S-HIS Real-time Processing and Data Transport

David J. Hoese, Caitlin M. Barnes, Fred A. Best, Raymond K. Garcia, P. Jonathan Gero,
Robert O. Knuteson, Henry E. Revercomb, Donald V. Sullivan, Joseph K. Taylor,
David C. Tobin, David Van Gilst, Elisabeth Weisz

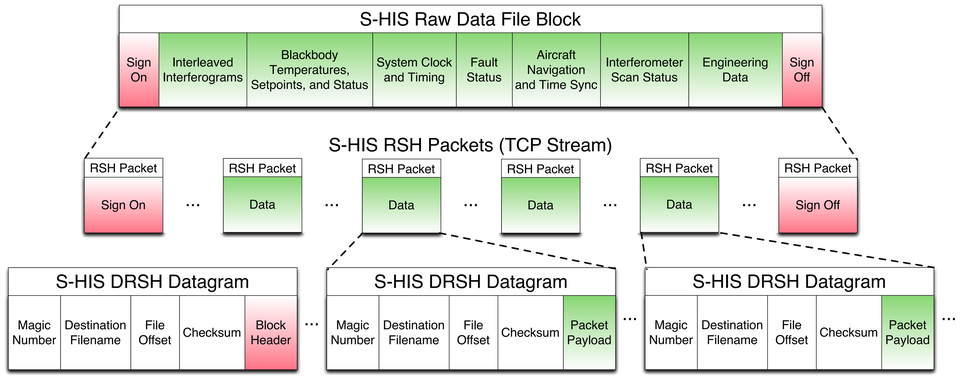
Space Science and Engineering Center, University of Wisconsin, Madison, WI
NASA Ames Research Center, Moffett Field, CA
University of California Santa Cruz, Santa Cruz, CA
University of North Dakota, Grand Forks, ND

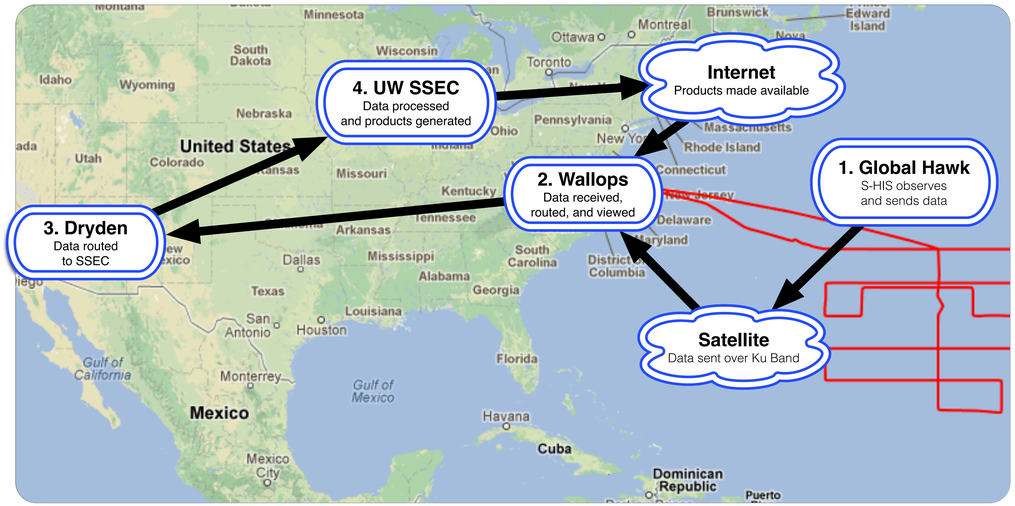
Abstract

The Hurricane and Severe Storm Sentinel (HS3) is a NASA mission to investigate the formation and evolution of hurricanes in the Atlantic basin. Field measurements take place over 3 years during the 2012-2014 hurricane seasons, based at the NASA Wallops Flight Facility. The Global Hawk aircraft are capable of high altitude flights with durations up to 30 hours, which allow extensive observations over distant storms, not typically possible with manned aircraft. Two NASA Global Hawks are equipped with instrument suites to study the storm environment, and inner core structure and processes respectively.

The Scanning High-Resolution Interferometer Sounder (S-HIS), designed and built by the University of Wisconsin (UW) Space Science and Engineering Center (SSEC), measures emitted thermal radiation at high spectral resolution between 3.3 and 18 microns. The S-HIS builds on 15+ years of SSEC research and experience in interferometry. The radiance measurements are used to obtain temperature and water vapor profiles of the Earth's atmosphere. The S-HIS spatial resolution is 2 km at nadir, across a 40 km ground swath from a nominal altitude of 20 kilometers. The S-HIS has been deployed extensively in the past aboard the NASA DC8, Proteus, ER-2 and WB-57 aircraft.

The UW S-HIS infrared sounder instrument has been equipped with a real-time ground data processing system capable of delivering atmospheric profiles, radiance data, and engineering status to mission support scientists - all within a minute of observation. This ground data processing system was assembled by a small team using existing software and proven practical techniques similar to a satellite ground system architecture. This poster displays the physical and logical path the data takes from the instrument to the scientists.





S-HIS Real-time Data Transport

Global Hawk (S-HIS): Observations from S-HIS are unicasted as DRSH datagrams (see upper-right diagram) to the link module onboard the aircraft. The link module then sends the data to Wallops via a satellite modem on the Ku radio band.

Wallops: Software written by NASA's technicians sends data to scientists on the ground at Wallops and to servers at the SSEC via a router at Dryden Flight Research Center in California. S-HIS data is processed and shown on a graphical user interface called the Dashboard as 2D line plots and color-coded text displays (see images below). Scientists at Wallops can view other S-HIS products from the SSEC S-HIS website or any data provided to NASA's Mission Tools Suite website within a minute of observation.

Space Science and Engineering Center, UW-Madison: DRSH datagrams are received by servers at the SSEC, RSH files are constructed, and raw blocks are processed to get radiances and atmospheric profiles. Binary circular-buffer files are used as intermediate storage between processing steps. Each scan line of data is added to existing quicklook images and WMS compatible geotiffs. The SSEC processing servers host these products as a S-HIS website containing information about current and past flights. The servers host WMS layers and KML placemark files that can viewed on NASA's Mission Tools Suite, Google Maps, or Google Earth.

3 Formats of Raw S-HIS Data

Raw Scanning-HIS Files (RSH Files)

Binary files on disk that are separated into blocks. A block represents one time step of observations and contains all the data recorded during that time. Each block is marked by a sign-on and sign-off byte.

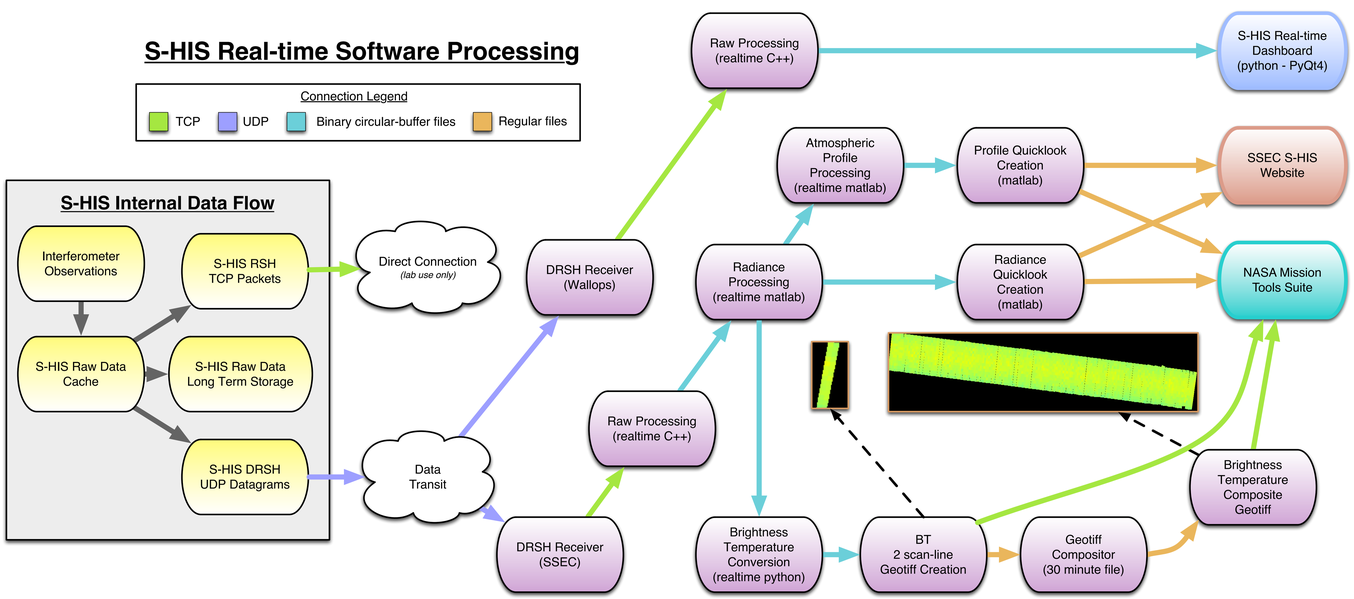
RSH TCP Stream

RSH file blocks sent over a connection-oriented TCP stream. Blocks are first divided into "RSH packets", where each packet has a header containing data type and size information.

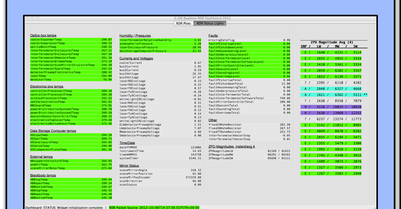
DRSH UDP Datagrams

RSH packets wrapped in an unordered connection-less UDP datagram. Each datagram contains a "magic number" stating that it is a DRSH datagram, the name of the destination file, the byte offset into that file, the checksum of the data payload, and the data itself.

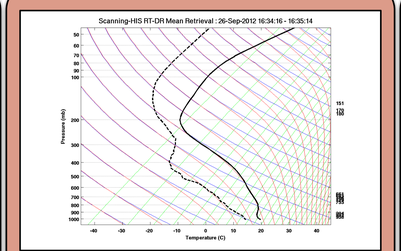
S-HIS Real-time Software Processing



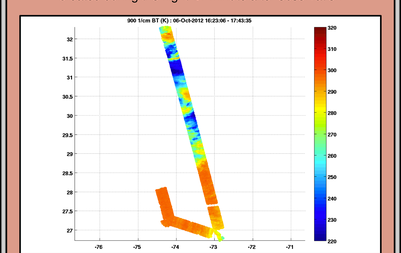
S-HIS RSH Dashboard Real-time Plots
Updates every half-second with engineering data during flight



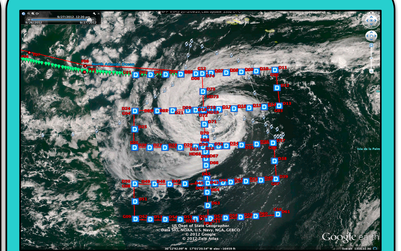
S-HIS RSH Dashboard Real-time Status Light Measurements
Updates every half-second with engineering data during flight
Colors of lights change based on data value to ensure nominal operation



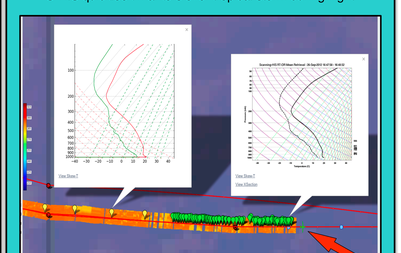
S-HIS Real-time Skew-T plot from S-HIS website created during the flight <1 minute after observation



S-HIS Real-time BT plot from S-HIS website showing brightness temperatures as the aircraft flies



Mission Tools map with flight path, dropsonde locations, and S-HIS quicklook markers over tropical storm during flight



Mission Tools map with flight path, S-HIS WMS brightness temperatures, and S-HIS quicklooks <1 minute after observation (note the aircraft in front of the data)