

NPP Validation Program for the Cross-track Infrared Microwave Sounding Suite (CrIMSS)



¹NOAA/NESDIS/STAR

Christopher D. Barnet,¹ Nicholas R. Nalli,^{1,2} Degui Gu,³ Lihang Zhou,^{1,4} *et al.*

²Dell Services Federal Government, Inc.

³Northrop Grumman Aerospace Systems (NGAS)

⁴Joint Polar Sounding System (JPSS)



Overview

- The Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) are the two sensors that make up the **Cross-track Infrared Microwave Sounding Suite (CrIMSS)** onboard the Joint Polar Satellite System (JPSS) NPP Satellite.
- CrIMSS measurements will result in three **Environmental Data Records (EDRs)**
 - Atmospheric Vertical Temperature Profile (AVTP)
 - Atmospheric Vertical Moisture Profile (AVMP)
 - Atmospheric Vertical Pressure Profile (AVPP)
- The AVTP and the AVMP are both JPSS **Key Performance Parameters (KPPs)** used for initialization of high-resolution NWP models, atmospheric stability, etc. AVPP is derived from AVTP and AVMP and requires independent validation.
- The **CrIMSS EDR Algorithm** has been developed, implemented and the EDR performance has been assessed and characterized with the simulated global synthetic data sets.
- The **NPP CrIMSS EDR Validation Plan** is to ensure the data products comply with the requirements of the sponsoring agencies.
- Pre-launch phase work is **currently underway** – see Posters #642 (Zhou *et al.*), #587 (Guo *et al.*), and #571 (Divakarla *et al.*)

Validation Plan Overview

- Given the long-term successful heritage of legacy systems, **the basis of our approach is to draw on lessons learned from validating the AIRS/AMSU and IASI/AMSU/MHS sounding systems** and to focus on those activities that have had the most impact in their respective validation efforts. This approach will leverage “user community” cal/val efforts and experience as much as possible.
- Typical validation methods characterize the performance of the EDRs in various ensembles of cases. **A “roll-up” of regional assessments will serve to determine whether the EDRs have met their global performance specifications.** Specifically, this will involve stratifying the specs according to various bins:
 - day/night
 - latitude bands (*i.e.*, polar, midlatitude, tropical)
 - land/ocean/ regional
 - (possibly) altitude and surface characteristics

- The EDR validation will include assessments of current capabilities using heritage sensors and associated algorithms. Most significant will be to use the ATOVS (HIRS/AMSU) operational products as part of our validation efforts to demonstrate the value of the hyperspectral measurements to the user community.
 - NOAA/NESDIS has decades of experience with the operational ATOVS and has performed detailed assessments of hyperspectral products (AIRS/AMSU, IASI/AMSU/MHS) against these ATOVS legacy products.
- Heritage hyperspectral sounding systems (AIRS/AMSU and IASI/AMSU/MHS) have a number of **scientific users** that are currently exploiting those data products for weather, air-quality, and climate applications. **We expect that user requirements will become more sophisticated over time;** therefore, part of the validation efforts will be to characterize the CrIS/ATMS EDR products for those applications in the same manner as AIRS and IASI products are currently characterized.
- In the EDR Products section below, tables of the **Integrated Operational Requirements Document –II (IORD II)** and NPP contractor **specification performance requirements** are given. These requirements will be replaced by JPSS documents.

EDR Products

Atmospheric Vertical Temperature Profile – AVTP

Parameter	IORD-II	NGAS SY15-0007
AVTP Partly Cloudy, surface to 300 mb	1.6 K/1-km layer	0.9 K/1-km ocean, 1.7 K/1-km land/ice
AVTP Partly Cloudy, 300 to 30 mb	1.5 K/3-km layer	1.0 K/3-km ocean, 1.5 K/3-km land/ice
AVTP Partly Cloudy, 30 mb to 1 mb	1.5 K/5-km layer	1.5 K/3-km
AVTP Partly Cloudy, 1 mb to 0.5 mb	3.5 K/5-km layer	3.5 K/5-km
AVTP Cloudy, surface to 700 mb	2.5 K/1-km layer	2.0 K/1-km
AVTP Cloudy, 700 mb to 300 mb	1.5 K/1-km layer	1.5 K/1-km
AVTP Cloudy, 300 mb to 30 mb	1.5 K/3-km layer	1.5 K/3-km
AVTP Cloudy, 30 mb to 1 mb	1.5 K/5-km layer	1.5 K/5-km
AVTP Cloudy, 1 mb to 0.05 mb	3.5 K/5-km layer	3.5 K/5-km

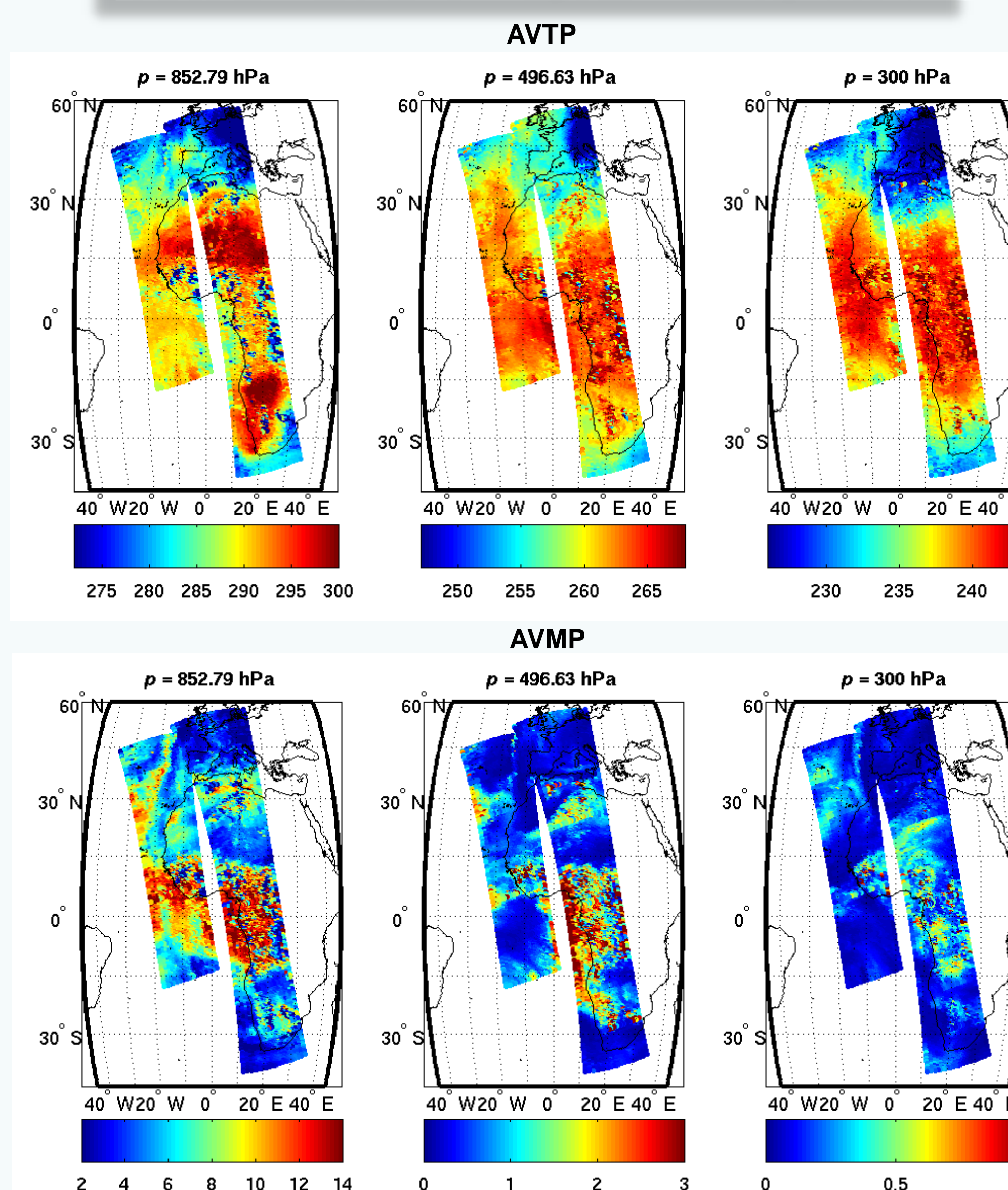
Atmospheric Vertical Moisture Profile – AVMP

Parameter	IORD-II	NGAS SY15-0007
AVMP Partly Cloudy, surface to 600 mb	Greater of 20% or 0.2 g/kg	14.1% ocean, 15.8% land and ice
AVMP Partly Cloudy, 600 to 300 mb	Greater of 35% or 0.1 g/kg	15% ocean, 20% land and ice
AVMP Partly Cloudy, 300 to 100 mb	Greater of 35% or 0.1 g/kg	0.05 g/kg ocean, 0.1 g/kg land and ice
AVMP Cloudy, surface to 600 mb	Greater of 20% of 0.2 g/kg	15.8%
AVMP Cloudy, 600 mb to 300 mb	Greater of 40% or 0.1 g/kg	20%
AVMP Cloudy, 300 mb to 100 mb	Greater of 40% or 0.1 g/kg	0.1 g/kg

Atmospheric Vertical Pressure Profile – AVPP

Parameter	IORD-II	NGAS SY15-0007
Pressure Profile	4 hPa threshold, 2 hPa goal	3 hPa (with precip and Psurf error exclusions)
CH4 (methane) column	1% precision, ±5% accuracy	CO and CH4 are experimental (P ³) products derived by science community from SDRs (not part of Program funded Cal/Val program).
CO (carbon monoxide) column	3% precision, ±5% accuracy	

CrIMSS EDR Retrieved from Proxy Data – Focus Day 19-Oct-07



CrIS/ATMS EDR Validation Team

Name	Organization	EDR
Chris Barnet	NOAA/NESDIS / STAR	Lead
Changyong Cao	NOAA/NESDIS / STAR	AVTP/AVMP
Mitch Goldberg	NOAA/NESDIS / STAR	AVTP/AVMP
Anthony Reale	NOAA/NESDIS / STAR	AVTP/AVMP
John Derber	NOAA/NCEP	CrIMSS SDR
Fuzhong Weng	NOAA/NESDIS / STAR	AVTP/AVMP
Gail Bingham	USU/SDL	CrIMSS SDR
Bill Blackwell	MIT	AVTP/AVMP
Allan Larar	NASA/LaRC	AVTP/AVMP
Xu Liu	NASA/LaRC	AVTP/AVMP
Hank Revercomb	SSEC	AVTP/AVMP
Dave Tobin	SSEC	AVTP/AVMP
Larrabee Strow	UMBC	AVTP/AVMP
Joel Susskind	NASA/GSFC	AVTP/AVMP
Denise Hagan, Degui Gu	NGAS	AVTP/AVMP; CrIMSS SDR
Steven Beck	Aerospace Corp.	CrIMSS SDR
Steven English	UKMET	CrIMSS SDR
William Bell	ECMWF	CrIMSS SDR
Steve Freidman	NASA/JPL	AVTP/AVMP
Steve Swadley, Ben Rustin	NRL	CrIMSS SDR

Et al.

SOAT Members

- M. Divakarla, G. Guo (NOAA/STAR)
- X. Liu, S. Kizer (NASA/LaRC)
- B. Blackwell (MIT)

EDR Validation by Cal/Val Phase

PRE-LAUNCH

- Derive proxy data from legacy systems (AIRS/AMSU, IASI/AMSU) and *in situ* correlative data (RAOB).
- Use proxy data to test concepts and exercise the CrIMSS EDR algorithm.
- Participate in field campaigns of opportunity (e.g., AEROSE).

EARLY ORBIT CHECK-OUT (EOC)

- Compare forward models, sanity checks on differences between observations and calculations.
- Use Simultaneous Nadir Overpass (SNO) and double differencing methods (as used for AIRS/IASI).
- Intercompare CrIMSS SDRs/EDRs with operational AIRS and/or IASI products.

INTENSIVE CAL/VAL (ICV)

- Compare early EDRs to operational products from AIRS & IASI to diagnose issues and find solutions.
- Compare SDRs w/ AIRS and IASI via SNOs and double differences to separate SDR and EDR issues.
- Principle Component Analysis and instrument monitoring to verify noise, random and systematic components, and monitor instrument health.
- Assess performance against operational and dedicated RAOBs.
- Participate in intensive field campaigns using aircraft-based FTS (e.g., NAST-I or S-HIS) for definitive assessment and analyze specific issues.

LONG-TERM MONITORING (LTM)

- Continuously monitor and analyze long-term performance via comparison to heritage products and *in situ* correlative data.
- Analyze effects of instrument changes on EDRs.

PRE-LAUNCH

EOC

ICV

LTM

2009

2010

2011

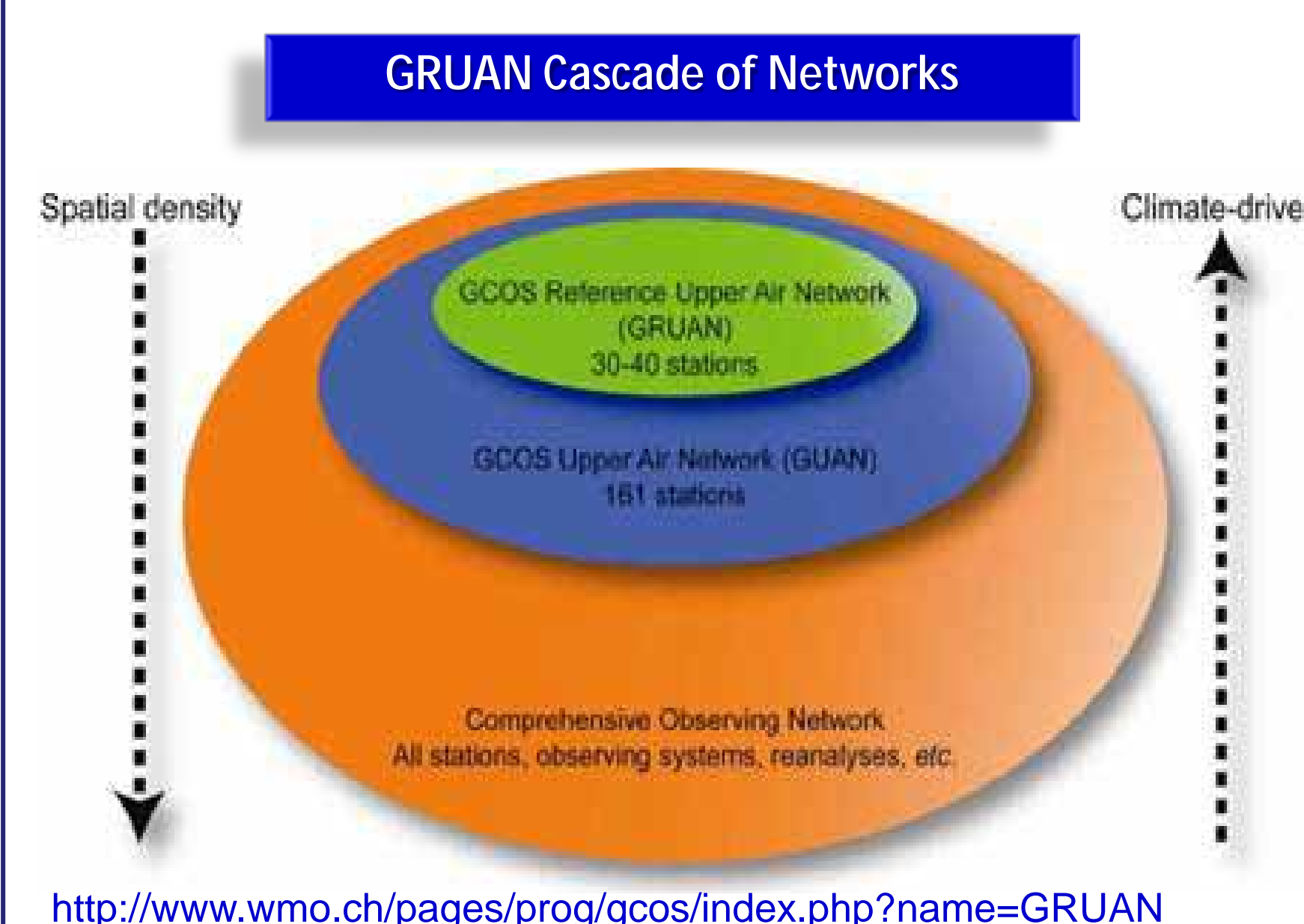
2012

2013

Correlative Data

Sources

NPROVS (global RAOB), GRUAN, AEROSE, ECMWF, NAST-I, NAST-M, S-HIS, WAVES, START, HIPPO, ARM, GFS, ESRL/GMD Carbontracker, Suominet, CERES



NOAA AEROSE Campaigns

See Poster #632 (Nalli *et al.*)

AEROSE Cruises 2004, 2006-2010

