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Covering the Period 29 December 2011 – 29 December 2012

A Report to the

National Aeronautics and Space Administration  
Science Mission Directorate

Attn: Dr. Adriana C. Ocampo & Ms. Natasha Johnson

For

**Venus Express Education and Public Outreach Program**

Grant Number NNX10AE21G

Conducted on behalf of  
The NASA Funded Participating and Interdisciplinary Scientists  
in collaboration with the Venus Express Mission, European Space Agency

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## **1. Overview**

The European Space Agency's Venus Express Mission continues to investigate our nearest planetary neighbor. With its new atmospheric observational tools and instrumentation observations of the Venusian atmosphere and surface at low spatial resolution through near infrared, observations continue to yield intriguing new data regarding the atmospheric circulation dynamics as well as the possibility of current volcanism. For the past five years, our E/PO efforts have highlighted the ongoing achievements of continuing Venus Express discoveries and have provided a dedicated E/PO Program focusing on the unique scientific value and importance of the Venus Express Mission. With a very modest funding level (\$30K/Yr), and the successful leveraging of ongoing activities and partnerships we have continued to conduct a highly effective and innovative E/PO initiative that includes both formal and informal educational activities and programming.

### **2.0 Year Six Accomplishments (29 December 2011 – 28 December 2012)**

In the sixth year of the Venus Express Education and Public Outreach (E/PO) effort, our team has continued to strive to represent ongoing research activities of the NASA funded scientists working in collaboration with the European Space Agency's Venus Express mission as well as support a special focus on the Venus Transit, that occurred in June, 2012. During the past funding period, major highlights and achievements include: (i) a dedicated web presence ([venus.wisc.edu](http://venus.wisc.edu)) that has been updated consistently with Venus events and content, (ii) teacher training and support of the baseline Venus Cloud Tracking Curriculum module (with leveraged support), (iii) public lectures and presentations targeting urban, minority youth, and (iv) a focused effort to provide lectures and special activities locally and internationally focusing on the unique contributions to science resulting from (historic) observations of the Venus Transit.

The level of funding for the Venus Express E/PO effort during the December 2011 through December 2012 period, was adjusted to \$30K/year (comparable to a ROSES E/PO award for an Institutional Parent Research effort with two funded science investigations). The majority of our effort has focused on formal education opportunities for teachers and students (with an emphasis on hands-on student research experiences). The ongoing upgrade of computer based VEX data analysis tools continues, and is critical in supporting VEX educational endeavors' potential for long-term educational utilization. In spite of limited funding, the website has also been consistently maintained and updated (with a special effort to highlight the 2012 Venus

Transit Event in June). We were also able to support several significant international (European) teacher professional development programs based on the solid foundation of formal curricular products developed through our ongoing efforts in the previous five years. Years 1 – 5 are summarized under section 3 to provide a perspective on progression of the Venus Express E/PO effort to date, as well as some exceptional programmatic highlights and special events.

### Formal Education

- The “The Unsolved Mysteries of Venus” learning modules were initially introduced in September 2006 and continue to be the centerpiece for formal education efforts. We have continued to update the product utilizing the best and/or most unique and interesting examples of processed Venus Express data as they become available from the past six years. The computer-based winds tracking application has now been more fully developed and is currently being used by several European schools as a direct result of several ESA sponsored teacher workshops in the past year.
- Two Teacher Professional Development Workshops were conducted in coordination with the European Space Agency. In Madrid, Spain (ESAC, February, 2012) twenty teachers representing sixteen European nations participated in a one-week training program that encompassed a Venus Science overview and review of basic mathematics skills required for a Venus data analysis activity. Teachers were introduced to the basic “Unsolved Mysteries of Venus” learning modules that allowed them to hand track VEX UV cloud images and calculate meridional and zonal wind vectors. They were also introduced to the computer software based data analysis of the VEX cloud data.



Teachers from Greece and the Netherlands ask questions about “Tracking winds on Venus.” Using actual VEX spacecraft data, participants discuss their results with VEX E/PO Team member, Rosalyn Pertzborn, during an ESAC sponsored Teacher Training Workshop in Madrid, Spain (March 2012).

- Evaluation: Based upon evaluation inputs from the ESTEC workshop and once again in coordination with Ms. Rebecca Barnes (ESA) a second VEX workshop for European educators was conducted in July, 2012 at ESTEC (Noordwijk, Netherlands). Thirty-five teachers from 18 European nations participated and provided useful input via our formal evaluation tools. Once again, the Venus Wind Tracking activities were very well received with numerous requests for follow-up opportunities, including school visits and additional training.
- For a third year, a workshop was conducted (5/19/2012) at the New Testament School (Milwaukee, WI) annual careers fair. Several dozen inner city students, parents and teachers participated in a special lecture on the Venus Transit event with a follow-on opportunity to experience the computer-based Venus Cloud tracking animations and make wind-speed predications.
- Presentations and activities utilizing Venus Express themes/data were once again included in the annual University of WI-Madison PEOPLE Program in June, 2012. PEOPLE, is an intensive three week summer STEM experience for college bound minority middle school students. Dr. Limaye and Ms. Pertzborn once again supported a “Venus Express Day”.

### **Informal Education**

- “Super Science Saturday” is an annual event (March 10, 2012) sponsored by the Madison (WI) Unified School District. This annual event is attended by ~ 400 middle school students and parents who are introduced to selected topical science presentations in the morning with follow-up hands-on experiences in the afternoon. VEX E/PO team members Rosalyn Pertzborn and graduate student Hsuan-Yun Pi presented a special lecture on “The History of Venus” as well as several follow-up mini-workshops using VEX data to track winds.
- In 2012, a total of nine discreet Informal Education events were conducted by various members of the VEX E/PO team including radio/television broadcasts. Audiences ranged in age from elementary students to broad general audiences.

### **Public Outreach and Web Updates**

- Due to extreme limitations of funding, we were unable to support staff time and travel for longer distance public outreach events; however updates focusing on current events/links were consistently made on the web site ([venus.wisc.edu](http://venus.wisc.edu)).
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## 2.1 Summary

With a very minimal budget, the Venus Express E/PO effort has continued to maintain continuity and support of several ongoing activities as a direct result of infrastructure/foundation established over the past six years. Although our efforts have historically been limited to relatively local (or leveraged) initiatives as a direct result of funding constraints, in 2012 we have successfully established a committed partnership with ESA to support 1-2 teacher professional training opportunities annually. Thus, we have achieved several major milestones including: 1) revision and testing of the computer software for VEX data analysis with professional educators, and 2) the successful revision through evaluation of our teacher professional development efforts resulting in a continuing demand for training and classroom resources. These milestones will continue to allow us to expand utilization of the formal education products for our European counterparts in the remaining two years of the project.

## 2.2 Acknowledgements

The continuing encouragement and support of the US and ESA Venus Express Team is an ongoing inspiration for our efforts. The major achievements of this past year in particular, could not have been achieved without the exceptional contributions and partnership of Ms. Rebecca Barnes of ESA. Without her insight and expertise into the formal education needs of the numerous participating European nations and rapport with exemplary teachers, we simply could not have achieved our educational goals in the past year.

As always, Dr. Adriana Ocampo of NASA Headquarters has been our champion. Her continued support for our efforts has enabled innovative STEM education programming with the use of authentic and inspiring data and resources available through the Venus Express mission and its international team of scientists. We also greatly appreciate our SSEC Director, Dr. Henry Revercomb, who continues to recognize the unique contributions and significance of our Venus Express scientific team members here at SSEC (Dr. Sanjay Limaye and Dr. Kevin Baines). And of course, last but certainly not least, we wish recognize the contributions of our talented and patient business office staff, Ms. Jenny Hackel and Ms. Wenhua Wu for their dedicated facilitation of this grant.

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### 3. Summary of Past Activities: Years 1 through 5

Yearly progress reports and accomplishments have been formally submitted for Years 1 through 5 and are included to provide a summative retrospective of the progression of the Venus Express E/PO program.

#### 3.1 Year 1 Highlights (16 May 2006 – 15 May 2007)

##### Formal Education

Curriculum module development:

- The “The Unsolved Mysteries of Venus” learning modules were initially introduced to the VEX team at the EuroPlanets meeting in September 2006. The curriculum materials were also presented to scientists at the Brussels Institute for Research Aeronomy and several middle school science teachers from the International School of Brussels (9/25 – 26/2006).
- A workshop was conducted (4/25/07) at the Belgium Royal Planetarium. Participants included both formal (classroom teachers) and informal (science museum/planetarium staff) educators.
- University of Wisconsin-Madison PEOPLE (Precollege Enrichment Opportunity Program for Learning Excellence) – June, 2006
- Venus Express outreach workshop for teachers – Belgium Institute for Research in Aeronomy (BIRA), September 2006
- Astronomy 101 – Venus lecture (David Grinspoon) at DPS 2006 – 13 October 2006, Pasadena, California
- Workshop for Teachers and Informal Education presenters – Planetarium of the Royal Observatory of Belgium – 26 April 2007
- Student Training
  - a. Outreach efforts (Christie Taylor, Hsuan-Yun Pi)
  - b. Venus cloud tracking (Megan Evensen)
  - c. Upper Elementary Curriculum (Jennifer Piper)

##### Informal Education

- Education and Outreach Workshop for scientists at Europlanets, Berlin, Sept. 2006
  - “Hows and Whys “– Kiosk Presentation at Great Lakes Visitor Center, Ashland, Wisconsin – May 2006
  - Milwaukee Public Museum – February 19, 2007
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- “One Sky, Two Views” Cultural Conference in Lac du Flambeau, WI (~400 members from the Ojibwe Nation participated) – April 13, 2007

### **Public Outreach**

1. Launched Amateur observations of Venus in UV and IR through ALPO and BAA – April 2006
2. Collecting amateur images since June 2006 and posting them on the web
3. Web Page launched – April 2006. Updated approximately every two months  
venus.wisc.edu
4. EGU 2006 Venus Outreach Presentation – Vienna, Austria, April 2006
5. Venus Express E/PO Paper at DPS 2006
6. Presentation – Madison Astronomical Society, 9 February 2007
7. EGU Presentation on Education and Outreach Effort, EGU 2007
8. Presentation at the Royal Observatory of Belgium, April 2007
9. Presentation at the Annual Meeting of the Association of Lunar Planetary Observers (June, 2007)

### **3.2 Year 2 Highlights (16 May 2007 – 15 May 2008)**

#### **Formal Education**

1. April 2, 2008: Planning session with Covey, Limaye, Pi, Pertzborn (telecon) and representatives from the Lawrence Livermore Unified School District.
2. April – June 2008: Venus Curriculum development underway. Development includes key participation from senior undergraduate student in Science Education (Kate Abitz) and Ph. D. Student in Science Education and Communication (Hsuan-Yun Pi).

Workshop topic/content development and planning session with Lawrence Livermore Unified School District (LLUSD) in May 28, 2008. Participants included Curriculum Specialist (Denise Boerder), Dr. Covey, Dr. Limaye, Ms. Pi and Ms. Pertzborn and district science teachers. Session addressed professional development requirements for teachers and students including:

- a. California State Science Standards (Middle School) Appropriate Grade Level(s) for proposed Venus Curriculum
  - b. Unique interests and needs of District students and teachers
  - c. Scientific presentations (Covey and Limaye)
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- d. Appropriate background and reference materials for prospective workshop participants.
3. June and July 2008: Refined development of workshop agenda and Venus Curricular activities (Pertzborn, Boerder and Pi).
4. Venus Curriculum Piloted at Ali'i Teacher Workshop in Honolulu, HA in mid July, 2008 (Limaye). Revisions based on preliminary teacher feedback.
5. LLUSD Teacher Workshop conducted August 4-6, 2008. Activities included:
  - a. Science Overview and Presentations (Limaye and Covey)
  - b. Comparative Planetology including focus on Earth Weather and Climate Modeling (introduction to GLOBE Atmospheric Protocol).
  - c. Venus Weather and Cloud Tracking Activities  
Reference and background materials
  - d. Teacher Classroom Implementation Planning
  - e. Participant assessment and evaluation of Venus Curricular product and overall workshop experience.
6. Classroom implementation for Fall of 2008.
7. Follow-up with LLUSD in Spring of 2009.

### **Informal Education**

November - December 2007 : " Why Explore Venus" by Sanjay Limaye, was published in Ciel et Terre – Bulletin de la Société Royale belge d'Astronomie, de Météorologie et de Physique du Globe, Vol. 123, n°6.

### **Public Outreach**

14 December 2007: Venus Express on Colorado Public Radio

Dr. David Grinspoon was interviewed for Colorado Public Radio about Venus Express, the importance of Venus Exploration and future missions.

Dr. Sanjay Limaye discussed Venus Express in a public talk on "Solar System Exploration Updates" at the Madison Astronomical Society (May 9, 2008).

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## Web Updates

The venus.wisc.edu web site for Venus Express E/PO was consistently updated. Presentations and audio/video materials were added as they became available.

### 3.3 Year 3 Accomplishments (16 May 2008 – 15 May 2009)

#### Formal Education

##### Curriculum Development

A cloud tracking activity for middle and high school students using Venus Monitoring Camera images was developed through leveraging of additional funding. The activity stresses the (scientific) process by which scientists measure the atmospheric circulation on Venus by following clouds over a sequence of images. It stresses math skills as well as an inquiry based, hands-on approach for students to learn basic concepts of atmospheric processes using authentic Venus Express data. The activity was presented to teachers in two workshops at the University of Hawaii, Honolulu and at the Joint Unified Livermore Valley School District. The teachers were trained in using the activity and were supported to implement the activities in their classrooms during the subsequent school year.

##### Teacher Workshops

The Venus cloud tracking curriculum module developed in the previous year was tested with teachers in Year 3. The objective was to provide interested teachers with background content knowledge and basic concepts about weather on Venus (as a compared to weather on Earth) and training them in the cloud tracking activity to give them an idea of how scientists obtain information about the atmospheric circulation on Venus. We developed and/or supported the following teacher professional development workshops during Year 3 of the effort.



*Figure 1. Teachers at the Astrobiology Learning Institute. Dr. Limaye made presentations for teachers from the mainland and Hawaii, and represented middle & high school and community colleges. The workshop was leveraged and was organized by Univ. of Hawaii - Manoa campus. It included presentations from scientists and hands-on activities such as the Venus curriculum activities.*

**1. Astrobiology Learning Institute, University of Hawaii, July 2008**

This was a teacher training workshop organized by University of Hawaii, Honolulu in July 2008. The teacher participants ranged from middle school to community college and the majority came from the mainland and a few from the neighboring islands. The teachers were provided some background on Venus and its atmosphere and trained in using the hands-on curriculum using mapped Venus Express image data in one afternoon session. At the end of the workshops the teachers presented a plan of how they envisioned using the module in a classroom.

**2. Exploring Venus Workshop at the Joint Unified Livermore Valley School District (JULVSD) in Livermore, California, August 2008.**

This workshop was held in collaboration with another E/PO effort and the Joint Unified Livermore Valley School District in Livermore, California and was aimed at training science teachers from the district in the Venus Cloud Tracking Curriculum module in the context of studying weather on Venus as a comparative meteorology topic. Six teachers participated and learned how to use the curriculum module in their classroom. One teacher is planning to use the curriculum during May 2009 with her class and we are anticipating additional feedback from other teachers by the end of the school year.



*Figure 2. Participants in the Venus Express Curriculum Workshop at the Joint Livermore Valley Unified School District in Livermore, California, held in August 2008.*

We solicited and received detailed feedback from the participating teachers in the pilot workshop held in Honolulu in July 2008. The feedback received from the previous workshop on the materials and the content was used to revise the materials extensively. The revisions proved to be very valuable.

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Figure 4. Teachers and instructors engaging in “Tracking Clouds on Venus” activity (using actual Venus Express Data) at the Livermore workshop.

In both of these workshops the teachers were given the Venus Express mission science presentation and the Venus Cloud Tracking curriculum module. Survey questionnaires provided useful feedback for revision and modification of the curriculum.

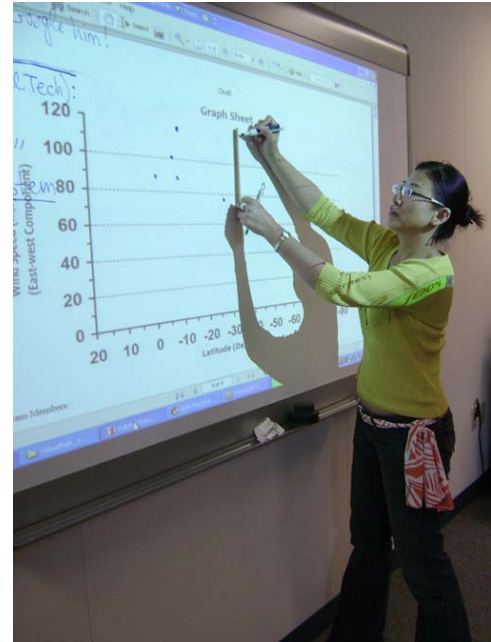


Figure 3. Education graduate student Hsuan-Yun Pi who participated in the curriculum development is plotting the teacher results. The Venus Cloud Tracking activity exposes the students to graphing activity to analyze the results of their measurements.

### **Astronomy and Astrobiology Workshop, Kauai Community College**

This workshop was organized by the Institute for Astronomy at the University of Hawaii, Manoa campus and was aimed at exposing both science teachers and high school students to Astronomy. The Venus Express mission was presented to the participants and with an interactive session to demonstrate the cloud tracking activity was conducted during the workshop.

### **Informal Education**

#### Visiting Scientist Program

Dr. Limaye visited the classrooms of two teachers trained in the ALI’I workshop in the use of the Venus Cloud Tracking curriculum module who subsequently implemented the activity in their classrooms. At Kamehameha High School, Hilo (Teacher: Tom) the students were generally from junior and senior classes. At the Niu Valley Middle School, Honolulu (Teacher; Clyde Kobashiyawa) the students were seventh and eighth grade. Dr. Limaye interacted with four separate groups of students who used the Cloud Tracking curriculum at each of the two schools. At both grade levels the students were able to follow the cloud tracking activity successfully.

## Public Outreach

### International Year of Astronomy Talks

Dr. Limaye gave four talks as part of the International Year of the Astronomy Program at the following sites:

“Venus”, an International Year of Astronomy presentation at the Kauai Community College, January 28, 2009

Exploring Venus, a presentation at the Nehru Planetarium, New Delhi, India, February 24, 2009

Venus Atmospheric Circulation – A Colloquium presented at Earth & Planetary Sciences Dept., Massachusetts Institute of Technology, Cambridge, MA, Apr. 2009

Exploring Venus with Venus Express, a public lecture at Science City, Ahmedabad, India, April 28, 2009



Figure 5. Teachers at the 2009 Astrobiology Learning Institute (University of Hawaii) for Instructors being trained by Mr. Clyde Kobashigawa (at the back) who used the activity in his classroom after being trained last year.

### **Venus Express E/PO Web site ([venus.wisc.edu](http://venus.wisc.edu))**

The URL for the Venus Express E/PO efforts, [venus.wisc.edu](http://venus.wisc.edu) was updated periodically as new information became available. The URL continues to receive a steady number of “hits” from all over the world, and including many NASA sites. The site provides basic information about Venus, the Venus Express mission and links to other resources. The Venus Express team members provided overview and input for the web content.

### **3.4 Year 4 Accomplishments (29 December 2009 – 28 December 2010)**

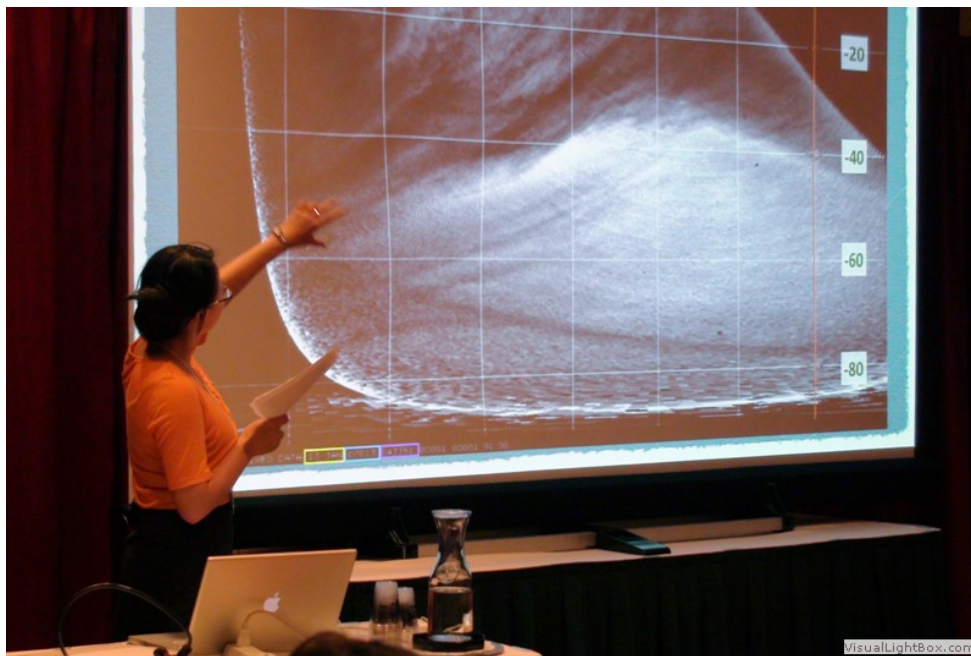
Due to a significant decrease (60%) in the level of funding for the Venus Express E/PO effort in Year 4, the level of activity was reduced and reflected the total funding level of \$20k which was received in two separate appropriations (\$5K in early 2010 and an additional \$15K on 11 June 2010). In spite of limited funding, the website was consistently maintained and updated, and several major events were supported based on the solid foundation established through consistent efforts in the previous three years (summarized under sections 3.1 through 3.3).

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## Formal Education

- The “The Unsolved Mysteries of Venus” learning modules were initially introduced in September 2006. In the past year, the product has been updated with more recently processed Venus Express data to provide better examples for classroom applications, based on prior teacher evaluation and inputs. Additional support for further development of the product has been pursued through an EPOESS (2010) proposal.
  - A workshop was conducted 5/22/2010 at the New Testament School (Milwaukee, WI) annual careers workshop. Thirty-one inner city students and three teachers participated in the “Venus Cloud Tracking Activity.” The overall workshop evaluation score was 4.8/5.0, the highest rated of the six individual STEM workshops conducted that day with the largest attendance (next highest attendance was 21). Ms. Rosalyn Pertzborn and Hsuan-Yun Pi developed and conducted the program. An invitation has already been received for the May 2011 program.
  - Presentations and activities utilizing Venus Express Themes were included in the annual University of Wisconsin-Madison PEOPLE Program in June, 2010. PEOPLE is an intensive three week summer STEM program for college bound minority middle students. Dr. Sanjay Limaye and Rosalyn Pertzborn supported Venus Express activities for this program.
  - A one day workshop was conducted for STEM educators at the Monona Terrace Convention Center on 8/31/2010. Over 110 STEM educators and professionals from the Upper Midwest attended the program which focused on promotion of STEM careers for young women. The workshop was developed by Ms. Rosalyn Pertzborn and jointly supported by the Wisconsin Department of Public Instruction and the National Girls’ Collaborative (NSF) and was held in conjunction with the International Venus Workshop, which enabled participation by leading Venus Scientists. Graduate Student, Hsuan-Yun Pi also provided significant support for program development and “Venus Cloud Tracking” mini-workshop.
  - Formal Education activities also include student training (Graduate Student, Hsuan-Yun Pi) and follow-up support for educators trained to use the current Venus Express curricular products. To date, three school districts in particular continue to actively utilize the curriculum in the classroom. These include several schools in Hawaii (Mr. Clyde Kobashigawa, State Science Curriculum
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Coordinator), a teacher in Washington State (Mr. Eric Wolgemuth), and a teacher in Aurora, CO (Ms. Kate Abitz-Lewandowski). Each of these teachers participated in the EPOESS 2010 proposal opportunity, submitted in June 2010.



Ms. Hsuan-Yun Pi teaches the “Venus Cloud Tracking Activity” (above) to participants attending the STEM Careers Workshop for Girls in Madison, WI on 8/31/10 in coordination with the 2010 International VEXAG Workshop.

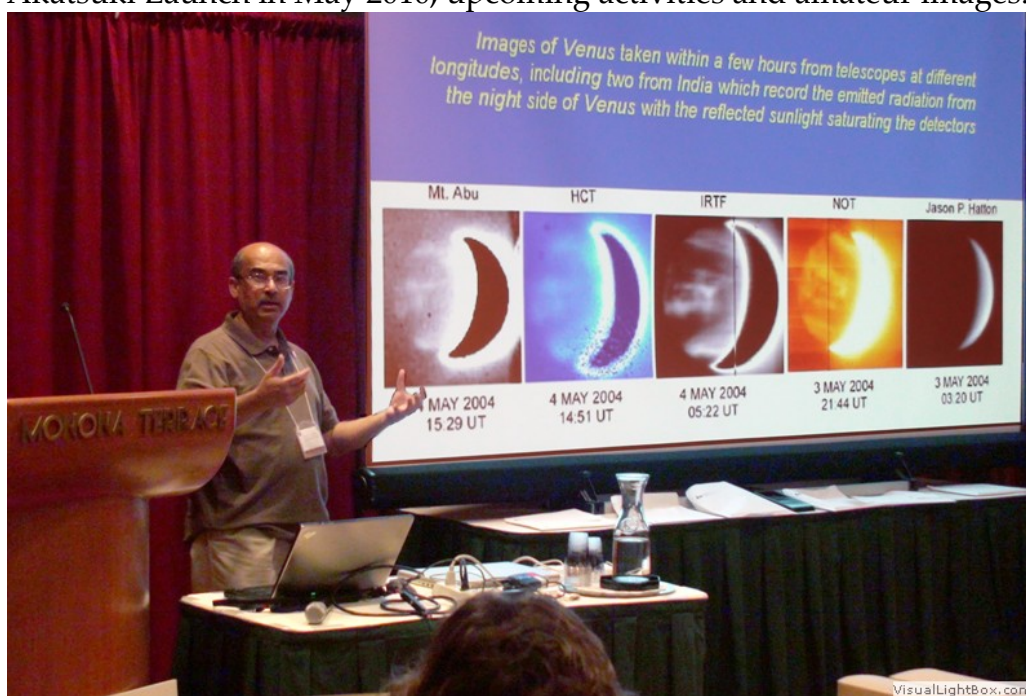
### Informal Education

- A one day program was conducted at the Ojibwe Tribal High School in Keshena, WI on April 22, 2010. Five high classes (~55 students) and two teachers participated in informal presentations and question/answer sessions that featured the topics of “Weather and Climate in the Solar System.” Particular emphasis was placed on the topic of Venus which holds special cultural importance for the Ojibwe Culture. Presenters included Dr. Sanjay Limaye, Rosalyn Pertzborn and Hsuan-Yun Pi.
- Venus Presentations by Dr. Sanjay Limaye (Venus Weather and Climate) and Dr. Kevin Baines (Lead US Scientist for Venus Express) to over 100 STEM educators in conjunction with the International Venus Conference on 8/31/2010 in Madison, WI at the Monona Terrace Convention Center.

### Public Outreach

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- Participating Venus Express Scientist, Dr. David Grinspoon gave a public presentation on Venus (“Impacts, Planetary Climates, and Venus) to an estimated audience of 500 at the Monona Terrace Public Auditorium on August 31, 2010.
- Dr. Sanjay Limaye and Rosalyn Pertzborn discussed the significance of Venus Weather and Climate on Wisconsin Public Radio 8/19/2010.
- Ongoing updates of the dedicated venus.wisc.edu website. Highlights included current VEX Data/images, (Venus) News and Events such as the Japanese Akatsuki Launch in May 2010, upcoming activities and amateur images.



Dr. Sanjay Limaye provides a science overview of Venus for participants at the STEM Careers Workshop for Girls at Monona Terrace Convention Ctr. in Madison, WI (8/31/10).

### Summary (Year 4)

Although the funding level for the past year was significantly reduced (from \$50K to \$20K), the Venus Express Education and Public Outreach effort has achieved several major successes in the past period of performance including the unprecedented level of regional participation of STEM Educators in conjunction with the STEM Education Workshop conducted on 8/31/2010 in Madison. The infrastructure established and developed in the prior three years enabled the ability of the Venus Express E/PO team to leverage resources in cooperation with the Wisconsin Department of Public

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Instruction and the National Girls' Collaborative (NSF). This extremely modest support from NASA and ongoing cooperation with US participating scientists (especially Drs. Sanjay Limaye and Dr. Kevin Baines) as well as the ongoing excellent relationships with ESA's Venus Express team have allowed us to continue to conduct a successful effort in informal and formal education and public outreach and have provided a basis to seek additional NASA funding through EPOESS for continuation of formal education product development and activities. Although the international nature of the Venus Express mission initially presented many unique challenges, it has proven to be one of the most important aspects of the overall E/PO effort. Participating educators as well as their students have gained a greatly expanded perspective and appreciation of the international nature of Space Science research and solar system exploration. This emphasis on international cooperation in the design of the Venus Express E/PO program has not only proven to be an invaluable learning experience for our team, but has also proven to be a highly appealing aspect of the program, especially for students in the relatively rural and isolated upper Midwest region who are exploring future STEM career opportunities.

### **3.5 Year Five Accomplishments (29 December 2010 – 28 December 2011)**

#### **Formal Education**

- The “The Unsolved Mysteries of Venus” learning modules were initially introduced in September 2006 and continue to be the centerpiece for formal education efforts. In the past year, the product has been updated with the best examples of processed Venus Express data (processed in the past year). The computer-based winds tracking application has been more fully developed and piloted with five high school students in a summer research project.
  - A summer research experience for five high school students was conducted over a ten week period at the Space Science and Engineering Center. The five young women from a rural high school (New Glarus, WI) underwent a two week introduction training period that encompassed a Venus Science overview and review of basic mathematics skills required for a Venus data analysis activity. During the third week, students were introduced to the basic “unsolved mysteries of Venus” learning modules that allowed them to hand track VEX UV cloud images and calculate meridional and zonal wind vectors. In week four they were introduced to the computer software based data analysis of the VEX cloud data. During the final six weeks the young women successfully conducted their own analysis of the VEX data. They were successfully able to graph multiple sets of Venus Express cloud images and ultimately validate
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earlier studies of Venus wind vectors from Pioneer Venus (Limaye, 1982). Their summer project was completed with an abstract and poster submitted to the 9<sup>th</sup> VEXAG International Venus Workshop in Washington, DC (August 2011).

- For a second year, a workshop was conducted (5/23/2011) at the New Testament School (Milwaukee, WI) annual careers fair. Over seventy inner city students, parents and teachers experienced the computer-based Venus Cloud tracking animations and provided feedback regarding their interest and usability.
- Presentations and activities utilizing Venus Express themes/data were once again included in the annual University of WI-Madison PEOPLE Program in June, 2011. PEOPLE, is an intensive three week summer STEM experience for college bound minority middle school students. Dr. Limaye and Ms. Pertzborn once again supported a “Venus Express Day”.
- Scientific support was provided by Dr. Limaye at the annual Ali’I Teacher Workshop in Honolulu, HA (July, 2011). He also introduced the Venus Express curricula at the HISTARS Astronomy Camp in Honolulu, HA in July, 2011.

### Informal Education

- Presentation at the HISTARS Astronomy Camp, July 3, 2011 by Dr. Sanjay Limaye.

### Public Outreach and Web Updates

- Due to extreme limitations of funding, we were unable to support staff time and travel for public outreach events; however updates focusing on current events/links were consistently made on the web site ([venus.wisc.edu](http://venus.wisc.edu)).

### Summary (Year 5)

With a very minimal budget (\$12.6K), the Venus Express E/PO effort has managed to maintain continuity and support of several ongoing activities as a direct result of infrastructure/foundation established over the past five years. Although our efforts



New Glarus, WI High School students analyze Venus Express data, Summer 2011

have been limited to relatively local (or leveraged) initiatives as a direct result of funding constraints, we have achieved several major milestones including: 1) revision and testing of the computer software for VEX data analysis with students, and 2) the successful use of that software for an authentic student research laboratory experience which has proven to be highly successful (see attached letter from Dr. Jon Joseph of New Glarus, High School). These milestones allowed us to maximize future efforts both regionally and nationally (especially with our European counterparts).

#### **4.0 Revised Statement of Work (December 29, 2011 – December 28, 2014)**

The Venus Express mission has been extended by ESA and, NASA has made extended funding for participating US scientists available through 2014. A continuation proposal was submitted in September of 2009 for Venus Express E/PO activities and this report covers activities supported under that proposal to date. As noted, due to a substantial decrease in the original level of funding requested from NASA (from ~\$75K/year to \$30K/Year) for the remaining three years, the level of effort has been adjusted to focus on the most critical activities demonstrating greatest potential for long-term educational value and impact. This focus is based on input from target audiences and product users over the past six years as well as current trends in STEM education.

Additionally, we intend to continue our efforts with our STEM Education counterparts in Europe who have continued to express a desire for our participation in their ongoing STEM education initiatives with ESA. Based upon the success and evaluation inputs from the two ESA sponsored teacher workshops in 2012, we are currently scheduled to participate in a third European Teacher Professional Development program in April 2013. Once again, due to cost sharing we are able to participate in a limited level of activity/support for ESA and other European STEM education opportunities. The ESA Venus Express Science Team members continue to be strongly supportive of these efforts for international STEM education collaboration and we now are formally planning to participate in 1-2 teacher professional development opportunities in the remaining two years of the Venus Express E/PO effort. In summary, in the final two years of the Venus Express E/PO program we will:

1. Focus on regional STEM formal education research experiences, especially targeting young women and predominantly rural, lower income communities.
  2. Informal education support for urban (98% African American) school districts in the Milwaukee, WI area with an emphasis on support for career fairs and student special events, as well as research opportunities for college bound students.
  3. Support for (up to two/year) international teacher training opportunities in cooperation with ESA Education personnel (Ms. Rebecca Barnes). We are
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currently scheduled to provide Venus Express Cloud Tracking activities for the ESA sponsored teacher workshop in the Netherlands in April 2013.

4. Support for 1-2 Professional Scientific Conference in the US (2013-2014).
  5. Participation by SSEC Venus Express Scientists (Drs. Limaye/Baines) in local/regional Public Outreach Events (travel funds supported by the Wisconsin Speakers Bureau).
  6. Ongoing refinement and completion (anticipated in 2013) of the on-line Venus Express Data analysis tool for STEM educational usage (classroom activities and student research).
  7. Ongoing support to update and maintain [venus.wisc.edu](http://venus.wisc.edu) website.
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