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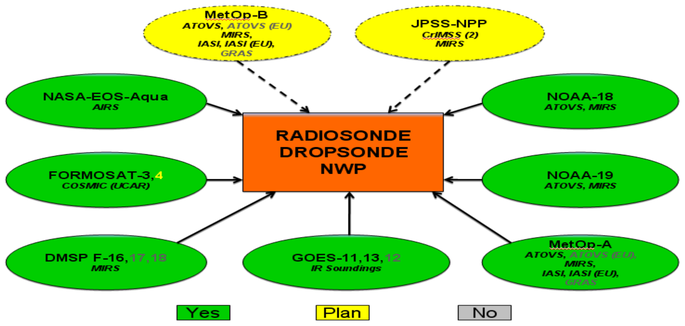
Evaluation of Satellite Sounding Products Using NOAA PROducts Validation System (NPROVS)

Bomin Sun[1], Anthony Reale[2], Michael Pettey[1], and Frank Tilley[1]

(1) I.M. Systems Group, Inc., Rockville, Maryland (Bomin.Sun@noaa.gov)
(2) NOAA NESDIS Center for Satellite Applications and Research (STAR), Camp Springs, Maryland

NPROVS Introduction

The NOAA PROducts Validation System (NPROVS) operated by the Office of SaTellite Applications and Research (STAR) provides daily compilation of collocated radiosonde and derived satellite soundings from multiple satellites and product systems



Advanced TIROS Operational Vertical Sounder (ATOVS)
- NOAA-18,19 and MetOp-A; AMSU and HIRS
- MetOp-B; AMSU and HIRS
- MetOp-A; AMSU, MHS and HIRS (**EUMETSAT**)
- MetOp-B; AMSU, MHS and HIRS (**EUMETSAT**)

Microwave Integrated Retrieval System (MIRS)
- NOAA-18,19 and MetOp-A; AMSU and MHS
- DMSP F-16, 17,18; SSMIS
- Metop-B; AMSU and MHS
- JPSS-NPP; ATMS

Geostationary (GOES)
- GOES 11,13, 12; Infra-Red Sounder

Atmospheric InfraRed Sounder (AIRS)
- NASA-EOS-Aqua; AIRS and AMSU

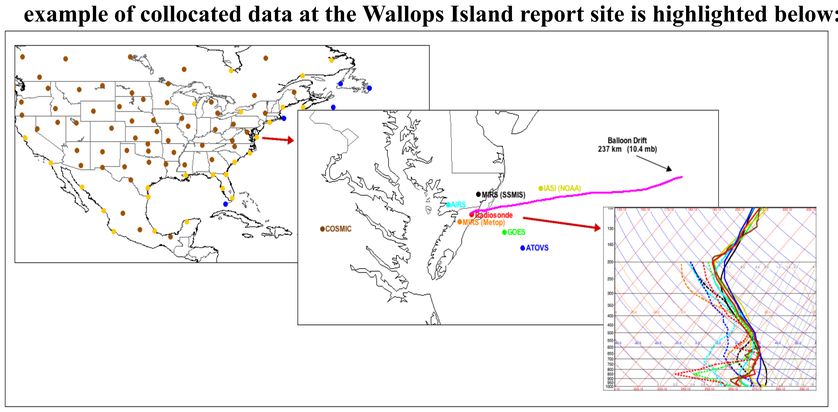
Infrared Atmospheric Sounding Interferometer (IASI)
- MetOp-A; IASI and ATMS
- MetOp-A; IASI (**EUMETSAT**)
- Metop-B; IASI and ATMS
- Metop-B; IASI (EU)

Constellation Observing System for Meteorology Ionosphere and Climate (COSMIC)
- Formosat-3, 4; GPSRO (UCAR)

CRoss-track Infrared Microwave Sounding System (CrIMSS)
- JPSS-NPP; CrIS and ATMS (2)

GNSS Receiver for Atmospheric Sounding (GRAS)
- MetOp-A; GPSRO (UCAR)
- MetOP-B; GPSRO (UCAR)

The NPROVS collocation strategy is consistent for all satellite product systems thus minimizing the introduction of systematic differences when characterizing respective product performance [Reale et al., J Atmos Ocean Tech 2012]. An example of collocated data at the Wallops Island report site is highlighted below:

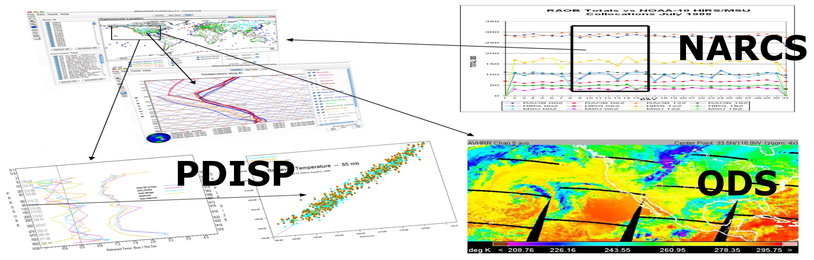


Key features of collocation strategy:
- **250 km space window**
- **+/- 6 hours time window**
- ***"Single, closest"* satellite profile to a given sonde retained from each product system**
- **Satellite ancillary data such as QC, cloud and terrain not considered in collocation**

NPROVS Web Site: http://www.star.nesdis.noaa.gov/smcd/opdb/poes/NPROVS.php

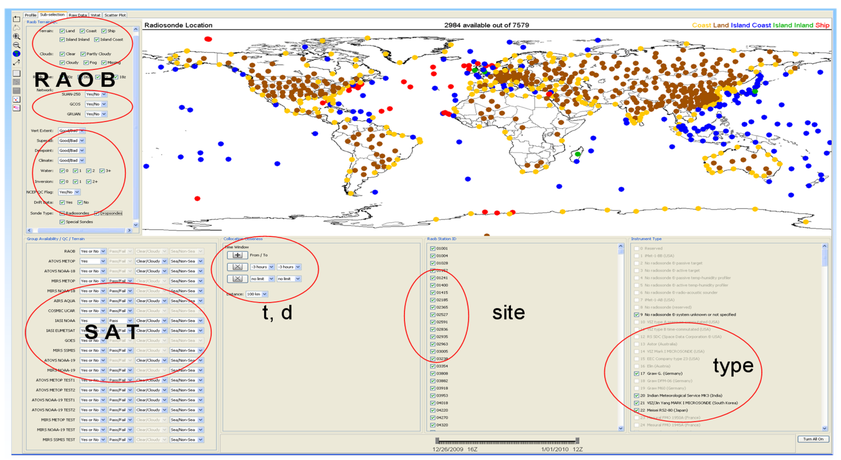
Satellite Products Validation

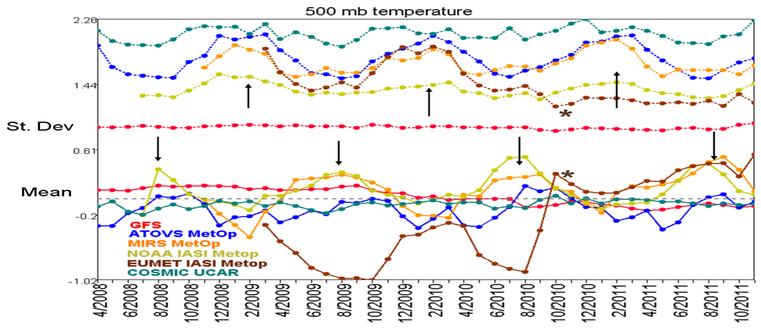
Environmental Data Graphic and Evaluation System *(EDGE)*
... *analytical interface*



NPROVS includes 3-way analytical interface

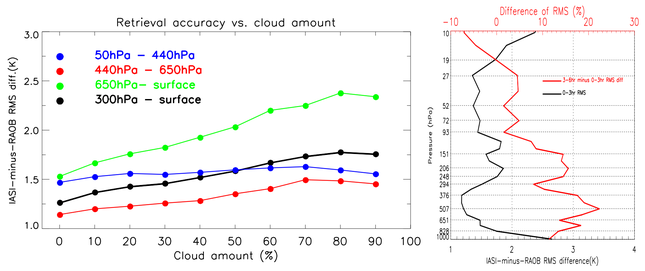
1) Profile Display (PDISP); short-term display and statistical analysis of collocations
2) NPROVS Archive Summary (NARCS); long-term trend analysis of satellite-minus-sonde differences
3) Orbital Display System (ODS); horizontal field display of all satellite data

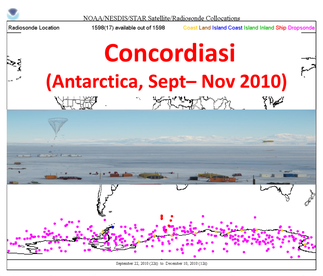




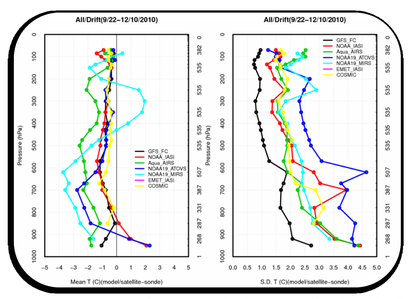
Monthly performance of mean (solid) and standard deviation (dashed) of 500mb temperature for selected satellite and forecast products versus global radiosondes over the period April 2008 through October 2011.

- **NOAA IASI retrieval accuracy evaluation using 2 years (2010 and 2011) IASI-RAOB data collected at NPROVS:**
  - **Cloud amount**
  - **Time window**





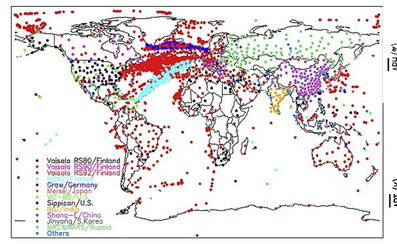
Collocations of dropsonde and radiosonde with satellite data in NPROVS.



Temperature validation statistics [Wang et al., WCRP 2011]

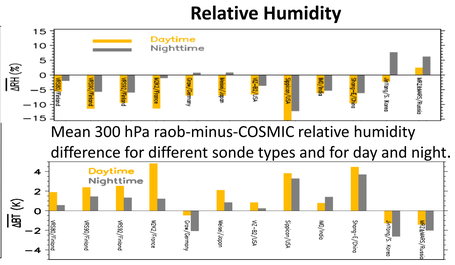
Uncertainties in Radiosonde Data

Radiosonde measurements are generally considered as the "reference" for satellite data validation in NPROVS. It's important to understand their accuracy characteristics.



Global distribution of radiosonde observations collocated with GPSRO COSMIC soundings (± 7 h, 250 km), 4/2008-10/2009.

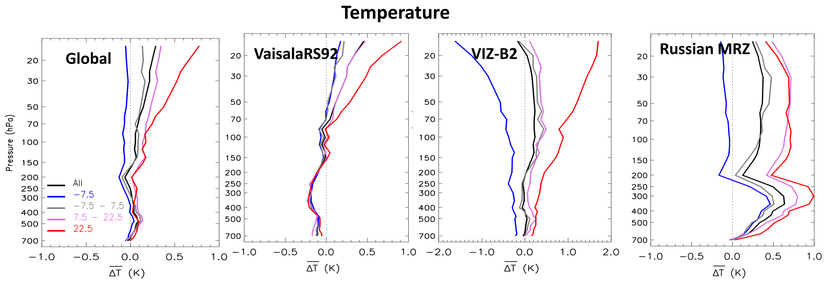
Relative Humidity



Mean 300 hPa raob-minus-COSMIC relative humidity difference for different sonde types and for day and night.

Same as above but for raob-minus-MHS upper tropospheric brightness temperature (BT). The MHS data is for MetOP chanal 3 (183 +/-1 gHz). Radiative model is used to compute raob BT [Sun et al., J Geophys Res 2010].

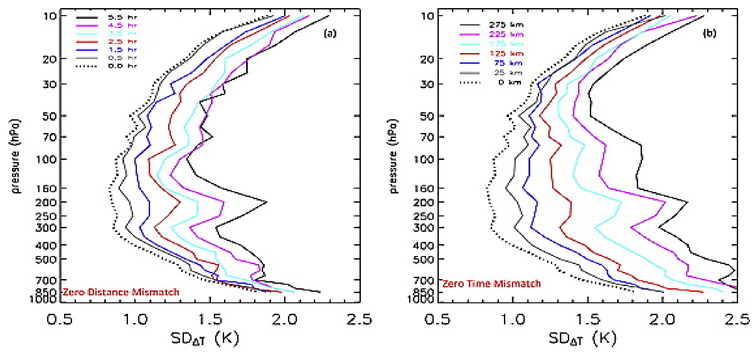
Temperature



Raob-minus-COSMIC temperature difference for May 2008- August 2011. Dark curves denote the statistics computed using ALL sample, and curves of other colors for different solar elevation angles as indicated by the legend. Examples of three sonde types are given. Sondes tend to show radiation-induced warm bias in the upper troposphere and low stratosphere [Sun et al., AMS annual meeting 2011].

Uncertainty due to Collocation Mismatch

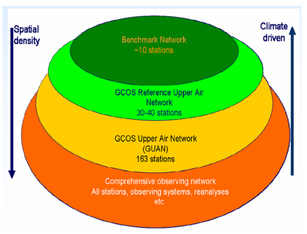
The standard deviation of raob-minus-COSMIC temperature difference ($SD_{\Delta T}$) is a measure of uncertainty associated with the mismatch in the collocation of the two observations [Sun et al., J Geophys Res 2010].



Dependence of $SD_{\Delta T}$ on time and distance collocation mismatch shows that collocation uncertainty increases as mismatch time or distance increases, due to atmospheric variability. Greatest mismatch uncertainty is in the lower troposphere where atmospheric variability is high and stratosphere where sonde measurement uncertainty is large.

GCOS Reference Upper Air Network (GRUAN)

Initially 15 stations, envisaged to be a network of 30-40 sites across the globe



GRUAN network objective is to constrain and calibrate data from more spatially-comprehensive global observing systems … including satellites and conventional radiosondes

Improved GRUAN / Satellite community interaction achieved through utility of NPROVS to routinely validate NPP satellite products at GRUAN site overpass using fully characterized sites atmospheric column Achieved through integrating reference sonde and ancillary ground data:

Coordinate with GRUAN WG Task Teams for Ancillary Measurement (Lidar, MWR, FTIR … satellites) and Measurement Scheduling to assess the availability of data, best measurement practices, associated uncertainties and the optimal mix (recipe) of measurements used to estimate the column state (SASBE)

Coordinate with GRUAN Analysis Team for Network Design and Operations Research (GATNDOR) to support and deploy "tool" to determine measurement compatibility given respective uncertainty estimations and spatial/temporal mismatch a key component of SASBE calculation

STAR Contact: Tony Reale
Email: Tony.Reale@noaa.gov
Internet: http://www.star.nesdis.noaa.gov/smcd/opdb/poes/