National Aeronautics and
Space Administration

Science Mission Directorate

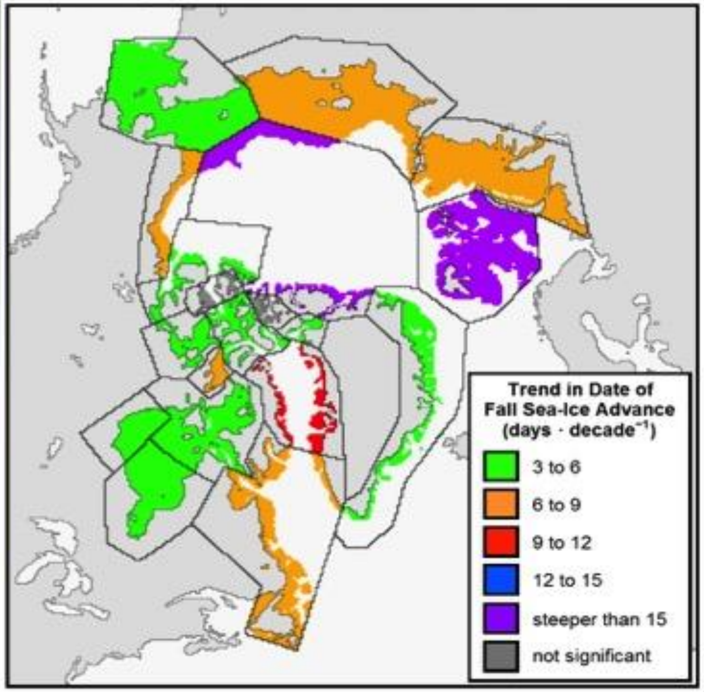
Weekly Highlights

September 16, 2016

Sea-ice Indicators of Polar Bear Habitat

Stern, H. L., & Laidre, K. L.| The Cryosphere Discussions| September 2016 | doi:10.5194/tc-2016-110, 2016

NASA-funded researchers analyzed the timing of sea-ice retreat and advance in all 19 polar bear subpopulation regions from 1979 to 2014, using daily sea-ice concentration data from NASA's Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) and the Defense Meteorological Satellite Program's (DMSP) passive microwave instruments. The scientists defined the dates of sea-ice retreat and advance in a region as the dates when the area of sea ice drops below a certain threshold (retreat) on its way to the summer minimum, or rises above the threshold (advance) on its way to the winter maximum. The threshold was chosen to be halfway between the historical (1979-2014) mean September and mean March sea-ice areas. In all 19 regions there was a trend toward earlier sea-ice retreat and later sea-ice advance. Trends generally ranged from -3 to -9 days per decade in spring, and from +3 to +9 days per decade in fall, with larger trends in the Barents Sea and central Arctic Basin. The study also found that the number of ice-covered days (days that the sea-ice area exceeded the threshold) was declining in all regions at the rate of −7 to −19 days per decade, with larger trends in the Barents Sea and central Arctic Basin.



Above: Trend map of the date of fall sea-ice advance for the shallow parts of each Polar Bear Specialist Group (PBSG) region.

Left: A polar bear tests the strength of thin sea ice. **Credits: Mario Hoppmann**

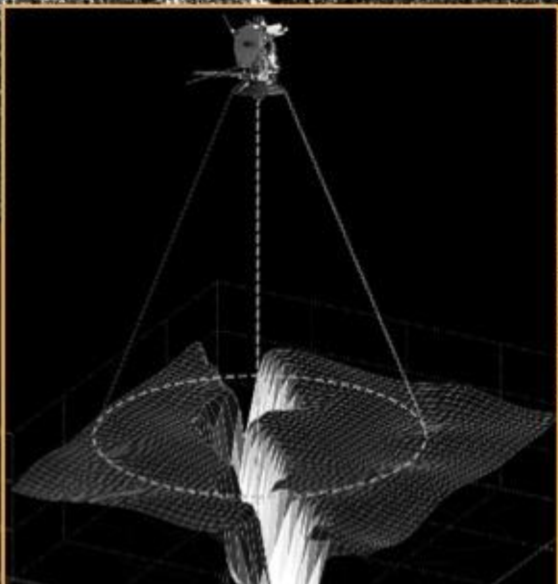
Polar bears depend on sea ice as a platform for essential activities, such as hunting, traveling and breeding. Sea-ice habitat changes impact polar bear abundance, productivity, body condition, and distributions. The study offers sea-ice metrics (or indicators of change in marine mammal habitat) that are designed to be useful for polar bear management and conservation plans.

Rivers of Hydrocarbons Flow Through Titan's Narrow Canyons

Cassini radar and altimeter echoes have revealed surprisingly deep (up to 1000 feet), steep canyons that are home to rivers of hydrocarbons on Saturn's moon Titan. These canyons appear to be connected to Titan's northern lake, Ligeia Mare.

The Titan canyons may have formed either when the land rose tectonically or the sea level temporarily dropped. Both mechanisms helped to carve the river canyons of the American Southwest. On Titan, however, the liquid is methane and ethane, not water, and the surface is rock-hard mix of water ice and solid hydrocarbons.

Upstream tributaries were found to be much higher than Ligeia's sea level. This difference would cause flow that could erode Titan's deep canyons in the way the Colorado River carved the Grand Canyon. The liquid at the river's mouth and main trunk, however, was level with the sea. This may be a sign of backflooding, producing a drowned river valley similar to the Georges River in Australia.

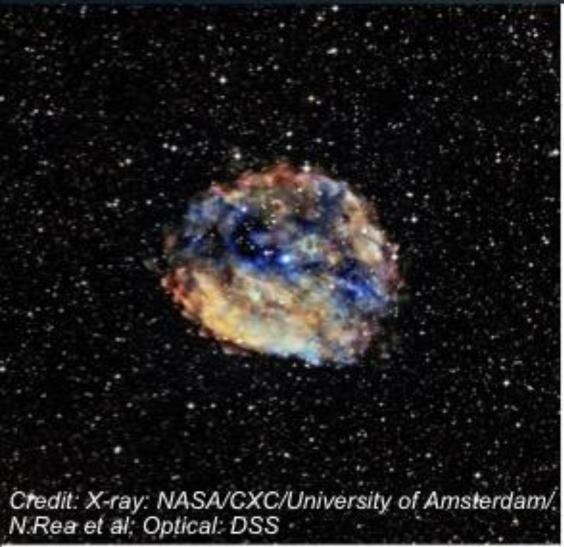


In the "Vid Flumina" river channel network, radar found nearly vertical canyons up to one-third mile deep and less than a half-mile wide. The radar echo from the canyon bottom showed the presence of liquid.

Poggiali, V., et al. (2016), GRL, doi: 10.1002/2016GL069679

Young Magnetar Likely the Slowest Pulsar Ever Detected

Published in the September 2, 2016 issue of The Astrophysical Journal Letters



Credit: X-ray: NASA/CXC/University of Amsterdam/N.Rea et al; Optical: DSS

- For decades, astronomers have known there is a dense, compact source at the center of RCW 103, the remains of a supernova explosion located about 9,000 light years from Earth. The image shows RCW 103 and its central source, 1E 161348-5055 (1E 1613, for short), in three bands of X-ray light detected by the Chandra X-ray Observatory. The lowest energy X-rays from Chandra are shown in red, the medium band in green, and the highest energy X-rays are blue. The bright blue X-ray source in the middle of RCW 103 is 1E 1613. The X-ray data have been combined with an optical image from the Digitized Sky Survey.
- Observers had previously agreed that 1E 1613 is a neutron star, an extremely dense star created by the supernova that produced RCW 103. However, the regular variation in the X-ray brightness of the source, with a period of about six and a half hours, presented a puzzle. All proposed models had problems explaining this slow periodicity.
- On June 22, 2016, an instrument aboard NASA's Swift telescope captured the release of a short burst of X-rays from 1E 1613. The Swift detection caught astronomers' attention because the source exhibited intense, rapid fluctuations on a time scale of milliseconds, similar to other known magnetars. These exotic objects possess the most powerful magnetic fields in the Universe - trillions of times that observed on the Sun - and can erupt with enormous amounts of energy.
- Seeking to investigate further, a team of astronomers quickly asked two other orbiting telescopes - NASA's Chandra X-ray Observatory and Nuclear Spectroscopic Telescope Array, or NuSTAR - to follow up with observations.
- New data from this trio of high-energy telescopes, and archival data from Chandra, Swift and ESA's XMM-Newton confirmed that 1E 1613 has the properties of a magnetar, making it only the 30th known. These properties include the relative amounts of X-rays produced at different energies and the way the neutron star cooled after the 2016 burst and another burst seen in 1999.
- The mystery of the slow spin remained. The source is rotating once every 24,000 seconds (6.67 hours), much slower than the slowest magnetars known until now, which spin around once every 10 seconds. This would make it the slowest spinning neutron star ever detected.
- Astronomers expect that a single neutron star will be spinning quickly after its birth in the supernova explosion and will then slow down over time as it loses energy. However, the researchers estimate that the magnetar within RCW 103 is about 2,000 years old, which is not enough time for the pulsar to slow down to a period of 24,000 seconds by conventional means.
- While it is still unclear why 1E 1613 is spinning so slowly, scientists do have some ideas. One leading scenario is that debris from the exploded star has fallen back onto magnetic field lines around the spinning neutron star, causing it to spin more slowly with time. Searches are currently being made for other very slowly spinning magnetars to study this idea in more detail.

New Advances in Reconnection at the Electron-Scale Level Using Heliophysics Magnetospheric Multi-Scale Mission (MMS) Data

Burch, J. L., and T. D. Phan (2016). MAGNETIC RECONNECTION AT THE DAYSIDE MAGNETOPAUSE: ADVANCES WITH MMS. *Geophysical Research Letters:* 43, 8327–8338. doi:10.1002/2016GL069787

The Magnetospheric Multi-Scale Mission (MMS) was implemented to probe the electron-scale interactions of magnetic reconnection. Past experimental efforts have advanced our understanding of ion-scale physics, but much closer spacings and higher time resolutions were needed to understand the electron-scale processes that cause magnetic reconnection. Before MMS, most of the advances in the understanding of the electron physics of magnetic reconnection were made using computer models, but they could not be verified.

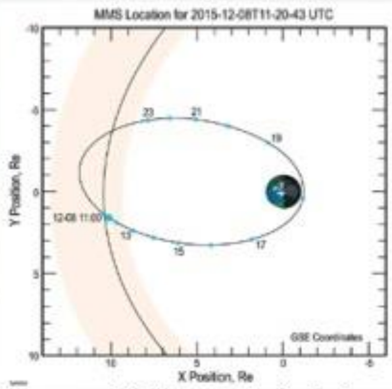


Figure: GSE equatorial-plane projection of MMS orbit on December 8, 2015 with UT hours noted. During 3-second interval MMS encountered an electron diffusion region (EDR) near the X-line of a magnetopause reconnection event.

Dr. Jim Burch, the PI for MMS, and Dr. Tai Phan, a Senior Fellow with the Space Sciences Laboratory, recently published a paper in the *Geophysical Research Letters* introducing a new magnetic reconnection event near an X-line of a reconnecting magnetopause region. This December 2015 event occurred in the dayside magnetopause, the boundary region between Earth's magnetosphere and the solar wind. The two magnetic fields involved in this event were at an angle near 45°, creating strong antiparallel components in the plane of reconnection. There was also an out-of-plane magnetic field component, which is known as the guide field. The effects of a guide field on magnetic reconnection has been an active topic of theoretical research.

An advantage of studying reconnection in the magnetopause is that spacecraft can sample numerous X line magnetopause crossings, which are areas in which reconnection is known to occur. Spacecraft specifically look for electron diffusion or dissipation regions (EDRs). MMS in particular was designed to capture and transmit all magnetopause crossings in burst mode so that no EDRs at the magnetopause are missed.

On December 8, 2015 the MMS tetrahedron of four orbiting spacecraft was on an inbound orbit crossing the dayside magnetopause when it encountered a reconnection region. During this 3-second boundary crossing, MMS was able to resolve multiple layers of the reconnection event. Scientists had previously predicted that a field-aligned mixture of magnetosheath and magnetospheric electrons exist in the in-plane magnetic null for guide-field reconnection and that out-of-plane currents are carried by crescent-shaped distributions at the flow stagnation point. Scientists predicted these results using simulations but it wasn't until this new era of electron-scale data from MMS that these predictions were able to be verified. The observation of out-of-plane current components flowing along the magnetic field and the X line seem to be distinguishing features of magnetic guide-field reconnection.

A second scan of the dayside magnetopause will begin this month, September 2016. During this scan, the spacecraft will be closer, around 7 km which will increase the probability of positioning all four spacecraft within EDR regions simultaneously. A study of more events is needed to further understand magnetic reconnection at this electron-scale level.

"Expanding Your Horizons: Career Discovery Day" STEM Career Event for Girls

- On September 10, 2016, as part of the NASA funded Universe of Learning program, Space Telescope Science Institute (STScI) staff led three student workshops during the "Expanding Your Horizons: Career Discovery Day" at Stevenson University in Pikesville, Maryland

- The workshops featured an astronomical "Hour of Code" activity in Pencil Code

- The activity allowed students to explore NASA data and basic coding, while also learning about the application of computers, color and filters in creating and analyzing astronomical images

- Students also learned about the application of data and coding in different science, technology, engineering, and math (STEM) careers

- Nearly 100 middle school girls attended this year's event

expanding your horizons

motivating young women in science + mathematics

The purpose of "Expanding Your Horizons" is to expose middle school girls to STEM career information as they participate in fun and challenging hands-on math, science, and engineering activities. More information about the astronomical "Hour of Code" please visit: http:// event.pencilcode.net/home/hoc2014.