Science Mission Directorate

Weekly Highlights

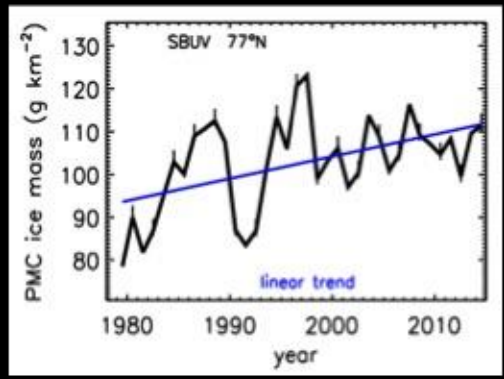
March 18, 2016

NASA And NOAA Satellite Data Shows That Air On The Edge Of Space Is Getting Colder And More Humid

Image taken from the Earth Observatory in July, 2010

Every summer, something strange and wonderful happens high above the north pole. Ice crystals form and cling to the smoky remains of meteors, forming electric-blue clouds with tendrils that ripple hypnotically against the sunset sky called Noctilucent clouds (NLCs), also referred to as Polar Mesospheric Clouds (PMCs). PMC's form at very high altitudes, between 50-53 miles, in the midst of the region called the mesosphere. Because these clouds reflect light after the sun sets, they've been dubbed "night clouds."

Recently, researchers used observations from instruments aboard NASA's Aeronomy of Ice in the Mesosphere (AIM) mission and NOAA's Solar Backscatter Ultraviolet Radiometer (SBUV) to reveal new information about these clouds. The SBUV series of satellites have observed PMCs since 1979, showing that the ice mass in PMCs has been increasing over the past 36 years. A rigorous interpretation of the SBUV results was recently developed using observations from AIM, which has measured PMCs, temperature, and water vapor since 2007. Analysis of AIM observations allow the SBUV PMC results to be expressed in terms of the underlying changes which have occurred in the mesosphere.



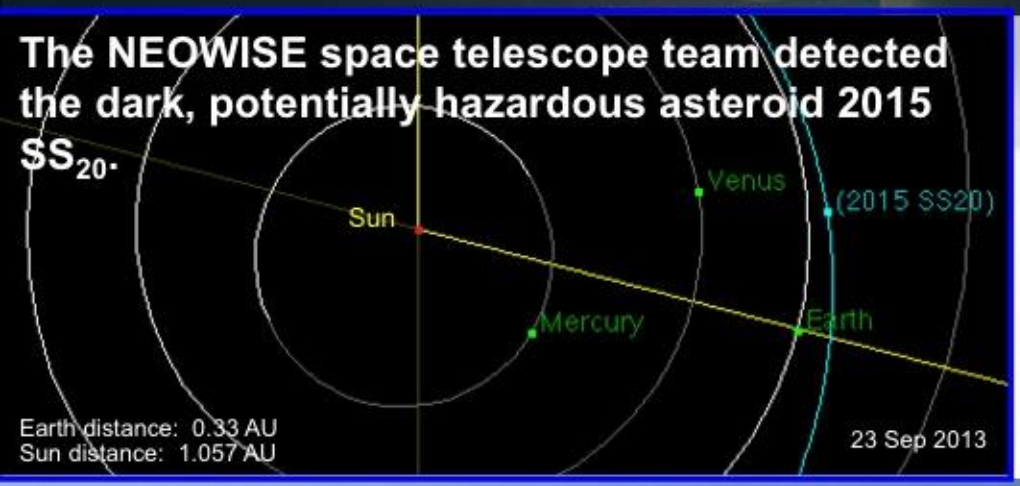
July averages of SBUV PMC ice water content for 72–82°N latitude.

In looking at these changes over time, the scientists found that ice mass and water density are increasing in the mesosphere, while temperatures are decreasing. These atmospheric changes are consistent with global climate model predictions. It has been suggested that these changes in PMCs are related to increased concentrations of greenhouse gases. While the release of carbon dioxide warms the surface of the earth, it cools the upper atmosphere; and, at the same time, increases in atmospheric methane lead to increases in water vapor at high altitudes. These facts point to a growing belief that greenhouse gases and global change have increased the number and brightness of PMCs.

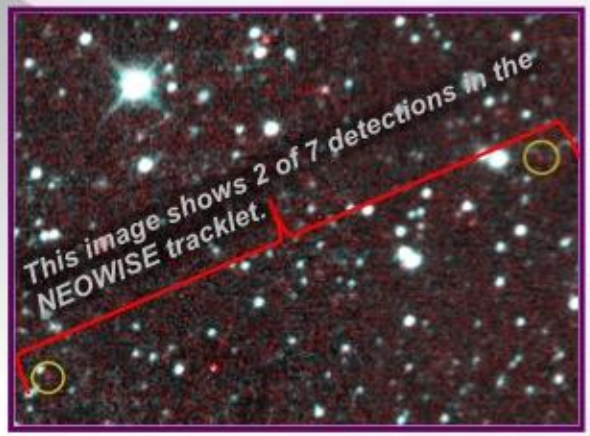
Hervig, Mark E., Uwe Berger and David E. Siskind, Decadal variability in PMC and implications for changing temperature and water vapor in the upper mesosphere, J. Geophys. Res. Atmos.,121, doi:10.1002/2015JD024439

NEOWISE Finds an Elusive Asteroid as Dark as a Lump of Coal

The NEOWISE space telescope team detected the dark, potentially hazardous asteroid 2015 SS_{20}.



The asteroid was first detected in 7 images by NEOWISE on Sep 23, 2015, but it was not tracked by ground-based observers who were unable to find it, since it was very dark.



- **Additional NEOWISE detections were later found of 2015 SS_{20} that were fainter than the threshold used by the automated science data processing pipeline. With these detections, images collected in October and December 2015 by the Canada-France-Hawaii Telescope (CFHT) on Mauna Kea were reviewed and more data for this dark near-Earth asteroid was detected, thus allowing for the orbit of 2015 SS_{20} to be determined well into the future. The minimum orbit intersection distance (MOID) between the asteroid and the Earth is 0.03 AU.**
- **Additional thermal modeling has revealed that 2015 SS_{20} is extremely dark (3-4% albedo) and approximately ~180-300 m (600-1000 ft) across.**

Located atop Mauna Kea and optimized in the optical/infrared, the CFHT has a 3.6-m aperture.

Telescopes Combine to Push Frontier on Galaxy Clusters

Published in the February 1, 2016 issue of The Astrophysical Journal.

Credit: X-ray: NASA/CXC/SAO/G.Ogrean et al.; Optical: NASA/STScI; Radio: NRAO/AUI/NSF

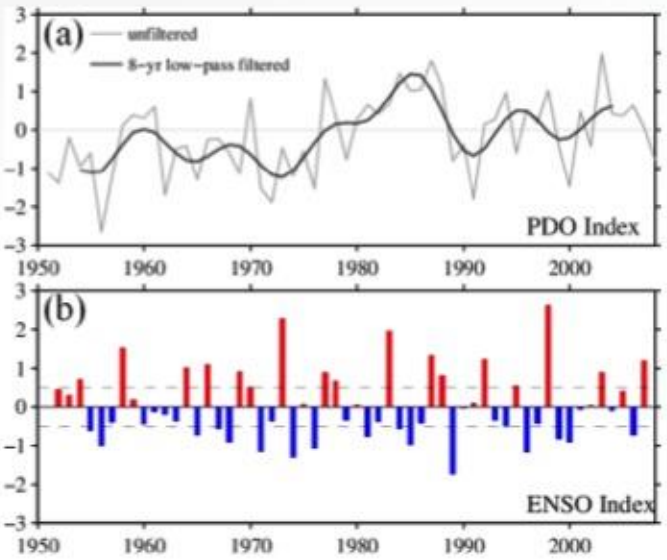
The above image contains data from three different telescopes: NASA's Chandra X-ray Observatory (diffuse emission in blue), Hubble Space Telescope (red, green, and blue), and the NSF's Jansky Very Large Array (diffuse emission in pink). Where the X-ray and radio emission overlap the image appears purple.

- Galaxy clusters are enormous collections of hundreds or even thousands of galaxies and vast reservoirs of hot gas embedded in massive clouds of dark matter, invisible material that does not emit or absorb light but can be detected through its gravitational effects.
- To learn more about clusters, including how they grow via collisions, astronomers have used some of the world's most powerful telescopes, looking at different types of light. They have focused long observations with these telescopes on a half dozen galaxy clusters. The name for this galaxy cluster project is the "Frontier Fields".
- One of these Frontier Fields galaxy clusters, MACS J0717.5+3745 (MACS J0717 for short) is located about 5.4 billion light years from Earth. MACS J0717 is one of the most complex and distorted galaxy clusters known. It is the site of a collision between four clusters.
- The Chandra data shows gas in the merging clusters with temperatures of millions of degrees. The optical data shows galaxies in the clusters and other, more distant, galaxies lying behind the clusters. Some of these background galaxies are highly distorted because of gravitational lensing, the bending of light by massive objects. This effect can also magnify the light from these objects, enabling astronomers to study background galaxies that would otherwise be too faint to detect. Finally, the structures in the radio data trace enormous shock waves and turbulence. The shocks are similar to sonic booms, generated by the mergers of the clusters.
- In Jansky Very Large Array images of this cluster, seven gravitationally-lensed sources are observed, all point sources or sources that are barely larger than points. This makes MACS J0717 the cluster with the highest number of known lensed radio sources. Two of these lensed sources are also detected in the Chandra image. The scientists are only aware of two other lensed X-ray sources behind a galaxy cluster.
- All of the lensed radio sources are galaxies located between 7.8 and 10.4 billion light years away from Earth. The brightness of the galaxies at radio wavelengths shows that they contain stars forming at high rates. Without the amplification by lensing, some of these radio sources would be too faint to detect with typical radio observations. The two lensed X-ray sources detected in the Chandra images are likely active galactic nuclei (AGN) at the center of galaxies. AGN are compact, luminous sources powered by gas heated to millions of degrees as it falls toward supermassive black holes. These two X-ray sources would have been detected without lensing but would have been two or three times fainter.

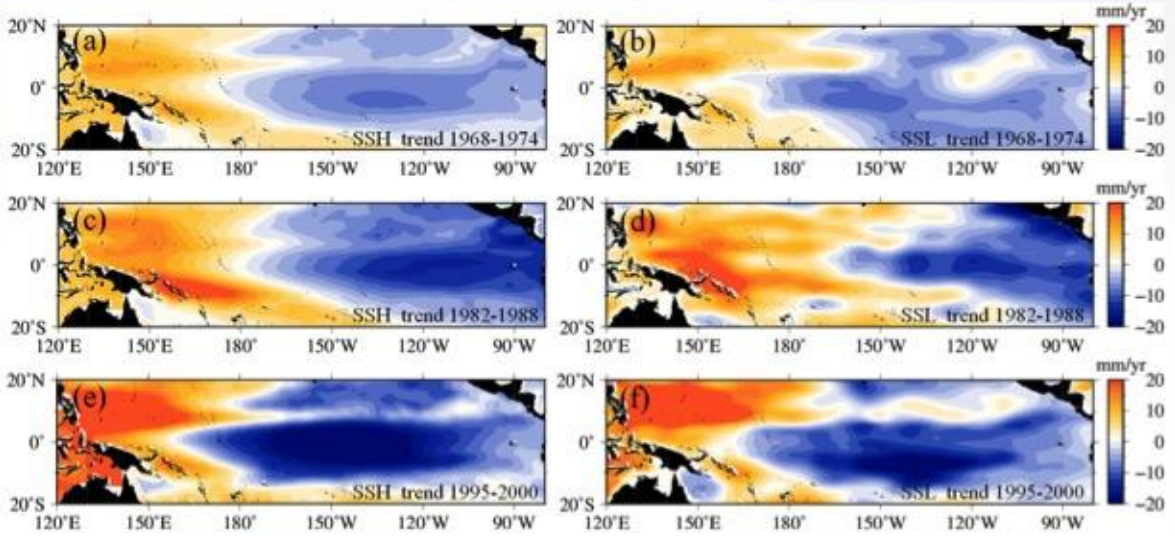
PDO And ENSO Modulations Intensified Decadal Sea Level Variability In The Tropical Pacific

Moon, Jae-Hong, Y. Tony Song, and HuiKyo Lee | December 2015 | doi:10.1002/2015JC011139

According to long-term sea level reconstruction (SSH) and steric sea level (SSL) data, regional sea levels in the tropical Pacific have oscillated between east and west on a decadal time scale over the past 60 years, but the oscillation has been intensified significantly in the last three decades. NASA funded researchers used altimetry-based sea level observations and tide gauge records to show that the recent intensification in sea level variability is caused by modulation between the Pacific Decadal Oscillation (PDO) and El Nino-Southern Oscillation (ENSO). Since the early 1980s, under more frequent in phase relationship between the ENSO and PDO, the see-saw mode of tropical sea level on decadal time scale has been amplified. In contrast, under the out of phase condition that occurred more frequently before 1980s, the sea level response to the phase transitions in the tropical Pacific is significantly weakened compared to those under the in phase condition. The intensified sea level oscillation, when superimposed on the global trend of sea level rise, will have profound implications for coastal communities, therefore, the combined effect of PDO and ENSO should be taken into account in the decadal sea level prediction in the tropical Pacific.



Above: (a) Unfiltered (thin line) and 8 year low-pass filtered (thick line) PDO indices and (b) ENSO index obtained from Niño3.4 index.



Above: Linear trends of (left) sea level and (right) SSL for the period of (a, b) 1968–1974, (c, d) 1982–1988, and (e, f) 1995–2000, when there is a decreasing trend of sea level differences between the eastern tropical Pacific (ETP) and the western tropical Pacific (WTP). All data here are averaged over three boreal winter months (December, January, and February, DJF) each year.

Chandra and Pencil Code Recoloring the Universe at The Wheeler School in Providence, RI

- On Tuesday, February 23, 2016, Kimberly Arcand spoke to 25 high school students grades 9th - 12th as well as two faculty members at The Wheeler School in Providence, RI about Chandra, the high-energy Universe and careers in science and technology

- Students learned about NASA's Chandra X-ray Observatory telescope that is specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes

- Students also completed the Pencil Code Recoloring the Universe activity prior to the talk in their physics class

- Chandra materials on 3D printing and openFits were given out, 3D files were downloaded for a future 3D print lab and follow-up plans were made for a larger Pencil Code workshop for other students, and a career discussion with special interest students