CIMSS IAPP Retrieval Software:
Update, Application and Validation
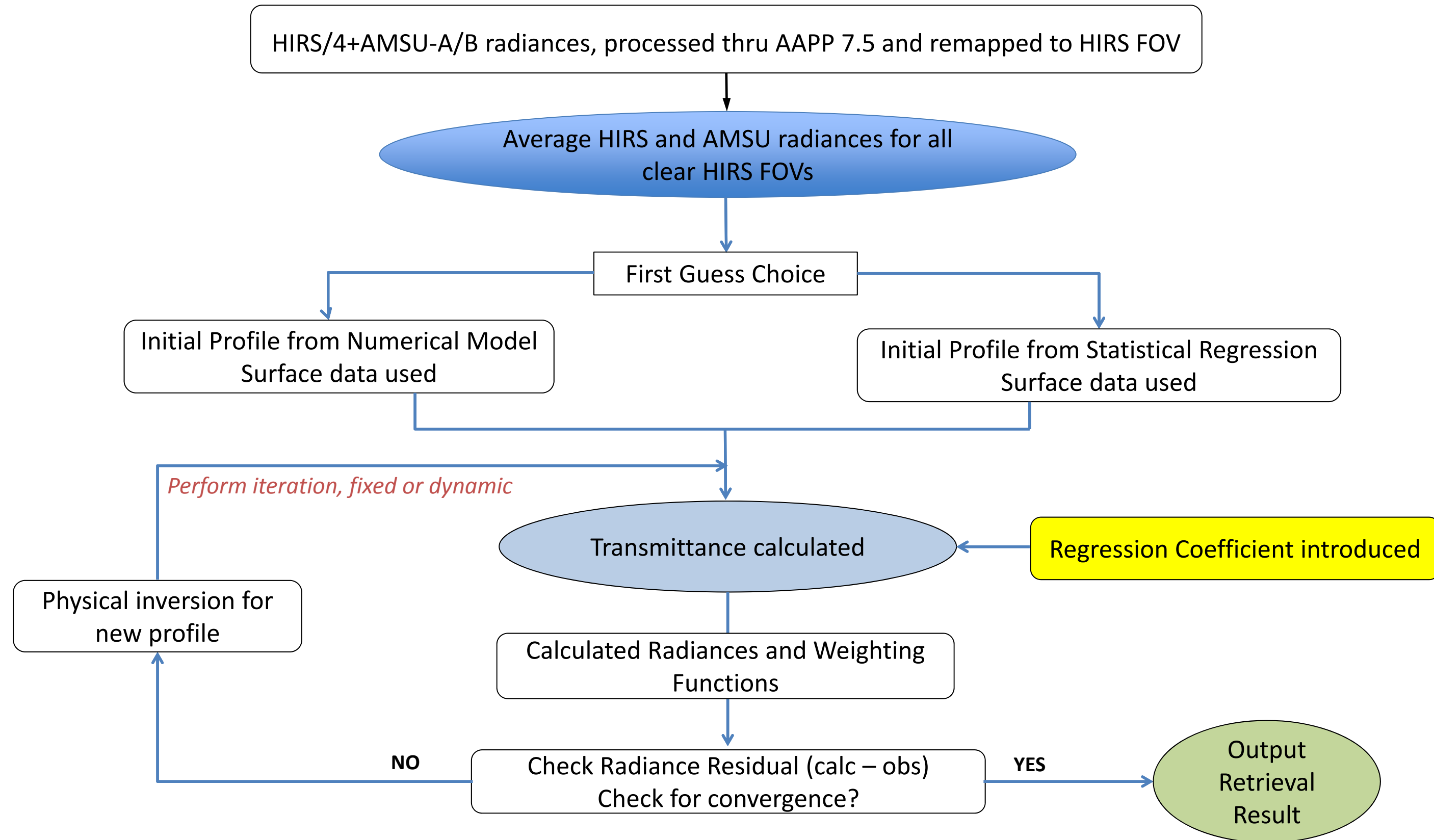
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C I M S S — Cooperative Institute for Meteorological Satellite Studies

SSEC

IAPP (International ATOVS Processing Package)

- Developed by Jun Li et al and the late Hal Woolf in 1999
- Current version 3.1 – can process NOAA-15 through Metop-A
- Forward model coefficients – from updated PFAAST[1] (Pressure layered Fast Algorithm for AtmoSpheric Transmittance) model, which used lblrtm version 12.1, AER version 3.1, and lnfl version 2.6
- Regression Coefficients – algorithm and process details in Technical Proceedings of ITSC-10[2]
- Version 4.0 – release in April 2014, with Metop-B added to the retrieval package

IAPP Retrieval System

HIRS/4+AMSU-A/B radiances, processed thru AAPP 7.5 and remapped to HIRS FOV

Average HIRS and AMSU radiances for all clear HIRS FOVs

First Guess Choice

Initial Profile from Numerical Model Surface data used

Initial Profile from Statistical Regression Surface data used

Perform iteration, fixed or dynamic

Transmittance calculated

Regression Coefficient introduced

Physical inversion for new profile

Calculated Radiances and Weighting Functions

Check Radiance Residual (calc - obs) Check for convergence?

NO / YES

Output Retrieval Result

(1) PFAAST reference paper: Hannon, Scott E., L. Larrabee Strow, and W. Wallace McMillan. "Atmospheric infrared fast transmittance models: A comparison of two approaches." *SPIE's 1996 International Symposium on Optical Science, Engineering, and Instrumentation. International Society for Optics and Photonics, 1996.*

(2) Regression Coefficients reference: Woolf, Van Delst, and Zhang (1999), "NOAA-15 HIRS/3 and AMSU Transmittance Model Validation," pp. 564-573 in the Technical Proceedings of ITSC-10.

HIRS CH8 (window) Brightness Temperature Global Track at FOV-5 09202013
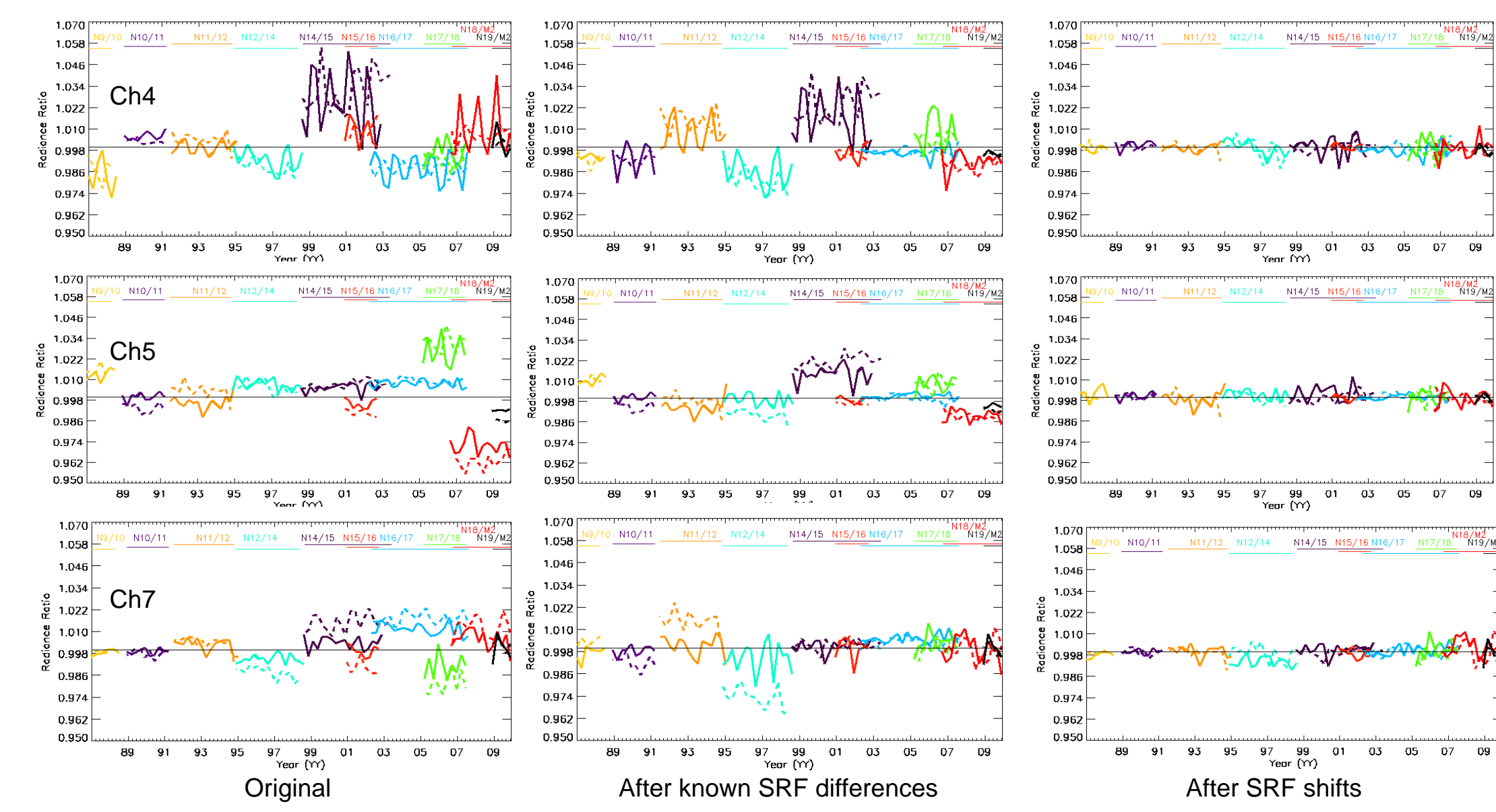
NOAA18 — Metop-A — Metop-B
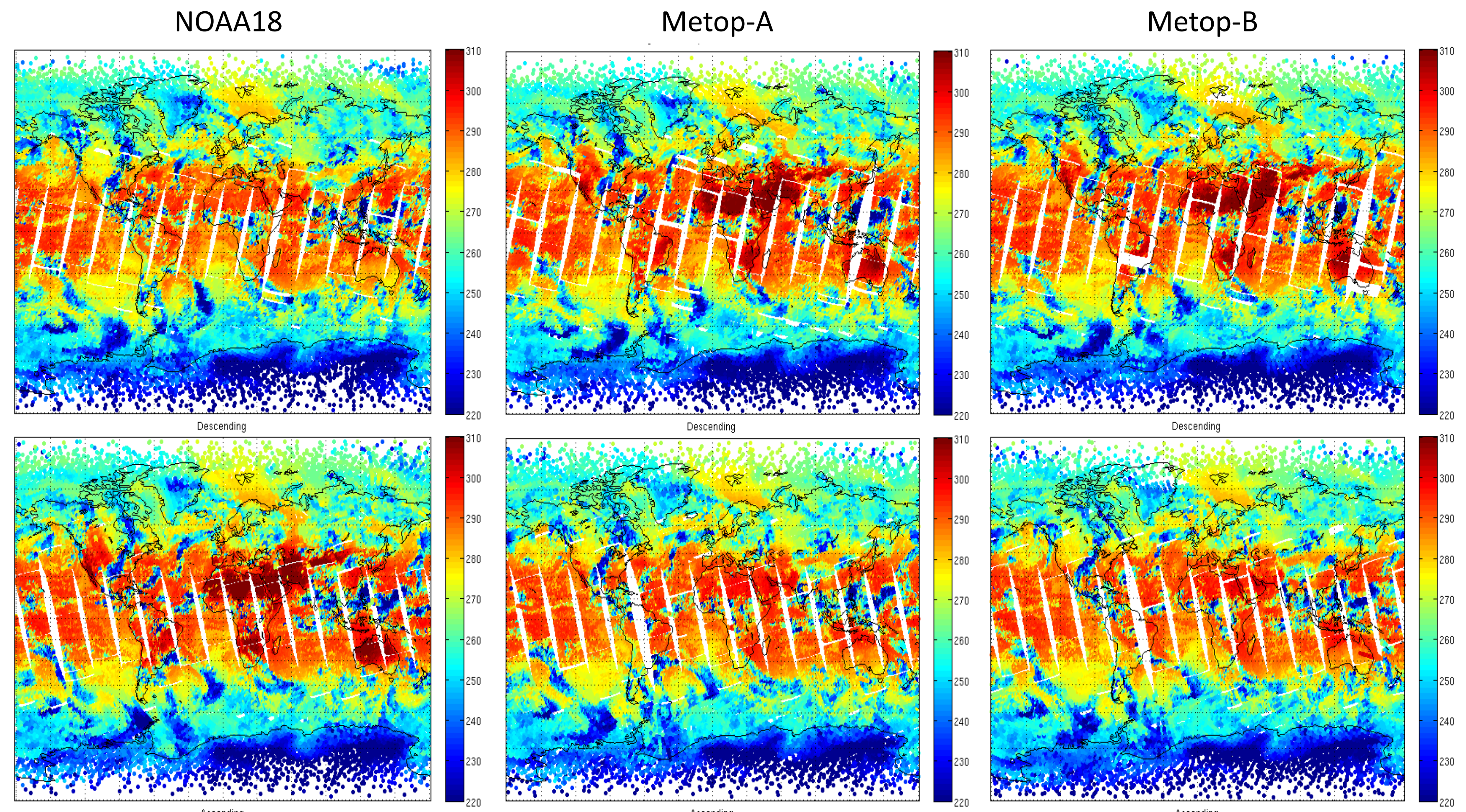
High-Resolution Infrared Sounder (HIRS)/4 on

- NOAA18, since 05/20/2005 – instruments changed from HIRS/3 to HIRS/4, AMSU-B to MHS
- Metop-A, since 10/19/2006 and Metop-B, since 17/09/2012. Both Metop's are on low earth orbit. Global data, regional data, and direct readout service are provided with real-time imagery.

ATOVS and AVHRR Pre-processing Package (AAPP) version 7.5, maintained by NWP SAF
- produce HIRS and AMSU L1d data used in IAPP

Process of HIRS Inter-satellite Calibration

Ch4 — Ch5 — Ch7

Original — After known SRF differences — After SRF shifts

- IASI-simulated HIRS data are used to develop linear models to estimate impacts of SRF differences and shifts on inter-satellite radiance biases
- After accounting for effect of pre-launch SRF differences, inter-satellite biases are recalculated (middle column)
- Optimized (i.e. *effective*) SRF shifts (as large as 2.5 cm-1) minimize RMS of biases to less than 1% (right column)

* Slide and information courtesy of Paul Menzel

Metop-A HIRS Channel 12
MidLat Summer model transmittance

Transmittance / no Shift / Shift
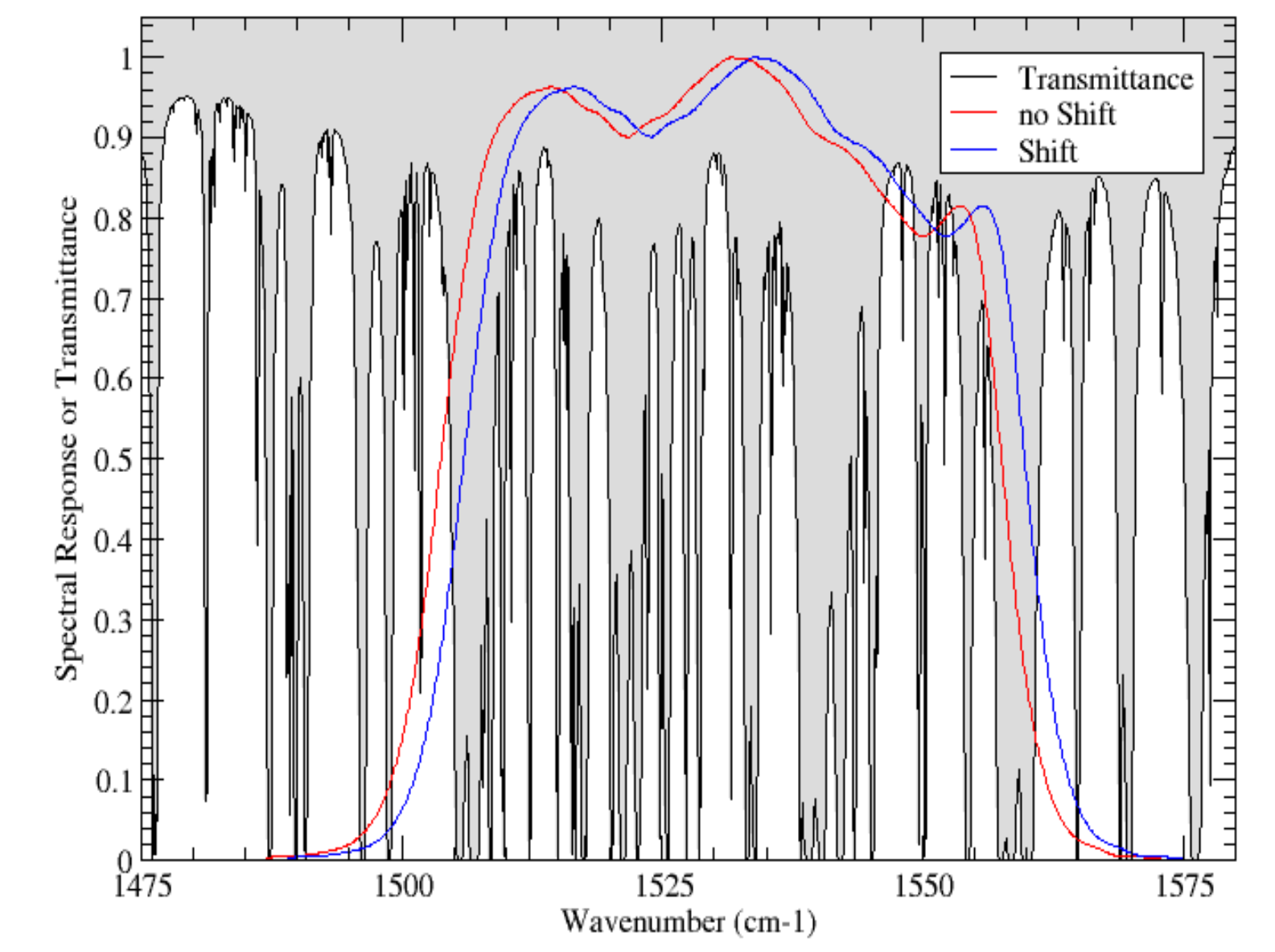
CO2 HIRS spectral shifts (Dec 21, 2012)
H2O HIRS Spectral shifts (Dec 13, 2012)

	Ch4(14.2)	Ch5(13.9)	Ch7(13.3)	Ch12(6.7)
hirs2n09	0.72	2.42	-0.67	1.1
hirs2n10	1.06	1.48	-1.12	3.0
hirs2n11	1.67	1.94	-0.04	4.2
hirs2n12	0.51	2.03	-2.25	4.1
hirs2n14	2.13	2.80	1.14	4.1
hirs3n15	-0.21	0.27	1.01	0.6
hirs3n16	0.22	0.62	0.47	0.6
hirs3n17	0.54	0.72	0.44	-0.3
hirs4n18	-0.71	-0.37	-0.49	3.3
hirs4n19	-0.00	-0.12	0.10	0.7
hirs4moa	-0.15	0.10	-0.15	2.2

Chart provided by ruiyue.chen@noaa.gov (NOAA STAR)

- The Metop-A HIRS effective SRF shift impact on IAPP retrievals is small, max(dT)~0.06 K and max(dMR)~0.6.
- The HIRS effective SRF shifts are typically larger for older NOAA satellites and can be expected to have more impact on retrievals.
- The effective SRF shift is based upon in-band SRF region only. Influence from the out-of-band SRF region is untested.

HIRS channel 12 shift impact on temperature and water mixing ratio
09202013 Gulf of Mexico case study

0.1 K — 0.1 g/Kg
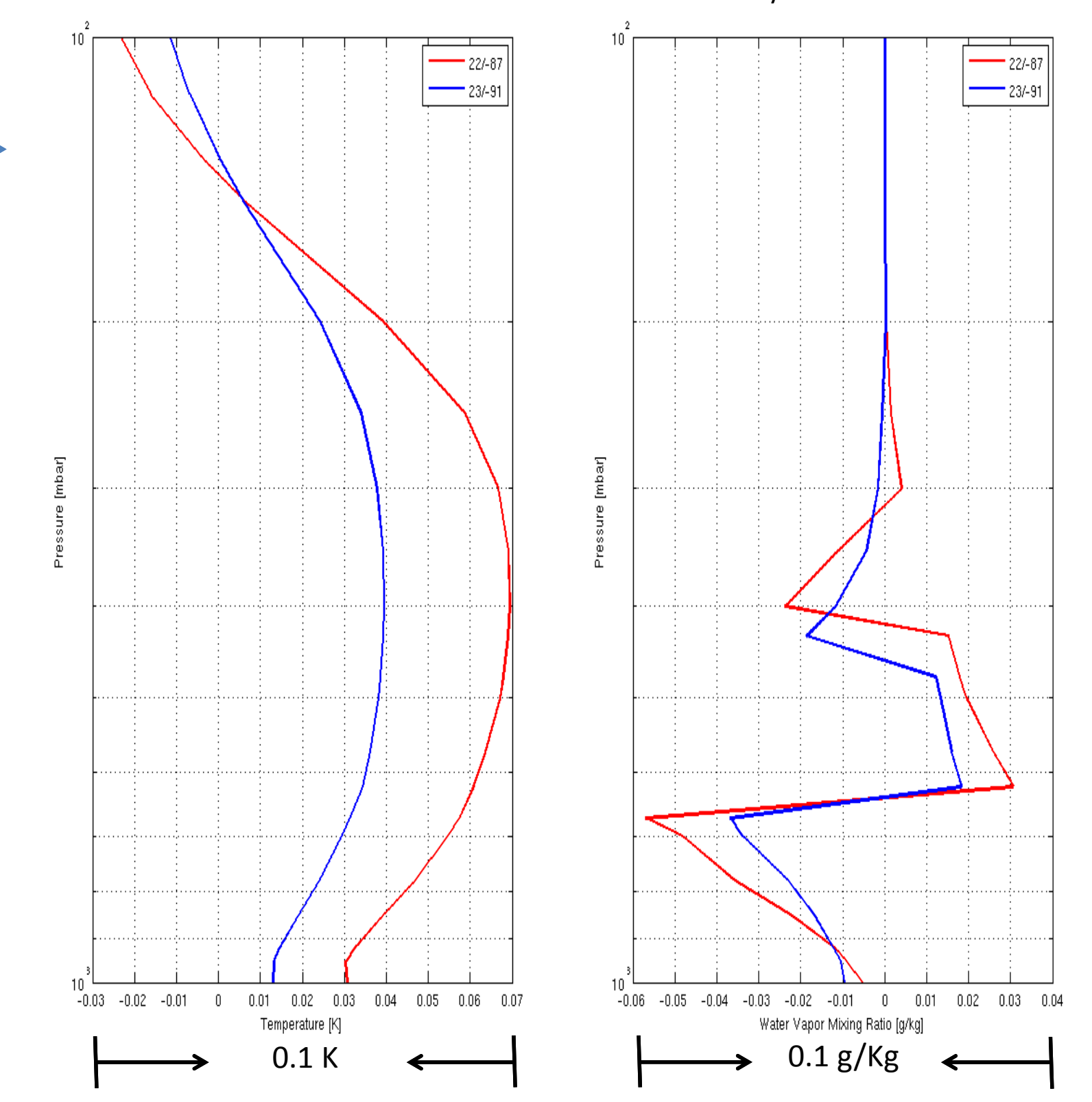
Scanning HIS (High-resolution Interferometer Sounder) on Global Hawk 20130919-20130220 Flight Track
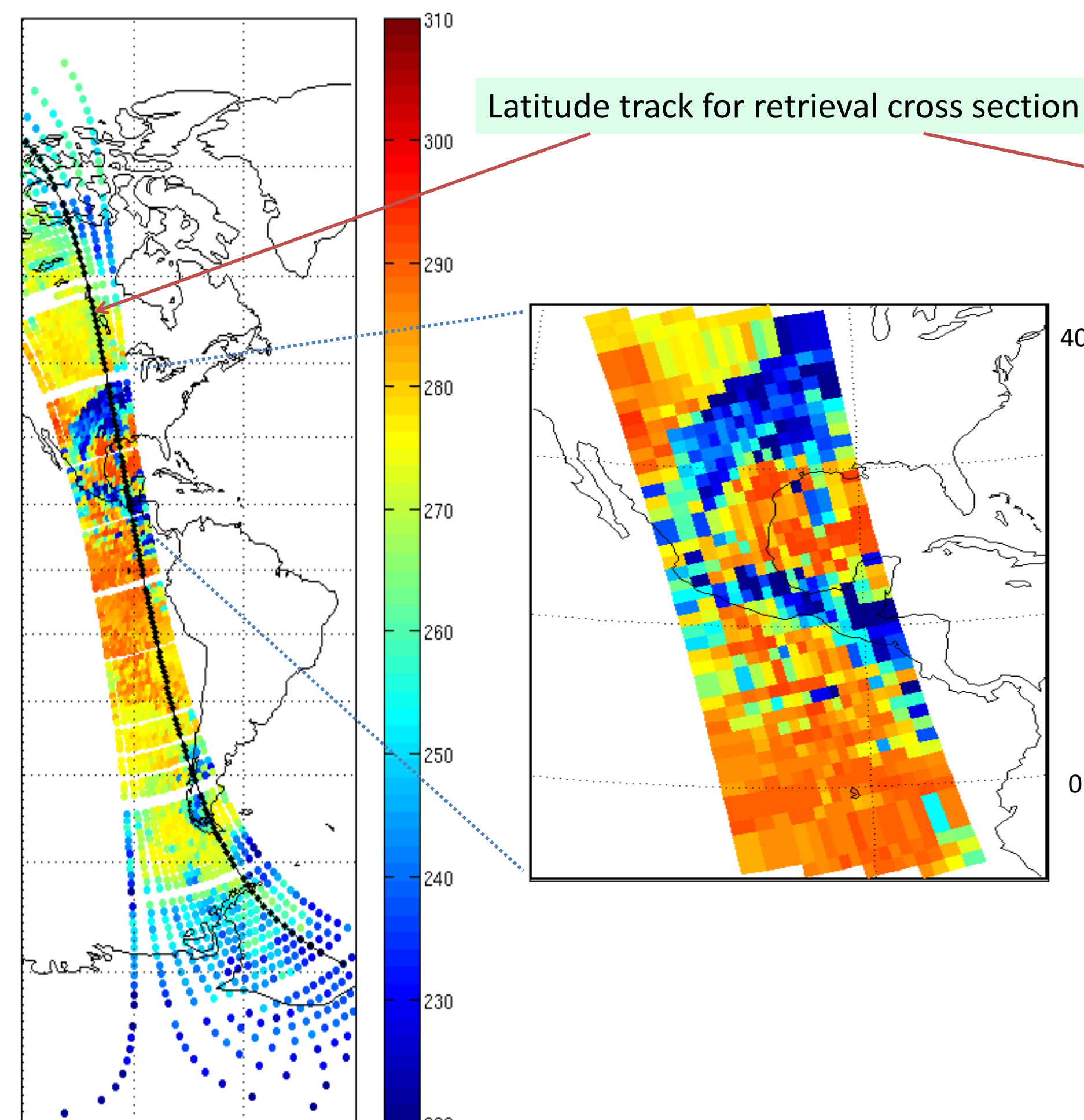

Drop Sondes along the flight
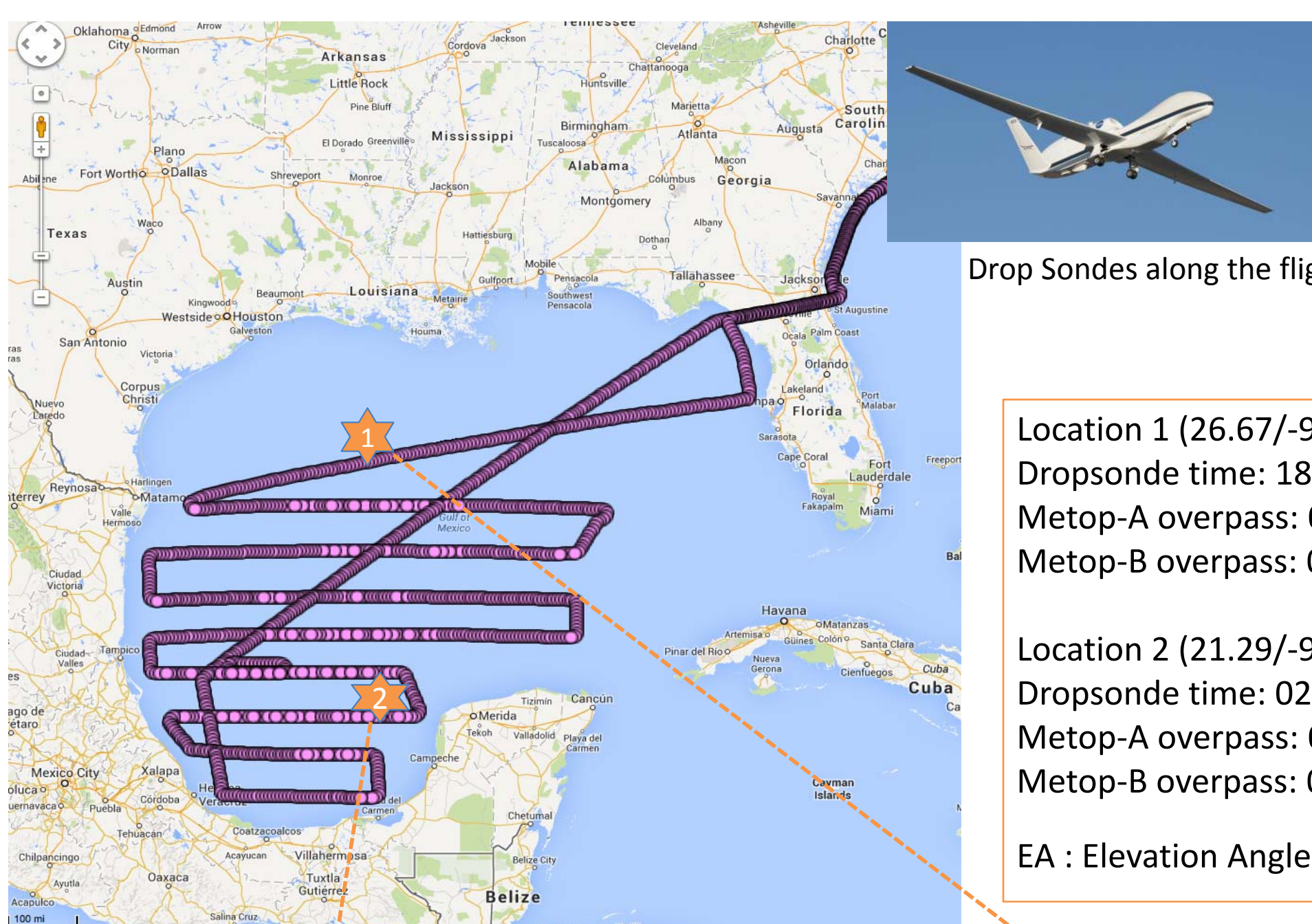
Location 1 (26.67/-92.23):
Dropsonde time: 1822 UTC (09192013)
Metop-A overpass: 0252 UTC/EA 44.9
Metop-B overpass: 0346 UTC/EA 51.0

Location 2 (21.29/-92.35):
Dropsonde time: 0207 UTC (09202013)
Metop-A overpass: 0250 UTC/EA 37.5
Metop-B overpass: 0344 UTC/EA 58.1

EA : Elevation Angle

Validation Case Study – 19/20 September 2013

- The NASA Global Hawk flew a lawnmower pattern in the Gulf of Mexico during the HS3 campaign. Earth scenes included very warm SSTs and high TPW.
- Unique opportunity with in-flight drop sondes for comparison to IAPP retrievals.
- Preliminary Metop-B retrieval is promising.

IAPP Retrievals compared with drop sonde at lat/lon (21.29/-92.35)
IAPP Retrievals compared with drop sonde at lat/lon (26.67/-92.23)

Clear Case — Cloudy Case

Metop-B / Metop-A / drop sonde

Metop-B HIRS Brightness Temperature ascending track for case study day

Latitude track for retrieval cross section

IAPP Retrieval Cross Section for METOP-B HIRS data at Longitude -92.35

Temperature [K]

Water Mixing Ratio [g/Kg]

Zoom in region
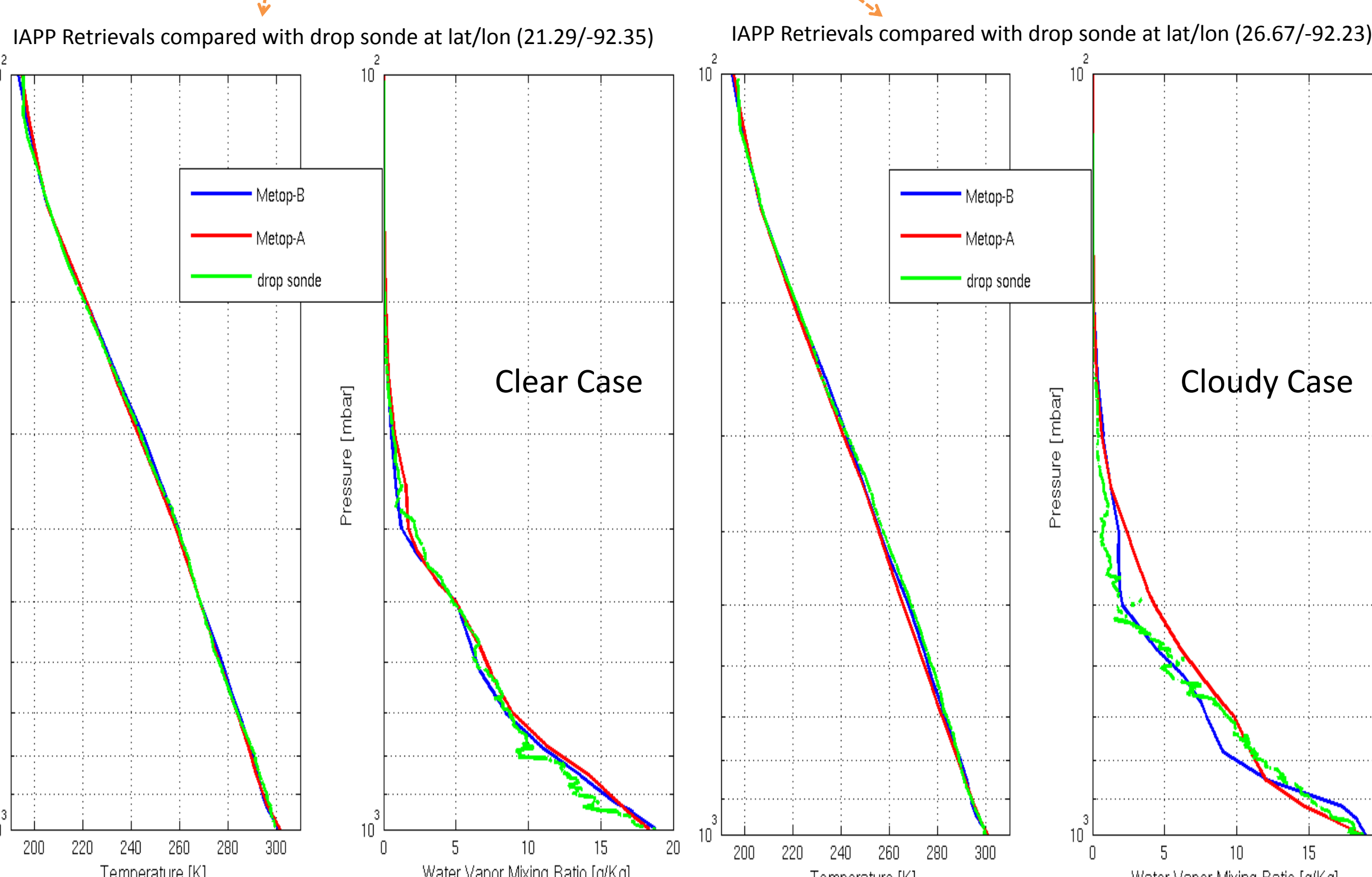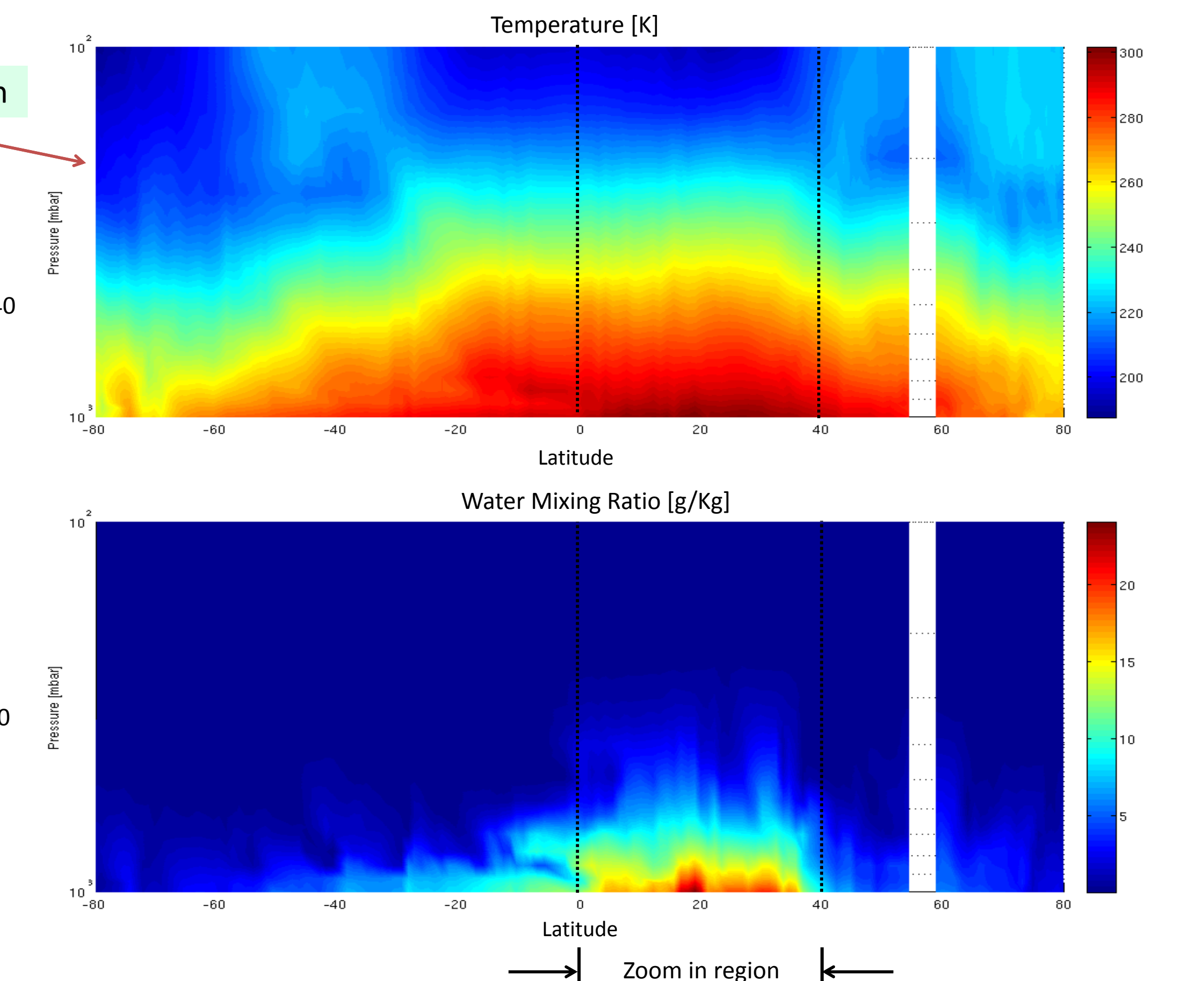
IAPP can be downloaded from : https://cimss.ssec.wisc.edu/opsats/polar/iapp/IAPP.html
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