

VEXAG

VENUS EXPLORATION ANALYSIS GROUP

Co-Chairs:

Sushil Atreya, University of Michigan, Ann Arbor (atreya@umich.edu)

Janet Luhmann, University of California, Berkeley (jgluhmann@ssl.berkeley.edu)

Focus Groups:

Planetary Formation and Evolution: Surface and Interior, Volcanism, Geodynamics, etc.

Focus Group Lead: Steve Mackwell, LPI (mackwell@lpi.usra.edu)

Atmospheric Evolution: Dynamics/Meteorology, Chemistry,

Focus Group Lead: Kevin Baines, JPL (kbaines@pop.jpl.nasa.gov),

Technology Needs for Venus In-Situ Exploration

Focus Group Lead: Jim Cutts, JPL (James.A.Cutts@jpl.naa.gov)

Other VEXAG contacts:

Adriana Ocampo, NASA Headquarters (adriana.c.ocampo@nasa.gov)

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VEXAG Meetings to Date:

- Kickoff Meeting November 4, 2005, Pasadena
- Related Venus Chapman Conference, Feb. '06
- First working meeting May 1-2, 2006, Pasadena
- Second Meeting held in Crystal City, VA on Jan 11-12, 2007

Current VEXAG Activities:

- Main priority: Creation of a “community consensus” report on Venus science priorities and technology development needs for future mission planning
- Providing Messenger flyby, VEX and VCO connections
- Supporting VEP and other international mission planning
- Providing HQ-requested and/or NRC-requested inputs

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Summary - January 2007 VEXAG Meeting

- **Venus Surface Sample Return remains a goal for Venus exploration but the formidable technological obstacles dictate that other more technologically feasible missions be undertaken first.**
- **The Venus Mobile Explorer represents a logical next step in Venus exploration but will still require significant investments in technology**
- **A NASA investment in extreme environment technology is needed to enable a significant step forward in the fundamental questions about our sister planet in particular the history of the Venus ocean**
- **VEXAG has recommended (Feb 2007)**
 - **Formation of an S(T)DT to guide studies of a Flagship mission, including architectures to guide technology development**
 - **Initiation of a technology program focused on technologies that are fundamental to operation at or near the Venus surface including power, extreme environments technology, mobility, sample acquisition and science instrumentation.**

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Continuing activities from the January meeting:

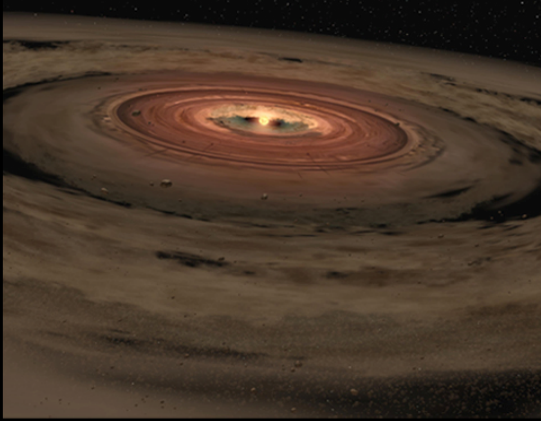
- Presentation of options for technology developments to Jim Green and others at NASA Headquarters
- Presentation on VEXAG to COMPLEX by Janet Luhmann
- Initiation of activities for a Flagship Mission Study in FY08
 - Small Pre-STDT formed - Will have a full-up SDT in FY08
- First public draft the VEXAG Goals-Objectives-Investigations Document in mid-summer

Next VEXAG Meeting in early November (Baltimore),
in conjunction with NASA Atmospheres Workshop
and OPAG Meeting

Venus Exploration Goals and Objectives

Goal 1:

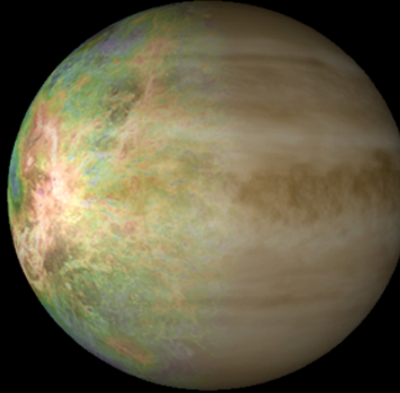
Origin and Early Evolution of Venus:
How did Venus originate and evolve, including the lifetime and conditions of habitable environments in solar systems?



- ◆ Determine isotopic composition of atmosphere
- ◆ Map the mineralogy and composition of the surface on a planetary scale
- ◆ Characterize the history of volatiles in the interior, surface and atmosphere
- ◆ Characterize the surface stratigraphy of lowland regions and the evidence for climate change
- ◆ Determine the ages of various rock units on Venus

Goal 2:

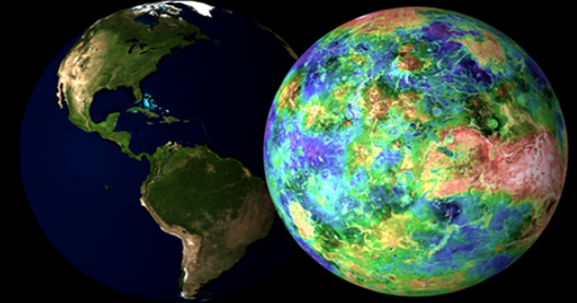
Venus as a terrestrial planet:
What are the processes that have and still shape the planet?



- ◆ Characterize and understand the radiative balance of the Venus atmosphere
- ◆ Investigate the resurface history and the role of tectonism, vulcanism, impact, erosion and weathering.
- ◆ Determine the chronology of volcanic activity and outgassing
- ◆ Determine the chronology of tectonic activity
- ◆ Investigate meteorological phenomena including waves, tides, clouds, lightning and precipitation.

Goal 3:

What does Venus tell us about the fate of Earth's environment?



- ◆ Search for fossil evidence of past climate change in the surface and atmospheric composition.
- ◆ Search for evidence of changes in interior dynamics and its impact on climate
- ◆ Characterize the Venus Greenhouse effect and its similarities to those on Earth and other planets

Venus Exploration
VEXING
Analysis Group

The Past

The Present

The Future

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Venus Technology Readiness

- **There is a lot of exciting and important science to do above and on Venus**
- **Much can be done with existing technologies to address priority objectives for Venus exploration**
- **Investments in new technologies are required for later/larger missions in the Venus exploration sequence**
- **Technology demonstrations in early missions will retire risk for later missions**

- **JPL is internally funding** and exploratory **study to prepare for** next FY's Flagship Class Venus Mobile Explorer (**VME**) **Study**
 - Using an approach **similar to the 90-day “Under \$1B Titan/Enceladus study”** performed from October to December 2006 (lead: Kim Reh)
 - Internal study lead by Dr Tibor Balint, JPL
 - Study limitations:
 - Somewhat **lower funding** level than for the 90-day study
 - **Limited number of previous Venus studies** to build upon
 - Completion by mid-September
- **Study Objectives:**
 - **Identify potential mission architectures and mission elements**
 - Through **brainstorming** sessions at JPL
 - Perform **top level cost assessment** through “rapid cost estimates using complexity indexes,” introduced during the 2005 SSE Roadmap activities
 - Ongoing **interaction with** the VEXAG's **pre-STDT**
 - **Communicate** findings, keep the **pre-STDT** in the loop
 - Organize **pre-STDT workshop at JPL** to coordinate internal study directions with VEXAG requirements (~mid-July)
 - **Incorporate the pre-STDT recommendations** to the study
 - **Prepare Traceability Matrix**
 - Map VEXAG Science Goals and Objectives against identified Flagship Mission Architectures and Mission Elements
 - Identify a subset of potential flagship class missions for next year's study
 - **Report findings** at the next VEXAG meeting



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Next VEXAG meeting in Baltimore

Sunday-Monday – November 4-5, 2007

**Same Hotel as Workshop on Planetary Atmospheres
Workshop and OPAG Meeting**

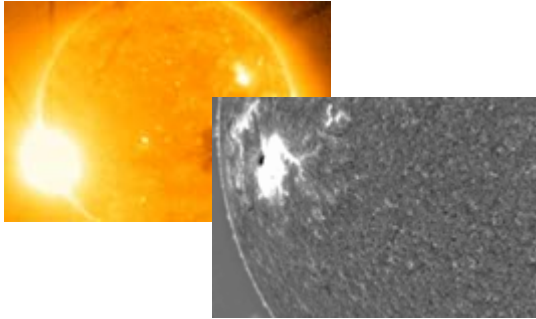
Preliminary/Tentative Agenda

Sunday Afternoon- Introductions, Technology ESA's Cosmic Vision,
Venus Mission Study, Education and Public Outreach

Monday Morning - MESSENGER Fly-by - Venus Express - VCO Status
Reports and Open Mike presentations

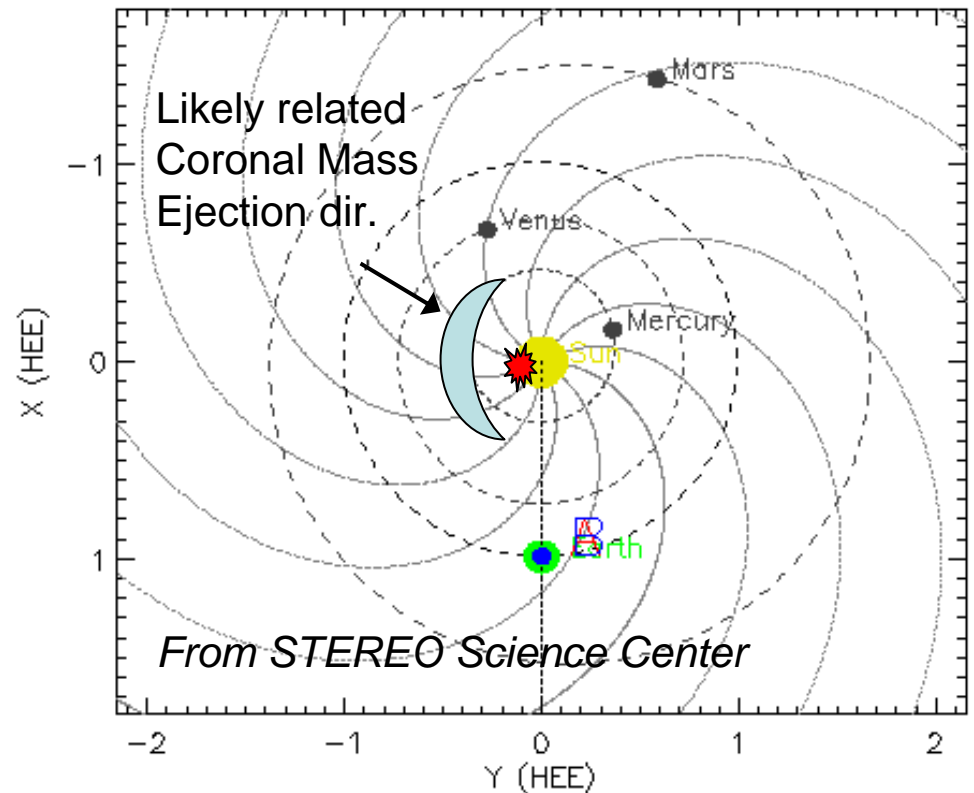
Monday Afternoon- Special Session on **Venus-Earth Climate Connections**

The December 5, 2006 space weather event included an East limb X9 flare and a sunquake observed from the ground



Flare image, sunquake movie from NSO.

Futaana et al. are submitting a PSS letter describing an inferred enhancement of ion escape measured at Venus by ASPERA-4 IMA. ASPERA also measured some plasma signatures of the shock and magnetic cloud arrival.



Both Venus Express and Mars Express were impacted by energetic particles from this event, which just nicked near-Earth STEREO and ACE. VEX's magnetometer detected a magnetic cloud