National Aeronautics and
Space Administration

Science Mission Directorate

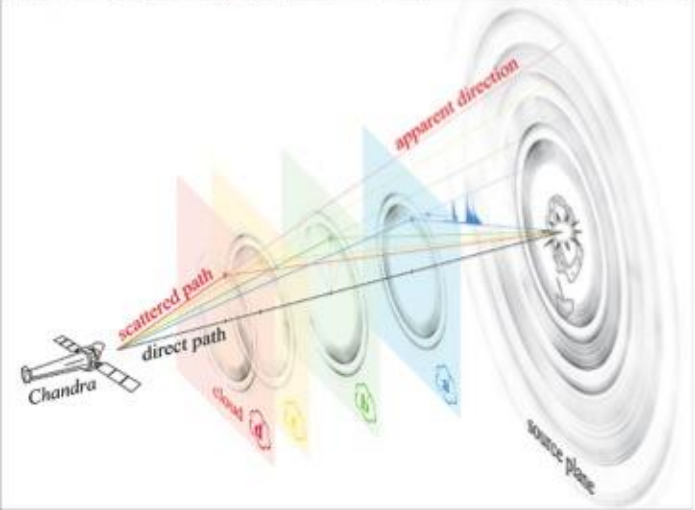
Weekly Highlights

June 26, 2015

NASA's Chandra Captures X-Ray Echoes Pinpointing Distant Neutron Star

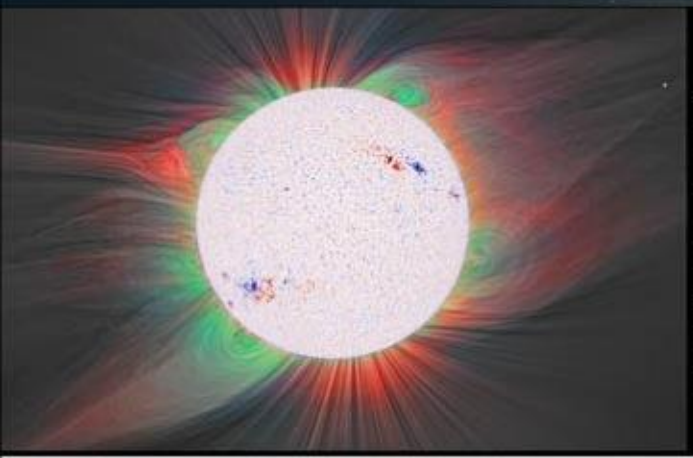
Published in the June 20, 2015 issue of the Astrophysical Journal

Credit: X-ray: NASA/CXC/Univ. of Wisconsin-Madison/S.Heinz et al; Optical: DSS

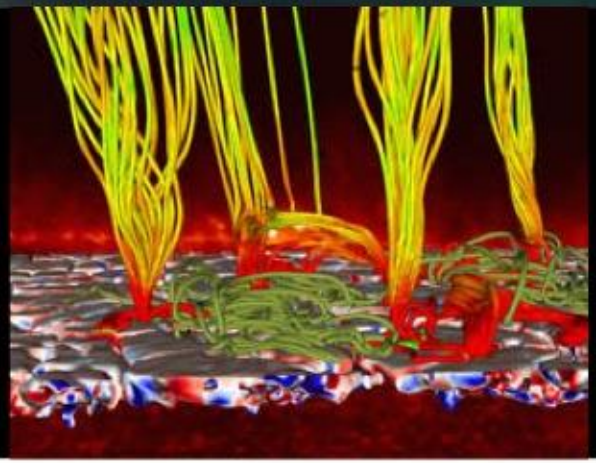


- Data from NASA's Chandra X-ray Observatory has helped provide a rare opportunity to determine the distance to an object on the other side of the Milky Way galaxy. The object is Circinus X-1, a double star system in the plane of our galaxy containing a neutron star, the dense remnant of a massive star pulverized in a supernova explosion. The neutron star is in orbit with another massive star, and is shrouded by thick clouds of interstellar gas and dust.
- The Chandra data reveal a set of four rings (top image) that appear as circles around Circinus X-1. These rings are seen where X-ray data from Chandra corresponding to low, medium and high-energy X-rays are shown in red, green, and blue respectively. These data have been combined with visible light data from the Digitized Sky Survey. The sharp edges are caused by the large size of the X-ray rings compared to the relatively small field-of-view of the Chandra detectors, providing only partial coverage.
- The rings are light echoes, similar to sound echoes that we may experience here on Earth. Instead of sound waves bouncing off a canyon wall, the echoes around Circinus X-1 are produced when a burst of X-rays from the star system ricochet off of clouds of dust between Circinus X-1 and Earth.
- The illustration (below) shows how the ringed structure is produced. Each ring is caused by X-rays from a Circinus X-1 flare bouncing off of different dust clouds. If the cloud is closer to us, the ring appears to be larger. The result, as seen by Chandra, is a set of concentric rings with different apparent sizes depending on the distance of the intervening cloud from us. The physical sizes of the rings, using the labels in the illustration, are 41 light years (ring a), 49 light years (ring b), 55 light years (ring c), and 52 light years (ring d).
- By combining the light echoes detected by Chandra with radio data from the Mopra radio telescope in Australia, which determined the distance to the intervening clouds, astronomers can estimate the distance to Circinus X-1 using relatively simple geometry. The light echo method generates a distance of 30,700 light years. The observation thus settles a large difference amongst previous results, one similar to this work and one indicating a much smaller distance of about 13,000 light years.

NASA Data Used to Explain Why the Sun's Atmosphere is Hotter than its Surface



Left: The Sun's surface and its 'salt-and-pepper' magnetic field, except for the large sunspot regions, based on data from NASA's SDO. Credit: T. Amari and NASA SDO.



Right: Complete model showing the shallow pan of boiling plasma, near the solar surface, that generates the magnetic field at the surface (blue/red). As the field emerges it creates a structure that heats the various layers of the solar atmosphere. Credit: T. Amari.

- The temperature of the Sun's atmosphere is hundreds of times hotter than its surface. Researchers have identified mechanisms that provide sufficient energy to heat the solar atmosphere by simulating the evolution of events in the solar interior and surface.

- Using a powerful numerical model made up of several layers simulating the solar interior and atmosphere, researchers observed that the thin layer under the Sun's surface actually behaves rather like a shallow pan containing boiling plasma, heated from below and forming 'bubbles' associated with granules. This boiling plasma soup generates a dynamo process that amplifies and maintains the magnetic field. As the field emerges from the surface, it takes on a salt-and-pepper appearance, forming concentrations dubbed 'mesospots' that are larger, fewer in number and more persistent, all of which is consistent with observations from NASA's Solar Dynamic Observatory, IRIS, and the joint JAXA/NASA Hinode spacecraft.

- The scientists also discovered that structures around the solar mesospots dive into the spaces between the granules, surrounding 'magnetic tree trunks' that rise up towards the corona and are associated with the larger-scale magnetic field. Calculations show heating of the atmosphere results from multiple micro-eruptions that carry intense energy in pace with boiling plasma bubbles.

- This eruptive process generates magnetic waves like sound traveling along a plucked string. The waves then transport energy to the upper solar atmosphere, which is heated by their progressive dissipation. Calculations also show that as the ejected matter falls back towards the surface, it forms solar tornadoes that have been observed. All these phenomena collectively make up the various sources of the energy produced by the boiling plasma, rather than it coming from a single source. This heating, which helps to generate and drive the solar wind that fills our heliosphere, most likely occurs in other sun-like stars throughout the galaxy.

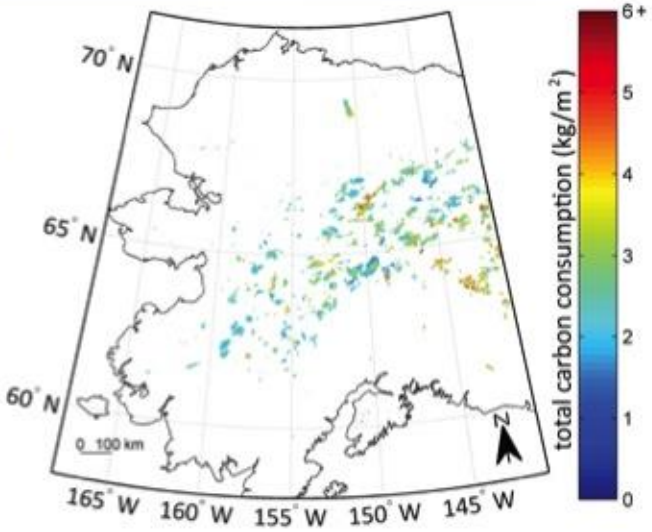
Daily Burned Area and Carbon Emissions from Boreal Fires in Alaska

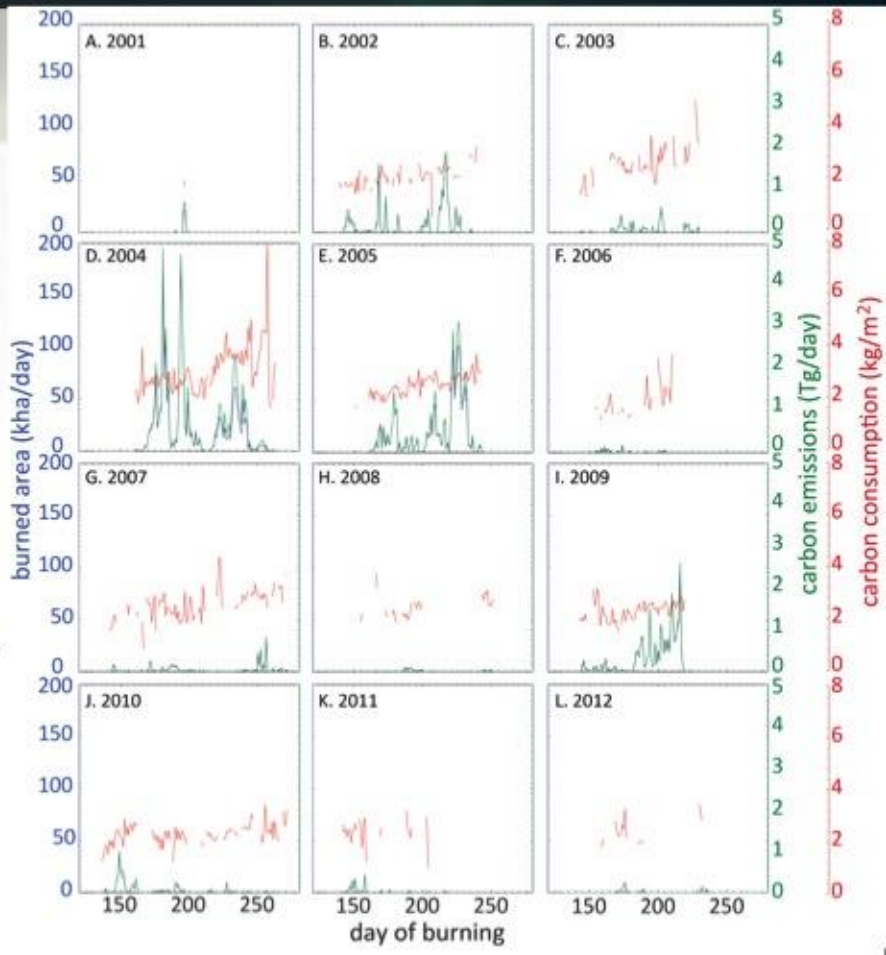
S. Veraverbeke, B. M. Rogers, and J. T. Randerson | Biogeosciences | JUNE 2015 | doi: 10.5194/bg-12-3579-2015

NASA-funded researchers developed a statistical model to predict carbon consumption by fire in boreal ecosystems using remote sensing, field, and fire perimeter data. The implemented methodology leverages imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) combined with fire perimeter data from the Alaska Large Fire Database. MODIS thermal anomalies of active fires were used to map day-by-day growth of fire perimeters during the period of 2001-2012.

The analysis highlights the importance of accounting for the spatial heterogeneity of fuels and combustion when extrapolating emissions in space and time, and the need for additional field campaigns to increase the density of observations as a function of tree cover and other environmental variables influencing consumption. Boreal fires burn into carbon-rich organic soils, thereby releasing large quantities of trace gases and aerosols that influence atmospheric composition and climate.

The daily burned area and carbon emissions product, derived in this study, referred to as the Alaskan Fire Emissions Database (AKFED), is the first wall-to-wall multi-year database with daily temporal resolution that is calibrated using field observations for Alaska and is publicly available.



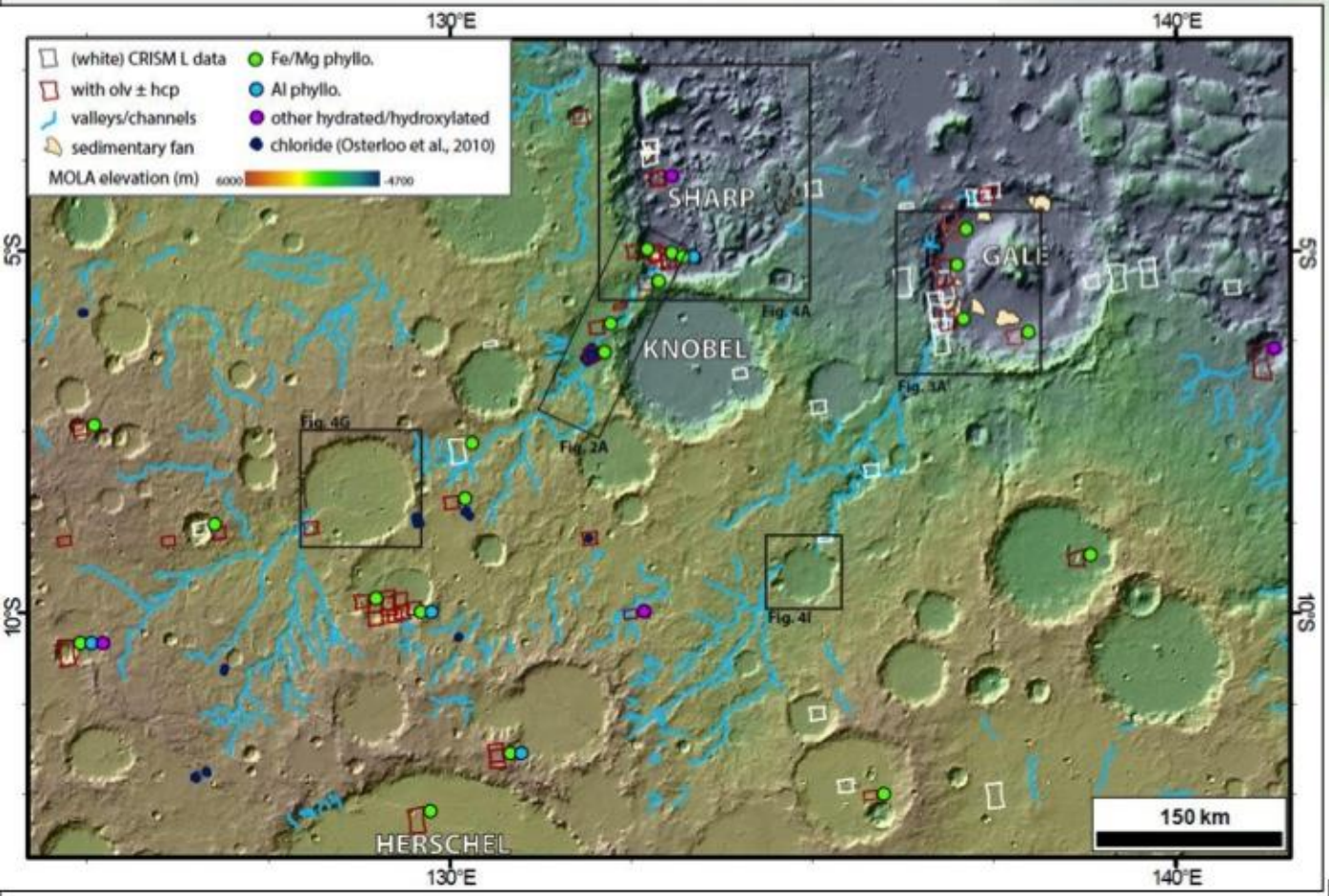


Left: Carbon consumption map of Alaskan fires between 2001 and 2012

Above: Daily burned area and carbon emissions time series for Alaska

Minerals in Watersheds Around Gale Crater

The bedrock mineralogy is similar throughout the neighborhood of Gale crater, where the Curiosity rover is exploring, whereas the clay deposits are different in next-door craters.



- These results come from data collected by the CRISM spectrometer on the Mars Reconnaissance Orbiter.
- Although mineralogy throughout the region is uniform, fluvial (flowing water) processes in Mars' wetter past deposited the clay minerals within the craters. As Mars dried out, the water flow through these depressions became isolated and salts dissolved in the water were left behind nonuniformly.
- These findings provide a context the geologic history being explored by the Curiosity rover.

Ehlmann and Buz (2014) *Geophs. Res. Lett.*

NASA's *"Orbit Pavilion"* at 2015 World Science Festival

Exhibits, displays and presenters from NASA participated in the 2015 World Science Festival in New York City, from May 27 - May 31, 2015.

The event included the premiere of "Orbit Pavilion," a massive walk-through sculpture that allows the public to hear the orbits of NASA's Earth-observing fleet of satellites as they orbit overhead.

Demonstrations included "Eyes on the Earth," and "Eyes on the Solar System" interactive space visualizations, NASA Viz app, World of Change/Landsat, Greenland Ice Core and Putty Glacier/IceSat Measuring Precipitation on the ground and from space.

NASA's Public Engagement specialists and scientists helped bring the exhibit to life, connecting art and sound to NASA's 20 active missions monitoring our home planet.

The Orbit Pavilion and visualization/app demos at New York University's Gould Plaza, 40 W. 4th Street, New York.

Thousands of visitors of all ages toured the Pavilion. It was featured in print, online and on TV by The Wall Street Journal, Mashable, Buzzfeed, Associated Press, Space.com, Yahoo, NY Magazine's Bedford + Bowery, Al Jazeera, NY1 and Telemundo.