VALIDATION OF JPSS RELATED SOUNDING MEASUREMENTS-SUOMI NPP AND HS3 AIRBORNE FIELD CAMPAIGNS

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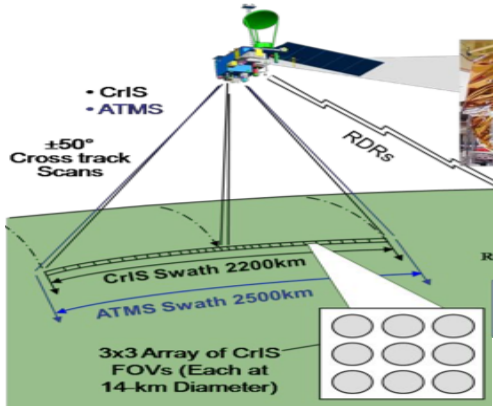
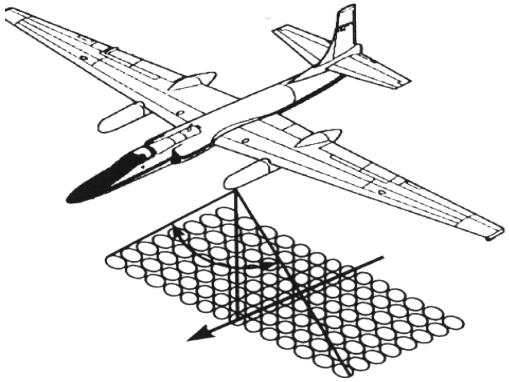
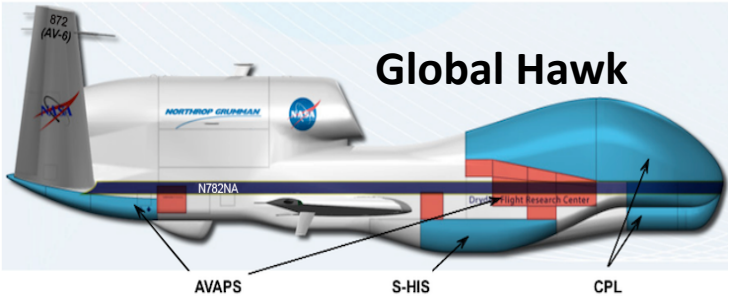
Suomi-NNP-1 & 2 CrIS Cal/Val

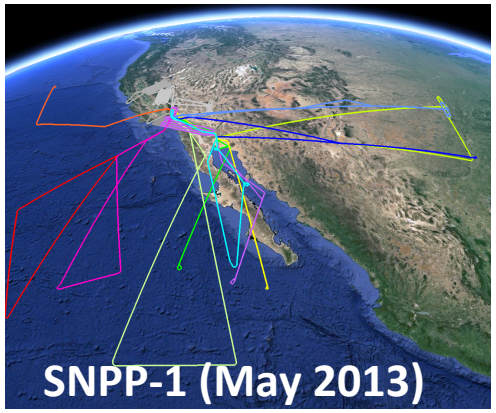


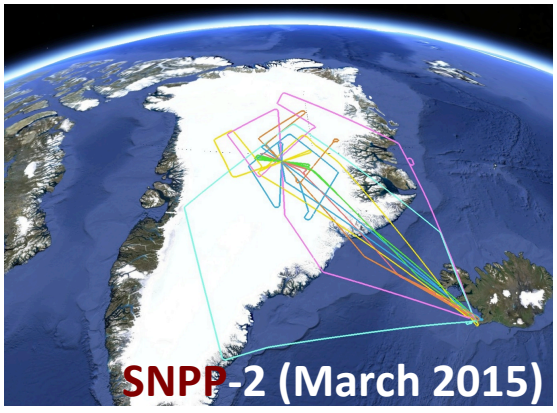
ER-2 NAST-I & S-HIS

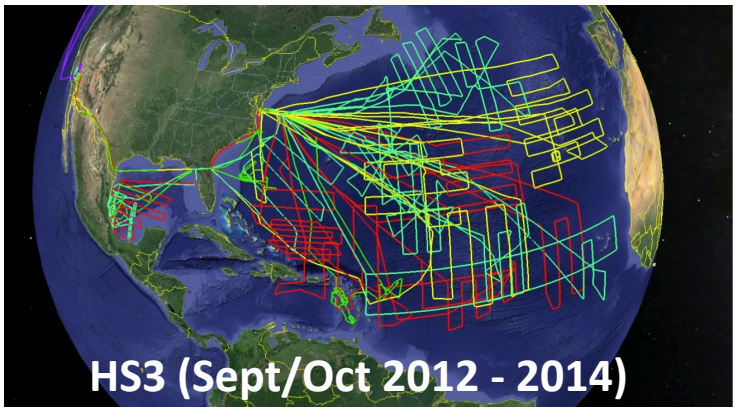


Hurricane and Severe Storm Sentinel (HS3)



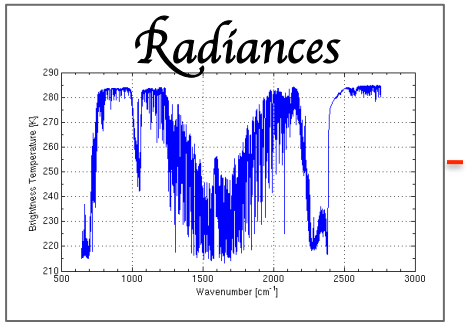






STAR JPSS 2016 Annual Science Team Meeting, 8-12 August 2016, College Park MD.

"Dual-Regression" Retrieval Algorithm* Overview



Global clear soundings

Radiances (clear FM)

Clear-trained regression coefficients

Global cloudy soundings

Radiances (cloudy FM)
Cloud height classes

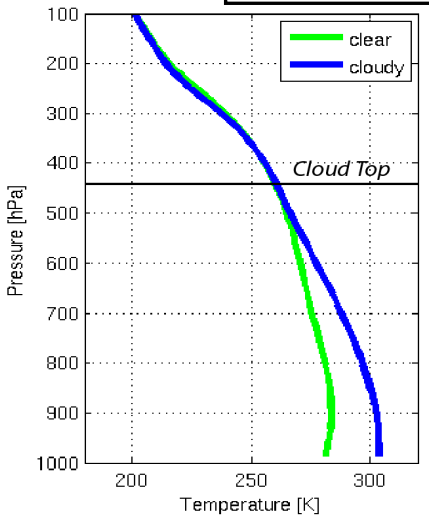
Cloud-trained regression coefficients

Theoretical Statistics

Radiance Observations

Clear-trained EOF regression retrieval

Cloud-trained EOF regression retrieval



Cloud Top Altitude
Level where $T_{cloudy} > T_{clear}$ for $p > p_{cld}$

Final Profile
Clear-trained above and cloud-trained Cloud Top

Temperature, Humidity and Ozone profiles, Surface and Cloud parameter at single FOV (0-2-km) resolution

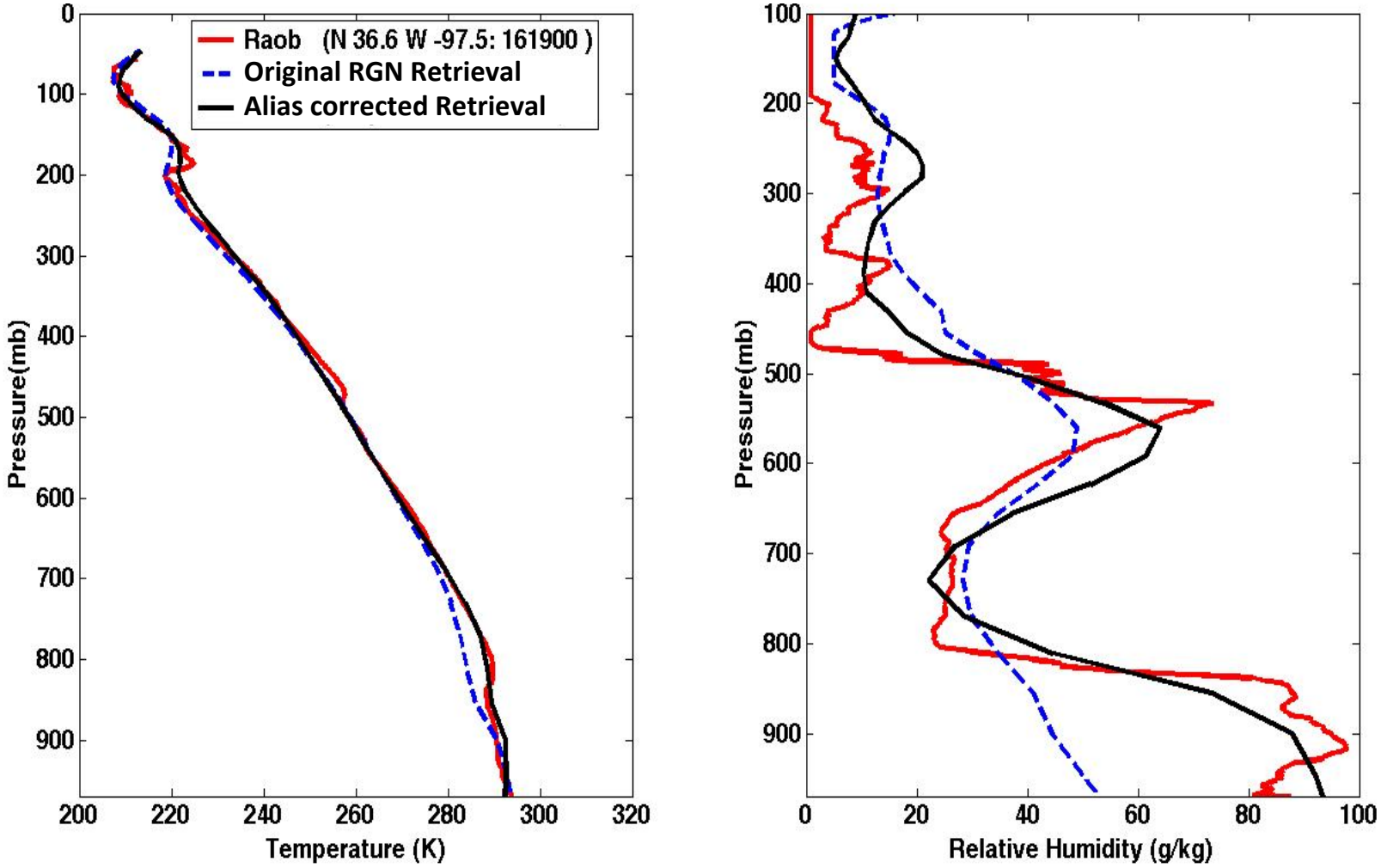
* Smith, W. L., E. Weisz, S. Kirev, D. K. Zhou, Z. Li, and E. E. Borbas (2012), Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. *J. Appl. Meteor. Clim., 51*, Issue 8, 1455-1476.

Physical Correction Using Forecast Model Profile

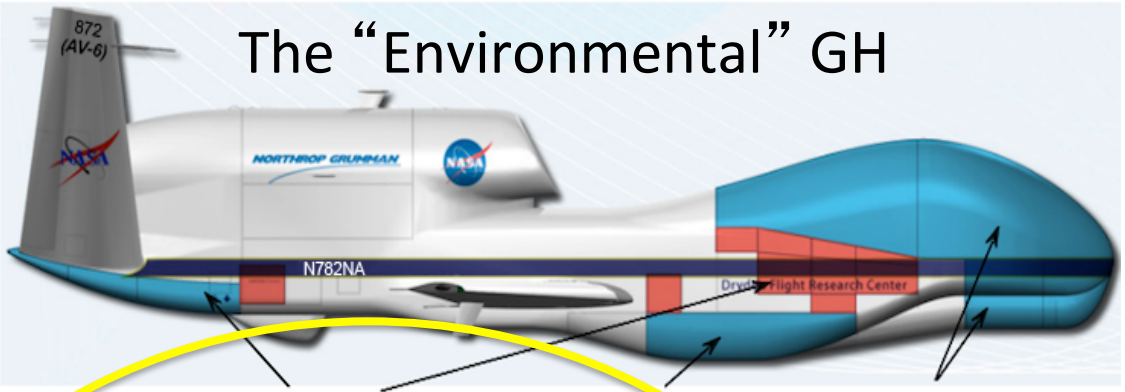
Problem: DR method uses a global statistical training data set. Imperfect skill, due to lack of vertical resolution in radiances leads to a vertical aliasing error.

Solution: Calculate radiance spectrum from forecast profile (FP) and perform DR retrieval using simulated forecast radiances.

Vertical Alias = Forecast Simulated Profile – Forecast Profile



The "Environmental" GH



Airborne Vertical Atmospheric Profiling System (AVAPS)

89 Dropsondes / flight

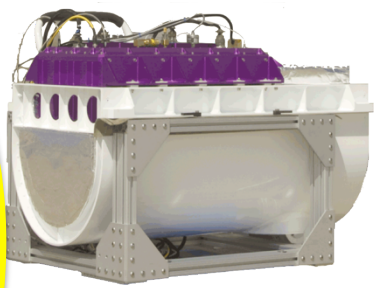
Temperature, Pressure, wind, humidity vertical profiles

Scanning High Resolution Infrared Sounder (S-HIS)

Upwelling thermal radiation at high spectral resolution between 3.3 and 18 microns.

Temperature, water vapor vertical profiles

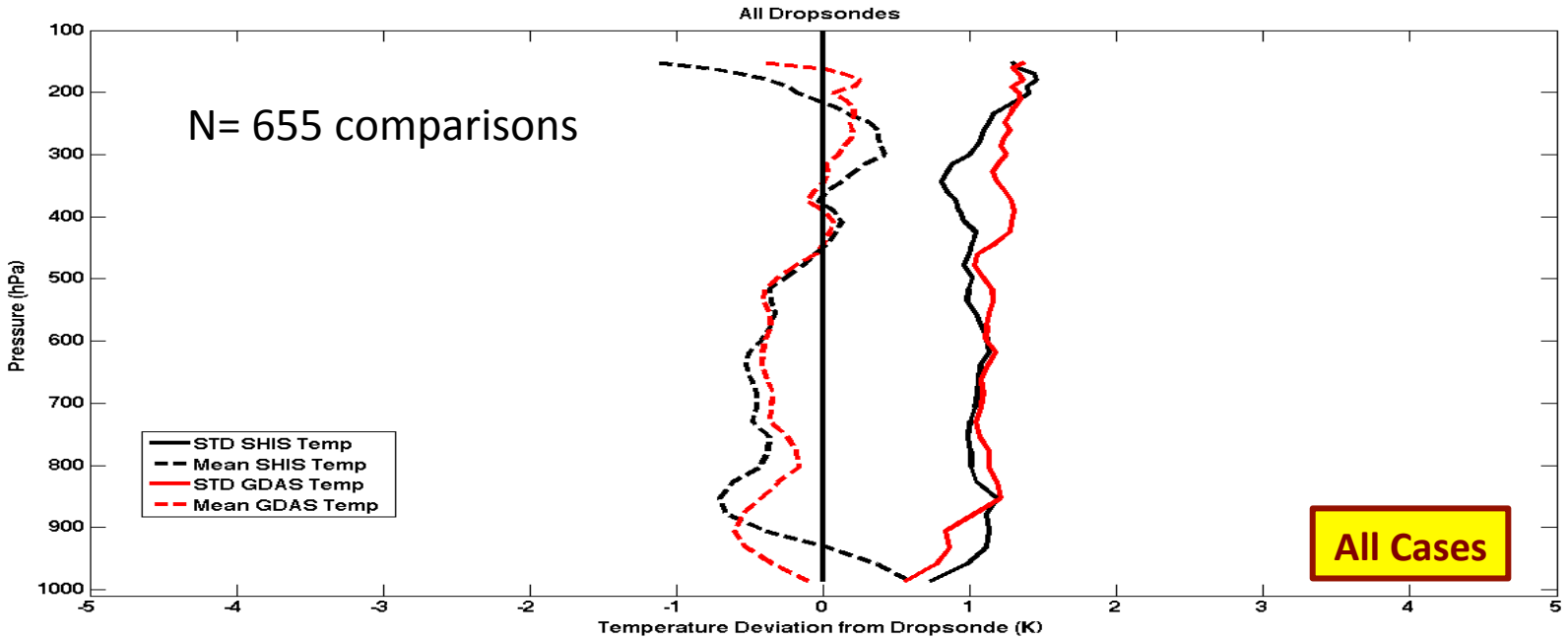
Cloud Physics Lidar (CPL)

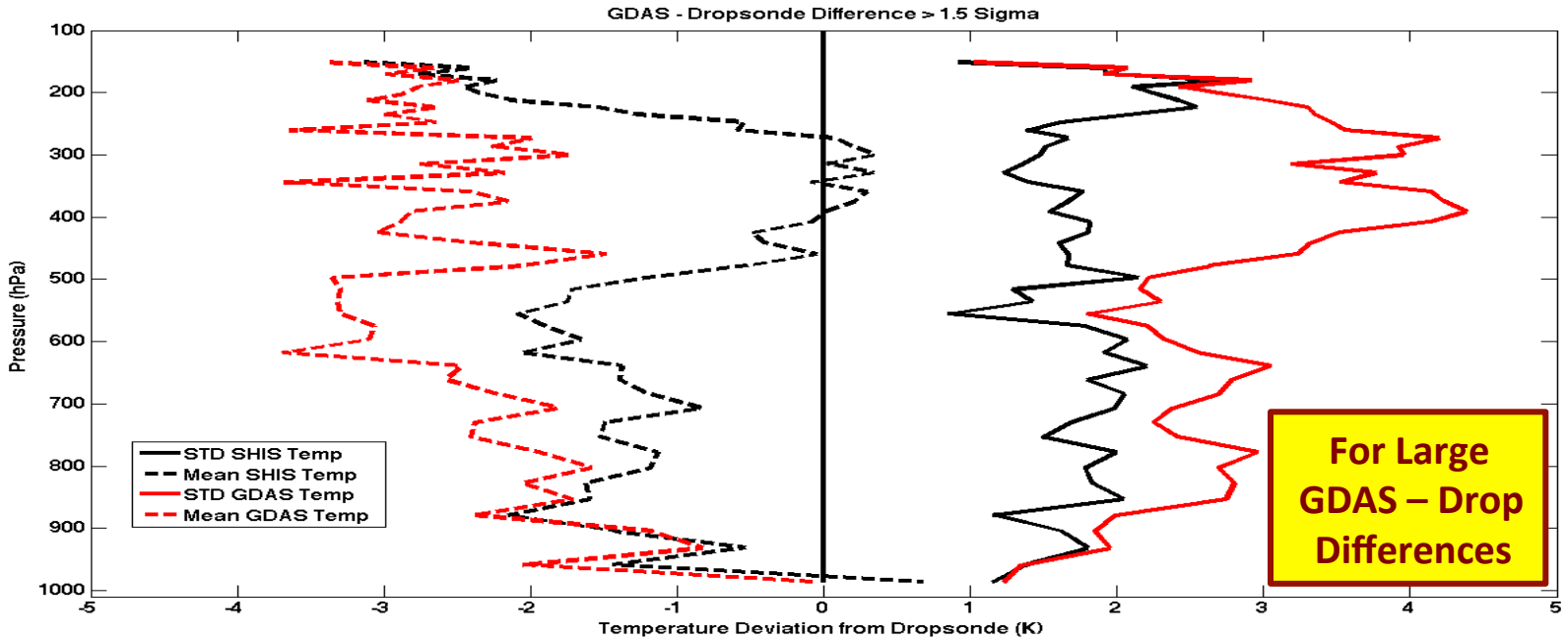


532/1064 nm Lidar Reflection

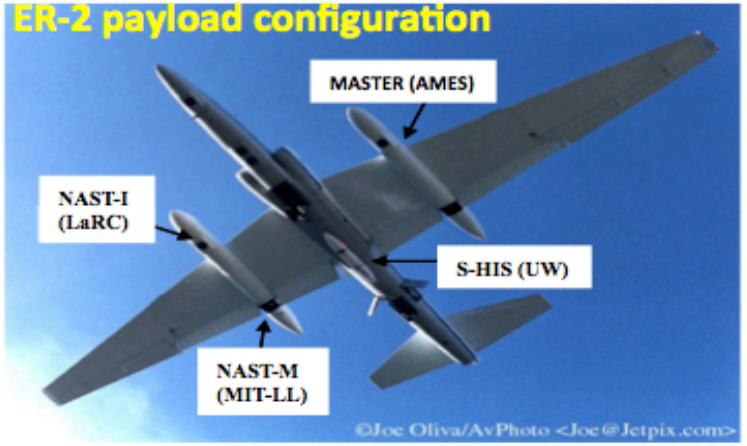
Cloud structure and depth

DA S-HIS Vs. Dropsonde Statistics (HS3-2014)





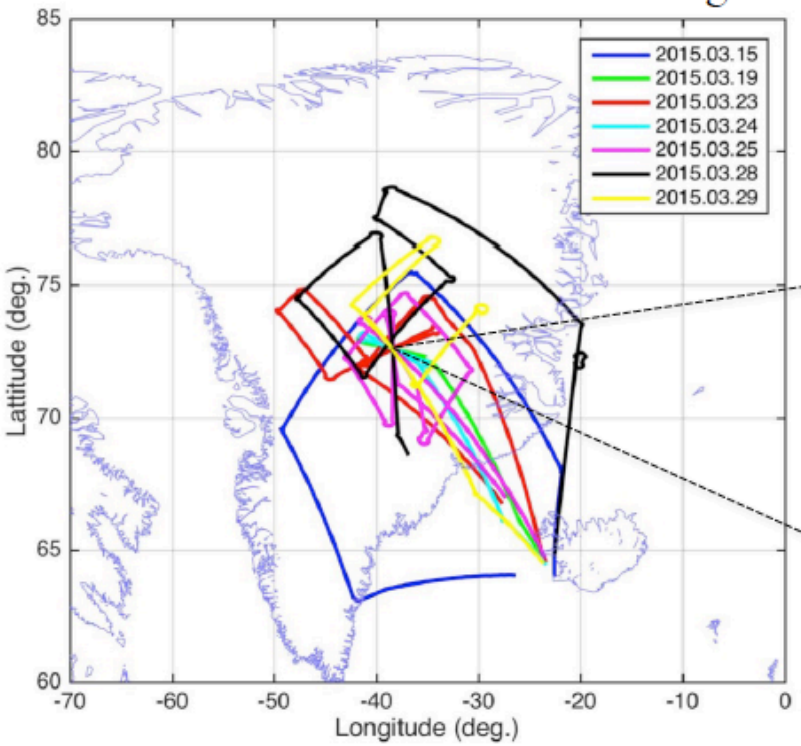
Second Suomi-NPP Calibration/Validation Experiment



ER-2 Mission Science Flights (over Greenland):

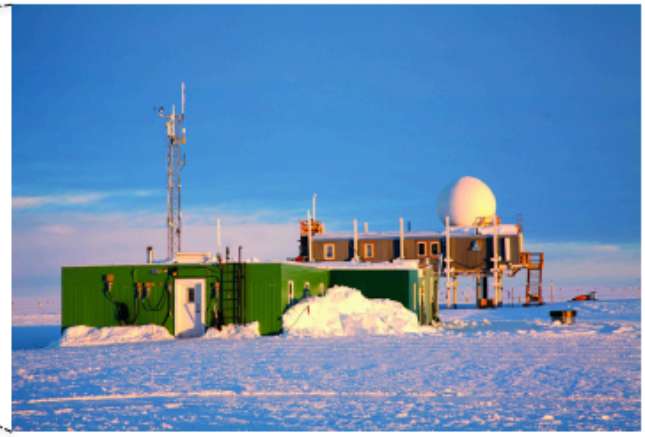
Date:	3/15/15	3/19/15	3/23/15	3/24/15	3/25/15	3/28/15	3/29/15
Duration (hrs.):	5.9	4.6	6.3	4.2	7.5	7.4	6.1
Summit Overpass:	0	4	2	2	4	2	2

Second Suomi NPP Cal/Val Science Flight Tracks



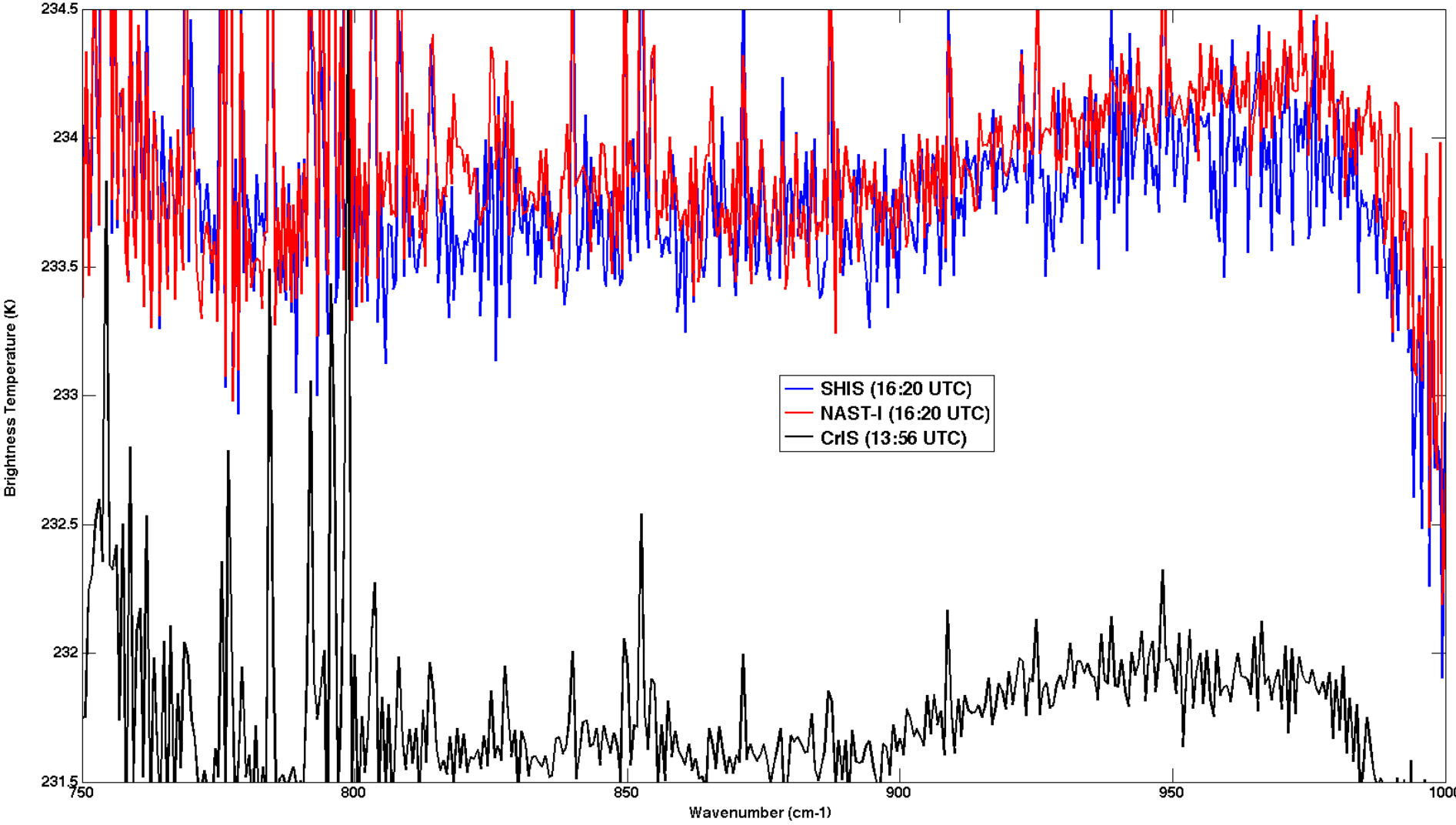
Ground Validation Site:

Summit Station (72°36′ North, 38°25′ West), a research platform at the summit of the Greenland ice sheet.

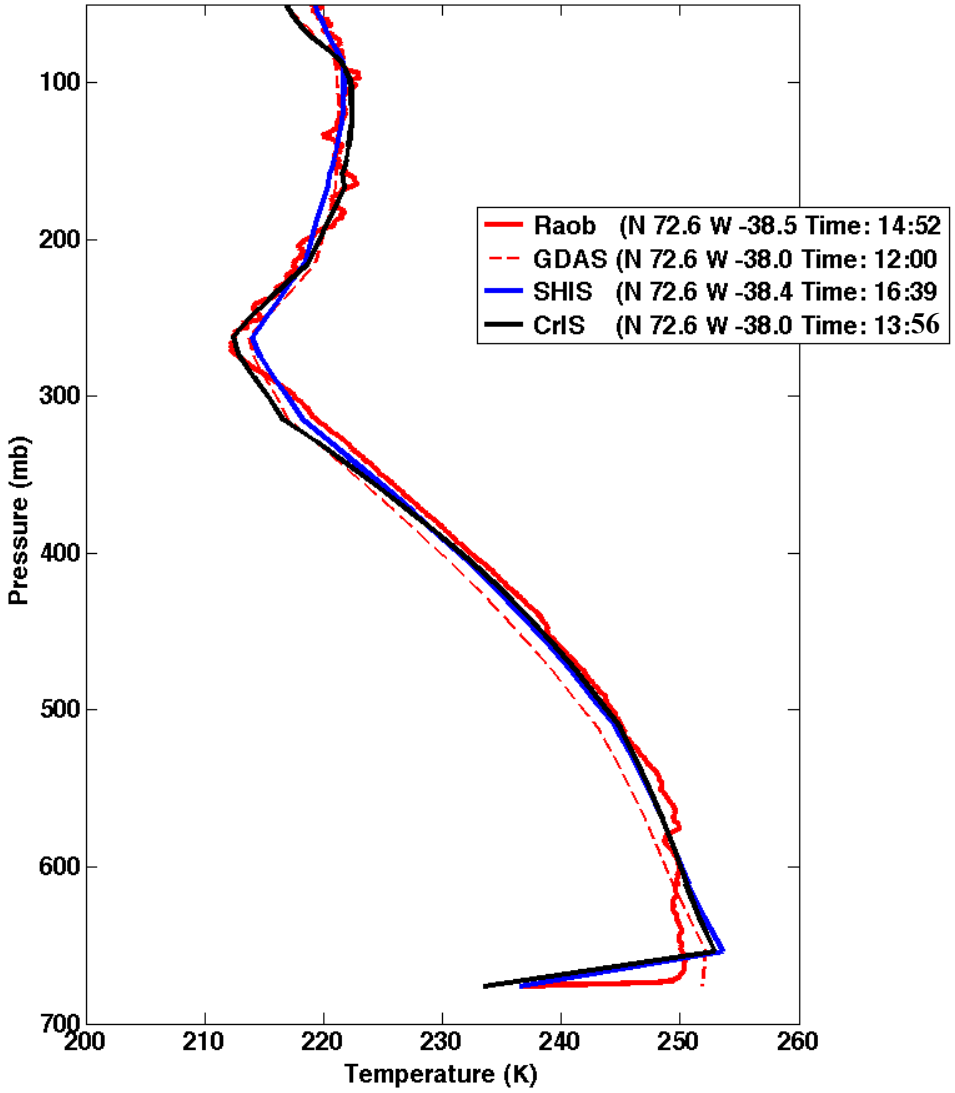


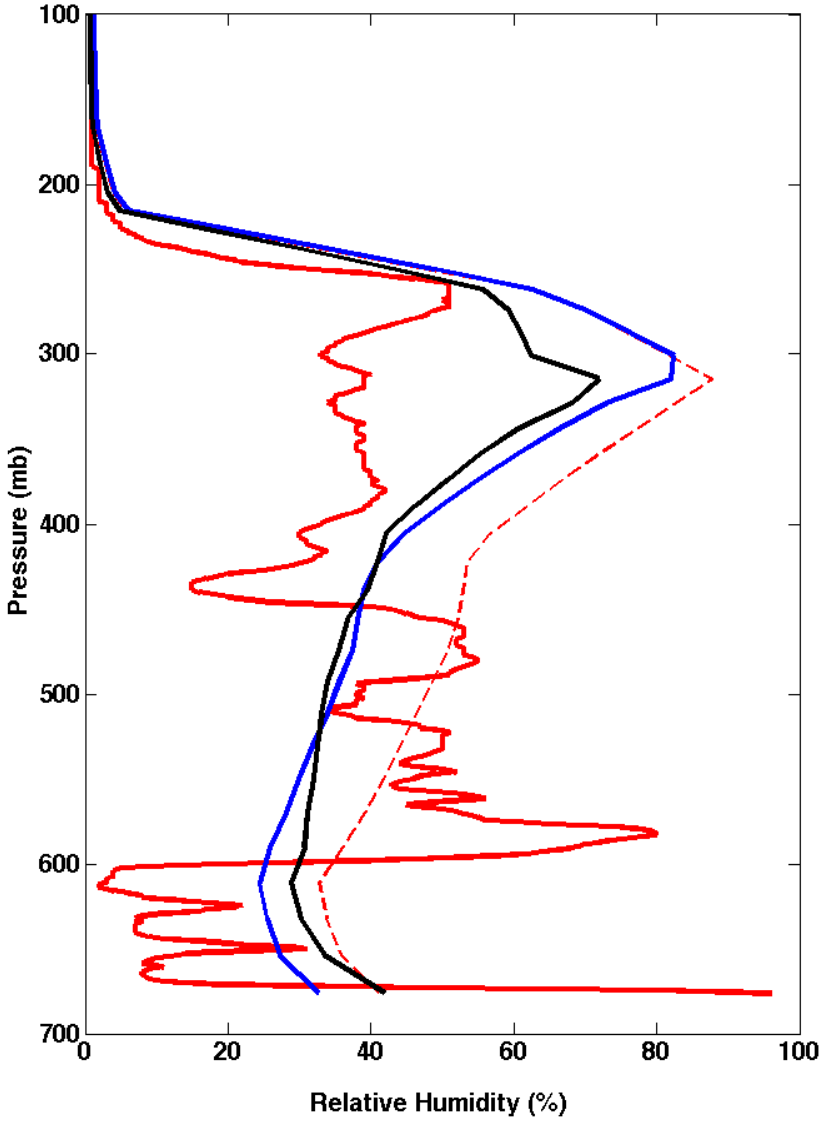
March 19, 2015 Radiance Comparison

Note: 3-Hr time difference between ER-2 and SNPP Radiance Observations

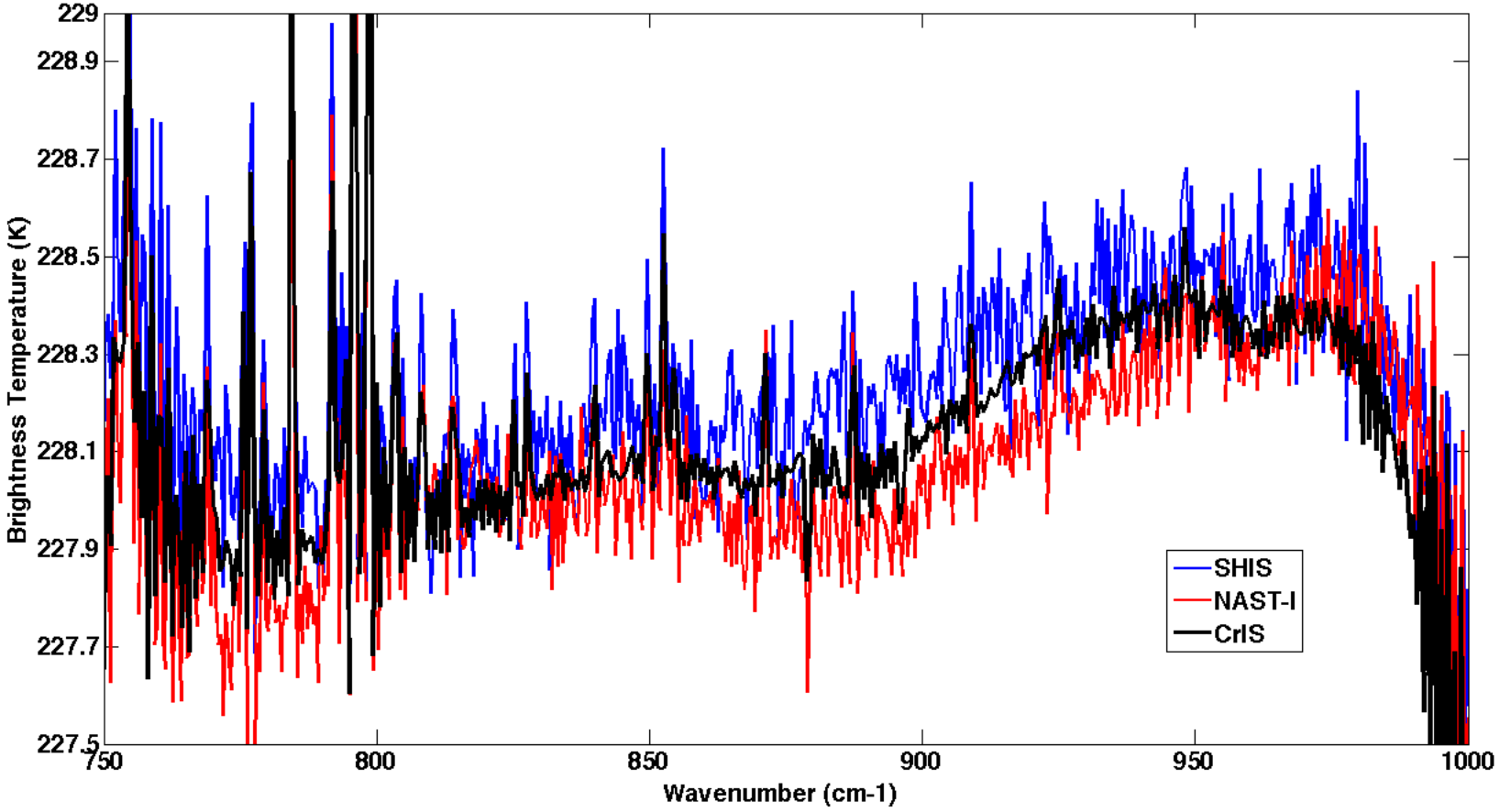


Raob Vs.SHIS & CrIS DR Retrieval Summit Greenland (March 19, 2015)

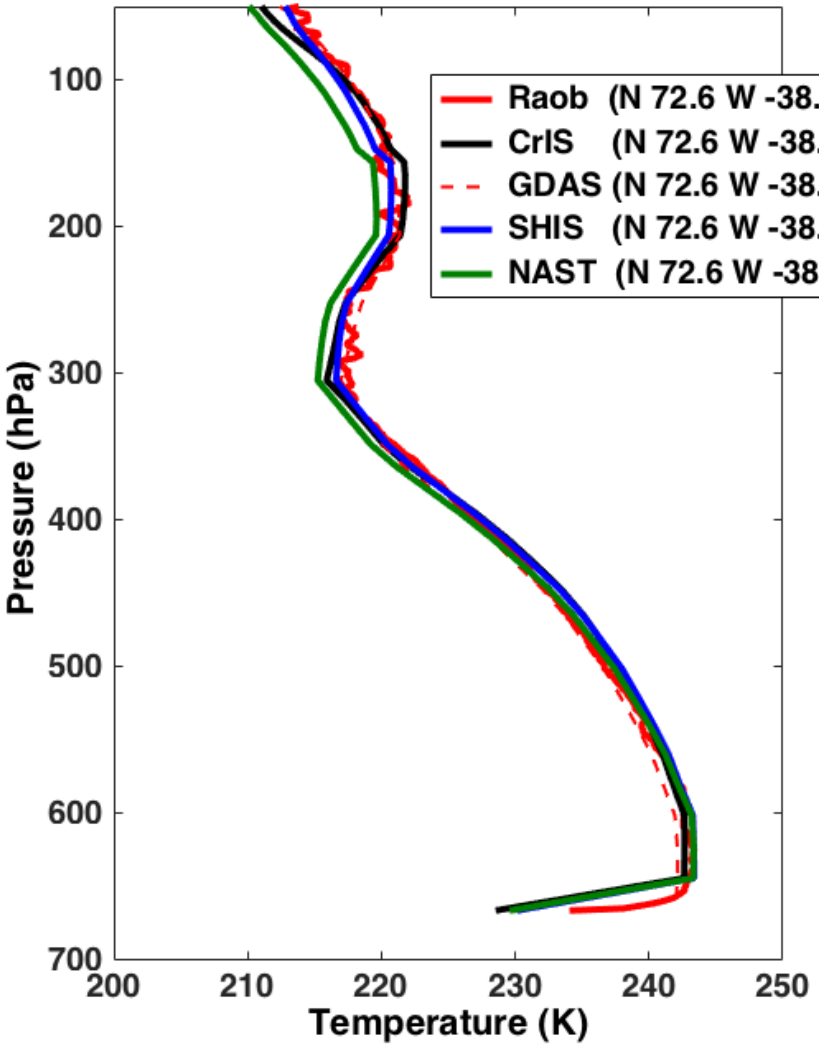


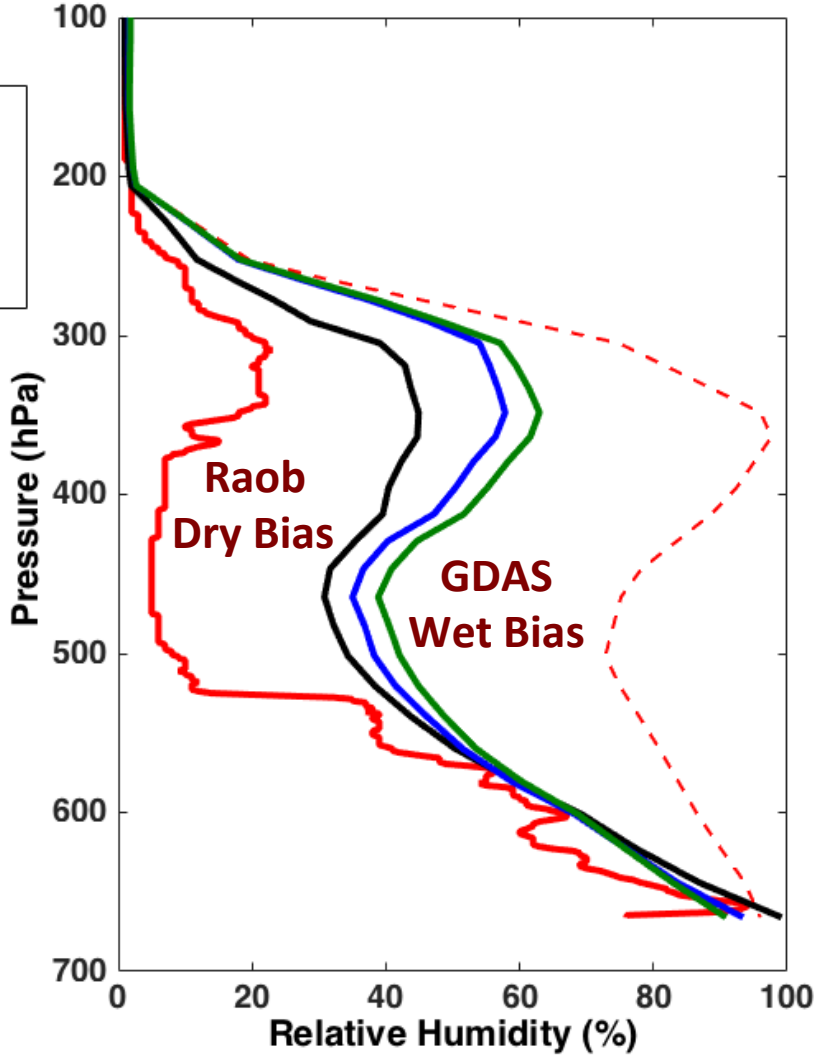


March 23, 2015 Radiance Comparison



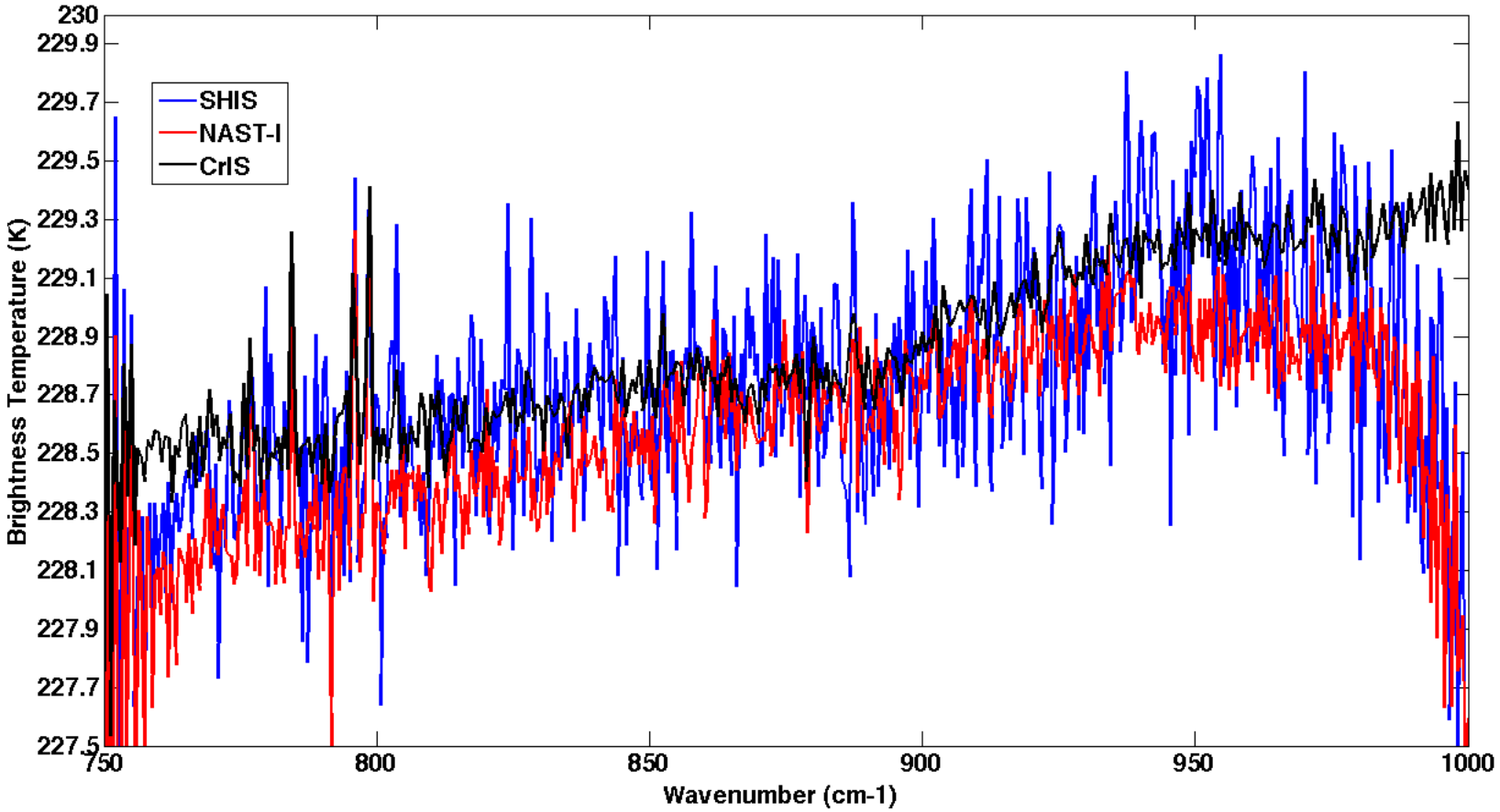
Radiosonde Vs. DR Retrievals*
Summit Greenland (March 23, 2015)



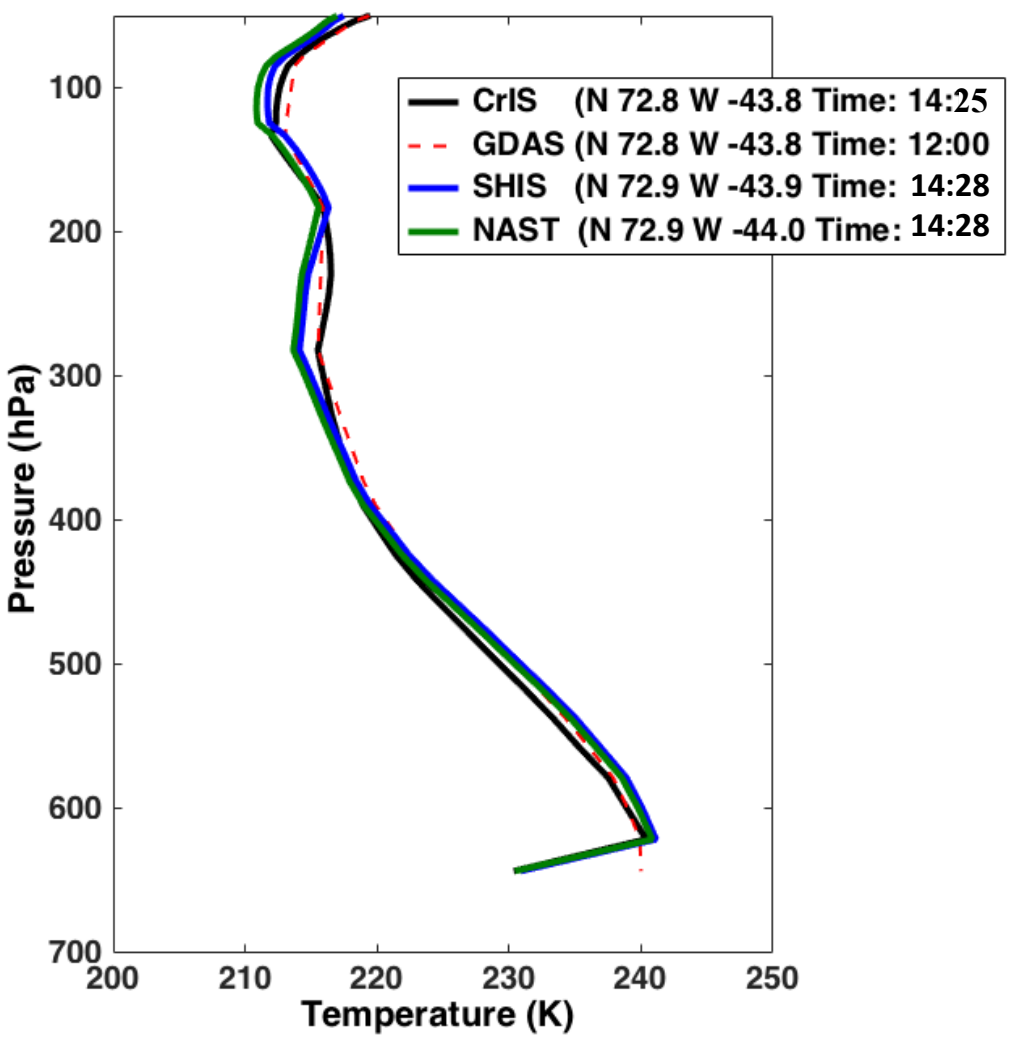


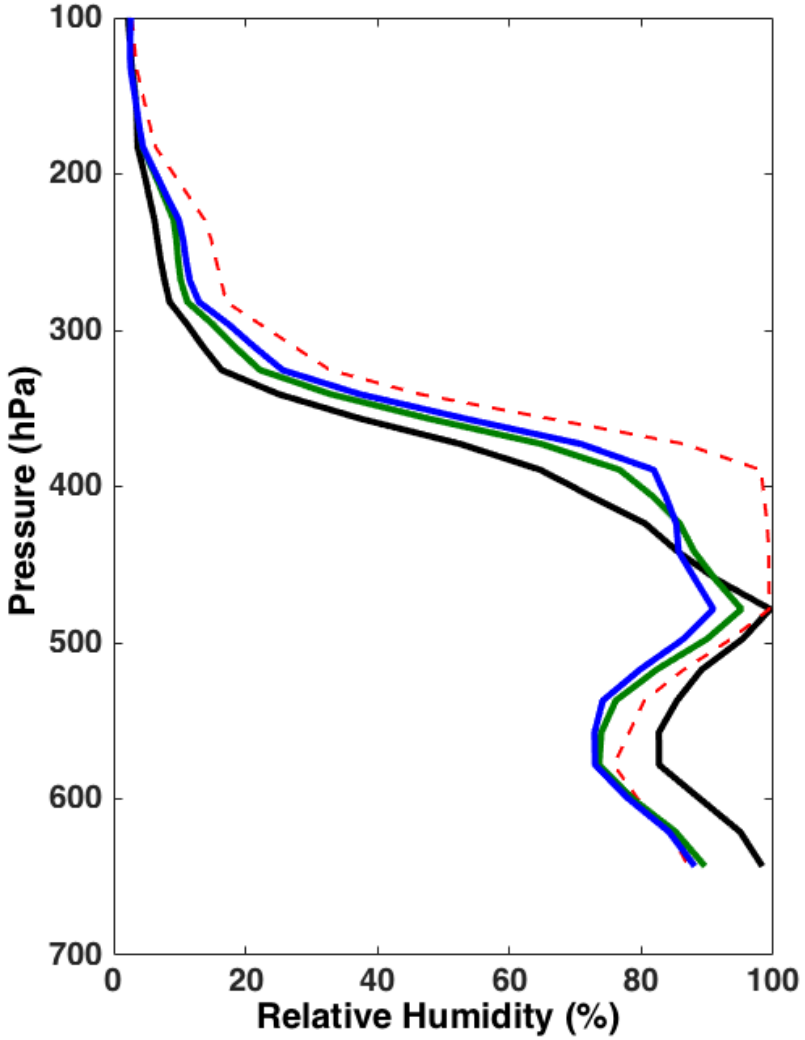
* 25-km Average Retrieval Closest to the Summit Radiosonde Location

March 28, 2015 Radiance Comparison

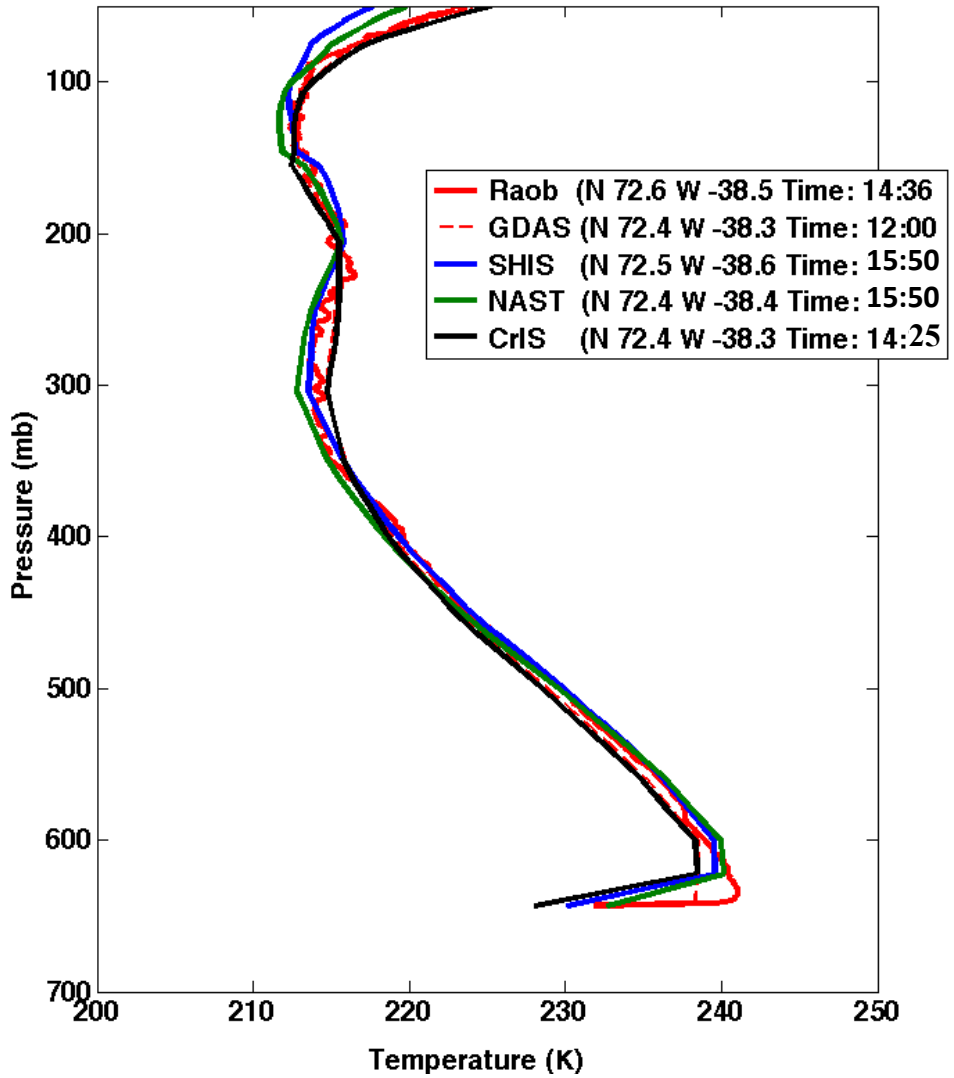


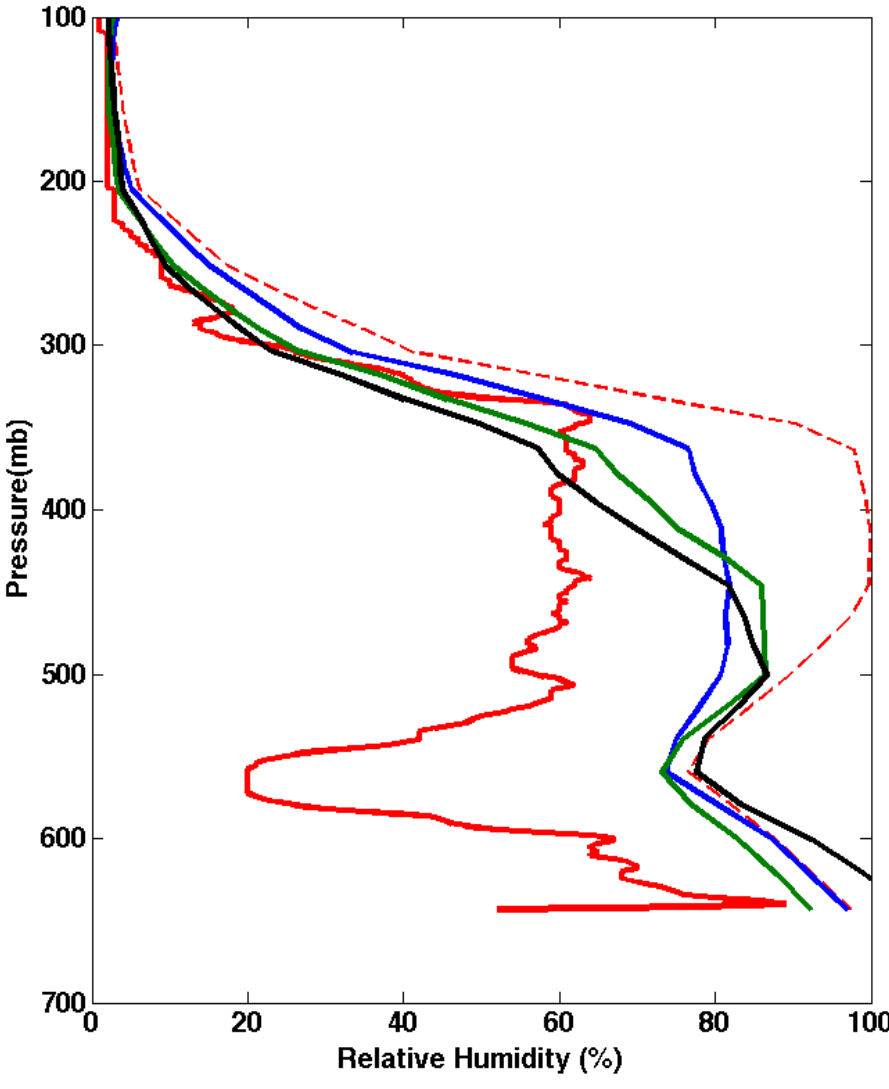
SHIS & NAST Vs. CrIS DR Retrieval Greenland (March 28, 2015)





Raob Vs.SHIS & NAST & CrIS DR Retrieval Summit Greenland (March 28, 2015)

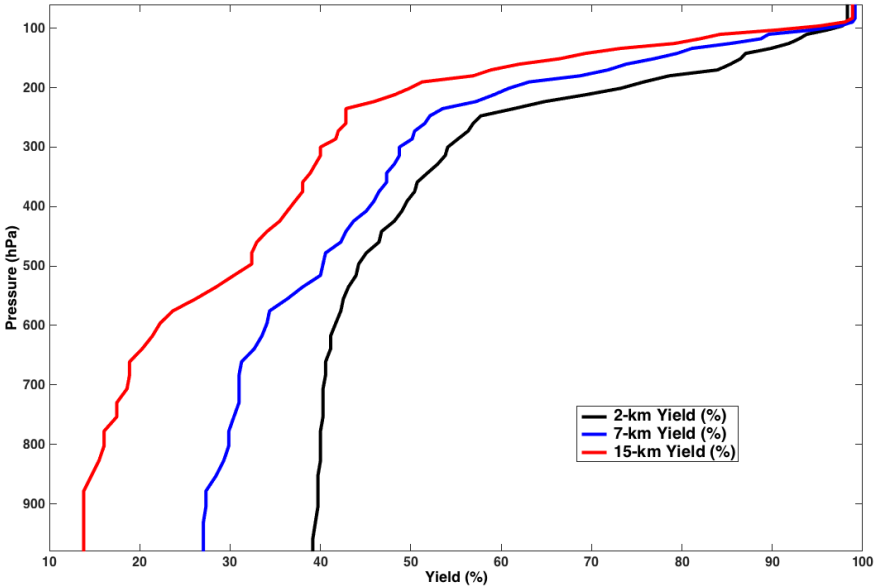




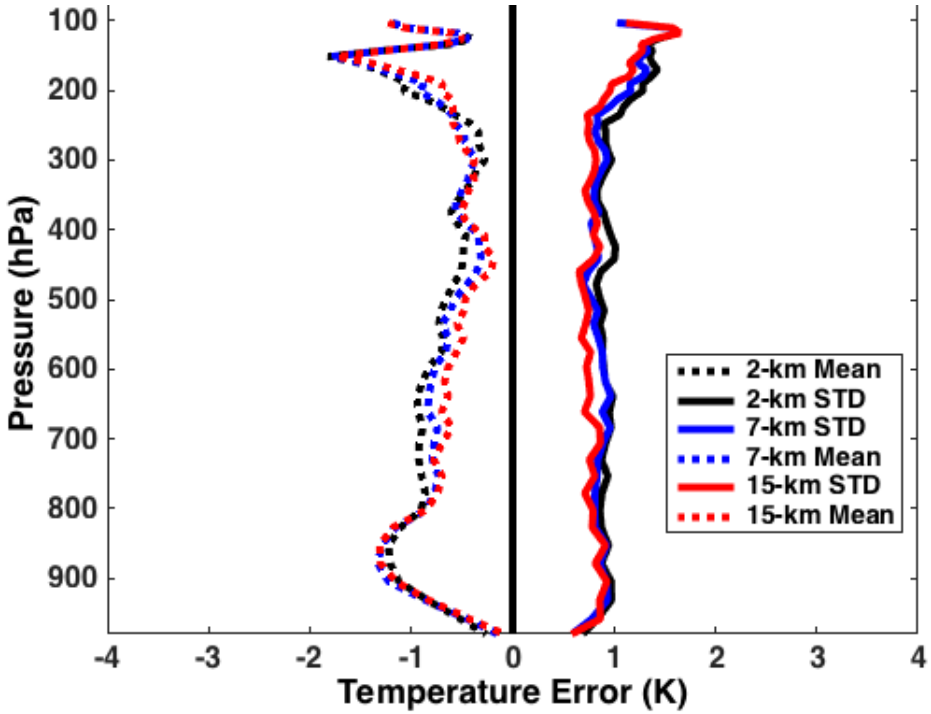
CrIS Sounding Dependence on FOV Size – Retrieval Yield and Accuracy

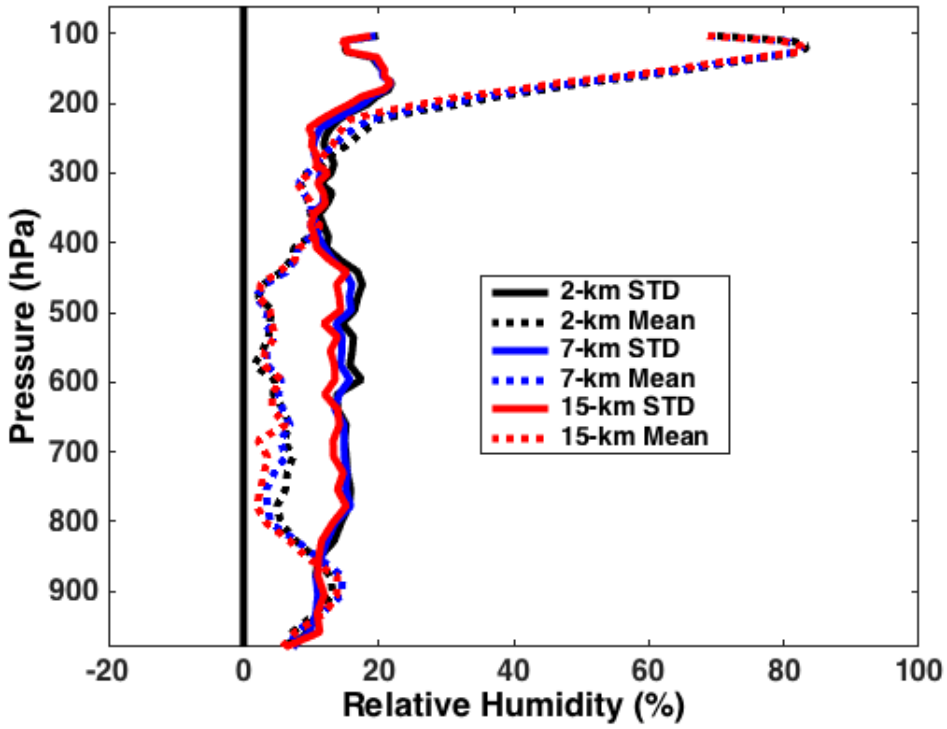
- **Future JPSS CrIS sounding yield can be greatly improved by reducing the Field-Of-View (FOV) size of the CrIS instrument.**
- **This improvement is demonstrated using NASA Global Hawk HS3 SHIS retrievals and simultaneous Dropsonde profiles.**
- **CrIS retrievals are created by averaging full resolution (1-2 km) SHIS retrievals over assumed CrIS FOV sizes (2-km, 7-km, 15-km).**
  - ***A single CrIS FOV sounding is considered to be missing below the highest cloud level of any SHIS retrieval being averaged, the profile in the clear air above the cloud is retained.***
  - ***The CrIS 50-km Field-of-Regard (FOR) average "CrIS" sounding is then formed and yield (%) and Mean and Random Error statistics are obtained by comparisons with simultaneous dropsonde profiles.***

Retrieval Accuracy and Yield Dependence on FOV Size



Results show that if the FOV density is increased with decreasing FOV size in order to maintain FOV contiguity, the FOR (e.g. 50-km area) sounding yield is greatly increased in cloudy sky conditions without increasing sounding noise level. This result is a result of the DR linear retrieval method which outputs clear-air retrievals above cloud-top level (i.e., all clear air radiance information within cloudy FOVs is used to obtain the average FOR profile).





Summary & Conclusions

- **Global Hawk S-HIS and dropsonde data have been used to validate the accuracy of the Dual Regression (DR) retrieval algorithm**
  - Temperature/humidity accuracy ≈ 1 K / 10 %
  - Errors much smaller than GDAS analysis errors when GDAS differs significantly from the dropsonde observations
- **Radiosonde observations and NASA ER-2 aircraft NAST-I and S-HIS observations utilized with the DR regression retrieval algorithm to validate SNPP CrIS sounding retrievals**
  - CrIS profile retrieval errors shown to be within the ≈ 1 K / 10% uncertainty of the DR retrieval error associated with airborne hyperspectral sounding retrievals and with radiosonde observations
- **If the FOV size of future CrIS instruments is reduced while maintaining FOV contiguity, the yield of sounding profiles can be greatly increased without sacrificing sounding accuracy**