Multitasking New Horizons observed solar wind changes on journey to Pluto

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In addition to its history-making encounter with Pluto last July, the New Horizons spacecraft also recorded significant changes in how the solar wind behaves far from the Sun.

The Solar Wind Around Pluto (SWAP) instrument, operated by Southwest Research Institute (SwRI), collected three years' worth of measurements before the July 15 Pluto flyby. Data showed that the tumultuous flow of solar particles, which in the inner solar system is structured by the interaction of fast and slow flows as well as eruptive events on the Sun, becomes more uniform by the time the solar wind has traversed the 3 billion miles to Pluto's orbit.

SWAP measures the solar wind and ions created as the neutral interstellar material becomes ionized and is "picked up" by the solar wind. These interstellar pickup ions can have up to twice the speed and four times the energy of the solar wind. Farther out in space, these ions may be the seeds of the extremely fast energetic particles called anomalous cosmic rays, which pose a radiation threat to astronauts closer to Earth. These ions also play an important role in shaping the boundary where the solar wind hits interstellar space. New Horizons is currently at about 35 astronomical units (about 35 times farther than the Earth to the Sun). It is the only operating spacecraft in the outer solar system. Only Voyager 2 has measured the solar wind farther away from the Sun; however, SWAP on New Horizons will be the first to measure the interstellar pickup ions in the outer solar system.

The results will appear in a study to be published April 6 by the *Astrophysical Journal Supplement*.

Lead author Dr. Heather Elliott, a principal scientist in SwRI's Space Science and Engineering Division, said the SWAP instrument was busy even when the rest of New Horizon's instruments were "hibernating" to save energy on the long, nine-year voyage to Pluto.

"The instrument was only scheduled to power on for annual checkouts after the Jupiter flyby in 2007," she said. "We came up with a plan to keep the particle instruments on during the cruise phase while the rest of the spacecraft was hibernating. We started observing in 2012."

The plan yielded three years of near-continuous observations, capturing detailed measurements of the space environment in a region few spacecraft have ever visited.

Because the Sun is the source of the solar wind, events on the Sun are the primary force that shapes the space environment. Shocks in the solar

wind—which can produce space weather, such as auroras, on worlds with magnetic fields—are created either by fast, dense clouds of material called coronal mass ejections or by the collision of two different-speed solar wind streams. These individual features are easily observed in the inner solar system, but New Horizons didn't see the same level of detail.

"At this distance, the scale size of discernible solar wind structures increases, since smaller structures are worn down or merge together," said Elliott. "It's hard to predict if the interaction between smaller structures will create a bigger structure, or if they will flatten out completely."

Subtler signs of the Sun's influence are also harder to spot in the outer solar system. Characteristics of the solar wind—speed, density, and temperature—are shaped by the region of the Sun it flows from. As the Sun and its different wind-producing regions rotate, patterns form. New Horizons didn't see patterns as defined as they are when closer to the Sun, but it nevertheless did spot some structure.

"Differences in speed and density average together as the solar wind moves out," said Elliott. "But the wind is still being heated as it travels and faster wind runs into slower wind, so you see evidence of the Sun's rotation pattern in the temperatures even in the outer solar system."

New Horizons is the first mission in NASA's New Frontiers program, managed by the agency's Marshall Space Flight Center in Huntsville, Ala. The Johns Hopkins University Applied Physics Laboratory designed, built, and operates the New Horizons spacecraft and manages the mission under Principal Investigator Dr. Alan Stern's direction for NASA's Science Mission Directorate. SwRI leads the science mission, payload operations, and encounter science planning. The NASA Heliophysics program also supported the analysis of these observations.

More information: "New Horizons Solar Wind Around Pluto (SWAP) Observations of the Solar Wind From 11-33 AU," H. A. Elliott et al., 2016, *Astrophysical Journal Supplement Series* , arxiv.org/abs/1601.07156

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