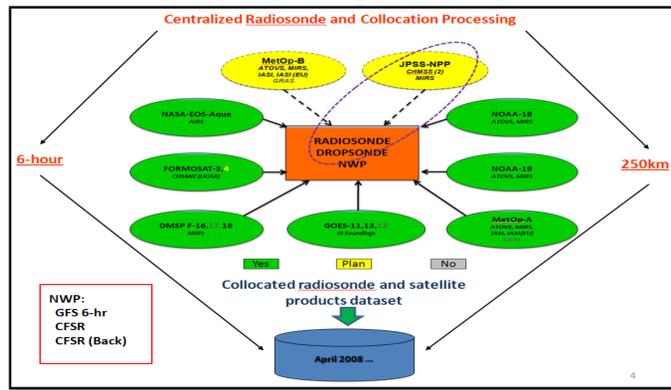


Validation of Pending Suomi-NPP Operational Sounding Retrievals Using Global Radiosondes and Future Plans

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INTRODUCTION

The NOAA Products Validation System (NPROVS) has been operated at the NOAA Center for Satellite Applications and Research (STAR) since April 2008. NPROVS provides centralized processing of operational conventional radiosondes (RAOB) and derived atmospheric sounding products from polar, geostationary and GPSRO environmental satellite platforms and is a key component of the Joint Polar Satellite System (JPSS) Cross-track Infrared (CrI) and Microwave Sounder Suite (CrIMSS) Environmental Data Record (EDR) Cal/Val plan. A schematic diagram of NPROVS and the operational satellite product systems routinely accessed is shown below:



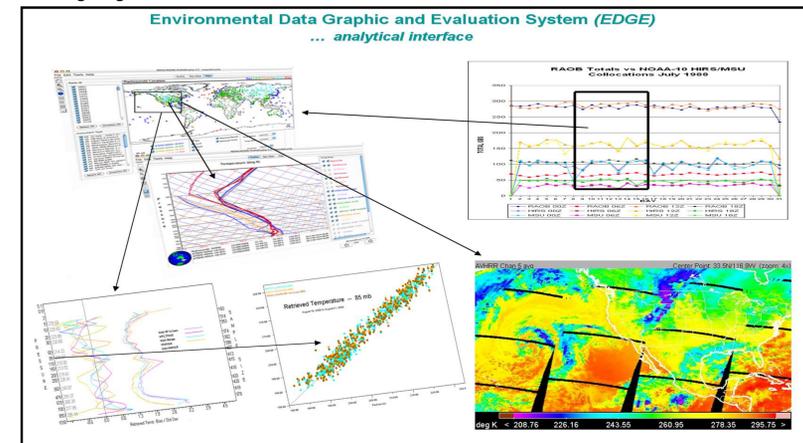
RAOB reports are from the WMO operational global network but are accessed by NPROVS after their assimilation into the NOAA Global Forecast System (GFS). Each report level includes a quality mark for temperature and moisture (Tdew) along with the "exactly" collocated 6-hour forecast. Corresponding NOAA Climate Forecast System Re-analysis (CFSR) and associated background are appended respectively.

The NPROVS collocation strategy for a given RAOB is to select the single, closest satellite sounding from each of the following:

- NOAA-18, 19, MetOp-A, MetOp-B, AMSU and HIRS
- **Microwave Integrated Retrieval System (MIRS)**
- NOAA-18, 19, MetOp-A, Suomi-NPP*, MetOp-B, AMSU and MHS, ATMS*
- Defense Meteorological Satellite Program (DMSP) F-16; SSMIS
- **Geostationary (GOES)**
- GOES 11 and 13; Infra-red Sounder
- **Atmospheric InfraRed Sounder (AIRS, version 5)**
- NASA-Earth Orbiting Satellite Aqua; AIRS and AMSU
- **Infrared Atmospheric Sounding Interferometer (IASI) NOAA**
- MetOp-A, MetOp-B, IASI and ATMS
- **Infrared Atmospheric Sounding Interferometer (IASI) EUMETSAT**
- MetOp-A, MetOp-B, IASI and ATMS
- **Constellation Observing System for Meteorology Ionosphere and Climate (COSMIC) UCAR (version1)**
- Formosat-3; GPSRO
- **Green-track Infrared (CrIS) and Microwave (AMTS) Sounder Suite (CrIMSS)**
- 1) Interface Data Processing Segment (IDPS ... version 6.2)
- 2) NOAA Unique CrIS/ATMS Processing System (NUCAPS)
- Suomi-NPP, CrIS and ATMS

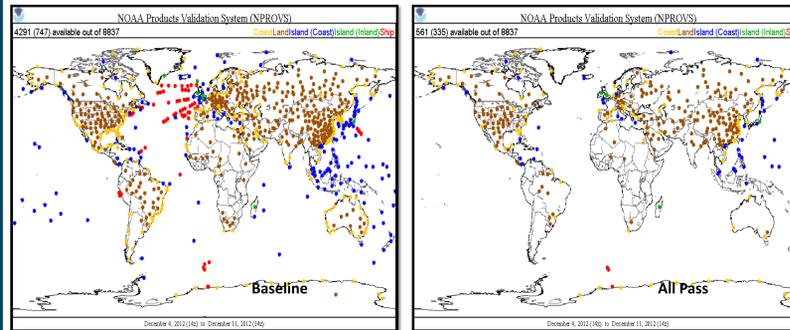
Satellites and Systems highlighted in "yellow" are in the process of being implemented into Operations. These include the IDPS, NUCAPS and MIRS products from Suomi-NPP presented in the RESULTS section. NPROVS is designed to access and bring-up product performance from operational satellite data streams. During operational and bring-up the projected operational data-streams may not yet contain the latest scientific software versions, currently the case for IDPS.

NPROVS includes an extensive analytical interface (see below) providing multiple options for interrogating the collocation datasets and satellite orbital data.



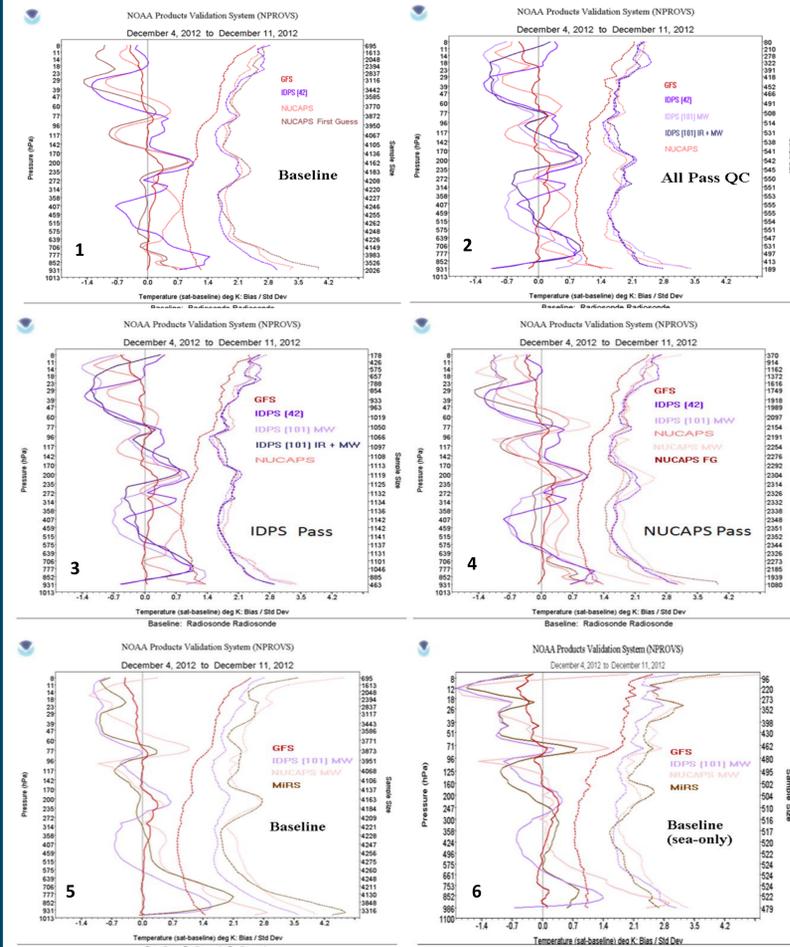
Please visit the NPROVS web site for more details including options for downloading datasets and graphical application (JAVA) applets.
<http://www.star.nesdis.noaa.gov/opdb/poes/NPROVS.php>

RESULTS



Baseline global distribution of NPROVS collocations (Dec 2012) of CrIMSS Suomi-NPP products (left) with global operational RAOBs and subset for which both the IDPS and NUCAPS passed QC (right). Locations are color-coded based on Raob terrain.

TEMPERATURE



Above results show Sat-minus-RAOB vertical temperature statistics for baseline (1) and the sub-sample which passed both the IDPS and NUCAPS internal qc (2). IDPS products are segregated into operational "42 layer averaged" and intermediate "101 level" profiles. NUCAPS and MIRS are at the 101 retrieved levels. The RAOB (and GFS) is interpolated to the 101 levels. IDPS (42) are the set of pre-selected "IR+MW" or "MW-only" retrievals which passed internal qc. "IPDS Pass" (3) and "NUCAPS Pass" (4) are sub-samples which passed their respective internal qc. Plots 5 and 6 are MW-only for "All" and "Sea-only" terrains; MIRS does not plan to distribute temperature soundings over land.

PARAMETER	THRESHOLD
AVTP Clear, surface to 300 mb	1.6 K / 1-km layer
AVTP Clear, 300 mb to 500 mb	1.5 K / 3-km layer
AVTP Clear, 500 mb to 800 mb	1.5 K / 3-km layer
AVTP Cloudy, surface to 700 mb	2.5 K / 1-km layer
AVTP Cloudy, 700 mb to 300 mb	1.5 K / 1-km layer
AVTP Cloudy, 300 mb to 30 mb	1.5 K / 3-km layer
AVTP Cloudy, 30 mb to 1 mb	1.5 K / 3-km layer
AVTP Cloudy, 1 mb to 0.5 mb	3.5 K / 5-km layer

PARAMETER	THRESHOLD
AVMP Clear, surface to 600 mb	Greater of 20% or 0.2 g/kg / 2-km layer
AVMP Clear, 600 to 300 mb	Greater of 35% or 0.1 g/kg / 2-km layer
AVMP Clear, 300 to 100 mb	Greater of 35% or 0.1 g/kg / 2-km layer
AVMP Cloudy, surface to 800 mb	Greater of 20% or 0.2 g/kg / 2-km layer
AVMP Cloudy, 800 mb to 400 mb	Greater of 40% or 0.1 g/kg / 2-km layer
AVMP Cloudy, 400 mb to 100 mb	Greater of 40% or 0.1 g/kg / 2-km layer

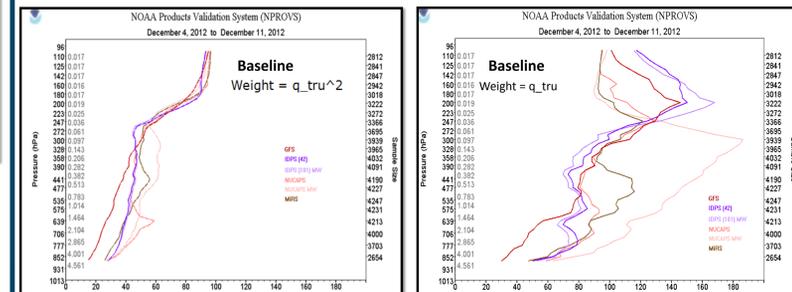
The above results are for levels while thresholds are specified for layers and cloudiness. Layer-averaging and cloud-sorting criteria are in final definition phase and will be deployed into NPROVS when available. Meanwhile a quick glance suggests it may be a challenge to meet specification particularly in lower troposphere. Other issues include low yields after qc, conventional sonde errors, impacts of collocation mismatch, etc.

RESULTS (Cont.)

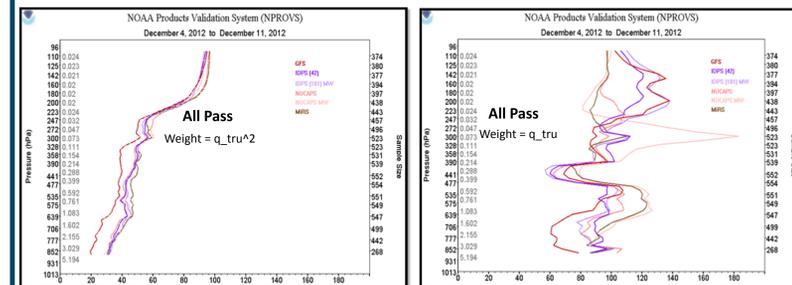
H2O Vapor Fraction

Sat-minus-RAOB Level H2O vapor percent (%) difference RMS statistics for the CrIMSS "Baseline" (upper) and "All Pass" (lower) collocation samples are shown.

A major concern is the impact of weighting potentially inversely proportional to AOB water vapor (q_{tru}) content to reduce the impact of statistically larger % difference associated with low water vapor contents.

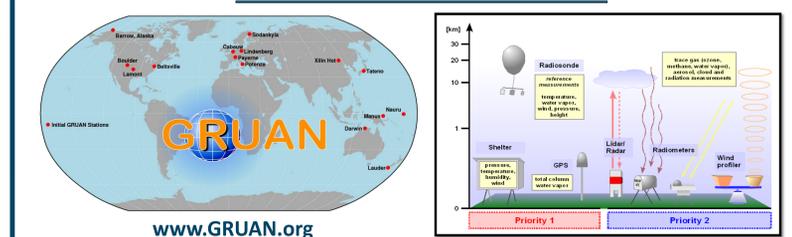


- Weight = 1
- $NBMS = 100 * \sqrt{sum((q_{tru} - q_{obs})^2 / sum(q_{tru}^2))}$
- Weight = q_{tru}
- $NBMS = 100 * \sqrt{sum((q_{tru} - q_{obs})^2 / sum(q_{tru}))}$
- Weight = q_{tru}^2
- $NBMS = 100 * \sqrt{sum((q_{tru} - q_{obs})^2 / sum(q_{tru}^2))}$
- %SDev = $\sqrt{sum((q_{tru} - q_{obs})^2 / sum(q_{tru}^2))} / sum(q_{tru}^2)$... all cases



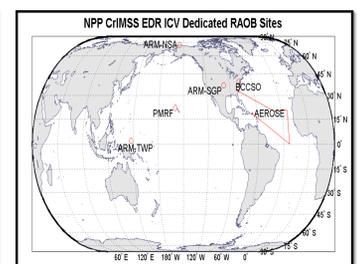
Historically, weighting by q_{tru}^2 (left plots) has been done but re-consideration to weight by q_{tru} (right plots) or not at all ($W=1$, not shown) is possible. As can be seen the impact of weighting on perceived performance is significant particularly with respect to meeting the CrIMSS moisture specification.

REFERENCE OBSERVATIONS



Activity is underway at STAR to routinely integrate observations from the evolving Global Climate Observing System (GCOS) Reference Upper Air Network into NPROVS. Currently 15 traceable sets of measurements of priority 1 and priority 2 climate variables (Fig 2). The underlying objective is to replace the concept of providing a "true value" and "error" for a given measurement with that of providing a "range of values" and "uncertainty".

Year	Month	Day	Time	Lat	Long	Alt	Regime	Platform	Instrument	Status
90	100	100	100	90	100	100	40	---	40-100	---
42	92	93	Launched	42	92	93	40	23	2	---
---	88	90	Launched	---	88	90	---	---	0	---
Aug	Jan-present	Jan-present	Time	Aug	Jan-present	Jan-present	May	May	Jan-Jul	Jan-Jul



In addition, dedicated radiosonde launches synchronized to Suomi-NPP satellite overpass are ongoing and/or planned at the above sites. These include Atmospheric Radiation Measurement (ARM)-GRUAN sites providing opportunity to calculate "Site Atmospheric State Best Estimates" which combine reference RAOB and ancillary (radiometer, lidar ...) measurements, and NOAA Aerosols and Ocean Science Expeditions (AEROSE ...) providing valuable dedicated validation over remote ocean. Their utility in routine Suomi-NPP products validation to better ascertain adherence to product specification (accuracy) is a key point of STAR and GRUAN agendas.

Reale, A., B. Sun, F. Tilley, and M. Pettey (2012), NOAA Products Validation System (NPROVS), *J. Atmos. Oceanic Tech.*, 29, 629-645, 15