Combining Polar Hyper-spectral and Geostationary Multi-spectral Sounding Data – A Method to Optimize Sounding Spatial and Temporal Resolution

W. L. Smith[1,2], E. Weisz[1], and J. McNabb[2]

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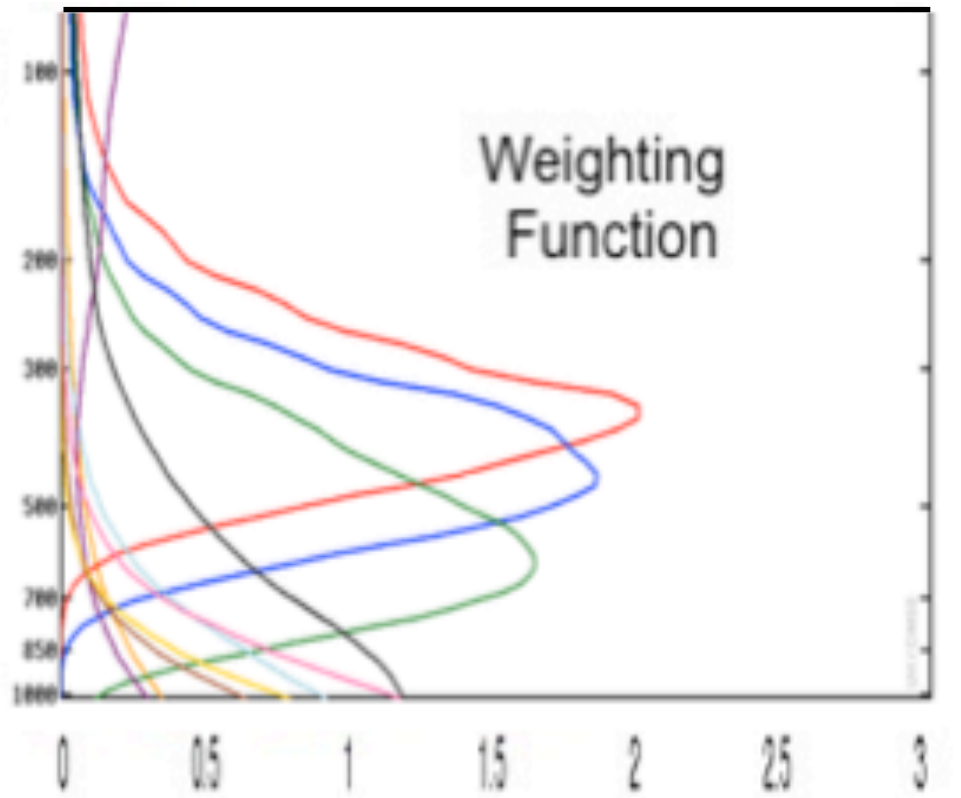
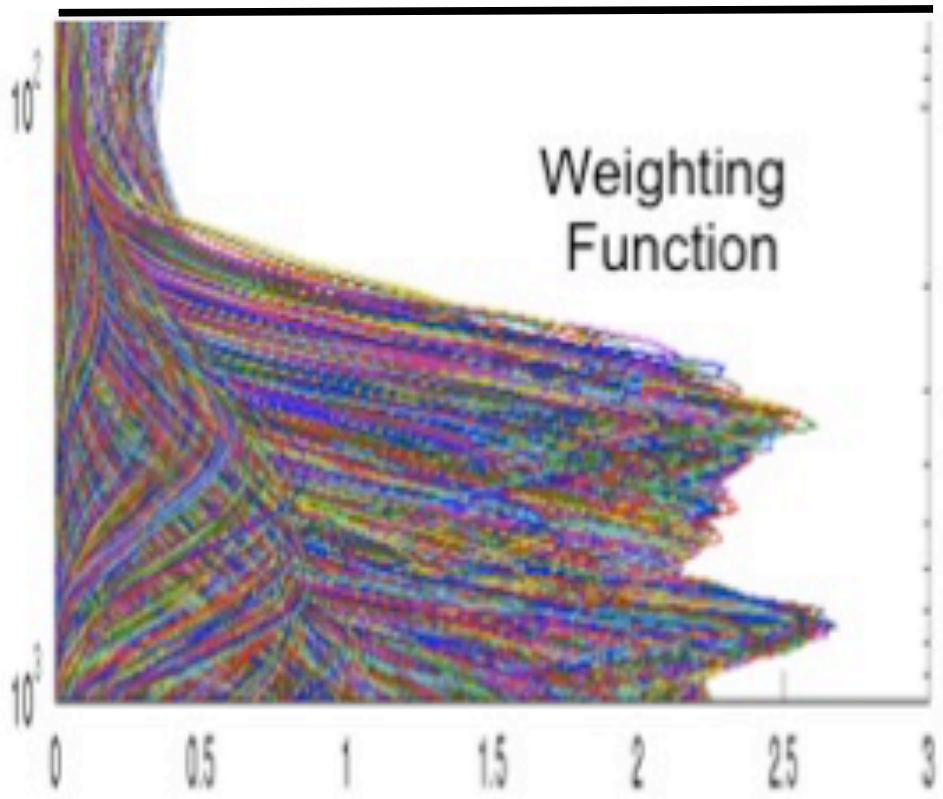
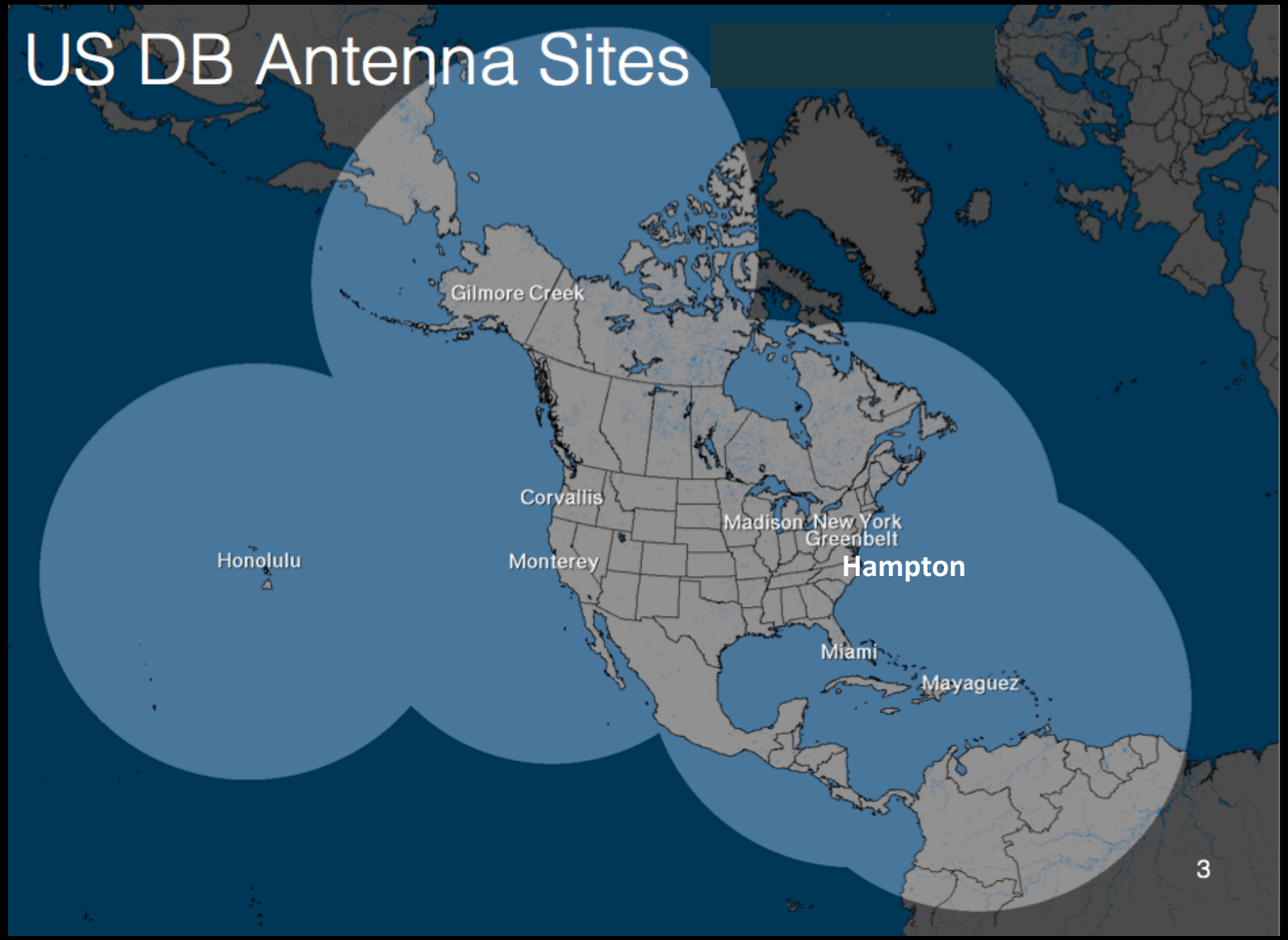


ABI: Vertical Res. 5-10 km
Horizontal Res. 2-km
Time Res. 5-15 min.



AIRS, IASI, CrIS: Vertical Res. 1-4 km
Horizontal Res. 14-km
Time Res. 1-7 hr.

US DB Antenna Sites



http://cas.hamptonu.edu/dbps_cron/plots/

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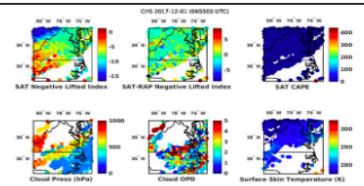
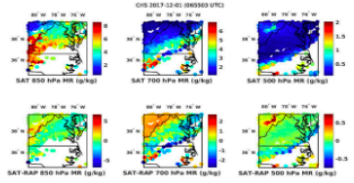
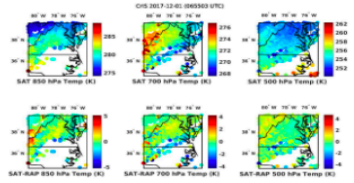
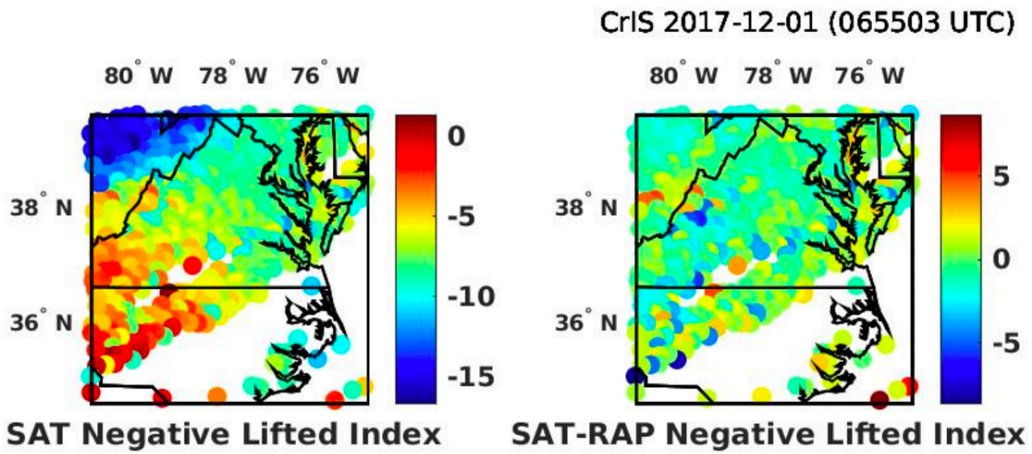
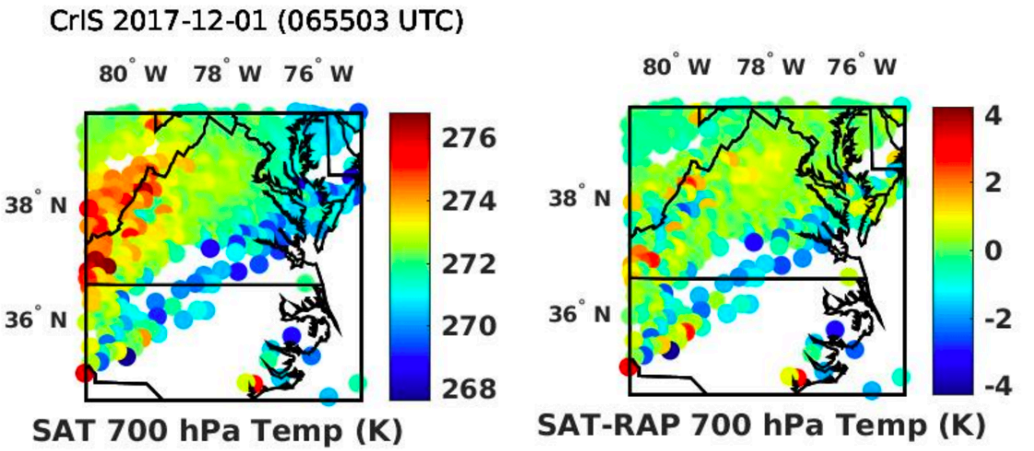
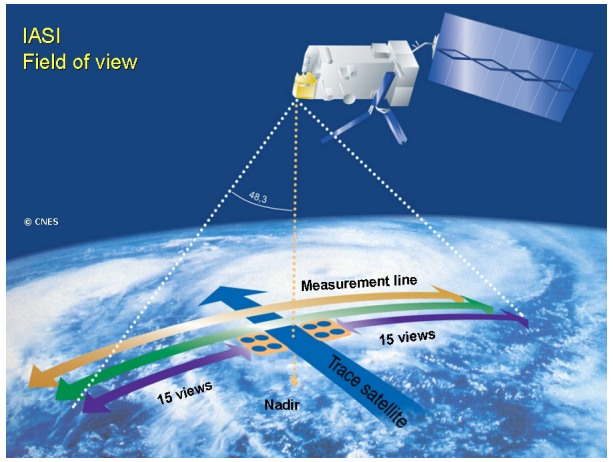
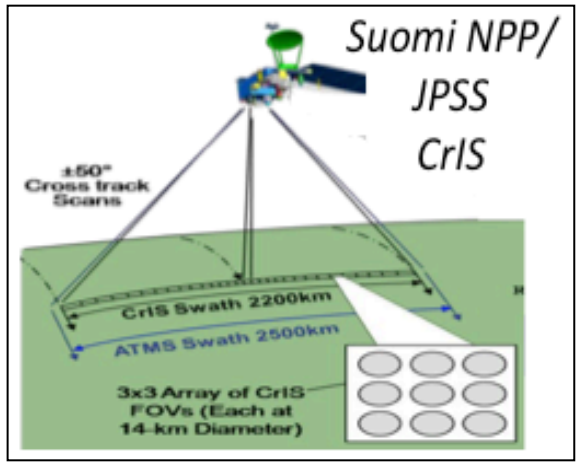
current_CRIS_f3.jpg	2017-12-01 07:37:33	
current_CRIS_f2.jpg	2017-12-01 07:37:22	
current_CRIS_f1.jpg	2017-12-01 07:37:10	





Polar-Orbiting Ultra-Spectral & Geostationary Sounders





Instrument	IASI	CrIS	ABI
Satellite	Metop-A, Metop-B	Suomi-NPP	GOES-16
Type	Michelson Interferometer	Michelson Interferometer	Radiometer
Spectral resolution	0.25 cm^{-1}	0.625 (LW), 1.25 (MW), 2.5 cm^{-1} (SW)	GOES-16
Spectral range	645 – 2760 cm^{-1} (15.5 – 3.62 µm)	650 – 2550 cm^{-1} (15.4 – 3.9 µm)	751.9 - 21276 cm^{-1} 0.47 – 13.3 µm
Number of Detectors/ Channels	12 / 8461	27 / 1305	16 / 16
NEDT range	0.1 – 0.75 K	0.05 – 0.5 K	0.01 /0.07
Spatial Resolution (at nadir)	12 km	14 km	2 km
Launched	2006, 2012	2011	2016

PHS (CrIS/IASI) + ABI Sounding

$$\mathbf{ABI/PHS = ABI\ (x,y,t) + [PHS\ (x_o,y_o,t_o) - ABI\ (x_o,y_o,t_o)]}$$

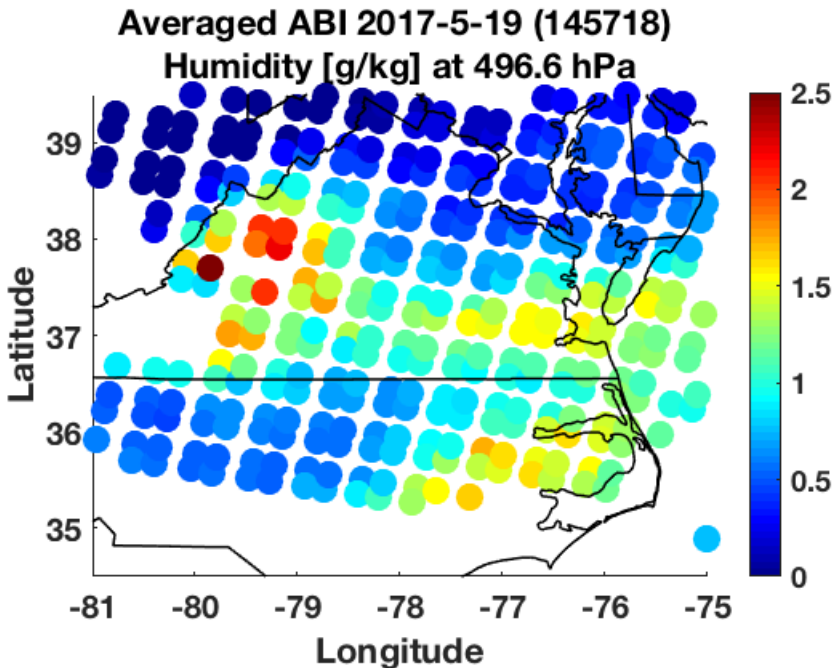
ABI (x,y,t): ABI retrieval value at location and time (x, y , t)

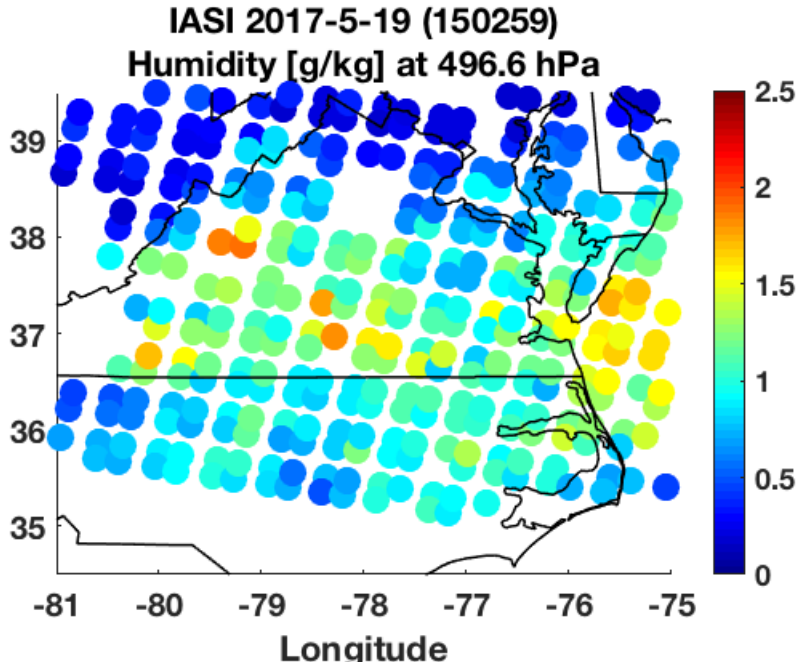
PHS (x_o,y_o,t_o): Mean of 5 reference PHS values closest to ABI location and time (x, y, t)

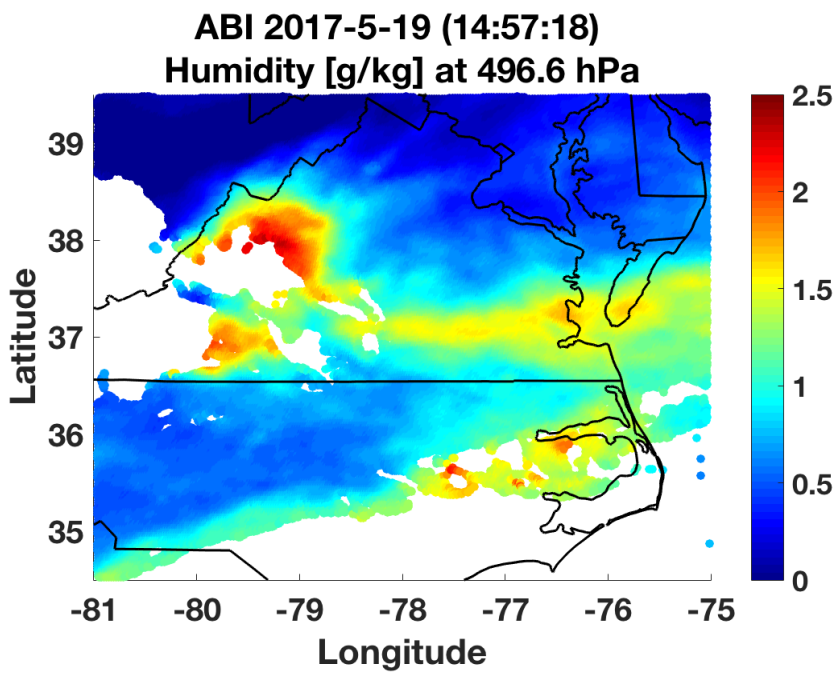
ABI (x_o,y_o,t_o): Mean of 5 reference PHS Field-of-View average ABI retrieval values closest to the ABI location and time (x, y, t)

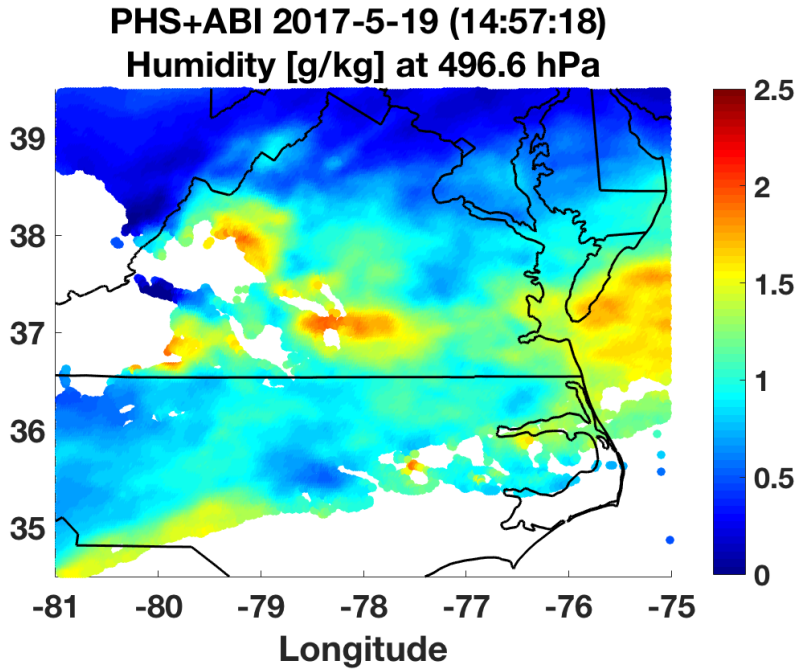
Implicit Assumption: *The vertical resolution induced error of multi-spectral ABI retrievals is persistent over the time interval between the acquisition times of the high vertical resolution polar hyperspectral soundings and over the spatial scale (i.e., 14-km) of the hyperspectral sounding data.*

Combining 500 hPa ABI with PHS (IASI) @ 15:00 UTC

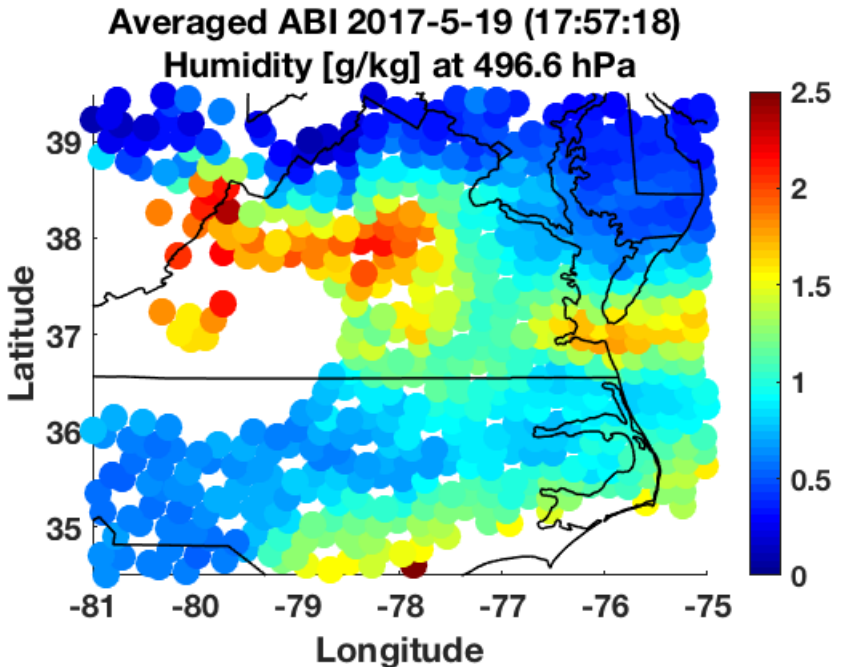


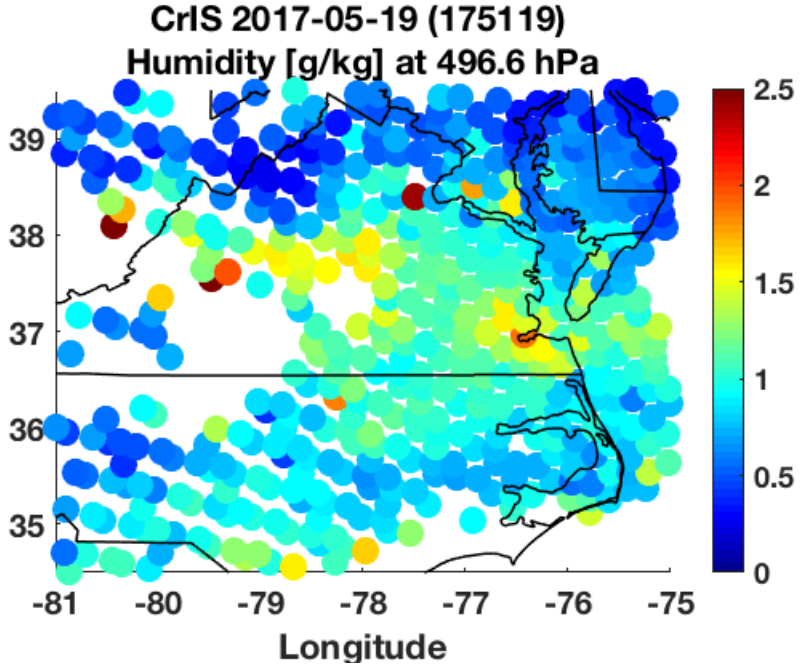


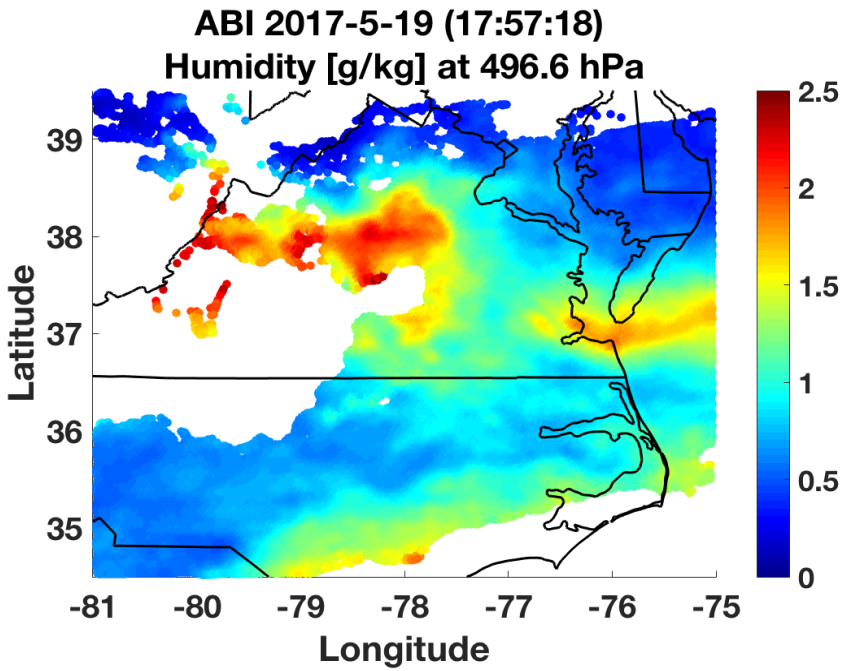


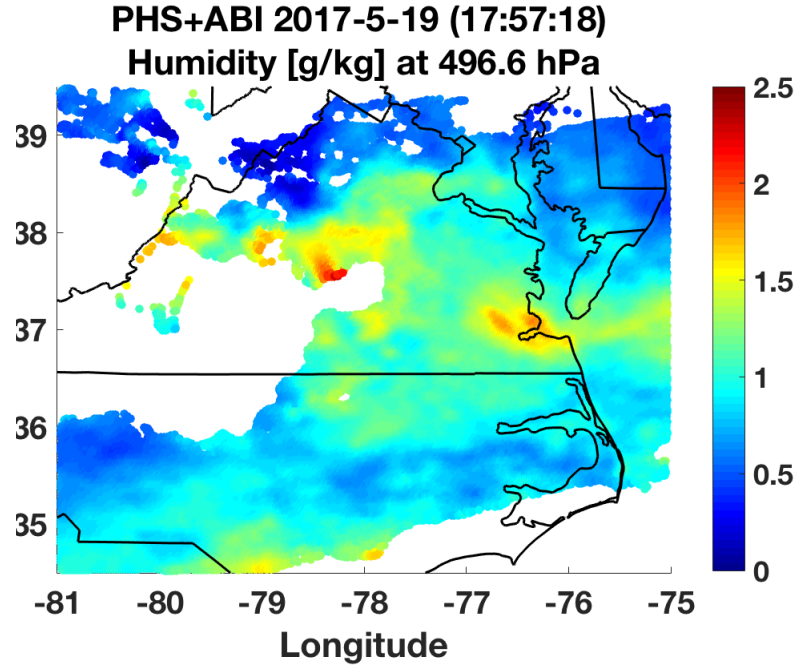


Combining ABI with PHS (CrIS) @ 17:55 UTC

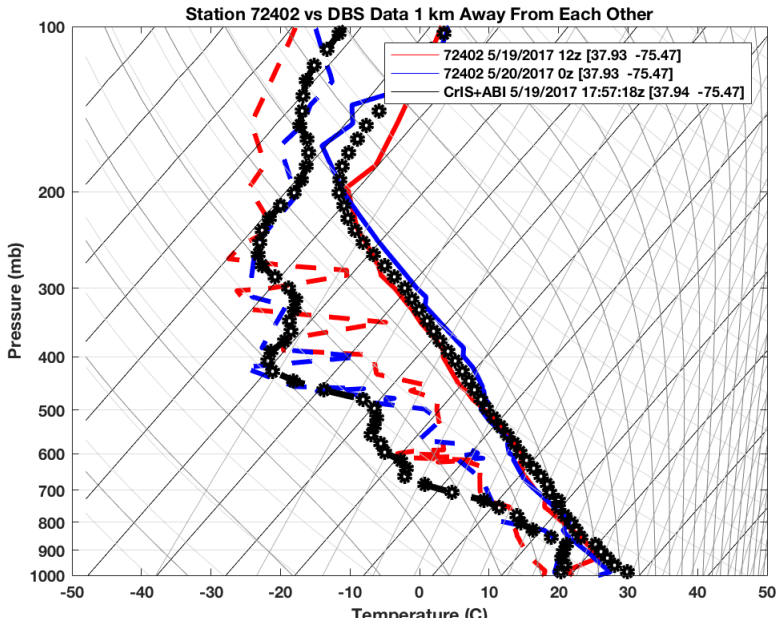


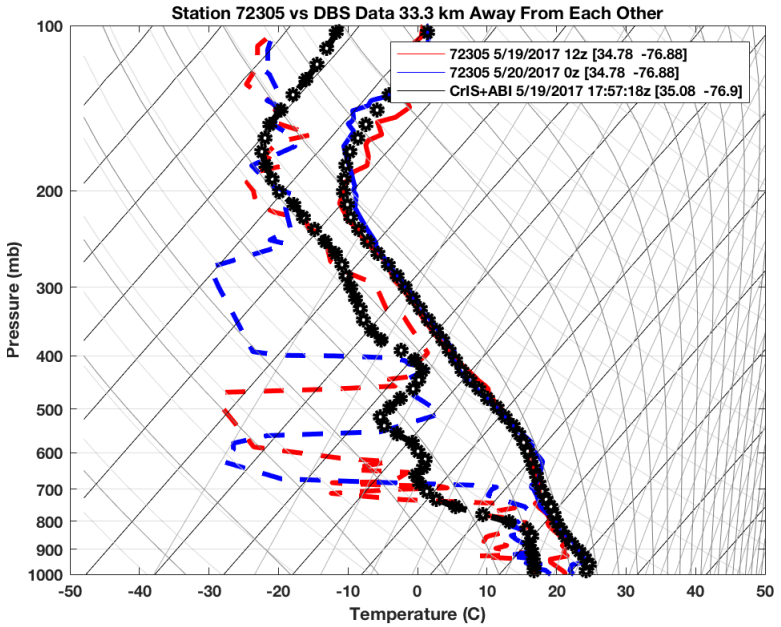


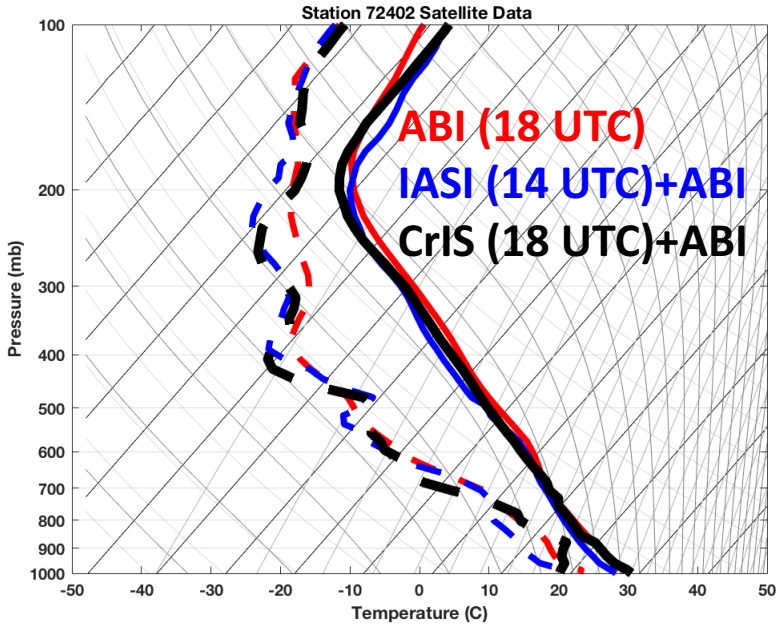


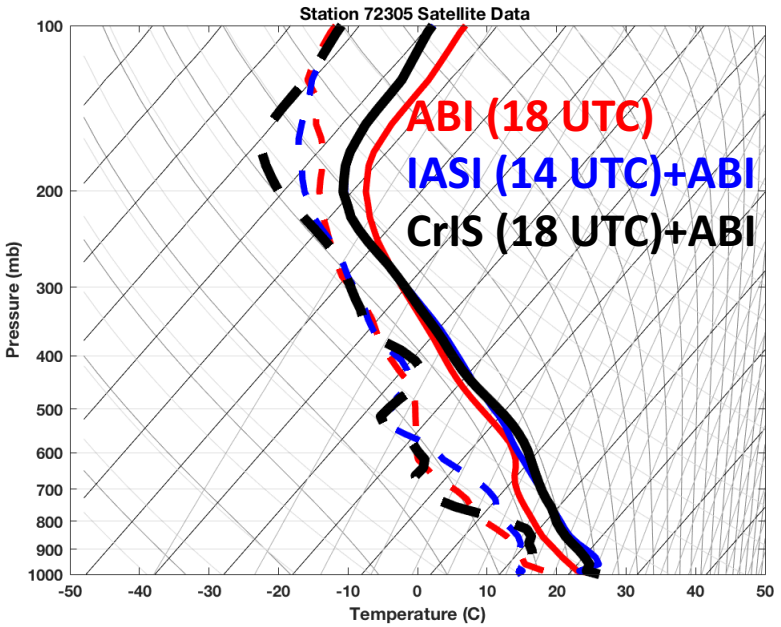


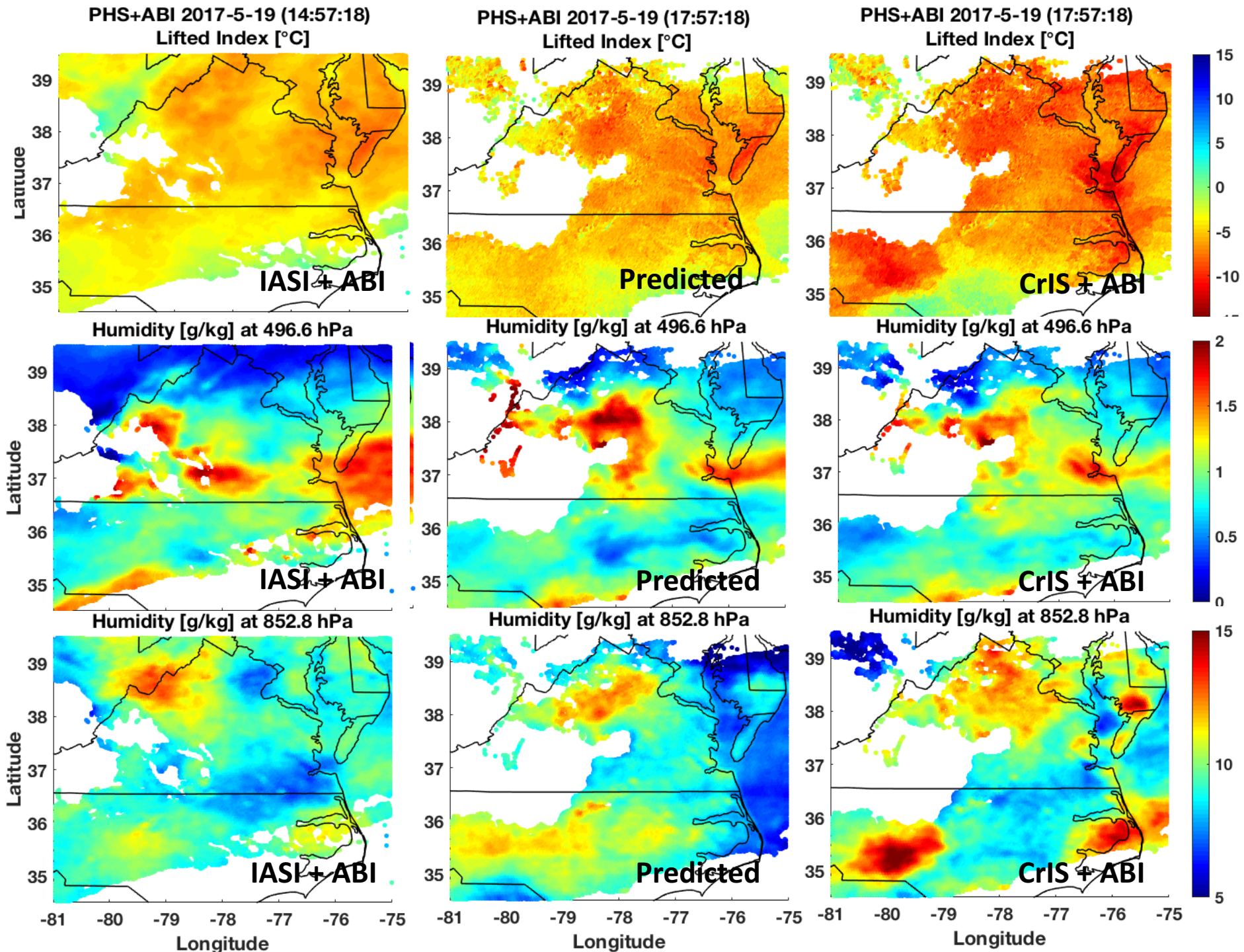
CrIS + ABI Vs Radiosondes (May 19, 2017)







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Lifted Index [°C]
PHS+ABI 2017-5-19 (17:57:18)
Lifted Index [°C]
PHS+ABI 2017-5-19 (17:57:18)
Lifted Index [°C]
IASI + ABI
Predicted
CrIS + ABI
Humidity [g/kg] at 496.6 hPa
Humidity [g/kg] at 496.6 hPa
Humidity [g/kg] at 496.6 hPa
IASI + ABI
Predicted
CrIS + ABI
Humidity [g/kg] at 852.8 hPa
Humidity [g/kg] at 852.8 hPa
Humidity [g/kg] at 852.8 hPa
IASI + ABI
Predicted
CrIS + ABI
Latitude
Longitude
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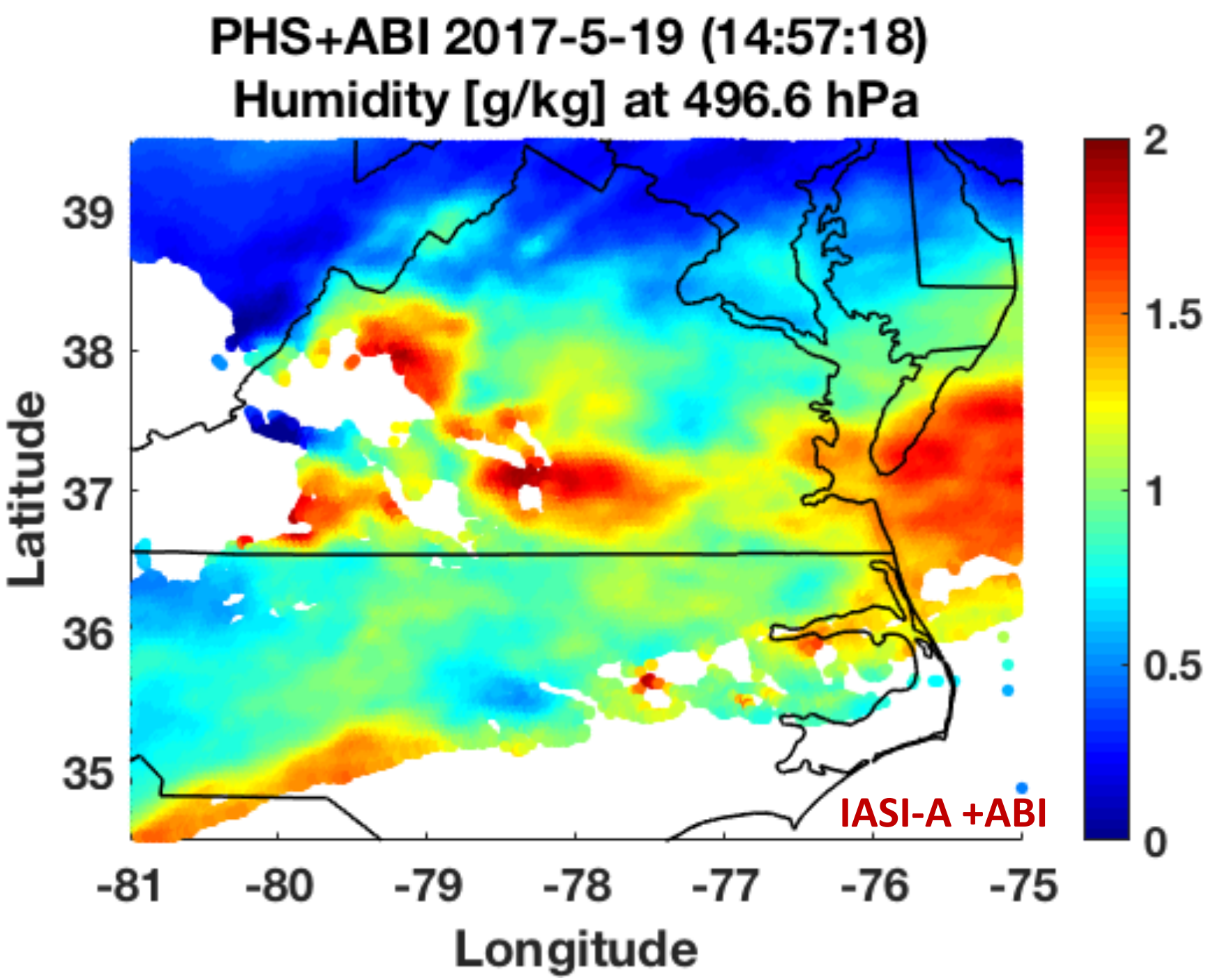
PHS+ABI Time Series (MOVIE)


PHS+ABI 2017-5-19 (14:57:18)
Humidity [g/kg] at 496.6 hPa
Latitude
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Longitude
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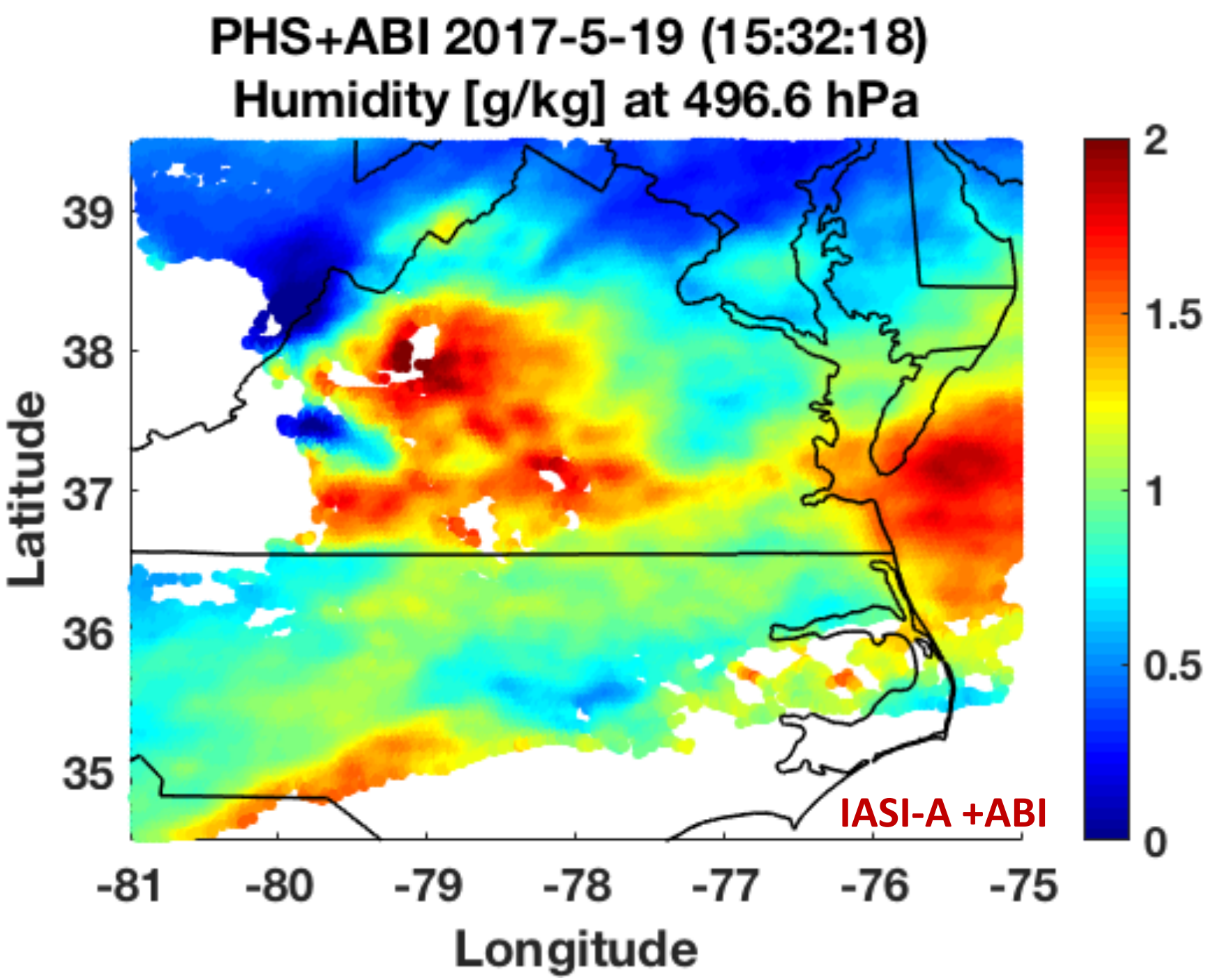
IASI-A +ABI


PHS+ABI 2017-5-19 (15:32:18)
Humidity [g/kg] at 496.6 hPa
Latitude
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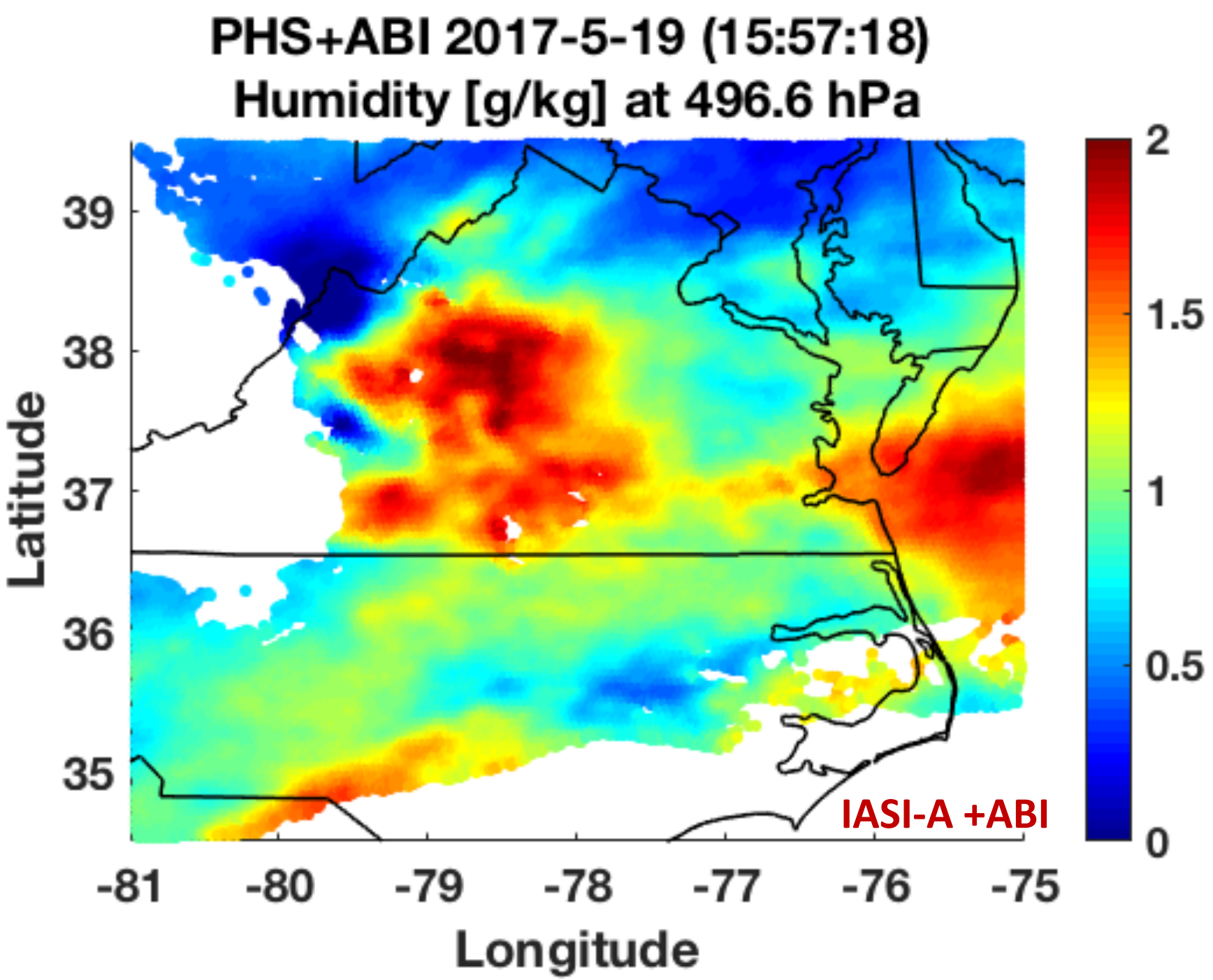
IASI-A +ABI


PHS+ABI 2017-5-19 (15:57:18)
Humidity [g/kg] at 496.6 hPa
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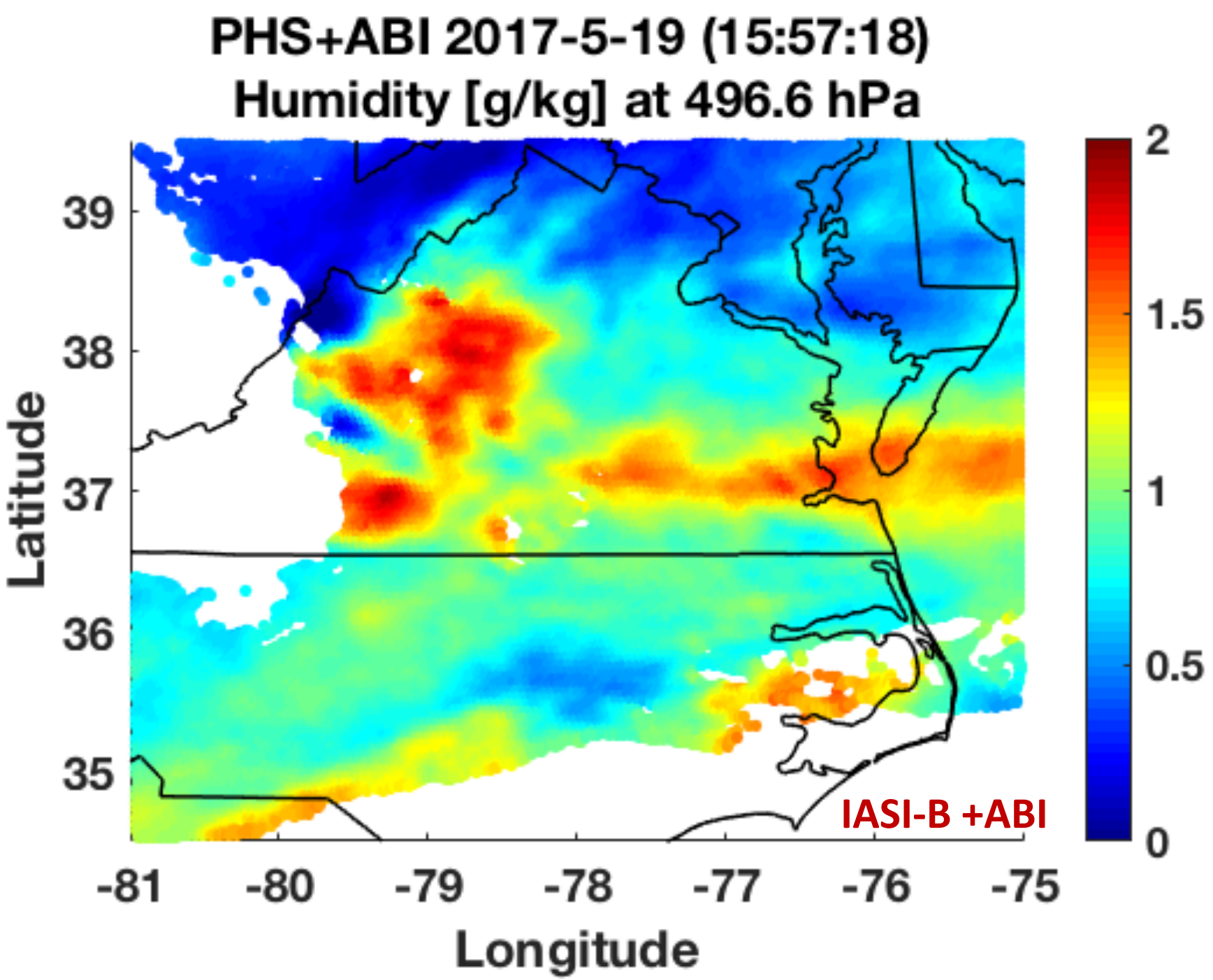
PHS+ABI 2017-5-19 (15:57:18)
Humidity [g/kg] at 496.6 hPa
Latitude
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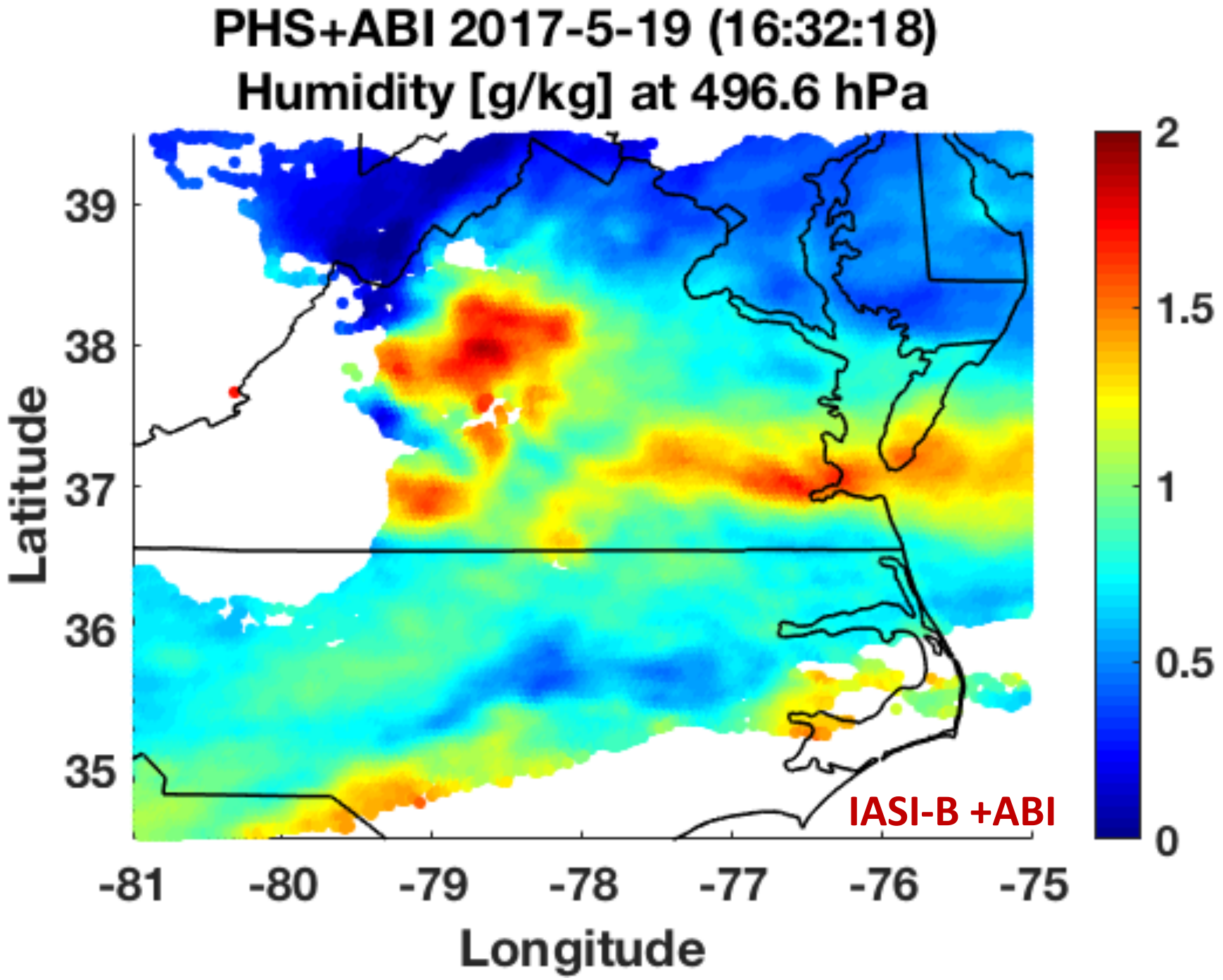
IASI-B +ABI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Humidity [g/kg] at 496.6 hPa
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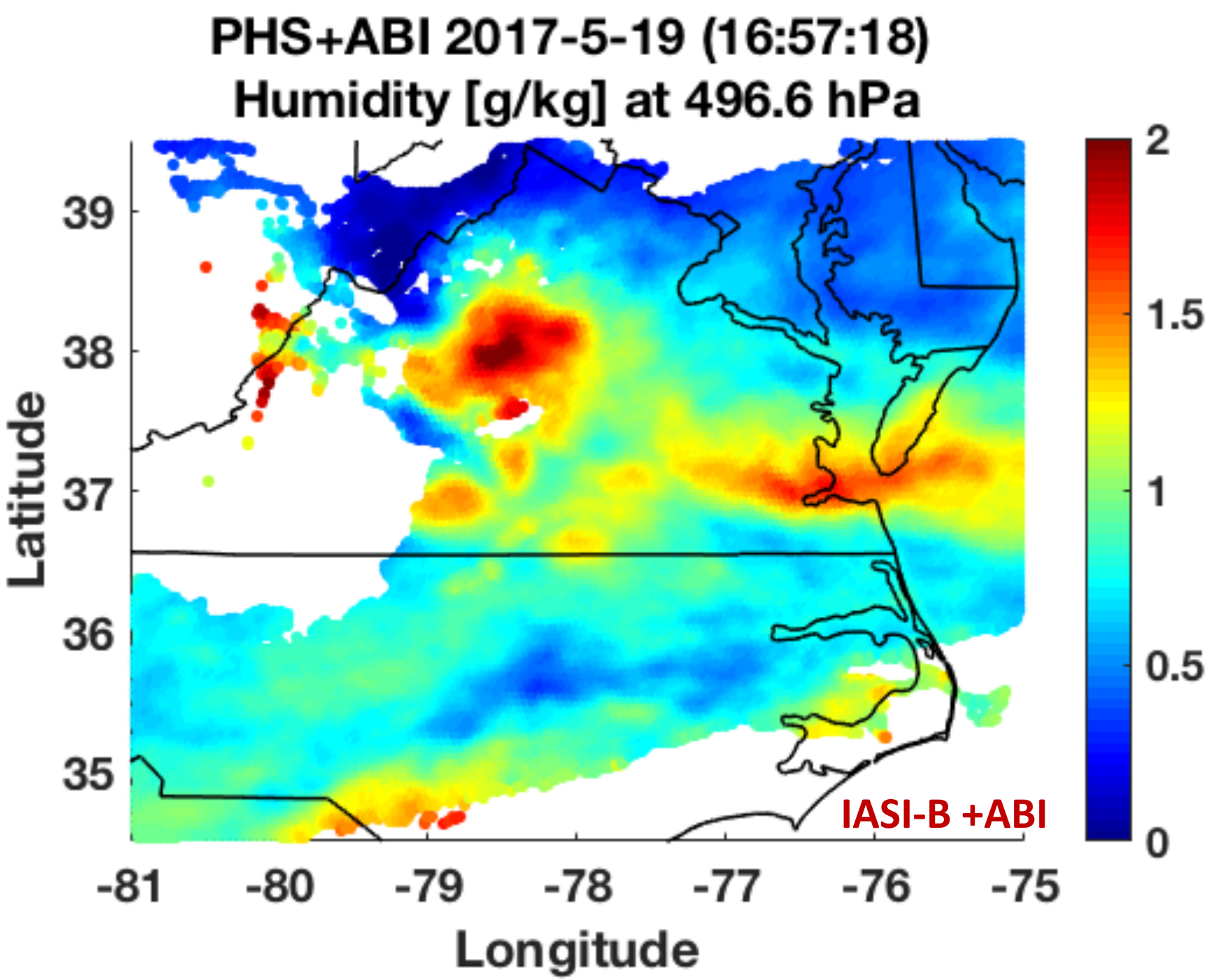
IASI-B +ABI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Humidity [g/kg] at 496.6 hPa
Latitude
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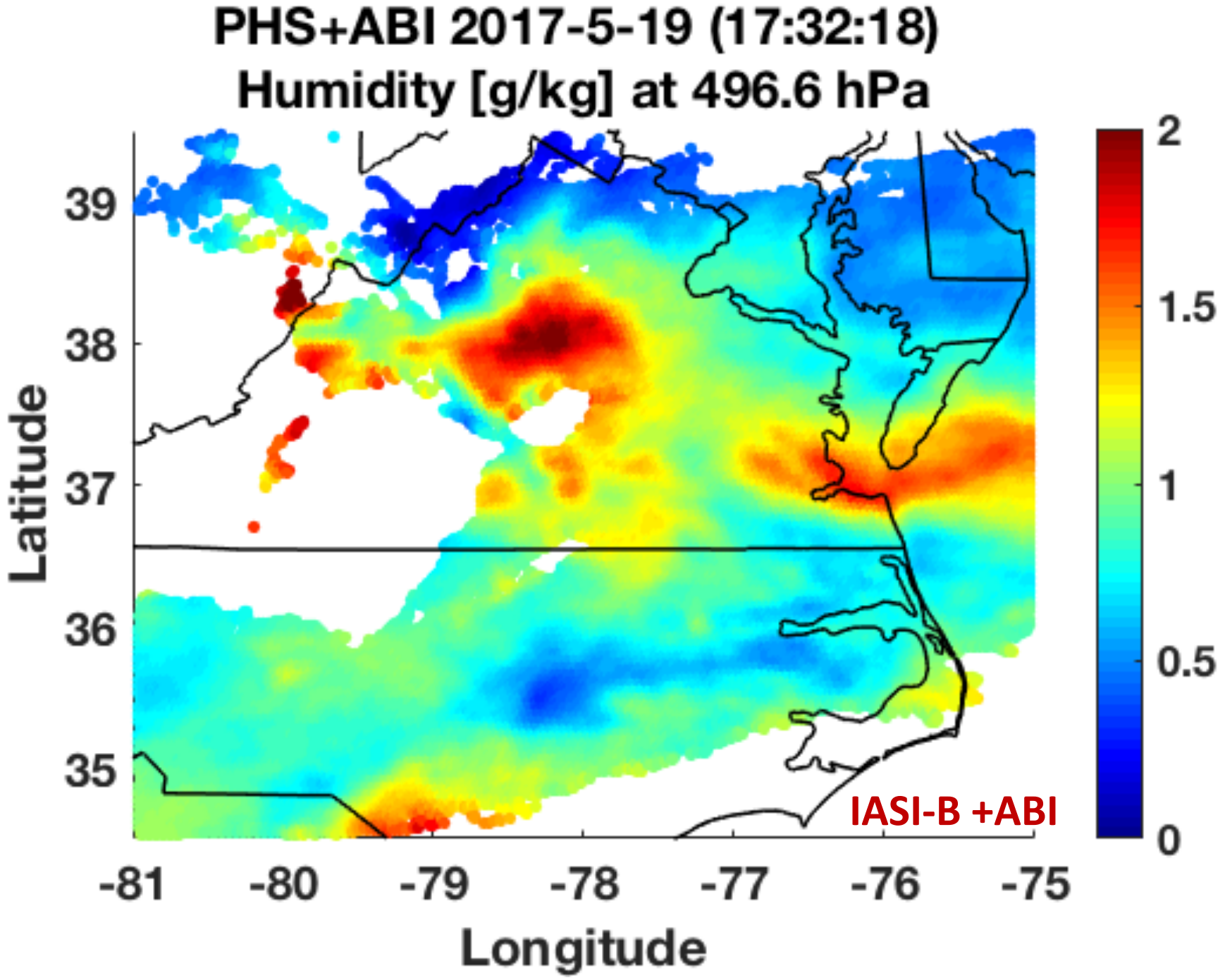
IASI-B +ABI


PHS+ABI 2017-5-19 (17:32:18)
Humidity [g/kg] at 496.6 hPa
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Longitude
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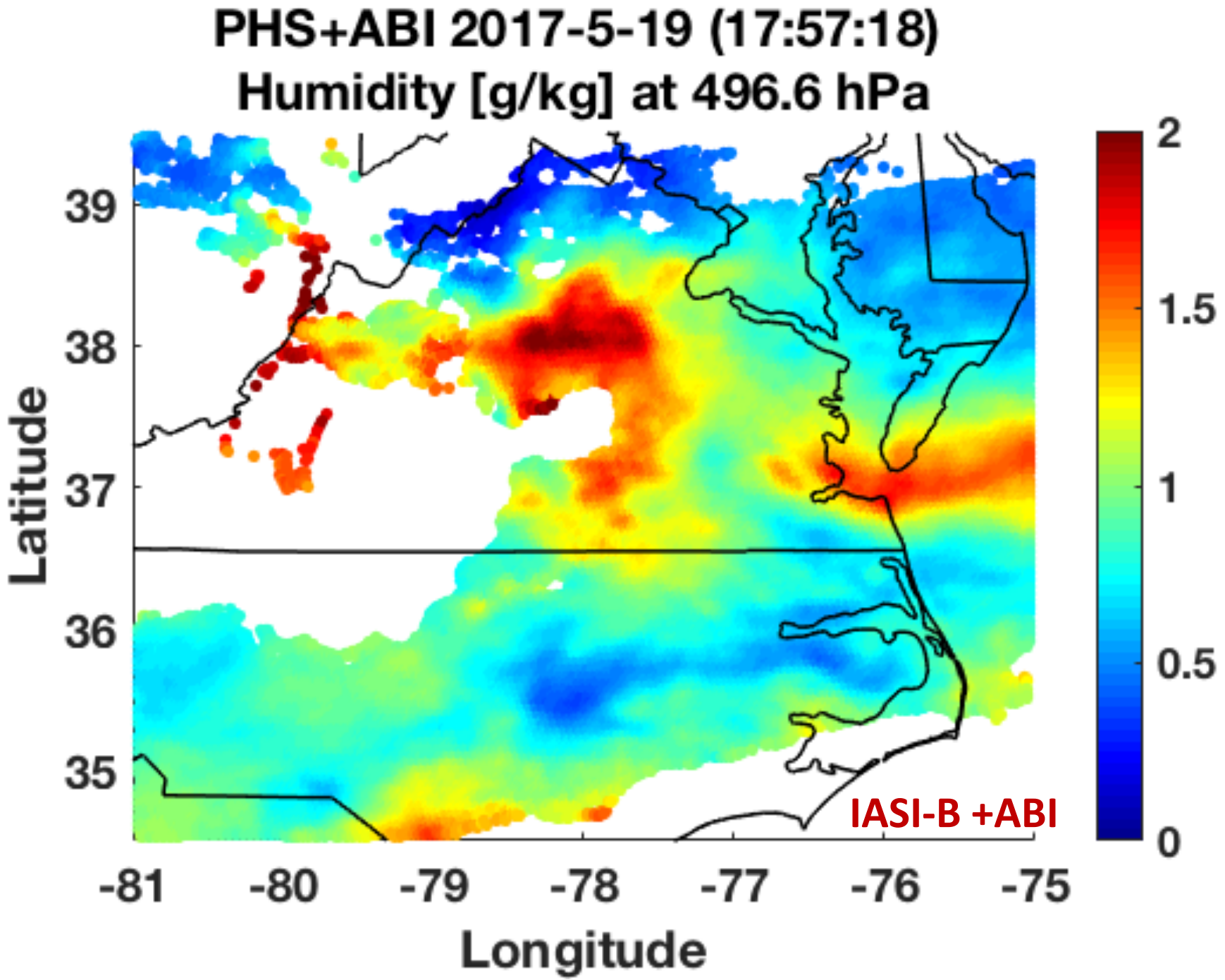
IASI-B +ABI


PHS+ABI 2017-5-19 (17:57:18)
Humidity [g/kg] at 496.6 hPa
Latitude
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Longitude
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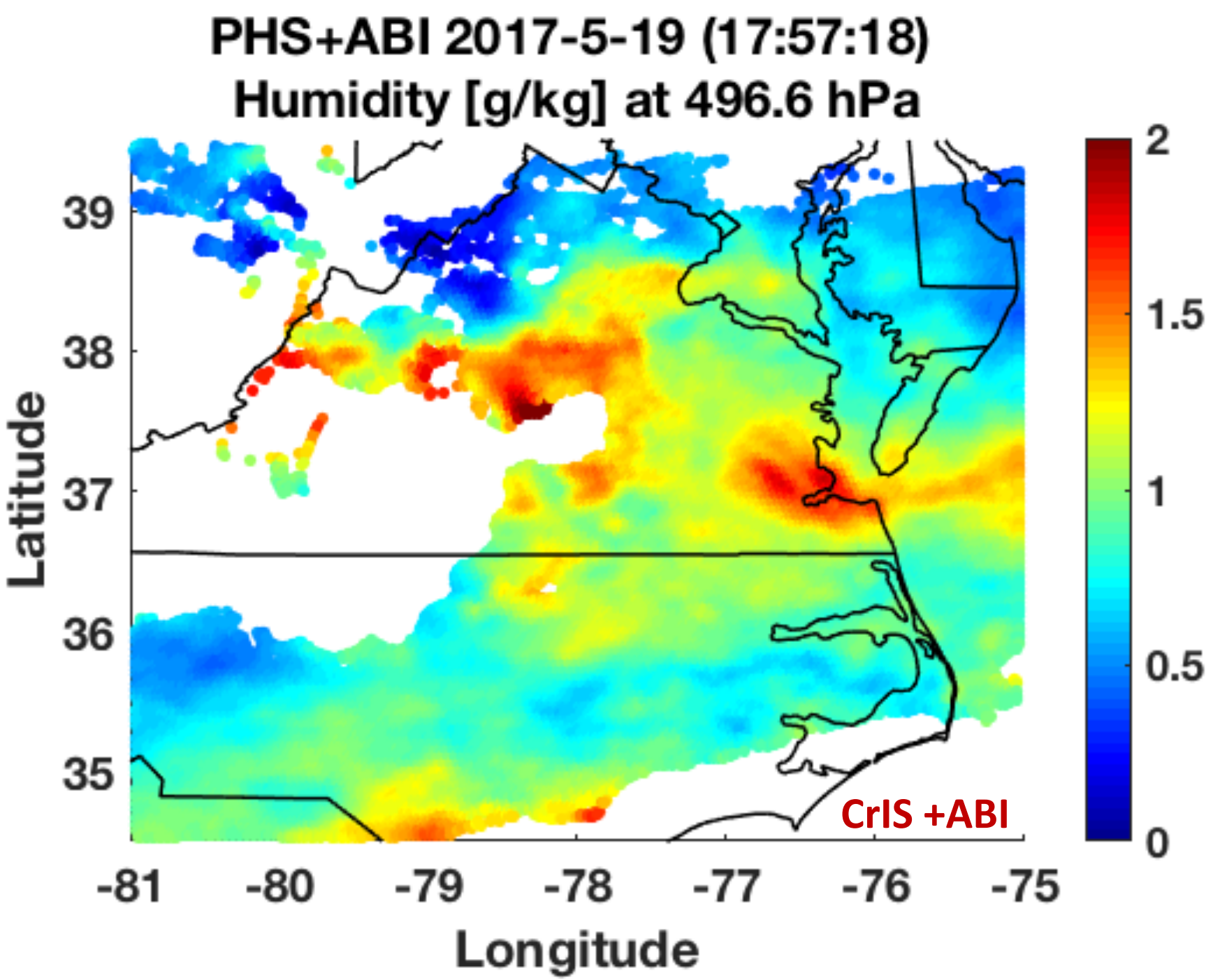
IASI-B +ABI


PHS+ABI 2017-5-19 (17:57:18)
Humidity [g/kg] at 496.6 hPa
Latitude
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Longitude
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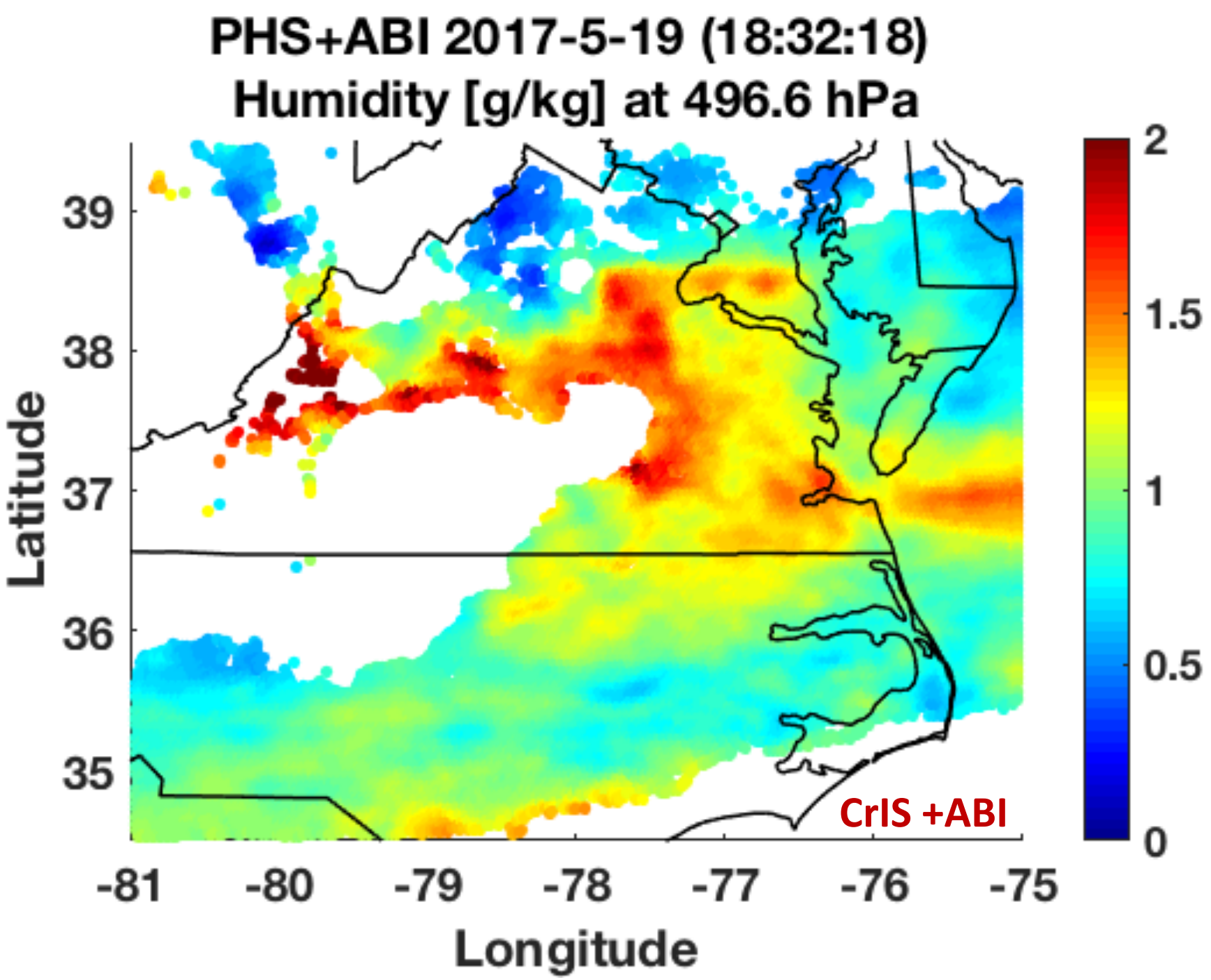
CrIS +ABI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Humidity [g/kg] at 496.6 hPa
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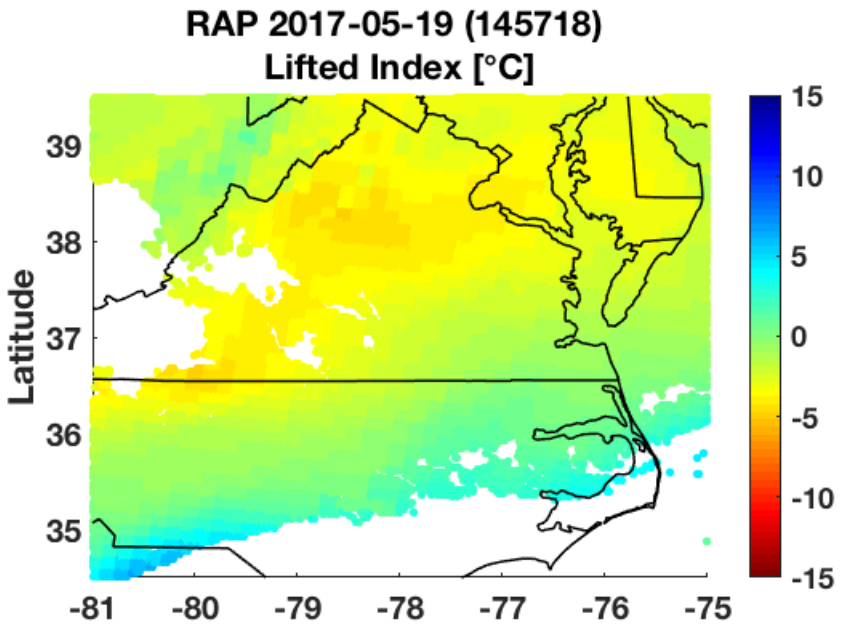
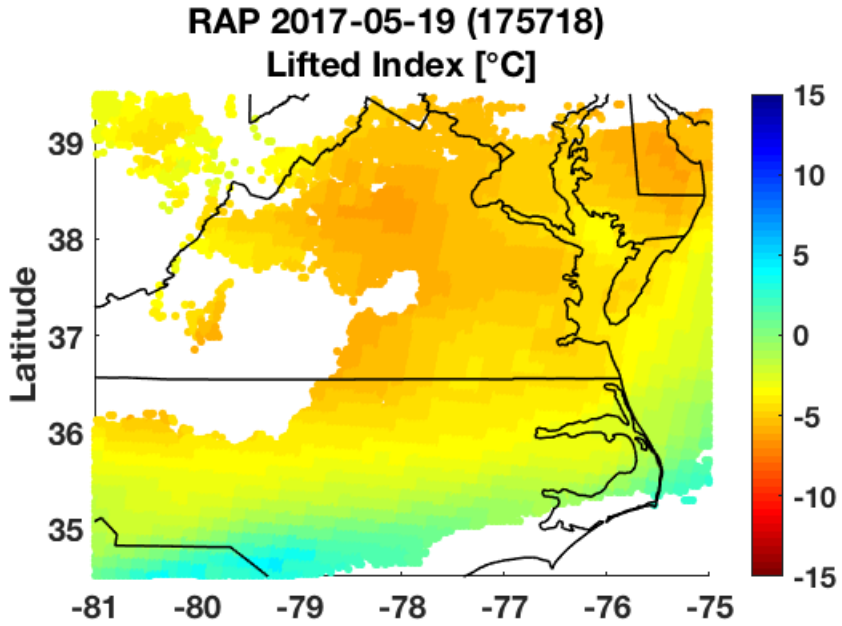
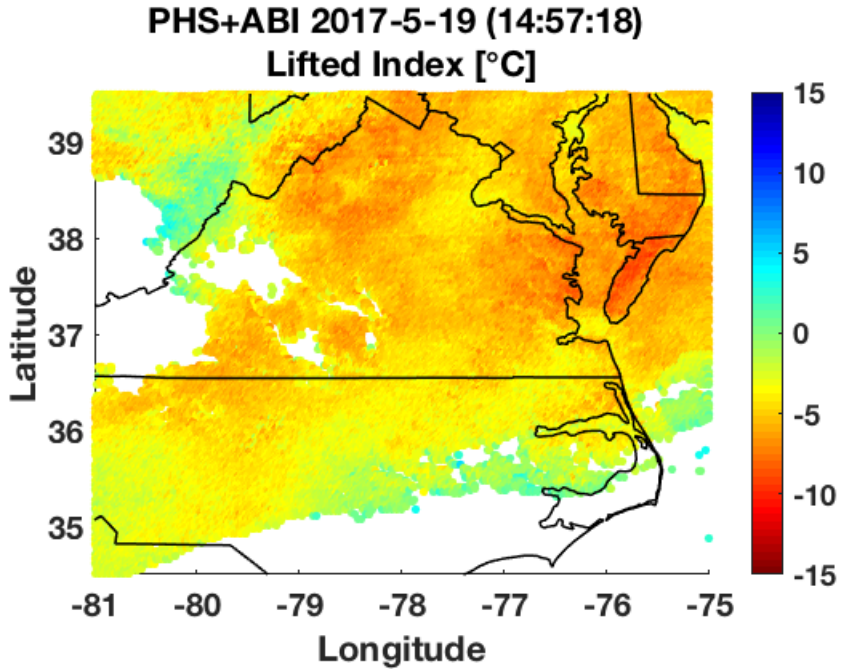
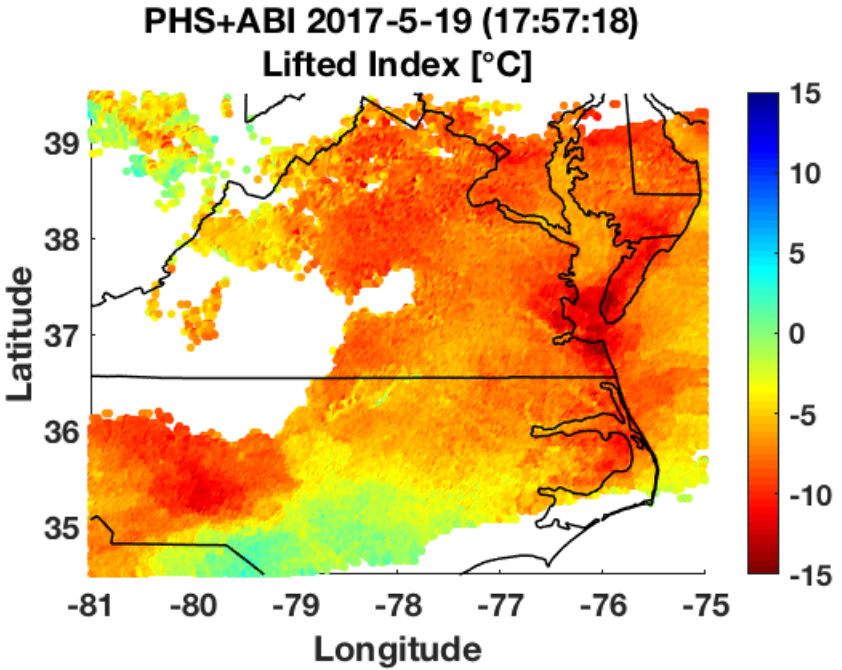
CrIS +ABI

Atmospheric Stability Change

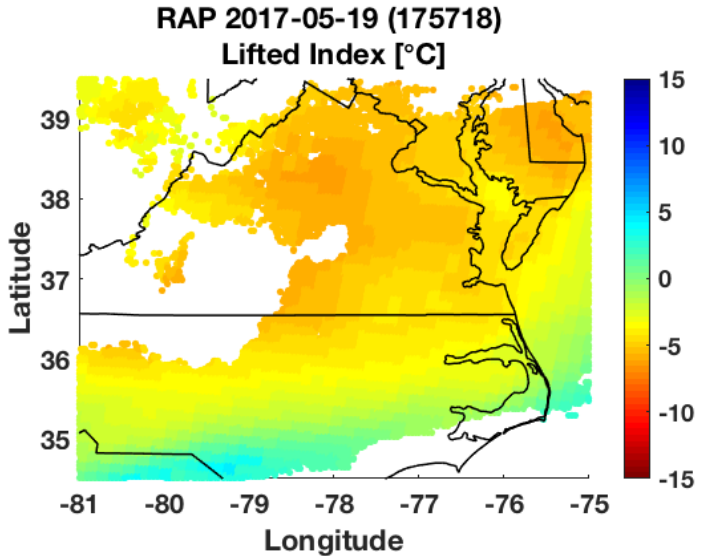


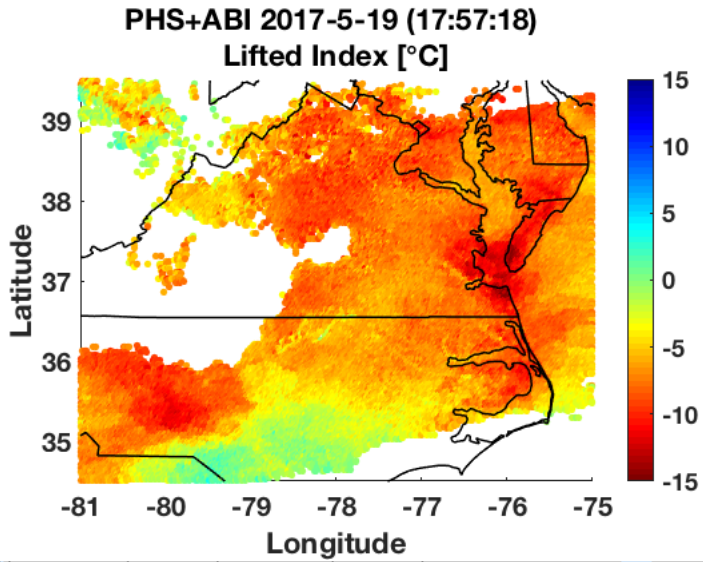


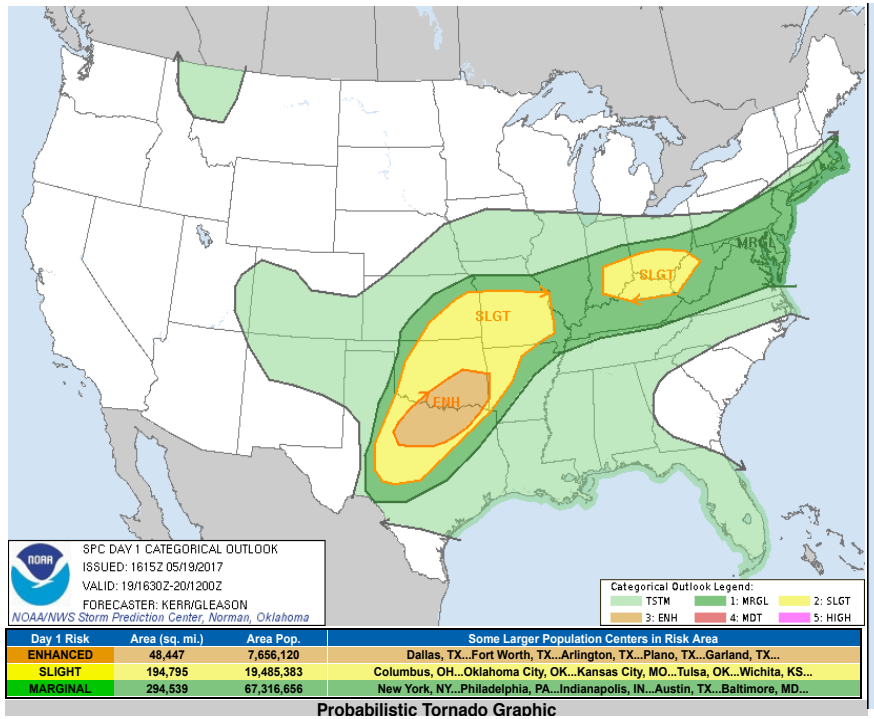




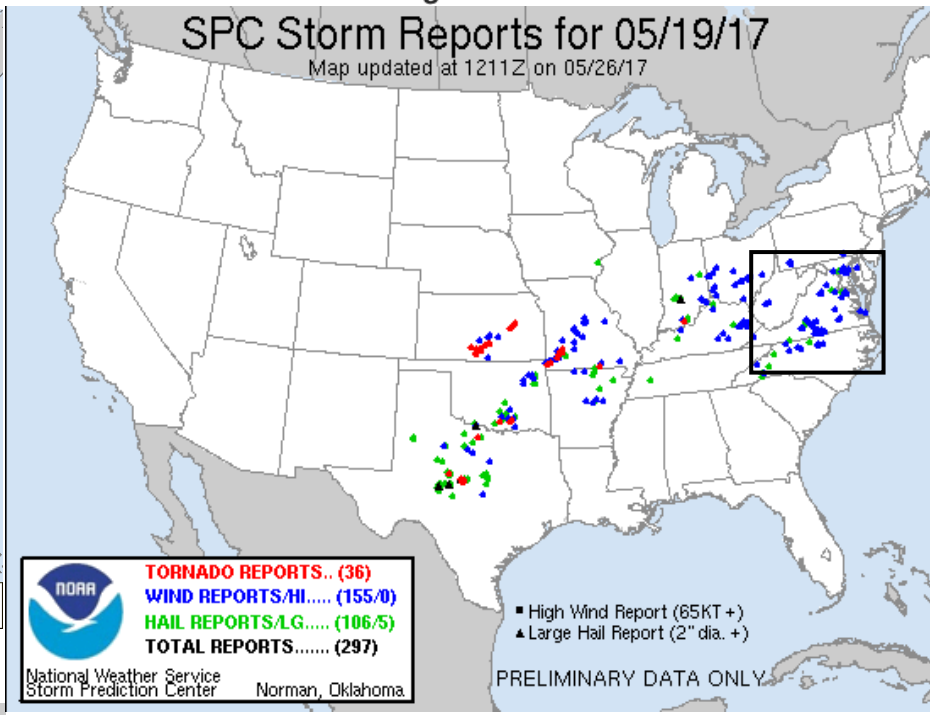
HR Severe Weather Not Predicted by NWS (May 19, 2017)







Probabilistic Tornado Graphic



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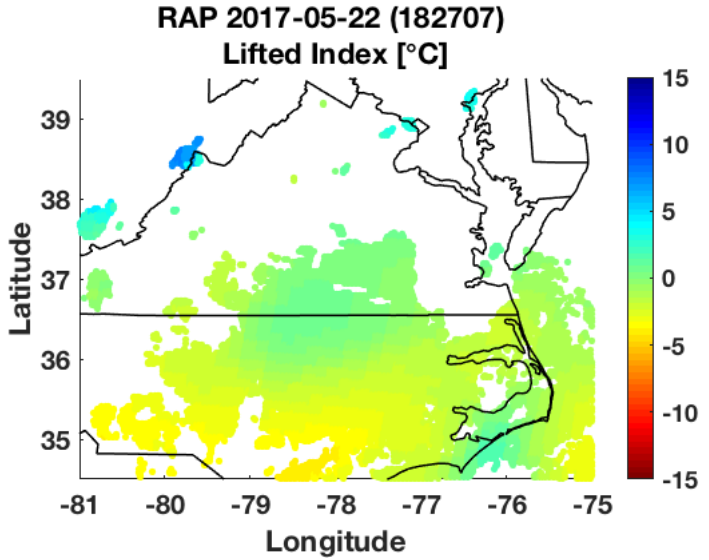

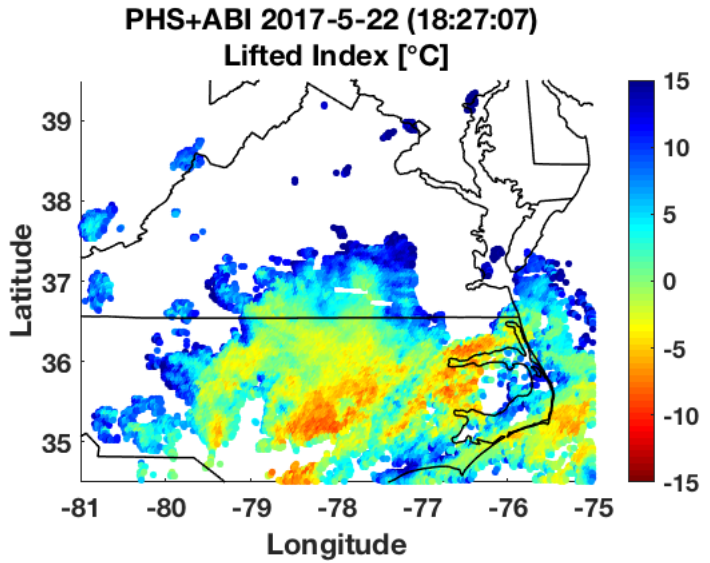

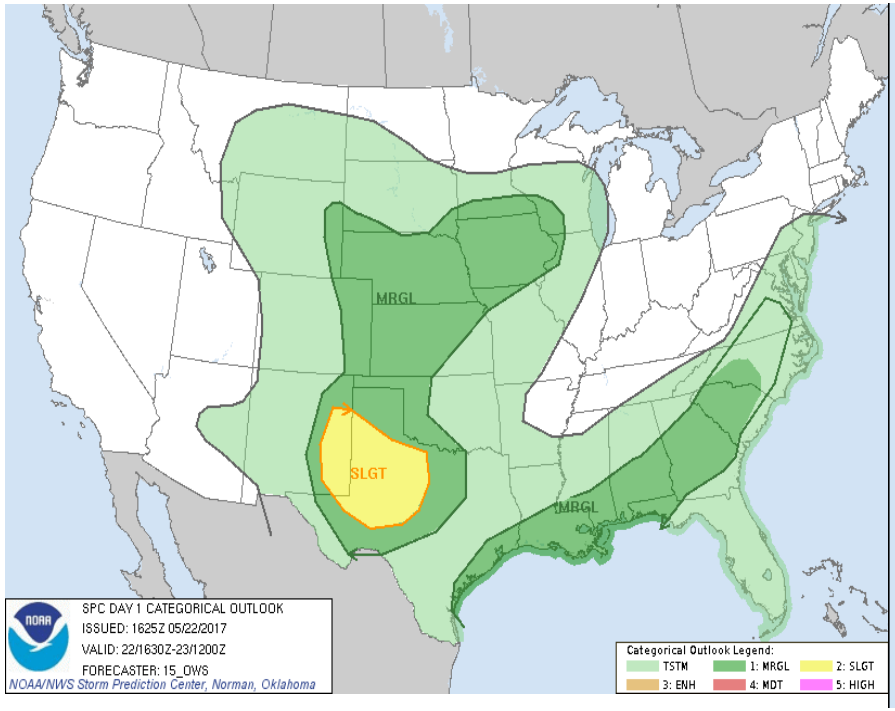

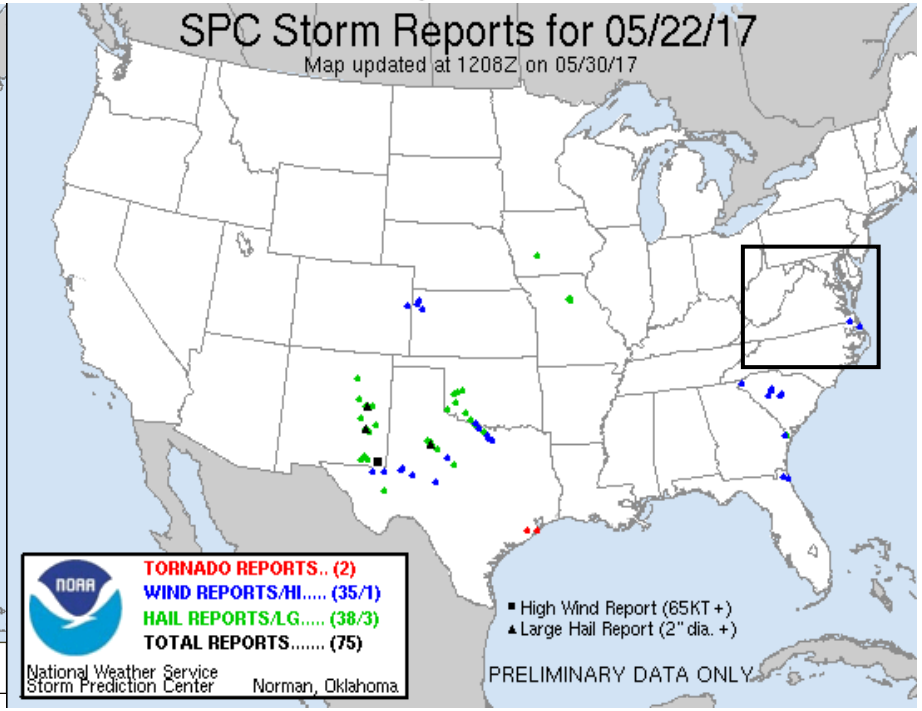

Summary and Conclusions

- **Profile Retrievals from Polar Hyperspectral Sounders and Geostationary Multi-spectral Instruments to Optimize the Vertical, Horizontal, and Temporal resolution of the Satellite Sounding Product**
  - Improving low altitude sounding coverage in partly cloudy areas
  - Observe spatial mesoscale details important for intense weather prediction
  - Provide high temporal resolution for predicting the onset of severe convection
  - Provide altitude-resolved water vapor imagery time sequences potentially useful for estimating 4-d wind profiles for NWP applications
- **Technique Can Provide Near-Global Coverage Using be Polar Satellite Hyperspectral Sounders (e.g., IASI, CrIS, HIRAS) Data Obtained Using the International Network of Direct Broadcast Systems (e.g., DBnet) and Geostationary Satellite Multi-spectral Instruments (e.g., ABI, AHI, AMI, and SEVIRI)**
- **PHS + ABI is NOT a replacement for the Geo-Hyperspectral Sounder**