

Ultra High Spectral Resolution Satellite Remote Sounding - Results from Aircraft and Satellite Measurements

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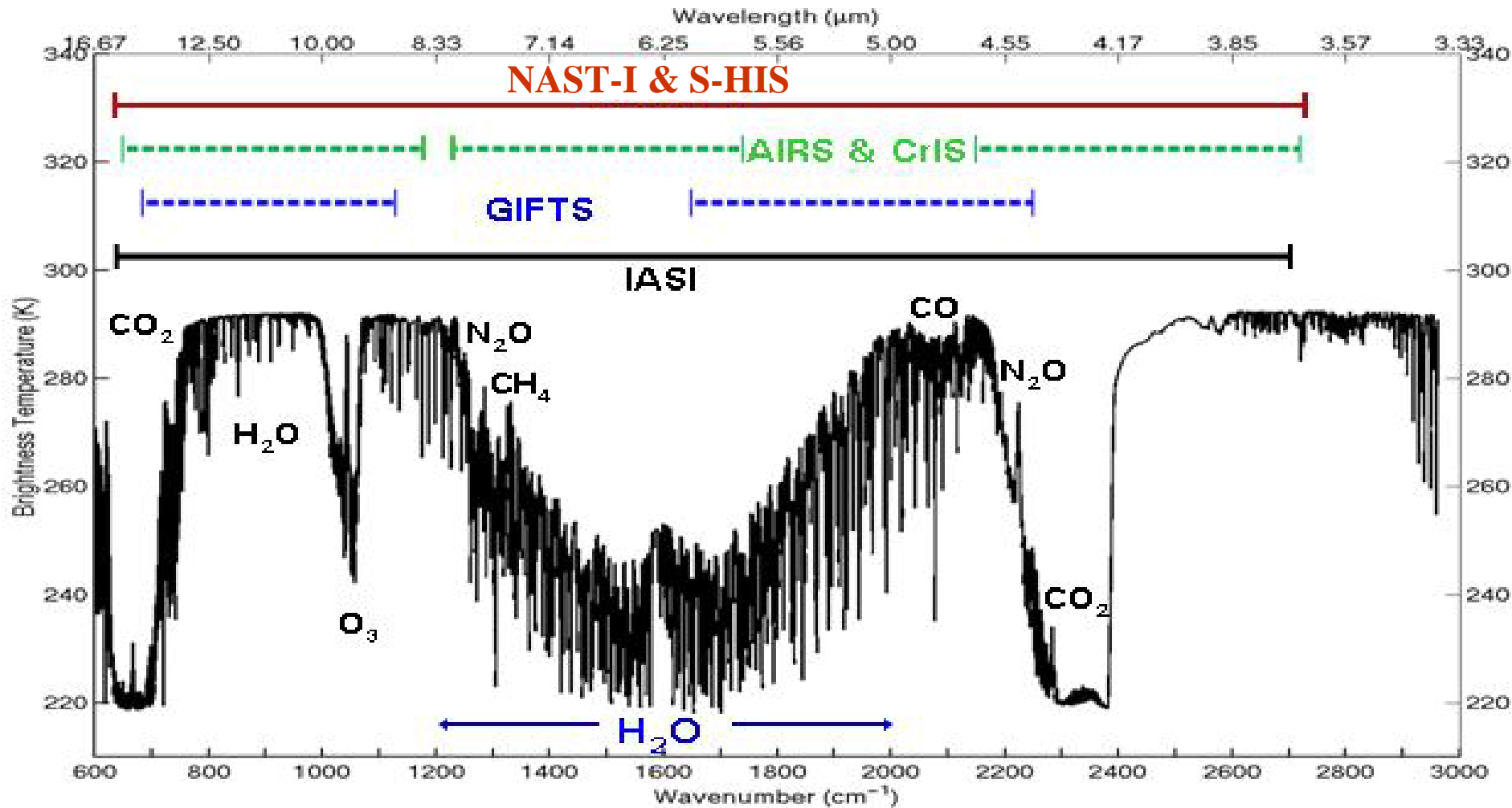
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²University of Wisconsin-Madison

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Ultraspectral Atmospheric Sounders



- Broad Spectral Coverage
- High Spectral Resolution
- Thousands of Spectral Channels
- High Information Content

Today's Ultraspectral Resolution IR Sounding Capability



AIRS

ER-2



NAST/SHIS

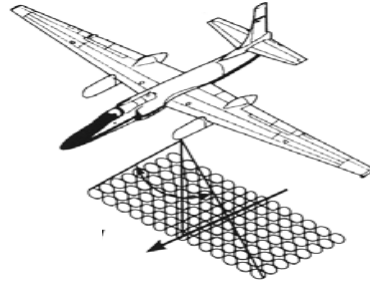


Proteus



NAST and AIRS Characteristics

Spatial Resolution
130m/km flight alt.
(2.6 km from 20km)
Swath Width
2 km /km flight alt.
(40 km from 20 km)



Instrument Characteristics

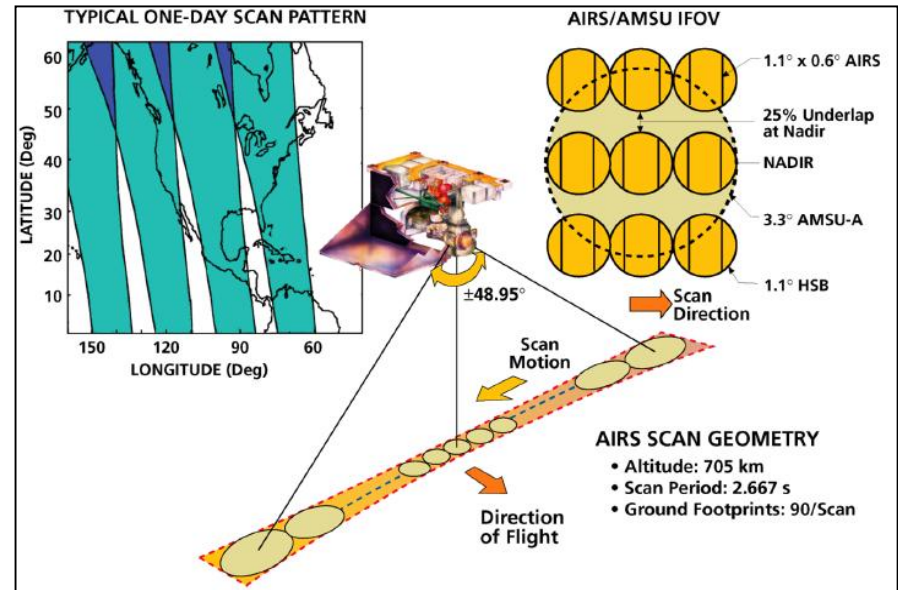
- infrared Michelson interferometer (~9000 spectral channels)
3.5 – 16 microns @ 0.25 cm^{-1}

Aircraft Accommodation

- ER-2 Super pod & Proteus Underbelly pod

Radiative Measurement Capability

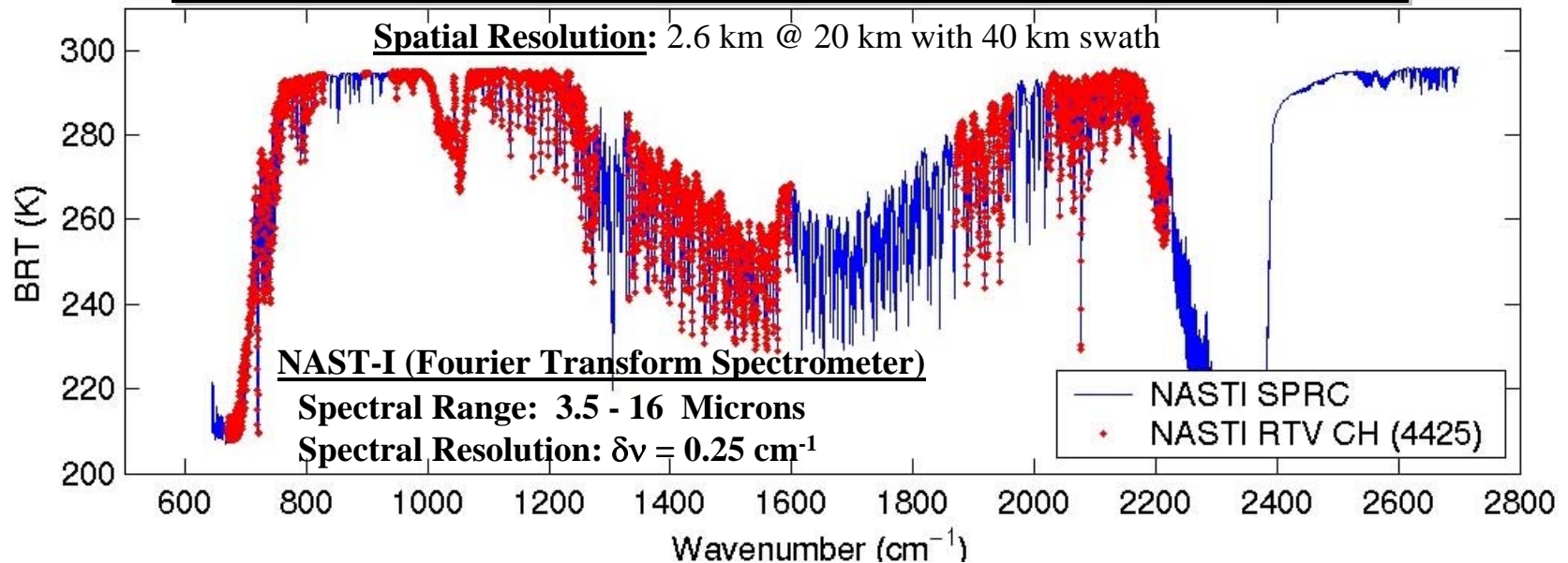
- calibrated radiances with
< 0.5 K absolute accuracy, < 0.2 K precision



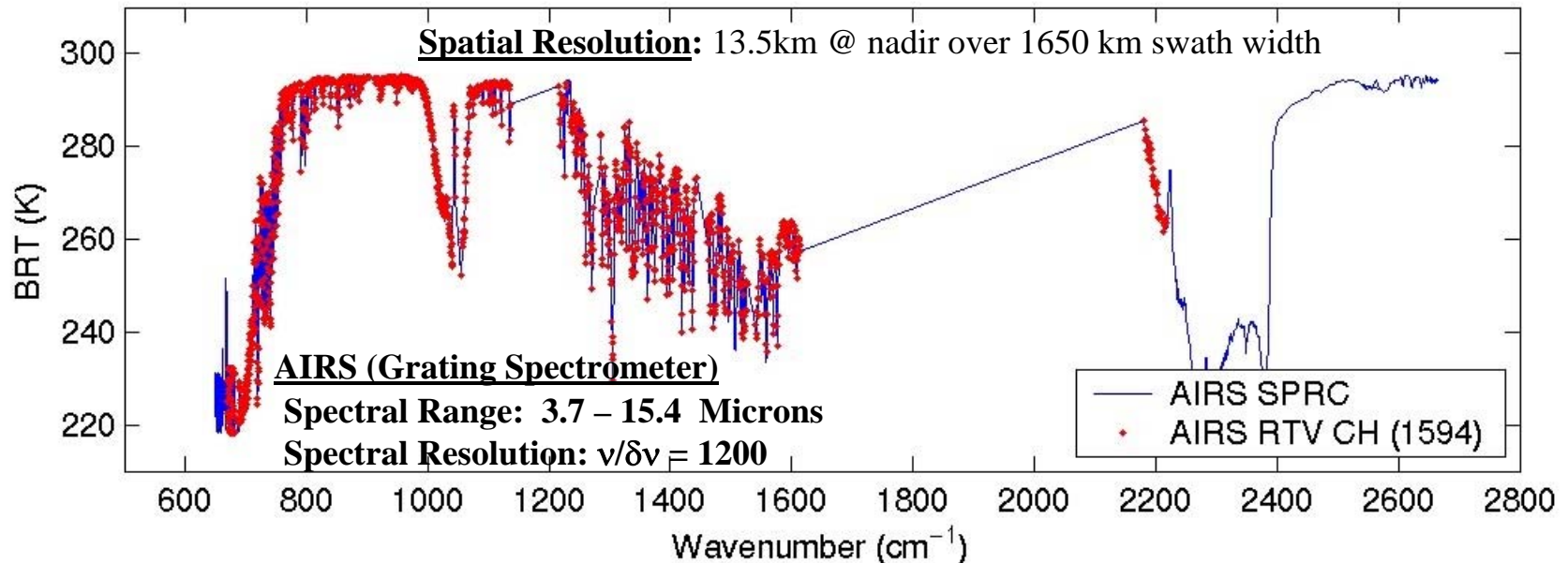
- The *NPOESS-I Aircraft Sounder Testbed – Interferometer* (NAST-I) consists of a 9000 spectral channel infrared interferometer ($600\text{-}2850 \text{ cm}^{-1}$) with a spectral resolution of 0.25 cm^{-1} . NAST-I spatially scan and provide a ground resolution of about 2.6 km and a swath width of approximately 40 km, from an aircraft altitude of 20 km.

- The *Aqua AIRS* instrument is a ~2500 spectral channel cooled grating spectrometer with a spectral resolving power of ~ 1200 ($0.5 - 2 \text{ cm}^{-1}$ spectral resolution) operating within the spectral range $650 - 2700 \text{ cm}^{-1}$. The spatial resolution of the AIRS is about 15 km, at nadir, and its cross track scan providing a swath width of approximately 1400 km.

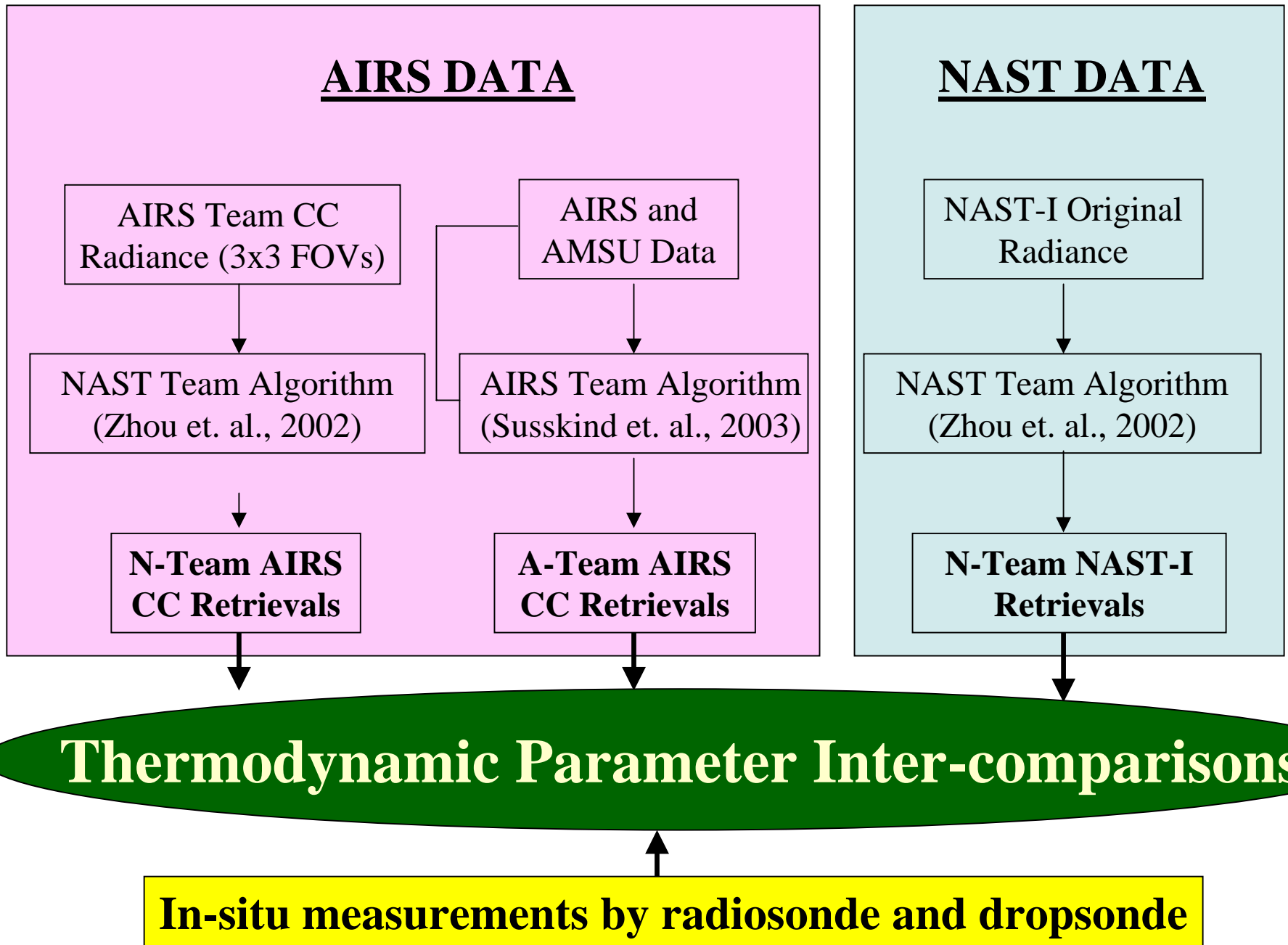
NAST-I & AIRS Spectral Characteristics



Quasi-continuous Measurements Over Broad Spectral Regions Enable High Vertical Resolution



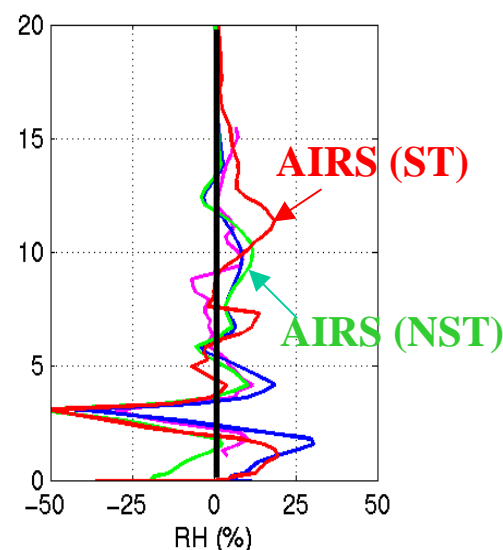
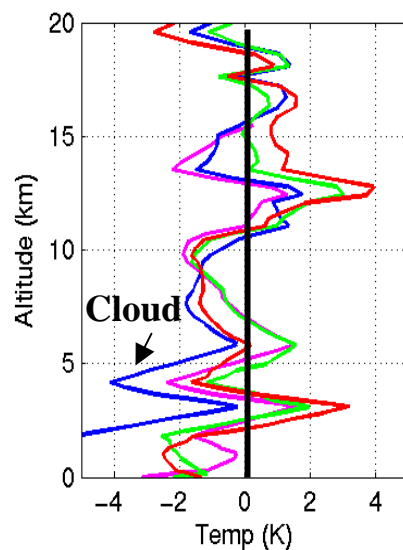
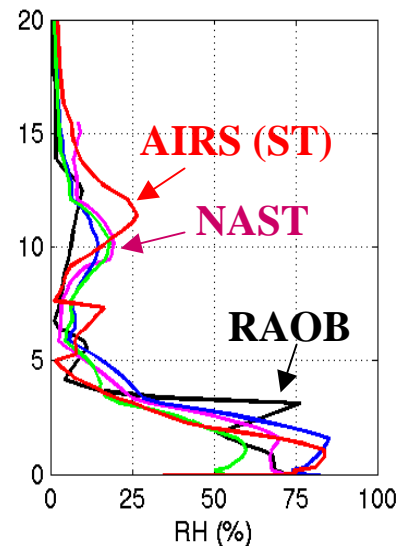
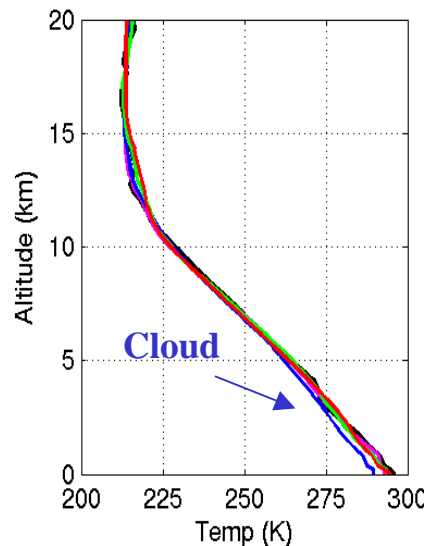
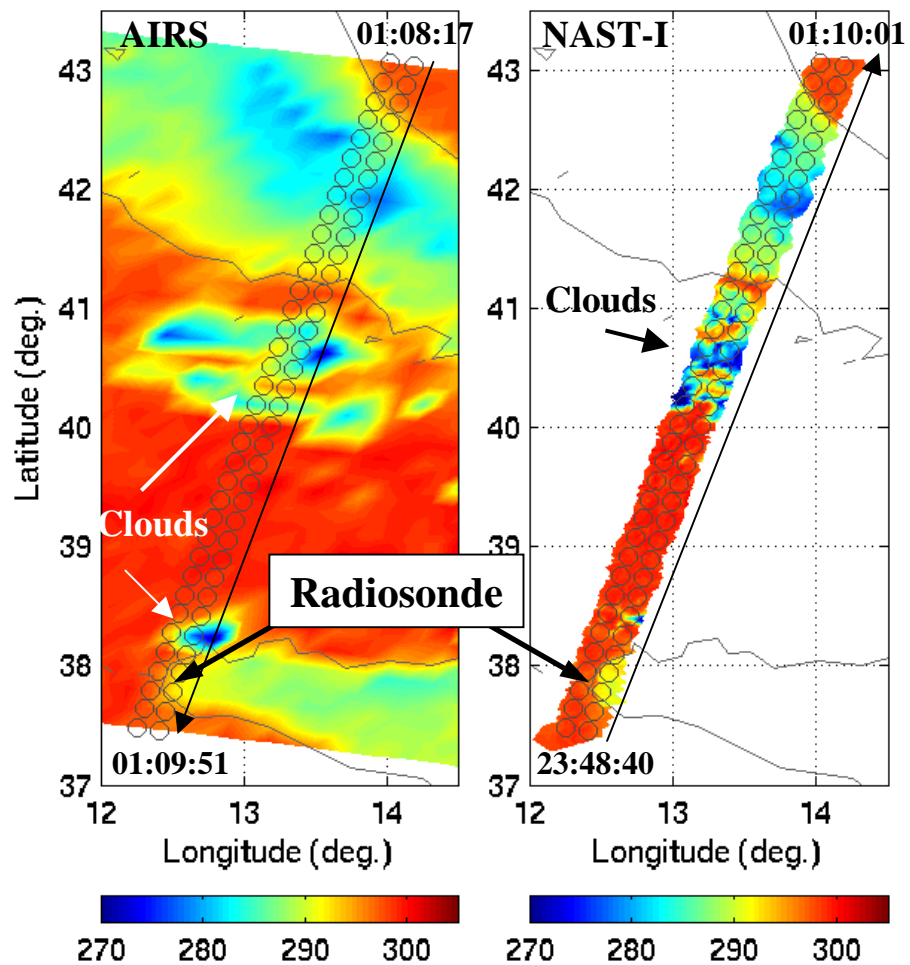
Data and Algorithms Used for Inter-Comparisons



Inter-Comparisons at Trapani/Birgi, Italy (04/09/08)

Trapani/Birgi (37.92N 12.5)

Retrieved Surface Skin Temperature

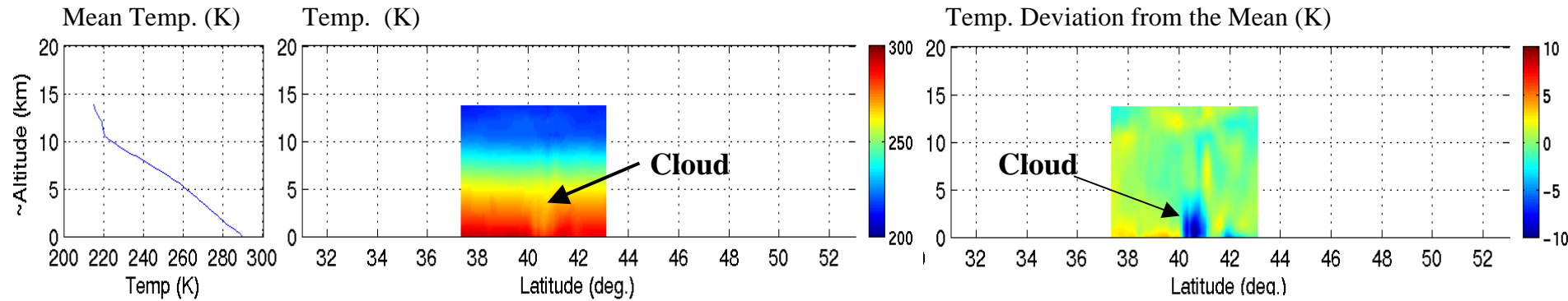


Deviation from RAOB

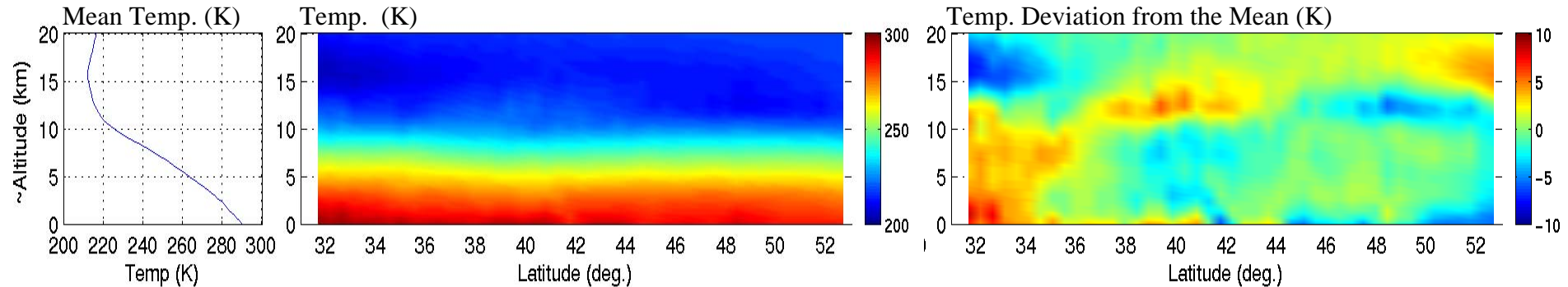
— Raob 23Z
 — N-team NAST 00Z
 — N-team AIRS 01Z
 — N-team CC AIRS 01Z
 — A-team AIRS 01Z

Temperature Cross Section Inter-Comparison (04/09/08)

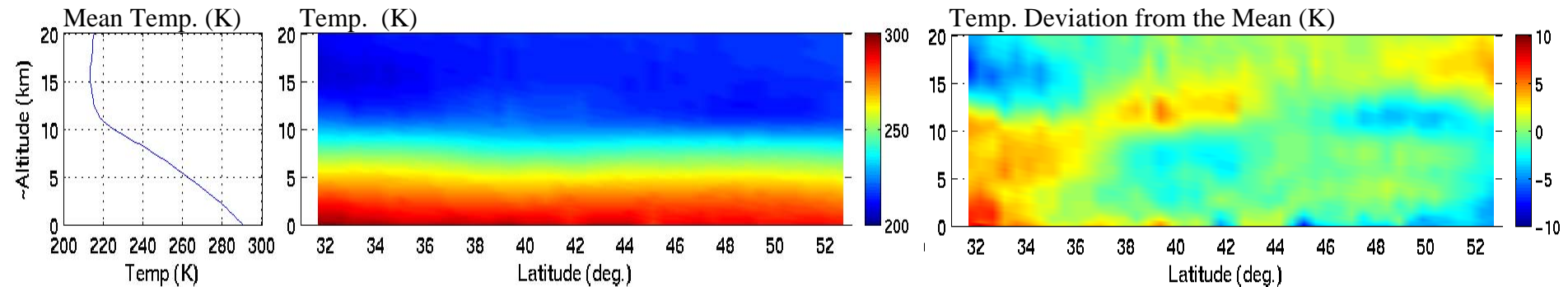
(1) NAST-Team NAST Retrieval



(2) NAST-Team AIRS Retrieval (CC)

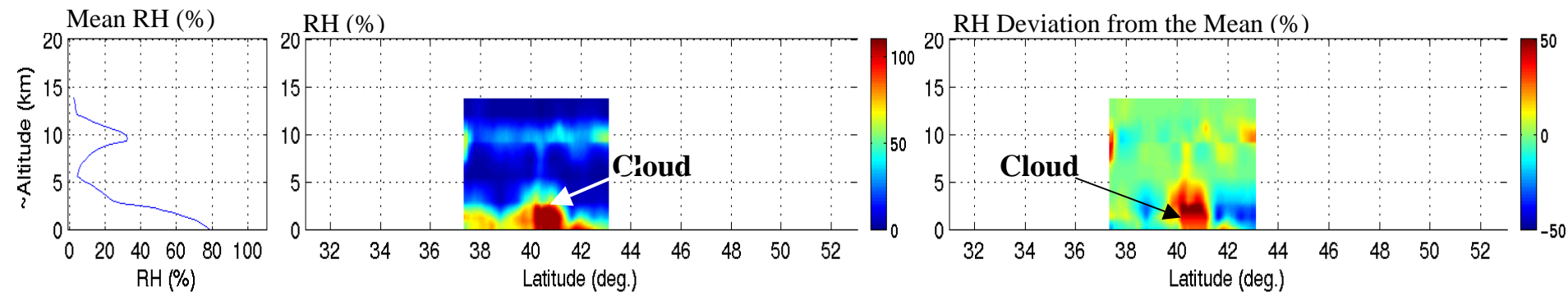


(3) AIRS-Team AIRS Retrieval (CC) ..ver. 4.0

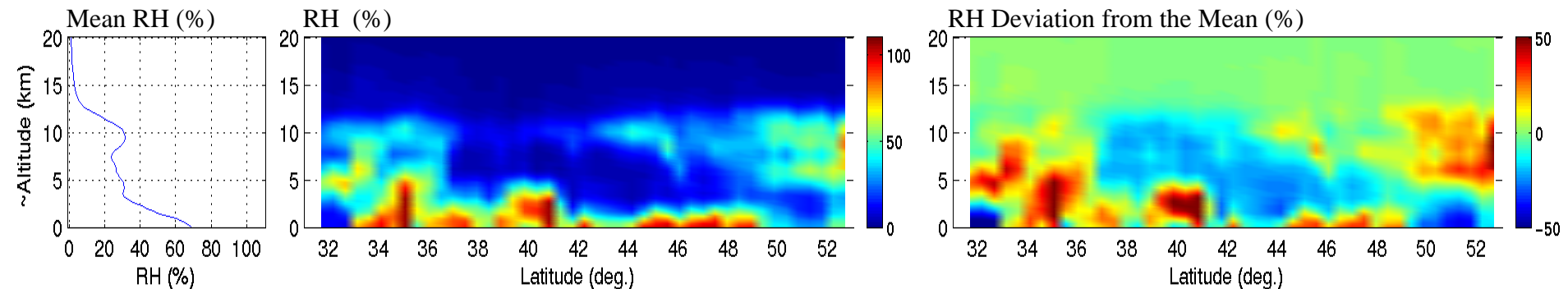


Moisture Cross Section Inter-Comparison (04/09/08)

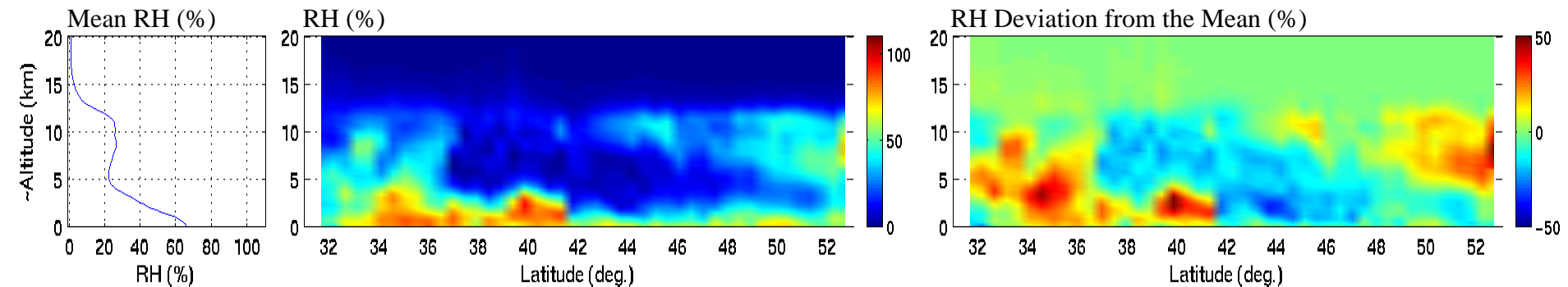
(1) NAST-Team NAST Retrieval



(2) NAST-Team Retrieval (CC)



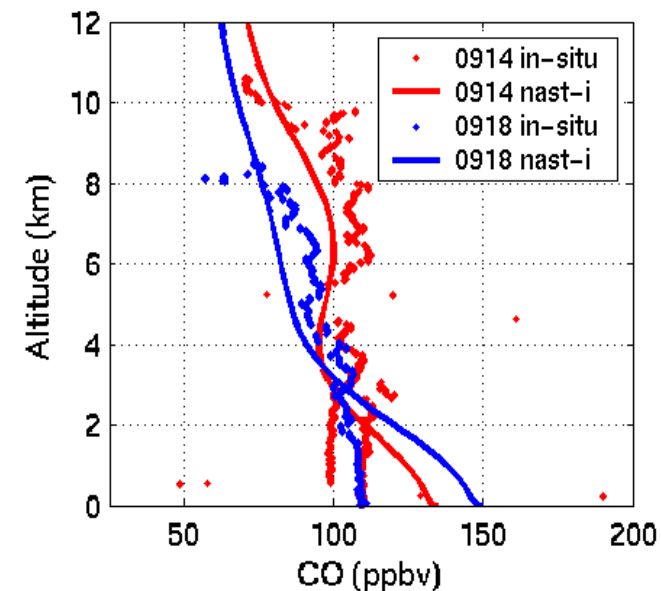
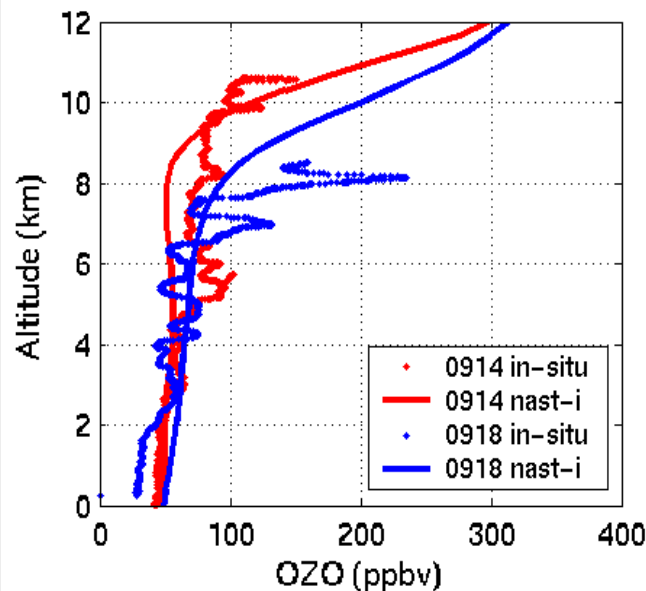
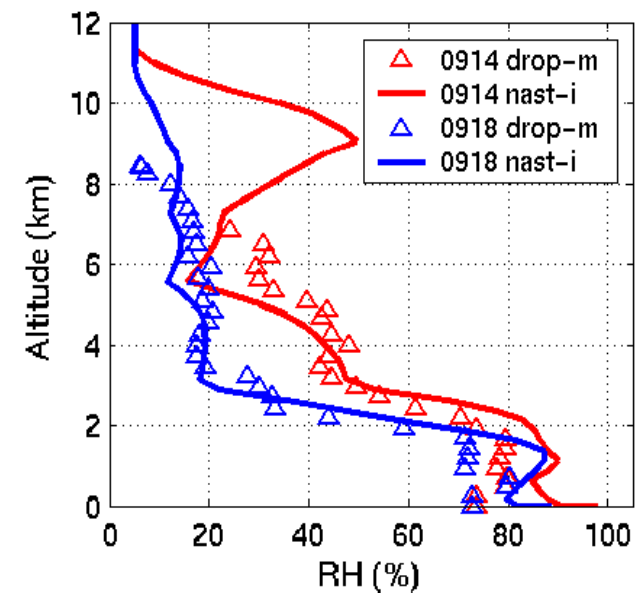
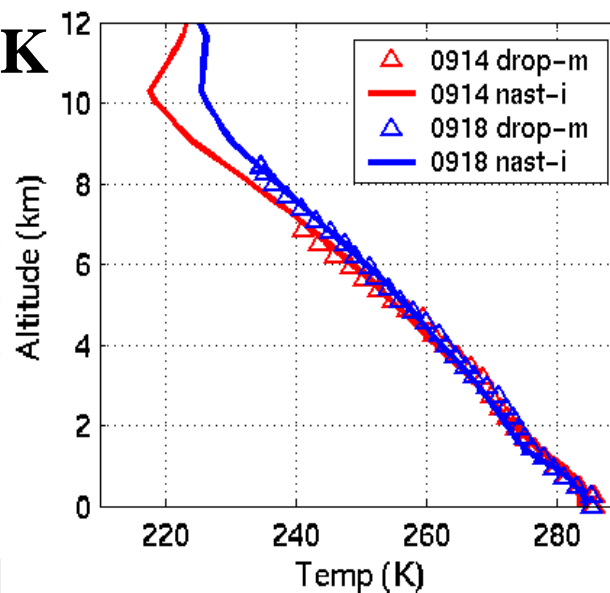
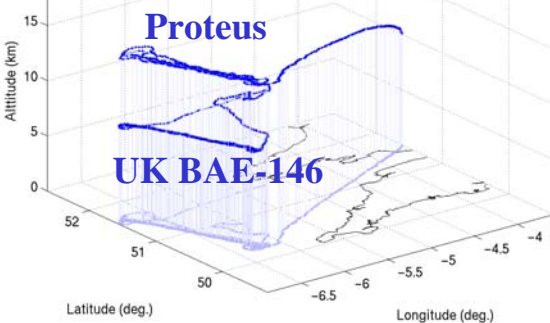
(3) AIRS-Team Retrieval (CC) ..ver. 4.0



United Kingdom (Air Chemistry)

SW Sea of Wales, UK

(September 14 & 18, 2004)



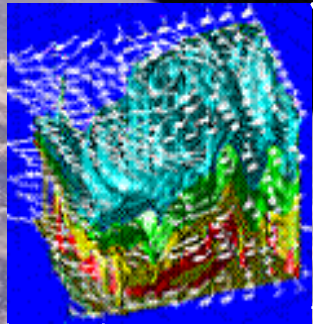
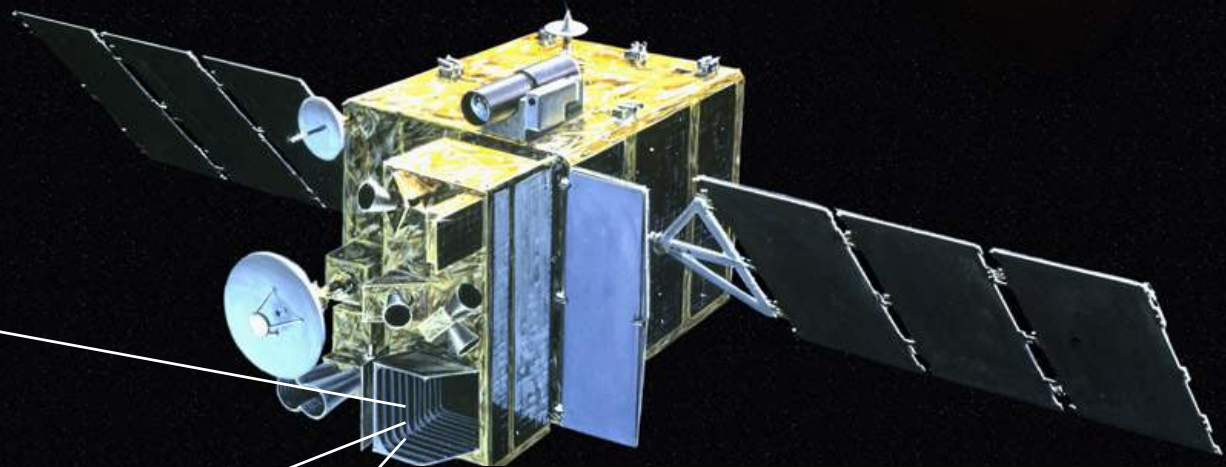
Four day interval
measurements taken at
the same geographical
location and local time

Day-to-day
variations shown by
NAST-I retrievals are
validated with
aircraft in-situ
measurements

Geostationary Imaging Fourier Transform Spectrometer

New Technology for Atmospheric Temperature, Moisture, Chemistry, &
Winds

“GIFTS”

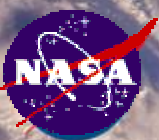


4-d Digital Camera:

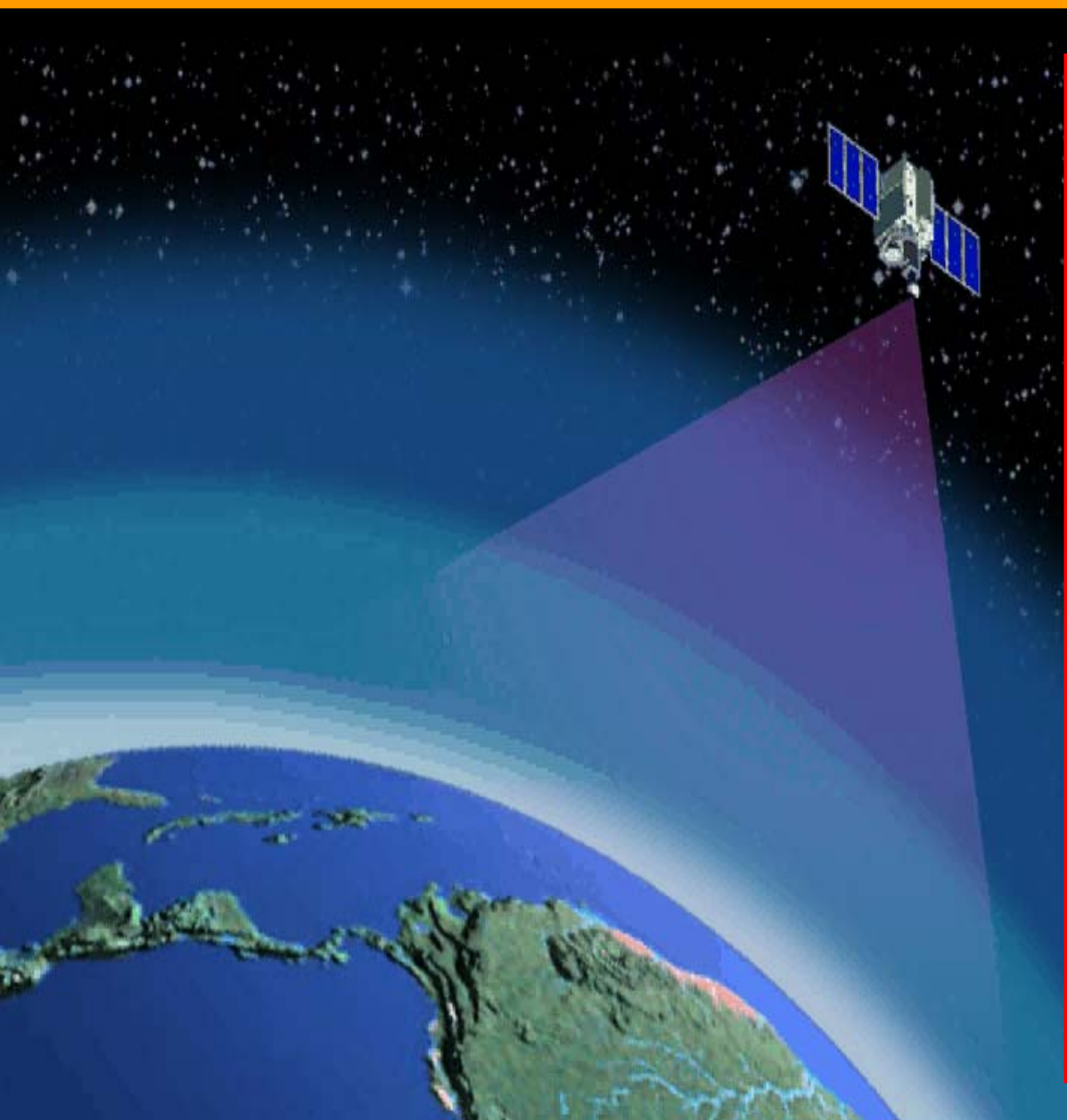
Horizontal: Large area format Focal Plane detector Arrays

Vertical: Fourier Transform Spectrometer

Time: Geostationary Satellite



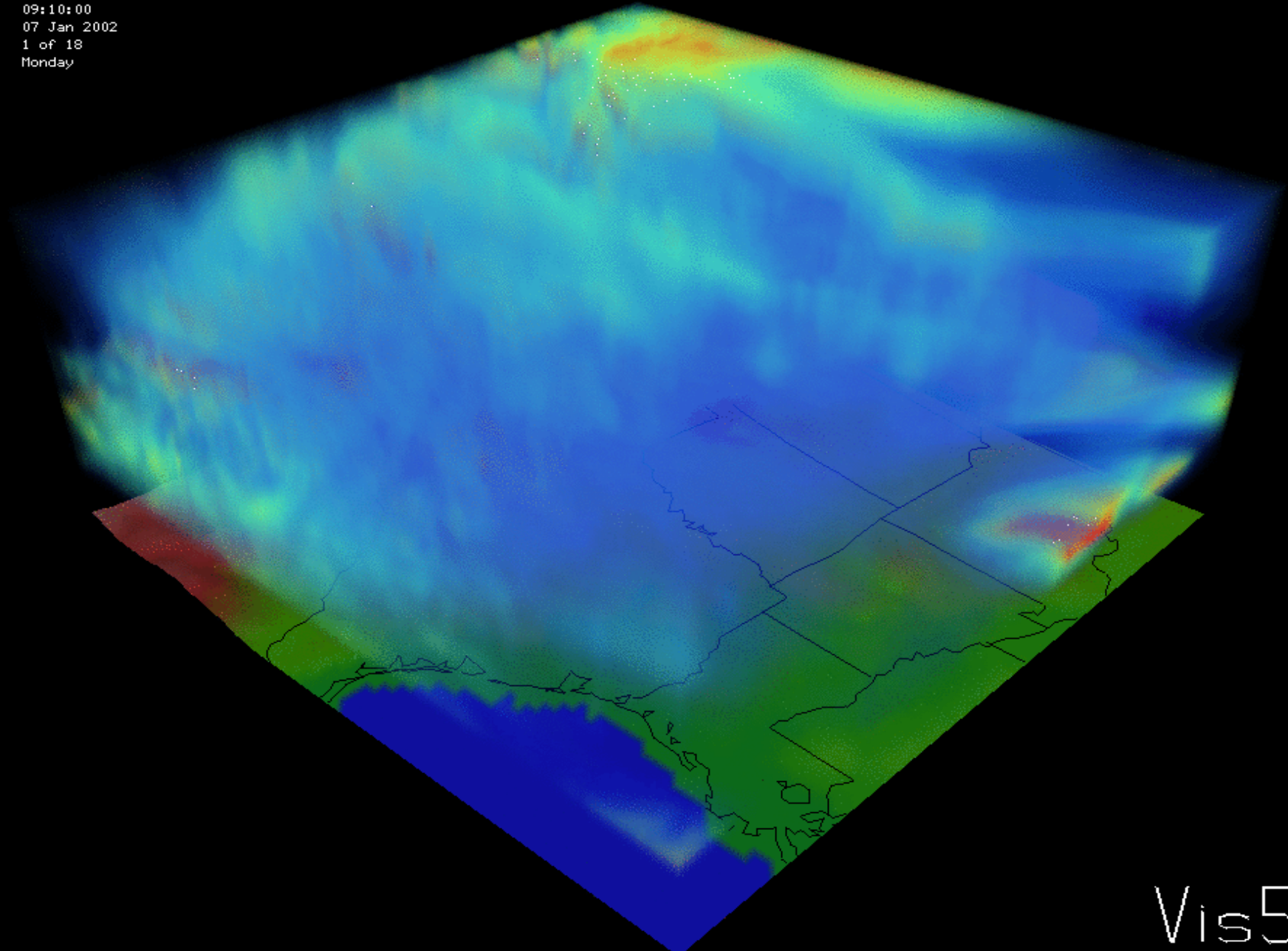
GIFTS Sampling Characteristics



- **Two 128x 128 Infrared focal plane detector arrays with 4 km footprint size**
- **A 512 x 512 Visible focal plane detector arrays with 1 km footprint size**
- **Field of Regard 512 km x 512 km at satellite sub-point**
- **Ten second full spectral resolution integration time per Field of Regard**
- **~ 80,000 Atmospheric Soundings every minute**

Water Vapor Flux (3 x 3 GIFTS Cubes)

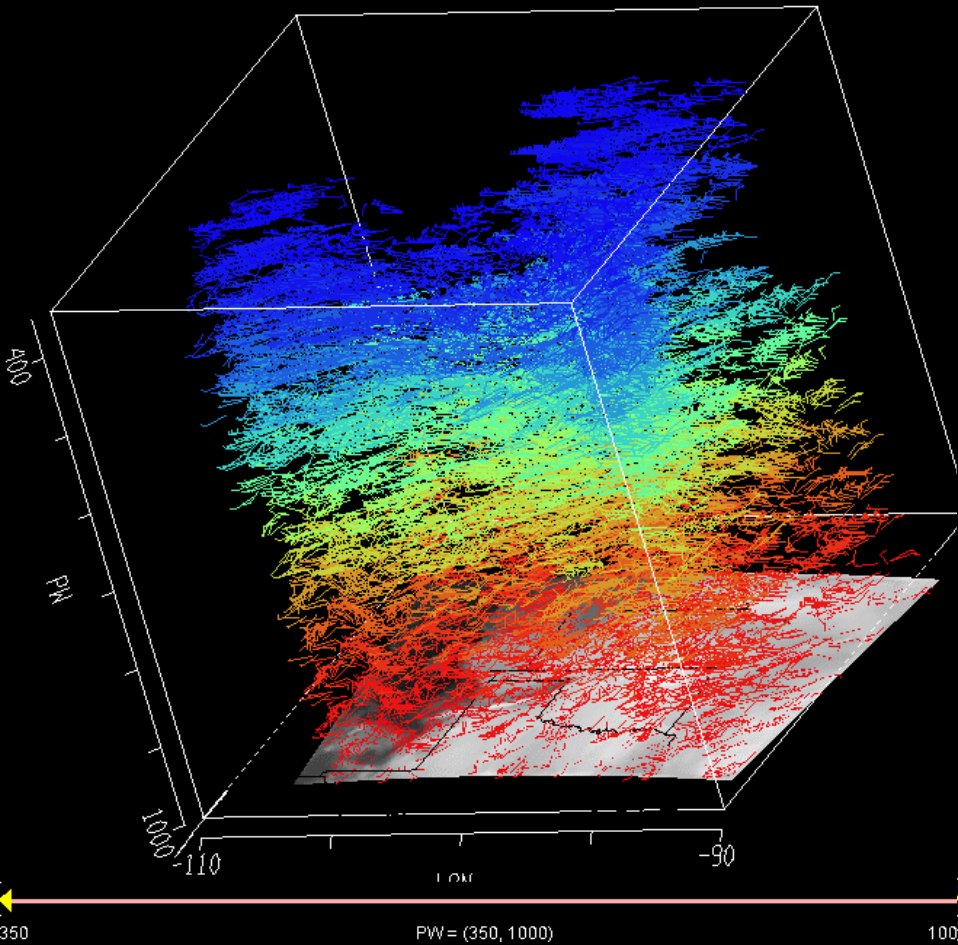
09:10:00
07 Jan 2002
1 of 18
Monday



Vis5D

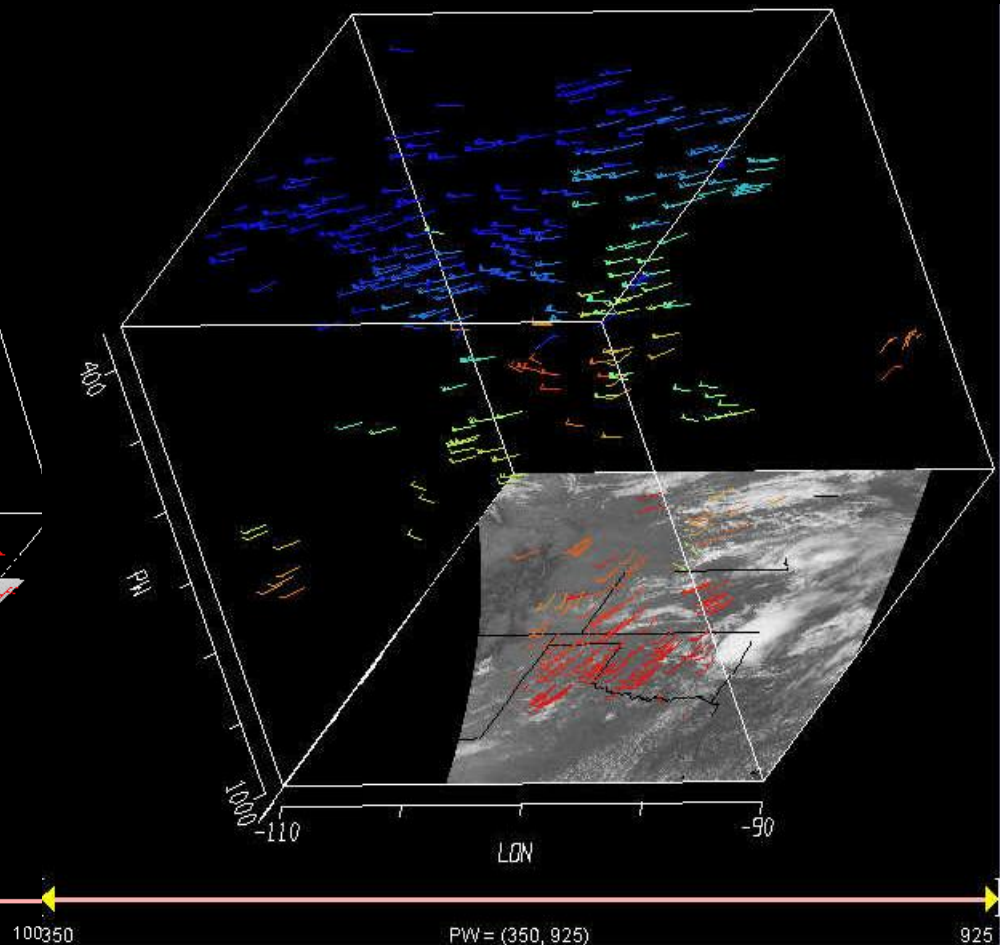
Primary Objective of the Geo-Sounder - Winds Profiles

GIFTS - Simulation



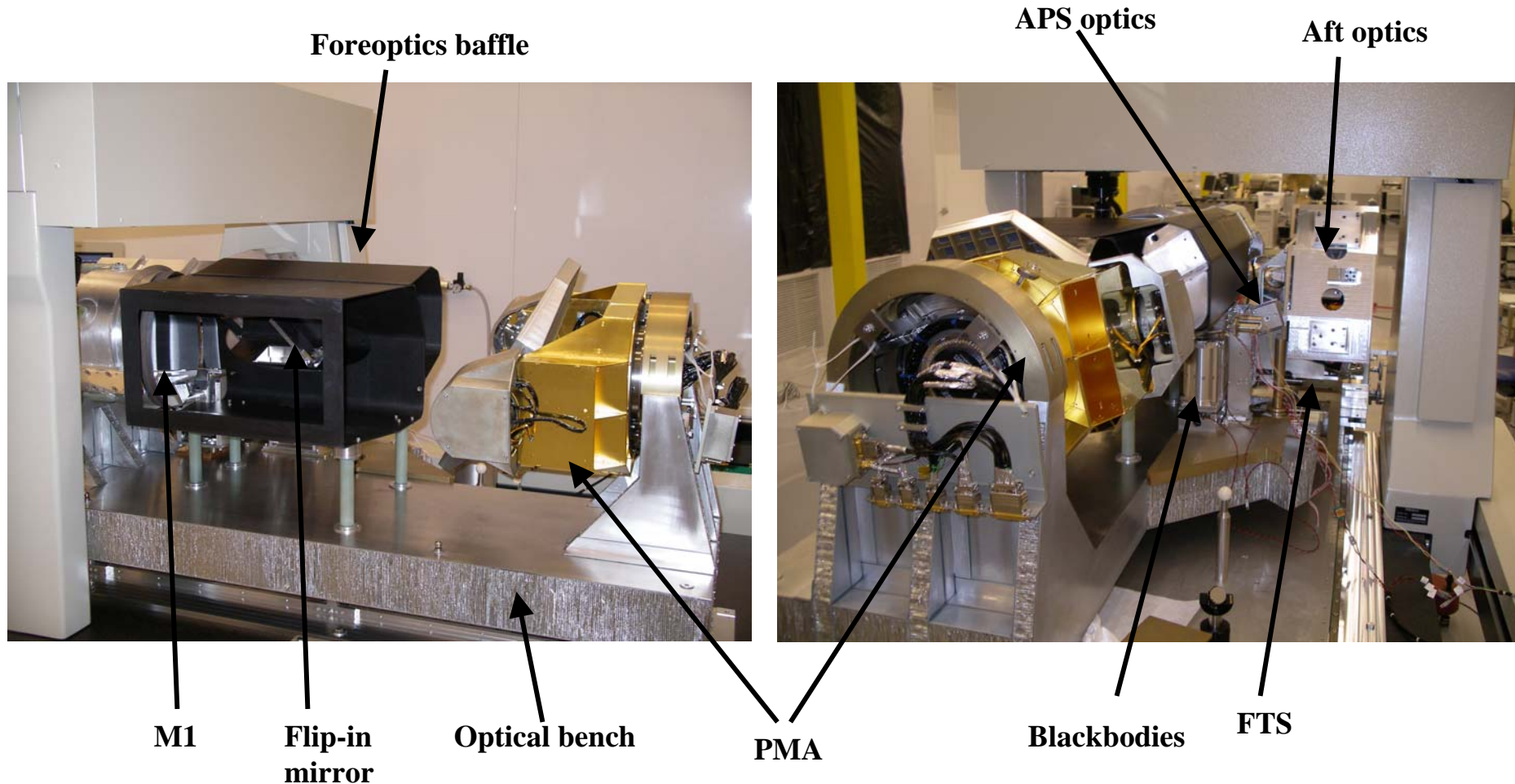
PW = (350, 1000)

GOES - Observation



PW = (350, 925)

GIFTS EDU to be Ground Tested



***Although GIFTS waits for a space flight opportunity
GIFTS-like instruments are expected to fly on next generation
operational geostationary weather satellites***

Summary

- **New ultra spectral remote sensing capabilities enable accurate atmospheric weather and chemistry depictions**
- **Latest (Ver 4.0) Aqua AIRS retrievals have been validated with radiosonde, dropsonde, and high vertical resolution airborne NAST-I soundings**
- **Future satellite ultra high spectral remote sensing instruments will provide most of the temperature and water vapor profile data for global data assimilation.**
- **Wind profiles will be provided by future ultra high spectral resolution geostationary satellite spectrometers**