

Venus Exploration

**VEXAG**  
Analysis Group



# VEXAG Update

## NASA PSS Meeting

### 4 September 2014

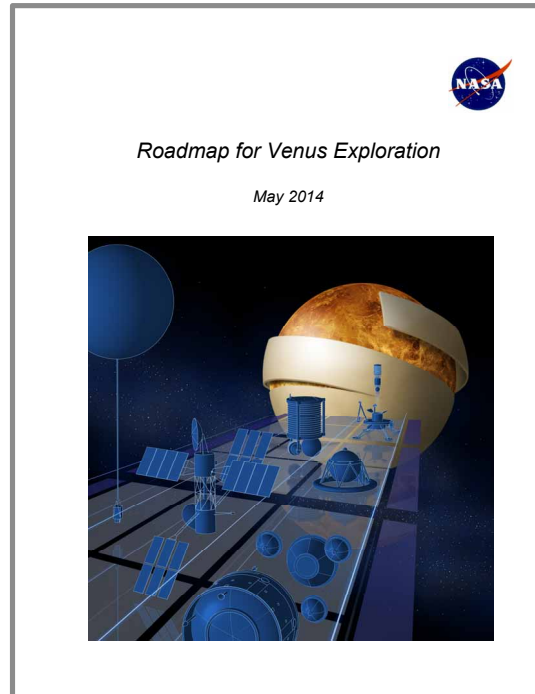
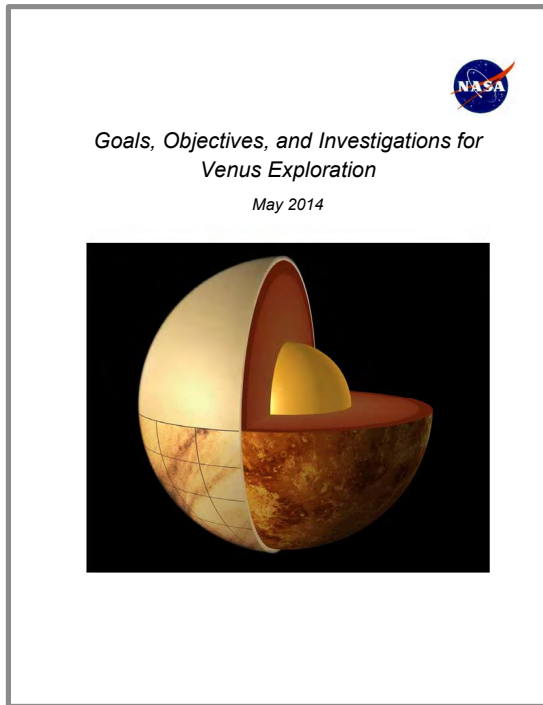
Lori S. Glaze, NASA GSFC - VEXAG Chair  
Pat Beauchamp – Deputy VEXAG Chair



- Activities Mar. 2014 – Aug. 2014
  - March: VEXAG Town Hall meeting at LPSC
    - Took final comments on community documents
    - Collected on-line endorsements of the Goals document (92, up from 63 at last PSS)
  - May: Finalized 3 community documents and posted on VEXAG website:
    - Goals, Objectives and Investigations
    - Roadmap for Venus Exploration
    - Technology Plan
  - May: Held Venus Exploration Targets Workshop
  - June: Participated in the Venus Seismology Workshop (sponsored by Keck Institute for Space Studies)
  - July: Provided feedback on the Draft Discovery AO, and provided current version of “Goals, Objectives, and Investigations” for the Discovery Program Library
- Ongoing:
  - Continue to explore the interest level in the community to compete in Centennial Challenges in various technology areas such as high temperature electronics and mechanisms, thermal management, and power systems that would be representative of Venus surface conditions.
    - RFI to go out sometime in the late fall to get formal inputs.
    - Considering / planning to have an industry day to get informal inputs and answer questions and give potential interests, which would be worked with the Centennial Challenges program office at NASA.



# May 2014 versions of the VEXAG Documents





## Venus Exploration Targets Workshop

- Held at the Lunar and Planetary Institute; Focus was on specifying measurement type, quality and precision required to answer top science Goals

Attracted 54 Venus research enthusiasts to identify high-value exploration targets for future exploration of Venus.

- Breakout sessions were organized around where the observations would be made: on the surface, in the atmosphere, or from orbit.
- Topics discussed included:
  - Locations on the surface or within the atmosphere that would optimize the science return,
  - Approaches required to meet objectives, and
  - Other considerations (e.g., risk management, technology development)
- The workshop was designed to contribute to the recent VEXAG goal of providing community-endorsed perspectives that mission planners will find useful.
- Workshop findings are still being developed through continual interaction among the organizers and breakout group participants.



## Venus Seismology KISS (Keck Institute for Space Studies) Workshop

### Purpose

- Investigate three approaches to the detection of seismic waves on Venus:
  - Conventional approach to detection of quakes is using sensors in contact with the planetary surface.
  - Detection of infrasonic waves in the atmosphere using balloons floating at 50 to 55 km altitude where temperatures are benign.
  - Detection from Venus orbit based on temperature and other physical changes that the infrasonic waves induce in the upper atmosphere and ionosphere. And there may be others !
- Identify technology developments and mission concepts that could implement those approaches that will be effective

### Key Findings

- All three approaches ( surface, balloon and orbital) can work since the dense atmosphere of Venus efficiently couples seismic signals into the atmosphere
- The three approaches are at different levels of technical maturity
  - Surface - Very low maturity because of need for high temperature electronics
  - Balloon – Basic measurement – infrasonic signal is easily made
  - Orbital – Appears to have no technological showstoppers but still need to be assessed.
- Main uncertainties are backgrounds for the three techniques which are different in each case. They can and should be the target of precursor missions with short life times – hours or days not months.



- Venus mission status
  - Venus Express:
    - Spacecraft in excellent condition after > 8 years in orbit
    - Extended mission approved through 2014;
    - Plan to extend mission into 2015 is being discussed.
    - Routine science mission paused on 15 May
    - Aerobraking campaign began on 15 May
    - Aerobraking completed 17 July with fuel still remaining
    - Full resumption of science on 01 August
  - To date, 137 refereed publications were supported directly by NASA's Venus Express Participating Scientist Program.
  - Akatsuki continues on a schedule toward Venus Orbit Insertion in 2015 (6 day orbit in equatorial plane) (another opportunity in 2016)
  - A joint IKI-NASA Venera-D Science Definition Team was established in February. Bi-lateral discussions between Russia and US began and then were halted in April by direction of the State Department.



- Upcoming Activities

- November 2014 DPS: Distribute VEXAG documents
- December 2014 AGU: Distribute VEXAG documents at the One NASA booth
- January (January 27-28): International Venus Exploration Laboratory Measurements and Instrument Definition Workshop (LaRC)
- March 2015: Venus Town Hall at LPSC
- April/May 2015: 12<sup>th</sup> VEXAG meeting at NASA HQ; after Discovery submissions and FY16 Budget release
- May 4-6, 2015: Comparative tectonics and geodynamics of Venus, Earth, and Exoplanets, Keck Center, Caltech, Pasadena
- September 8-11, 2015: Comparative Climate of the Terrestrial Planets II, NASA Ames



## Issues

- VEXAG is concerned that since many programs have been consolidated in the Solar Systems Working solicitation it may be hard to assess how the Venus community fares in this new structure.
- VEXAG has expressed its concerns on this restructuring and the only way to judge how well these concerns have been addressed is to do an in-depth analysis on the selection rates of the Solar System Working awards.
- We request NASA undertake such an analysis, which would be extremely beneficial and useful to the entire planetary community.
- We also suggest that NASA PSD review their goals and metrics and assess the overall R&A restructuring.
- We can then evaluate the report to assess its positive or negative impacts to the Venus science community.



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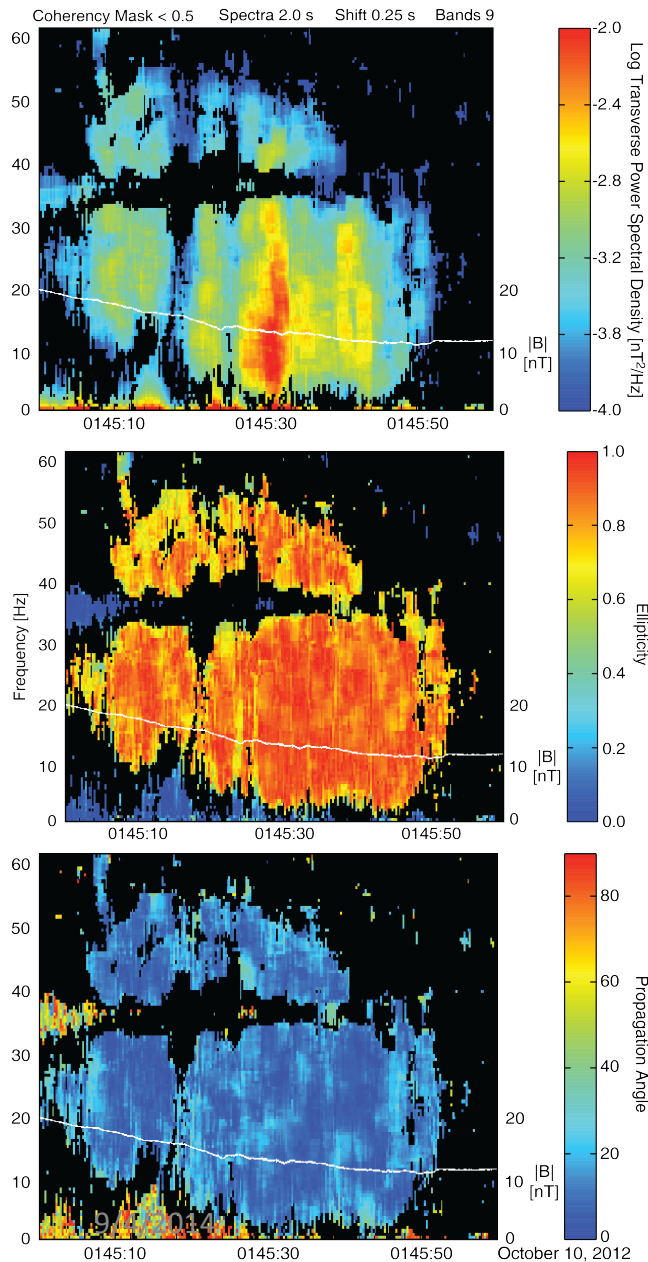
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# SCIENCE NUGGETS

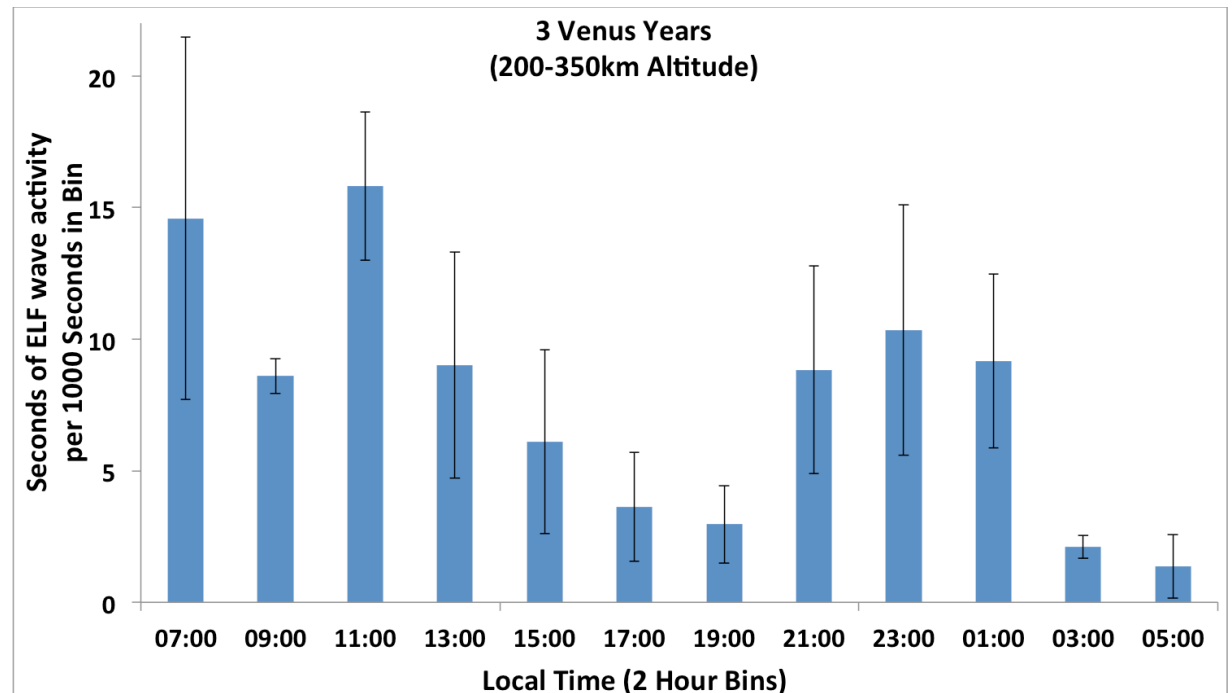
# Statistics of Lightning Generated ELF Waves

Richard Hart and Chris Russell, UCLA



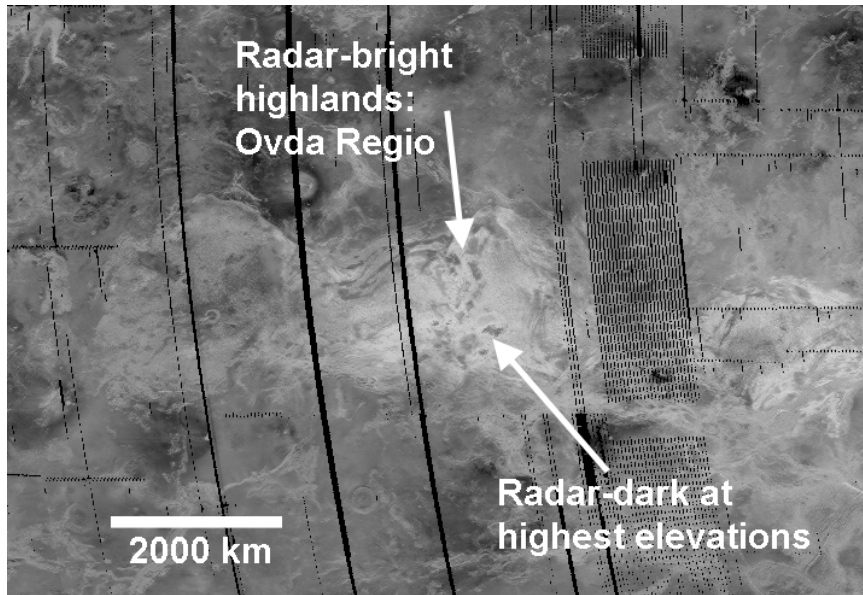
Dynamic spectra (left) of ELF waves observed by the VEX magnetometer are transverse to the field, right-hand circularly polarized, propagating along the local magnetic field, **as expected for waves entering the ionosphere from lightning** in the Venus clouds.

Three Venus years of VEX data have been surveyed with such plots. These waves occur at all local times and **are detected about 1% of the time** from 200-350 km altitude. Lightning is prevalent on Venus as on Earth.



# Radar-bright Highlands on Venus: Confirmation of a Ferroelectric Substance

Elise Harrington, Simon Fraser Univ. (LPI undergraduate intern); Allan Treiman, LPI.



Venus' highlands appear bright in backscattered (SAR) radar, here from Magellan, and their highest elevations appear dark. **This first-order feature of Venus has not been explained, and is important for understanding the surface and its interaction with the atmosphere.** We re-investigated this problem, using new high-resolution altimetry data. Our results confirm the hypothesis of Arvidson et al. (1994), that Venus' highlands contain a ferroelectric material. Very few natural materials are ferroelectric, and none known are consistent with the properties of Venus' highlands.

Explanations of the radar-brightness of Venus' highlands include: 'frosts' of heavy metal compounds; varying proportions and species of Fe oxides and sulfides; and ferroelectric material. The latter would be recognized by a sharp spike in radar properties at its Curie temperature. Arvidson et al. (1994) proposed, from Magellan altimetry and emissivity data, that the highlands of Ovda Regio contained a ferroelectric compound (black symbols & line), but had few points below the Curie temperature (at the highest elevations).

We analyzed parts of Ovda at spatial resolution of  $\sim 1$  km, using elevations from stereogrammetry (R. Herrick) and SAR backscatter brightness. Our results (red symbols) confirm Arvidson's, with much less scatter and with hundreds of points with at high elevation with low radar backscatter. The identity of the ferroelectric material is not yet known.

