破曉號

Akatsuki Mission

Modeling the Distribution of Sulfur Species in the Atmosphere of Venus

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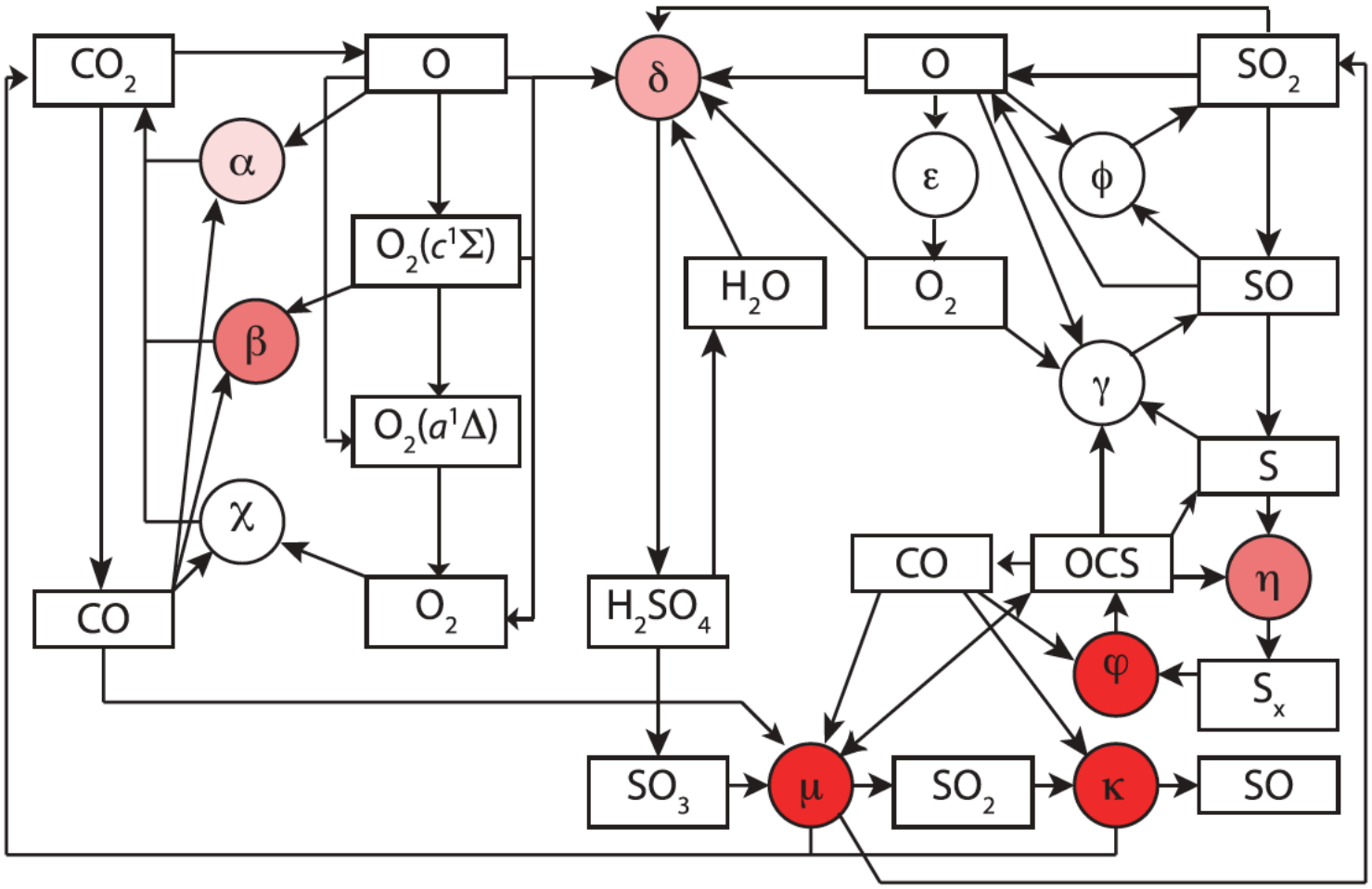
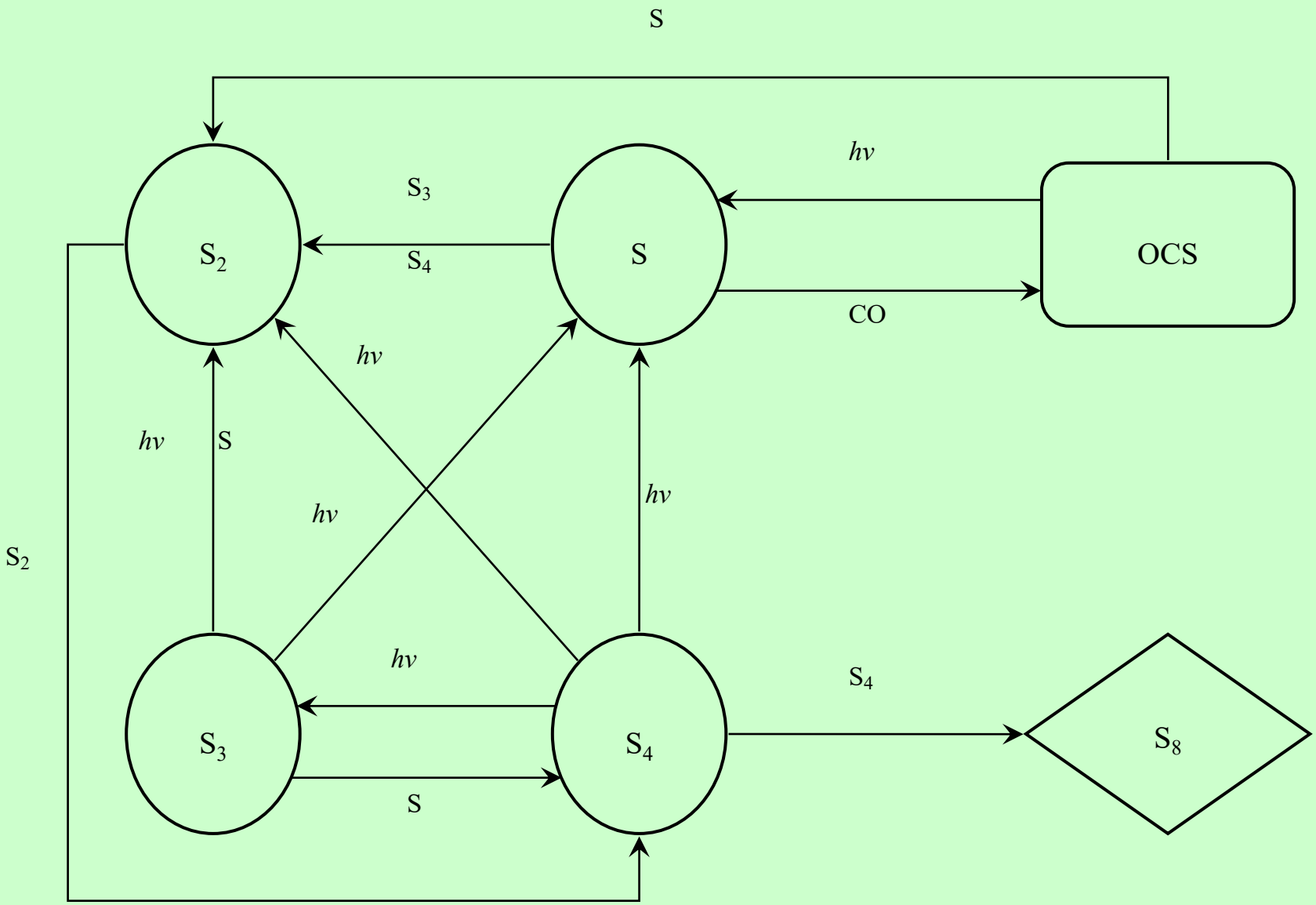
International Venus Conference, 74th Fujihara Seminar
Niseko, Japan, May 31 – June 3 2019



Mills, Esposito and Yung 2006

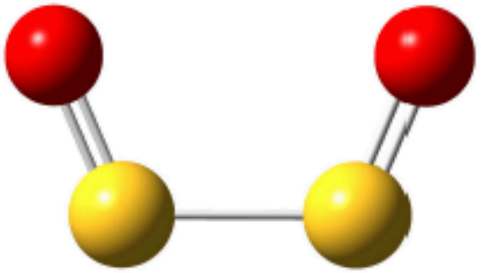
Polysulfur Chemistry (Yung et al. 2009)



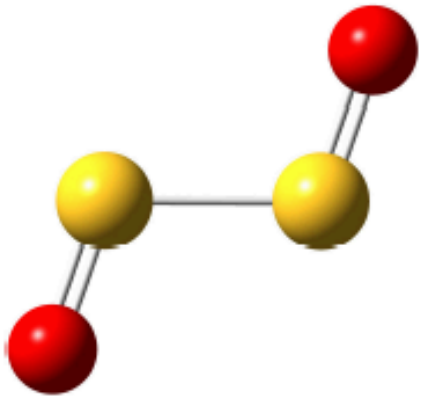
Frandsen et al. 2016, Krasnopolsky 2018, Wu et al. 2018

$SO + SO = (SO)_2$

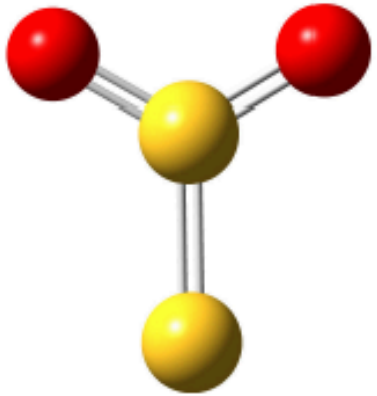
cis-OSSO



trans-OSSO



trigonal-S_2O_2

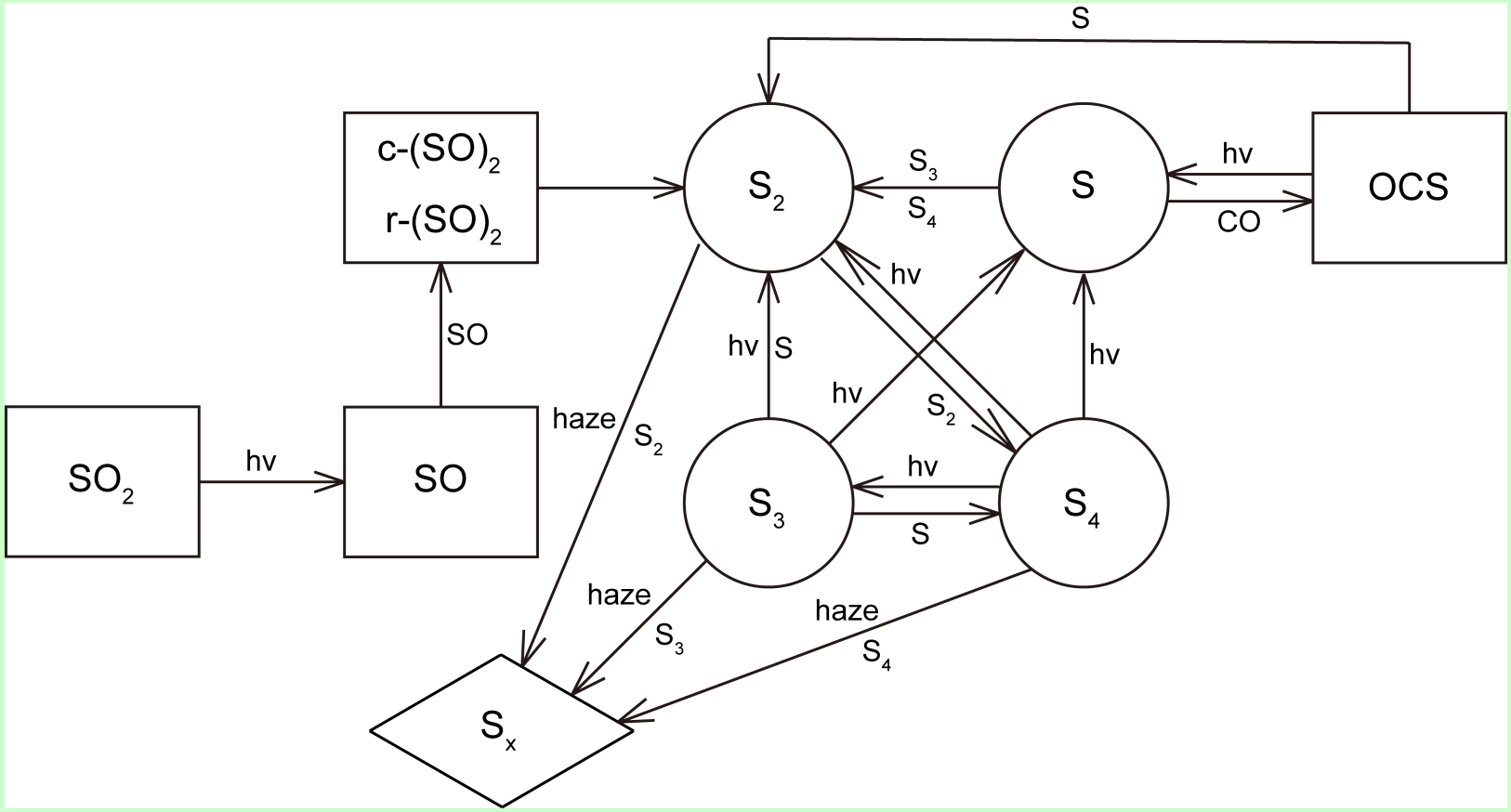


c-OSSO

t-OSSO

r-S2O2

SO Dimer as a path to Sx



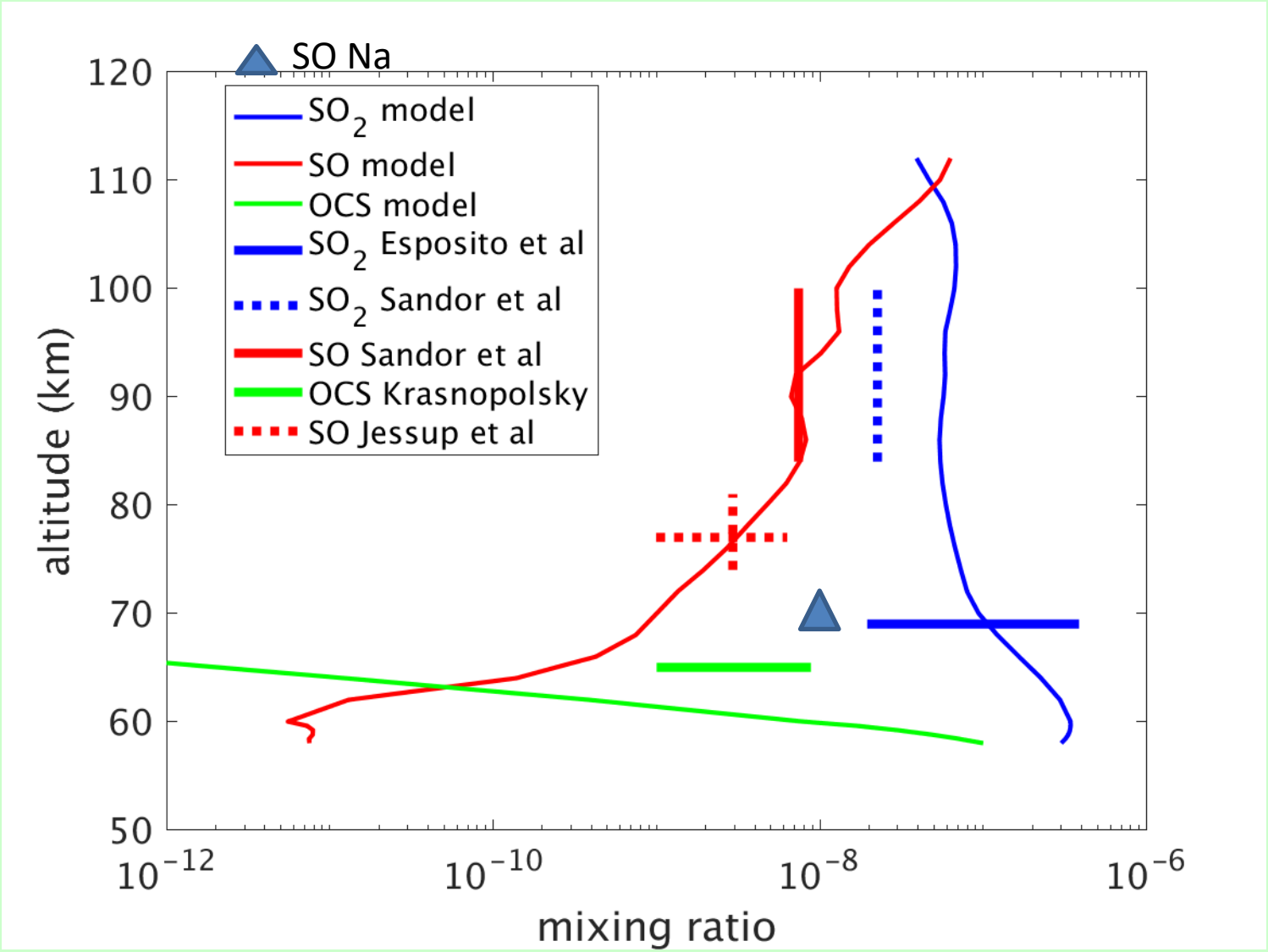
Caltech/JPL KINETICS Model

Based on Yung and DeMore (1982)

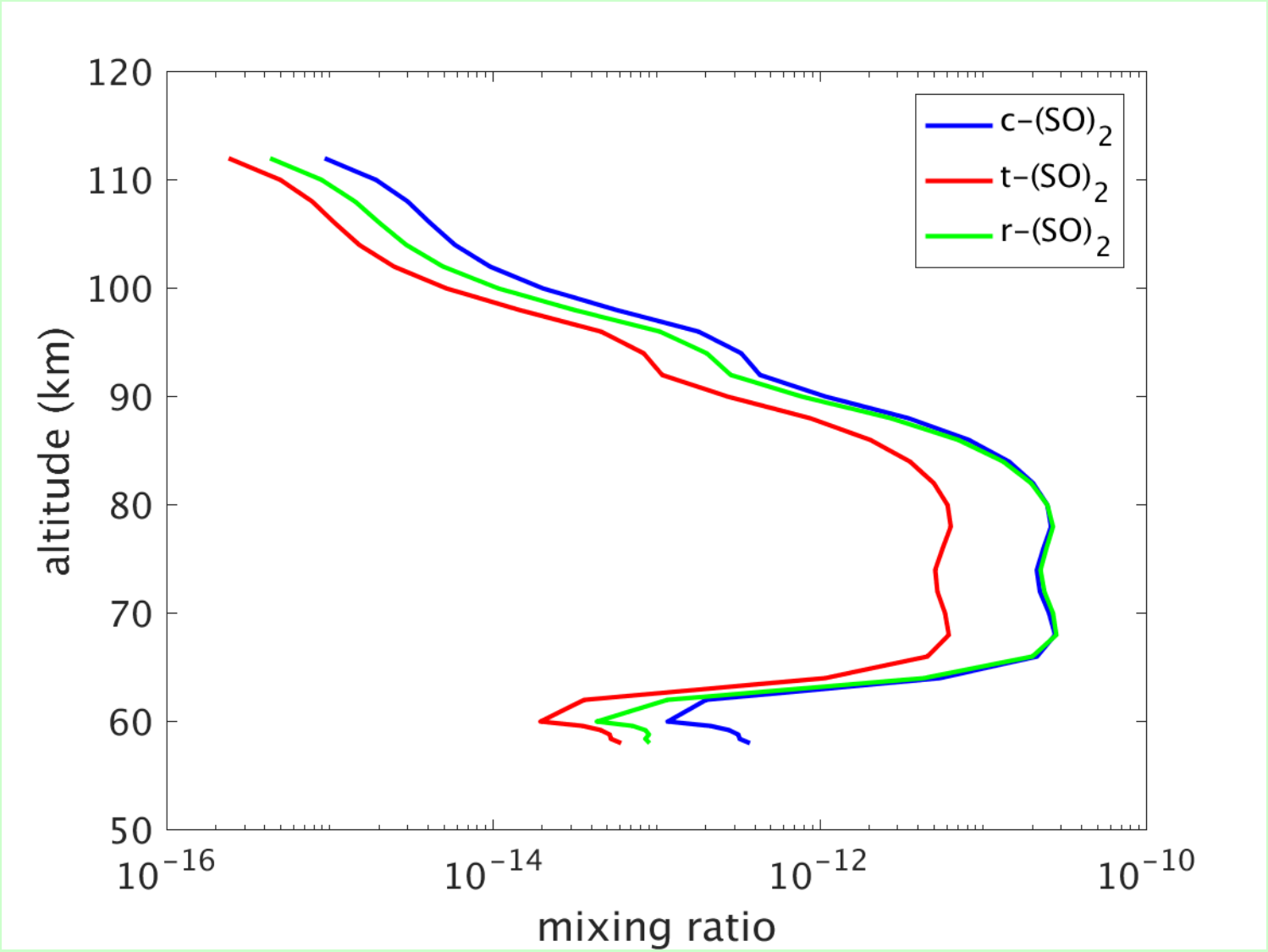
60 species

488 reactions

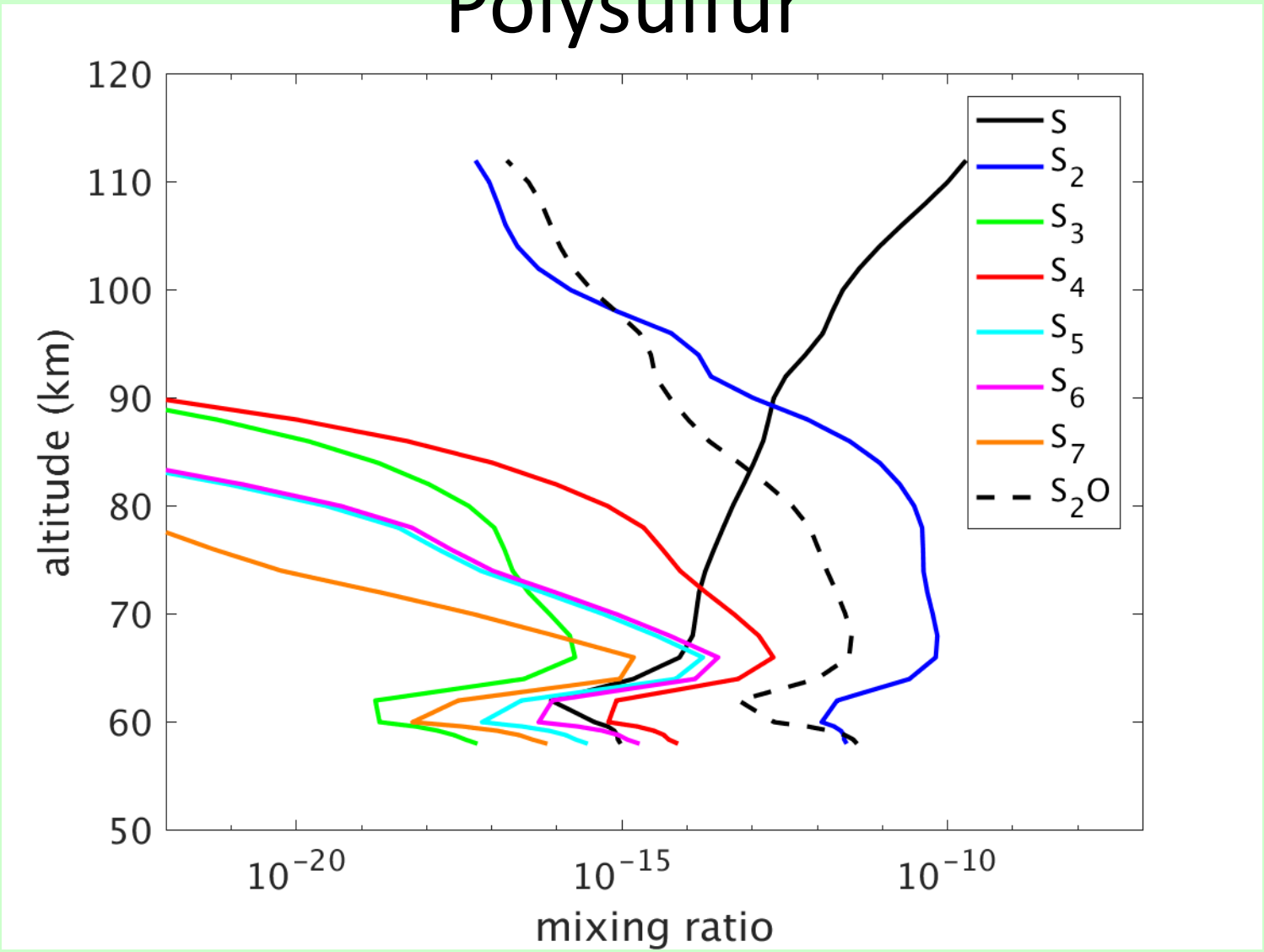
~30 new dimer reactions


SO Na
SO2 model
SO model
OCS model
SO2 Esposito et al
SO2 Sandor et al
SO Sandor et al
OCS Krasnopolsky
SO Jessup et al
altitude (km)
120
110
100
90
80
70
60
50
10−12
10−10
10−8
10−6
mixing ratio

SO dimer


120
110
100
90
80
70
60
50
altitude (km)
10^{-16}
10^{-14}
10^{-12}
10^{-10}
mixing ratio
c-$(SO)_2$
t-$(SO)_2$
r-$(SO)_2$

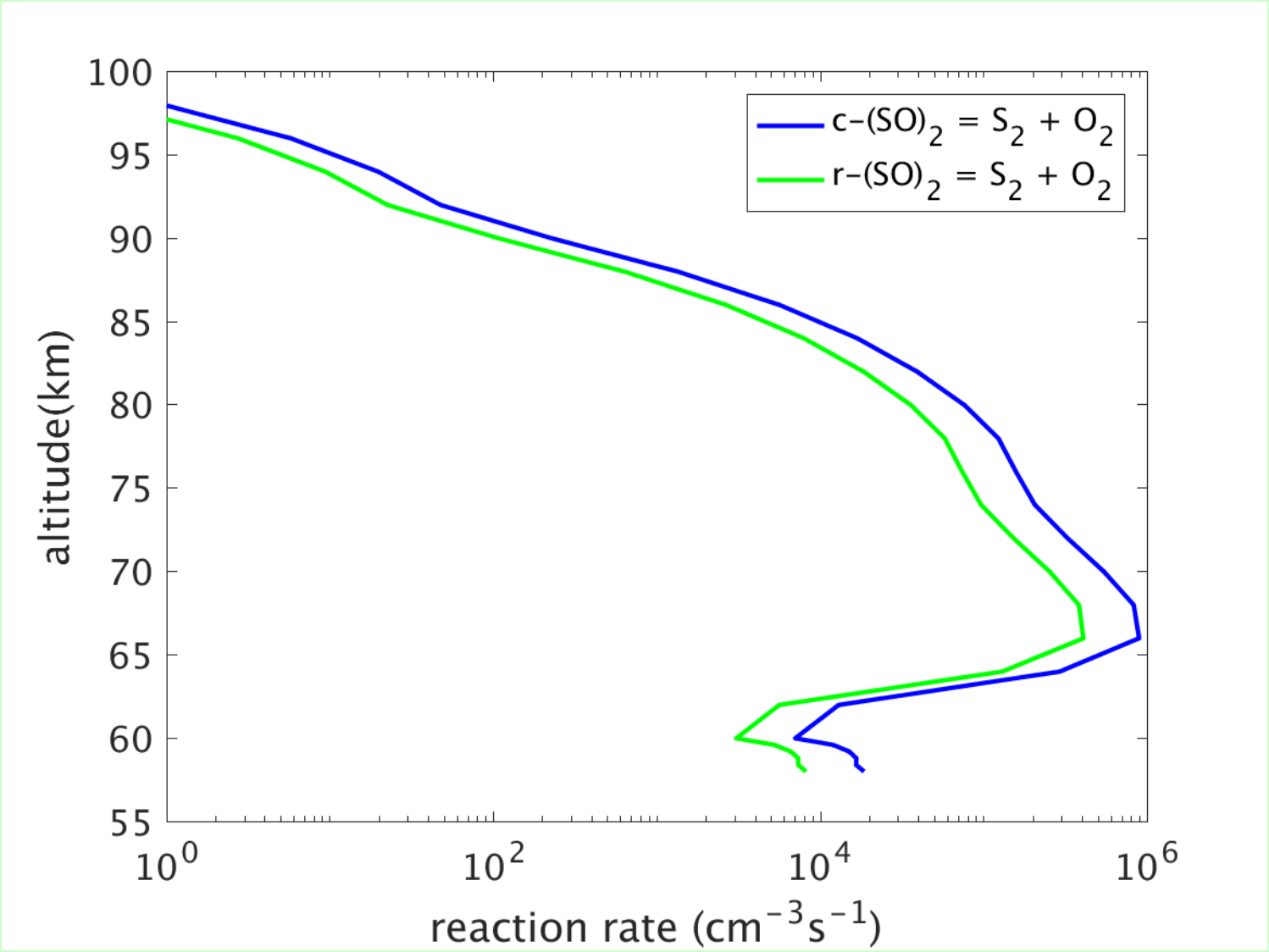
Polysulfur


120
110
100
90
80
70
60
50
altitude (km)
10^{-20}
10^{-15}
10^{-10}
mixing ratio
S
S_2
S_3
S_4
S_5
S_6
S_7
S_2O

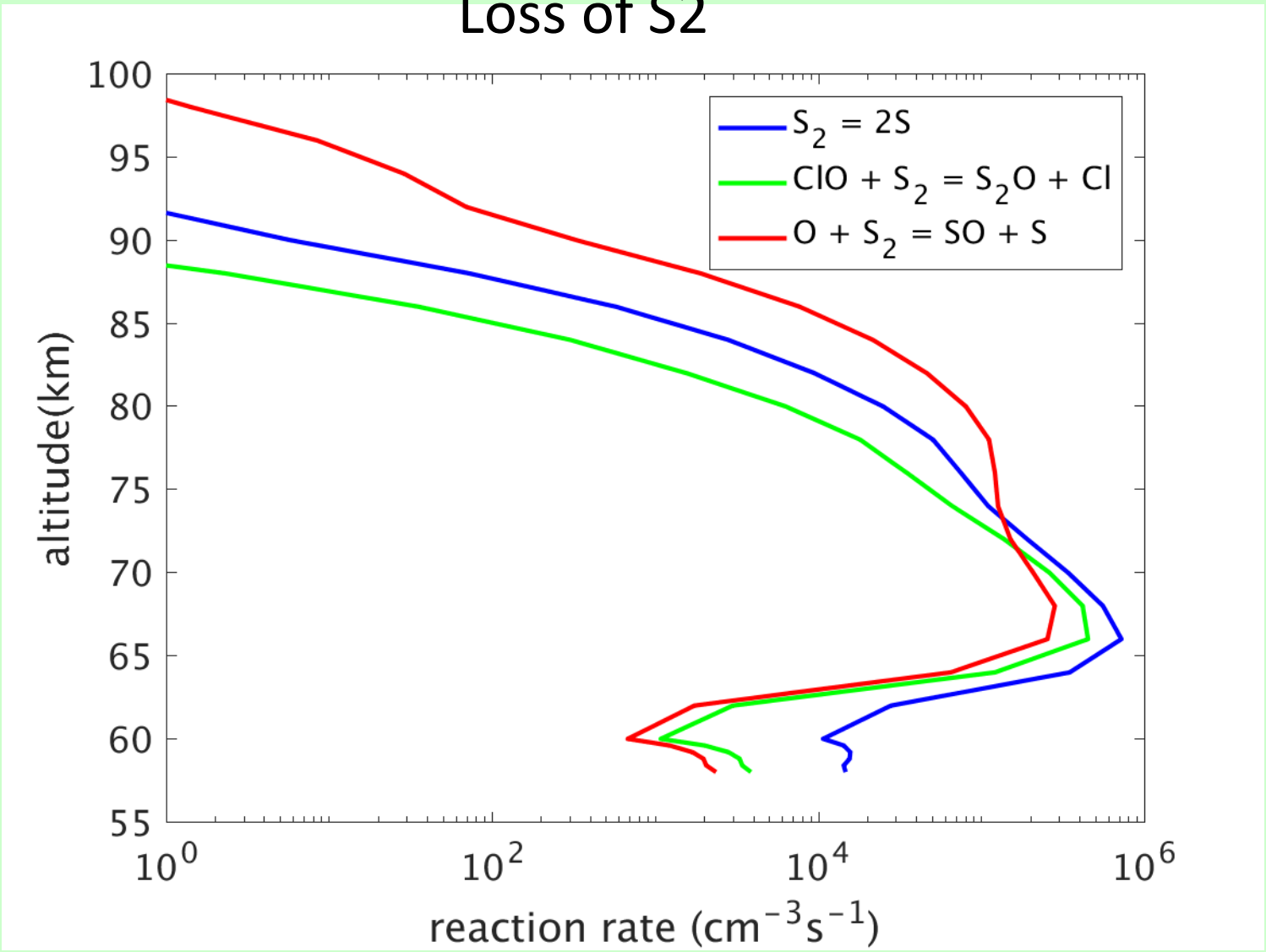
Column Abundances: molecules cm^{-2}

SO	1.8×10^{15}
S_2O	7.5×10^{12}
c-$(SO)_2$	3.3×10^{13}
t- $(SO)_2$	7.4×10^{12}
r-$(SO)_2$	3.2×10^{13}
Sx	4.7×10^{17}

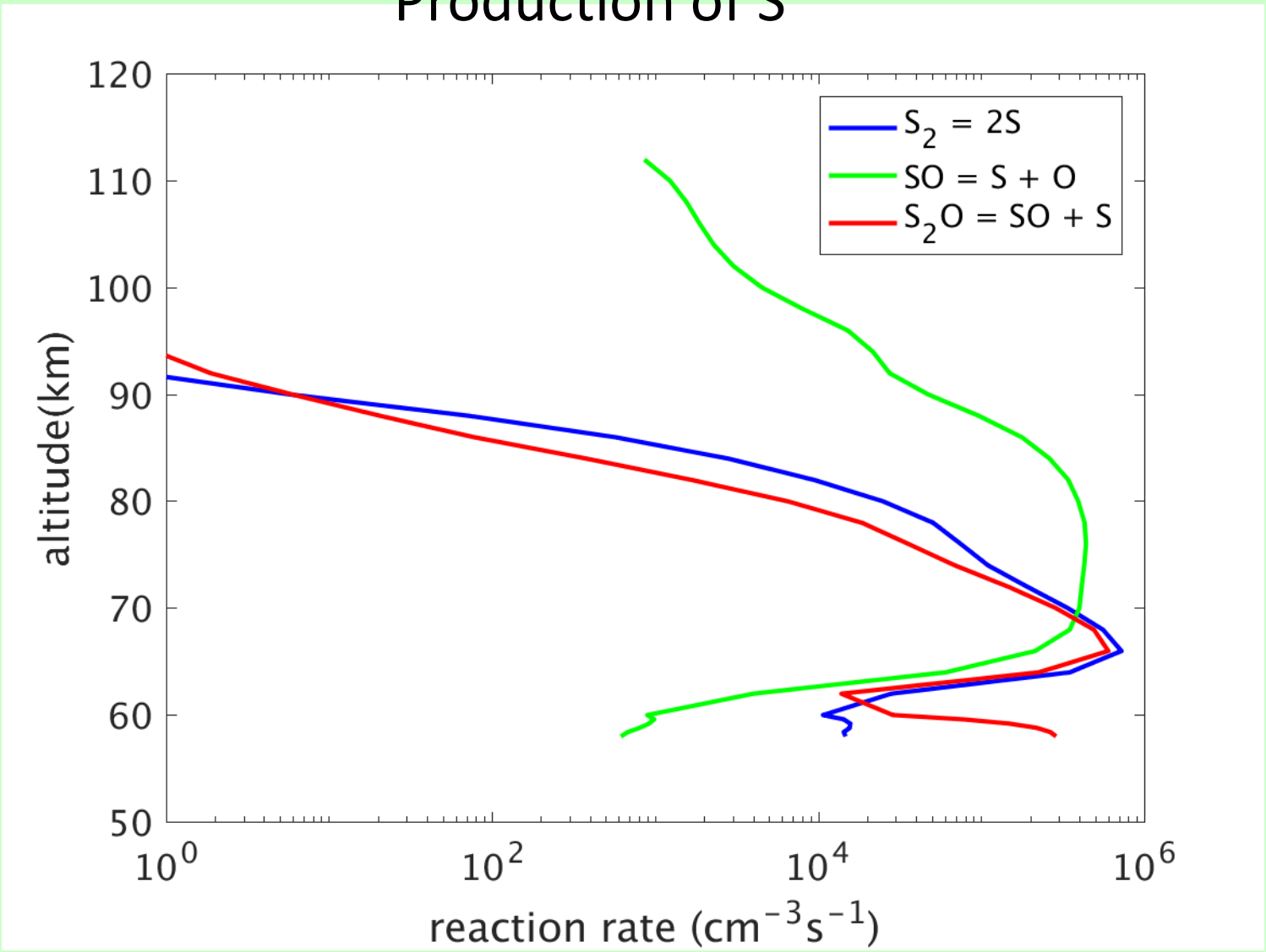
Production of S2 from SO dimer



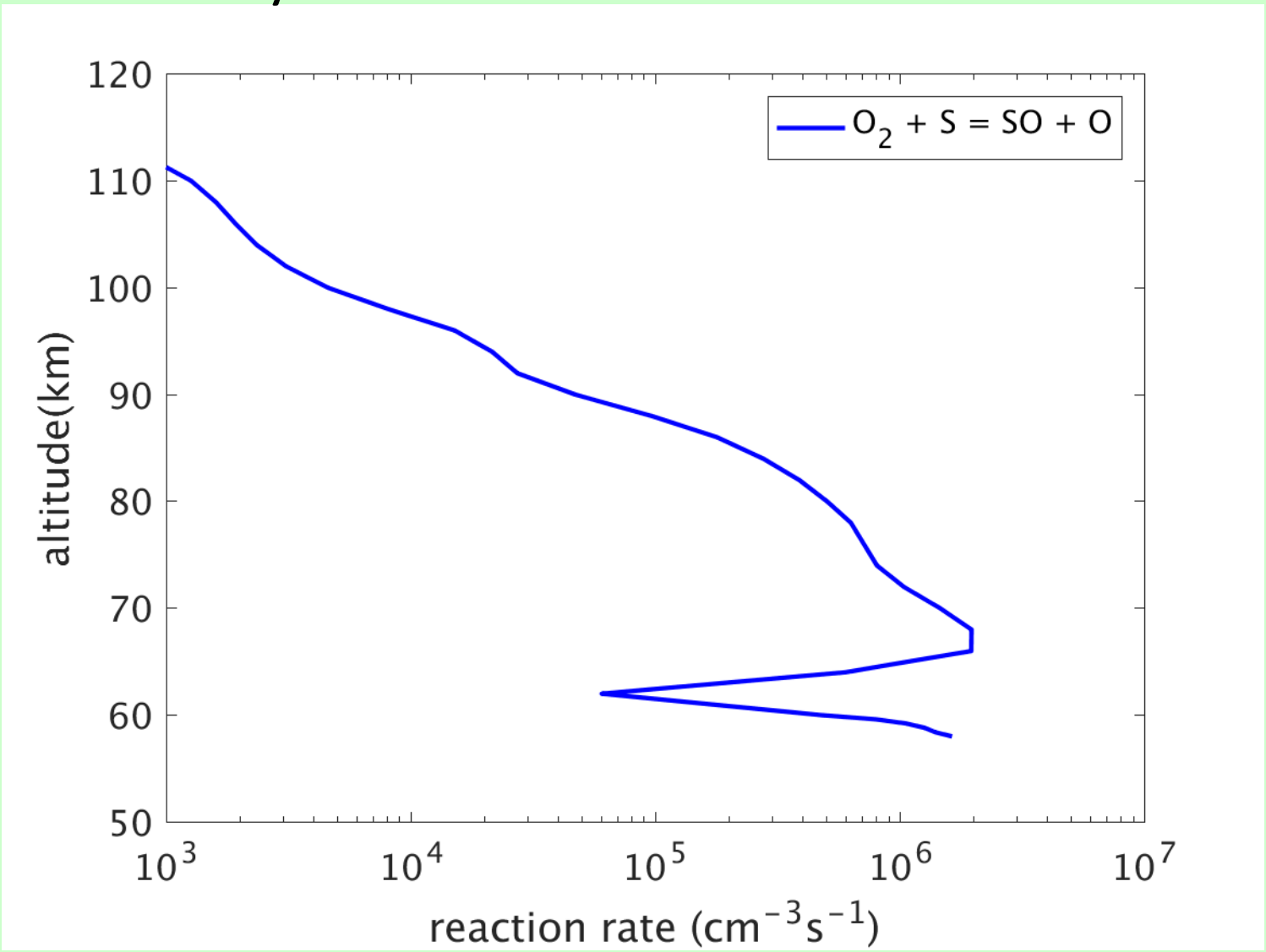
Loss of S2


100
95
90
85
80
75
70
65
60
55
altitude(km)
10^0
10^2
10^4
10^6
reaction rate ($cm^{-3}s^{-1}$)
$S_2 = 2S$
$ClO + S_2 = S_2O + Cl$
$O + S_2 = SO + S$

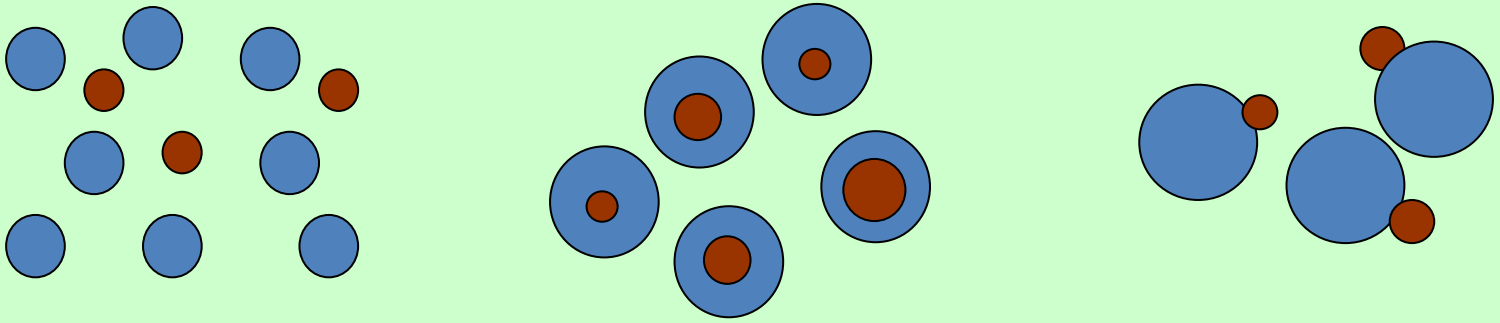
Production of S



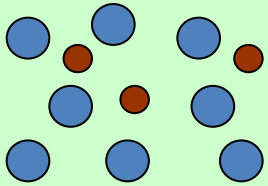
Why it is so hard to make Sx from S

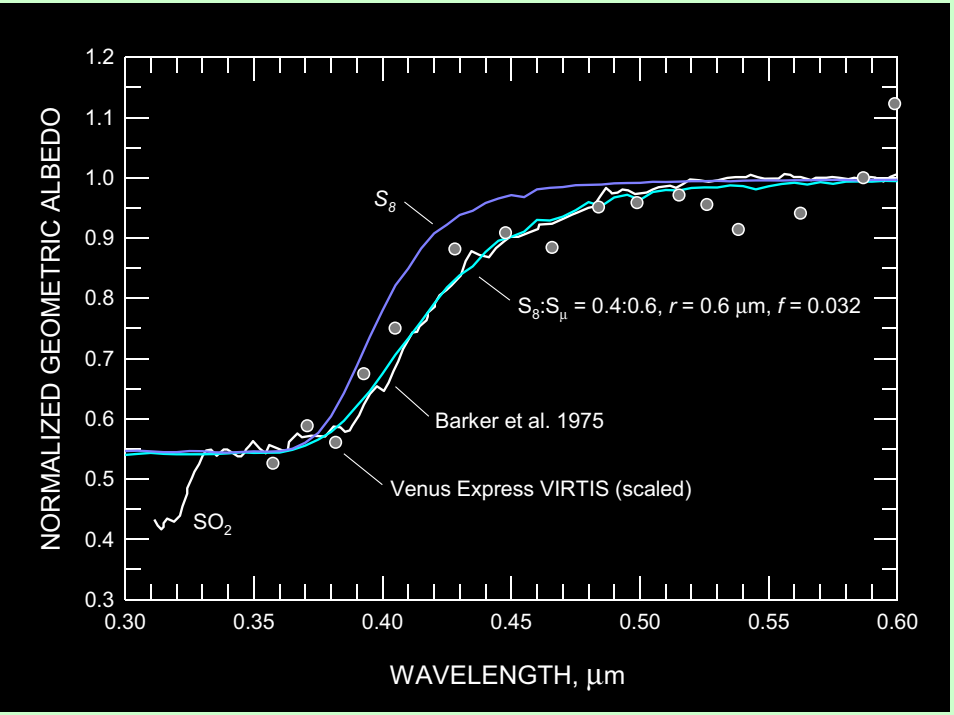


UV Absorber

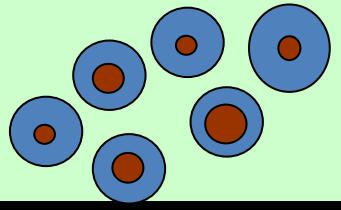


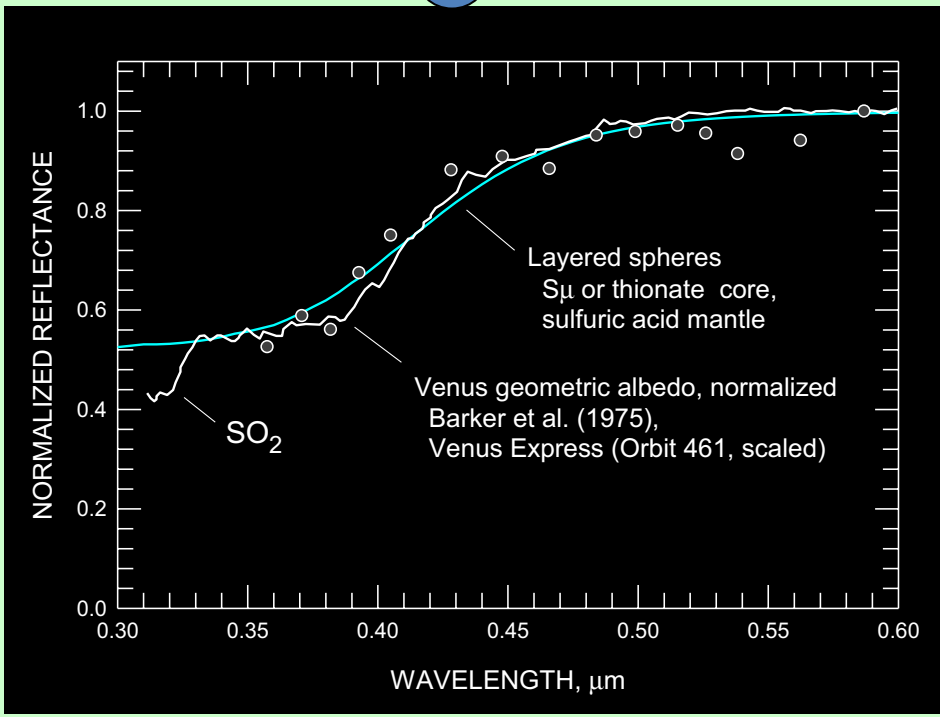
Two-component cloud





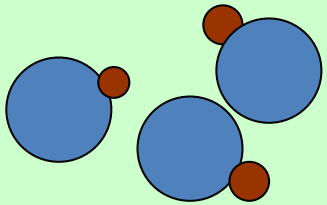
Composite particles

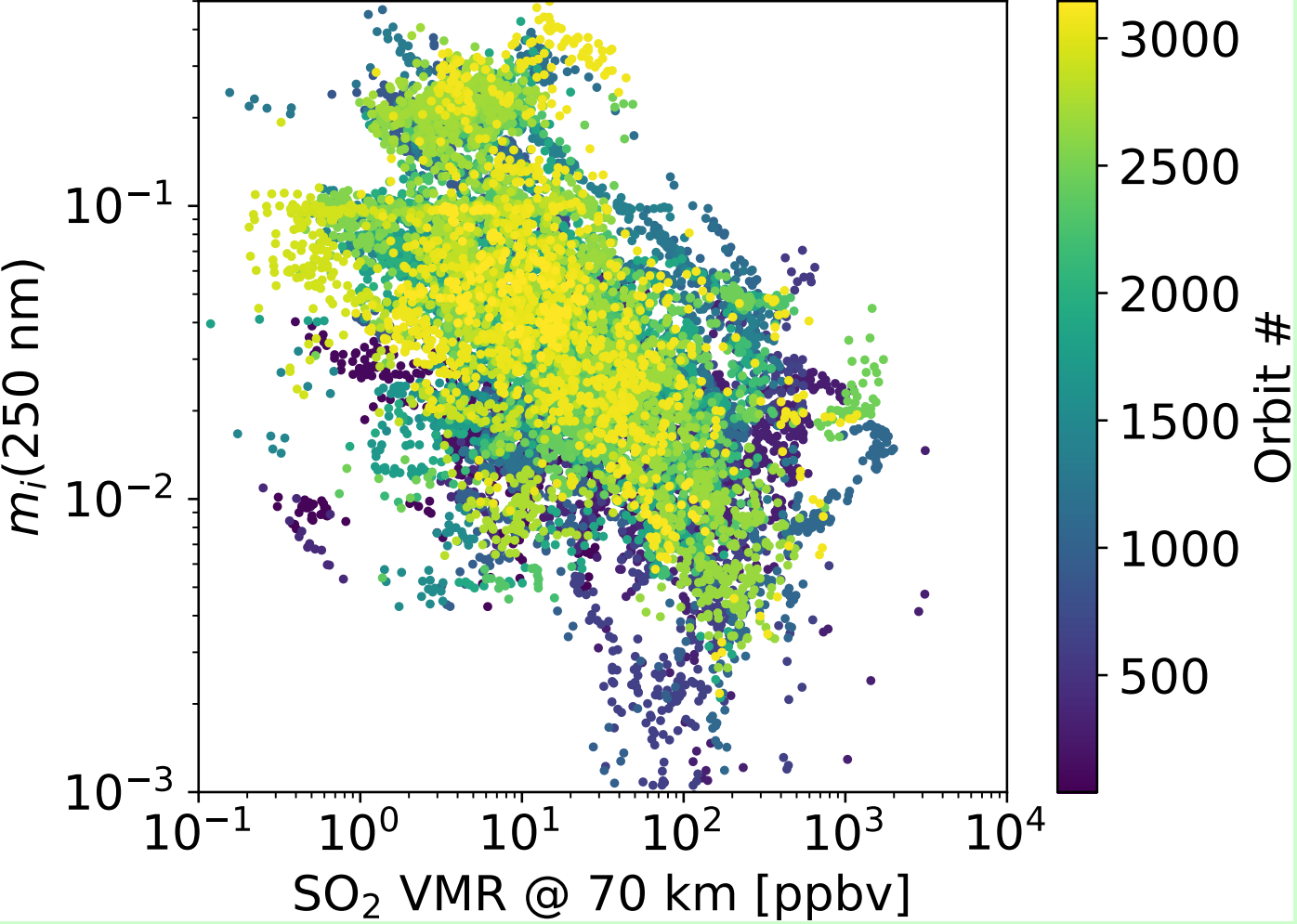




Carlson et al. (2010)

The 'Gumdrop' model





Marcq et al.

2019

Conversion time

~ 1 day

$8SO_2 + 16OCS = 3S_8 + 16CO_2$

$8SO_2 + 16CO = S_8 + 16CO_2$

Implications

- Connection to UV Albedo
- Akatsuki Mission: Patterns and Variability
- Urgent need for laboratory kinetics studies

Must go beyond Herron and Huie (1980)!

Acknowledgements