

# The role of sulfur in detecting climate change on Venus

Mark A. Bullock

Southwest Research Institute

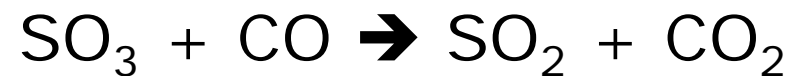
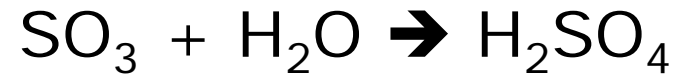
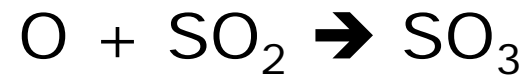
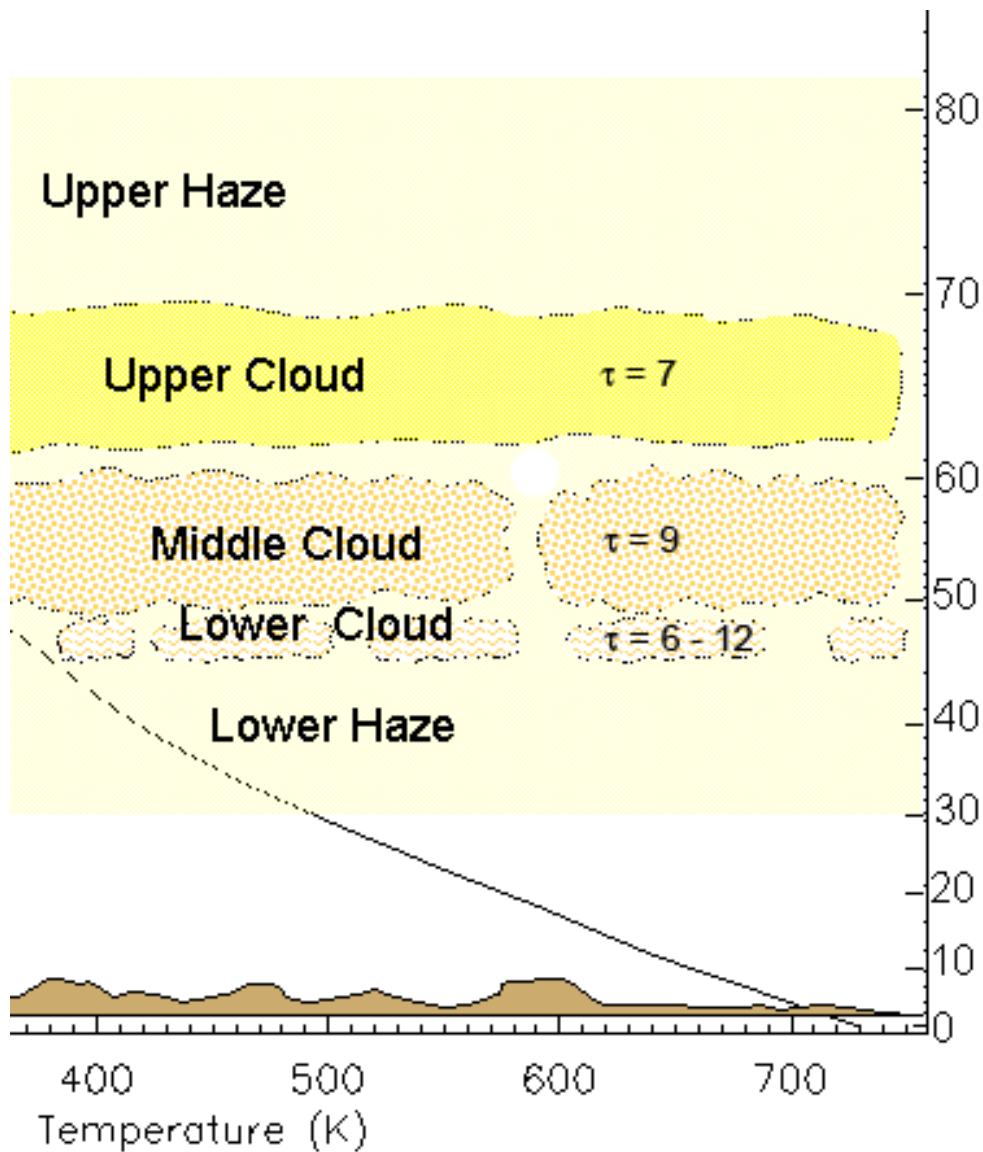
February 27, 2008

Venus Geochemistry: Progress, Prospects,  
and New Missions LPI Gilruth Center

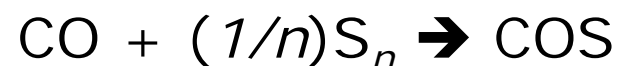
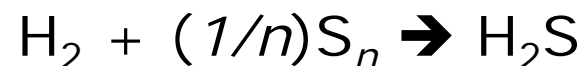
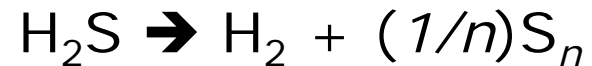
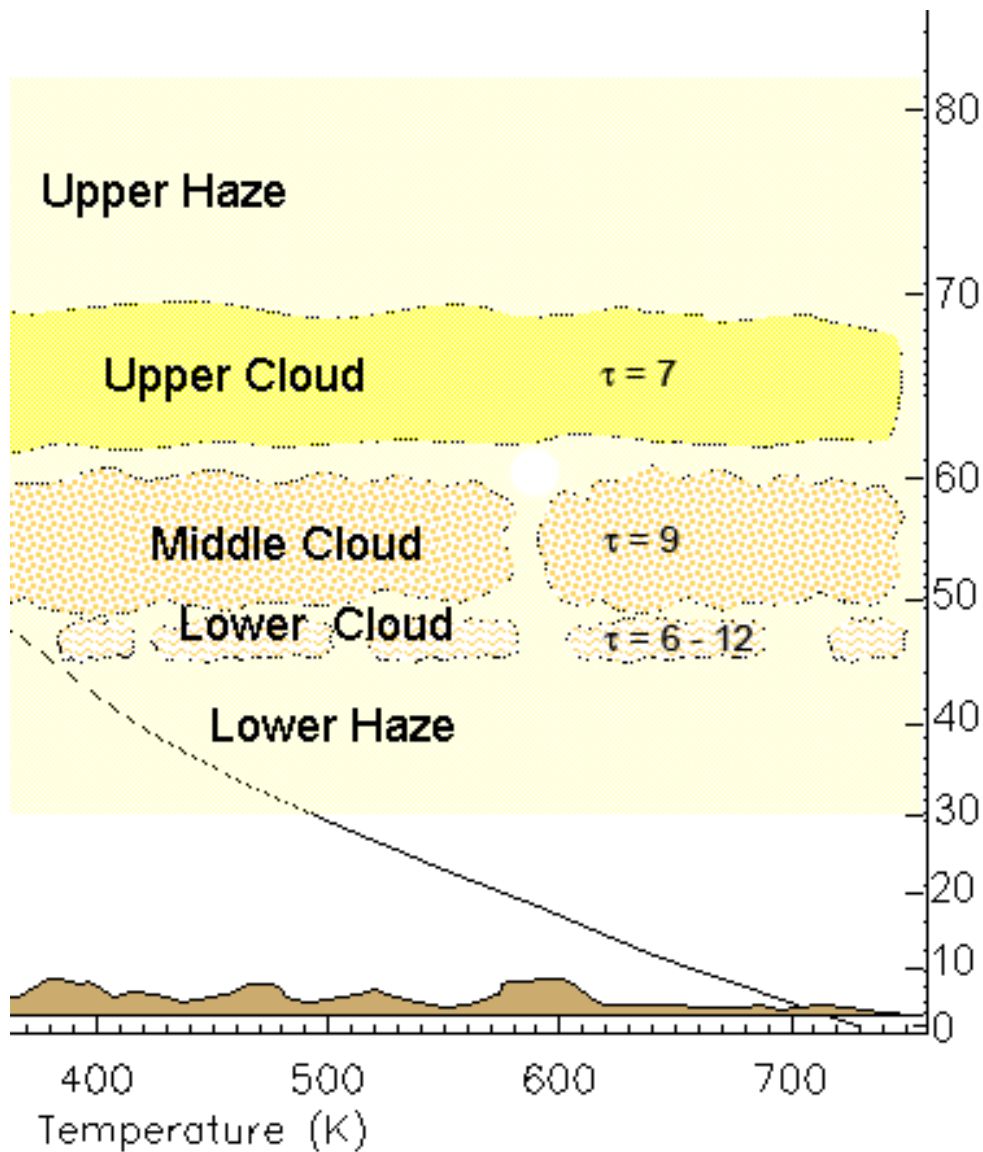
# Sulfur Cycles

- Fast Atmospheric
  - Photochemical production of  $\text{H}_2\text{SO}_4$
  - CO is consumed beneath the clouds
- Slow Atmospheric
  - Distributes S between  $\text{SO}_2$ , COS, and  $\text{H}_2\text{S}$ , and  $\text{S}_n$ .
- Slow Geologic
  - Sulfides decompose to COS and  $\text{H}_2\text{S}$ .
  - S is taken up by calcite conversion to anhydrite
  - Anhydrite converted back to sulfides.

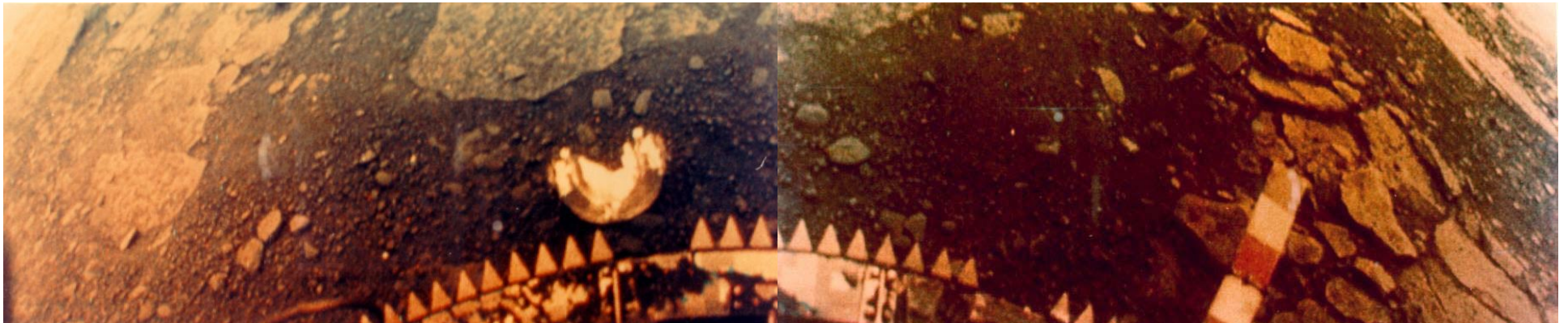
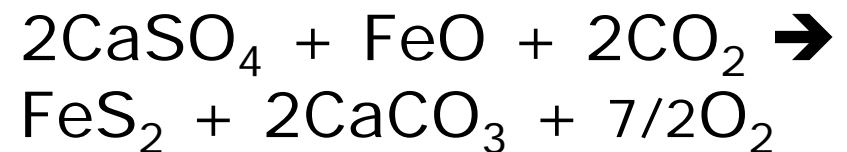
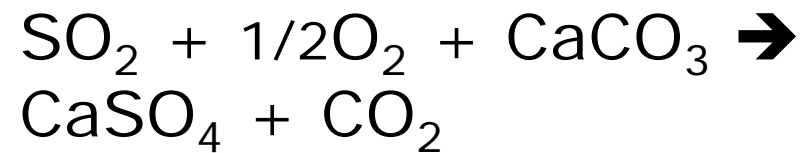
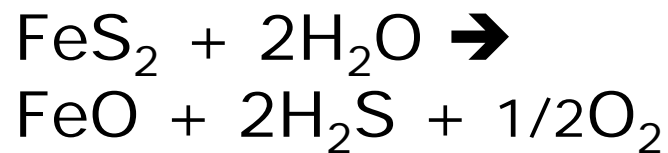
# Fast Atmospheric S Cycle



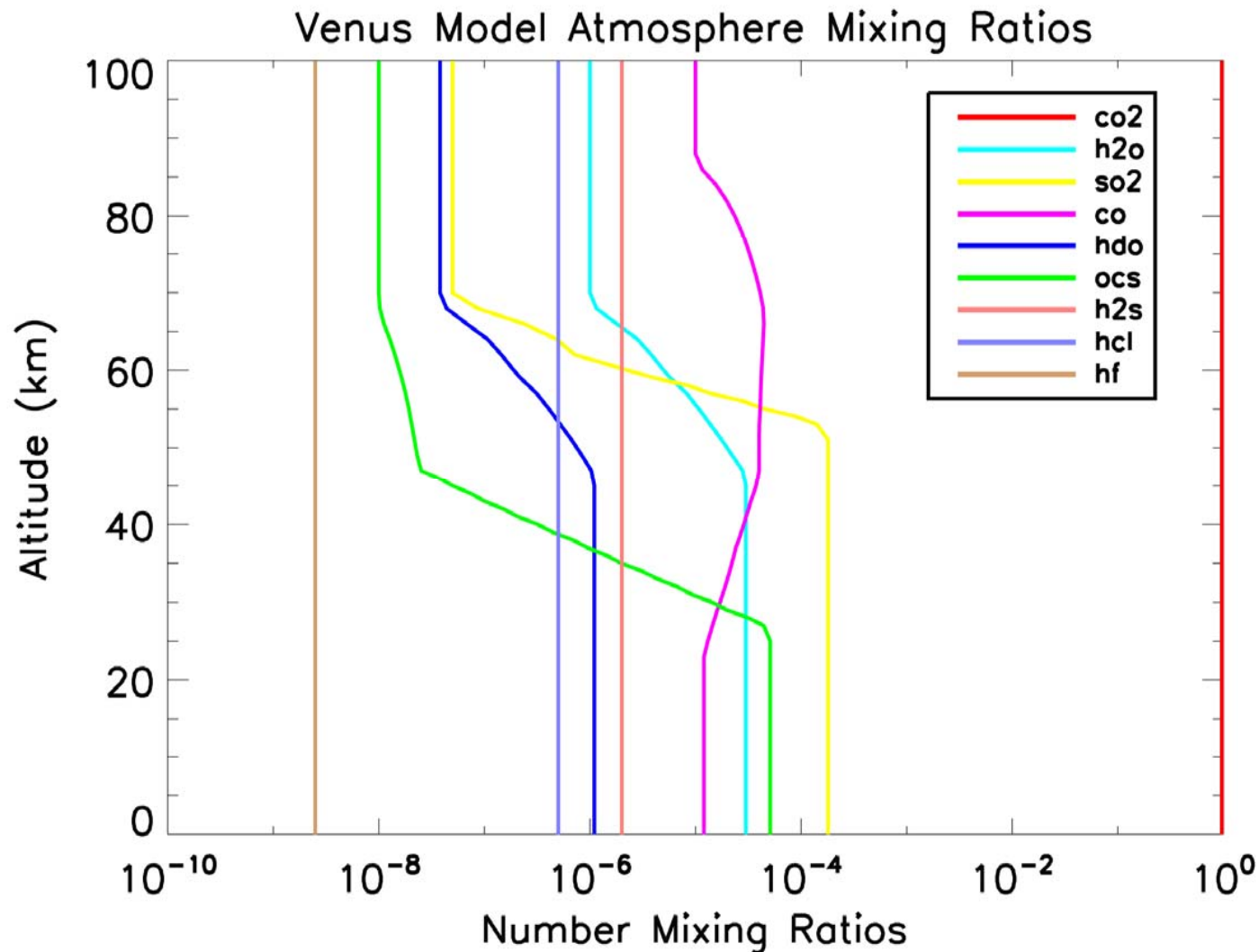
# Slow Atmospheric S Cycle



# Geologic Sulfur Cycle

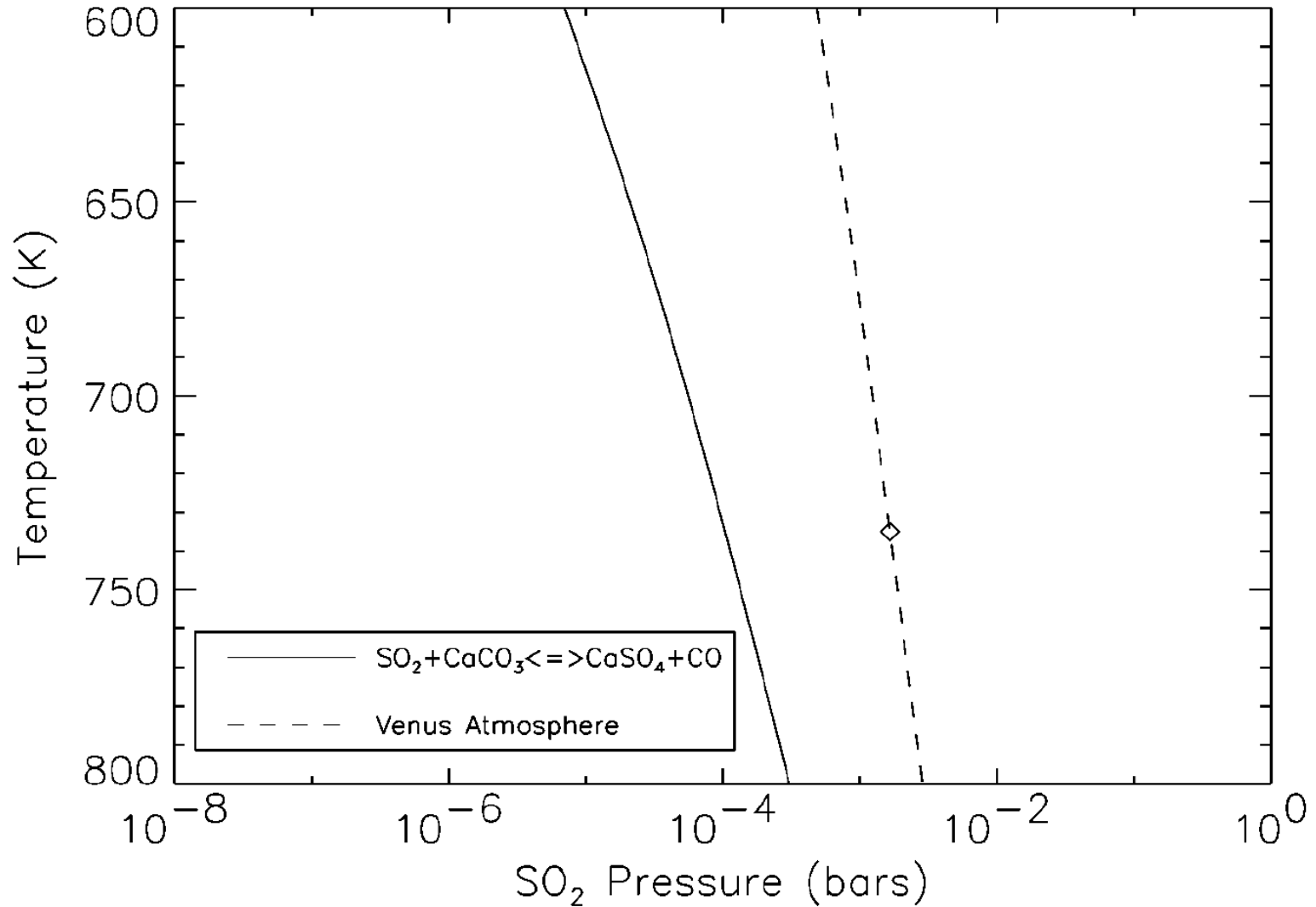


# Minor Gases

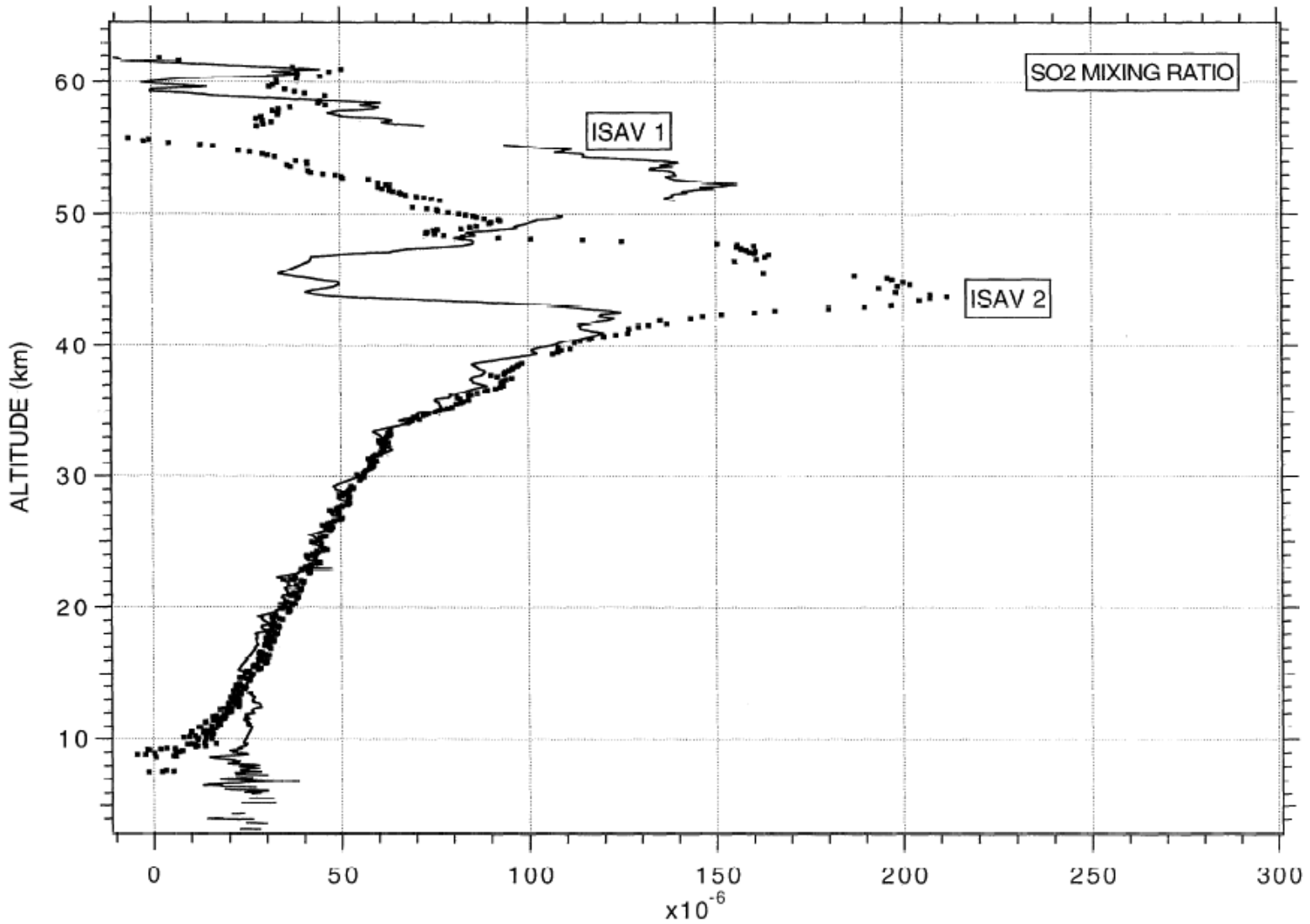


- Greenhouse gases: H<sub>2</sub>O, SO<sub>2</sub>, OCS, CO, H<sub>2</sub>SO<sub>4</sub>, HCl, HF
- Cloud-forming gases: SO<sub>2</sub>, H<sub>2</sub>O, OCS, CO, H<sub>2</sub>SO<sub>4</sub>
- Noble gases: He, Ne, Ar, Kr, Xe

# SO<sub>2</sub> Atmosphere-Mineral Equilibrium



# How Much Sulfur is in the Venus Atmosphere?



# Implications

- Is  $\text{SO}_2$  in chemical equilibrium with surface minerals?
- If the surface is a net sink for S, does current volcanism provide the source?
- Could atmospheric S decrease to the point that the clouds disappear?
- What is the variation of S alteration products with depth in surface rocks? With different lithologies?
- What does this tell us about the history of  $\text{SO}_2$  and the persistence of the clouds and greenhouse?