National Aeronautics and
Space Administration

Science Mission Directorate

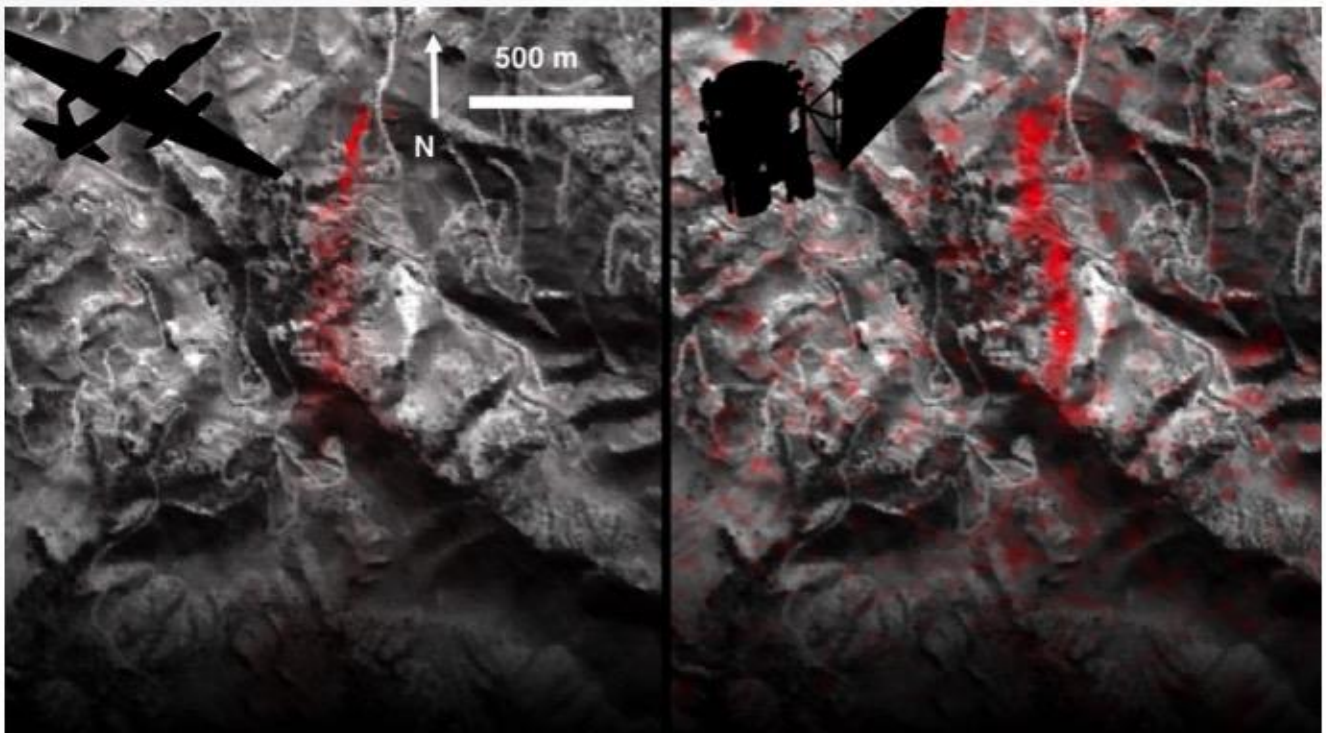
Weekly Highlights

July 15, 2016

A First: NASA Spots Single Methane Leak from Space

http://www.jpl.nasa.gov/news/news.php?feature=6535

NASA scientists and collaborators used data from NASA's Hyperion instrument on Earth Observing-1 (EO-1) to measure the methane emissions from a single, specific leaking facility on Earth's surface, which occurred over Aliso Canyon, near Porter Ranch, California. The Hyperion instrument successfully detected the methane leak on three separate overpasses during the winter of 2015-16. The research was part of an investigation of the large accidental Aliso Canyon methane release last fall and winter. The orbital observations from Hyperion were consistent with airborne measurements made by NASA's Airborne/Infrared Imaging Spectrometer (AVIRIS) imager flying onboard a NASA ER-2 aircraft. Part of NASA's New Millennium Program, EO-1 is an advanced land-imaging mission designed to demonstrate new instruments and spacecraft systems. Launched in 2000, EO-1 has validated technologies for the Operational Land Imager used on the Landsat-8 satellite mission and future imaging spectrometer missions, and supported disaster-response applications.



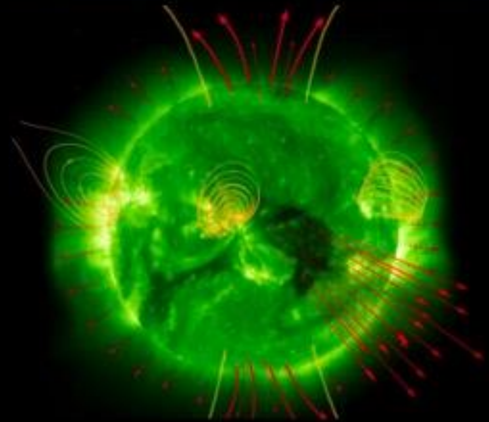
The observation -- by the Hyperion spectrometer on EO-1 -- is an important breakthrough in our ability to eventually measure and monitor emissions of this potent greenhouse gas from space.

Left: Comparison of detected methane plumes over Aliso Canyon, California, acquired 11 days apart in Jan. 2016 by: **(left)** NASA's AVIRIS instrument on a NASA ER-2 aircraft at 4.1 miles altitude; **(right)** by the Hyperion instrument on NASA's EO-1 satellite in low-Earth orbit.

Learning More About Earth's Space Environment: Clues to the Origins of Slow Solar Wind

Kepko, L., N. M. Viall, S. K. Antiochos, S. T. Lepri, J. C. Kasper, and M. Weberg (2016). IMPLICATIONS OF L1 OBSERVATIONS FOR SLOW SOLAR WIND FORMATION BY SOLAR RECONNECTION. Geophys. Res. Lett., 43. doi:10.1002/2016GL068607

Earth is surrounded by a slow solar wind much of the time. The solar wind is the continuous stream of charged particles flowing out from the sun that is one of the largest drivers for space weather processes and events. It's a tenuous medium that supports a variety of plasma processes, many of which we don't fully understand, although they affect us. We know fast solar wind (which travels over 500 km/s) originates from so-called "coronal holes," but we don't know where slow solar wind comes from. We can learn more about how solar wind is created through studying its properties as it arrives at our doorstep in near-Earth space. A paper published in May of this year in *Geo-physical Research Letters* outlined research using new data released from the Heliophysics ACE mission's to give us a better grasp on where slow solar wind might originate. The Heliophysics Communications team at GSFC also produced this feature on the paper earlier this summer.



In this image, yellow whorls represent the Sun's magnetic fields and the long red arrows indicate the fast solar wind exiting coronal holes (the dark regions of lower temperature and density). Image from the SOHO Extreme ultraviolet Imaging Telescope. Credit: ESA/NASA

The research team looked at slow solar wind composition at the L1 libration point, where the ACE mission is stationed. This point, which is 1.5M km closer to the sun than the Earth, is well outside the influence of Earth's magnetic field. Therefore, the composition of the slow solar wind at this distance would still contain imprints of the conditions under which it was formed. They specifically looked at the variability in the wind's charge state, or number of electrons, and the relative abundance of heavy elements like oxygen, carbon and helium in its overall composition.

Previous studies examining slow solar wind properties have focused on long-term averages, on the order of hours, largely due to the lack of enough data for viable statistics. But, the ACE mission recently produced a new data set of high time resolution (12 min) measurements of the solar wind properties that enabled analysis at ~90 min timescales. This allowed the authors to test the hypotheses of the three most popular models of where the slow solar wind originates. In their analysis, they find that the *S-Web* model did the best job of explaining all the features studied. In *S-Web*, the slow solar wind is created at the boundary between "open" and "closed" magnetic field lines within the solar corona. Closed magnetic field lines are those that originate and end at the Sun while open field lines extend out into the solar system. Also, *S-Web* has a dynamic open-closed boundary with closed flux opening up and open flux closing down as a result of instabilities or direct driving within the solar atmosphere. The acceleration process for the wind in this model is energy released by magnetic reconnection that can occur either in the closed or open magnetic field line regions. As a result, *S-Web* was able to best explain the varying properties seen in the event studied in the paper.

This study provides compelling evidence that the slow solar wind is inherently dynamic and that the dynamics are not due to turbulence developing after the wind enters into the inner heliosphere but to some magnetically driven process occurring at the wind source. This research is giving us a first look into places on the Sun we can't see with our instruments yet, like the sun's corona. And, it's paving the way for the research to come from NASA Heliophysics' Solar Probe Plus mission, which is being built for launch in 2018 and programmed to fly through the sun's corona.

This research was supported by the NASA Heliophysics Living with a Star and Heliophysics Guest Investigator Programs.

Cassini Snags Rare Specks of Speeding Interstellar Dust

Three dozen interstellar particles zooming through our solar system smashed into Cassini's bucket-shaped cosmic dust analyzer, giving scientists new information about the raw material from which stars are made. The dust grains were each smaller than a smoke particle.

- Their origin from beyond the solar system was betrayed by their high speed of more than 45,000 miles per hour (72,000 kilometers per hour) and distinctive angle of flight.
- Cassini analyzed the composition of the interstellar dust particles for the first time, finding them to be a homogeneous mix of rock-building elements such as magnesium, silicon, calcium and iron, in proportions similar to those that make up our local galactic neighborhood.
- The dust particles were deficient in elements such as carbon and sulfur, likely due to changes induced by shock waves in the interstellar medium.
- The homogenous composition of the interstellar dust grains detected by Cassini indicates that most dust grains that go into creating new solar systems are not the fresh, pristine dust produced by stellar explosions.
- This finding provides a new understanding of the "DNA" of stars and planets.

Cassini's Cosmic Dust Analyzer

"Flux and Composition of Interstellar Dust at Saturn from Cassin's Cosmic Dust Analyzer," N. Altobelli *et al.*, Science, 352, 312-318, 2016. https://saturn.jpl.nasa.gov/news/2895/

Frankenstein Galaxy

The results will appear in an upcoming issue of The Astrophysical Journal.

- A new study reveals the secret of UGC 1382, a galaxy about 250 million light-years away. Originally thought to be old, small and typical, scientists have discovered that the galaxy is 10 times bigger than previously thought and, unlike most galaxies, its insides are younger than its outsides.
- Scientists came upon this galaxy by accident. They had been looking for stars forming in run-of-the-mill elliptical galaxies, which do not spin and are more three-dimensional and football-shaped than flat disks. Astronomers originally thought that UGC 1382 was one of those.
- But while looking at images of galaxies in ultraviolet light from NASA's Galaxy Evolution Explorer (GALEX), a behemoth began to emerge from the darkness. Spiral arms extending far outside the galaxy were observed.
- Researchers then looked at data of the galaxy from other telescopes: the Sloan Digital Sky Survey, the Two Micron All-Sky Survey, NASA's Wide-field Infrared Survey Explorer (WISE), the National Radio Astronomy Observatory's Very Large Array and Carnegie's du Pont Telescope at Las Campanas Observatory. Optical and infrared light observations from the other telescopes allowed the researchers to build a new model of this mysterious galaxy.
- UGC 1382, at about 718,000 light-years across, is more than seven times wider than the Milky Way. It is also one of the three largest isolated disk galaxies ever discovered. This galaxy is a rotating disk of low-density gas. Stars don't form here very quickly because the gas is so spread out.
- But the biggest surprise was how the relative ages of the galaxy's components appear backwards. In most galaxies, the innermost portion forms first and contains the oldest stars. As the galaxy grows, its outer, newer regions have the youngest stars. Not so with UGC 1382.

The composite image shows the same galaxy as viewed with different instruments. In left image, UGC 1382 appears to be a simple elliptical galaxy, based on optical data from the Sloan Digital Sky Survey (SDSS). But spiral arms emerged when astronomers incorporated ultraviolet data from GALEX and deep optical data from SDSS, as seen in the middle image. Combining that with a view of low-density hydrogen gas (shown in green), detected at radio wavelengths by the Very Large Array, scientists discovered that UGC 1382 is a giant, and one of the largest isolated galaxies known. Astronomers also used Stripe 82 of SDSS, a small region of sky where SDSS imaged the sky 80 times longer than the original standard SDSS survey. This enabled optical detection of much fainter features as well.

- Astronomers were able to piece together the historical record of when stars formed in this galaxy. The center is actually younger than the spiral disk surrounding it. The unique galactic structure may have resulted from separate entities coming together, rather than a single entity that grew outward. In other words, two parts of the galaxy seem to have evolved independently before merging -- each with its own history.
- At first, there was likely a group of small galaxies dominated by gas and dark matter, which is an invisible substance that makes up about 27 percent of all matter and energy in the universe (our own matter is only 5 percent). Later, a lenticular galaxy, a rotating disk without spiral arms, would have formed nearby. At least 3 billion years ago, the smaller galaxies may have fallen into orbit around the lenticular galaxy, eventually settling into the wide disk seen today.

The 37th Annual Odyssey of the Mind World Finals

Opening ceremonies

- Held at Iowa State University in Ames, Iowa, on May 26-28, 2016
- Over 18,000 K-12 finalists, coaches, chaperones, and parents from 800 teams came from across the U.S. and 25 other countries for the *creative problem solving* extravaganza

Kristen Weaver explains ocean color remote sensing

Classroom Activities: Using the GLOBE Observer app for clouds and an ocean color remote sensing activity, 64 sessions were offered to over 1,300 students

Erika Podest interacts with students after LandSat presentation

E-Theater: 11 science presentations were attended by over 1,500 participants over three days.

Brian Campbell answers student questions

Creativity Festival: an interactive investigation using Landsat image cubes and a spectrometer

Dorian Janney demonstrates GLOBE Observer with mobile phone or tablet

NASA participation is supported by the Earth Science Education Collaborative team from IGES, GSFC, LaRC and JPL, funded by SMD.

For more information on Odyssey of the Mind:
http://www.odysseyofthemind.com