

Notes - Venus Exploration Analysis Group (VEXAG) Meeting #2 - May 1-2, 2006

Sushil Atreya, VEXAG Co-Chair, welcomed over 60 attendees and presented an overview of the agenda. Sushil noted that the goal of this meeting is to draft a VEXAG Goals, Objectives, Investigations, and Priorities document that expresses “What we really want to do in a Venus Science Mission”. There are two new things at this second meeting of VEXAG. The first was a science presentation on Atmosphere Dynamics. Second, three students attended the meeting through the generosity of NASA Headquarters. Meeting attendees were encouraged to interact with the student participants. Both the science presentation and student attendees will be done at future VEXAG meetings.

Janet Luhmann VEXAG Co-Chair, invited the meeting participants to meet individually with her to share any inputs they might have, as she would be participating in the Planetary Sciences Subcommittee (part of the new NASA Advisory Council) meetings later in the week.

Adriana Ocampo, Venus Program Executive at NASA Headquarters, presented “A View from Washington”. Adriana congratulated the Venus Express team for their successful orbit insertion, and noted that NASA now has 10 funded Venus Express Participating Scientists. The selection of Venus Express Interdisciplinary Scientists and Support Investigators will be announced soon. Adriana noted that VEXAG is the voice of the Venus Science Community – it makes inputs to NASA on community assessments. Adriana concluded by encouraging VEXAG to get together with other NASA Advisory Groups (MEPAG, OPAG, LEAG) in order to make integrated inputs to NASA.

Larry Esposito, Venus Chapman Conference Co-Chair, provided a summary of February’s Chapman Conference. This was a well attended conference with over 100 attendees. Larry noted that the Program Committee is pursuing an AGU Monograph on Venus as a Terrestrial Planet. They are waiting for a response from the AGU editors, which have some issues. If the Monograph is not published by the AGU, another publisher will be sought. In parallel with the Monograph, Conference proceedings in the form of a special issue of the Journal of Geophysical Research is being pursued. AGU is currently accepting papers for this with a deadline of the end of May. Larry showed a series of science ‘teaser’ viewgraphs with questions from the Conference that had been presented to arouse science interest in future missions. After considering all of the items discussed at the Conference, it was concluded that no major changes were needed to the Decadal Survey, although there are technical capabilities that need to be developed to enable future missions. Future Chapman Conferences might focus on comparative planetology.

Hakan Svedhem, Venus Express Project Scientist, reported on the status of the Venus Express Mission. Hakan noted that “It’s doing fine and that things really look good.” The spacecraft has demonstrated a strong robustness and is working very well. Capabilities and objectives of the seven instruments on board, some from Rosetta, some from Mars Express, were described as well as the sequence from launch through cruise, orbit insertion and getting into its mapping orbit. Venus Express at the time of this meeting was executing various maneuvers in order to get into its operation orbit, which should be acquired in early May. As the orbit insertion was only a few second off from perfect, a considerable amount of fuel remains, enough to extend the mission to 6 years. Hakan showed images from the instruments taken during the first capture orbits. Hakan concluded by noting that the nominal mission begins June 4 and that the first data will be presented to COSPAR in July.

Hakan Svedhem, also provided a summary of ESA's Venus Entry Probe Workshop that was held at ESA/ESTEC on 19-20 January. This workshop examined Europe's next step in Venus exploration based on ESA's Cosmic Vision call for proposals. Scenarios that were considered including Focus on Climate, Focus on Clouds and Cloud Dynamics, Focus on Lower Atmospheric Chemistry, Focus on Surface Remote Sensing and Atmospheric Investigations on Regional Scales supported in part by several brief mission study concepts. Implementation via Aerobots, Atmospheric Microprobes and two different orbiters (polar and elliptical) are being considered. Workshop participants were aware that international cooperation would be very beneficial. The US, Japan and Russia participated in the workshop and preliminary contacts have been initiated with India. The next steps will be to finish a white paper, which summarizes the workshop findings. It is expected that ESA will issue a call for ideas to support their Cosmic Vision in the Ma, with proposals due in September. This will be followed by a selection of six for future study. Future ESA Venus workshops are planned for July and September.

Ralph McNutt, Project Scientist for Messenger, provided an overview of the Messenger mission and its flybys of Venus, which will be executed on its way to its primary objective, Mercury. No observations will be taken on Messenger's first flyby of Venus in October because of the Earth/Venus/Sun alignment. However, the second flyby in June of 2007 will provide the opportunity to take data from all Messenger instruments from down to 300 km above the surface when the spacecraft is moving 300 km/sec. This provides an opportunity for Messenger and VEX to do cooperative science. The images and data products generated during this flyby will provide useful practice for their Mercury encounters. An animation of the orbital path of Messenger from launch through the 2nd Venus flyby was stunning as well as a great education and outreach tool. The Messenger web site is <http://messenger.jhuapl.edu>. Ralph concluded by noting, "One has to give oneself an opportunity to be lucky".

Takehiko Satoh (Planet-C Team member from Kumamoto Univ and JAXA) presented an update on Planet C, Japan's Venus Climate Orbiter (VCO). This is JAXA's 24th science spacecraft, and is dedicated to the exploration of Venus meteorology. It will launch in June 2010 and arrive in December 2010 with a planned mission life greater than 2 years. VCO has four cameras from the UV to the IR, a lightning and airglow imager, and radio science experiments. Its primary science objective is the meteorology of Venus – how it is generated and how it is maintained. Secondary science objectives are solid planet studies and zodiac light (during cruise).

Ellen Stofan, Janet Luhmann, and Jim Cutts discussed NASA's Strategic Plan. Ellen and Jim said that the first draft of the Roadmap was developed to provide the answers to five key science questions adopted by NASA's Office of Space Science in 2003. These questions were:

1. How did the sun's family of and minor bodies originate?
2. How did the solar system evolve to its current diverse state?
3. What are the characteristics of the solar system that lead to the origin of life?
4. How did life begin and evolve on Earth and has it evolved elsewhere in the solar system?
5. What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?

A draft was submitted last year to the NRC, who responded with a careful analysis. After a brief hiatus, NASA Headquarters asked the team to complete the draft and submit it to the new Planetary Sciences Sub-Committee for their review. Because of the short time available to complete the report, it was agreed that the version that will be submitted to the Sub-Committee would be an Interim Final Report. This Roadmap, which is four years newer than the Decadal Survey, reflects the President's vision to search for life throughout the solar system. Although the Roadmap developers concluded are not much changed for most of the planets, there are

significant changes for Venus. The Venus sample return mission, proposed by the Next Decadal Study, is out of the question in the foreseeable future. Instead a surface exploration mission is more realistic. The Roadmap will argue for small and medium missions with a flagship mission to study of the crustal environment of Venus with the Venus Surface Explorer (VSE). VSE will address how long ago an ocean on Venus might have existed and how long Venus might have had the potential to nurture life. This will require considerable mobility technology development. VSE is visualized to be a new start in the second decade after a flagship Titan mission. Specific science goals and measurement objectives to be developed by VEXAG will be used to refine the objectives of VSE. It was noted that once the Roadmap is accepted, a VSE science definition must take place in order to determine what investigations and measurements will be carried out. In addition, the Venus In-Situ Surface Explorer (VISE) is viewed as a precursor mission to VSE.

Steve Mackwell discussed Technology Challenges for Future Exploration of Venus, which was generated from discussion at VEXAG Meeting #1 in November. Steve noted that the key issues are:

- High temperature
- High atmospheric pressure
- High surface winds

This argues for multiuse, translatable, technologies, such as high temperature, high-pressure electronic components, etc. Also, there is a division between short-term and long-term technology as the difference between less than a day and more than one day implies a difference between passive vs. active cooling. Steve also noted that each of the analysis groups (VEXAG, OPAG, MEPAG, LEAG) has its own technology component and we need to get together and form a common set of requirements.

Steve Mackell continued with an overview of the VEXAG Goals, Objectives, Investigations, and Priorities document, which is just getting underway with this meeting. This is envisioned as a living document, which should be revisited and kept up to date annually. A key effort for this VEXAG meeting was to make significant progress on this document, which would be based on:

- VEXAG White Paper preparation -- targeting NASA advisory groups, program management, providing support for mission concepts
- Review Goals, Objectives, Investigations and Priorities and then define Measurements
- Timeframe
 - o Inputs from the focus groups today and tomorrow
 - o Assimilation and draft by Summer
 - o Completion of the draft document by the next VEXAG meeting

Greg Vane, JPL Competed Missions Office, presented a recap of the PI Lessons-Learned Workshop held April 11. There were over 150 attendees. This was one of a series of NASA Lessons-Learned Workshops. Greg's main points were from a Brad Perry presentation on the results of a study of how perceived risks affect the probability of a proposal being accepted. For the 550 proposals submitted over 12 years:

- Generally the science scores were very high (and science is 70% of the total score)
- 1/3 have been high risk, 1/3 have been medium risk, and 1/3 have been low risk
- Only low risk and low-to-medium risk proposals have a chance

Risks come from

- High cost risk (often that's due to low reserves)
- Poor design margins
- Instrument implementation
- Systems engineering

- Management and schedule
 - o #1 cause – selection of partners who are not clearly qualified
 - o Complexity of organization

Jim Cutts, JPL Planetary Probe Workshop lead, provided a preview of the 4th International Planetary Probe Workshop, which will be held in Pasadena during the last week of June. This workshop emphasis would be placed on potential areas for collaboration, including:

- Future Venus missions
- Future outer planets missions
- Future Titan missions

In addition there will be a short course on “In-Situ Instruments for Planetary Probes and Aerial Platforms” offered in conjunction with the Workshop. Both will be held at the Pasadena Hilton. Information on the workshop and short course are on web-site ippw.jpl.nasa.gov. There will be funding for US and European students, (thanks to NASA and ESA). Further detail is in Attachment A.

OPEN MIKE PRESENTATIONS

Gerry Schubert addressed the current status of Venus atmospheric dynamics science. Although there has been a lot of progress in Venus atmospheric circulation modeling, there is still a great deal that is not understood as the current models do not produce realistic results. He said that there are six questions that need answers. These are:

- What drives the super-rotation of the atmosphere of Venus?
- What is the nature of the meridional circulation?
- What is the nature of the polar vortex?
- How does the atmosphere interact with the surface and what are the properties of the atmosphere in the lowest scale height?
- What are the processes that drive circulation in the upper atmosphere?
- Why is the upper atmosphere flow so highly variable in time?

Gerry, Kevin Baines and others have formed the Venus Atmospheric Dynamics Modeling Group and they plan to generate a more realistic model. They will address the question of whether current General Circulation Models (GCMs) used for Earth are transferable to the planets. Gerry concluded by providing a list of measurements that are needed to solve the 4-day circulation problem. In particular, measurements of wind velocities and temperatures are needed at all levels of the atmosphere and at different times in order to distinguish the thermal tides, large-scale wave systems, and meridional circulation. Also, similar quantities need to be measured in the mesosphere and thermosphere to separate the subsolar-antisolar flow from the retrograde zonal circulation and determine the presence of waves and tides.

Steve Mackwell reported that they are in discussions with Bill – of the University of Iowa about building a Venus chamber – at first 6 inches in size, after that scaling up to whatever the community needs.

Chuck Acton, NAIF-SPICE at JPL, described SPICE support for Venus space science investigations. SPICE is a system, which provides ancillary data to help researchers deal with science data. SPICE components are free, free of export restrictions, and available in several computer languages. Any interested investigators should contact Chuck with their needs. The SPICE website is <http://naif.jpl.nasa.gov>.

Haken Svedhem showed another film – 1.7-micron images taken over one hour showing the circulation of the atmosphere.

P.C. Brandt, JHUAPL and VEX Participating Scientist, discussed solar wind interactions and atmosphere loss at Venus. The questions are:

- How does the solar wind interact with Venus and how does that affect atmospheric evolution?
- What are the loss rates?
- What is the acceleration mechanism?
- What is the energy deposition?

Mars Express ASPERA-3 investigations provide a valuable precursor for Venus Express' ASPERA-4 data. These studies are important because the atmosphere of Venus ultimately escapes into space and because ASPERA provides unprecedented plasma and neutral particle measurements of that escape.

Mark Bullock, Southwest Research Institute, discussed human exploration of Venus as a long-term goal, proposing an architecture that would have astronauts orbiting Venus and controlling surface rovers in real time. Mark argued that this is the next logical step in Venus exploration. This generated considerable discussion.

Emily Lakdawalla discussed Planetary Society public involvement and outreach activities related to Venus. She talked about a recent contest – Post Cards from Venus – that can be found at the Society web site. She looks forward to being able to show some of the cloud images seen at this meeting to the public and she invited the attendees to submit to the Society any ideas of how they can get involved in the program. Emily also noted that a Planetary Society/National Space Society ISDC Conference to be held at the LAX Sheraton Gateway Hotel, Thursday afternoon, 04 May, starting at 2 PM. See <http://www.isdc2006.org>.

Sanjay Limaye, Venus Express Participating Scientist at University of Wisconsin, described the use of Doppler wind LIDAR for measuring winds around Venus. He invited VEXAG attendees to contact him if they have any interest in the measurement.

Robert Okojie, NASA Glenn Research Center, described how their TRL 5 and 6 Silicon Carbide MEMs technology could be applied to Venus applications. Their integrated circuits operate at 600 degrees C in current devices for the Armed Services. An integrated temperature, pressure and wind speed sensor is fabricated on a single Silicon Carbide chip.

Rosalyn Pertzborn, Venus Education and Public Outreach at the University of Wisconsin, discussed VEX EPO by presenting a list of events and completed and planned accomplishments, including participation in meetings, workshops, and conferences. One of their programs, “One Sky, Two Views” is being prepared to present Venus to Native American groups. She solicited VEX team members to participate in their activities as presenters, writers, providers of materials, etc. A new Venus EPO web site at the University of Wisconsin is venus.wisc.edu.

End Of Day One (Monday, May 1, 2006)

Day Two – May 2, 2006

Focus Group Preview

Day 2 was devoted to Focus Group breakout sessions, which addressed the VEXAG Goals, Objectives, Investigations, and Priorities document,

The Focus Group were asked to:

1. Review Goals
2. Review, modify, delete, and add Objectives
3. Prepare a list of Investigations (measurements needed to satisfy each objective)
4. Think about priorities (what needs to happen first)

The three VEXAG Goals for discussion were:

1. How Venus originated and evolved including the potential for an early biosphere
2. Characterize the processes that shape Venus
3. Determine what Venus can tell us about the fate of the Earth's environment

Focus Group Recaps:

Kevin Baines and Steve Mackell presented the results of their Focus Groups and it was agreed that these need to be reworked and reconciled. Regarding the Objectives, Goal 1 objectives will be re-worded to be Objectives rather than investigations. There was considerable discussion about nearly all of the individual Objectives. Proposed changes will also be worked/reconciled with the other Focus Group before they are presented to the full membership. Regarding Measurements, the Focus Group attempted to list the measurements necessary to achieve each of the Objectives. This was all energetically discussed including what exactly comprised an Investigation or a Measurement.

Proposed next steps are:

- Executive editing by Steve Mackwell then
- Editing and reconciliation/consensus by Steve Mackwell, Kevin Baines and Ellen Stofan to draft a document with Goals and Objectives. This will be a bare list, without wordy embellishment.
- Distribution via the web of the Goals and Objectives to VEXAG members for their feedback. A firm deadline to reply will be established.
- Some subset of the VEXAG membership will draft the next iteration of the document with narrative back-up to the Goals and Objectives and a proposed list of measurements.
- This iteration of the document will be distributed to the membership for their comments.

These steps need to be completed by end of 2006 with a goal of having a second draft VEXAG Goals, Objectives, Investigations, and Priorities document ready for the next meeting of VEXAG.

Jim Cutts added that there was a small technology meeting held in parallel to the Focus Groups that he kicked off using some charts that he presented at Chapman Conference. They talked about some mission concepts. The issues discussed included the extremes of the environment, communications, the performance of high temperature electronics, peculiarities of Venus (e.g. its very slow rotation). They also discussed the concept of a floating communications imaging mission – this needs checking out - the limitations will be substantial. Jim concluded by noting that this was a very useful session.

Sushil Atreya drew the meeting to a close by noting that he feels very positive with the good things that are happening with Venus Express there now, the Messenger Flyby in 2007 and Venus Climate Orbiter arriving in 2010.

The next VEXAG meeting will be held in coordination with MEPAG as we did for VEXAG meeting #1 in November. Thus, VEXAG Meeting #3 is tentatively scheduled for Monday-Tuesday, January 8 and 9, 2007, assuming that MEPAG's next meeting is Wednesday-Thursday, January 10-11, 2007. Location is TBD, either the Pasadena area or on the East Coast.

Attachment A –

Fourth International Planetary Probe Workshop June 27-30th 2006 in Pasadena, California

*** Abstract Deadline Imminent - Short Extension Given To May 9***

*** Register Now: <http://ippw.jpl.nasa.gov/>

The next steps in the robotic exploration of the solar system involve missions to planets and satellites with significant atmospheres. The four major planets Jupiter, Saturn, Uranus and Neptune have bottomless atmospheric oceans, but Mars, Venus and Saturn's moon Titan have solid accessible surfaces. The International Planetary Probe Workshop series was established to bring together scientists, spacecraft engineers, technologists, and mission designers interested in the technological challenges and scientific opportunities involved in entry, descent and flight in these planetary atmospheres and scientific exploration of their atmospheres.

The Fourth Workshop (IPPW-4), to be held in Pasadena in June 2006, will build upon the accomplishments of the three earlier workshops - two held in Europe (Lisbon, Portugal, 2003 and Athens, Greece, 2005) and one in the USA (NASA Ames Research Center, 2004). As with previous workshops, key objectives include fostering international involvement in planetary exploration with probes and engaging the next generation of scientists and engineers in this exciting field.

For IPPW-4 we are expecting a continuing focus on Outer Planet probe missions as well as concepts for probe and aerial platform missions to Mars, Venus and Titan. There will be a session on technologies for the extreme environments experienced in entry, descent and flight at these targets. Applications of Earth entry and descent science and technology will also be featured, including data from the Stardust mission which returned a cometary sample to Earth on January 15, 2006. To accommodate additional papers, the workshop format has been changed to include parallel sessions on the third day of the workshop.

Immediately preceding the workshop, a two day short course "In Situ Instruments for Planetary Probes and Aerial Platforms" will be held on June 25-26.

Date: June 27-30, 2006

Location: Hilton Pasadena, 168 South Los Robles Avenue, Pasadena, CA, US

Web Site Address: <http://ippw.jpl.nasa.gov/>

Contact Email Address: ippw4@jpl.nasa.gov