National Aeronautics and
Space Administration

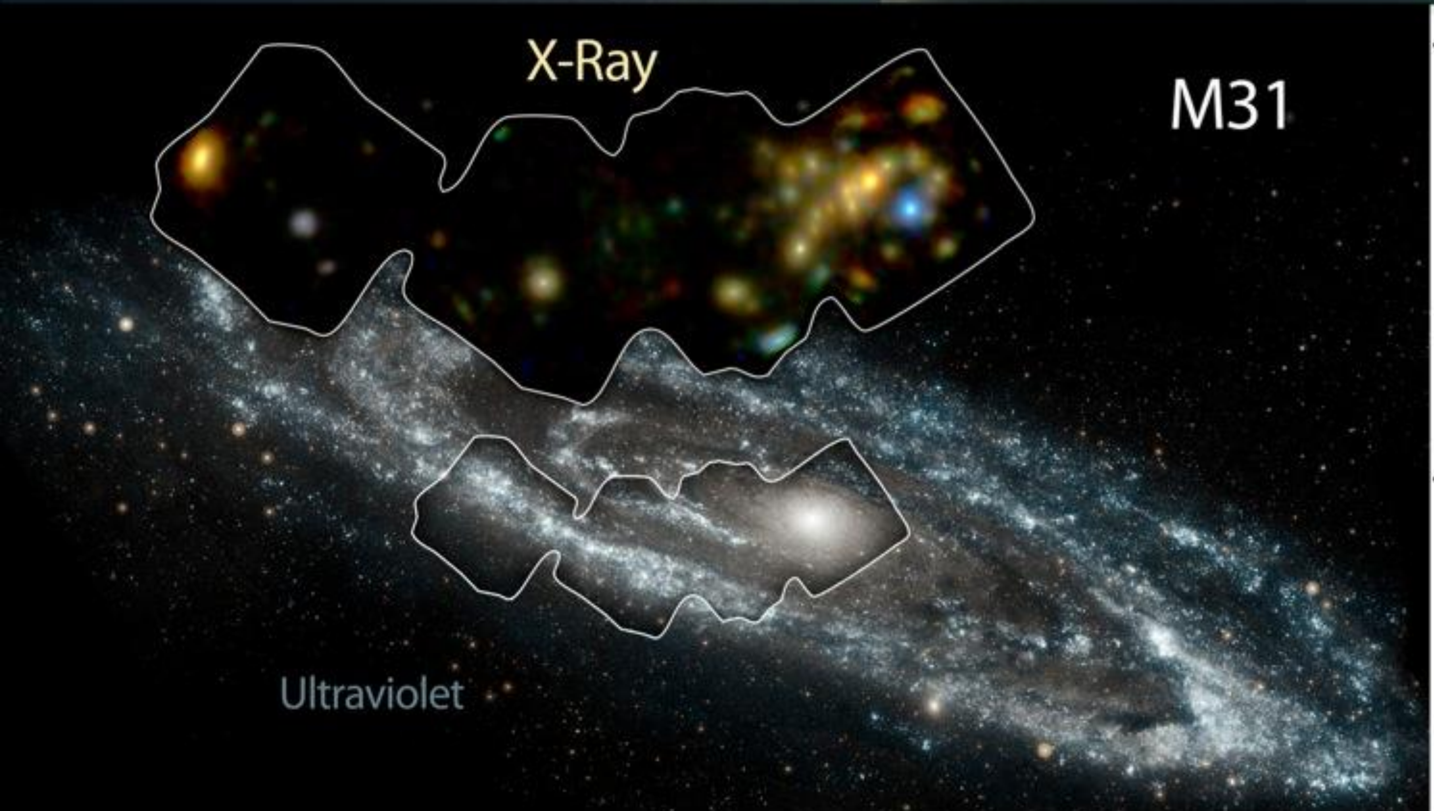
Science Mission Directorate

Weekly Highlights

January 29, 2016

NASA's NuSTAR Captures Best High-Energy X-ray View of Andromeda Yet

Presented at the recent 227th meeting of the American Astronomical Society in Kissimmee, Florida.

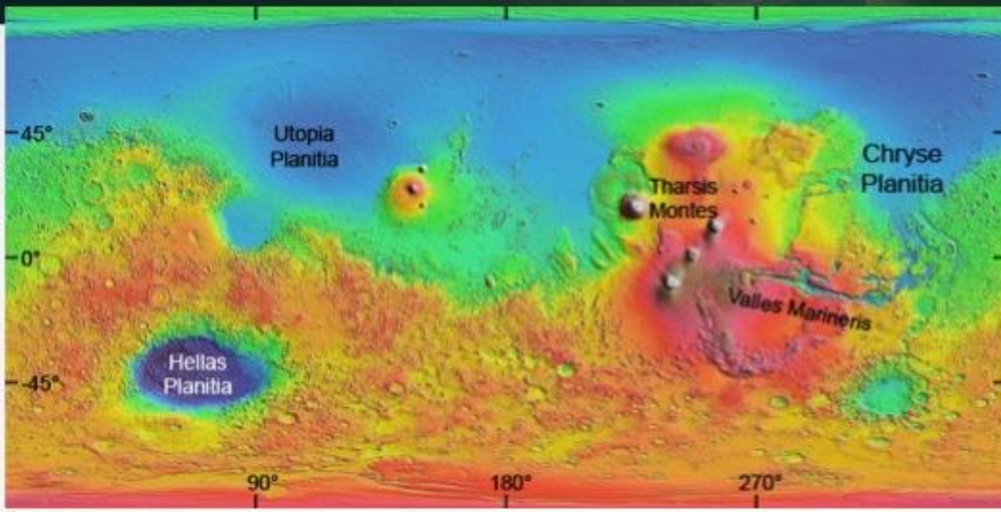


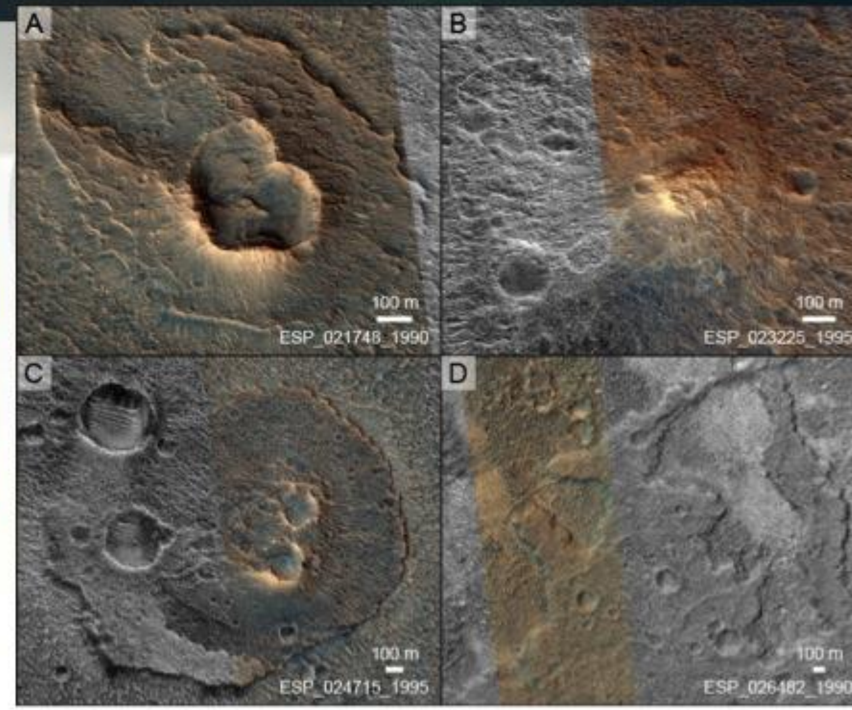
Andromeda, also known as M31, can be thought of as the big sister to our own Milky Way galaxy. Both galaxies are spiral in shape, but Andromeda is slightly larger than the Milky Way in size. Lying 2.5 million light-years away, Andromeda is relatively nearby in cosmic terms. It can even be seen by the naked eye in dark, clear skies.

- The Nuclear Spectroscopic Telescope Array, or NuSTAR, has captured the best high-energy X-ray view yet of a portion of our nearest large, neighboring galaxy, Andromeda. The space mission has observed 40 "X-ray binaries" -- intense sources of X-rays comprised of a black hole or neutron star that feeds off a stellar companion.
- Other space missions, such as NASA's Chandra X-ray Observatory, have obtained crisper images of Andromeda at lower X-ray energies than the high-energy X-rays detected by NuSTAR. The combination of Chandra and NuSTAR provides astronomers with a powerful tool for narrowing in on the nature of the X-ray binaries in spiral galaxies.

- The results will ultimately help researchers better understand the role of X-ray binaries in the evolution of our universe. According to astronomers, these energetic objects may play a critical role in heating the intergalactic bath of gas in which the very first galaxies formed.
- The new research also reveals how Andromeda may differ from our Milky Way. Fiona Harrison, NuSTAR's principal investigator added, "Studying the extreme stellar populations in Andromeda tells us about how its history of forming stars may be different than in our neighborhood."

Small Mounds In Chryse Planitia: Assessment Of Mud Volcano Hypothesis





Small mounds less than a few kilometers in diameter and up to a few hundred meters in height (A-C), often associated with lobate features (D), are widely distributed in Chryse Planitia.

Analysis of High Resolution Imaging Science Experiment (HiRISE) images supports formation through mud volcanism, based on observed morphological characteristics (e.g., slopes, height-to-diameter ratios, surface textures, stratification) and comparisons with terrestrial analogs.

Hydrated minerals detected on these mounds in Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) data further support the mud volcanism hypothesis.

Alternative mechanisms such as magmatic volcanism are not ruled out, but they have less support from our analyses.

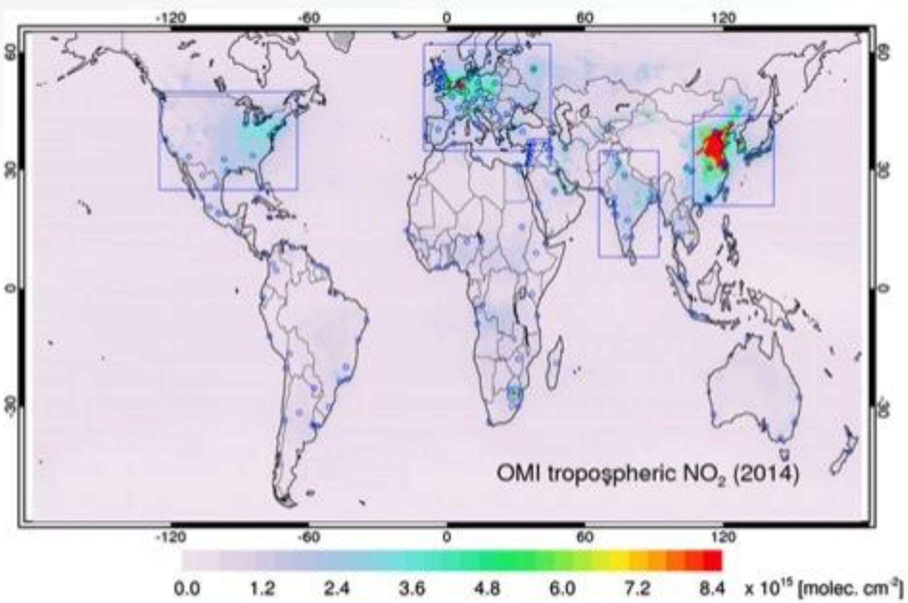
Terrestrial mud volcanoes and mud flows are important sites for the transfer of subsurface volatiles and biosignatures to the surface, thus these edifices and lobate features are key sites for future astrobiologic exploration.

Komatsu et al. [2015] Icarus, web release 12/28/15

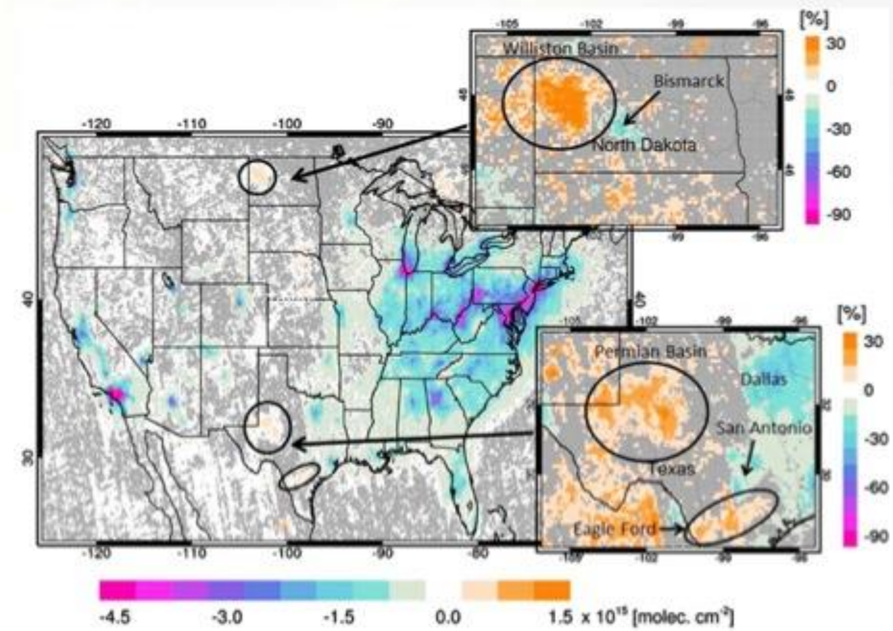
A Space-based, High-resolution View of Notable Changes in Urban NOx Pollution Around the World (2005–2014)

Bryan N. Duncan, Lok N. Lamsal, Anne M. Thompson, Yasuko Yoshida, Zifeng Lu, David G. Streets, Margaret M. Hurwitz, and Kenneth E. Pickering *| DECEMBER 2015 | doi: 10.1002/2015JD024121*

NASA-funded scientists used high-resolution nitrogen dioxide data (NO_2) from the Ozone Monitoring Instrument (OMI) on board the Aura satellite to analyze changes in urban NO_2 levels around the world, from 2005 to 2014. The researchers found complex heterogeneity in these changes, and discussed their potential drivers. First, they noted that compliance with environmental regulations resulted in large NOx decreases. The only large increases in the United States may have been associated with three areas of intensive energy activity. Second, rapid economic growth and associated energy consumption resulted in elevated NO2 levels over many Asian, tropical, and subtropical cities. Two of the largest increases occurred over recently expanded petrochemical complexes in Jamnagar (India) and Daesan (Korea). Spatial heterogeneity within several megacities may reflect mixed efforts to cope with air quality degradation. The study also showed the potential of high-resolution data for identifying NOx emission sources in regions with a complex mix of sources. Intensive monitoring of the world's tropical/subtropical megacities will remain a priority, as their populations and emissions of pollutants and greenhouse gases are expected to increase significantly. Nitrogen oxides may serve as a proxy for fossil fuel –based energy/ usage and co-emitted greenhouse gas and other pollutants.



Above: OMI NO_2 data as an annual average for 2014. The circles represent the cities for which changes have been calculated.



Above: (left center) OMI NO_2 absolute changes from 2005 to 2014 over the U.S. (inset top right) Change (%) over North Dakota. (inset bottom right) Change (%) over Texas.

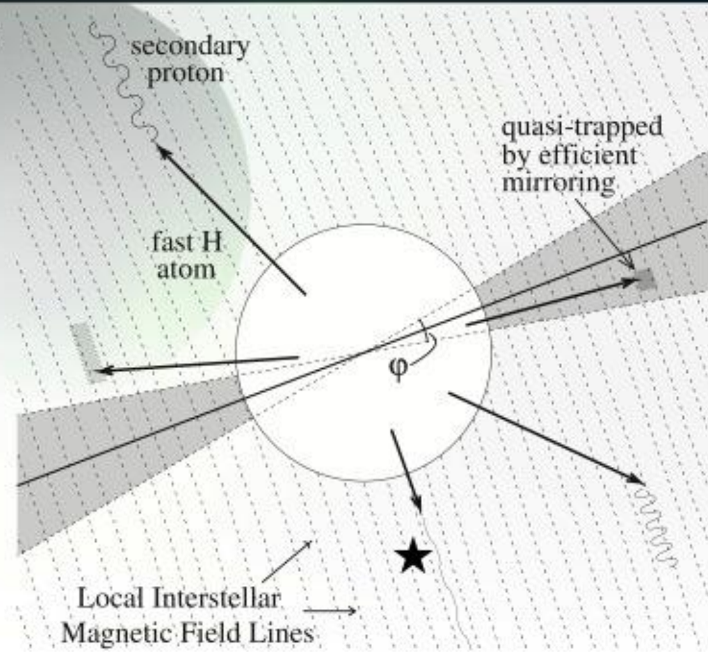
A New Model for the Heliosphere's "IBEX Ribbon"

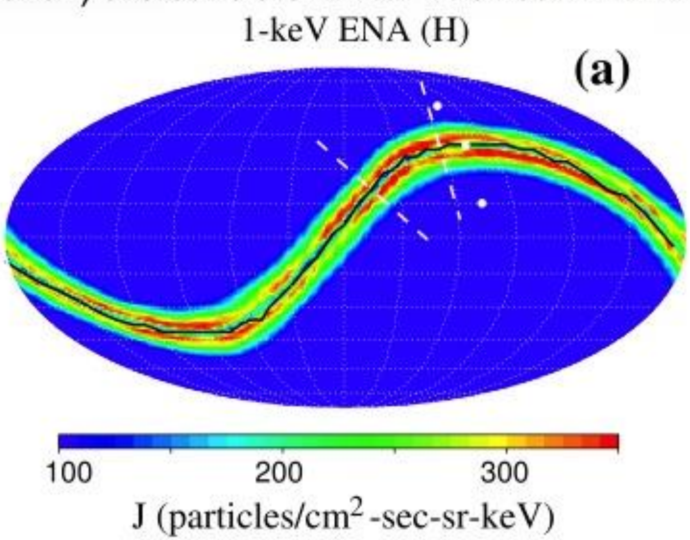
The Astrophysical Journal Letters, 812:L9 (5pp), 2015 October 10 ; doi:10.1088/2041-8205/812/1/L9
Work funded through the Heliophysics Supporting Research Program

The existence and origin of the "IBEX ribbon" has been one of the most interesting things we've learned about from the IBEX (Interstellar Boundary Explorer) mission. This "ribbon" was not predicted by any of the models before the launch of IBEX. The ribbon, made up of energetic neutral atoms (ENAs), serves as a partial boundary between the heliosphere and the surrounding interstellar medium. Understanding the origin of this "IBEX ribbon" is still an area of intense research and debate.

A recent paper by Joe Giacalone and Randy Jokipii presents a new explanation for the existence of the ribbon, and their analysis predicts the intensity and breadth observed by IBEX.

Below are the steps used in the computer model the authors created to simulate what the "ribbon" should look like. The results (shown on the left) are consistent with what both IBEX and Voyager are seeing.





Breaking down the Theory:

1. Traveling solar wind ions charge-exchange with interstellar neutral atoms, which makes them neutral so they continue traveling out radially. The now neutral solar wind particles exit the heliosphere.
2. Somewhere outside the heliopause (the boundary between interstellar space and the heliosphere), these neutral particles charge-exchange again and begin to gyrate about the local interstellar magnetic field (LISM).
3. Particles that were traveling perpendicular to the LISM (grey area in figure above) mostly gyrate about the magnetic field and are easily "trapped" by small fluctuations in the magnitude of the magnetic field along their trajectories. Those that were traveling parallel to the LISM (marked with a ★) continue to travel away from the heliosphere.
4. The trapped ions eventually charge-exchange one last time before becoming neutral once again. Some fraction of those particles are pointed toward Earth when this happens, and they return to Earth where they are detected by the IBEX spacecraft.

Astrophysics Outreach

- On Thursday, January 21, 2016, Chandra mission's Kimberly Arcand delivered an interactive presentation in Cambridge, MA at the Harvard Art Museum's Visualization Gallery on the Chandra mission discoveries, light/astronomy, image processing and aesthetics/astronomy research
- The following day, January 22, 2016, Ms. Arcand spoke about Chandra, science/technology careers, and Mars
- There was also a special viewing of "The Martian" movie at an underserved at the Woonsocket Area Career and Technical Center in Woonsocket, RI, with 20 students and faculty