Mysteries of the sulfur cycle on Venus

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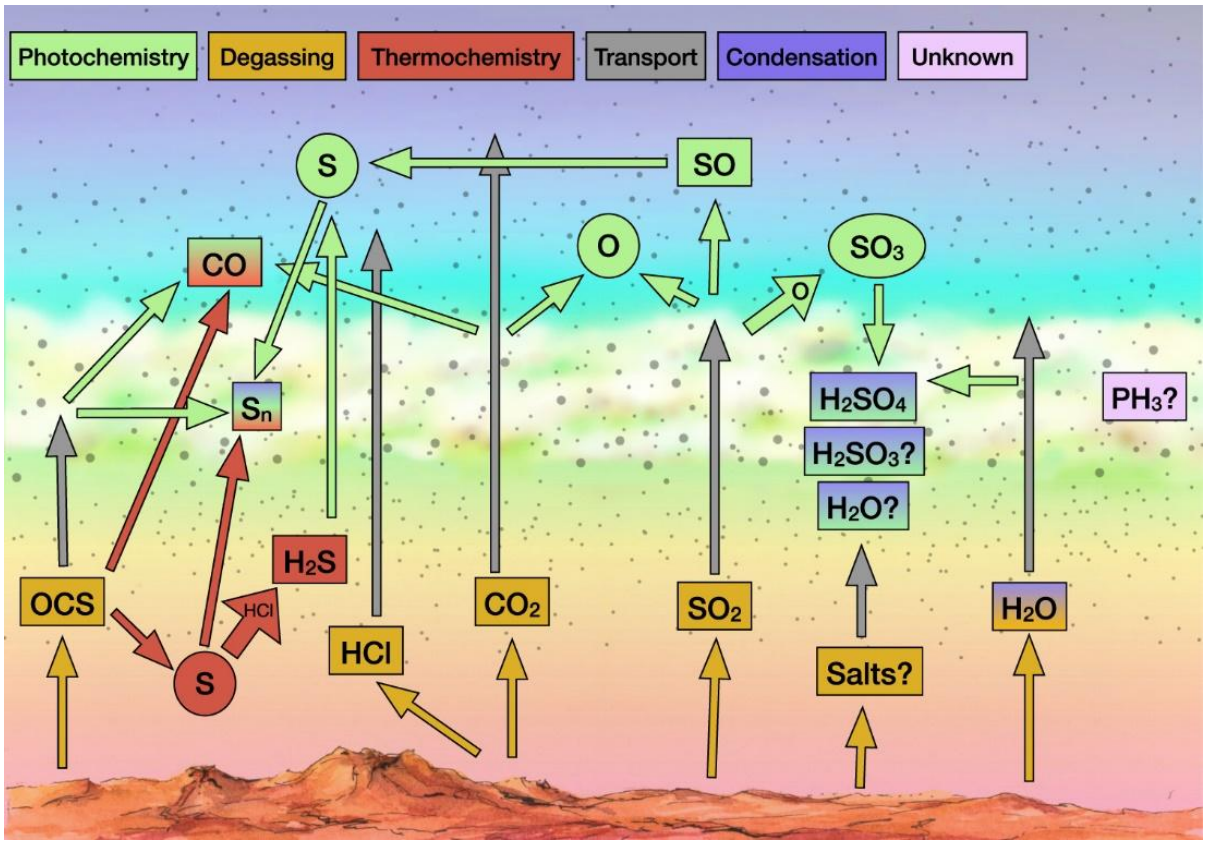

Figure 1 - A scheme of the sulfur cycle on Venus. Reproduced from [1].

Project highlights:

- The sulfur cycle on Venus is critical to the composition of the Venusian atmosphere but still puzzles us to this day
- This project will investigate components of the sulfur cycle to investigate its observed spatiotemporal distribution
- Opportunity to participate in the ESA EnVision mission preparations to Venus in the 2030s

Project description:

The sulfur cycle is a vital chemical cycle in the atmosphere of Venus; sulfur dioxide is transported from the lower atmosphere to the middle atmosphere where it is then dissociated by UV light to form multiple sulfur-bearing species essential for the formation of Venus' sulfuric acid clouds and haze. The atmospheric dynamics on Venus can also be traced through the long-lived sulfur dioxide in its atmosphere. This project will involve the use of the state-of-the-art Venus Planetary Climate Model [2] that now includes a comprehensive

photochemistry module [3] to investigate the Venusian sulfur cycle and the atmospheric processes that control its observed distribution.

Several mysteries related to the sulfur cycle on Venus still puzzle scientists to this day. Spatial variations in sulfur dioxide have been observed by multiple spacecraft that are extremely difficult to explain by known atmospheric physical, chemical or dynamical processes [4,5]. The gradient of sulfur dioxide from the lower atmosphere to the upper atmosphere is also massively underestimated from current understanding of atmospheric processes, hinting at missing atmospheric processes that are not yet accounted for.

The project will involve the simulation of chemistry and dynamics in the atmosphere of Venus and detailed comparison of model predictions with observations made by orbiting spacecraft and historical data. The cause of observed spatial and temporal variations in sulfur dioxide will be investigated.

Modelling work in this project will be closely linked to past and present observations of sulfur species taken by multiple satellites that have observed the atmosphere of Venus. There are also several upcoming missions destined for Venus in the 2030s, one being the European Space Agency's EnVision mission that includes as part of its payload suite the VenSpec-U instrument, which our team at the Open University is involved in. This project will provide preparations for the science observations and analysis from this mission, through involvement in the instrument team.

References:

1. Rimmer, P.B et al., 2021. Hydroxide salts in the clouds of Venus: Their effect on the sulfur cycle and cloud droplet pH. Planet. Sci. J. 2 (4), 133.
2. Lebonnois, S et al., 2010. Superrotation of Venus' atmosphere analyzed with a full general circulation model. J. Geophys. Res. 115 (E6).
3. Stolzenbach A. et al., 2023. Three-dimensional modeling of venus photochemistry and clouds. Icarus 395, 115447.
4. Encrenaz, T. et al, 2020. HDO and SO2 thermal mapping on Venus - V. Evidence for a long-term anti-correlation. Astron. Astrophys. 639, A69.
5. Marcq, E. et al., 2020. Climatology of SO2 and UV absorber at Venus' cloud top from SPICAV-UV nadir dataset. Icarus 335 (1), 113368.

Qualifications required: (Note: STFC requires at least BSc 2:1 or a MSc in a relevant discipline)

Suitable for graduates with a physics, mathematics or related numerate undergraduate degree. A BSc 2:1 or a MSc in a relevant discipline is required by STFC.