High Spatial and Spectral Resolution Infrared Observations from the Scanning High-resolution Interferometer Sounder (S-HIS): Recent Datasets and Next-Gen Sensor Development

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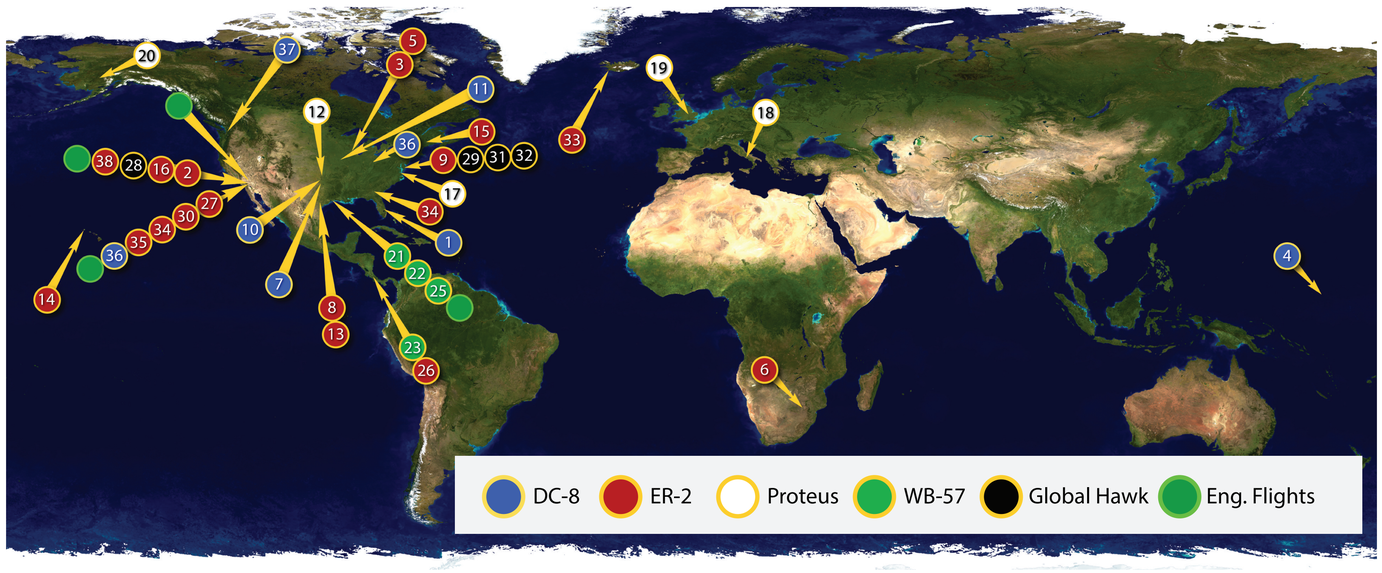
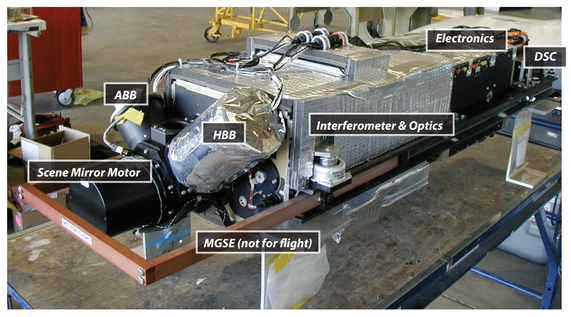
The Scanning High-resolution Interferometer Sounder (S-HIS)





IFOV:	100 mrad (2km @ 20km, nadir)
FOR:	Programmable 45° scene mirror nadir ± 40° typical
Spectral Coverage:	580 - 3000 cm^{-1}
Spectral Resolution:	0.5 cm^{-1}

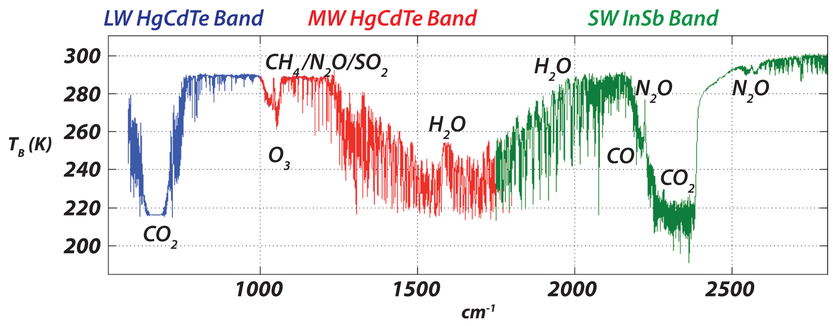
Since 1998, the S-HIS has participated in 38 field campaigns on the NASA ER-2, DC-8, Proteus, WB-57, and Global Hawk airborne platforms. The S-HIS has proven to be extremely dependable with high calibration accuracy and consistent performance on all platforms, with S-HIS data yield typically above 99% for flight science data collection.

Calibration, Calibration Verification, and Traceability

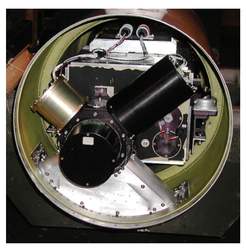
- Pre-integration **calibration of on-board blackbody references** at subsystem level
- **Pre and post deployment end-to-end calibration verification**
- Periodic **end-to-end radiance evaluations under flight like conditions with NIST transfer sensors.**
- Instrument calibration during flight using **two on-board calibration blackbodies**

Geophysical Retrievals (Dual Regression)

- Temperature Profiles
- Water Vapor Profiles (RH, Mixing Ratio)
- CO, N_2O, CH_4, O_3 Profiles
- Total Column CO_2
- Surface Temperature and Emissivity

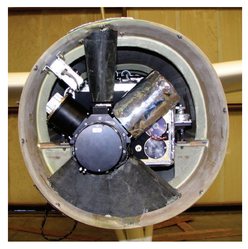


Sample upwelling S-HIS brightness temperature spectra. Installing an existing 4-detector dewar would extend coverage to 420 cm^{-1}



ER-2 centerline pod

DC-8



Proteus wing boom

WB-57 wingpod

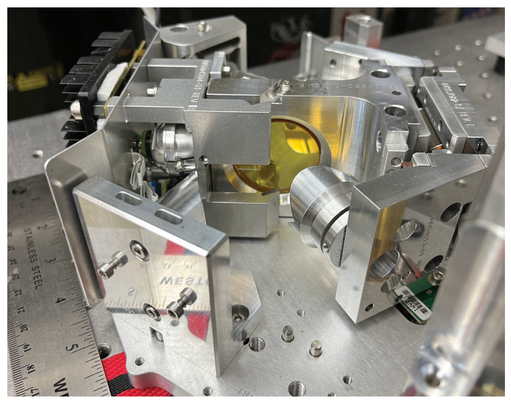
S-HIS mounted on AV-6, Zone 25

Next-Gen Sensor Development

Design Study and Early-Stage Breadboard Development of Key Components

The S-HIS has demonstrated exceptional performance and reliability for over 20+ years as an airborne research and satellite calibration validation asset used by NASA, NOAA, and the DOE. Due to its age, responding to any critical component failure could be cost prohibitive, and a replacement of the S-HIS with a next-generation instrument is not only desirable, but becoming necessary.

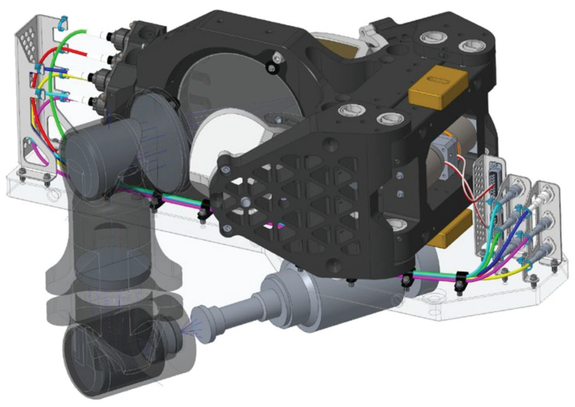
- One of the most valuable enhanced capabilities of the next generation of hyperspectral infrared sounders, particularly for PBL, is improved spatial resolution, which can be efficiently provided via an Imaging Fourier Transform Spectrometer. Improved spatial resolution will also enable a wider breadth of research and applications.
- We have completed an engineering design study to identify and outline a modular modernization, upgrade, and replacement approach for the S-HIS and were funded to conduct early breadboard development and testing of three core next-generation subsystems: (1) an Imaging Fourier Transform Spectrometer (IFTS), (2) the real-time instrument controller, and (3) the calibration reference controller.
- The interferometer development conducted within the early breadboard phase leverages a commercial off-the-shelf (COTS) interferometer and focal plane array.



- The interferometer utilizes a flight representative detector sampling scheme, metrology and data interfaces, and opto-mechanical architecture at relatively low cost.

The High-resolution InfraRed Imaging Sounder (HIRIS): A Compact High Spatial Resolution Infrared Imaging Fourier Transform Spectrometer for Sounding of the PBL

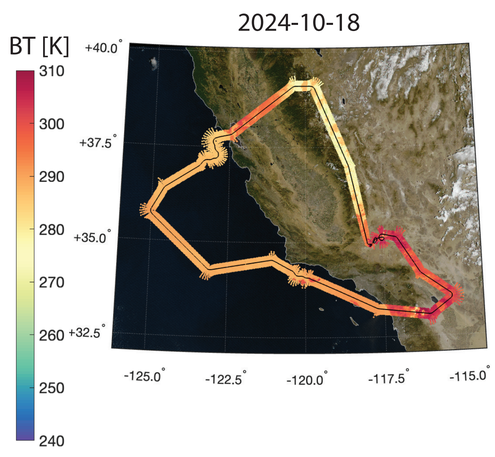
- PBL DSI Technology 2024: Proposed the development and characterization of a ***Wide-field Imaging Spectrometer Core*** (WISC) that meets or surpasses the infrared sounder observational goals identified by the NASA PBL Incubation Study Team Report; characterization of the WISC to be completed in a breadboard implementation of a next-generation sensor, HIRIS.
- This phase of development will lead to the capability for accurate, high spectral resolution infrared radiance measurements of the PBL with ***revolutionary spatial resolution*** from airborne (HIRIS-A, 100m spatial sampling from 20km altitude) and smallSat LEO platforms (HIRIS-L, 1km spatial sampling from 800km altitude), with the ***capability for spatial oversampling and multi-angle viewing***.

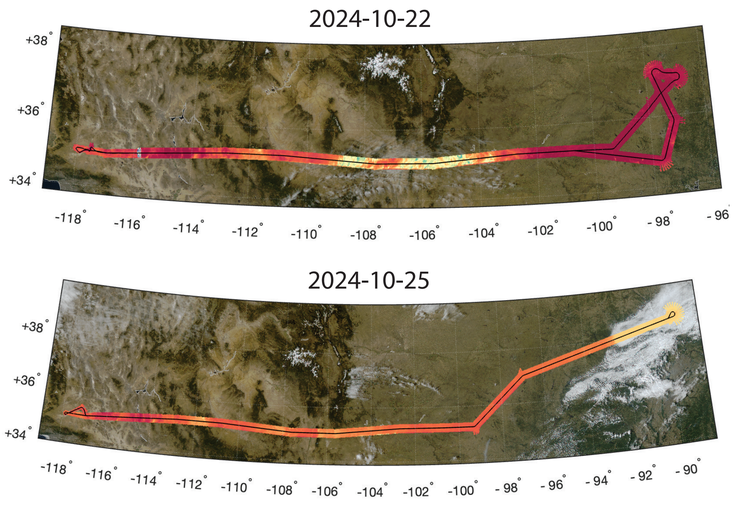


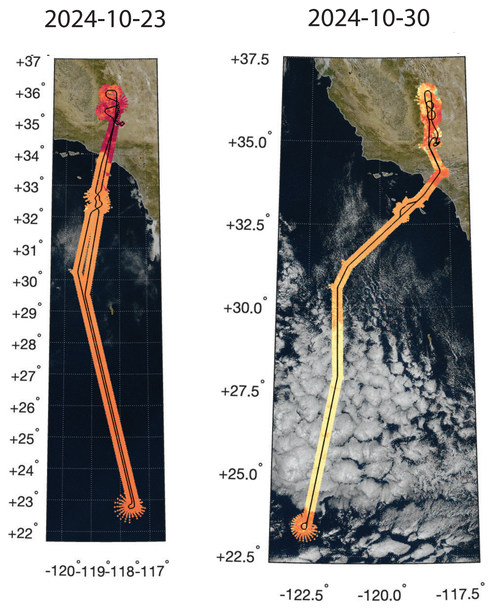
WISC includes a high TRL Fourier Transform Spectrometer, a commercially available and high TRL longwave (680 – 1210 cm^{-1}) imaging detector array developed for the Meteosat Third Generation InfraRed Sounder (MTG-IRS) program, custom detector readout electronics, and appropriate aft- optics, cooler, and electronics. The modular WISC/HIRIS design supports full spectral coverage including the midwave and/or shortwave infrared sounder bands via additional aft-optics/detector assemblies.

S-HIS WH²yMSIE Datasets (ER-2), 2024

895 - 905 cm^{-1} S-HIS Mean BT Maps







ABI mid-flight true color images produced using geo2grid