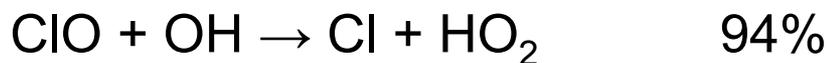
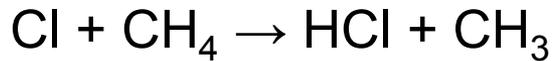
SMILES HOCl measurements together with ClO and HO₂ measurements can be used to assess importance of the ClO+HO₂ cycle.

Global ClO distribution

Inorganic Chlorine in the Polar Stratosphere



The background ClO_x level is important to quantify the in-situ O₃ loss at mid-latitudes. However, its global distribution has not been observed with high precision.

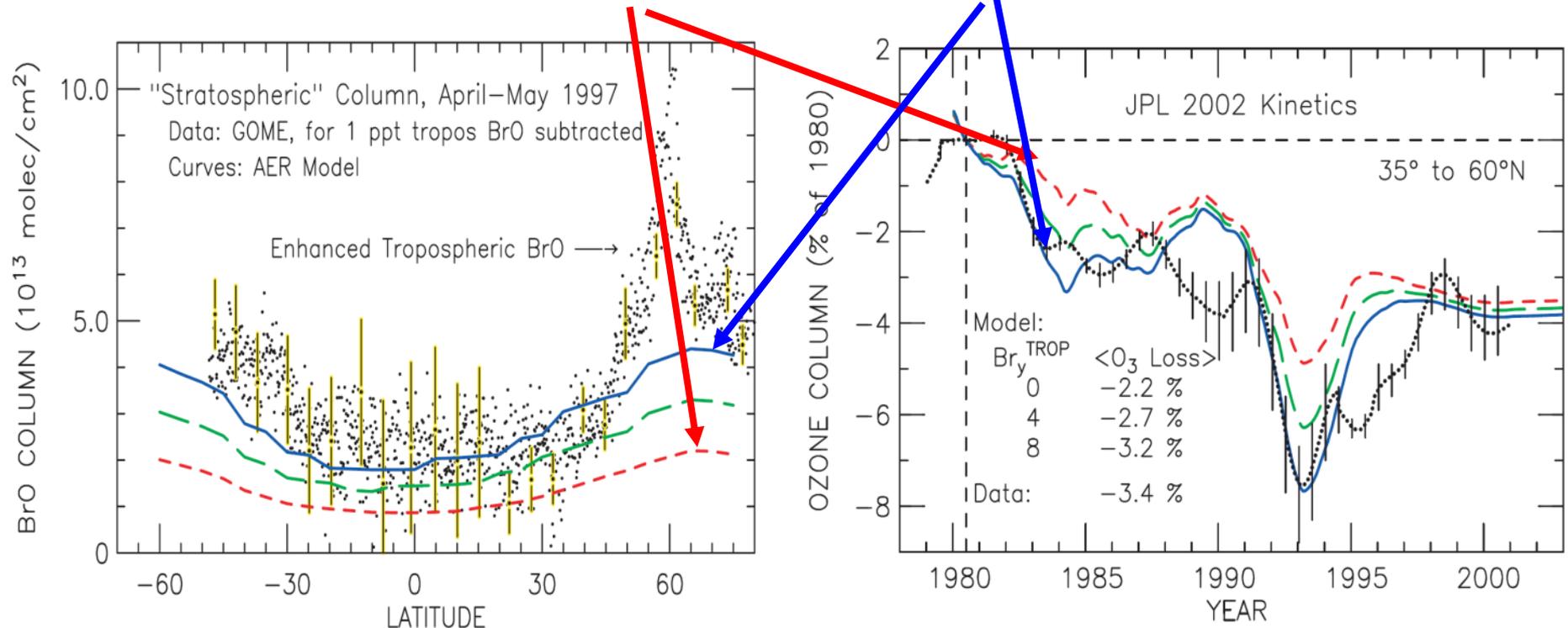


SMILES provides global ClO distribution with high precision. Furthermore, measurements of ClO, HCl, HOCl, and HO₂ can provide important insights into the Cl_y chemistry.

Bromine budget

Br_y from CH_3Br & Halons

+ 8 pptv Br_y Source

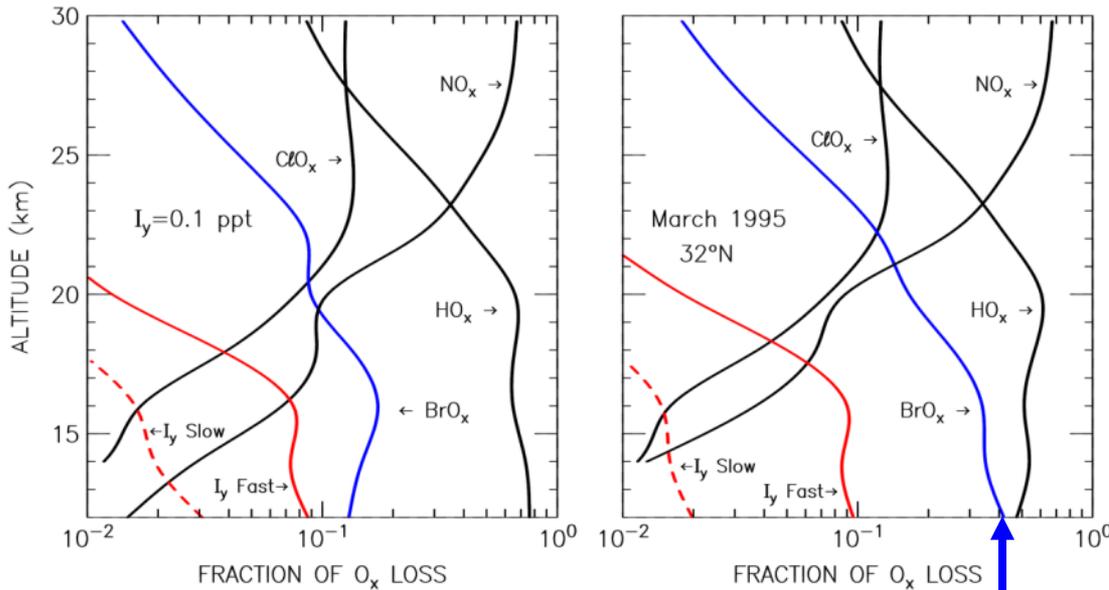


BrO measurements suggest that in addition to long-lived source gases (halons and methyl bromide), very short-lived ($\tau < 6$ months) source gases likely contribute to Br_y by about 5 pptv. This difference can be important for O_3 in the LS. (Salawitch et al., 2005)

Bromine budget

Br_y from
CH₃Br & Halons

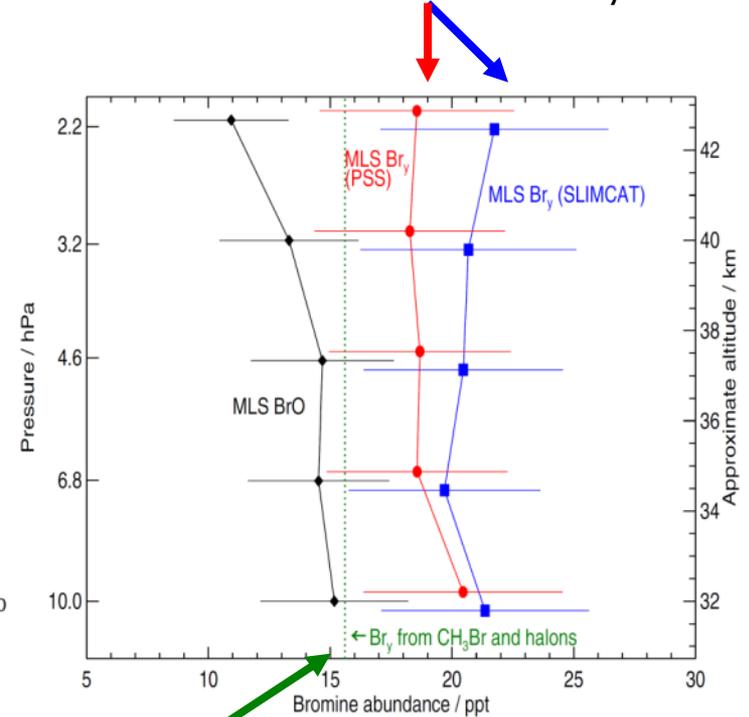
+ 5 pptv



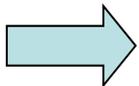
(WMO, 2006)

BrO + ClO & BrO + HO₂ cycles

MLS-derived Br_y



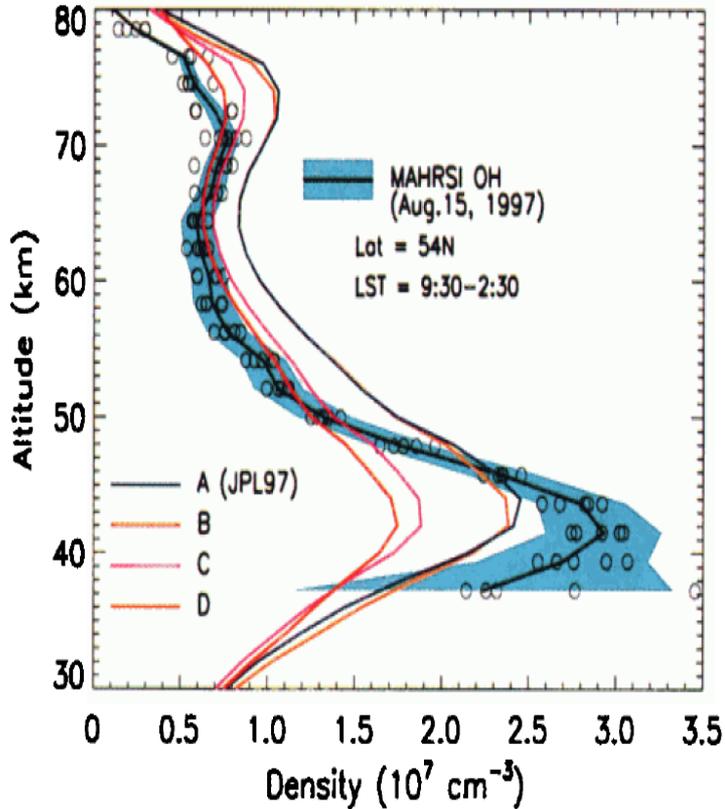
Br_y from CH₃Br & Halons
(Livesey et al., 2006)



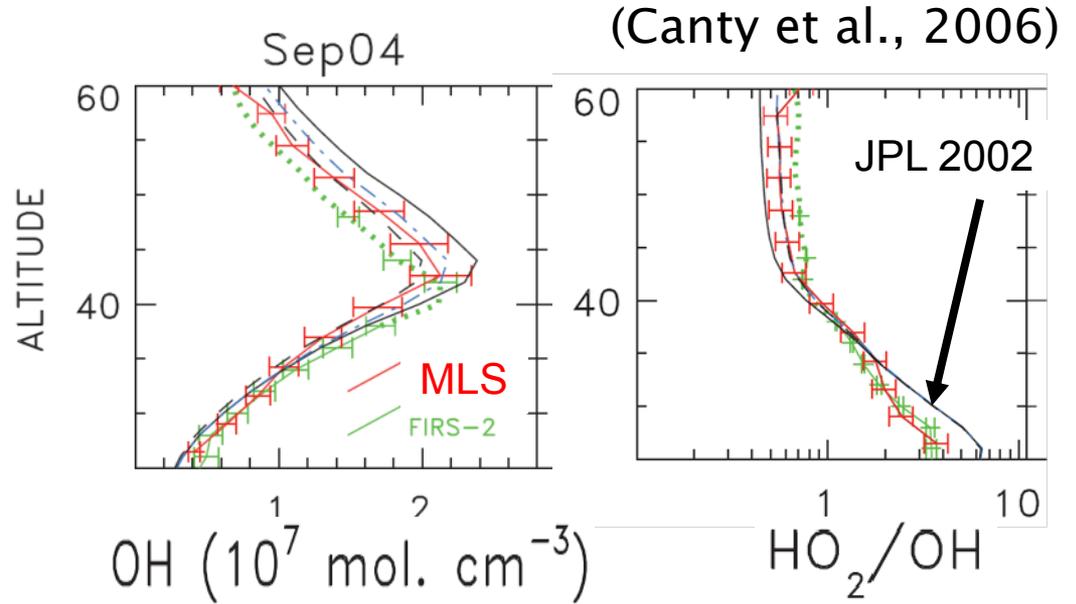
SMILES BrO measurements provide further constraints to Br_y level, which affects O₃ chemistry in the LS.

HO_x budget

HO_x dilemma



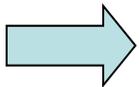
(Conway et al., 2000)



HO_x loss



OH/HO₂ ratio

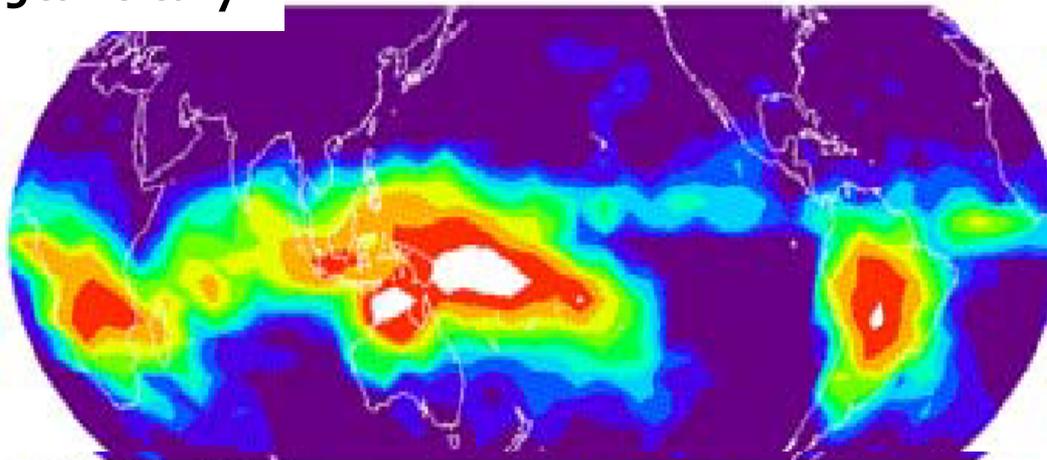


SMILES measurements will provide vertical profiles of HO₂, which can be used to test our understanding of HO_x chemistry.

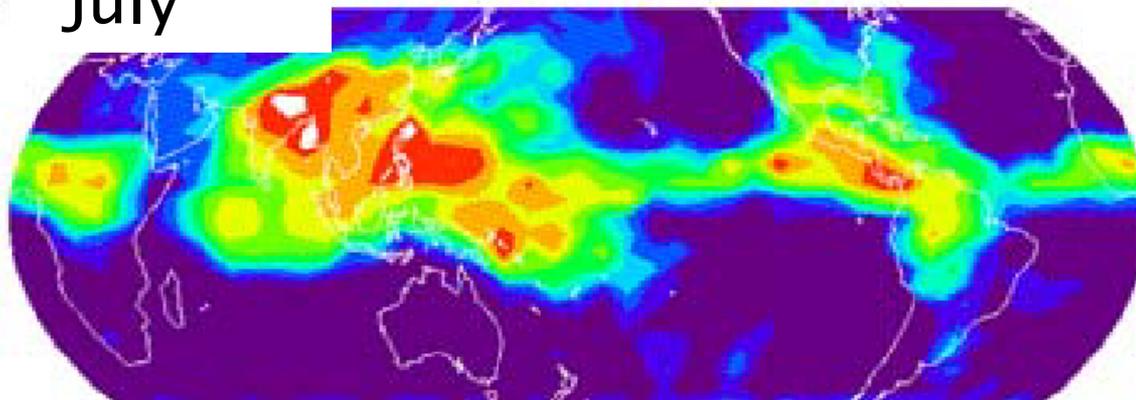
Cirrus clouds : Heterogeneous reactions and radiation budget

MLS-derived
IWC at 147 hPa

January



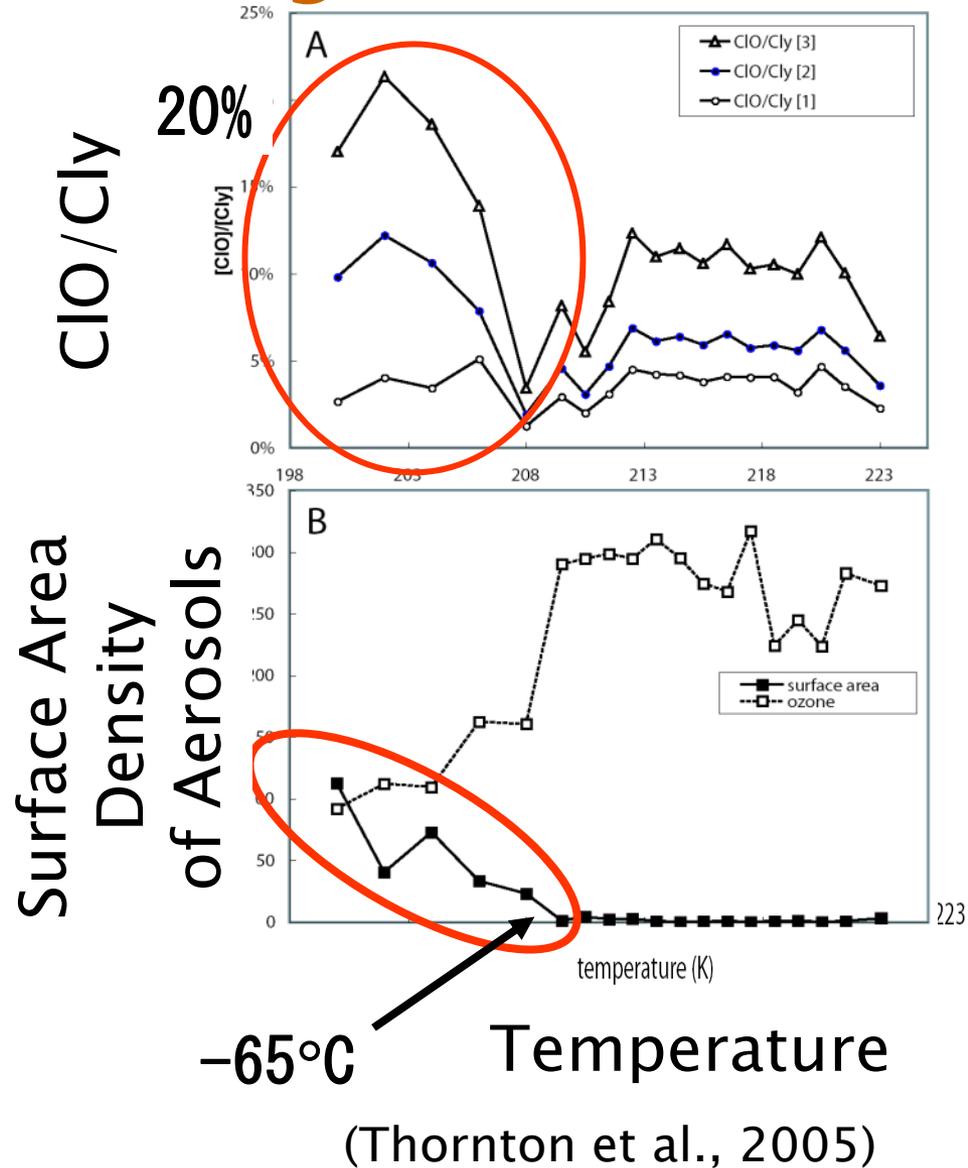
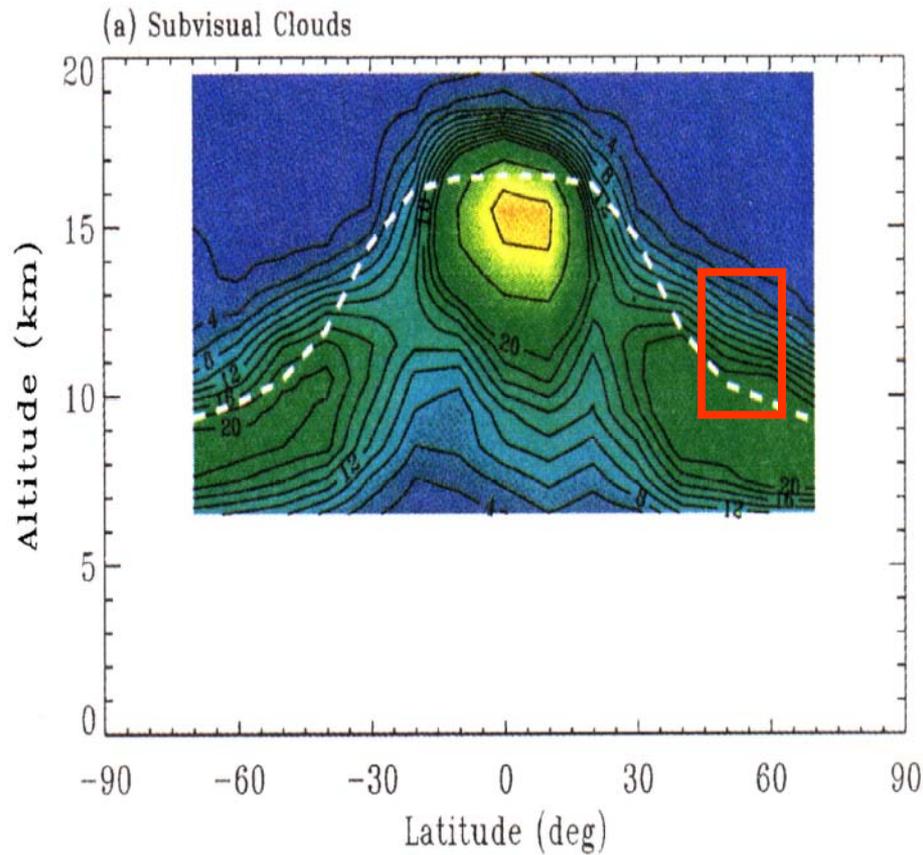
July



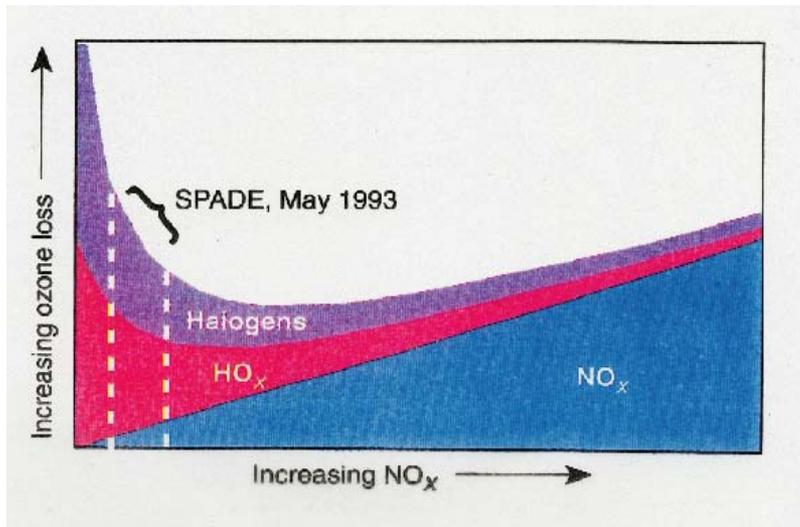
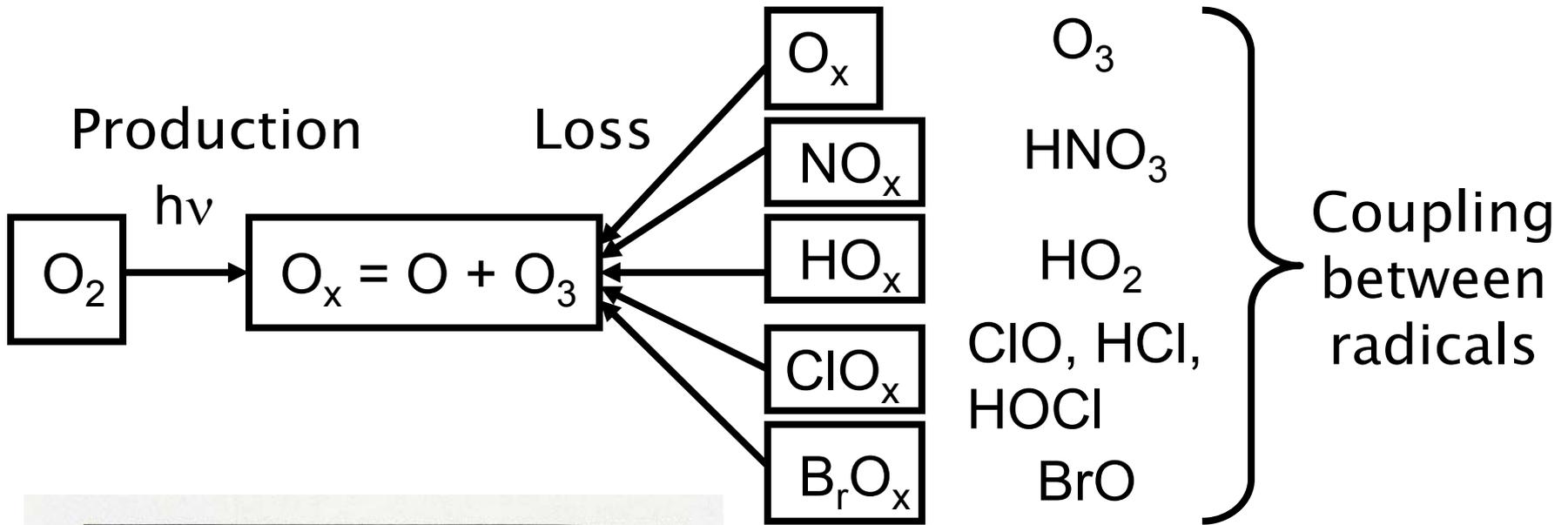
(Wu et al., 2008)

Cirrus Clouds : Heterogeneous reactions and radiation budget

Cirrus clouds

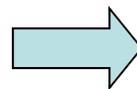


Stratospheric O_3 chemistry



(Wennberg et al., 1994)

- + analyses on dynamics
- + data from other satellites
- + 3D CTM calculations



Better understandings
of O_3 trend

Summary

- **Inorganic chlorine chemistry**

Chlorine is the key species for O₃ trend. SMILES provide major Cl_y species, including ClO, HCl, and HOCl. These data set will be utilized to test our understanding in Cl_y chemistry, especially that affects O₃ trend in the US and LS.

- **Bromine budget**

Very short-lived ($\tau < 6$ months) bromine containing species likely to be important for the budget of bromine, which plays significant role in O₃ chemistry. SMILES will provide useful constraint to study bromine budget.

- **HO_x budget**

SMILES HO₂ data can be utilized to test our understanding of HO_x chemistry.

- **Systematic understanding of O₃ chemistry and transport**

Combination of high precision O₃ data and those of related species will be utilized for overall test for the O₃ chemistry (O₃-NO_x-ClO_x-BrO_x) and transport (low-mid-latitudes) processes that control O₃ levels.