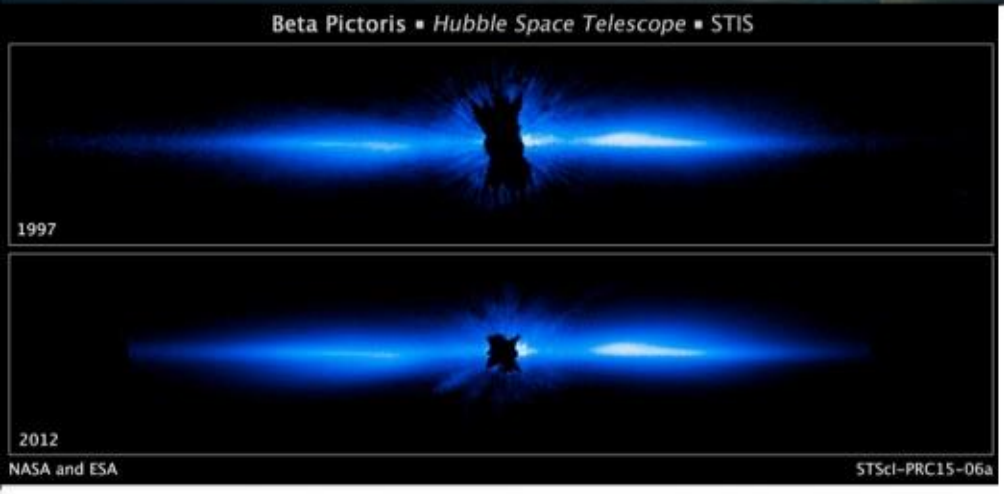
Science Mission Directorate

Weekly Highlights

February 27, 2015

Circumstellar Debris Disk Distorted by a Planet



The photo at the bottom is the most detailed picture to date of a large, edge-on, gas-and-dust disk encircling the 20-million-year-old star Beta Pictoris. Both the 1997 and 2012 images were taken in visible light with Hubble's Space Telescope Imaging Spectrograph in its coronagraphic imaging mode. A coronagraph blocks out the glare of the central star so that the disk can be seen. The Hubble Space Telescope photo has been artificially colored to bring out detail in the disk's structure.

- Astronomers have used NASA's Hubble Space Telescope to take the most detailed picture to date of a large, edge-on, gas-and-dust disk encircling the 20-million-year-old star Beta Pictoris. Beta Pictoris remains the only directly imaged debris disk that has a giant planet (discovered in 2009). Because the orbital period is comparatively short (estimated to be between 18 and 22 years), astronomers can see large motion in just a few years. This allows scientists to study how the Beta Pictoris disk is distorted by the presence of a massive planet embedded within the disk.
- The new visible-light Hubble image traces the disk in closer to the star to within about 650 million miles of the star. When comparing the latest Hubble images to Hubble images taken in 1997, astronomers find that the disk's dust distribution has barely changed over 15 years despite the fact that the entire structure is orbiting the star like a carousel. This means the disk's structure is smoothly continuous in the direction of its rotation on the timescale, roughly, of the accompanying planet's orbital period.
- In 1984 Beta Pictoris was the very first star discovered to host a bright disk of light-scattering circumstellar dust and debris. The disk is easily seen because it is tilted edge-on and is especially bright due to a very large amount of starlight-scattering dust. Though nearly all of the approximately two-dozen known light-scattering circumstellar disks have been viewed by Hubble to date, Beta Pictoris is the first and best example of what a young planetary system looks like.
- One thing astronomers have recently learned about circumstellar debris disks is that their structure, and amount of dust, is incredibly diverse and may be related to the locations and masses of planets in those systems. The Beta Pictoris disk is exceptionally dusty. This may be due to recent major collisions among unseen planetary-sized and asteroid-sized bodies embedded within it. In particular, a bright lobe of dust and gas on the southwestern side of the disk may be the result of the pulverization of a Mars-sized body in a giant collision.

Magnetospheric Multiscale Prepares for March 12 Launch

NASA's MMS observatories are shown here in the clean room being processed for a March 12 launch from Space Launch Complex 41 on Cape Canaveral Air Force Station, Florida. Credit: NASA

- Final preparations are underway for the launch of NASA's quartet of Magnetospheric Multiscale (MMS) spacecraft, which constitute the first space mission dedicated to the study of magnetic reconnection. This fundamental process occurs throughout the universe where magnetic fields connect and disconnect with an explosive release of energy.

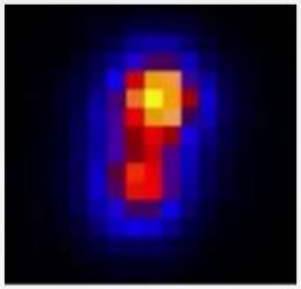
- Magnetic reconnection is one of the most important drivers of space weather events. Eruptive solar flares, coronal mass ejections, and geomagnetic storms all involve the release, through reconnection, of energy stored in magnetic fields. Space weather events can affect modern technological systems such as communications networks, GPS navigation, and electrical power grids.

- The launch of MMS, on a United Launch Alliance Atlas V rocket, will be managed by the Launch Services Program at NASA's Kennedy Space Center in Florida. Liftoff is targeted for 10:44 p.m. - EDT Thursday March 12 from Space Launch Complex 41 on Cape Canaveral Air Force Station, Florida.

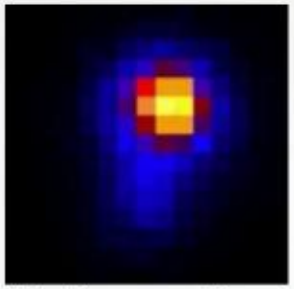
- The spacecraft will begin science operations in September. Unlike previous missions to observe the evidence of magnetic reconnection events, MMS will have sufficient resolution to measure the characteristics of ongoing reconnection events as they occur. The mission consists of four identical space observatories that will provide the first three-dimensional view of magnetic reconnection. Because the observatories will fly through reconnection regions in a tight formation, in less than a second, key sensors on each spacecraft are designed to measure the space environment at rates100 times faster than any previous mission.

- MMS engineers have completed final observatory closeout procedures and checks and are working the transport to the launch pad for integration with the Atlas rocket. The mission observes reconnection directly in Earth's protective magnetic space environment known as the magnetosphere. By studying reconnection in this local, natural laboratory, MMS helps us understand reconnection elsewhere, such as the atmosphere of the sun, the vicinity of black holes and neutron stars, and the boundary between our solar system and interstellar space.

Pluto Twinkles Starlight: It has an Atmosphere!

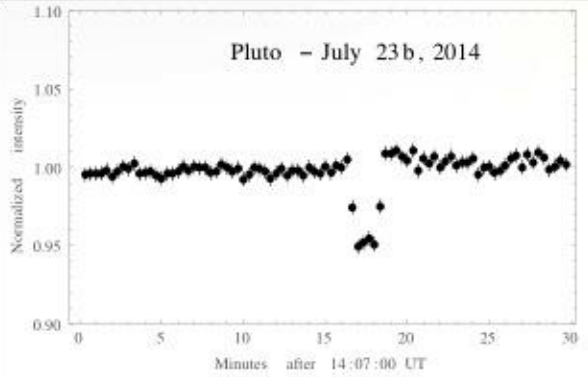


Pluto (top) and a star (bottom).



Pluto's moon Charon occults, or blocks the light from, the star.

(Williams College/MIT Collaboration)



Light from a star dims as Pluto passes in front of it, as in the dip shown here, allowing astronomers to study the properties of Pluto's atmosphere and the size of the dwarf planet.

Planetary scientists analyze the composition, temperature, and density of Pluto's atmosphere by looking at the variations in starlight—a sort of twinkling—as it passes through Pluto's atmosphere. A series of observations of Pluto and Charon passing in front of – or occulting - stars has been obtained with ground-based telescopes of all sizes, from 0.6 m up to 8 m, and with the 2.5-m telescope aboard NASA's airplane SOFIA (Stratospheric Observatory for Infrared Astronomy). The stars are so far away that Pluto's shadow on the Earth is the same size as Pluto itself, about 2400 km across. The diameter of Pluto's moon Charon is about half that. If those narrow shadow paths do not pass over an observatory, astronomers and portable telescopes or SOFIA must chased the shadows to make their observations.

Solid lines show the range of predicted locations of Pluto's shadow on the Earth before it passed in front of a star in 2014.

In June 2015, only a couple of weeks before NASA's New Horizons flies by Pluto, a 12th magnitude star, about 10 times brighter than Pluto, is predicted to be occulted. Astronomers using telescopes on the ground in New Zealand and Australia and from aloft using SOFIA will be able to use this relatively bright star to again probe the properties of Pluto's atmosphere. Ongoing ground-based observations will therefore link with New Horizons observations to understand Pluto's atmosphere and how it changes over time.

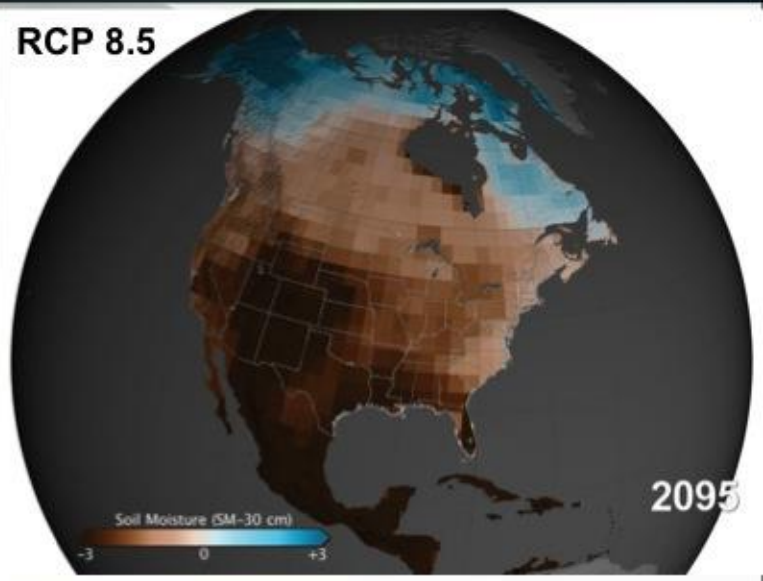
These "stellar occultations" are also used to measure the size of Pluto and other dwarf planets like Eris, which is thought thought to be a little larger than Pluto. However, Pluto's lowest atmosphere bends and absorbs starlight so well that we cannot tell exactly how big it is. Ground-based observations have determined the size of Eris, and that it is more massive than Pluto, and the New Horizons observations will accurately determine Pluto's size and ultimately which is the largest dwarf planet.

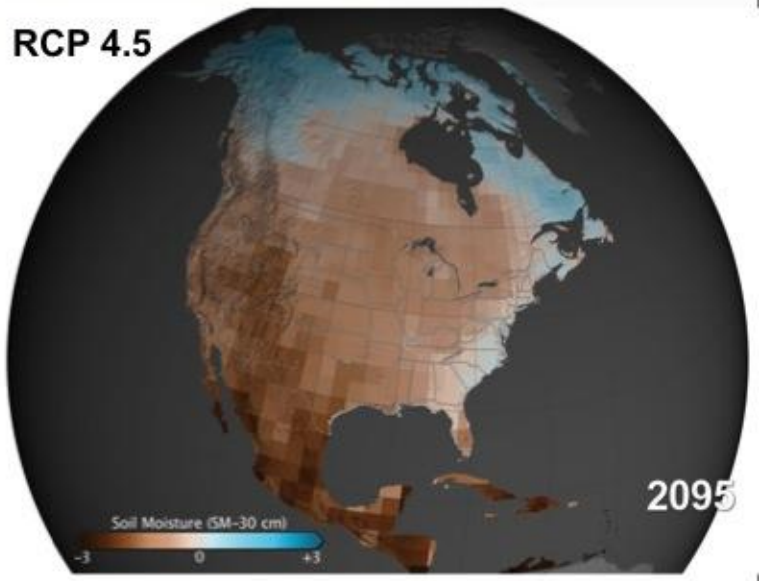
Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains

Benjamin I. Cook, Toby R. Ault, Jason E. Smerdon | Science Advances | FEBRUARY 2015 | doi: 10.1126/sciadv.1400082

A recent NASA study used an empirical drought reconstruction and three soil moisture metrics from 17 state-of-the-art general circulation models (GCMs) to show that these models project a significantly drier later half of the 21st-century compared to the 20th-century and earlier paleoclimatic intervals. This desiccation is consistent across the majority of models regardless of the employed moisture balance variable, indicating a coherent and robust drying response to warming despite the diversity of models and metrics analyzed. Notably, future drought risk will likely exceed even the driest centuries of the Medieval Climate Anomaly (1100–1300 CE) in both moderate (RCP 4.5) and high (RCP 8.5) future emissions scenarios, leading to drought conditions without precedent during the last millennium.

In the Southwest and Central Plains of Western North America, climate change is expected to increase drought severity in the coming decades. These regions nevertheless experienced extended Medieval-era droughts that were more persistent than any historical event, providing crucial targets in the paleoclimate record for benchmarking the severity of future drought risks.





Right: Soil moisture 30 cm below ground projected through 2100 for high emissions scenario ***Top****: RCP 8.5 and* ***Bottom****: RCP 4.5.* The soil moisture data are standardized to the Palmer Drought Severity Index and are deviations from the 20th century average.

* RCP: Representative Concentration Pathway climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) as part of the organization's fifth assessment report.

Informal Heliophysics Educator Ambassador (IHEA) Workshop held in Chicago, IL

This workshop was held February 8-13, 2015, in Chicago, IL, and brought 20 informal educators from around the country for training on how to use NASA educational resources. Additionally, each participant committed – upon their return home – to lead two workshops for classroom teachers, mentoring another informal educator, and using the materials they were trained on directly with an informal audience. Participants, known as Educator Ambassadors, will interact with mission subject matter experts, and will continue to engage with each other through follow up webinars and online collaboration.

Mission collaborators included missions from across the Astrophysics and Heliophysics science disciplines.

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