IBEX and Voyager spacecraft drive advances in outer heliosphere research

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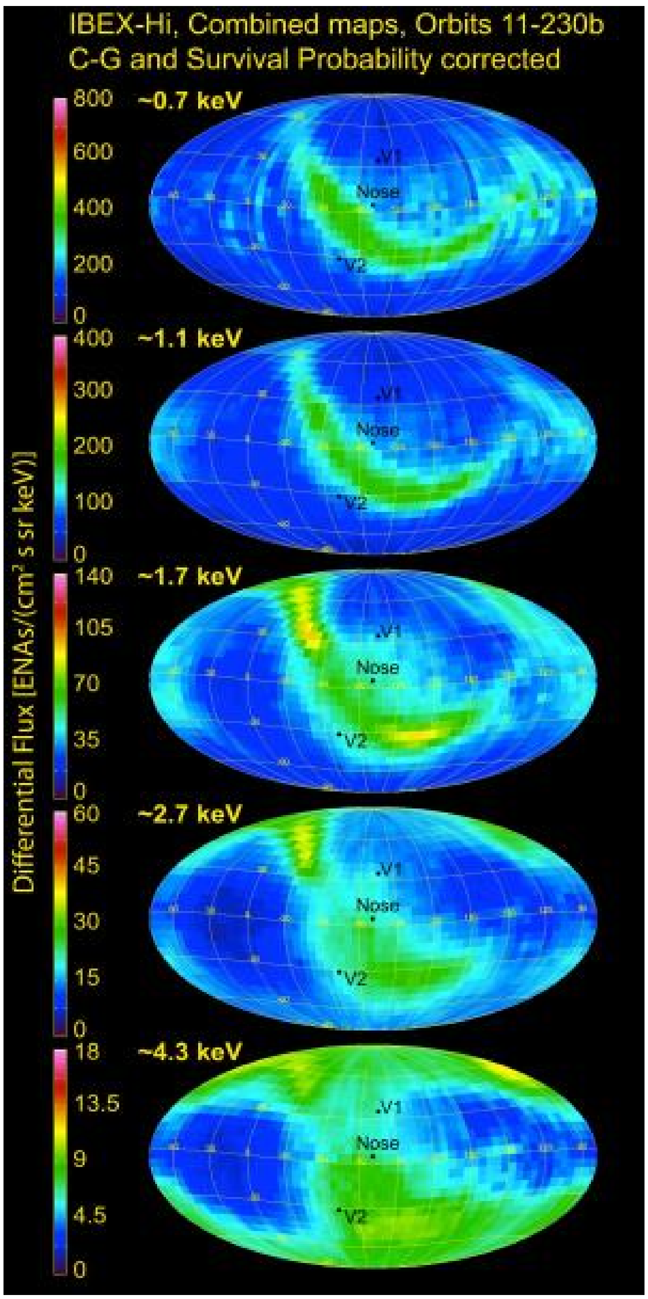


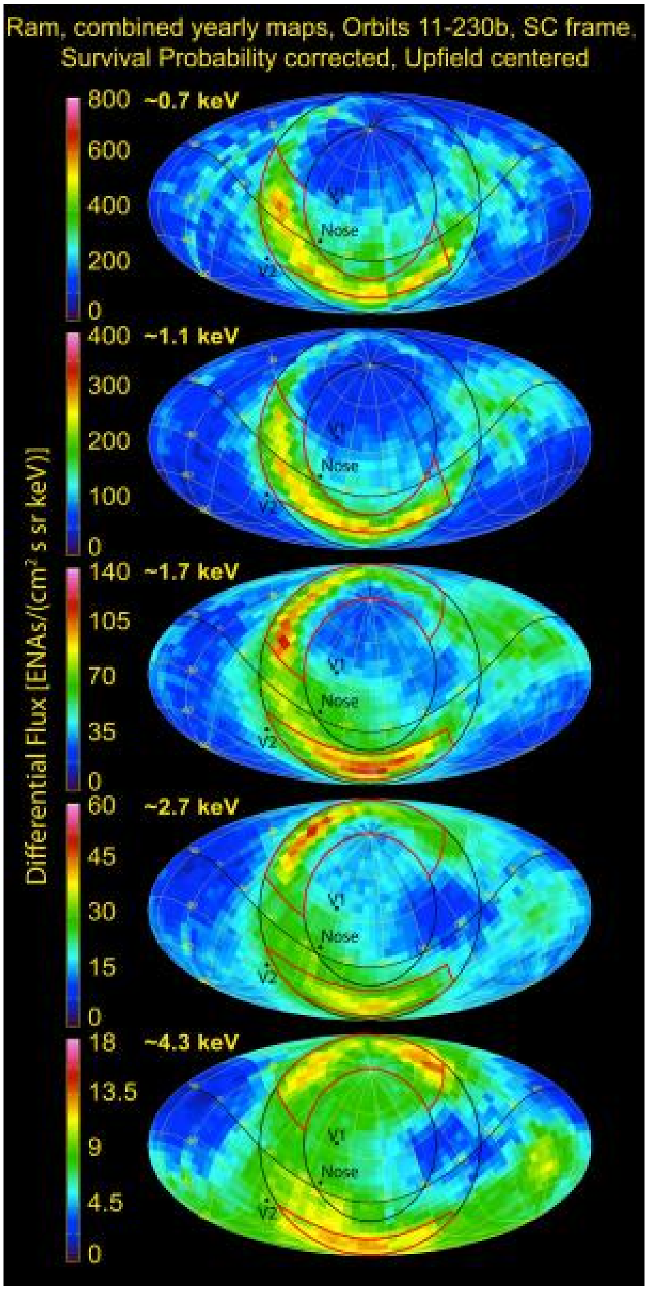
This image highlights the statically combined survival probability and C-G corrected maps, indicative of energetic neutral atom (ENA) fluxes in the outer heliosphere directed inward and before ionization losses. Credit: Southwest Research Institute

Scientists yesterday highlighted an impressive list of achievements in researching the outer heliosphere at the 40th International Committee on Space Research (COSPAR) Scientific Assembly in Moscow.

"Between NASA's Voyager and IBEX missions, it's an incredible time for outer heliospheric science," says Dr. Dave McComas, IBEX principal investigator and assistant vice president of the Space Science and Engineering Division at Southwest Research Institute, who also will be recognized with a 2014 COSPAR Space Science Award at the assembly. "Ten years ago you could hardly find an outer heliosphere technical session. Now it's the hottest thing going."

The million-mile-per-hour solar wind pushed out by the Sun inflates a giant bubble in the interstellar medium called the heliosphere, which envelops the Earth and the other planets. After the two Voyager spacecraft, launched in 1977, completed their mission to study Jupiter, Saturn, Uranus and Neptune, they continued on their journey to interstellar space. Another mission, the Interstellar Boundary Explorer (IBEX) launched in 2008, is designed to map and study the global interactions at the boundary between the heliosphere and interstellar space.

Together, the Voyagers and IBEX have helped advance an important area of research to provide insight to humankind's evolving home in the galaxy.



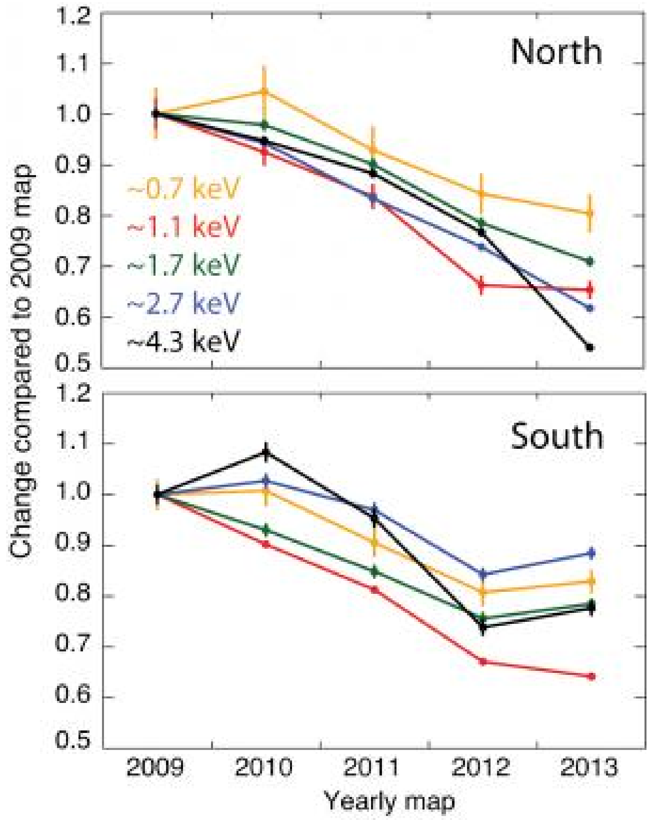
This image shows a selection of dominant ribbon ENA emission regions (red outlined areas in each map). The ribbon emissions are strongest at increasingly higher latitudes for higher energies, consistent with the latitude ordering of the solar wind around solar minimum. Credit: Southwest Research Institute

Both Voyagers provide "point" measurements along their journey out of the solar system. Those measurements offer important details about interactions occurring along their paths. IBEX complements the Voyagers' measurements by imaging the interactions occurring at the edge of the heliosphere over all directions in space.

"It's a lot like the difference between a CT scan and associated biopsies. A biopsy provides specific information at the point it samples, while a CT scan provides the global images and context for the big picture of what's going on. The combination of point and global measurements is really dynamite," says McComas. A ribbon of enhanced emissions snakes through the sky at the boundary between the heliosphere and interstellar space, right between the two Voyager spacecraft point measurements. The ribbon went undetected until IBEX observed it in 2009.

IBEX creates images of energetic neutral atoms (ENAs) to make visible the invisible energetic interactions at the edge of the solar system. In the paper "IBEX: The First Five Years (2009)," published this month *by The Astrophysical Journal Supplement Series*, the science team summarized its first five years of accomplishments, including the first five years of maps showing interactions at the edge of the solar system, a trove of data in multiple formats, and aspects of data analysis and the methods used to refine them.

Current research has the team studying the enigmatic ribbon separately in two hemispheres. The ribbon in the northern hemisphere extends farther back in distance—and in time—than the southern hemisphere. Recognizing that time differentiation plays a role in the observations is helping the team differentiate between the more than dozen current models that seek to explain the ribbon.



This image shows ENA fluxes at various energies from the latitude-dependent ribbon regions specified in the opposite image. The northern hemisphere (top frame) and southern hemisphere (bottom frame) fluxes show similar reductions from 2009 to 2012, but clearly diverge in 2013. Credit: Southwest Research Institute

IBEX's five years of operation cover almost half a solar cycle (11 years, on average), with plans to continue through a full cycle. Since the start of the mission, 169 papers have been published in scientific journals, with another dozen submissions in process. Combined with Voyager, the amount of scientific research generated on the heliosphere is impressive.

While Voyager and IBEX have significantly advanced the field of heliospheric physics, there's more to learn. The National Research Council ranked an outer heliosphere mission as its highest priority in the

Solar Terrestrial Probe Program in the National Academy Decadal Survey released online in 2012 and in print in 2013. That proposed NASA mission, the Interstellar Mapping and Acceleration Probe (IMAP), would use IBEX-type measurements with 100 times better combined sensitivity and resolution to explore the boundaries of the solar system, while other measurements would directly study energetic particle acceleration in the solar wind.

Despite the extensive knowledge gained about the outer heliosphere, the question of whether the Voyagers have already left the solar system continues to stir debate. "For me, it's not the central question," says McComas. "Whether Voyager-1 has crossed the boundary of the heliosphere or remains in some exotic region inside it, the data are still spectacular."

Provided by Southwest Research Institute

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