National Aeronautics and
Space Administration

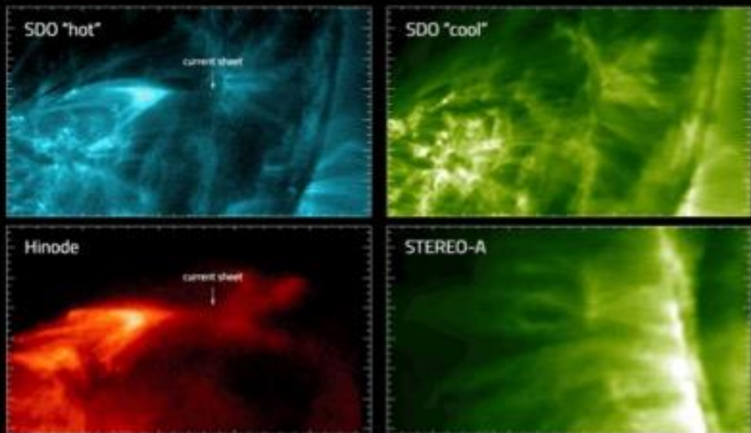
Science Mission Directorate

Weekly Highlights

April 22, 2016

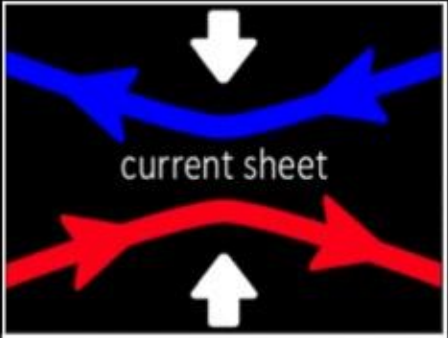
Understanding the Origins of Solar Flares

Chumming, Z., Rui, L., Alexander, D., McAteer, R. (2016). *OBSERVATION OF THE EVOLUTION OF A CURRENT SHEET IN A SOLAR FLARE. Astrophysical Journal Letters, 821(2), doi:10.3847/2041-8205/821/2/L29*



- Solar flares, important drivers of space weather, send intense high energy light and particles into space at or near the speed of light, which means we get very little warning that a flare is going to come our way. Forecasting incoming solar flares is important. These eruptions can impact the ionized part of Earth's atmosphere – the ionosphere – and interfere with our communications and navigation systems, like radio and GPS, and also disrupt satellite electronics aboard our missions. Understanding how solar flares are created will provide useful insight to help us better forecast how solar flares may impact space weather events headed our way. A recent study sheds new light on the creation of solar flares through looking at the role current sheets play in their formation.

- A current sheet occurs in the space between two oppositely-aligned magnetic fields that are in close proximity. A solar flare occurs when these complicated magnetic fields suddenly and explosively rearrange themselves, converting magnetic energy into light. This energy conversion process is called magnetic reconnection and occurs in many other places throughout the Solar System including close to home, in our very own planet's magnetosphere where NASA's Magnetospheric Multiscale (MMS) mission is now providing key insights.
- During a December 2013 solar flare, NASA 's Heliophysics Solar Dynamic Observatory (SDO), Solar TErrestrial RElations Observatory (STEREO) and the NASA/JAXA Hinode observatory, observed the formation of a current sheet.
- This wasn't the first time a current sheet was observed but what makes this event unique is the breadth of measurements – such as speed, temperature, density and size -- that were obtained. Even when scientists think they have spotted something that might be a current sheet in solar data, they can't be certain without ticking off a long list of attributes. Using the combined observations from multiple spacecraft in the Heliophysics System Observatory, scientists were able to confirm that the measured properties over the course of the December 2013 event were, indeed, consistent with those of a current sheet.



Current sheets are formed in the space between two oppositely-aligned magnetic fields that are in close proximity. Oppositely-aligned fields can explosively realign to a new configuration in a process called magnetic reconnection. Because current sheets are so closely tied to magnetic reconnection, observations of a current sheet during the 2013 flare bolster the idea that solar flares can result from magnetic reconnection. **Credits: ESA (European Space Agency)**

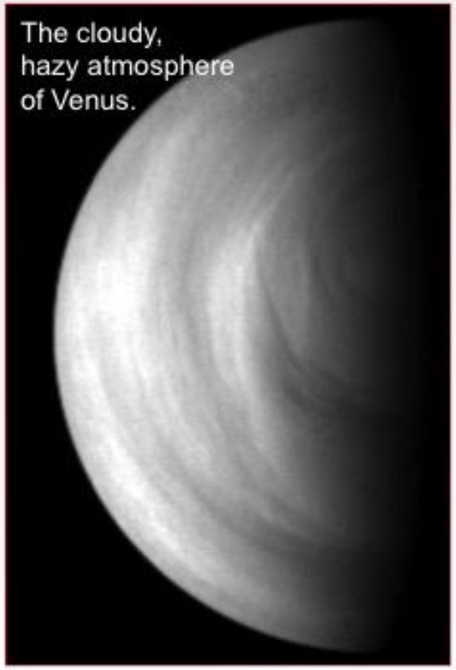
The image above is s still capture of an animation from Zhu, et al. found at: http://www.nasa.gov/feature/goddard/2016/seeing-double-nasa-missions-measure-solar-flare-from-2-spots-in-space

A Stellar Fingerprint

Text credit: ESA Image credit: ESA/Hubble & NASA
Acknowledgement: Judy Schmidt

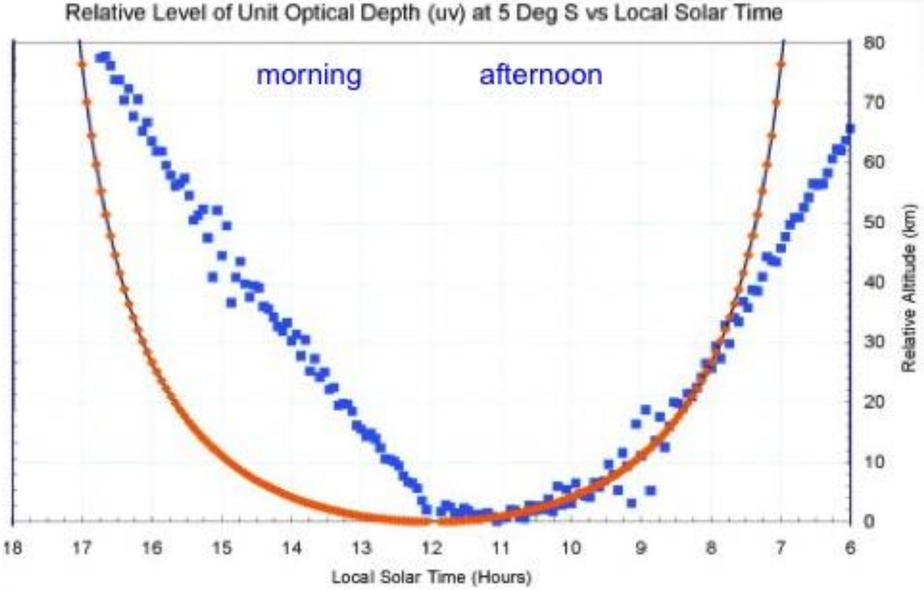
- Showcased at the center of this NASA/ESA Hubble Space Telescope image is an emission-line star known as IRAS 12196-6300 located in the constellation Crux.
- Located just under 2300 light-years from Earth, this star displays prominent emission lines, meaning that the star's light, dispersed into a spectrum, shows up as a rainbow of colors marked with a characteristic pattern of dark and bright lines. The characteristics of these lines, when compared to the "fingerprints" left by particular atoms and molecules, can be used to reveal IRAS 12196-6300's chemical composition.
- Under 10 million years old and not yet burning hydrogen at its core, unlike the Sun, this star is still in its infancy. Further evidence of IRAS 12196-6300's youth is provided by the presence of reflection nebulae. These hazy clouds, pictured floating above and below IRAS 12196-6300, are created when light from a star reflects off a high concentration of nearby dust, such as the dusty material still remaining from IRAS 12196-6300's formation.

Venus Clouds Differ from Morning to Evening



Though the mission has ended, analysis of data captured by the Venus Monitoring Camera (VMC) on Venus Express is still shining light into Venus' cloudy atmosphere.

- Venus is covered globally with a mixture of clouds and hazes. These are comprised of two particle sizes and composed of dilute sulfuric acid and other substances whose identities remain unknown.
- Results from the VMC showed that the distribution of cloud and haze particles was not symmetric about local noon. The orange line in the figure below is an idealized "clear atmosphere" model that shows how the relative altitude of the optical depth changes with local time. The blue dots show the actual variation at 1013 nm wavelength which is due to the presence of hazes and clouds.



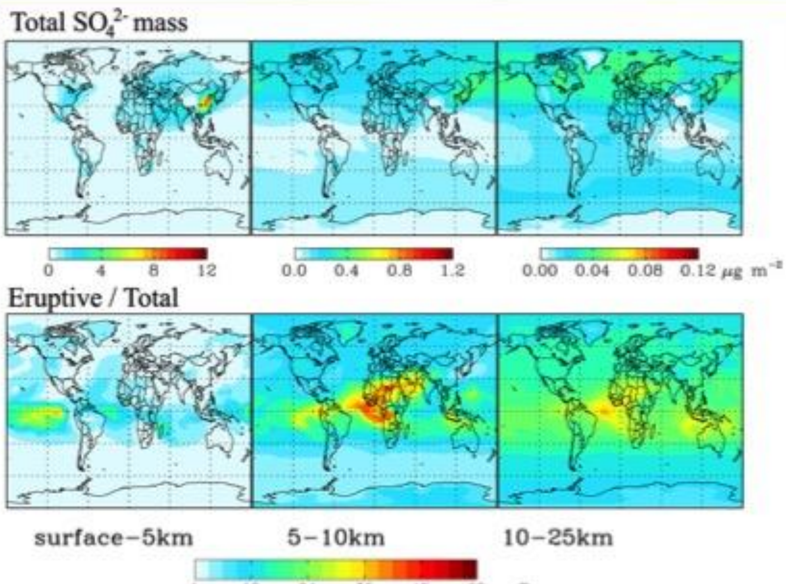
- After eliminating many reasons for these inconsistencies, scientists concluded that this data indicated that the haze reaches much higher altitudes than the clouds, and that there is a variation in this optical depth of the atmosphere with latitude.
- Additionally, the data indicates that different photochemical processes are at work during different periods of the day.

Limaye et al. (2015). *Planetary and Space Science*

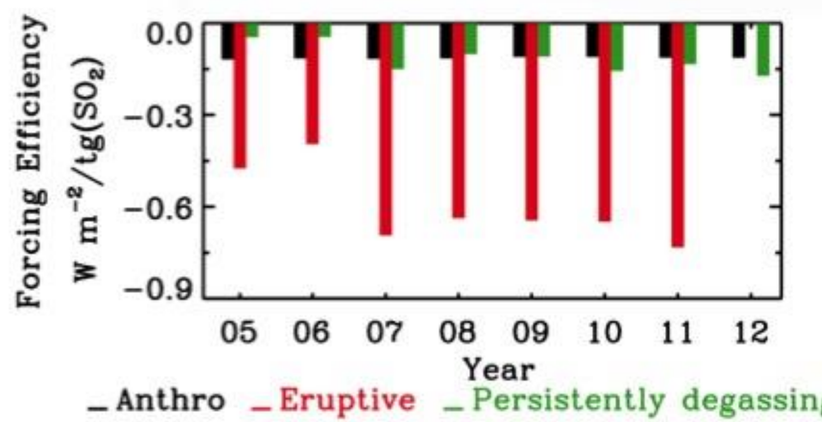
Satellite-based Global Volcanic SO_2 Emissions and Sulfate Direct Radiative Forcing During 2005–2012

Ge, C., Wang, J., Carn, S., Yang, K., Ginoux, P., & Krotkov, N. | Journal of Geophysical Research: Atmospheres | April 2016 | doi: 10.1126/sciadv.1501693

NASA-funded scientists estimated an 8-year volcanic sulfur dioxide (SO_2) emission inventory for 2005–2012, based on satellite measurements of SO_2 from OMI (Ozone Monitoring Instrument) and ancillary information from the Global Volcanism Program. The new volcanic SO_2 emission inventory includes contributions not only from global volcanic eruptions but also from eight persistently degassing volcanoes. The new inventory represents the largest volcanic SO_2 sources detected by OMI in 2005–2012. Emissions from Nyamuragira in November 2006 and Grímsvötn in May 2011 that were excluded from the IPCC 5 inventory are now included. The eight year average contribution of eruptive volcanic sulfate (SO_4^{2-}) to total SO_4^{2-} loading is ~10% over most areas of Northern Hemisphere above 10 km, and can be up to 30% in the tropics where the anthropogenic emissions are relatively lower. Although the 7-year average (2005-2011) of eruptive volcanic sulfate forcing of −0.10 W m^{-2} in this study is comparable to that in the 2013 IPCC report, there is significant annual variability. Furthermore, the study found that the radiative forcing efficiency ranges from −40 to −80 W m^{-2}per unit sulfate aerosol, much higher than the −25 W m^{-2} constant value in the IPCC. The global and monthly mean sulfate forcing efficiency to SO_2 emission was calculated for three emission categories. The forcing efficiency for eruptive volcanic sulfate is nearly 5 times that of the anthropogenic sulfate. In contrast, the forcing efficiency for eight tropical persistently degassing volcanic sulfates, on average, is close to the anthropogenic sulfate forcing efficiency. Large volcanic eruptions are not only known as significant hazards to aviation and health but also important contributors to the climate's natural variability.



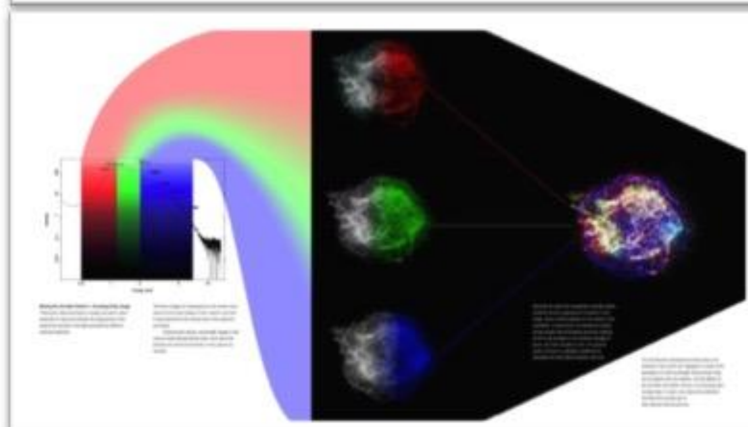
Left: 2005–2012 average at different levels: (top) the total SO_4^{2-} mass and (bottom) ratio in percentage of eruptive volcanic SO_4^{2-} to total SO_4^{2-} mass loading.



Above: Annual volcanic sulfate (SO_4^{2-}) forcing efficiency of three sources during 2005–2012.

Cambridge Science Festival Celebrates 10th Anniversary at Harvard Art Museum

- The Cambridge Science Festival celebrated it's 10 years anniversary by 10 days of celebration of science, technology, engineering, art and math (STEM) from April 15-24, 2016, at the Harvard Art Museum in Cambridge, Massachusetts
- On April 17 & 18, 2016, Joe DePasquale and Kimberly Arcand each delivered a talk at the Cambridge Science Festival on Chandra, astronomy, light, data visualization and 3D printing at the Harvard Art Museum to visitors
- The digital museum exhibit on Chandra observations of Cassiopeia A (Cas A) created for museum visualization walls was also unveiled
- On 11 screens, the exhibit describes Cas A, the data path, image processing and supernova remnants (SNRs)
- The celebration consisted of STEM exhibits, recurring programs, Museum of Science activities and tours



http://www.cambridgesciencefestival.org/2016Festival/EventIndex.aspx