

**A fully coupled photochemical-condensation  
model of the Venus atmosphere from the  
ground to 110 km**



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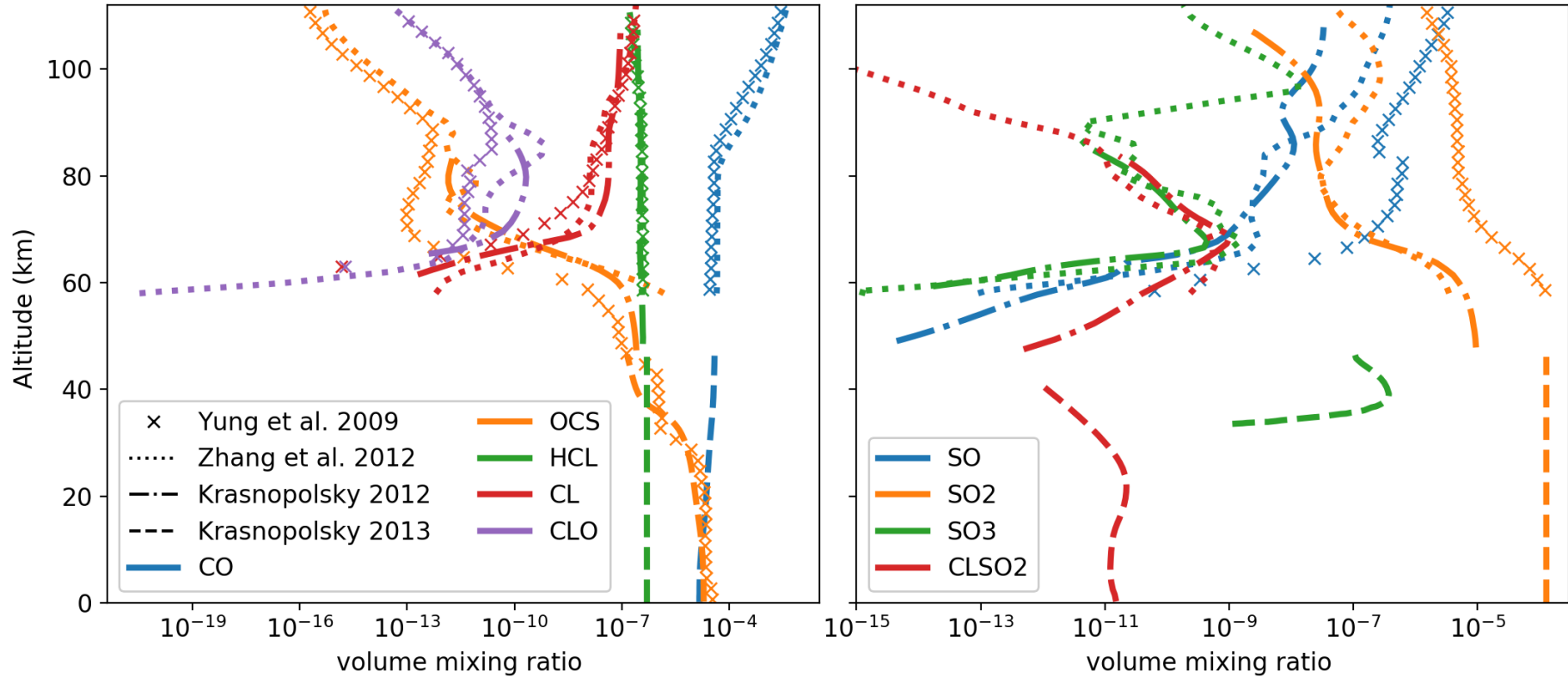
# The chemical structure of the Venus atmosphere



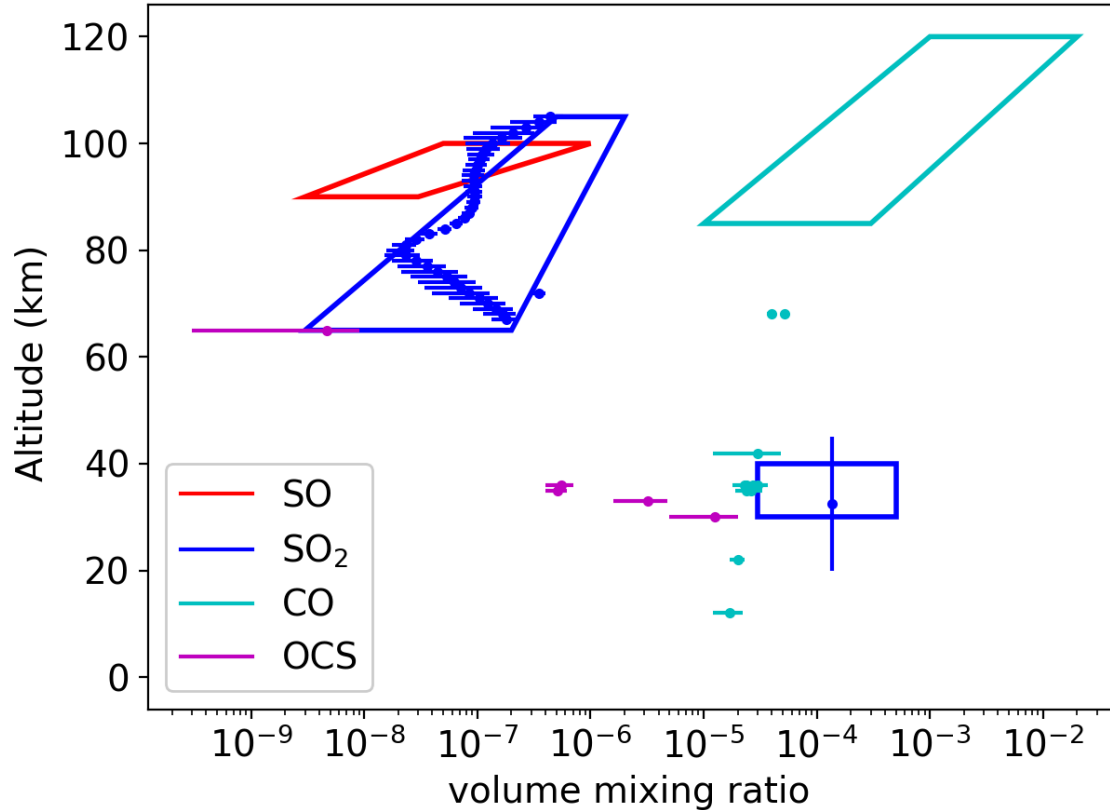
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# Previous models



# Observations

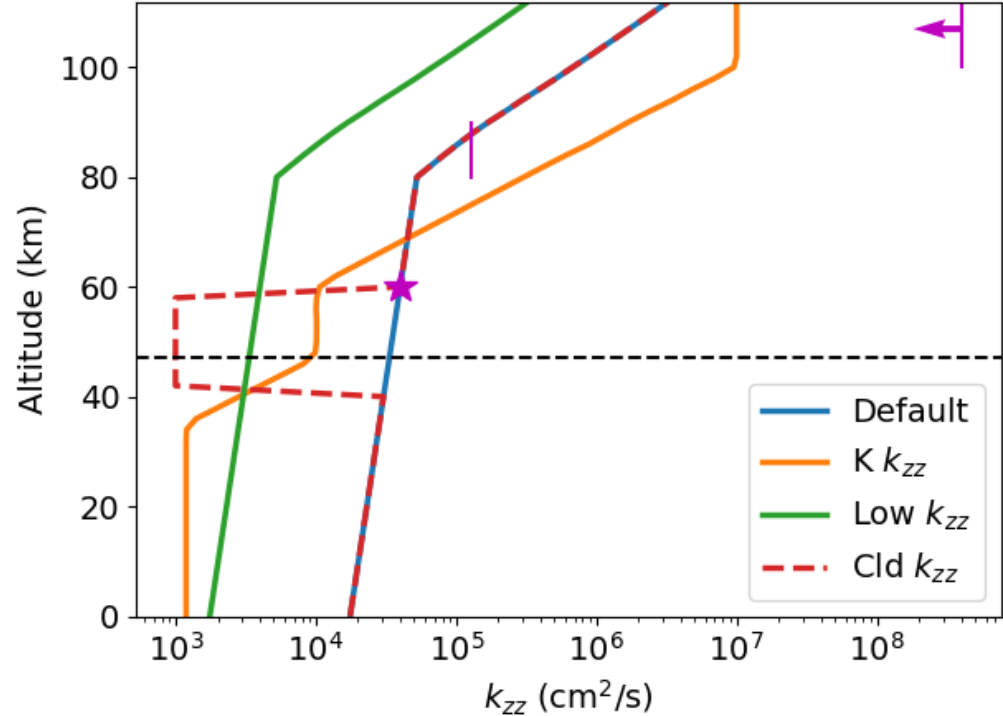


Sources:

Arney et al. 2014,  
Kranspolsky 2010,  
Marcq et al. 2006,  
Bertaux et al. 2007,  
Sandor and Clancy 2018,  
Belyaev et al. 2012,  
Vandaele et al. 2016,  
Vandaele et al. 2017

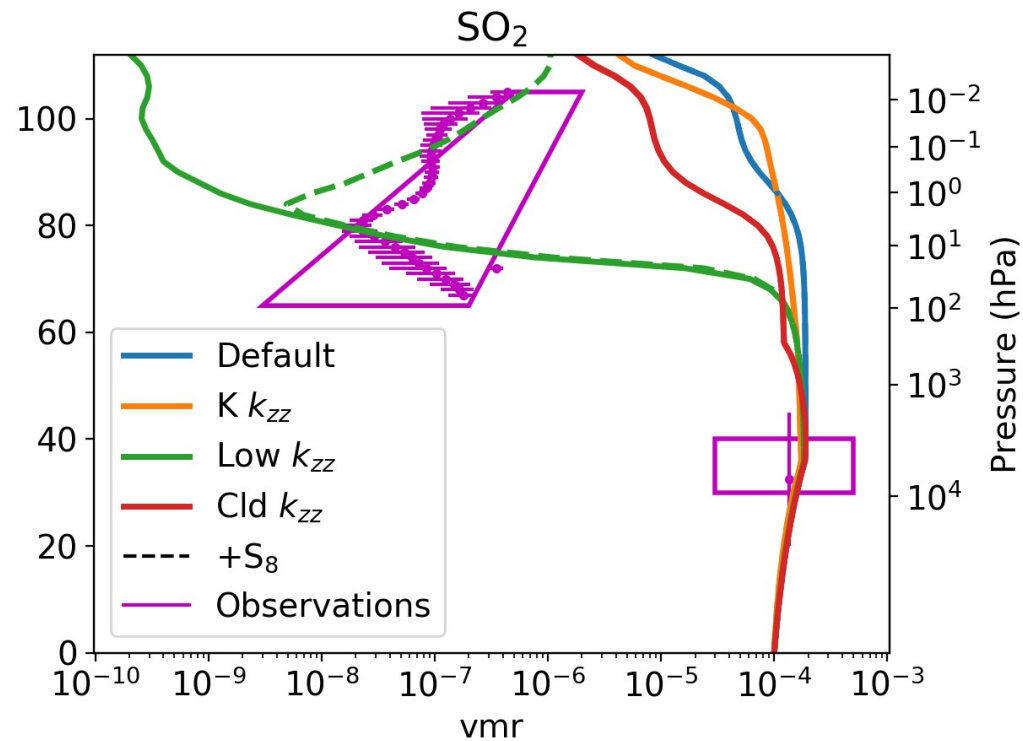
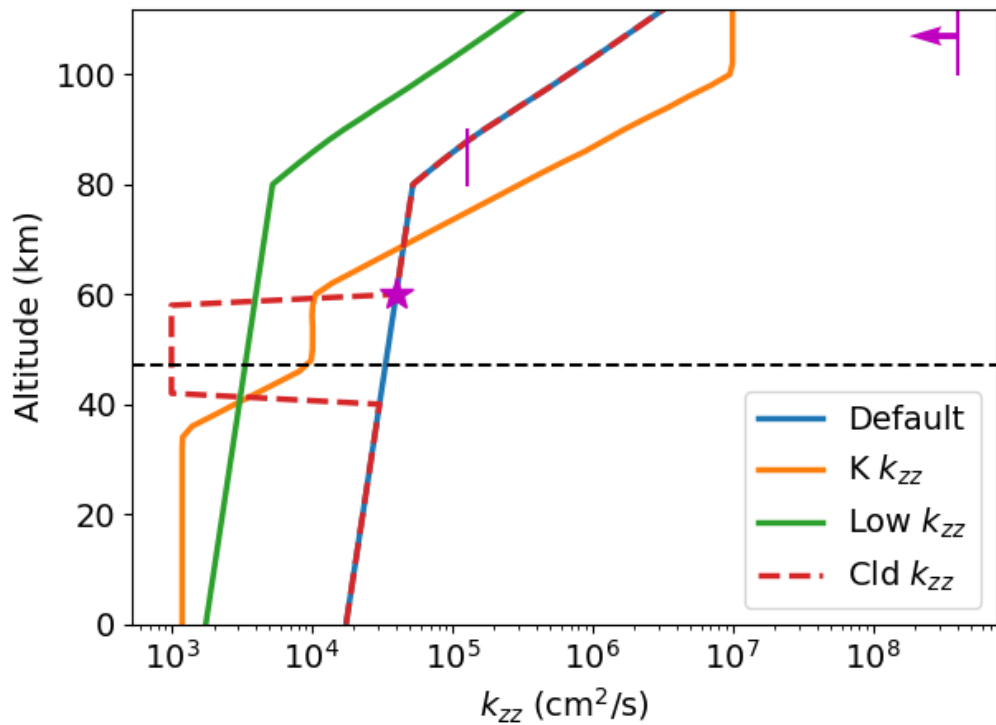
# Our new model

- **Domain: Surface-110 km**
- **Updated chemistry from Zhang et al. 2012**
- **Includes ~50 species ( $\text{SO}_x$ ,  $\text{NO}_x$ ,  $\text{Cl}_x$ ,  $\text{O}_x$ )**
- **Using fixed profiles for  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{SO}_4$ , and  $\text{N}_2$**
- **Not trying to make the best model, but a useful one**



$k_{zz}$  observations from: von Zahn et al., 1979;  
Woo & Ishimaru, 1981; Lane & Opstbaum, 1983

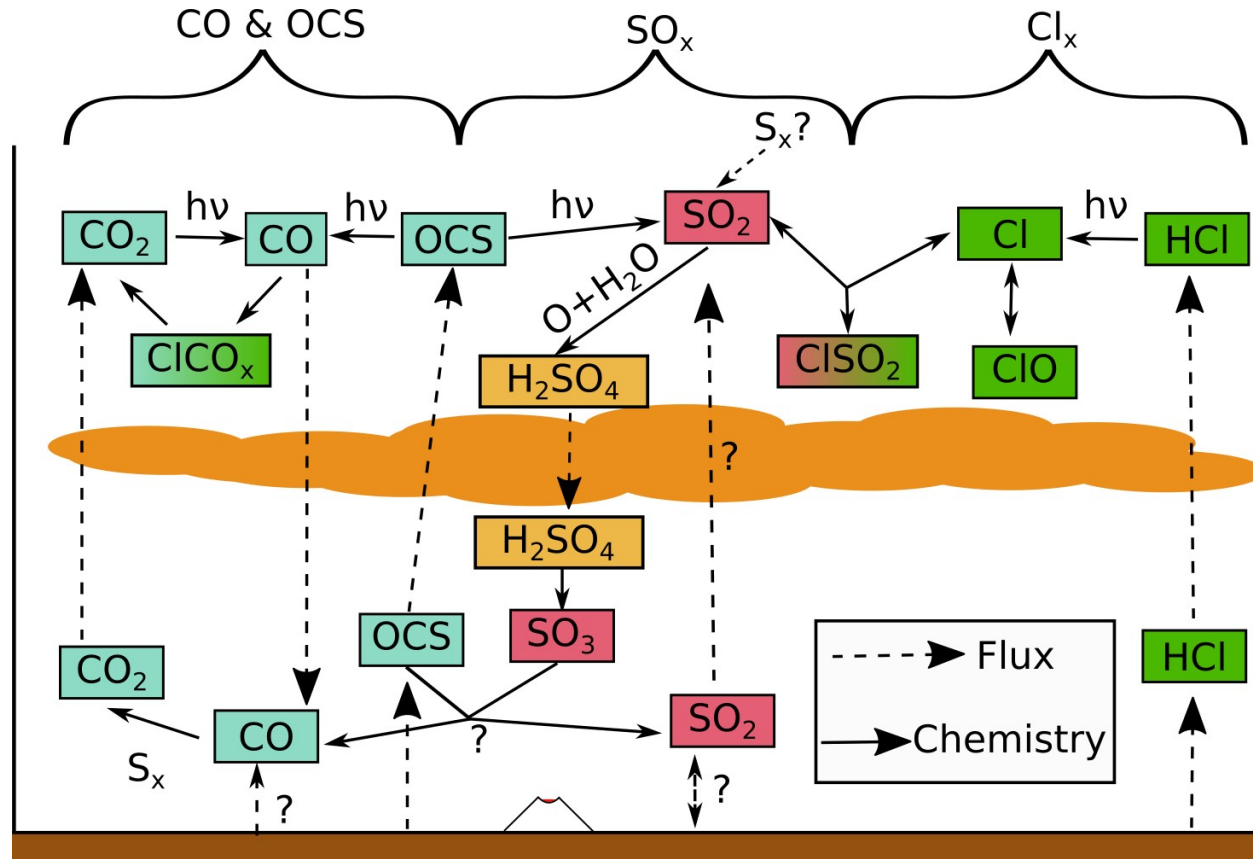
# Profiles



# OCS Destruction pathway

Krasnopolsky and Pollack 1994	Yung et al. 2009	This work
$\text{OCS} + \text{SO}_3 \rightarrow \text{CO}_2 + (\text{SO})_2$ $(\text{SO})_2 + \text{OCS} \rightarrow \text{CO} + \text{SO}_2 + \text{S}_2$	$\text{OCS} + \text{S} \rightarrow \text{CO} + \text{S}_2$	$2\text{SO}_3 + \text{OCS} \rightarrow \text{CO} + 3\text{SO}_2$

# Back to the big picture





# Findings

- **Eddy diffusivity alone is not enough to limit SO<sub>2</sub> flux through the clouds**
- **Some chemical pathways break down with more complete chemistry**
- **We need to carefully consider the physical implications of boundary conditions in the cloud deck**

# Next steps

- **Next Steps:**
  - Integrate condensation
  - Test mechanisms for limiting  $\text{SO}_2$  flux through the clouds
- **Needed lab studies:**
  - Polysulfur chemistry ( $\text{S-S}_8$ )
  - $\text{SO}_3$ -OCS chemistry