



THE CARINA NEBULA

IMAGE CREDIT: NASA, ESA/ STSCI

## Big News in Astronomy:

### Hello Pluto!

*New Horizons* scientists are using enhanced color images to detect differences in the composition and texture of Pluto's surface. The 'heart of the heart', Sputnik Planum, is suggestive of a source region of ices. The two bluish-white 'lobes' that extend to the south-west and north-east of the 'heart' may represent exotic ices being transported away from Sputnik Planum.



Image Credit: NASA New Horizons

More from NASA in the coming months on these astounding new discoveries! Congratulations to past and present SSI folks (Anne Verbiscer, Emma Birath, Nicole Martin) and our fellow Boulder colleagues who made international news this month!

### Introducing....Kepler-452b

On July 23, NASA announced the discovery of Kepler-452b, the most Earth-like exoplanet known to date. According to Jenkins et al. (2015), the star that Kepler-452b orbits is slightly larger and older than the Sun (size ~ 1.11 solar radii and age ~ 6 Gyr). Over 1500 exoplanets have been discovered from ground- and space-based observatories by such means as direct imaging, Doppler, transit, and gravitational microlensing surveys. Kepler-452b is one of only 6 exoplanets found thus far that could be analogous to Earth. Kepler-452b is squarely in the habitable zone (i.e., at the right distance from its parent star to be able to support liquid water on its surface) and should remain there for another ~3 Gyr.

Kepler-452b is about 1,400 light-years away from us, meaning that at the speed of the *New Horizons* spacecraft, (~37,000 mph), it would take ~26 million years to get there!

For more Kepler-452b details check out:  
<https://www.nasa.gov/sites/default/files/atoms/files/ms-ms-r1b.pdf> or  
<https://www.nasa.gov/keplerbriefing0723>

Read Meg Urry's full article at:  
<http://www.cnn.com/2015/07/15/opinions/urry-new-horizons-mission-women/index.html>

# Space Science Institute

Newsletter



### IN THIS ISSUE



### Cassini's View of Dione

The landscape of Saturn's fracture-faced moon, Dione, is revealed in new June 16, 2015 images.

Image Credit: NASA/JPL/SSI



### Inclusive Astronomy Conference

Want to read all about the highlights of this year's Inclusive Astronomy Conference? Executive Director Karly Pitman has the scoop!

# Eight-year Climatology of Dust Optical Depth on Mars

**Submitted by** Dr. Luca Montabone, MD Office & Dr. Mike Wolff, WI Office

We have produced a multiannual climatology of airborne dust from martian year 24–31 using multiple datasets of retrieved or estimated column optical depths. The datasets are based on observations of the martian atmosphere from April 1999 to July 2013 made by different orbiting instruments: the Thermal Emission Spectrometer (TES) aboard Mars Global Surveyor, the Thermal Emission Imaging System (THEMIS) aboard Mars Odyssey, and the Mars Climate

calculates averages and uncertainties on a regularly spaced spatio-temporal grid, using an iterative procedure that is weighted in space, time, and retrieval quality. The lack of observations at certain times and locations introduces missing grid points in the maps, which therefore may result in irregularly gridded (i.e. incomplete) fields. In order to evaluate the strengths and weaknesses of the resulting gridded maps, we compare with independent observations of CDOD by PanCam cameras and Mini-TES spectrometers aboard the Mars Exploration Rovers “Spirit” and “Opportunity”, by the Surface Stereo Imager aboard the Phoenix lander, and by the Compact Reconnaissance Imaging Spectrometer for Mars aboard MRO. We have statistically analyzed the irregularly gridded maps to provide an overview of the dust climatology on Mars over eight

Database (MCD) version 5, and are useful in many modeling applications. The two datasets for the eight available martian years are publicly available and distributed with open access on the MCD website.

This paper makes the following dataset on Mars dust climatology available to the public: [http://www-mars.lmd.jussieu.fr/mars/dust\\_climatology/](http://www-mars.lmd.jussieu.fr/mars/dust_climatology/)

## Coordinated Hubble Space Telescope and Venus Express Observations of Venus’ Upper Cloud Deck

**Submitted by** Dr. Frank Mills, Australia

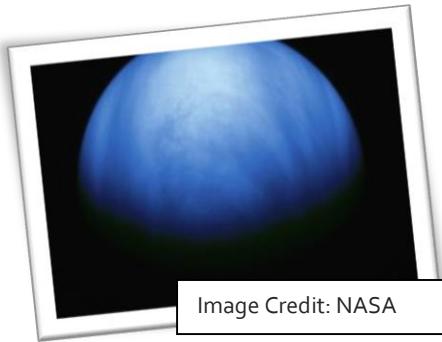


Image Credit: NASA

Hubble Space Telescope Imaging Spectrograph (HST/STIS) ultraviolet observations of Venus’ upper cloud tops were obtained between 20°N and 40°S latitude on December 28, 2010; January 22, 2011 and January 27, 2011 in coordination with the Venus Express (VEx) mission. The high spectral (0.27 nanometer) and spatial (40–60 km/pixel) resolution HST/STIS data provide the first direct and simultaneous record of the latitude and local time distribution of Venus’ 70–80 km SO and SO<sub>2</sub> (SO<sub>x</sub>) gas density on Venus’ morning quadrant. These data were obtained simultaneously with (a) VEx/SOIR occultation and/or ground-based James Clerk Maxwell Telescope sub-mm observations that record

**Climatological year:** Average of maps, excluding global-scale dust events

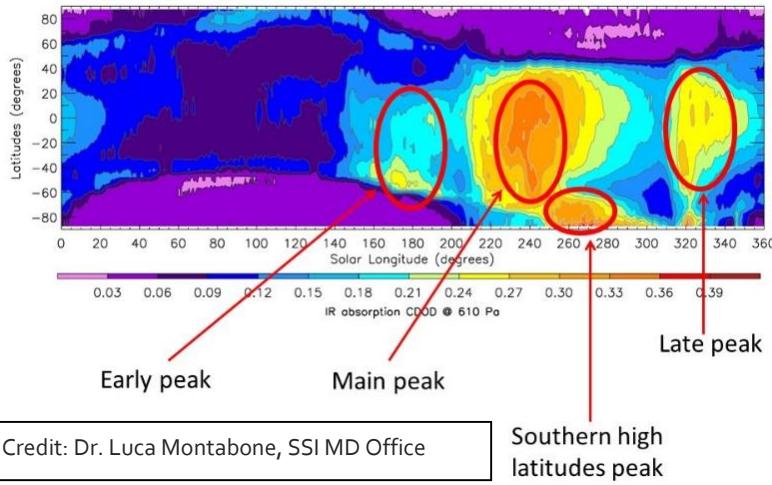


Image Credit: Dr. Luca Montabone, SSI MD Office

Sounder (MCS) aboard Mars Reconnaissance Orbiter (MRO). The procedure we have adopted consists of gridding the available retrievals of column dust optical depth (CDOD) from TES and THEMIS nadir observations, as well as the estimates of this quantity from MCS limb observations. Our gridding method

years, specifically in relation to its interseasonal and interannual variability, in addition to provide a basis for instrument intercomparison. Finally, we have produced regularly gridded maps of CDOD by spatially interpolating the irregularly gridded maps using a kriging method. These complete maps are used as dust scenarios in the Mars Climate

respectively, Venus' near-terminator SO<sub>2</sub> and dayside SO<sub>x</sub> vertical profiles between ~75 and 100 km; and (b) 0.36 μm VEx/VMC images of Venus' cloud-tops. Updating the (Marcq, E. et al. [2011] Icarus 211, 58–69) radiative transfer model SO<sub>2</sub> gas column densities, ~2–10 μm-atm and ~0.4–1.8 μm-atm are retrieved from the December 2010 and January 2011 HST observations, respectively on Venus' dayside (i.e., at solar zenith angles (SZA) < 60°); SO gas column densities of 0.1–0.11 μm-atm, 0.03–0.31 μm-atm and 0.01–0.13 μm-atm are also retrieved from the respective December 28, 2010, January 22, 2011 and January 27, 2011 HST observations. A decline in the observed low-latitude 0.24 and 0.36 μm cloud top brightness paralleled the declining SO<sub>x</sub> gas densities. On December 28, 2010 SO<sub>2</sub> volume mixing ratios (VMR) values ~280–290 ppb are retrieved between 74 and

81 km from the HST and SOIR data obtained near Venus' morning terminator (at SZAs equal to 70° and 90°, respectively); these values are 10x higher than the HST-retrieved January 2011 near terminator values. Thus, the cloud top SO<sub>2</sub> gas abundance declined at all local times between the three HST observing dates. On all dates the average dayside SO<sub>2</sub>/SO ratio inferred from HST between 70 and 80 km is higher than that inferred from the sub-mm the JCMT data above 84 km confirming that SO<sub>x</sub> photolysis is more efficient at higher altitudes. **The direct correlation of the SO<sub>x</sub> gases provides the first clear evidence that SO<sub>x</sub> photolysis is not the only source for**

**Venus' 70–80 km sulfur reservoir.** The cloud top SO<sub>2</sub> gas density is dependent in part on the vertical transport of the gas from the lower atmosphere; and the 0.24 μm cloud top brightness levels are linked to the density of the sub-micron haze. Thus, the new results may suggest a correlation between Venus' cloud-top sub-micron haze density and the vertical transport rate. These new results must be considered in models designed to simulate and explore the relationship between Venus' sulfur chemistry cycle, H<sub>2</sub>SO<sub>4</sub> cloud formation rate and climate



**CREDIT:** Galileo Project, JPL, NASA  
*Clouds on Venus*  
This colorized image of Venus was recorded by the Jupiter-bound Galileo spacecraft shortly after its gravity assist flyby of Venus in February of 1990. Galileo's glimpse of the veiled planet shows structure in swirling sulfuric acid clouds.

state with increasing SZA, as function of altitude within Venus' mesosphere, showing the photochemical and dynamical basis for the factor of ~2 enhancements in the SO<sub>x</sub> gas densities observed by HST near the terminator above that observed at smaller SZA.

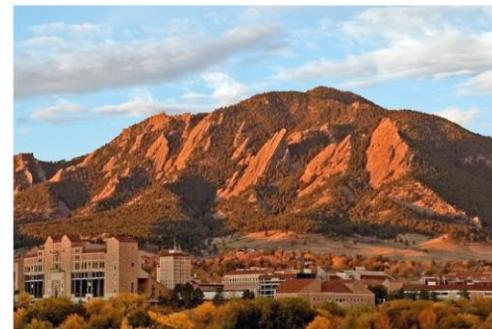
Read more at:  
<http://www.sciencedirect.com/science/article/pii/S0019103515002377>

## SSI IN THE PRESS!



### Dr. William Farrand on the John Batchelor Show!

Wednesday, June 24<sup>th</sup>, Dr. William Farrand was on the airwaves once again! This time around, he was on the John Batchelor Show and you can listen to the broadcast here: <http://johnbatchelorshow.com/podcasts/wed-62415-hr-1-jbs-co-host-gordon-chang-forbescom-scott-harald-rand-rick-fisher>



### Notable Employer in #1 College Town

SSI received a nod recently in an article written by Merrill Cook, listing the 50 Best College Towns in America. Boulder, SSI HQ's hometown, was listed as #1, where SSI was mentioned as one of a few notable employers and contributing factors to the high ranking.

**1,600+**

The number of known volcanos on the Venusian surface.

**243**

The number of Earth days it takes Venus to make 1 rotation.

### COMING UP NEXT ISSUE:

All about Mars and the Rover Mission(s)!

## CASSINI ISS INSTRUMENT OPERATIONS

SSI is also extremely proud of the work done by the Cassini Imaging Science Subsystem Instrument Operations team, based out of SSI's Boulder office. Approximately 50 scientists from the United States and Europe comprise the imaging team that uses cameras from the Cassini-Huygens mission to investigate many unique features of Saturn, its rings and moons. The Cassini ISS team is arguably the most productive of the Cassini instrument teams in delivering its wealth of data and images to scientists and the general public, and continues to deepen our knowledge about Saturn and the processes by which planets – and whole planetary systems – form and develop with time.

## The Face of Dione

By Steve Mullins, CICLOPS, SSI HQ Office

The rugged landscape of Saturn's fracture-faced moon Dione is revealed in images sent back by NASA's Cassini spacecraft from its latest flyby. Cassini buzzed past Dione on June 16, coming within 321 miles (516 kilometers) of the moon's surface.

This flyby was the fourth targeted encounter with Dione of Cassini's long mission. Targeted encounters require a propulsion maneuver to precisely steer the spacecraft toward a desired path above a moon. Cassini's closest-ever flyby of

Dione was in Dec. 2011, at a distance of 60 miles (100 kilometers). The spacecraft will fly past Dione one final time, on Aug. 17, swooping within 295 miles (474 kilometers) of the surface. The final Dione encounter will be Cassini's second-closest brush with the icy moon.

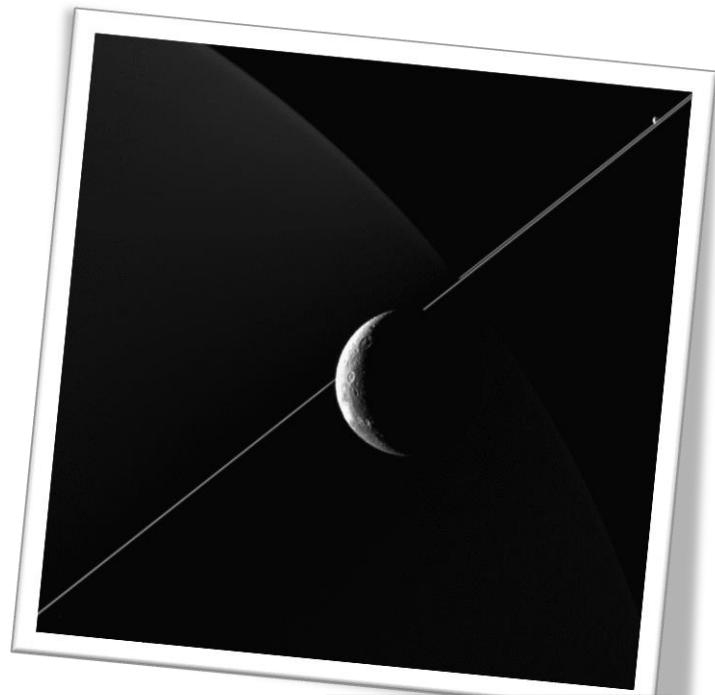


Image Credit: NASA/JPL/SSI

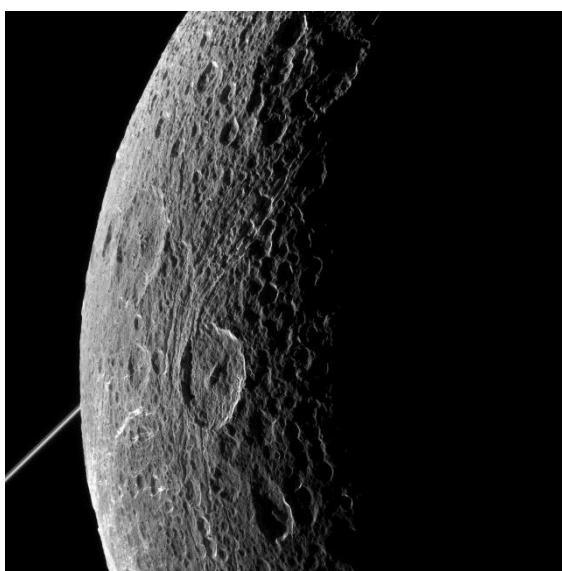


Image Credit: NASA/JPL/SSI

### CASSINI ISS INSTRUMENT OPERATIONS AT SSI

For more about what the SSI Cassini team members are up to on a regular basis, and Dr. Carolyn Porco's Captain's Log, please check out: [www.ciclops.org](http://www.ciclops.org)

# National Center for Interactive Learning

SSI is home to the National Center for Interactive Learning, which leverages SSI's successful experience in research, museum, science center and library educational programs, public outreach, and digital technologies into accessible and inspiring learning opportunities.



## Great Balls of Fire Exhibition Tour

by Anne Holland, NCIL, SSI HQ Office

The 3,500 square foot NSF-funded exhibit "Great Balls of Fire: Comets, Asteroids and Meteors" is currently on tour, with only 2 slots remaining! The exhibit includes computer and physical interactives, touchable meteorites and an immersive tour through the Solar System.

**Come see it in a city near you!**

Image Credit: SSI



Image Credit: SSI

### Tour Dates/Locations:

#### Summer 2015

Space Foundation  
Colorado Springs, CO

#### Fall 2015

Museum of Discovery and Science  
Ft. Lauderdale, FL

#### Spring 2016

Delaware Museum of Natural History  
Wilmington, DE

#### Summer 2016

OPEN  
OPEN



### FOR MORE INFORMATION

Click on :

[www.GreatBallsofFireExhibit.org](http://www.GreatBallsofFireExhibit.org)

or contact Anne Holland directly at :

[aholland@spacescience.org](mailto:aholland@spacescience.org)

## Welcome to Starchitect!

Building worlds and learning astronomy on Facebook

NCIL staff have developed *Starchitect*: a NASA and NSF funded, end-to-end, stellar and planetary evolution game for the Facebook platform. The game uses a "sporadic play" model to engage players in the creation and evolution of a solar system. Players build their own stars and planets and then watch as the system evolves in scaled real time (a million years to the minute). Massive stars will supernova within minutes, while lower mass stars like our Sun will live for weeks, possibly evolving life before passing through a red giant stage and ending their lives as white dwarfs. Successful systems can be photographed and posted to the player's Facebook wall. The game introduces players to a wide spectrum of astronomy concepts while simultaneously providing a platform for exploring the educational effectiveness of sporadic play games embedded in social networks. Data from this game is being collected so that we can evaluate the number of times a player returns to the game, and their level of engagement.

See what you can do...make a star, add some planets, and see if you can get life going. For information and to start the game, click [here](#).

# Highlights from the Inclusive Astronomy Conference 2015!

by Dr. Karly Pitman, SSI HQ Office

on June 17th-19th, 176 astronomers descended upon Vanderbilt University to discuss ways to make the astronomical community more inclusive of underrepresented minorities and marginalized groups, and therefore, more productive. For the first such conference of its kind, turnout was impressive; institutions from all states of the union were represented. Keivan Stassun (Vanderbilt Univ.) and the rest of the local organizing committee did a wonderful job in making sure all attendees were taken care of, from letting everyone speak their mind in the Q&A sessions to offering good meal options for those with dietary and religious restrictions.

power, and decision making; and establishing a community of inclusive practice. There were many notable talks; a few not mentioned on other recaps of the event (e.g., <http://www.planetary.org/blogs/guest-blogs/2015/0625-inclusive-astronomy.html>) are summarized here.

Rachel Ivie (American Institute of Physics) presented a statistics plenary which included data from several surveys including AIP's longitudinal survey of astronomy graduate students (LSAGS). (*see also Rachel's poster during the 2nd week of the Aug. 2015 AAS/IAU meeting in Honolulu*). Results from the first two rounds of LSAGS were used to examine the reasons for employment attrition



1st ever Inclusive Astronomy conference  
Image Credit: Don Pickert/Vanderbilt

The main program centered around four broad areas: barriers to access (e.g., in college admissions and career); creating inclusive climates; inclusion and access to leadership,

from the field of astronomy. In an upcoming paper (*Ivie et al. 2015, Physical Review Special Topics – Physics Education Research, in review*), they found that the 2-body problem and relationships with advisors are factors that directly affect whether

someone leaves astronomy; thus, sex has an indirect effect on attrition because women are more likely to report 2-body problems and are less likely to report positive relationships with their graduate advisors. A web page with featuring other reports from the LSAGS data will be coming out in a few months, linked to NSF's website.

The plenary talk by Lydia Brown ([lydia@autistichoya.com](mailto:lydia@autistichoya.com)) about disability activism was quite powerful, garnering a standing ovation from the crowd. If you're preparing a proposal or talk that has anything to do with disability, she has some great slides on "Ways of Thinking About Disability" critiquing the paradigm that there is "one normal and that other than is defect," as well as useful recommendations on appropriate language and best practices (e.g., avoiding categorizing disabled persons as inspirational; resources for autistic persons). The breakout session focusing on access issues for disabled astronomers was also interesting. According to Wanda Diaz-Merced (CfA/SAO), audio text reader technology has extreme difficulty reading PDFs and tables, making it tough for blind and dyslexic people who make use of this technology to have full access to journal articles and proposals. The deaf community also has a request for more signs in ASL to convey scientific concepts; according to Jason Nordhaus (RIT) and Tom Rice (Univ. Michigan), a cadre of sign language interpreters is being assembled for the AAS winter meeting so that we can produce the next John Goodricke, Annie Jump Cannon, Henrietta Leavitt, or Olaf Hassel (all of whom had partial or total hearing loss).

David Helfand (Columbia Univ.; Quest) and Dara Norman (Howard Univ.; NOAO) are preparing a toolkit on improving access to Power & Policy, including a comprehensive list of all the leadership committees that exist in astronomy ranked by degree of influence on the field. Some examples of committees that have high influence and offer easy entry for newcomers are telescope time and other allocation committees (e.g., funds, grants, fellowships). One time or standing agency advisory committees and management committees (e.g., for observatories) have moderate impact. Policy committees such as Decadal Surveys and National Academy committees offer the opportunity to make moderate culture changes but require a high number of service hours. Among governance committees (e.g., for AAS), the nominating committees have the real power to affect change.

Dara Norman also gave a great talk entitled "Who Runs What (And How): What Managing Organizations Are and Do." Managing organizations in astronomy (e.g., AURA, which runs NOAO; USRA; SURA; AUI) guide high level policy and management. Joel Parriott (AAS) presented on federal advisory and policy bodies, including the National Science Board which runs NSF, PCAST (President's Council of Advisors in Science & Technology), and various Blue Ribbon panels. Two types of committee members that are desirable to both representative voting and ad hoc consensus advisory bodies are people who are willing to write and do research as needed and people who are interested in consensus.

Along the theme of barriers to access in college admissions, Casey Miller (RIT) presented data in his presentation "GRE Misuse Negatively

Impacts Diversity" that shows concretely that the physics GRE test, which is used in 96% of graduate school admissions programs, is worthless at predicting career success in physics and astronomy and moreover filters out women and minorities. New data is in publication; similar plots are available at  
<http://www.aps.org/publications/apsnews/201302/backpage.cfm>

<http://www.nature.com/naturejobs/science/articles/10.1038/nj7504-303a>  
Dina Stroud (Fisk-Vanderbilt) provided a diversity toolkit to help identify students with unrealized potential and measure the "second derivative" of student performance, including metrics for quantifying level of perseverance and grit which is another large criterion in scholastic admissions and ascent to leadership positions in science.

### *Some Interesting Facts:*

- You can request double-blind peer review for the AAS journal. Double blind review is not done by default but any requests for this will be honored/taken seriously to give your article a fair review.
- There is a group working toward renaming of astronomical objects to be less offensive to underrepresented minorities and marginalized groups (e.g., "The Eskimo Nebula").
- The AAS Working Group on LGBTIQ Equality (WGLE) and LGBT+ Physicists have a new best practices guide for improving climate and advocacy at the departmental and institutional levels for LGBTIQ physicists and astronomers:  
<http://wgle.aas.org/sites/wgle.aas.org/files/BestPracticesGuide.pdf>

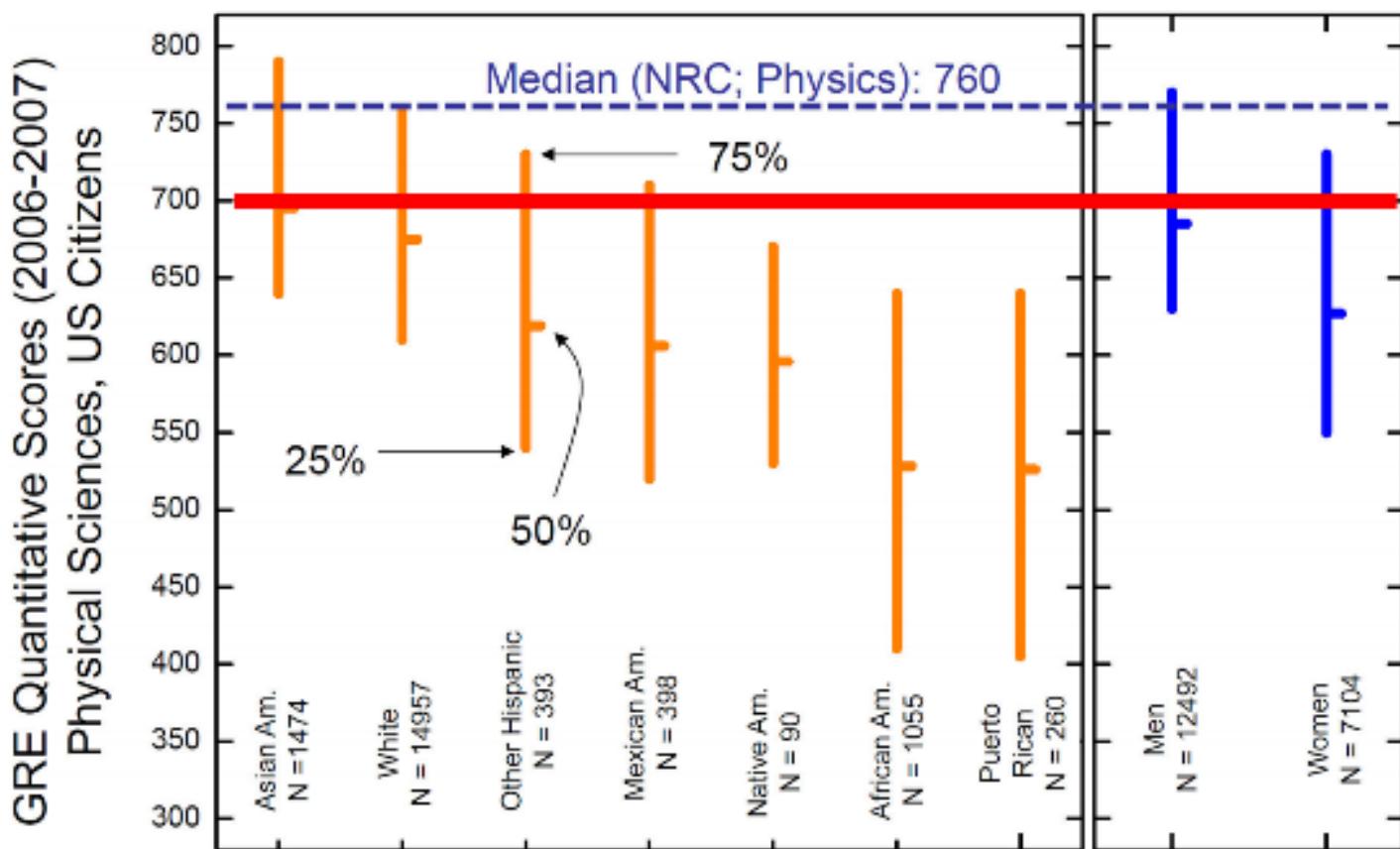
- According to presenter Kenjus Watson (Occidental), research on telomere length points to accelerated aging for groups who experience continuous stress from microaggressions (cf. Geronimus et al. 2011,  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2861506/>).

- African-American and Hispanic astronomy faculty are few and far between (7% and 4% of degrees awarded). At the top 40 institutions, 0% of faculty are Native Americans and out of 38 tribal colleges, none have physics and astronomy departments. Bridge programs at Fisk-Vanderbilt and Columbia University are working to get more minorities into physics and astronomy Ph.D. programs.

Most of the meeting was devoted to brainstorming a list of recommendations (similar to the AAS CSWA Pasadena recommendations) that would improve working conditions in astronomy for underrepresented minorities and marginalized groups. The draft white paper is under the section "Findings & Recommendations" at:

<https://vanderbilt.irisregistration.com/Home/Site?code=InclusiveAstronomy2015>

There is a Google form for submitting your recommendations to be included in the draft. Within the next ~2 months, the Inclusive Astronomy organizers and participants will be incorporating all of the suggestions, at which time it will be released the community at large for comment. Keivan Stassun hopes to host a session at the January 2016 AAS meeting to further share the report and recommendations with the community and with AAS leadership.



GRE Quantitative scores are often used as a selection criterion for which students can enter graduate school in physics and astronomy. The red line is the minimally acceptable score for most physics Ph.D. departments, while the blue dashed line is the median score of the people who were accepted to those departments in 2006-2007. Note the race/ethnicity and gender imbalances in such standards. Source: C. Miller, [http://www.aas.org/cswa/status>Status2015\\_Jan.pdf](http://www.aas.org/cswa/status>Status2015_Jan.pdf).

## Welcome to SSI:



**Wren Raming** is a student assistant and part of SSI Senior Research Scientist Bill Farrand's grant through the Center for the Advancement of Science in Space (CASIS) on "Hyperspectral Mapping of Iron-bearing Minerals Associated with Dry and Ephemeral Lakes". Wren is a senior undergraduate in the Geology and Geophysics Department at the University of Utah. When he is not at school or doing research he is either working as a river guide in the Grand Canyon or spending time with friends and family in the mountains. The project was originally funded to use hyperspectral remote sensing data from the Hyperspectral Imager for the Coastal Ocean (HICO) to map minerals in dry and ephemeral lakes in the southwestern U.S. and several acid-saline lakes in Australia. After the failure of the HICO instrument last Fall, before several of the study areas could be imaged, the project has expanded to use other remote sensing data sets to study the dry lakes.



**Netsha J. Santiago-González** visited the Space Science Institute in Boulder this summer to work with Dr. Savita Mathur as a summer internship. Netsha became interested in science when she was a teen. She was a student at the Ana G. Méndez University System (AGMUS) Saturday Academy Pre-College Program from 2010-2013. The goal of the program is to prepare and guide the next generation of scientists from Puerto Rico through a research mentoring experience in Science, Technology, Engineering, and Mathematics (STEM). She is currently a third year student at the University of Puerto Rico at Cayey where she is studying Natural Sciences and a mentor herself at the Saturday Academy in the areas of genetics, biology, and mathematics. This summer, she temporarily left her main field of interest to become acquainted with stellar astrophysics and asteroseismology. Her summer project consisted of studying the surface rotation and magnetic activity levels of solar-like stars where no acoustic modes have been detected. To do so, she analyzed data collected for ~ 4 years by the *Kepler* mission. Her results are being compared to the rotation rates and magnetic activity levels of a sample of solar-like stars where oscillations could be detected with the *Kepler* data. This study will help us understand how magnetic activity affects the amplitude of acoustic modes and hence their detectability.

On July 30<sup>th</sup>, Netsha presented a poster at NCAR (*the building at Center Green*) entitled:

**STUDYING CORRELATION BETWEEN MAGNETIC ACTIVITY AND ACOUSTIC MODES DETECTION IN SOLAR-LIKE STARS OBSERVED BY KEPLER**



**Barbara Shepley** is SSI's new Administrative Assistant. She has a strong background of experience in organization, communication, and facilitation while assisting high-level management members, as well as excellent office skills and customer service. Her bright and cheery smile, along with go-getter & handle anything attitude, comes through in all she does. She is a proud Grandmother and firmly believes that with lots of encouragement and faith, you can make it through anything.