Scanning-HIS Participation in HS3

Year 1 Progress Report

NASA Grant NNX10AV08G

For the period of:
9/1/2010 – 8/31/2011

Submitted on behalf of
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Space Science and Engineering Center
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31 August 2011

HS3 Year-1 Progress Report
University of Wisconsin, Space Science and Engineering Center
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Introduction

This is the Year 1 report for the time period 9/1/10 - 8/31/2011 of NASA Grant NNX10AV08G to the University of Wisconsin (UW) Space Science and Engineering Center for Scanning High-resolution Interferometer Sounder (S-HIS) instrument participation in the NASA EV-1 Hurricane and Severe Storms Sentinel (HS3) project. The goal of HS3 is to enhance our understanding of the processes that underlie hurricane intensity change in the Atlantic Ocean basin. Primarily, activities were focused on supporting coordination meetings of the HS3 Science Team as well as corresponding engineering efforts leading to a successful test flight of the Scanning HIS instrument on the NASA Global Hawk from the NASA Dryden Flight Research Facility near Lancaster, California. The Scanning HIS has extensive flight experience on NASA high altitude aircraft (ER-2, WB-57, and Proteus) however the Scanning HIS was integrated to the Global Hawk aircraft for the first time using Year 1 funding of the HS3 project.

The Scanning HIS is an aircraft prototype of the Cross-track Infra-Red Sounder (CrIS) on the NPP satellite. The airborne Scanning-HIS instrument has somewhat higher spectral and spatial resolution than the satellite sensor but uses a similar Michelson interferometer spectrometer concept. The measurement characteristics of the Scanning HIS are given in Figure 1. The complete spectral range is measured using three detectors (MCT, MCT, and InSb) covering the LW, MW, and SW thermal infrared spectrum. The brightness temperature spectrum shown in Figure 1 is measured every 0.5 seconds and contains information on the vertical distribution of atmospheric temperature, water vapor, and trace gases.

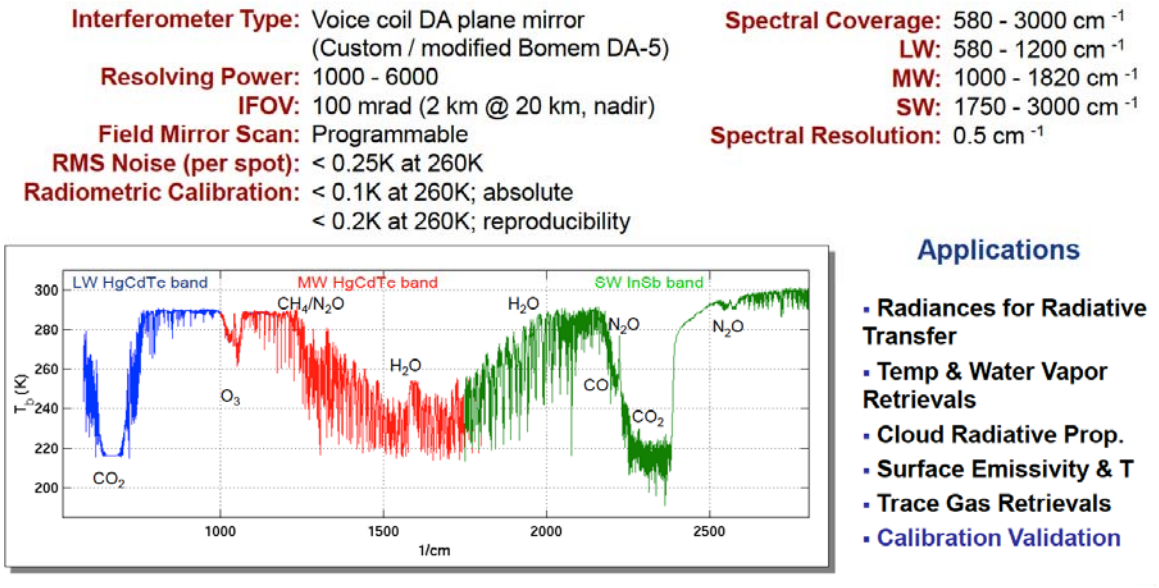


Figure 1. Scanning-HIS measurement characteristics.

Support of Science Team

The Scanning HIS supported periodic Science Team telecons during the reporting period in addition to the Science Team Kick-Off meeting on October 19-21, 2010, where Dr. Robert Knuteson, UW-SSEC, presented the Scanning HIS overview and summary of proposed work. This presentation is available on the HS3 home page at: http://www.espo.nasa.gov/hs3/presentations.php

Emphasis in the science team presentation was given to the calibration accuracy of the measured upwelling infrared radiances and in the retrieval of atmospheric temperature and water vapor profiles. Figures 2-4 highlight the calibration experience and expected radiance and retrieval performance on the Global Hawk. The S-HIS has recently been used in a series of tests in collaboration with the National Institute of Standards and Technology (NIST) and the NASA Instrument Incubator Program (IIP).

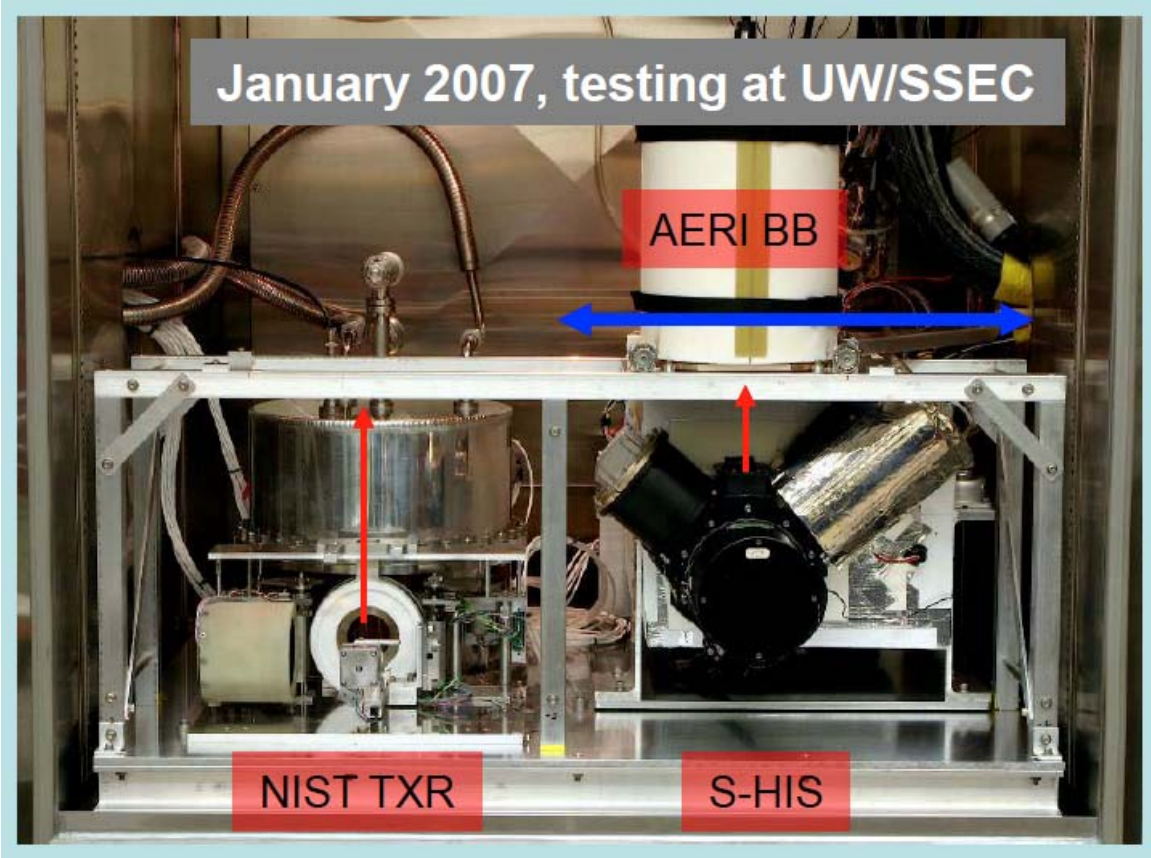


Figure 2. The Scanning HIS has undergone extensive calibration verification including a side-by-side inter-calibration against the NIST Transfer Radiometer (TXR).

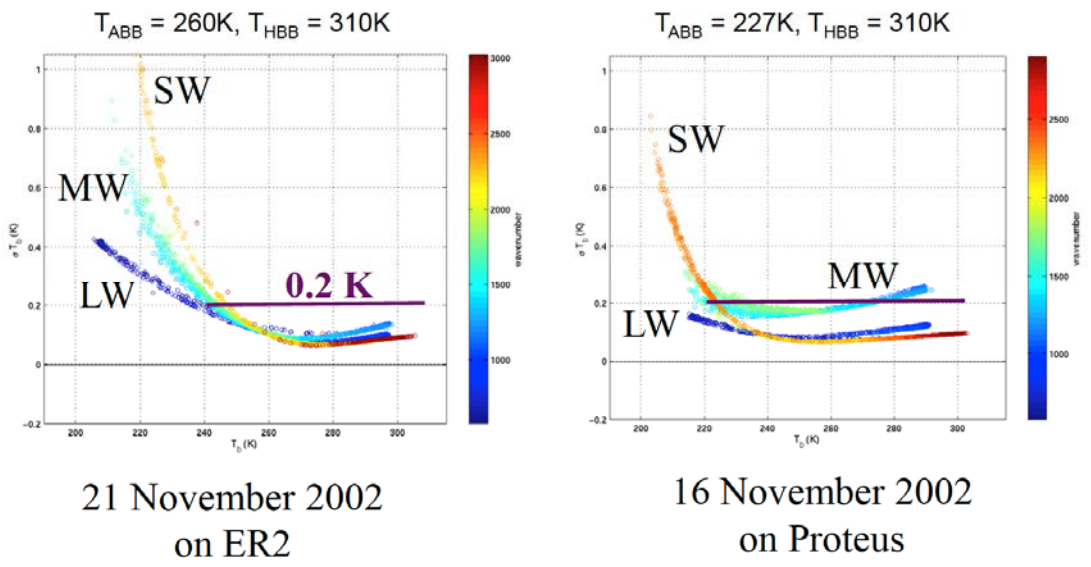


Figure 3. Systematic error (k=3) of the Scanning HIS brightness temperature measurements over a range of scene temperatures with two relevant examples (ER-2 and Proteus) differing in how closely the on-board cold blackbody is coupled to the external environment. This issue will be evaluated during the GH test flights of the S-HIS in the fall of 2011.

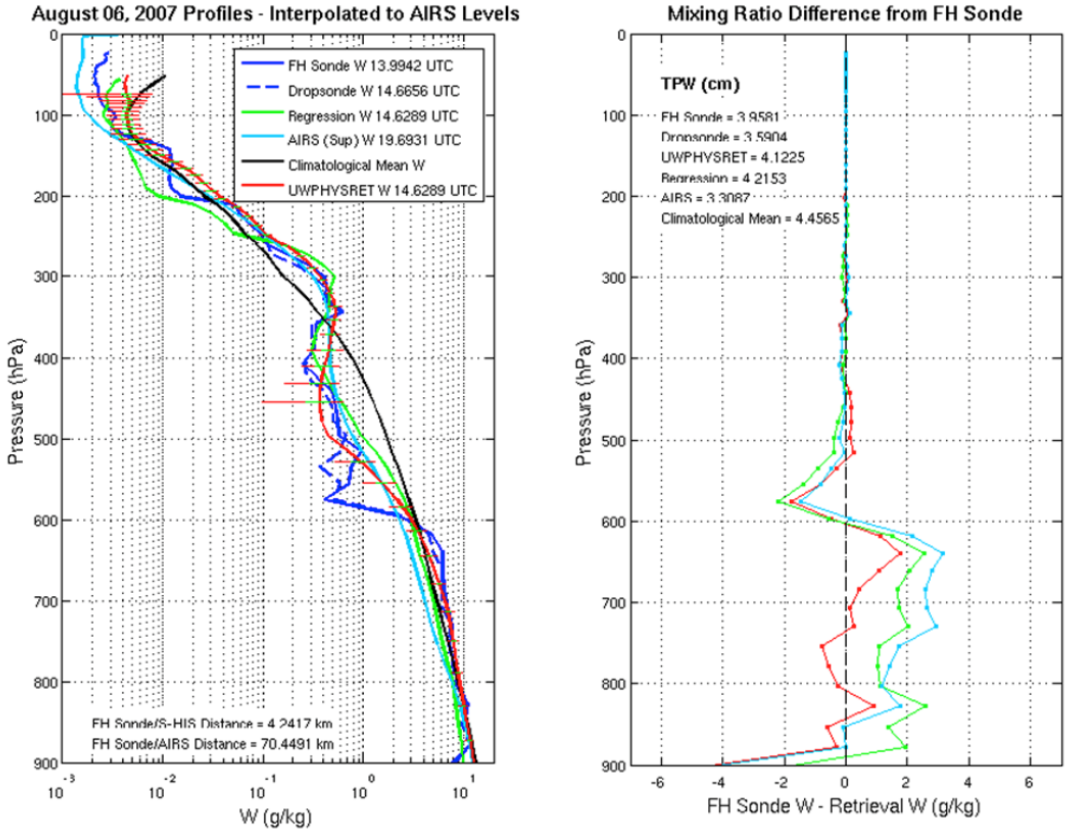


Figure 4. Water vapor retrieval validation example comparing the Scanning HIS (labeled UWPHYSRET) to frost point hygrometer (FP) and dropsondes during the TC4 experiment based in Costa Rica. The red horizontal bars are the S-HIS profile uncertainties that follow from an optimal estimation retrieval methodology.

Accommodation of the Scanning HIS on Global Hawk

The scanning HIS engineering team reviewed the Global Hawk Users Guide and other accommodation documentation in order to assess the optimal accommodation of the instrument on the Global Hawk platform. On November 22, 2010 Dave Fratello visited UW-SSEC to review the Global Hawk mechanical, electrical, and data interface information, and to get briefed on the Scanning HIS instrument measurements, operations, and interfaces.

The UW team submitted the Global Hawk Science Instrument Information Form and Hazard Form. We also reviewed and approved the NASA Dryden mechanical integration configuration for Zone 25 in the Global Hawk.

We designed the Scanning HIS interface cabling to the Global Hawk Experiment Interface Panel (EIP). Two EIP connectors will be used to allow the most flexible power consumption for each operating mode, including heater power. Figure 5 shows the Scanning HIS heater circuits and temperature sensors.

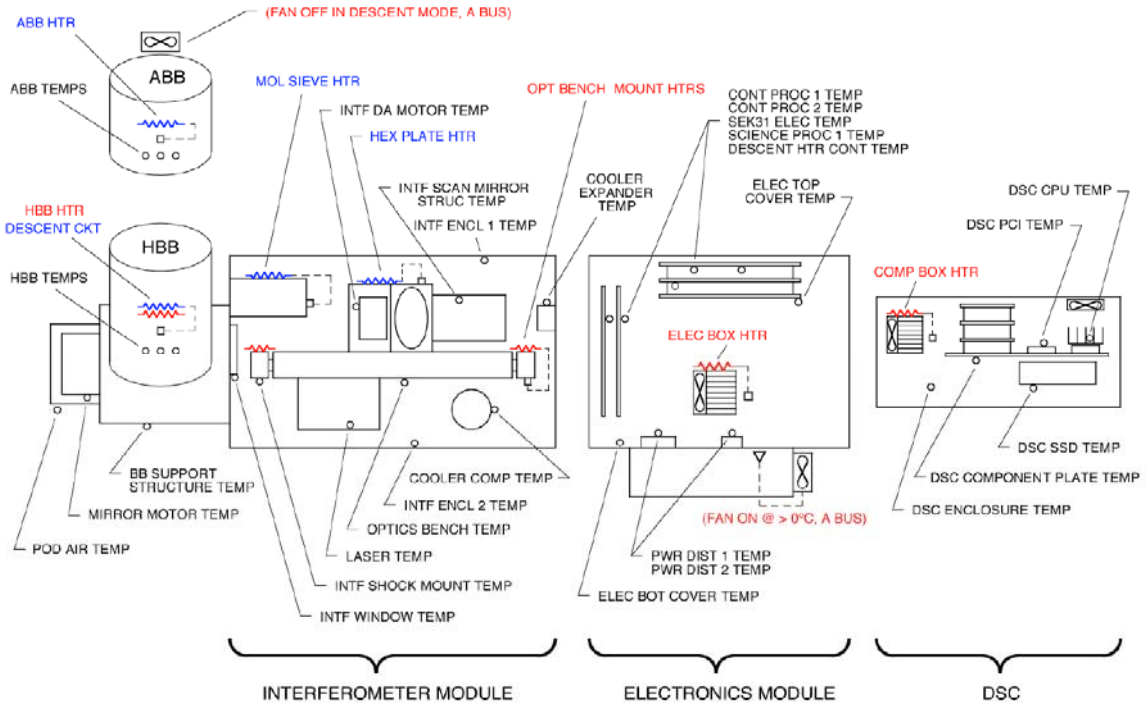


Figure 5. Schematic of the Scanning-HIS module sensor design allowing for flexible accommodation on new platforms such as the NASA Global Hawk. The various heater circuits provide safe operating temperatures for all operating modes.

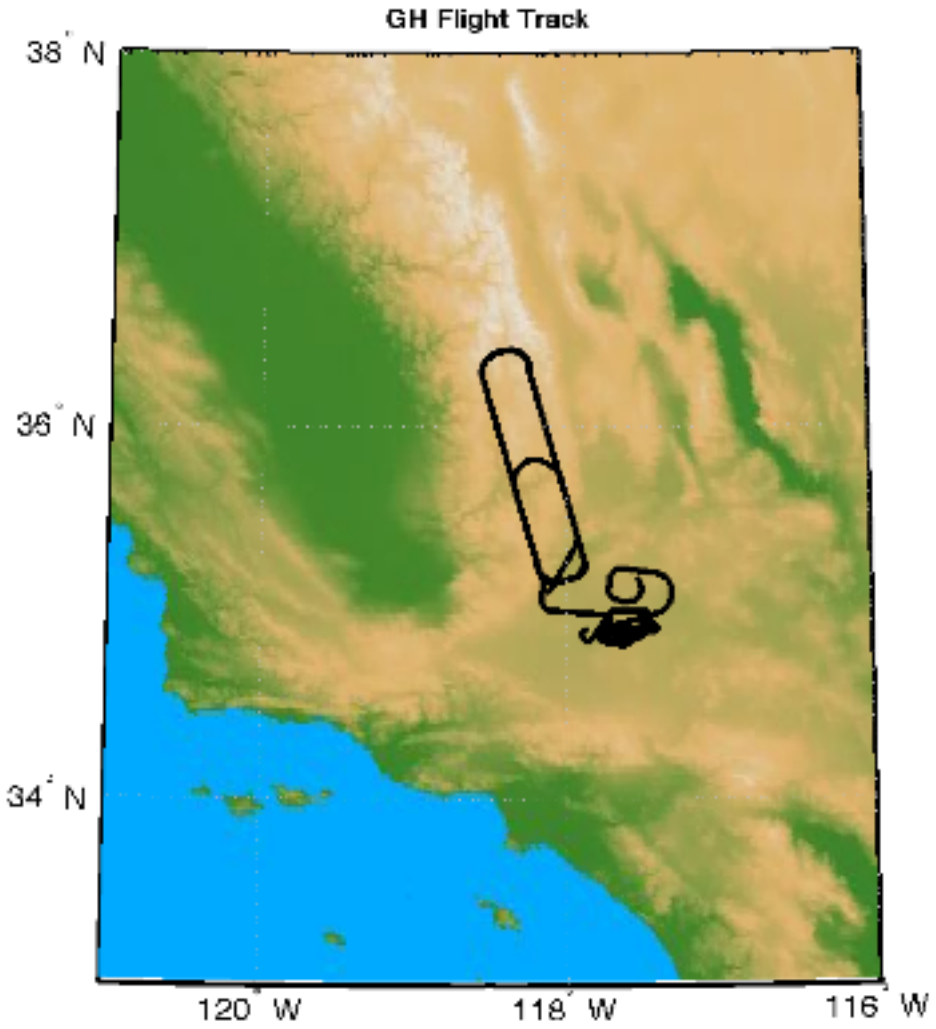
In August 2011, the Scanning HIS was driven by equipment van to NASA Dryden for a mechanical fit-check into the Global Hawk Zone 25 and to perform a bench-top electrical check with the Global Hawk simulator. S-HIS flight software changes included provisions of real-time status information, limited remote instrument control, and the potential for high bandwidth downlink of science data to the ground facility.

First Test Flight of the Scanning HIS on Global Hawk

At the end of the reporting period (01 September 2011), a test range flight of the Global Hawk was conducted with a payload consisting of S-HIS, CPL, and dropsondes (AVAPS). This test flight was the first flight of the University of Wisconsin Scanning HIS on the Global Hawk platform. The flight was entirely successful for S-HIS despite the GH operating at a low altitude (warm temperatures) for dropsonde testing during the first two hours of the 6 hour flight. Figures 6 and 7 show photos of the S-HIS installation on the Global Hawk in the NASA DFRC hangar. Figure 8 and 9 show the flight track and example graphs of the S-HIS engineering data collected during the test flight. All S-HIS engineering parameters remained in an acceptable range. Additional cooling of the zone-25 region was determined to be desirable to optimize instrument performance and this initiated discussions with the Dryden/NG support team on how this might be accomplished on future flights. Immediately following this reporting period, two successful long-duration science flights were performed (9/9/2011 and 9/14/2011). The reporting of results from those flights will be included in the Year 2 contract report.

Figure 6. (LL) S-HIS power check. (UL) S-HIS comm check. (UR) S-HIS fit check. (LR) S-HIS installation on NASA Global Hawk.

Figure 7. Final S-HIS installation on the NASA Global Hawk 872 (August 2011 at DFRC).



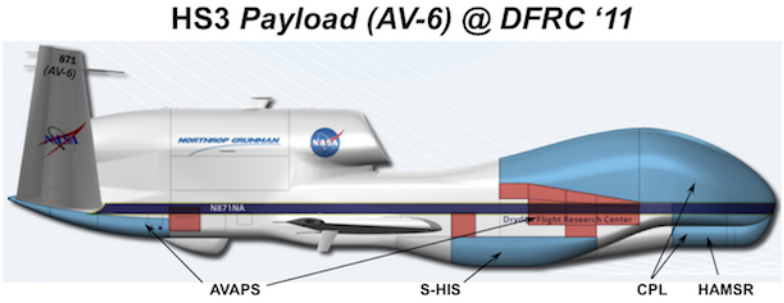


Figure 8. (upper panel) Global Hawk flight track on 01 Sept 2011 as collected by the S-HIS instrument during the six hour range flight. (lower panel) HS3 payload for the engineering test flight included S-HIS, CPL, and AVAPS. The first range test flight of the UW Scanning HIS was completely successful.

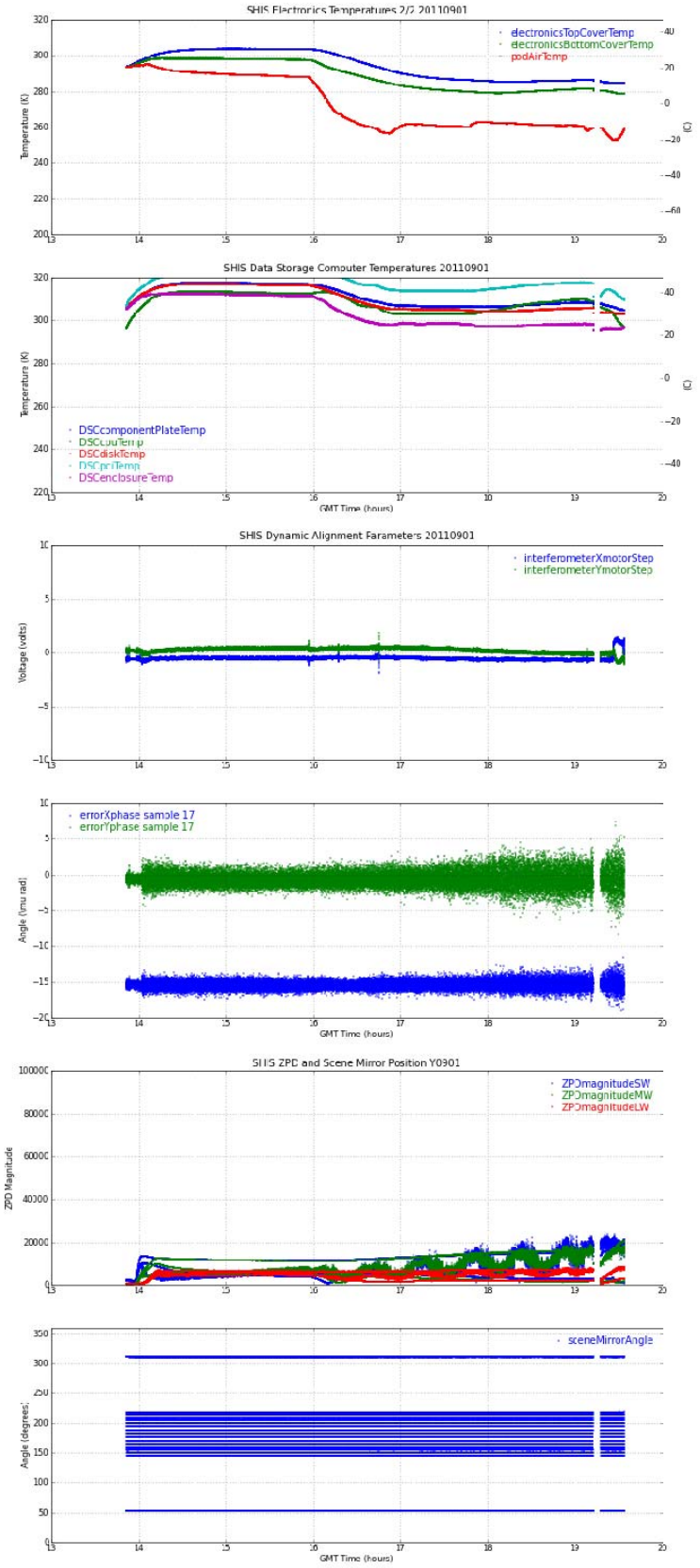


Figure 9. Example Scanning HIS engineering plots for the successful range test flight of 9/1/2011.

UW HS3 Year 1 Summary of Accomplishments

During the first year of support from the NASA HS3 project, the University of Wisconsin Space Science and Engineering Center accomplished the following objectives;

- Supported HS3 science team meetings in person and via telephone.
- Evaluated existing S-HIS hardware and software for compatibility with long duration (>24 hour) flights and made adjustments as necessary.
- In coordination with NASA DFRC, made provision for the on-board generation of S-HIS health and status packets required for real-time monitoring.
- Communicated technical drawings and specifications of the Scanning HIS instrument to NASA DFRC to facilitate the fabrication of mounting support and electrical cabling hardware for Zone 25 of the NASA Global Hawk.
- Provided UW personnel at NASA DFRC in support of the mechanical fit check, electrical power check, communications check, and final instrument installation in Global Hawk 872.
- Supported a six hour range test flight of the S-HIS on 9/1/2011. This was the first flight of the UW S-HIS on the NASA Global Hawk and it was entirely successful.

Immediately following the range test flight, the UW team supported two successful science flights (9/9/2011 and 9/14/2011) in the Pacific and Gulf of Mexico respectively. Since these flight dates fall under the Year 2 reporting period they will not be discussed here. However the success of all three Global Hawk flight during September 2011 provides high confidence that the UW Scanning HIS will be ready for flight operations in 2012.

Some of the activities that are being pursued under Year 2 funding in preparation for the 2012 campaign include;

- Continued support of science team meetings and telecons.
- Analysis of the S-HIS temperature and water vapor retrievals from the 2011 campaign with comparison against dropsondes and HAMSR retrievals.
- Improvements to the real-time data downlink capability.
- Improvements to the automated ground-processing of the long duration flights.
- Improvements to the GH Zone 25 temperature environment.