

## Questions About Venus after Venus Express

Sanjay Limaye

University of Wisconsin-Madison, Space Science and Engineering Center, Madison, United States (sanjayl@ssec.wisc.edu)

The observations from Venus Express for nearly 13 Venus years or 26 solar days from April 2006 till 27 November 2014. Earlier, Venus has been explored by fly-by spacecraft, orbiters, descending probes, landers and floating balloons. These data have been supplemented by many ground based observations at reflected solar wavelengths, short and long wave infrared, millimeter to radio waves. Venus Express added significantly to the collection that will continue to be examined for understanding the planet's atmosphere and continuing analysis will inform us about new facets of the atmosphere and raise new questions. Inter-comparison of the measurements have been able to provide a general idea of the global atmosphere. However, re-visiting these observations also raises some questions about the atmosphere that have not received much attention lately but deserve to be explored and considered for future measurements.

These questions are about the precise atmospheric composition in the deep atmosphere, the atmospheric state in the lower atmosphere, the static stability of the lower atmosphere, the clouds and hazes, the nature of the ultraviolet absorber(s) in the cloud layer, and wind speed and direction near the surface from equator to the pole, interaction between the atmosphere and the solid planet. The answers to these questions are important for a better understanding of Venus, its weather and climate and how the climate has evolved.

The questions include: (i) What are the implications of the supercritical state of the two primary constituents of the Venus atmosphere – carbon dioxide and nitrogen in the lower atmosphere? (ii) Is the Venus (lower) atmosphere well mixed? (iii) What determines the observed alternating stable and unstable layers (static stability) in the lower atmosphere? (iv) What causes the contrasts seen in reflected sunlight which are largest at ultraviolet wavelengths and very muted at other visible wavelengths? (v) what causes the morning –afternoon asymmetry in the haze distribution? (vi) what is the direction of the near surface wind at different locations on the planet?

JAXA's Akatsuki orbiter will soon begin collecting unique and valuable observations in April 2016 which will increase our knowledge, but other measurements required to answer these questions require careful and sustained observations within the atmosphere and from surface based stations. Some of these measurements should and can be made by large missions such as Venera-D, Venus Climate Mission or the Venus Flagship Design Reference Mission which have been studied in recent years, but some have not been addressed in such studies. Many new missions to Venus are being developed or conceived and it is important to keep the key questions about Venus in focus.