Mixing in the Atmosphere of Venus

Supervision team: Professor Stephen Lewis and Dr Manish Patel

Lead contact: Stephen Lewis

Description:

It is known that the atmosphere of Venus super-rotates at cloud-top level, but the nature of the processes that transport and mix both momentum and trace gas species are not very well understood. Observations of trace gases, such as sulfur dioxide, suggest that these gases are not uniformly distributed. We seek a quantitative description of vertical transport from surface sources to the altitudes at which gases are observed and horizontal transport once they are at cloud level.

Active vortices have been observed in the atmosphere of Venus at both poles and mixing at their boundaries may be one key to understanding the horizontal distribution of species. Strong polar vortices are also a feature of the Earth's atmosphere in winter, where they play a vital role in trapping and mixing air in the stratosphere. The ESA Venus Express spacecraft has made detailed observations of the vortex at the south pole which changes dramatically from monopole to bipole and sometimes tripole structure [1]. With the current JAXA Akatsuki mission [2], and several proposed future missions to Venus, more data will be expected in future.

Atmospheric layers can form in the venusian atmosphere, and it has even been suggested that they could provide a potential 'safe zone', with environmental factors such as ionising radiation and ultraviolet irradiance reducing to terrestrial values over a small range of altitudes. The movement and mixing of these layers are not yet understood but they are likely to be a critical factor in assessing the potential for an aerial biosphere on Venus. This project aims to perform dedicated modelling of the atmosphere of Venus to help to understand and interpret existing observations from Venus, and to quantify the vertical atmospheric flux of constituents and the degree of interlayer mixing. The student will investigate the interlayer mixing and representation of the polar vortices in a global circulation model and compare them with existing modelling results [3]. Data from the ESA Venus Express mission will be used to constrain the model. Model results will in turn be used to plan future observations.

References:

1. Titov, D. V., et al. (2009) 'Venus Express: Highlights of the Nominal Mission'. *Solar System Research* 43, 185–209. https://doi.org/10.1134/S0038094609030010.
2. Limaye, S. S., et al. (2018) 'Venus Looks Different from Day to Night across Wavelengths: Morphology from Akatsuki Multispectral Images'. *Earth, Planets and Space* 70, 24. https://doi.org/10.1186/s40623-018-0789-5.

Continued

3. Bengtsson, L., et al. eds. (2013) *Towards Understanding the Climate of Venus*. Springer, New York. https://doi.org/10.1007/978-1-4614-5064-1.

Qualifications required: Suitable for graduates with a physics, mathematics or related numerate undergraduate degree.