Science Mission Directorate

Weekly Highlights

October 14, 2016

Giant ‘Cannonballs’ Shooting from Star Detected

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Scenario for plasma ejections from V Hydrae

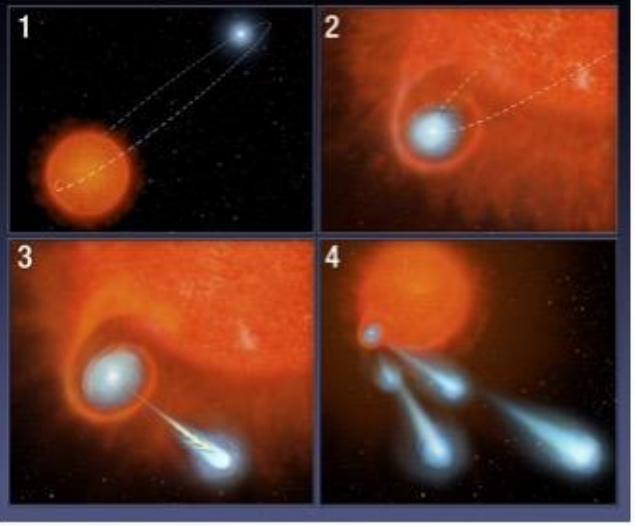


Illustration: NASA, ESA, and A. Feild (STScI)

This graphic illustrates how the binary-star system V Hydrae is launching balls of plasma into space.

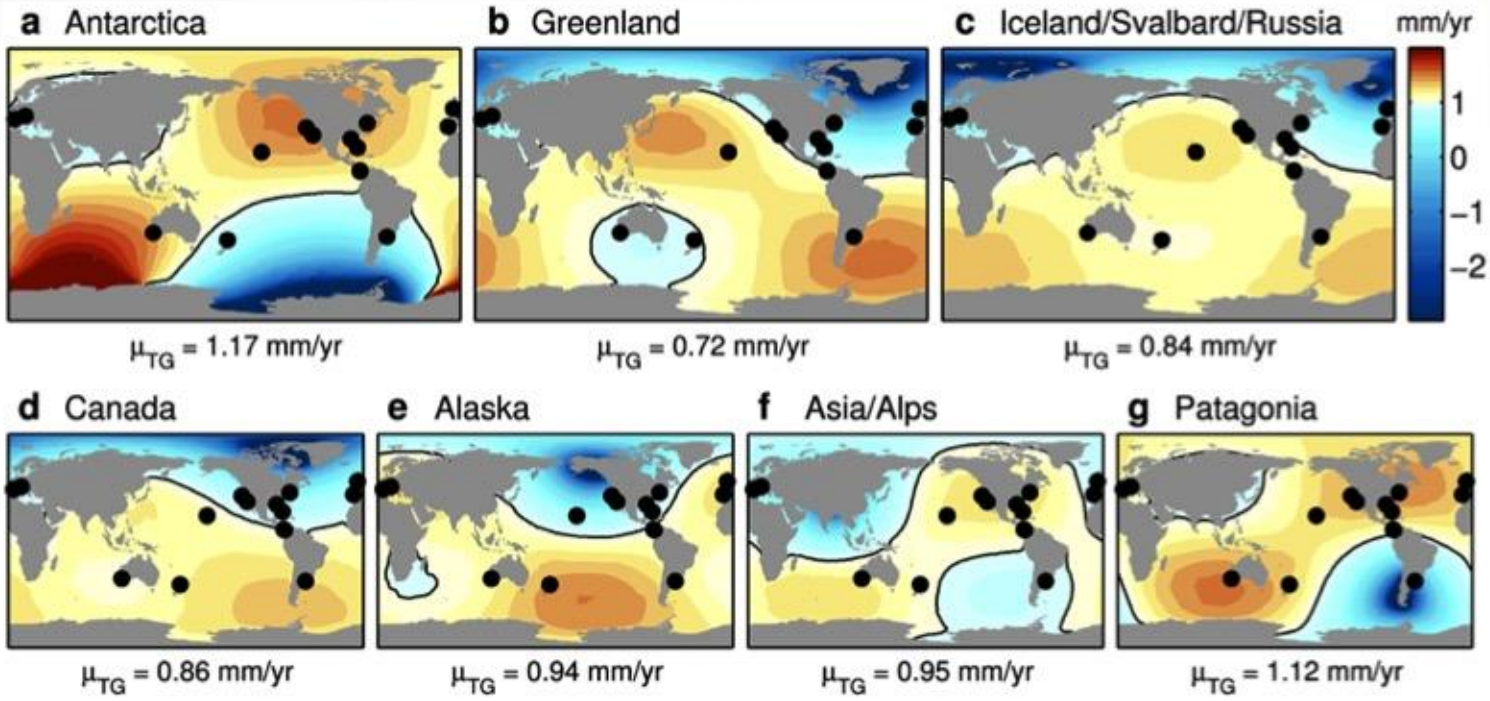
- *Panel 1 shows the two stars orbiting each other. One of the stars is nearing the end of its life and has swelled in size, becoming a red giant.*
- *In panel 2, the smaller star's orbit carries the star into the red giant's expanded atmosphere. As the star moves through the atmosphere, it gobbles up material from the red giant, which settles into a disk around the star.*
- *The buildup of material reaches a tipping point and is eventually ejected as blobs of hot plasma along the star's spin axis, shown in panel 3.*
- *This ejection process is repeated every eight and a half years, the time it takes for the orbiting star to make another pass through the bloated red giant's envelope, shown in panel 4.*

- NASA's Hubble Space Telescope has detected superhot blobs of gas being ejected near a dying star. The fireballs present a puzzle to astronomers, because the ejected material could not have been shot out by the host star, called V Hydrae. The star is a bloated red giant, residing 1,200 light-years away, which has probably shed at least half of its mass into space during its death throes.
- The current best explanation suggests the plasma balls were launched by an unseen companion star. According to this theory, the companion would have to be in an elliptical orbit that carries it close to the red giant's puffed-up atmosphere every 8.5 years. As the companion enters the bloated star's outer atmosphere, it gobbles up material. This material then settles into a disk around the companion, and serves as the launching pad for blobs of plasma, which travel at roughly a half-million miles per hour.
- This star system could be the archetype to explain a variety of glowing shapes uncovered by Hubble that are seen around dying stars, called planetary nebulae. A planetary nebula is an expanding shell of glowing gas expelled by a star late in its life.
- Hubble observations over the past two decades have revealed an enormous complexity and diversity of structure in planetary nebulae. The telescope captured knots of material in the glowing gas clouds surrounding the dying stars. Astronomers speculated that these knots were actually jets ejected by disks of material around companion stars.
- Researchers used Hubble's Space Telescope Imaging Spectrograph (STIS) to conduct observations of V Hydrae and its surrounding region over an 11-year period. The data showed a string of monstrous blobs, each with a temperature of more than 17,000 degrees Fahrenheit. The researchers compiled a detailed map of the blobs' location. STIS detected the giant structures as far away as 37 billion miles away from V Hydrae.
- The blobs expand and cool as they move farther away, and are then not detectable in visible light. But observations taken at longer sub-millimeter wavelengths, by the Submillimeter Array in Hawaii, revealed fuzzy, knotty structures that may be blobs launched 400 years ago.
- A surprise from the STIS observation was that the disk does not fire the monster clumps in exactly the same direction every 8.5 years. The direction flip-flops slightly from side-to-side to back-and-forth due to a possible wobble in the accretion disk.
- Astronomers have noted that V Hydrae is obscured every 17 years, as if something is blocking its light. The researchers suggest that due to the back-and-forth wobble of the jet direction, the blobs alternate between passing behind and in front of V Hydrae. When a blob passes in front of V Hydrae, it shields the red giant from view.

Are Long Tide Gauge Records in the Wrong Place to Measure Global Mean Sea Level Rise?

Thompson, P. R., Hamlington, B. D., Landerer, F. W., & Adhikari, S.| Geophysical Research Letters | October 2016 | doi:10.1002/2016GL070552

NASA funded scientists used observations and simulations of spatial structure in sea level change to estimate the likelihood that several Earth processes cause sea level trends in the longest and highest-quality tide gauge records to be systematically biased relative to the true global mean rate. Such processes include ocean dynamics, vertical land motion, and changes in Earth's gravitational and rotational fields. Sea level change due to the melting of ice on land is not spatially uniform, because the Earth is a self-gravitating, viscoelastically compressible, rotating planet. The team used time-varying gravity data from NASA's Gravity Recovery and Climate Experiment (GRACE) satellites to obtain "ice melt fingerprints", which are global patterns of sea level change caused by deviations in Earth's rotation and local gravity that occur when a large ice mass melts, during January 2003 to January 2015. The analyzed records have an average twentieth century rate of approximately 1.6 mm/year, but based on the locations of these gauges, they showed that the simple average underestimates the twentieth century global mean rate by 0.1 ± 0.2 mm/year. Given the distribution of potential sampling biases, they found less than 1% probability that observed trends from the longest and highest-quality tide gauge records are consistent with global mean rates less than 1.4 mm/year.

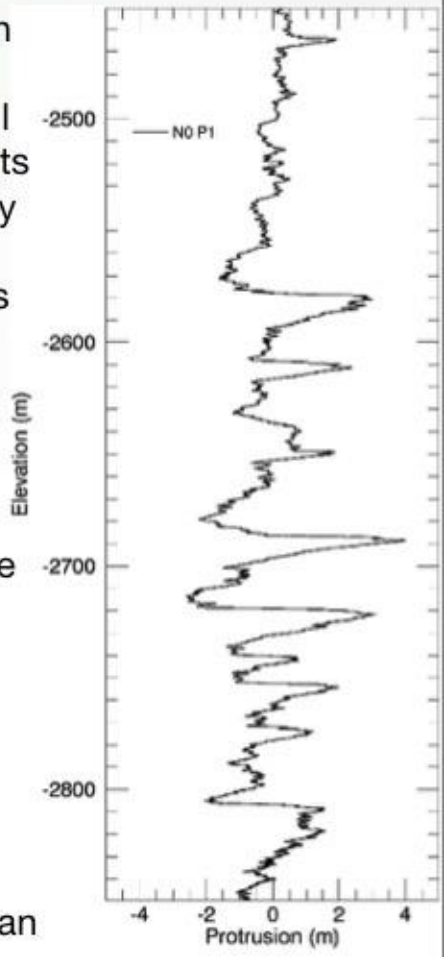


Left: Gravitational ice melt fingerprints from GRACE on an elastic, rotating Earth. Units are sea level equivalent, and each fingerprint is normalized to have a global spatial mean of 1 mm/yr. The mean sea level change rate at the locations of tide gauge records (μTG) represents the degree to which these locations systematically underestimate or overestimate the global mean trend associated with each melt source.

Mars' Polar Topography Reveals Astronomical Forcing of Climate

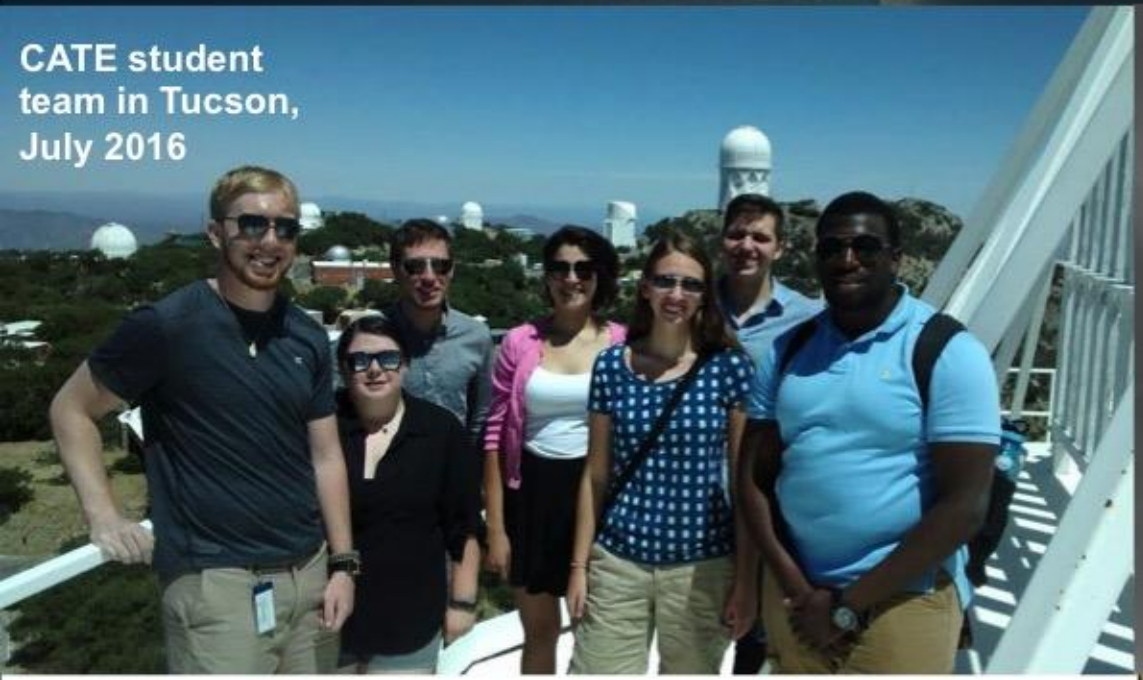
Analysis of the topography of exposures of the icy layers of Mars' North Polar Cap connects periodic changes in layer properties to the oscillation of Mars' orbit and rotation.

- On Earth, climate variations recorded in ice cores result in part from orbital oscillations, but are also affected by changes in the oceans, and the activity of humans as well as other living organisms. Separating out the orbital effects is a complex problem, but Mars offers a natural laboratory where this is possible.
- Mars' climate oscillates as the planet's orbit and spin axis change with periods of 51,000 and 120,000 years, respectively. These had been expected to affect polar layered ice since it was discovered 45 years ago, but this link has never been demonstrated unambiguously.
- Images from the High Resolution Imaging Science Experiment (HiRISE) camera on the Mars Reconnaissance Orbiter (MRO) can image these layers (left) in stereo so their physical properties – measured by how far different layers protrude relative to others – can be read like ice cores on Earth. With this data (right) overlapping periodicities in the stratigraphy can be measured and, using climate models, two dominant signals can be matched to the orbital history of Mars.
- These new findings allow us to confidently connect martian polar ice layers with specific dates for the first time.

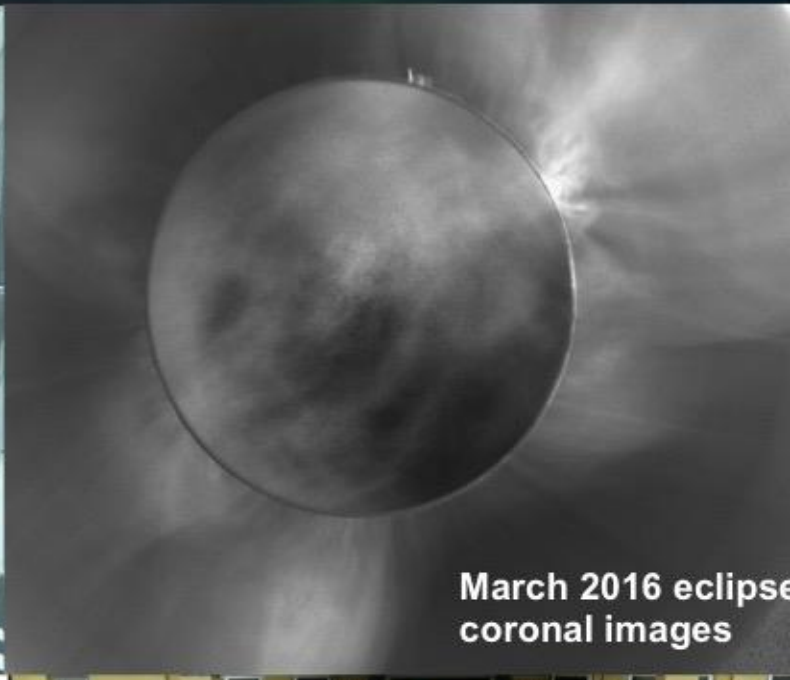


(Becerra, 2016, PhD Thesis, Univ. of Arizona)

Citizen CATE Experiment: Lessons from Indonesia 2016



CATE student team in Tucson, July 2016



March 2016 eclipse coronal images

- The Citizen Continental-America Telescopic Eclipse (CATE) Experiment team returned from the March 2016 Indonesia eclipse with outreach experience and scientific data
- During a summer program at the National Solar Observatory in Tucson the team produced improvements for the 2017 equipment, and training videos for the 60+ volunteers in the CATE 2017 experiment
- Preparations are continuing for the August 21, 2017, total eclipse across the entire North American continent -- first time since 1918!

CATE Team outreach at SMA1 Nigera, Tandjungpandan Indonesia