
# VEXAG Update
# PSS
# October 6, 2015

Lori S. Glaze, NASA GSFC - VEXAG Chair
Pat Beauchamp – Deputy VEXAG Chair (outgoing)
Bob Grimm – Deputy VEXAG Chair (incoming)

# Changes in Executive Committee Membership

- Rolled off at the end of July 2015:
  - Sue Smrekar (JPL) – had served as co-chair and past chair
  - Dave Crisp (JPL)
  - Gordon Chin (GSFC)
- Added in August 2015:
  - Constantine Tsang (SwRI)
  - Paul Steffes (Georgia Tech)
  - Noam Izenberg (APL)
- Pat Beauchamp rolling off at the end of October:
  - EC slot to be filled by Jim Cutts (JPL)
  - Deputy Chair position to be filled by Bob Grimm (SwRI)
- Early Career Scholars Focus Group:
  - Lynnae Quick to be replaced by Giada Arney as Lead


# Discovery!

- Venus community is ecstatic to have 2 missions selected for Phase A studies!
  - VERITAS: Venus Emissivity, Radio Science, InSAR Topography and Spectroscopy (Sue Smrekar), a mission to map Venus' surface with radar
  - DAVINCI: Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (Lori Glaze), which would study the chemical composition of Venus' atmosphere during descent.
- VEXAG meeting in October will include briefings from both PIs on the science.

Venus Exploration VEXAG Analysis Group

## VEXAG Events since March PSS meeting:

- Venus Science Priorities Workshop for Laboratory Measurements and Instrument Definition, April 7-8, 2015 (Hampton, VA)
- 12th VEXAG meeting April 9, 2015 (Hampton, VA)
- Comparative Tectonics and Geodynamics of Venus, Earth, and Exoplanets Conference, May 4-6, 2015 (Pasadena, CA)
- Comparative Climatology of Terrestrial Planets II: Understanding How Climate Systems Work, September 8-11, 2015 (Moffet Field, CA)

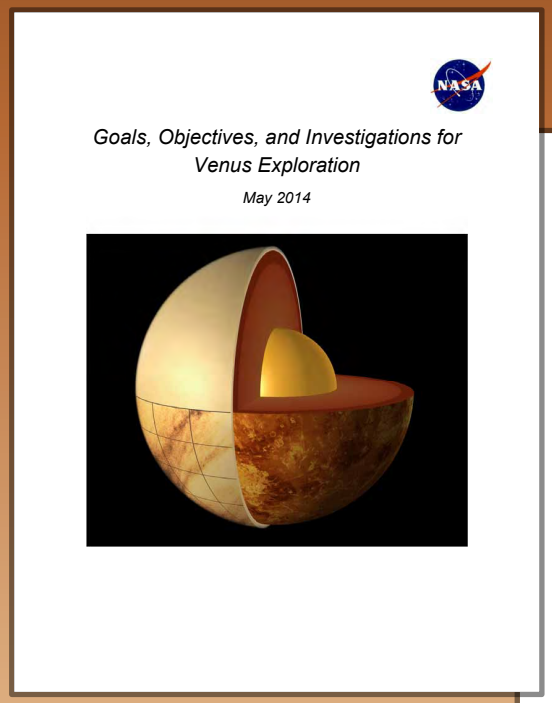

## VEXAG Activities since March PSS meeting:

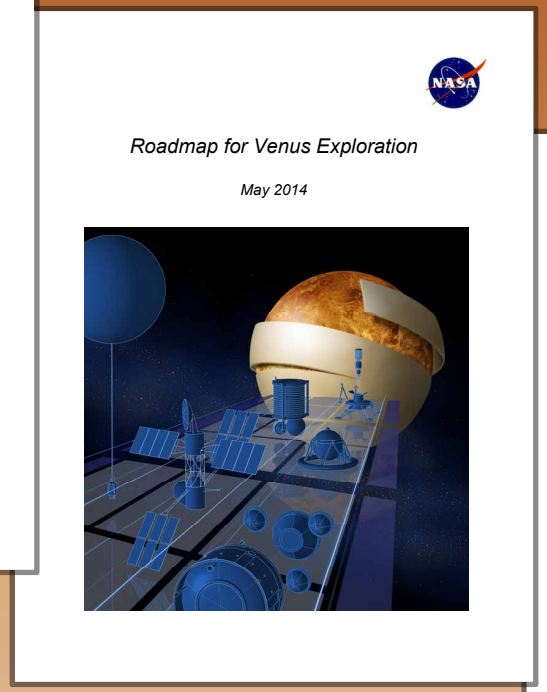
- Glenn Extreme Environments Chamber (GEER) is now “operational”; can simulate full Venus atmosphere chemistry at near surface T/P; large enough to test full scale instruments and hardware; propose through ROSES

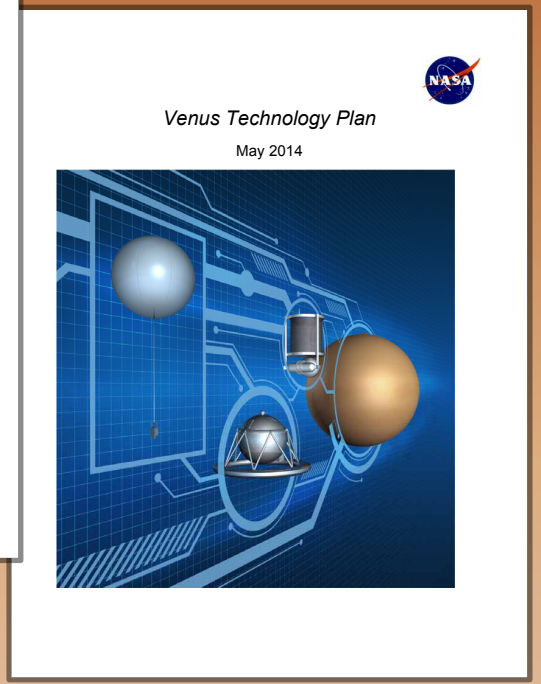

## Upcoming Highlights:

- Venus Exploration Targets Workshop report coming soon! (workshop held May 19-21, 2014 in Houston, TX)
- Venus III Book in preparation (chapter drafts due soon for review)
- 13th VEXAG meeting October 27 – 29, 2015 (NASA HQ, Washington, DC)
- Akatsuki planning orbit insertion on December 7, 2015 (5 years to the day since 2010 attempt)
  - NASA has selected 2 Scientists in Residence (Limaye & McGouldrick) and 4 Participating Scientists (Acton, Lorenz, Schubert, Bullock/Young)
- International Venus Conference, April 4 - 8, 2016 (Oxford, England)

Venus Exploration Analysis Group



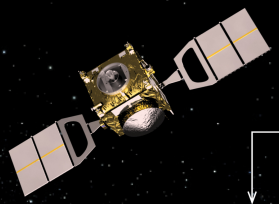



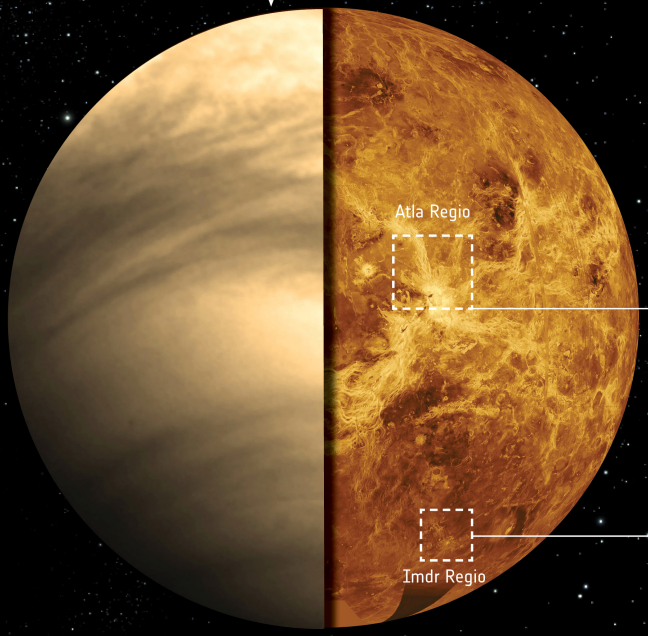




# SCIENCE NUGGETS

# VENUS EXPRESS EVIDENCE FOR ACTIVE VENUSIAN VOLCANOES

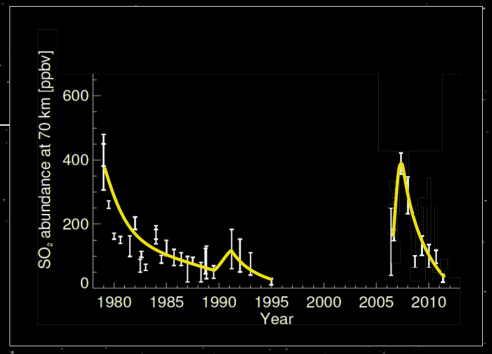
## → EVIDENCE FOR ACTIVE VOLCANOES ON VENUS






*Left: False-colour image of Venus cloud tops (credits: ESA/MPS/DLR/IDA); right: Magellan radar map of Venus (credits: NASA/JPL) The cloud tops image is a local view over high southern latitudes whereas the radar image is a global view centred on the equator.*

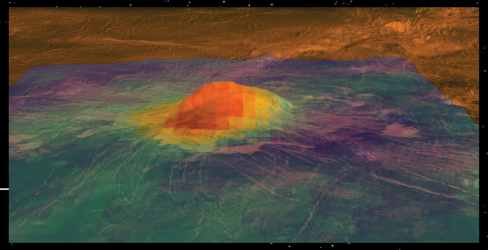
### ATMOSPHERIC CHANGES




The rise and fall of sulphur dioxide ($SO_2$) in the upper atmosphere of Venus over the last 40 years, seen by NASA's Pioneer Venus and other spacecraft between 1978 and 1995, and ESA's Venus Express between 2006 and 2012. A possible explanation is the injection of $SO_2$ into the atmosphere by volcanic eruptions.

*Credits: E. Marcq et al (2012)*

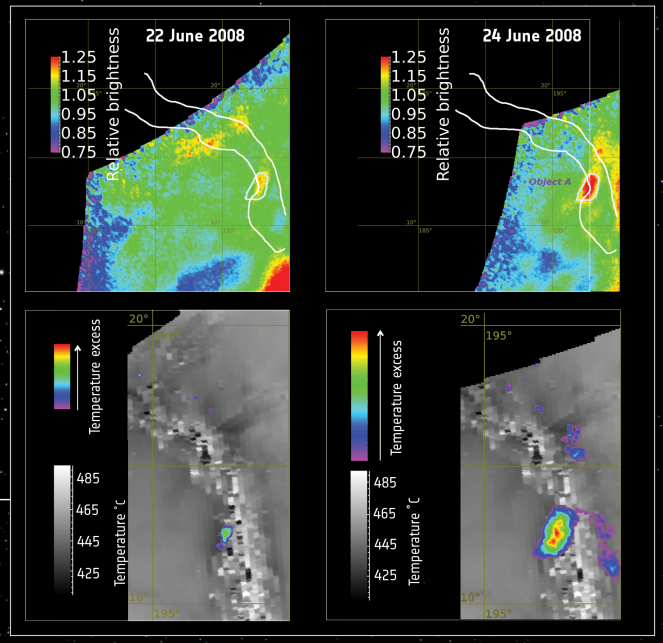
### YOUNG LAVA



Venus Express found that the area around Idunn Mons in Imdr Regio was unusually dark compared with its surrounds, suggesting a different, younger, composition, pointing to lava flows within the last 2.5 million years. The map shows near-infrared emissivity; red–orange is high emissivity (darkest), purple is the lowest emissivity.

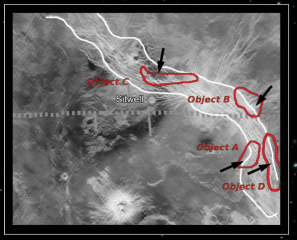
*Credits: ESA/NASA/JPL/S. Smrekar et al (2010)*

### TRANSIENT HOT SPOTS




Four transient hotspots were detected by Venus Express in the Ganiki Chasma rift zone in Atla Regio (labelled Objects A–D in the radar map, right). Changes in relative brightness (top row) and temperature (bottom row) are shown for Object A. Some changes due to clouds are also visible in the top row. The bottom row shows the temperature excess compared with the average surface background temperature. Taking into account atmospheric effects, hotspot A is likely only 1 square km with a temperature of 830°C.

*Credits: E. Shalygin et al (2015)*

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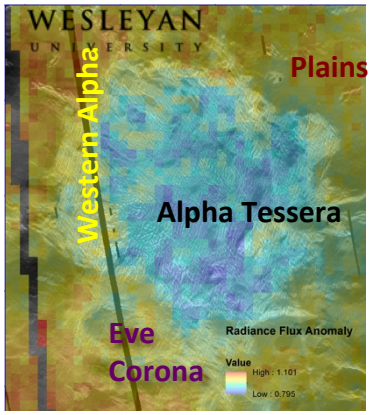
European Space Agency

ESA Press Release – June 15, 2015

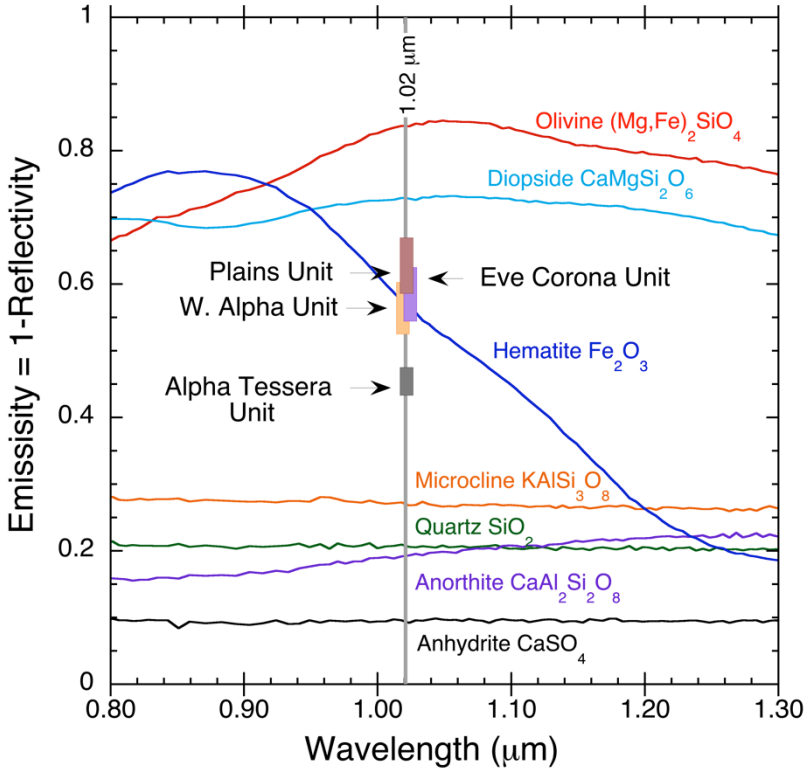
# VIRTIS Emissivity of Alpha Regio, Venus, with Implications for Tessera Composition

Martha Gilmore, Wesleyan University, mgilmore@wesleyan.edu
Nils Mueller & Jörn Helbert, DLR, Berlin

Icarus, v. 254, 350, 2015.




**VIRTIS 1 µm emissivity of Alpha tessera is lower than the plains and deformed plains of W. Alpha.** The lower flux is thus independent of macroscale roughness, elevation, or local conditions. The emissivity values are consistent with felsic minerals and rock weathering products.



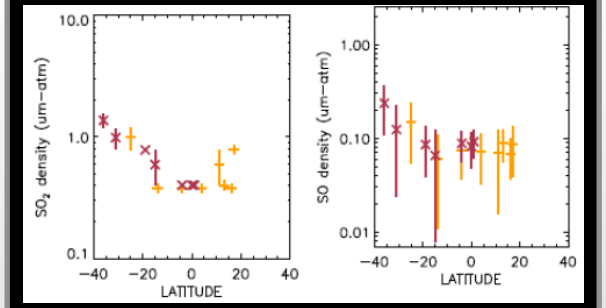

## Implications:

### Tesserae record an extinct geodynamic regime

- Tesserae are true granites formed via plate recycling of (ancient) surface water,
- OR, tesserae are granites or anorthosites formed via the collection and preservation copious amounts of partial melts of basalts from the pre-plains era.

### Tesserae record an extinct weathering regime

- Sulfates, phyllosilicates or carbonates formed via weathering of rock under a higher $P_{H2O}$ atmosphere, such as that envisioned to accompany global plains emplacement.




**HST/STIS observations show $SO_2$ and SO gas densities increase and decrease simultaneously at the cloud tops**

**Venus' $H_2SO_4$ clouds drive greenhouse effect by trapping heat between surface and clouds.**

**$H_2SO_4$ is known to be formed from $H_2O+SO_3$**

**Because $SO_3$ is formed from the $SO_x$ photolysis process, it is central to $H_2SO_4$ formation**

**The correlation of the $SO_x$ gases contradicts the expected photolysis behavior.**

**This new discovery reveals that the reservoir of gases needed for the $H_2SO_4$ formation process is reliant on both photochemical and microphysical processes**

**The new HST/STIS data provides a clear empirical constraint that must be met by models used to study Venus' $H_2SO_4$ formation process.**

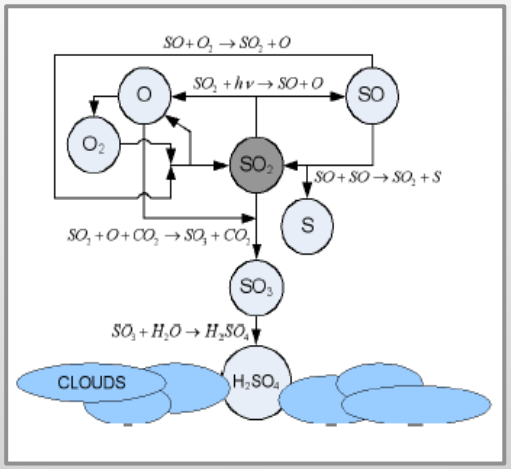
**Thus, it provides a new way to improve and accurately model Venus' $H_2SO_4$ cloud formation through time, thus improving our ability to accurately model Venus' climate evolution**

**HST/STIS observations obtained during the Venus Express Mission provide the first (and only) direct and simultaneous record of the latitude and local time distribution of Venus' 70-80 km SO and $SO_2$ (collectively $SO_x$) gas density.**

**These observations provide the first direct mapping of the $SO_x$ photolysis process in the 70-80 km region, i.e. at the cloud tops.**

**The new observations show that the two gases are directly correlated.**

## Sulfur Chemistry Cycle:

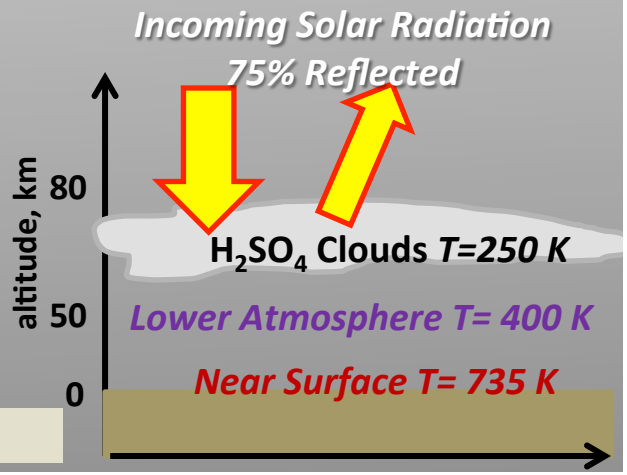



**Photolysis of $SO_2$ → SO, S, O**

**Kinetic reaction with photolysis components → $O_2$, $SO_2$, $SO_3$**

**$H_2SO_4$ is formed from kinetic reaction of $SO_3+H_2SO_4$**

**Venus' $H_2SO_4$ formation cannot be understood independent of the sulfur chemistry cycle**




**Jessup et al., 2015** doi:10.1016/j.icarus.2015.05.027; this work was sponsored by NASA, ESA and STScI.


# BACKUP SLIDES: FINDINGS FROM APRIL VEXAG MEETING


## Findings of the 12th VEXAG

- VEXAG is enthusiastic about the science observations of the dynamic environment of Venus that can be made during the more than two dozen gravity-assist fly-bys that will occur through 2024 from ESA and NASA missions - Solar Orbiter, BepiColombo and Solar Probe Plus. These would be particularly valuable to maintain continuity of Venus observations until the next mission(s) to Venus. VEXAG appreciates the role that PSD played in identifying these opportunities and in supporting the assessment of possible science observations. VEXAG encourages PSD to identify future opportunities to include Venus science with missions that have other primary applications/targets. Many mission trajectories include one or more Venus flybys and these opportunities may enable new low cost mission data. VEXAG also encourages PSD to consider secondary payloads for Venus observations that can take advantage of missions that may have excess launch mass capacity.


## Findings of the 12th VEXAG, cont.

- VEXAG encourages PSD to create a sustained mechanism for the development/maturation of specialized spacecraft systems that will enable PSD to explore all the Solar System, including the challenging yet scientifically significant atmosphere and surface of Venus. Future Venus missions can be enhanced or enabled by advanced technology. Some of these technologies are of a specialized nature with limited applications outside of planetary science and therefore unlikely to be developed or matured by others. Examples of technologies that are critical for future Venus exploration include high temperature electronics, high temperature power generation and storage systems, and high temperature mechanisms. Currently there is no mechanism for these technologies to get proposed or funded within PSD or elsewhere.


# Findings of the 12th VEXAG, cont.

- VEXAG encourages PSD to explore the feasibility of STMD supporting technologies applicable to Venus missions. Some technologies could benefit from space demonstrations and could be prime candidates for consideration in the Technology Demonstration Mission program.

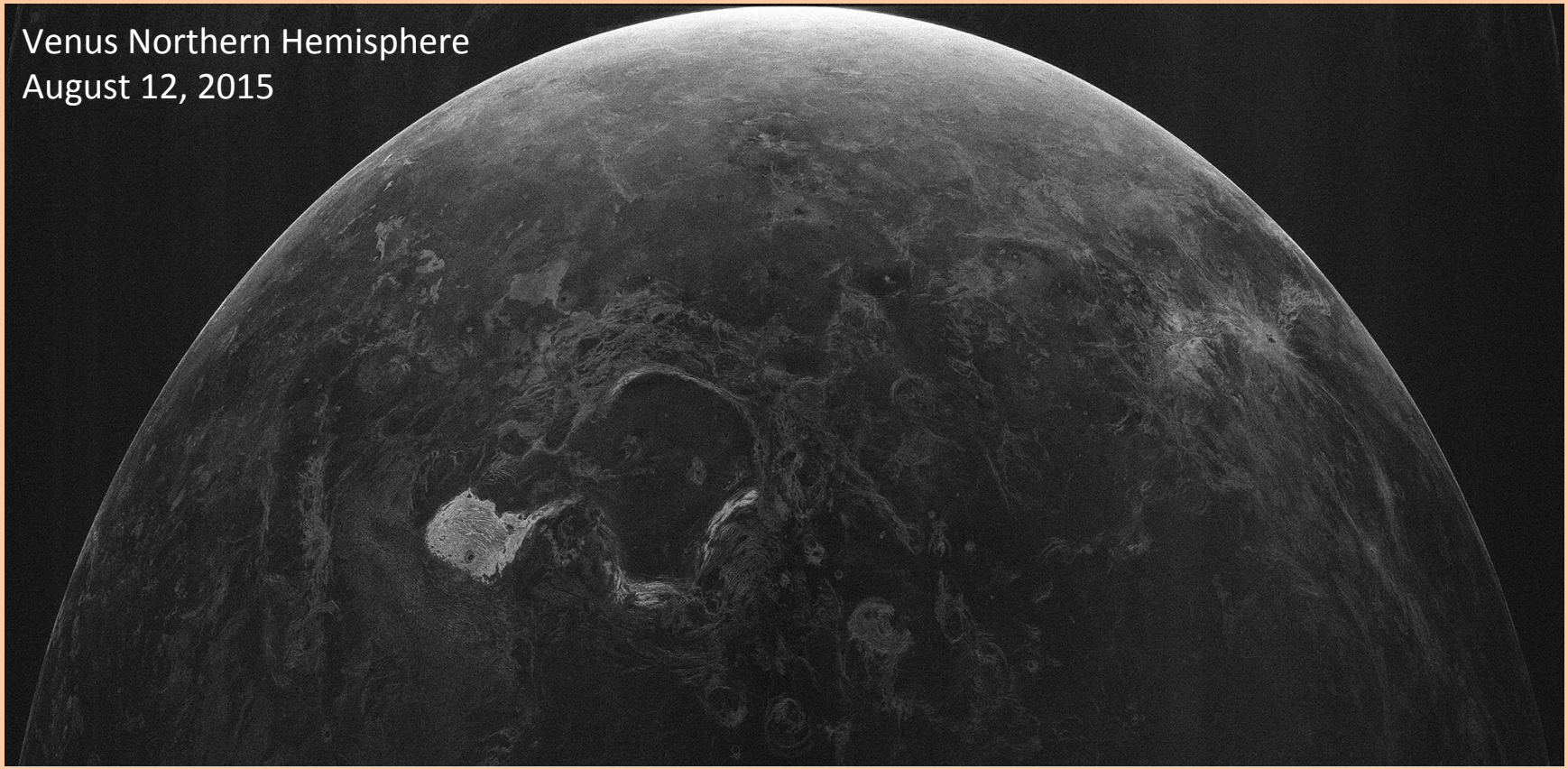

## Findings of the 12th VEXAG, cont.

- VEXAG encourages PSD to support the further development of a new stratospheric observing asset that would be made available to the science community. The recent assessments and demonstrations of stratospheric balloon borne telescopes offer promise and could benefit the Venus community by providing science data such as day and night time winds, cloud properties, emissivity mapping, and more. A facility balloon asset would provide frequent and much needed opportunities to engage in missions and science measurements. Competing the science and observing time through ROSES is encouraged to maximize community access and engagement, as well as the science returned.


# Findings of the 12th VEXAG, cont.

- VEXAG continues to encourage NASA participation in future international partnerships including mission collaboration and participating scientist programs (e.g., Akatsuki and Venus Express). NASA support of the International Venus Exploration Working Group (COSPAR) will facilitate the needed dialog towards the exploration programs.
  - Have heard ISRO is interested in a Venus mission

# 2015 Radar Observations of Venus




We used the Arecibo radar system to make 12.6-cm wavelength maps of Venus from August 10-16, 2015. These maps will be used to continue our studies of surface properties and deposits of crater ejecta in the highlands, and to search for evidence of volcanic activity using data from 1988 to the present.


- Bruce Campbell, Smithsonian Institution; Lynn Carter, NASA Goddard Space Flight Center; Donald Campbell, Cornell University
- Gareth Morgan and Jennifer Whitten, Smithsonian Institution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