

**Progress Report
University Of Wisconsin-Madison**

Project Title: Venus Express Participating Scientist

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Kevin Baines: Progress Report for Task 6480 (NNX11-AJ85G) Venus Express Participating Scientist for FY 2014

In this task, we provide quantitative constraints on the atmospheric structure, meteorology, dynamics, and chemistry of the deep Venus atmosphere through the planning, acquisition, and analysis of UV, visible, and IR images and spectra with the the Visible/InfraRed Thermal Imaging Spectrometer (VIRTIS) and the Venus Monitoring Camera (VMC). In particular, we measure a range of structural properties of clouds and their wind speeds inferred from day-side VMC UV and night-side VIRTIS near-IR feature motions to begin to provide a comprehensive description of the cloud-layer dynamics, yielding clues to mechanisms responsible for Venus' strong cloud-level super-rotation. We also perform analysis of particle albedos and do theoretical studies of gas/particle chemistry as we endeavor to understand Venesian chemistry. Finally, we investigate clues to Venus' formation and evolution, particularly as revealed from Venus missions in the past and perhaps in the future.

In FY 2014, our team – including chemist Mona Delitsky, UW scientist Sanjay Limaye, JPL scientists David Crisp and Tom Momary, and University of Colorado Collaborator Kevin McGouldrick – continued studies of the role of lightning in Venus' atmosphere in generating exotic materials – including a possible role in generating a significant fraction of the mysterious UV-absorber present near the cloud tops. As well, we continued our detailed study of aqueous chemistry within the Venesian clouds, utilizing the water that is associated with sulfuric acid molecules comprising the bulk of cloud materials. For this work, chemist Mona Delitsky was funded through California Specialty Engineering, on contract with JPL through the JPL portion of these Venus Express Participating Scientists funds. In March 2014, we submitted a paper on the products of Venus lightning to the Venus special issue of *Planetary and Space Sciences*. In October 2013, Baines delivered a paper on chemical products of aqueous chemistry at the DPS meeting in Denver, Colorado.

For the Comparative Climatology book stemming out of the Comparative Climatology of Terrestrial Planets meeting held in Boulder Colorado, June 25-26, 2012, Baines led the research and writing of a chapter on the origins and early evolution of Venus and the other terrestrial planets. The accepted paper was published as a chapter in the book in October, 2013.

A significant portion of the funding for this task also supports the management activities of Baines as the NASA-appointed leader of the US Science Team on Venus Express. In FY 14, he attended the Venus Express Science Working Team (SWT) meeting at Kiruna, Sweden in December, 2013 and will shortly attend the SWT meeting in Darmstadt, Germany in June, 2014. He also attended the Venus-Express-sponsored Venus International workshop in Catania, Sicily, June 10-14, 2013. At these meetings, Baines reports on activities of NASA and Venus Express scientists activities and takes detailed notes of the meetings for dissemination to all NASA-funded Venus Express scientists. At the Catania meeting, Baines reported on new research on the origin of Venus and the other terrestrial planets. On May 7-8 2014, Baines will also attend a VIRTIS Team meeting in Lisbon, Portugal as a NASA-named and ESA-named member of the VIRTIS Science Team, where he will report on the status of Venus exploration in the US and on his team's science activities, including new details of aqueous and lightning chemistry in the Venus clouds.

In FY 15, we plan to continue our collaboration with Dr. McGouldrick, in particular continuing our study of temporal variability of the regional cloud structure. We also plan to continue a collaboration with Dr. Sanjay Limaye, a Co-I of the camera (VMC) team,

combining VMC and VIRTIS observations of clouds and their motions at two distinct levels in the atmosphere. As part of this work, we plan to compare the photometry of VMC in several of its filters using VIRTIS observations over the same bandpass as a means for recalibrating the VMC observations, which Limaye has recently brought into question. We also will continue our fruitful collaboration with chemist Mona Delitsky (Triton Fun of La Canada, CA) to continue to explore Venus aqueous chemistry. As in all previous years, Baines plans to attend all Venus Express SWT and VIRTIS Team meetings, currently planned as two meetings apiece.

FY 2014 Publications:

Baines, K. H., Atreya, S. K., Bullock, M. A., Grinspoon, D., Mahaffy, P., Russell, C. T., Schubert, G., and Zahnle, K. The atmospheres of the terrestrial planets: Clues to the origins and early evolution of Venus, Earth and Mars. (2013). In *Comparative Climatology of Terrestrial Planets* (S. J. Mackwell, A. A. Simon-Miller, J. W. Harder, and M. A. Bullock, Ed). University of Arizona Press, Pp. 137-160.

Delitsky, M. L., Baines, K. H. (2014). Storms on Venus: Lightning-induced chemistry and predicted products. *Planet. Space Sci.*, submitted.

Baines, K. H. and Delitsky, M. L. (2013). Aqueous chemistry in the clouds of Venus: A possible source for the UV absorber. Abstract 118.10. Proceedings of the 45th Annual Meeting of the Division of Planetary Sciences.