



NOAA Aerosols and Ocean Science Expeditions (AEROSE) and Satellite Sounder EDR Validation

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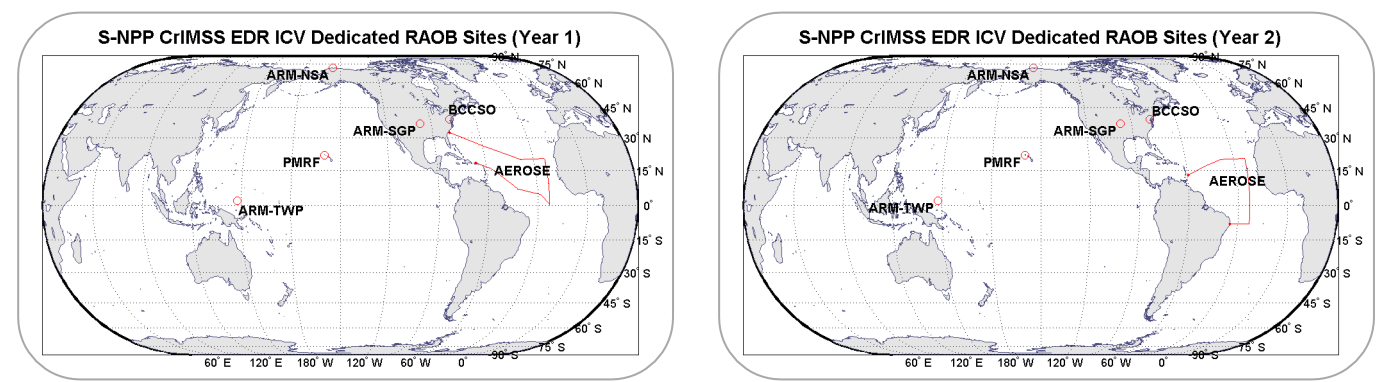


AEROSE

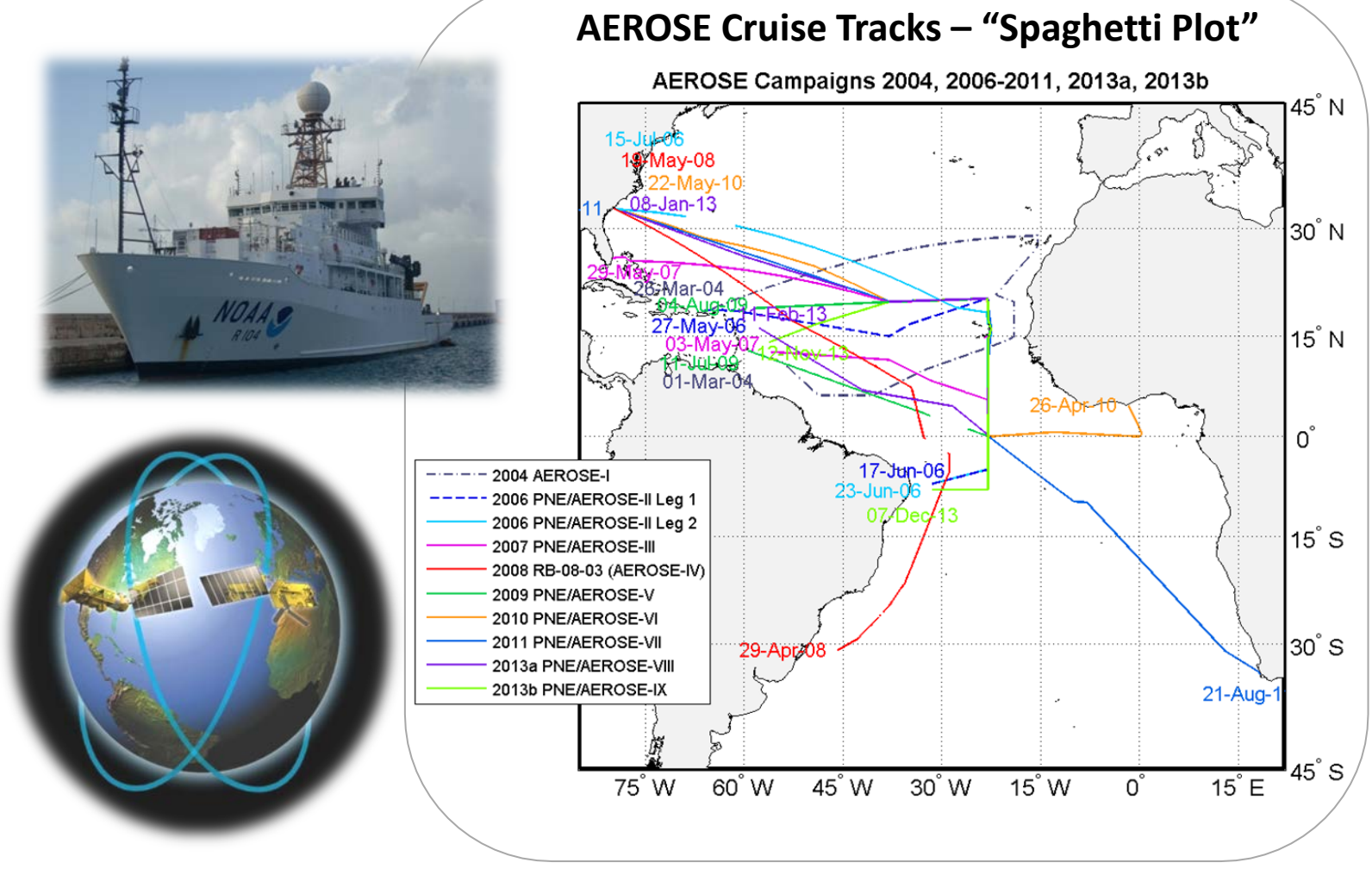


NOAA Aerosols and Ocean Science Expeditions (AEROSE)

- Trans-Atlantic intensive field campaigns conducted aboard the NOAA Ship *Ronald H. Brown* (Morris *et al.* 2006; Nalli *et al.* 2011):
 - AEROSE-I (March 2004; 4 weeks)
 - PNE/AMMA/AEROSE-II (Jun-Jul 2006; two legs, 8 weeks)
 - PNE/AEROSE-III (May 2007; 4 weeks)
 - AEROSE-IV (Apr-May 2008; 3.5 weeks)
 - PNE/AEROSE-V (Jul-Aug 2009; 4 wks)
 - PNE/AEROSE-VI (Apr-May 2010; 4 wks)
 - PNE/AEROSE-VII (Jul-Aug 2011; 5 wks)
 - PNE/AEROSE-VIII (Jan-Feb 2013; 5.5 wks)**
 - PNE/AEROSE-IX (Nov-Dec 2013; 4 wks)**
- AEROSE has yielded an unprecedented collection of *in situ* measurements of the Saharan air layer (SAL) and associated African dust and smoke outflows over the tropical Atlantic Ocean
 - Transport, microphysical evolution and regional impacts
 - Regional atmospheric chemistry and marine meteorology
- Ocean-based truth data (e.g., dedicated RAOBs) from AEROSE forms an important component of the overall JPSS Intensive Cal/Val (ICV) effort (Nalli *et al.* 2006, 2011, 2013; Xie *et al.* 2013)



- The AEROSE domain is germane to satellite sounder mesoscale-synoptic observing missions (e.g., operational user Advanced Weather Interactive Processing System, AWIPS)
 - Saharan air layer (SAL) and distribution of tropical water vapor
 - Dust and biomass burning aerosols
 - Tropospheric ozone dynamics



PNE/AEROSE Partnership

- Participating Institutions
 - Howard University NOAA Center for Atmospheric Sciences (HU/NCAS)
 - NOAA/NESDIS/STAR
 - University of Miami/RSMAS
 - NOAA/ESRL/PSD
 - NOAA/OAR Atlantic Oceanographic and Meteorological Laboratory (AOML)
 - NOAA Pacific Marine Environmental Laboratory (PMEL)
- Synergism
 - Low Cost – Low Risk
 - Engages broader science community on specific problems.
 - All parties gain access to all data.
 - AEROSE is a key component of the PNE cruises. NOAA's allocation of ship time on the *Ronald H. Brown* for PNE/AEROSE cruises is fully optimized.

NAME	INSTITUTION	COLLABORATION
N. Nalli, C. Barnet, T. Reale, A. Gambacorta, T. King, H. Xie, B. Sun, W. Wolf, et al.	NOAA/NESDIS/STAR	CrIMSS/GOES-R EDR Cal/Val IASI, AIRS Cal/Val IR Radiative Transfer NPOVCS
E. Joseph, V. Morris, M. Oyola, E. Roper, C. Spells, A. Flores, et al.	HU/NCAS Hampton U.	Aerosol and Chemistry Radiation Measurements Ozone sondes Helium
R. Lumpkin, G. Foltz, C. Schmidt	NOAA/NOML	PNE Chief Scientists TACI Moored CTDO, XBTs
P. Minnett, M. Szczodrak, M. Isiguro	UAM/RSMAS	M-AERI MW Radiometer All-sky camera
D. Wolfe et al.	NOAA/OAR/ESRL/PSD	Vaisala Sounding System, Surface Flux Measurements, Vaisala Ceilometer

AEROSE Truth Datasets

Dedicated Radiosonde Observations (RAOBs)

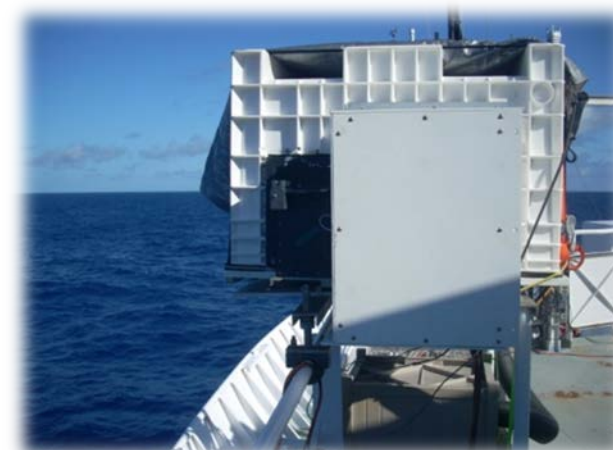
- Vaisala RS92 GPS rawinsondes
 - Launched coinciding LEO environmental satellite overpasses
 - Suomi NPP (CrIMSS)
 - MetOp-A and -B (IASI)
 - Aqua, A-Train (AIRS)
 - Pressure, temperature, humidity, PTU(z)
 - GPS Winds, u(z), v(z), and altitude, z(t)
 - Not uploaded into GTS (i.e., *not assimilated*)
 - 892 total RAOBs to date
 - 110 PTU soundings in Jan-Feb 2013
 - 96 PTU soundings in Nov-Dec 2013



- ECC Ozone sondes interfaced with RS92
 - Measure O₃(z) partial pressure
 - ~1/day during S-NPP and MetOp overpasses
 - 156 O₃ soundings to date
 - 24 O₃ soundings in Jan-Feb 2013
 - 19 O₃ soundings in Nov-Dec 2013

Marine Atmospheric Emitted Radiance Interferometer (M-AERI)

- Ship-based FTS that measures downwelling and upwelling calibrated IR spectra (Minnett *et al.* 2001)
- High accuracy calibration using 2 NIST-traceable blackbodies
- Derived (EDR) products
 - High accuracy skin SST derived from semi-opaque spectral region (~7.7 μm) (Smith *et al.* 1996)
 - Skin SST is an important state parameter and "ground truth"
 - Retrievals of lower tropospheric profiles at turbulent time scales (e.g., Szczodrak *et al.* 2007)
 - Ocean surface spectral emissivity (e.g., Hanafin and Minnett 2005; Nalli *et al.* 2008b)



Other Shipboard Data

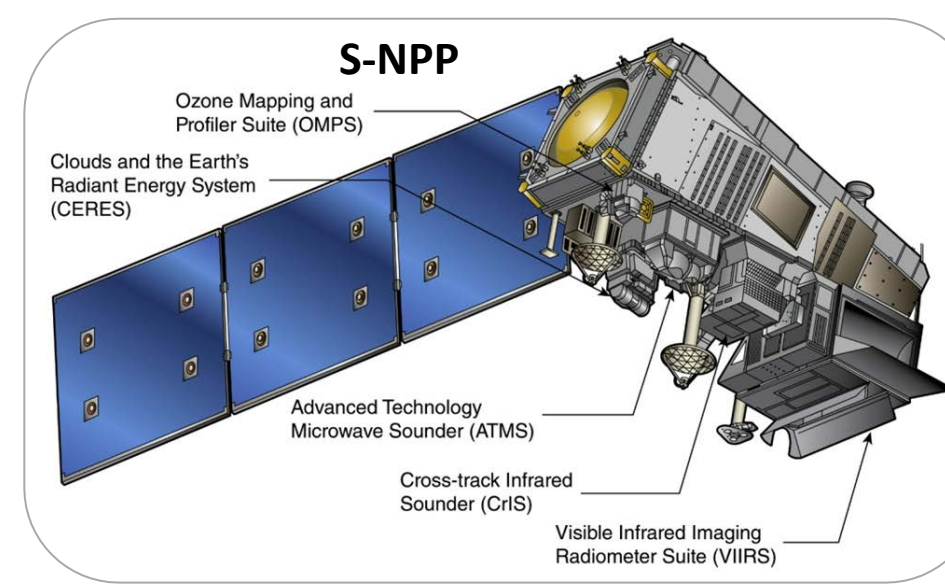
- Microtops Sunphotometer
 - Multi-channel raw data provides information on changes in total column aerosols
 - Since 2009, the AEROSE Team collaborated with the NASA/GSFC AERONET Maritime Aerosol Network (Smirnov *et al.* 2011).
- Vaisala Ceilometer (low power lidar) attenuated backscatter for aerosol vertical distribution
- Broadband pyranometers and pyrgeometers (downwelling LW and SW Fluxes)
- In situ gas & particle measurements
- Meteorological and oceanographic surface measurements



Satellite Sounder Environmental Data Record (EDR) Validation Over Open Ocean

Satellite Sounder EDRs

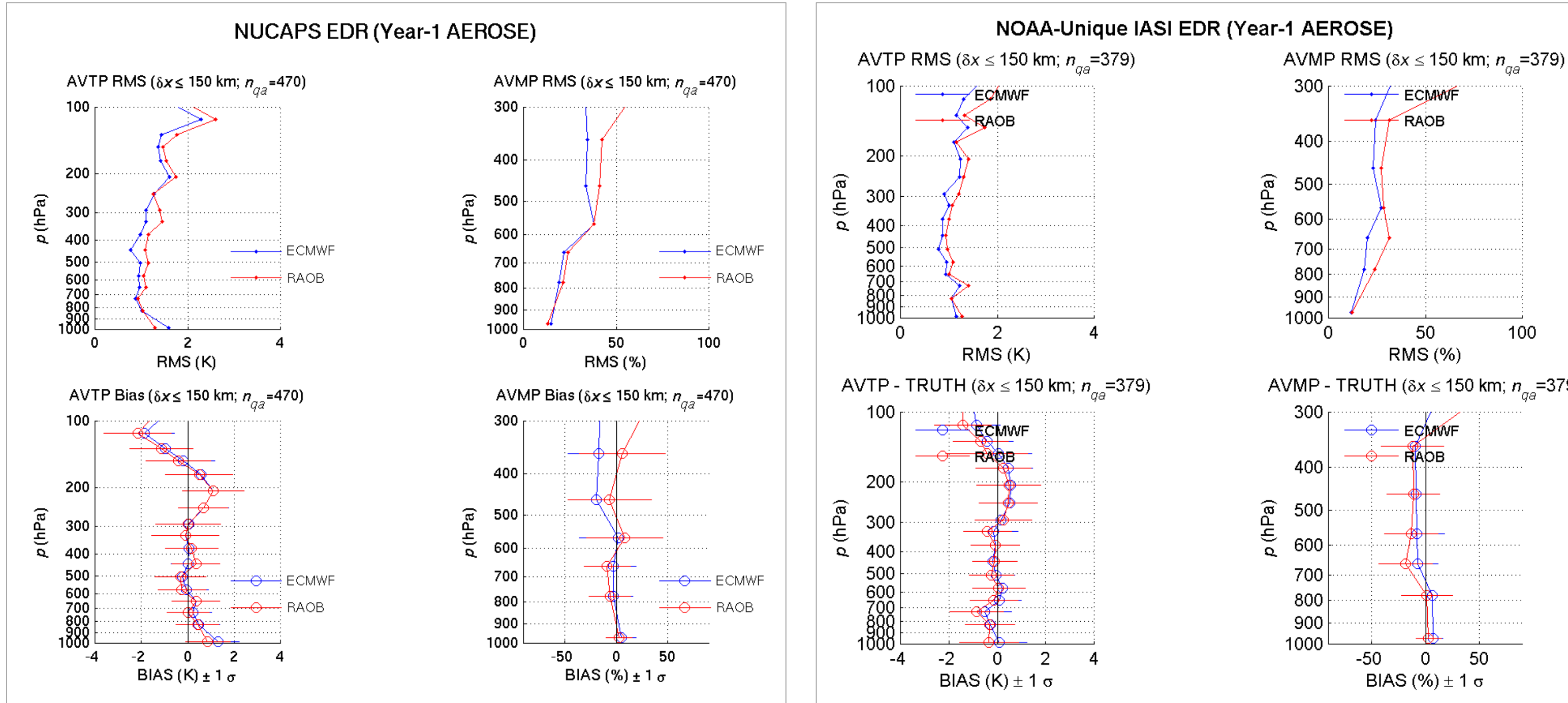
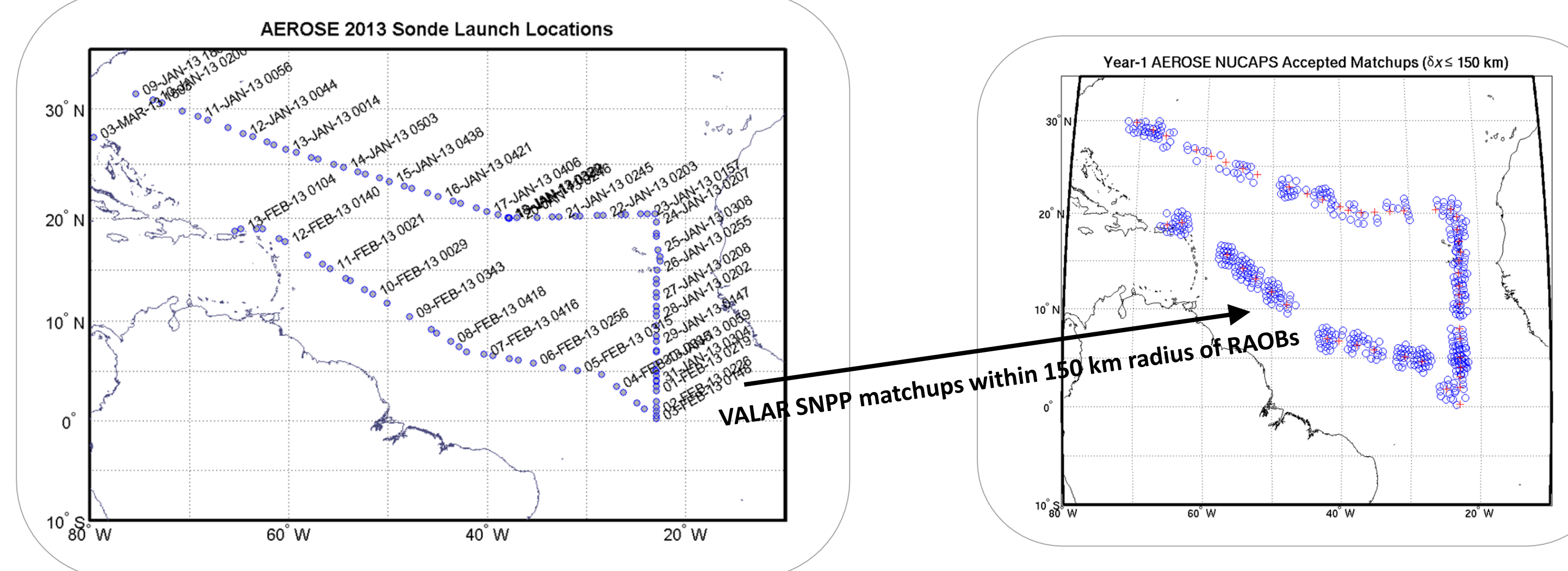
- S-NPP Cross-track Infrared Microwave Sounder Suite (CrIMSS)
 - NOAA-Unique CrIS/ATMS Processing System (NUCAPS) EDR
 - See 10thGOES-R/JPSS Oral 9.1, Gambacorta *et al.*
 - Original CrIMSS IDPS EDR
- MetOp-A, -B NOAA-Unique IASI EDR
- Aqua AIRS Science Team EDR (dedicated RAOBs for S-NPP)



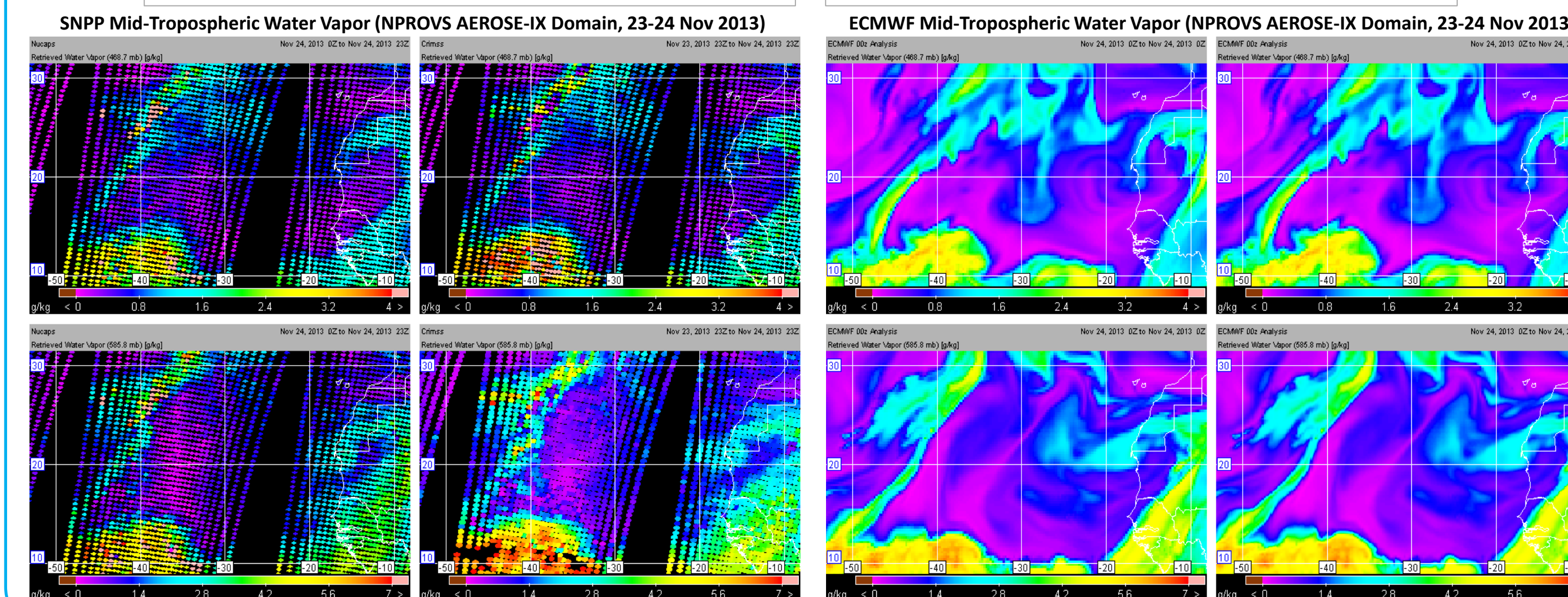
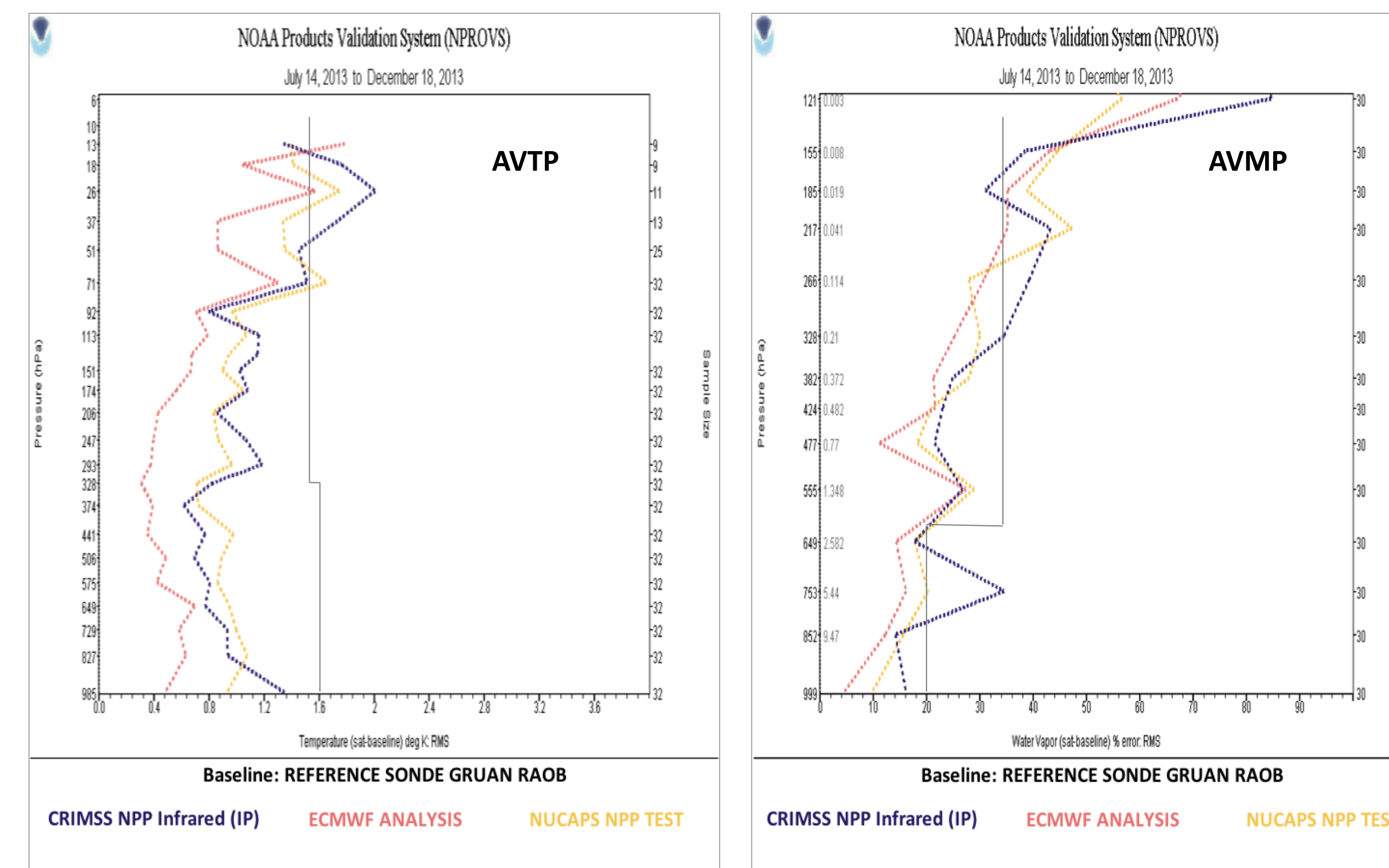
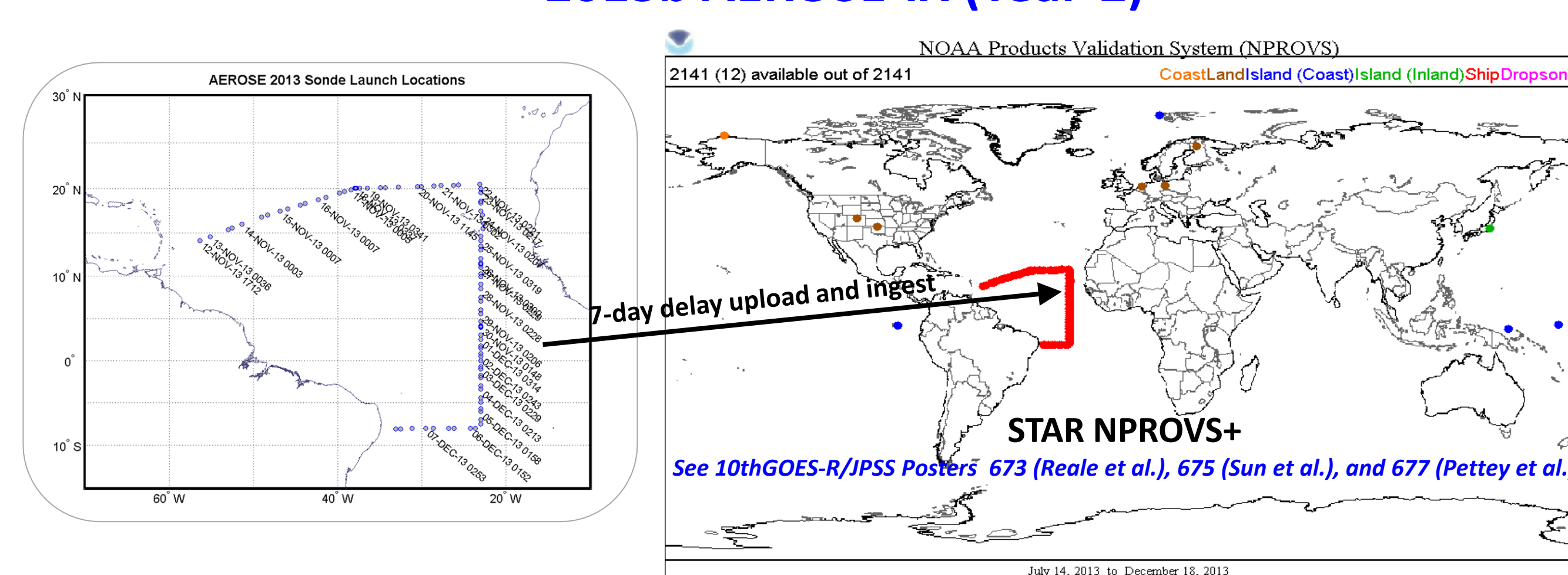
2013a AEROSE-VIII (Year-1)

STAR EDR Validation Archive (VALAR) and Methodology

See 10thGOES-R/JPSS Oral 9.3, Nalli *et al.*



2013b AEROSE-IX (Year-2)



Summary

- AEROSE has compiled a multiyear set of ship-based, marine *in situ* cross-sectional truth measurements over the tropical Atlantic Ocean.
 - The cruise domains span a region of meteorological interest in terms of the SAL, tropical storm formation, and tropospheric ozone/carbon/aerosol chemistry and transport.
 - Numerous interdisciplinary applications of these data
- AEROSE contribution to satellite sounder EDR intensive cal/val includes (e.g., Nalli *et al.*, 2011)
 - AEROSE domain is an important region for observations from satellite sounder missions, thus validation is desirable.
 - Oceans cover ~70% of Earth surface area and it is the satellite data over oceans that have the biggest impact on NWP.
 - Ocean-based truth data carries unique value for cal/val given that the ocean surface is far easier to characterize radiatively.
 - Ancillary data (M-AERI, ozone, etc.) enable the possibility of cal/val "dissections" (Nalli *et al.*, 2013)
- SNPP CrIMSS NUCAPS EDRs (and IASI EDRs) meet performance specifications versus AEROSE dedicated RAOB data.

Future Work

- SNPP CrIMSS NUCAPS Stages 1-3 Validated Maturities
 - AVTP, AVMP validation over open ocean, within and without Saharan air layer, dust, smoke
 - Dusty scene risk reduction
 - SAL detection
 - Ozone, carbon monoxide trace gas profile validation
 - Skin SST validation
 - Apply averaging kernels in error analysis (e.g., see 10thGOES-R/JPSS Oral 9.3, Nalli *et al.*)
 - NUCAPS EDR algorithm development
- The next AEROSE is on hold until a suitable replacement is found for the *Ronald H. Brown*, which NOAA is deploying to the Pacific Ocean for the next several years.

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- The PIRATA Northeast Extension Project; R. Lumpkin, C. Schmidt, G. Foltz (NOAA/AOML)
- Frank Tilley, Michael Pettay, W. W. Wolf, (NOAA/NESDIS/STAR)
- CrIMSS EDR cal/val team, especially Xu Liu (LaRC), Bill Smith (Hampton U.)
- T. Pagano (JPL) and the NASA Sounder Science Team
- The many students, who participated in, and contributed to, the campaigns over the years
- The officers and crew of the *Ronald H. Brown*

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