THE OPERATIONAL IASI L2 v6: STATUS , APPLICATIONS AND EVOLUTIONS

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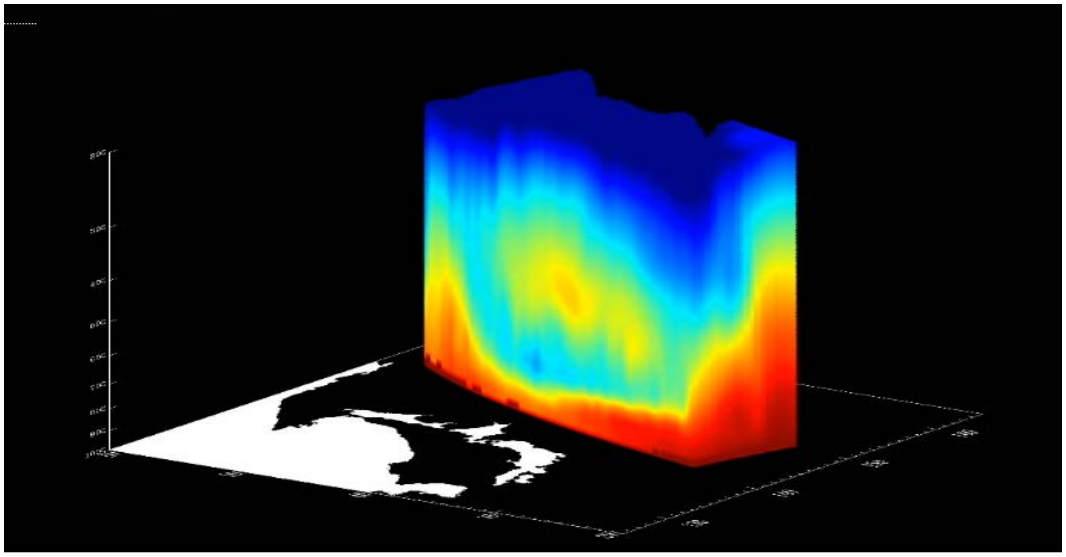
P. Coheur, D. Hurtmans (ULB),
D. Zhou (NASA)

Outline

1. The IASI L2 v6 Processor & Products
   - Algorithm overview
   - Performances
2. Current and potential utilisations
3. Further algorithm developments



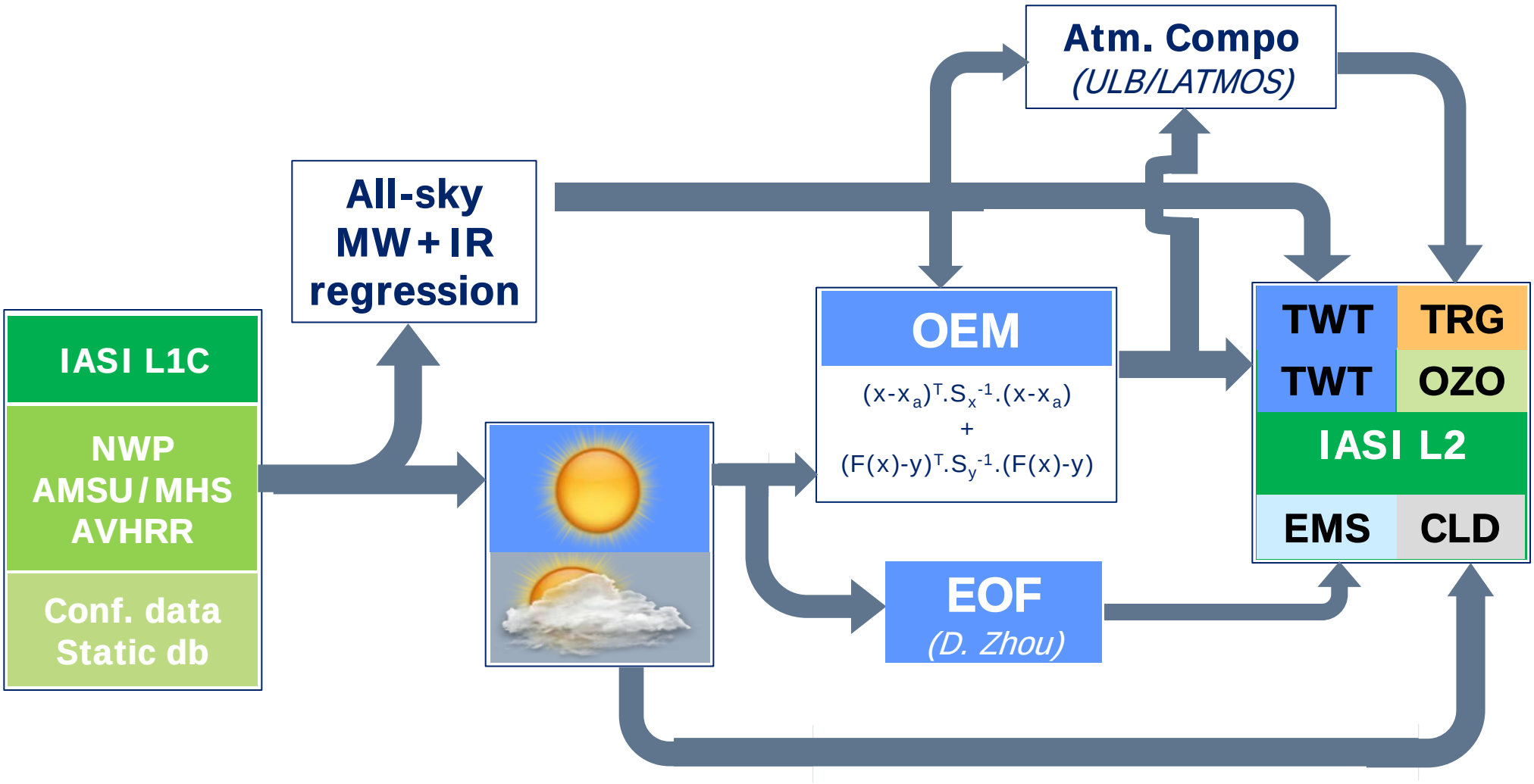
1. The IASI L2 v6 products

Disseminated in NRT (<2h from sensing)
Operational since 30 September 2014

TWT	Temperature (vertical profiles) + Averaging Kernels Humidity (vertical profiles) Surface Temperature (Land & Sea)
EMS	Surface emissivity
CLD	Cloud detection and characterisation
OZO	O_3 profiles + Averaging Kernels
TRG	CO, N_2O, CH_4, CO_2 Total columns CO profiles + AK, (SO_2, HNO_3)

1. The IASI L2 v6 processor

High-level overview



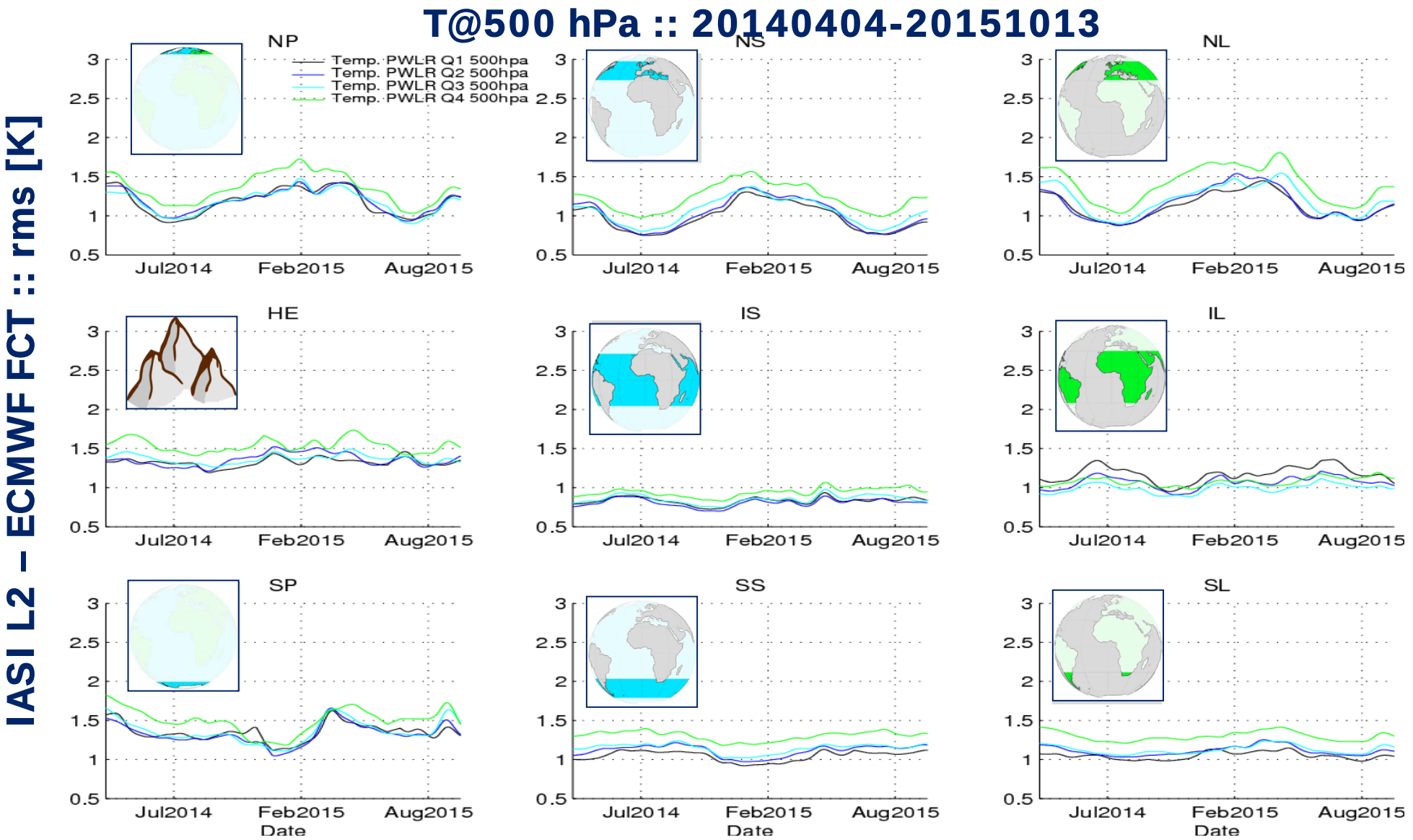
1. The IASI L2 v6 processor

High-level overview

	FG	Cloud	LSE	Final T,q	Final AC
Inputs	IASI + AMSU + MHS	IASI + PWLR T,q	IASI	IASI PC-rec'd radiances + PWLR T,q	IASI L1c + L2 T,q
Params	T, q, Ts	Detection CFR, CTP	Emissivity in 12 PC-chans	T, q, Ts + AK	CO, O_3 + AK
Methods	PWLR (statistical)	CO_2-slicing χ^2 minim.	EOF regression (D. Zhou)	Radiance fit OEM	OEM (FORLI)
Scope	"All-sky" Yield ~85%	Cloudy pixels	Clear & Clear-enough pixels Yield ~20%	Clear & Clear-enough pixels Yield ~20%	Clear & Clear-enough pixels Yield ~20%

1. The IASI L2 v6 products

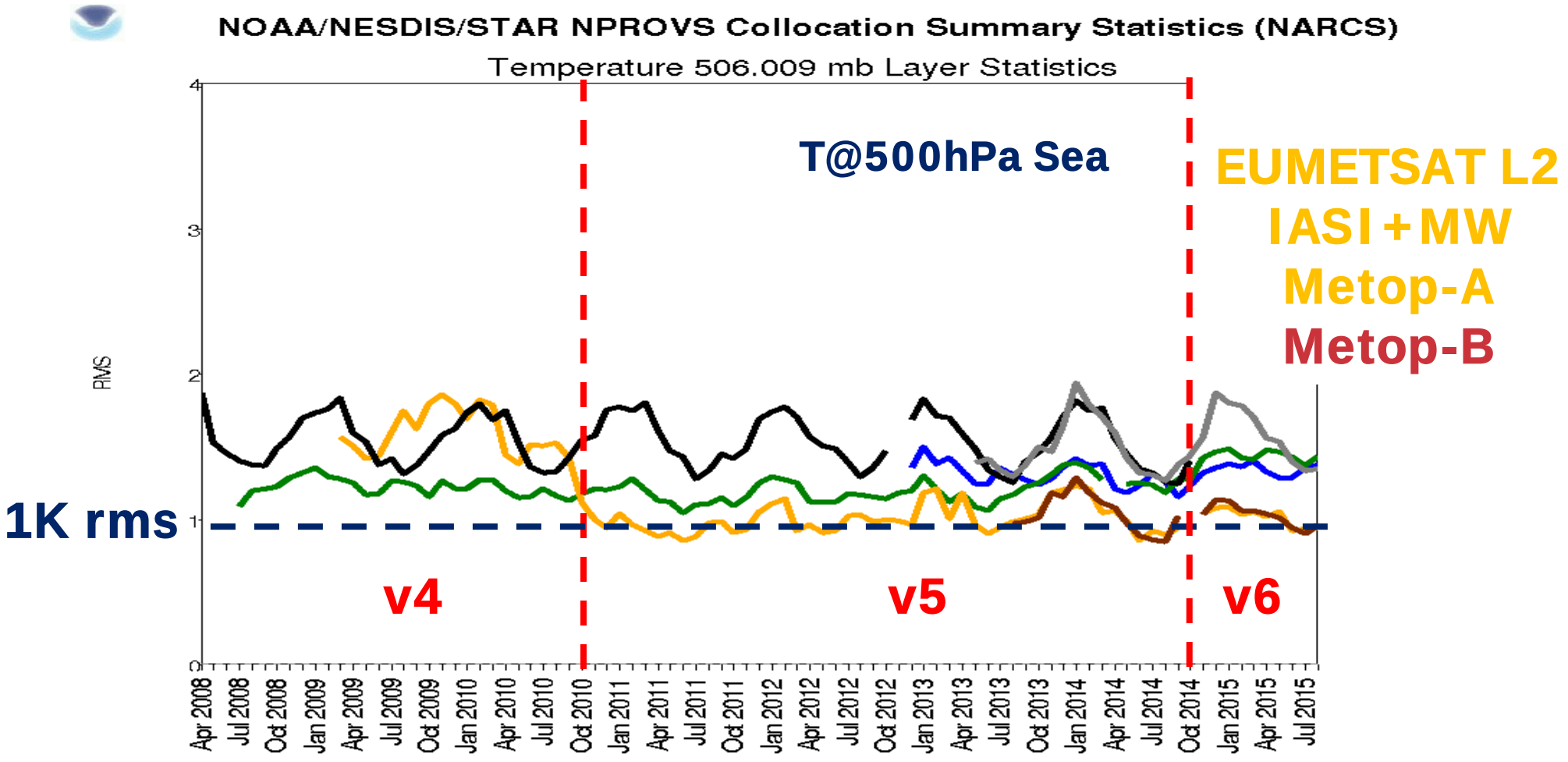
Monitoring with ECMWF FCT



1. The IASI L2 v6 products

Monitoring with *in situ* data

www.star.nesdis.noaa.gov/smcd/opdb/nprovs/NPROVS_trends.php#crumb



Credits: B. Sun, T. Reale (NOAA)

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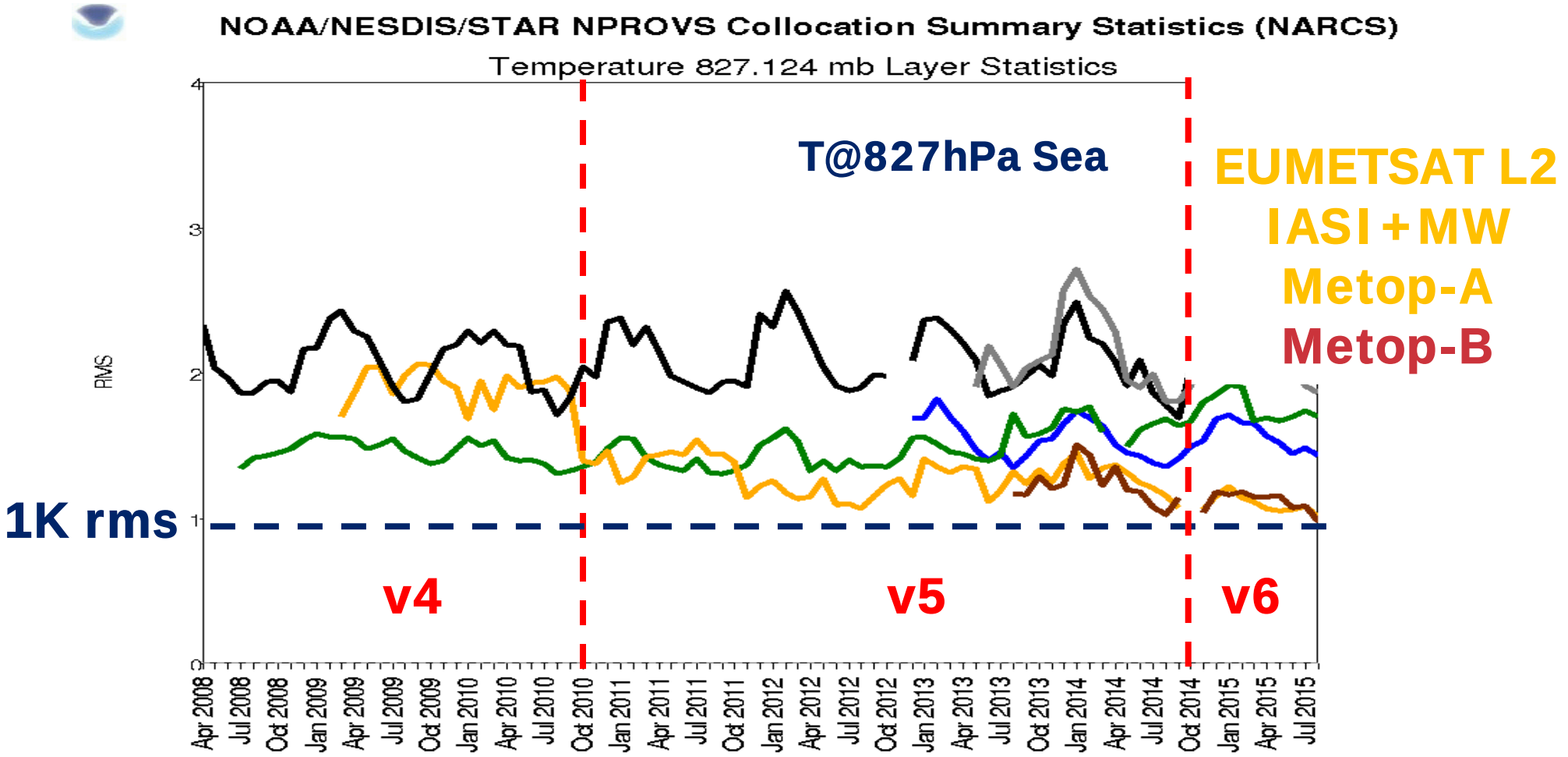

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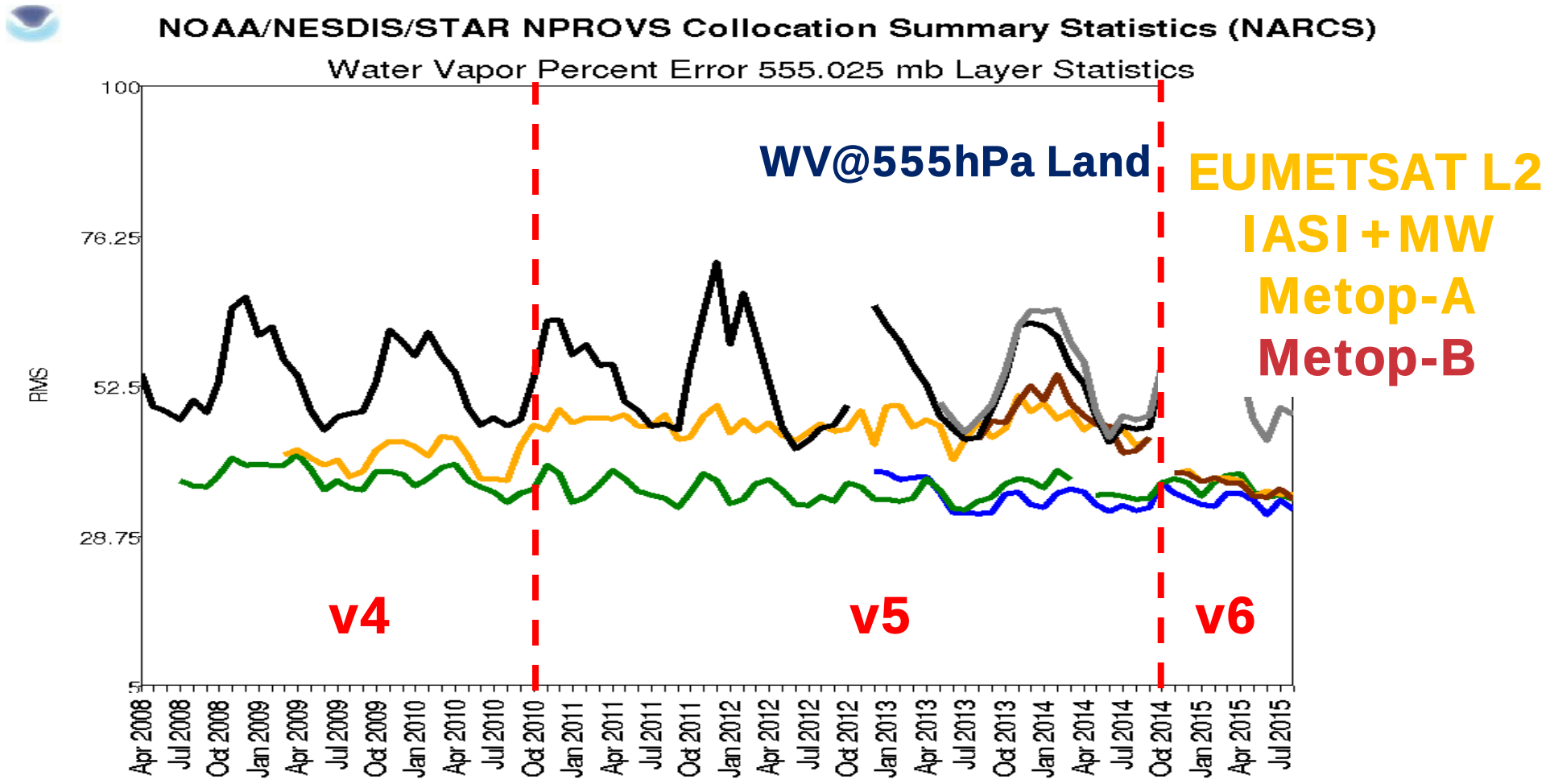

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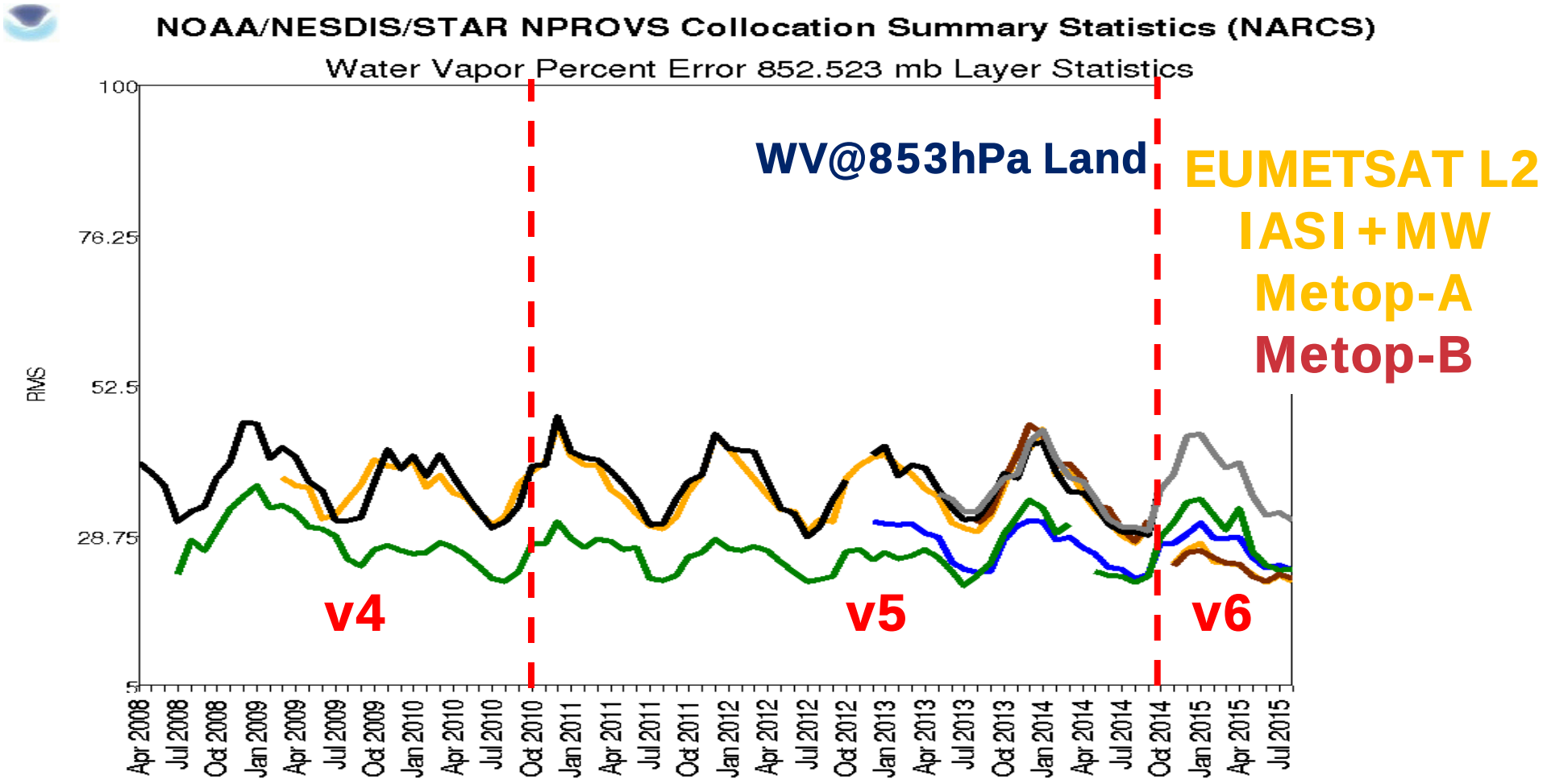

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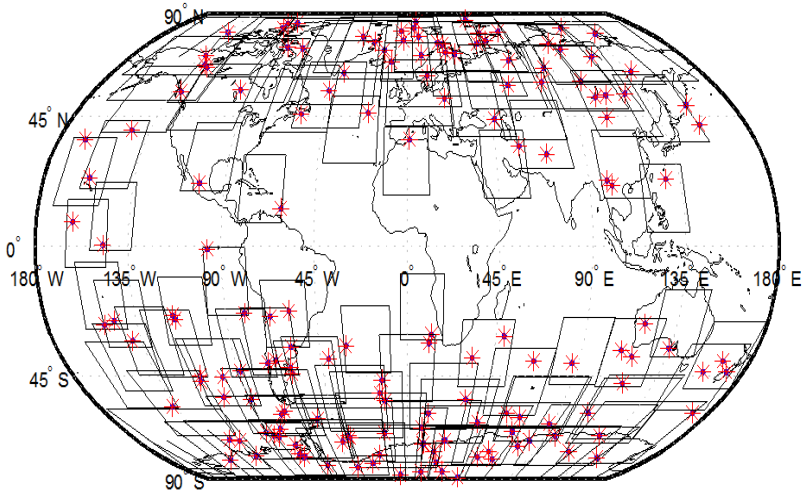
1. IASI L2 v6 products

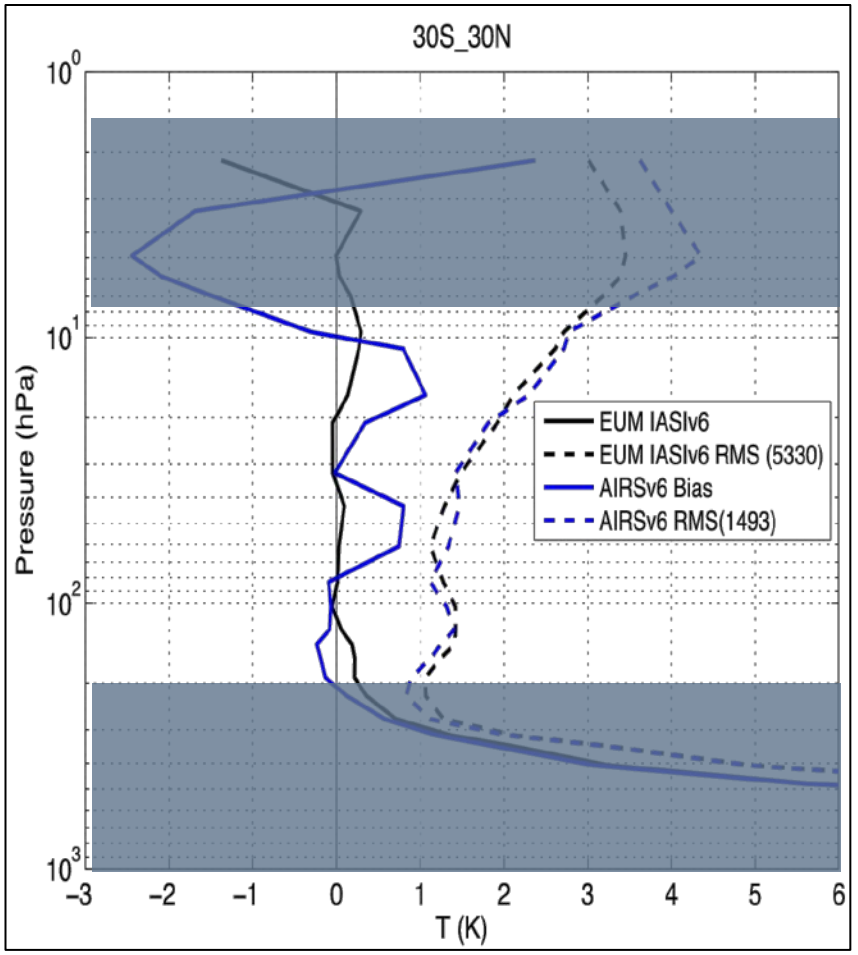
Strato. Temperature vs GPS-RO



Initial results of validation with GPS-RO dry temperature profiles (COSMIC UCAR product)

Credits: M. Feltz (Uni. Wisconsin)

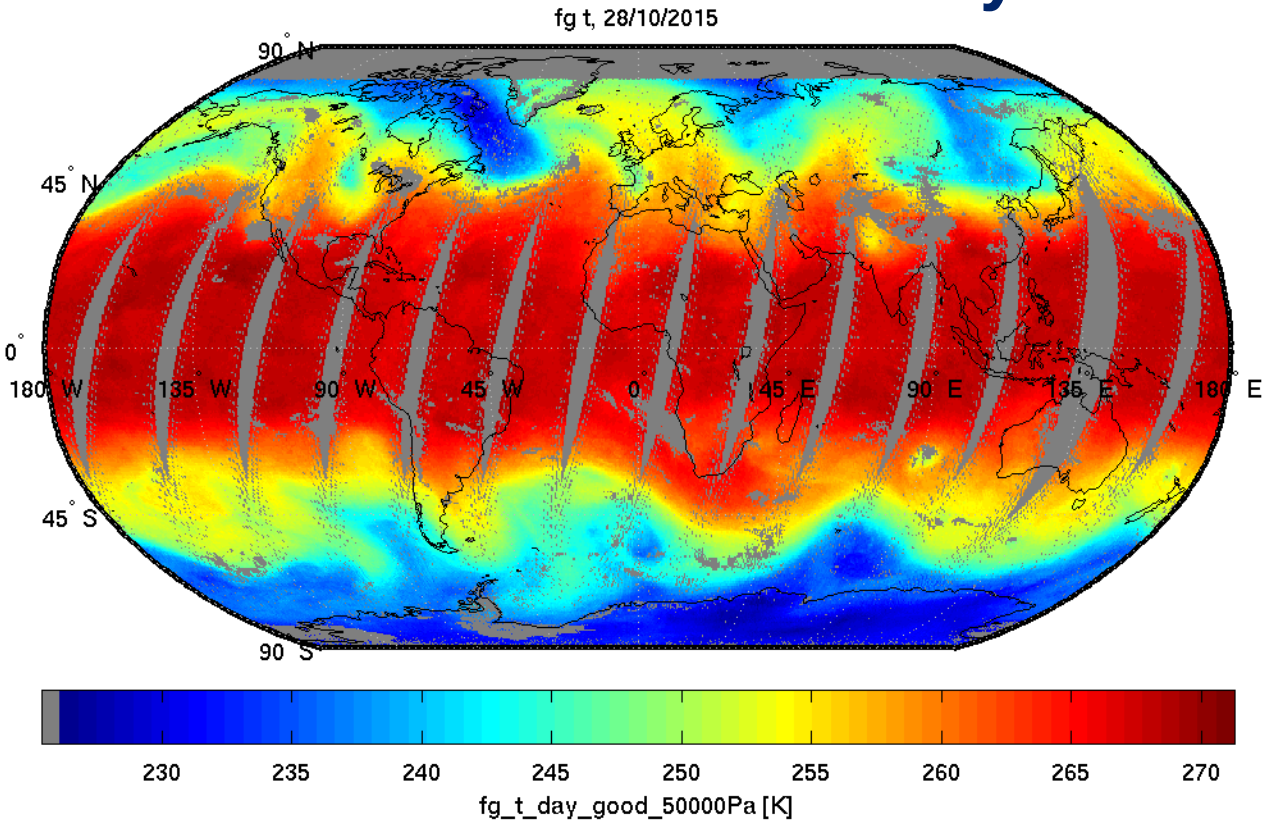
After Feltz et al in JGR 2013, and AMTD 2013

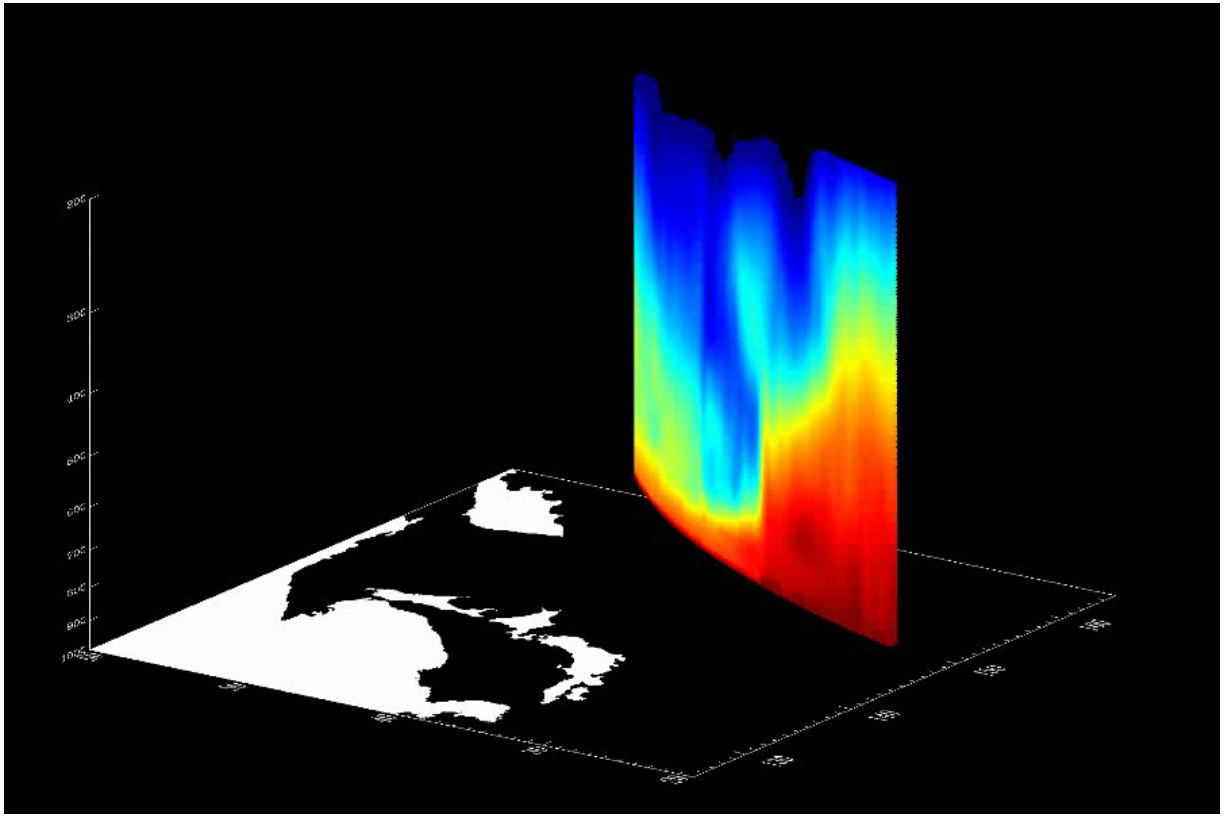


1. IASI L2 v6 products

Typical useful yield

All-sky PWLR





With their high coverage, the vertical information in temperature and humidity and their level of accuracy, the IASI L2 v6 are a good option for short-term applications and/or applications requiring operations at the IASI footprint resolution and acquisition time (e.g. air quality, some climate, NWC)

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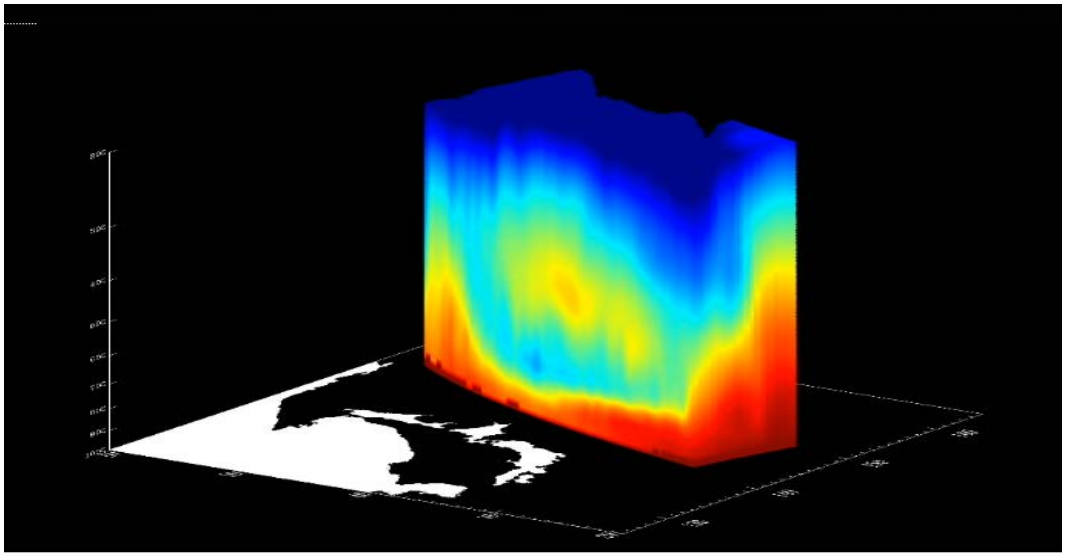
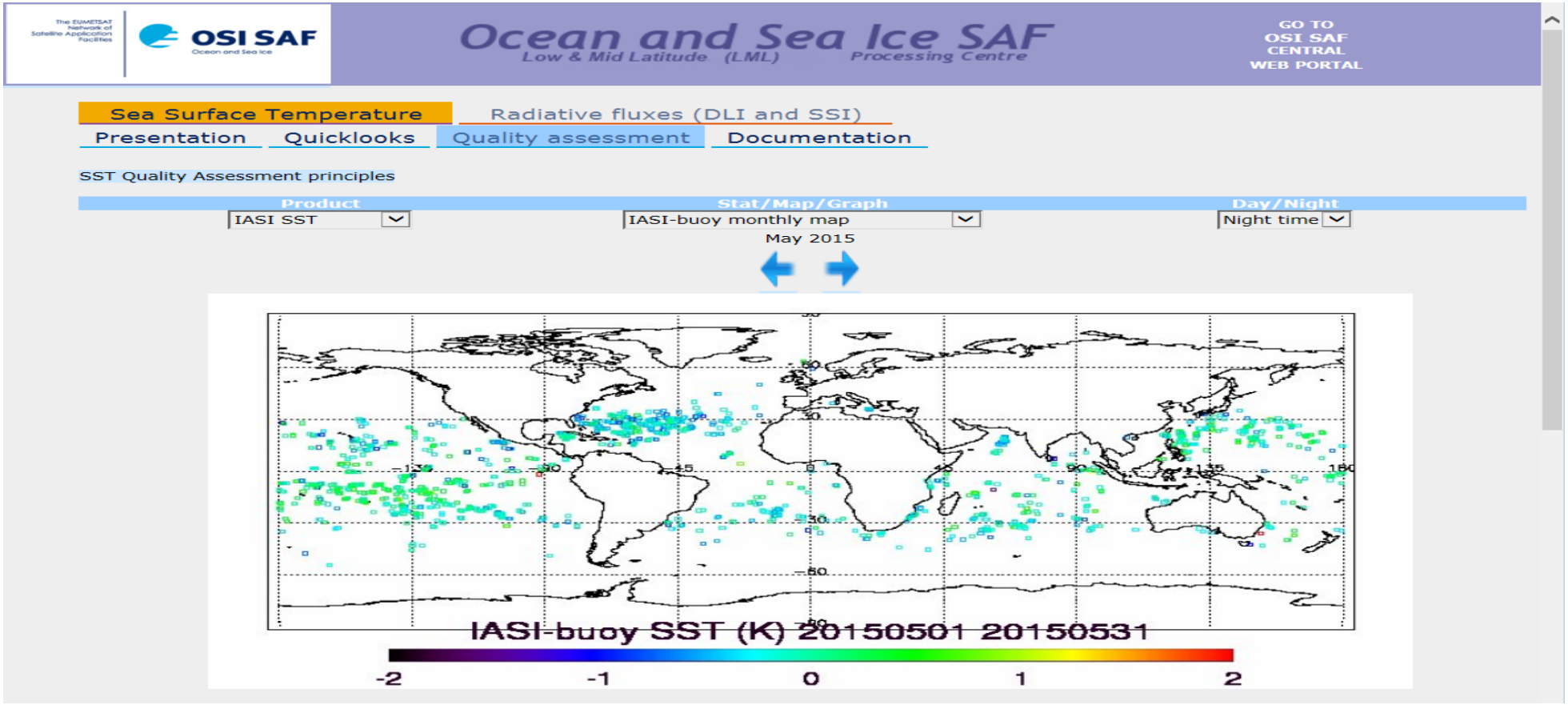


2. Applications with IASI L2

Contribution to GHRSST

The IASI L2 SST products are monitored at the Ocean & Sea-Ice Satellite Application Facility against *in situ* buoys measurements.

The IASI L2P SST contribute to GHRSST. The precision is of about 0.35K in the highest quality classes.



2. Applications with IASI L2

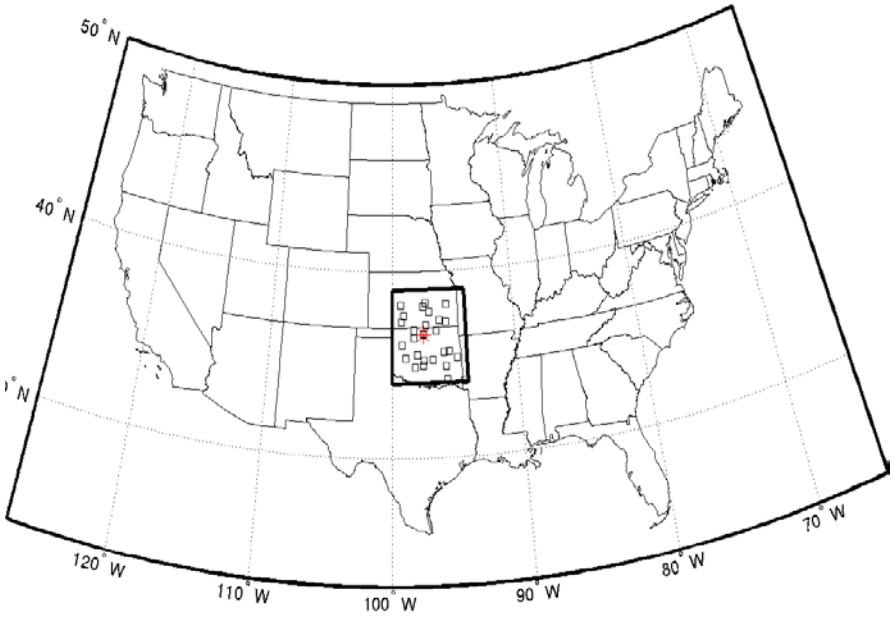
Atmospheric composition

The IASI L2 T,q profiles are used as inputs to a number of atmospheric composition retrieval algorithms, e.g. in the ESA CCI aerosol project or for the generation of near-real time AC products, which in turn are used for air quality and climate monitoring.

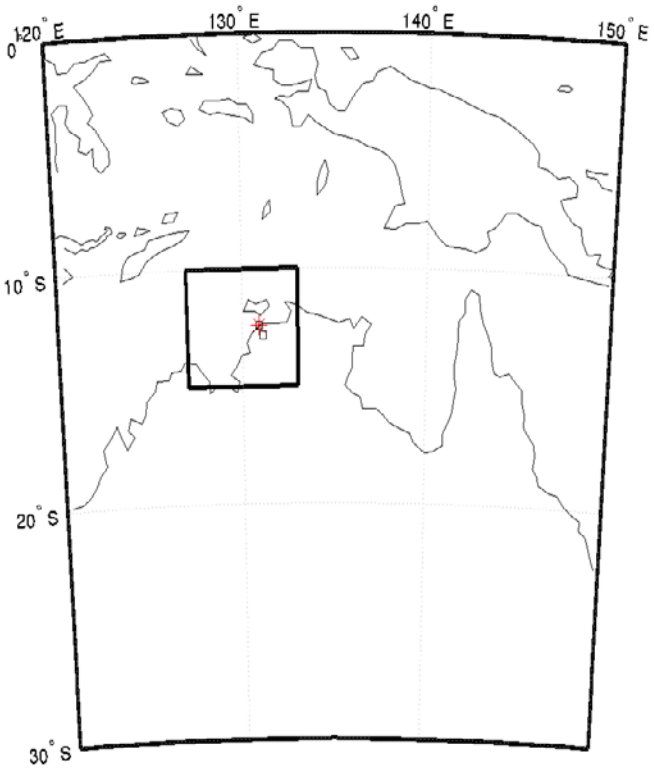
2. Applications with IASI L2

WV records for climate?

ARM site Lamont, US



ARM site Darwin, AUS



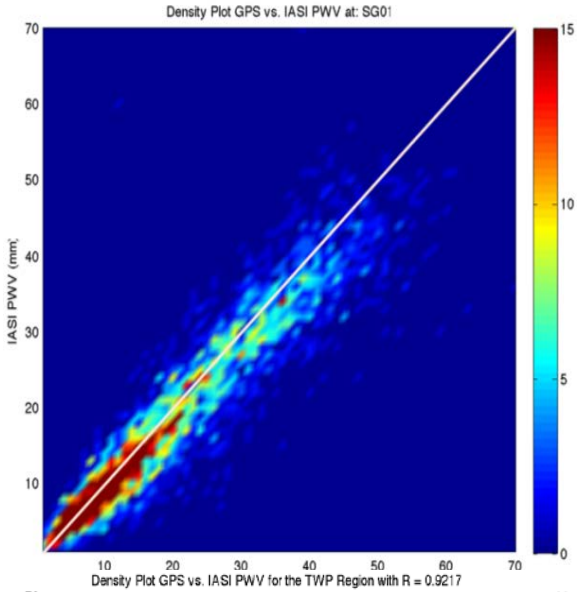
- IASI-A and –B full mission series (PWLR)
- ground-based **GPS-RO**, MW radiometer, Lidar and Sondes measurements.

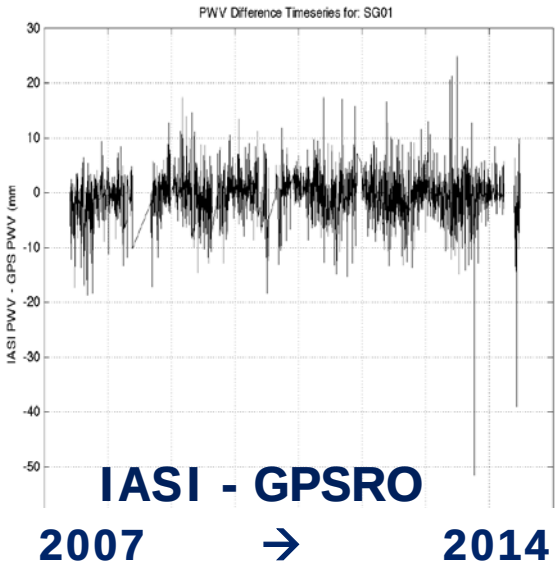
Credits: J. Roman (Uni. Wisconsin)
After Roman et al, AIP Proc. 2013

2. Applications with IASI L2

WV records for climate?

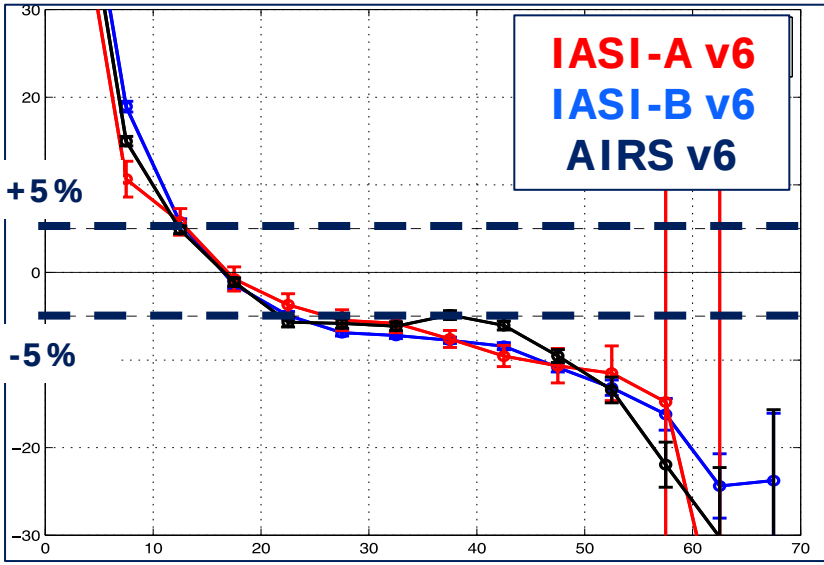
Lamont



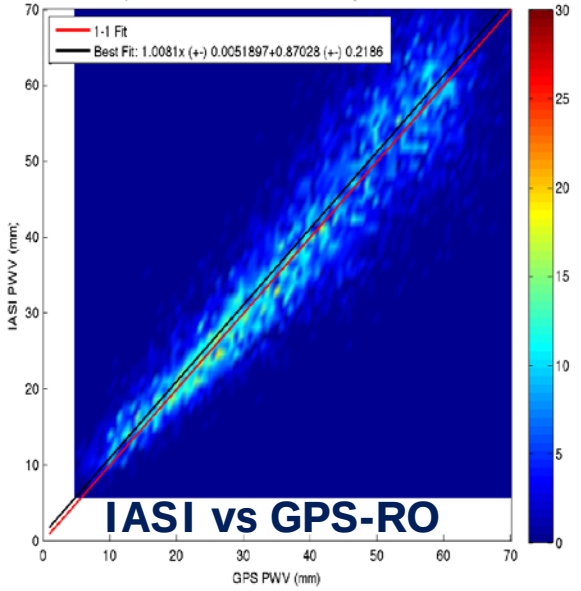


IASI - GPSRO

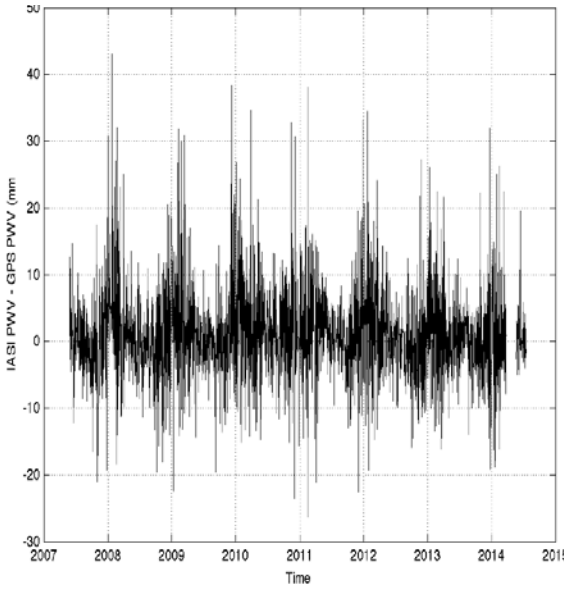
2007 → 2014

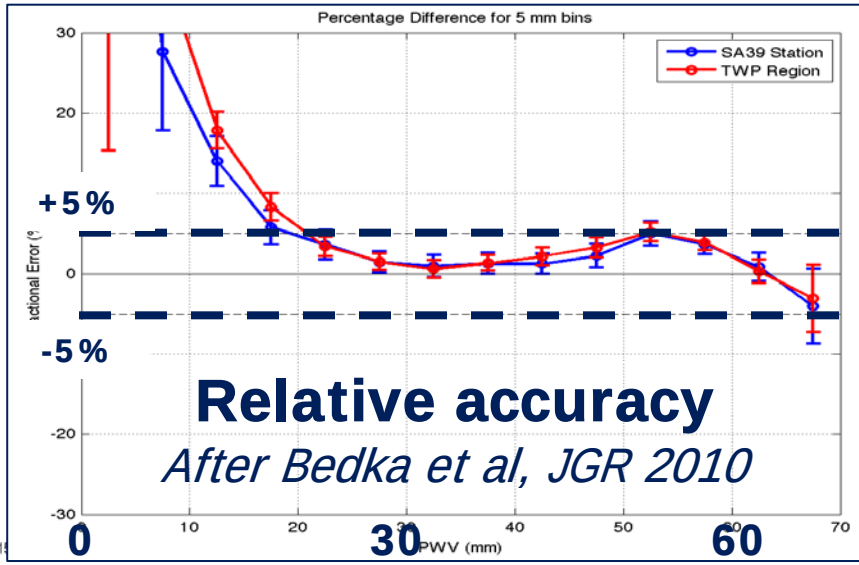


Darwin



IASI vs GPS-RO





Relative accuracy

After Bedka et al, JGR 2010

0 30 60

PWV [mm]

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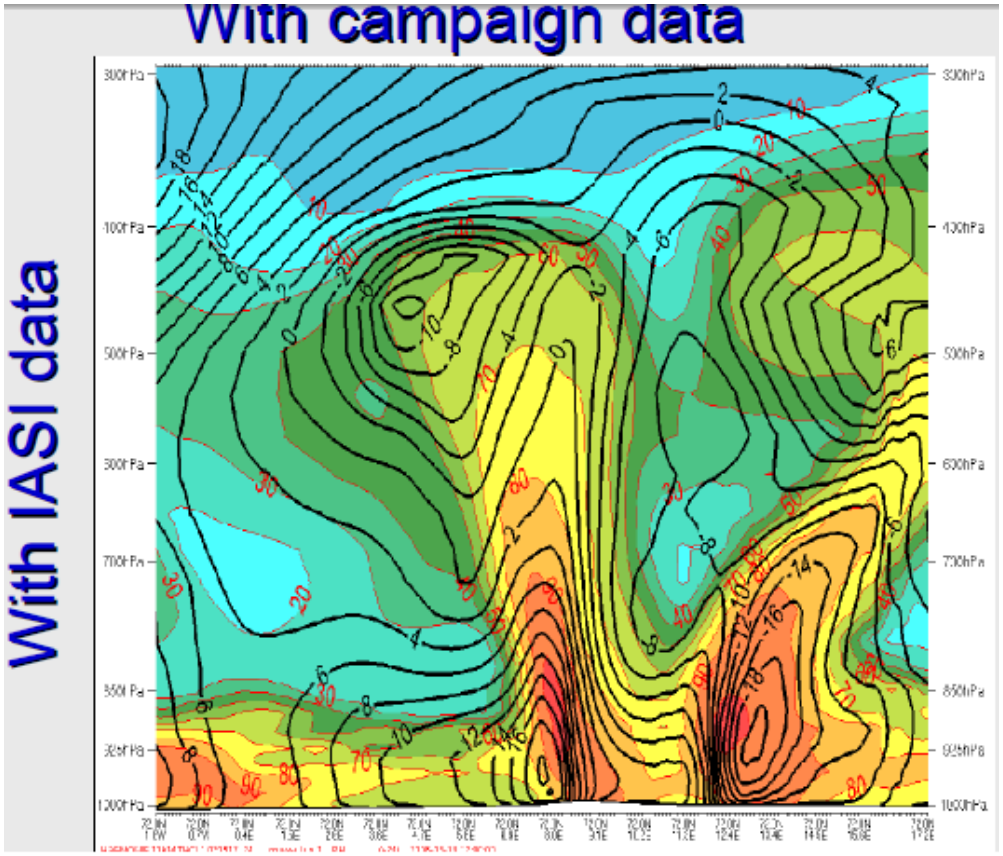
2. Potential new utilisation

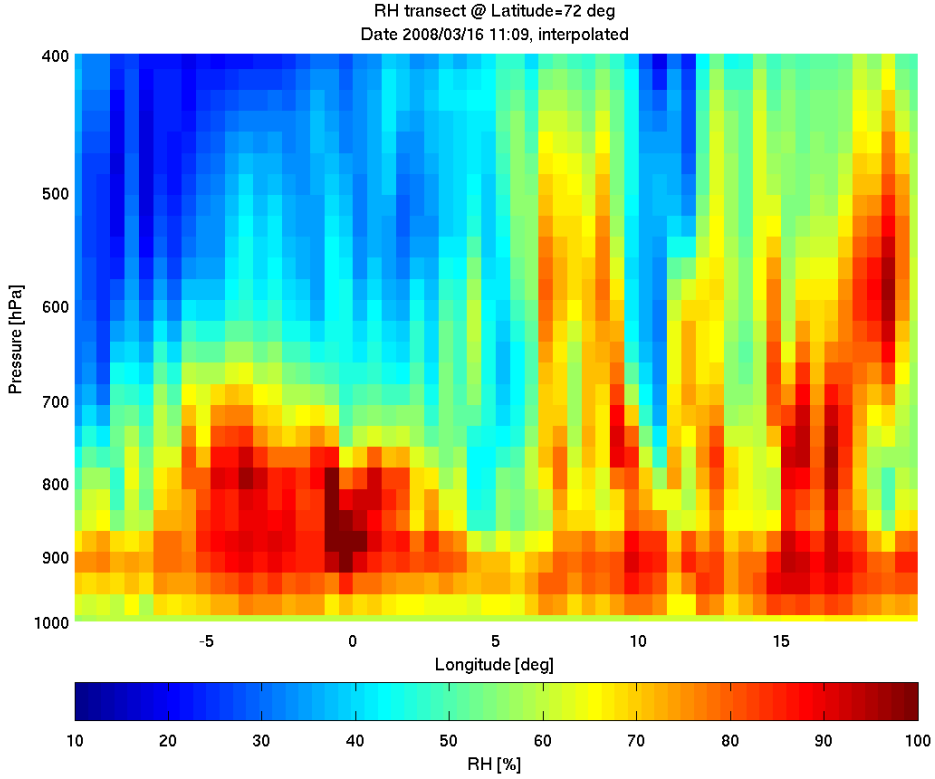
Tracking Polar lows?



Case of a "Polar Low" off Norwegian coasts on 16/03/2008 captured in relative humidity in the NWP after assimilation of IASI data and dedicated *in situ* campaign measurements.

Results: R. Randriamampianina (MetNo)

IASI L2 v6
for the same transect
on the 72°N parallel

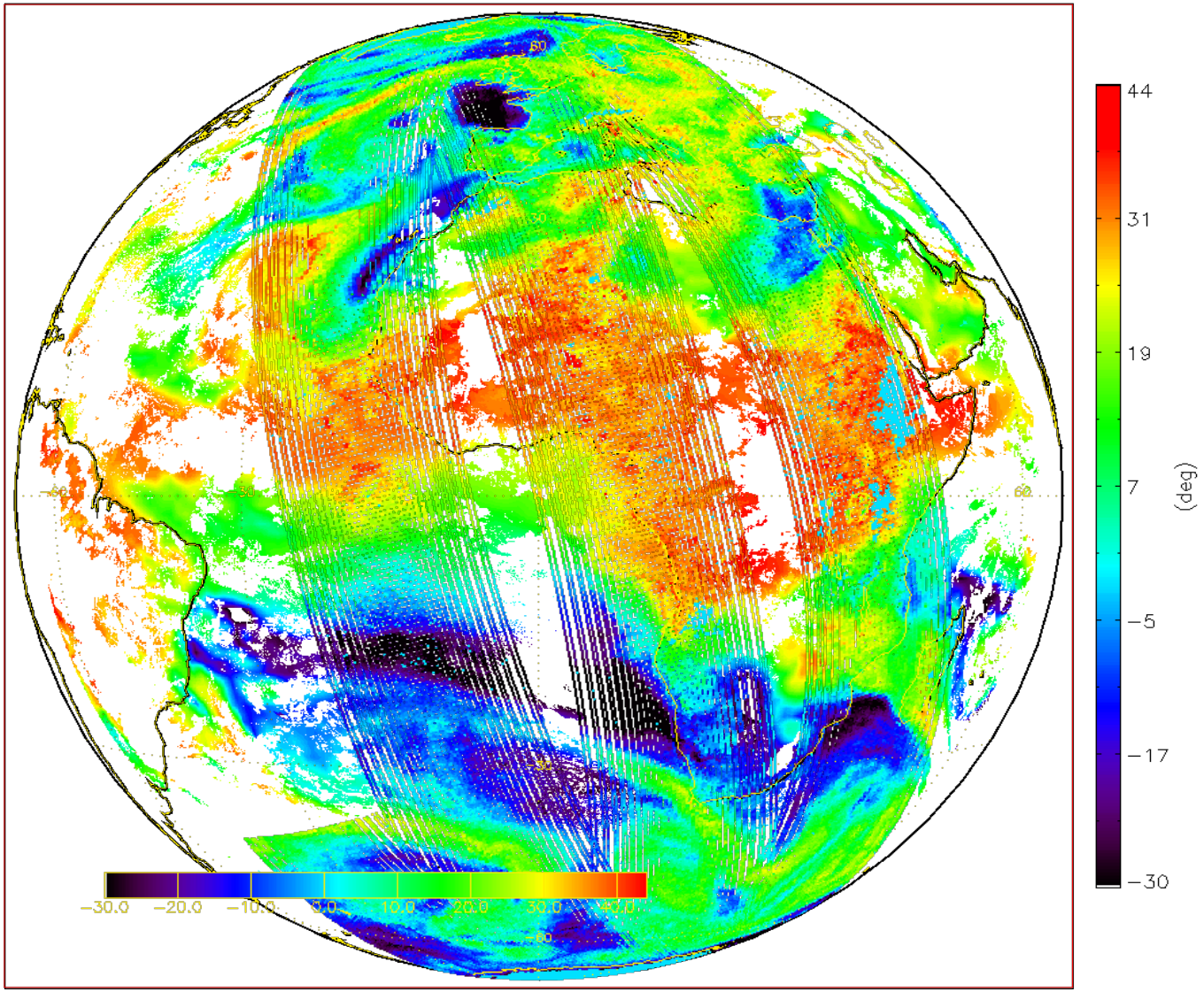


2. Potential new utilisation

Tracking instabilities

MSG Geo Instability Index + IASI v6

IASI L2 v6 is consistent with the GII and **complementary** as it provides information in the **cloudy areas** and at **high latitudes**.



Results: M. Koenig (EUMETSAT)

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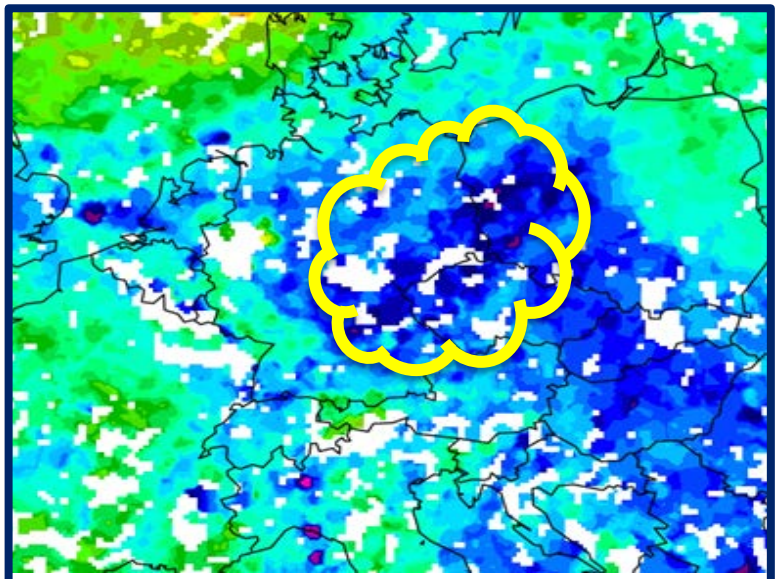
2. Potential new utilisation

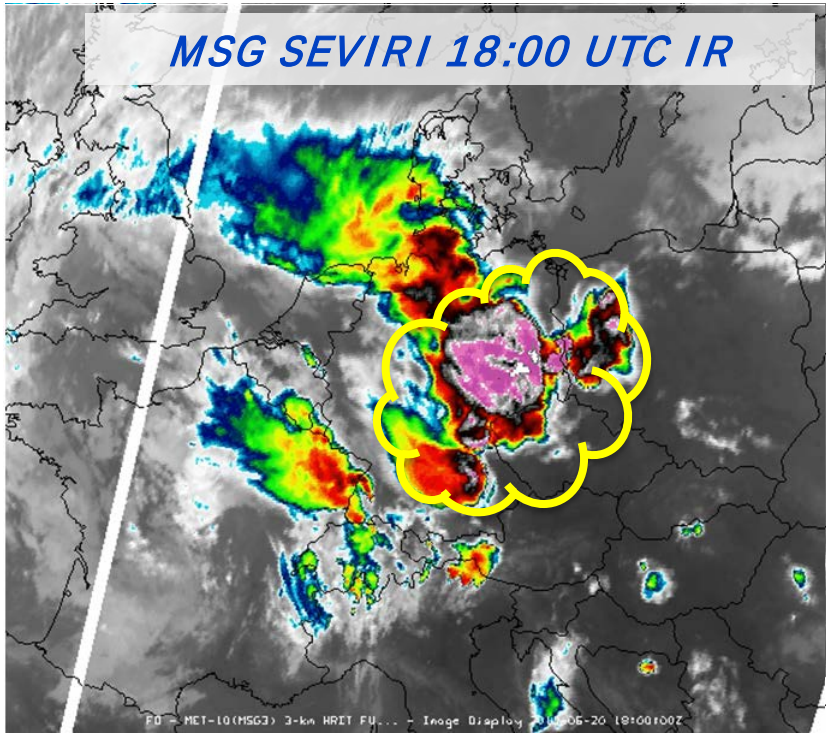
Tracking instabilities

Case study:
Central Europe Flooding 20 June 2013

Credits: L. Cronce, R. Petersen
(Uni. Wisconsin)



IASI L2 v6 Morning
+
NearCast at 18:00



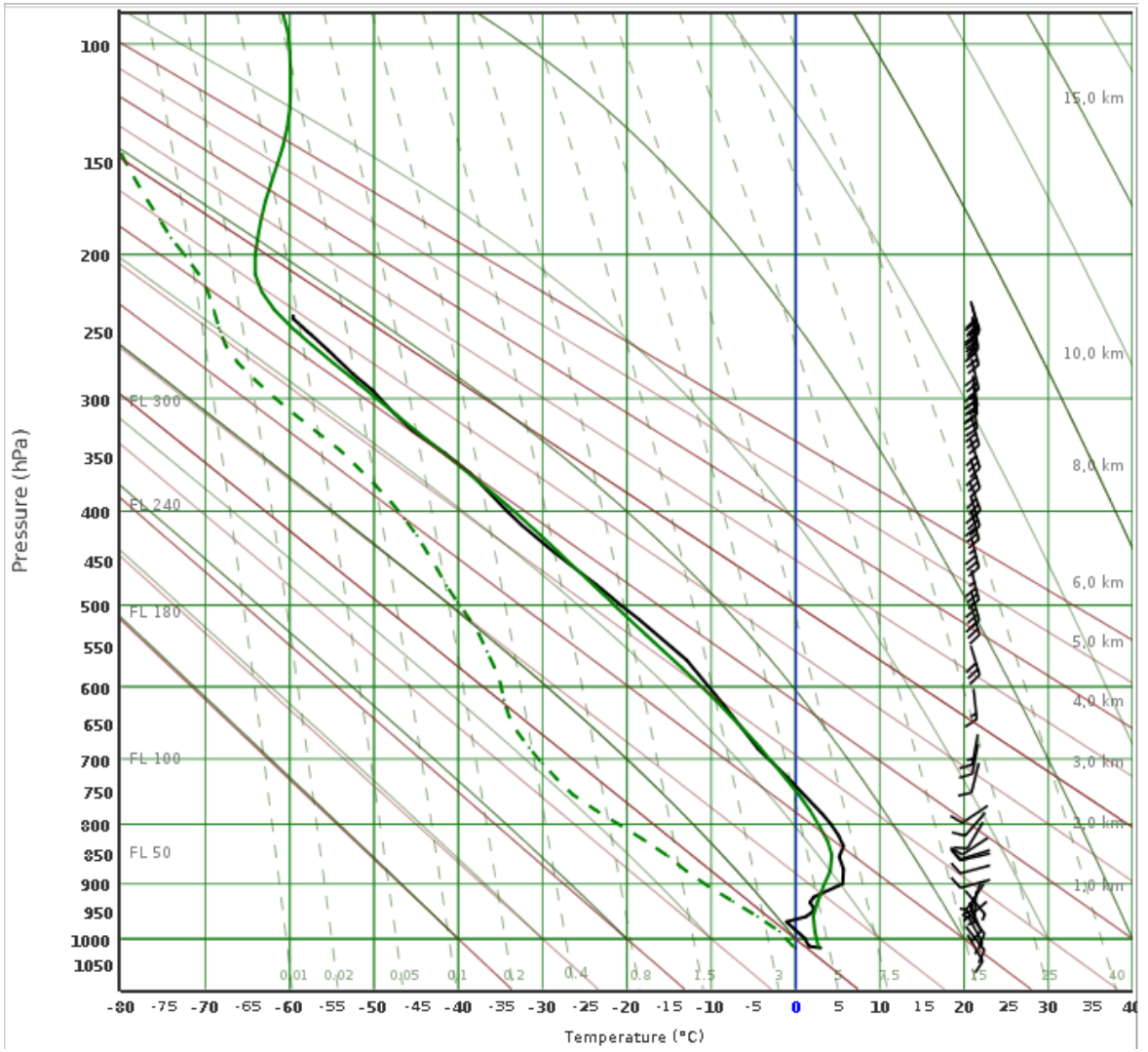
2. Potential new utilisation

Support nowcasting

The IASI L2 v6 products are actively monitored at DWD, with the NiNO system.

Following users requests to make these products available faster, **plans are to extend the EARS-IASI to enable the regional processing of IASI L2 sounding products** (PWLR) from direct read-out.

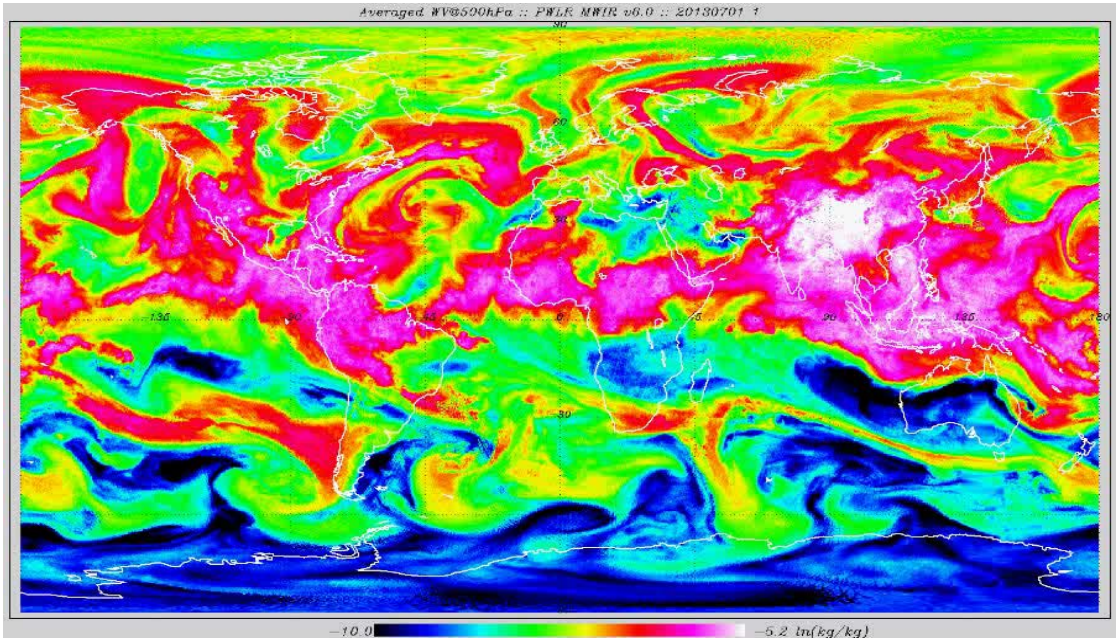
IASI L2 v6 vs Radiosonde in Nürnberg (Germany), 12/02/2015. Courtesy J. Asmus (DWD)



2. Potential new utilisation

WV profiles and AMVs ?

WV@500 hPa :: Global
July 2013 – July 2014



Preliminary work is starting to assess the potential of optical flow methods to exploit the vertical WV information in IASI products and derive AMV profiles from successive overpasses (single Metop at high latitudes or dual Metop sounding).

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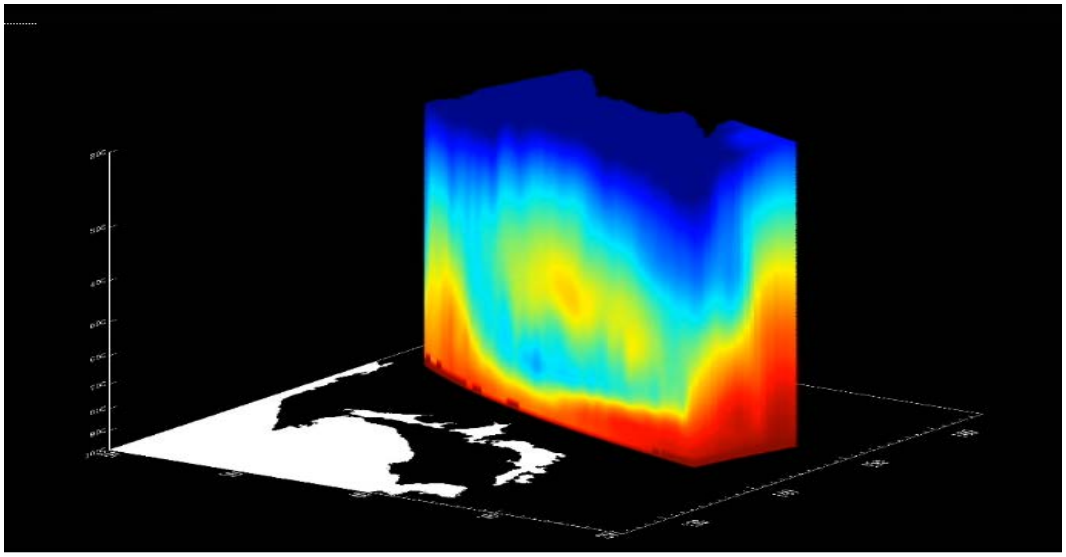


3. IASI L2 developments

Improving surface emissivity

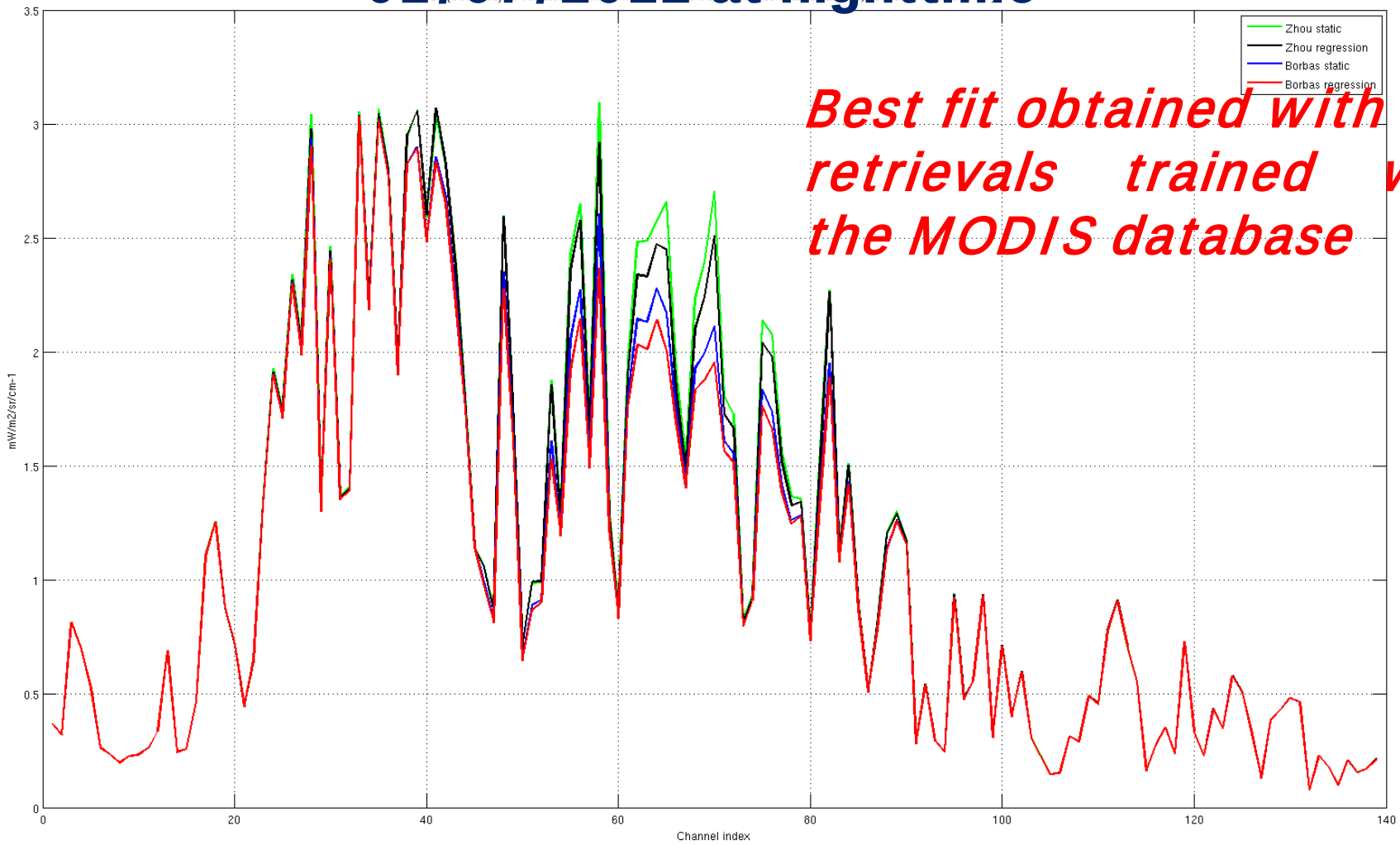
Motivation:

- Inaccurate background surface terms prevent OEM convergence
- Accurate surface emissivity is important for low tropo sounding, especially for precise humidity sounding

Experiment:

- Two static land emissivity databases were tested, from D. Zhou and MODIS monthly atlases. *Note: MODIS db is built-in in RTTOV and is the basis for OEM in IASI L2 v6*
- The PWLR statistical retrieval was trained using these two static databases and collocated IASI and micro-wave measurements
- OBS-CALC are computed, using IASI L2 v6 vertical profiles and surface temperature together with, in turn, the two static land emissivity databases and the retrievals trained with these atlases.

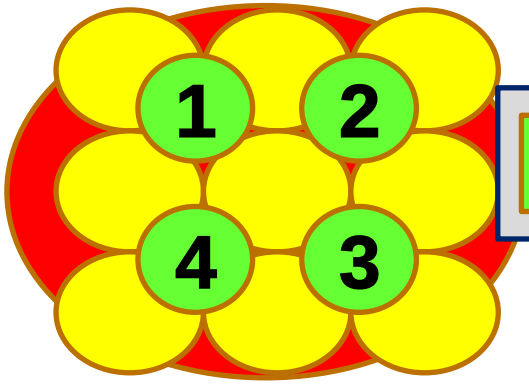
Stddev(OBS-CALC) in the 139 OEM channels 01/07/2012 at nighttime



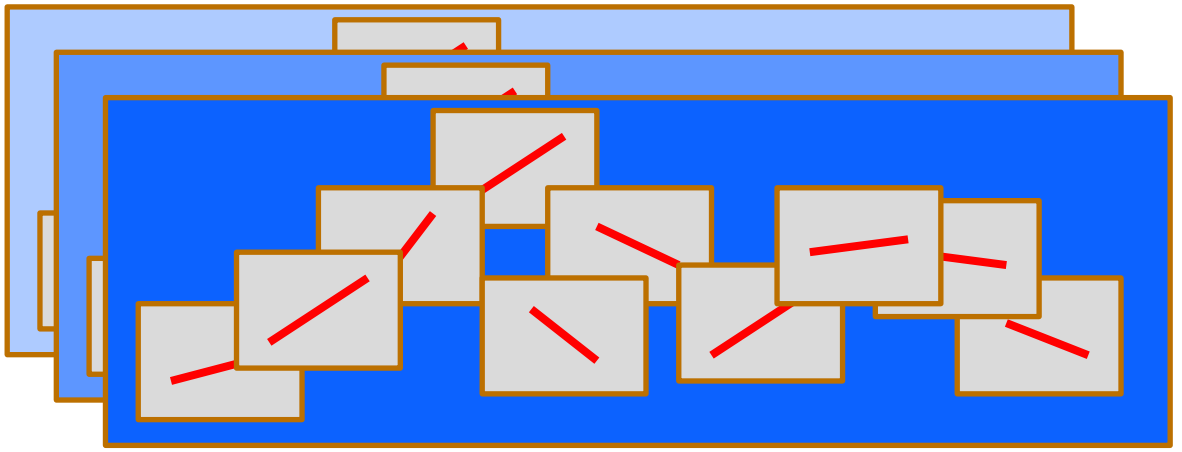
Best fit obtained with LSE retrievals trained with the MODIS database

3. IASI L2 developments

Exploiting horizontal correlation



A single input vector with all measurements



PWLR³

Piece-Wise Linear Regression

- **K-mean clustering to define regression classes**
- **Ensemble retrieval with different clustering**
- **Simultaneous retrieval in adjacent pixels**

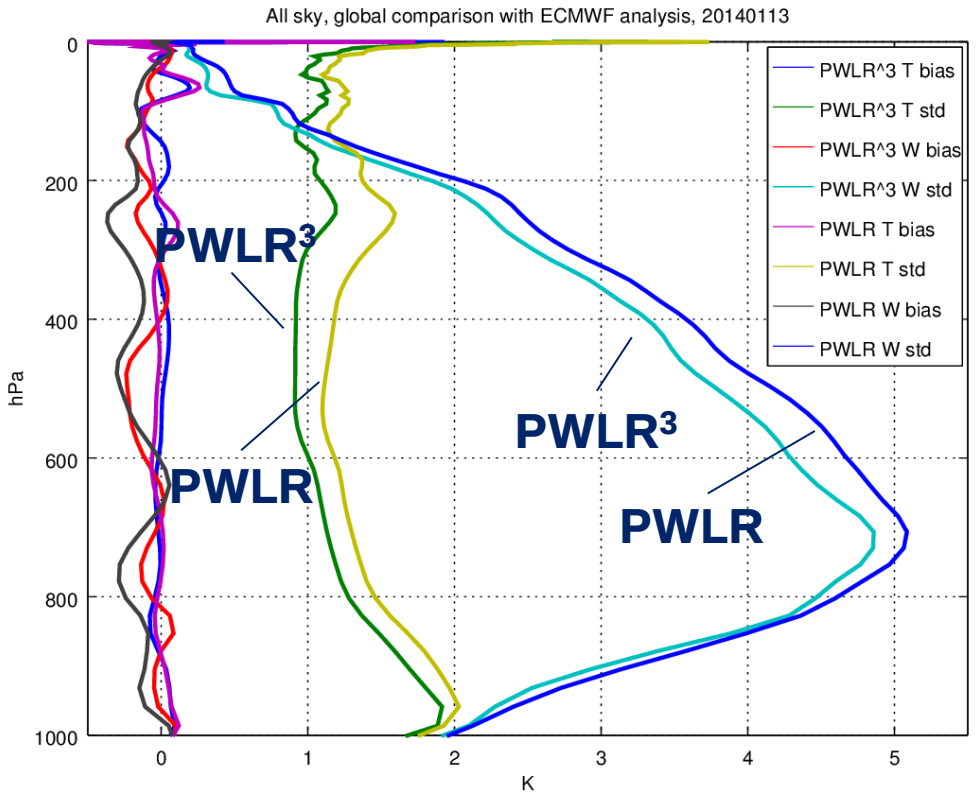
T, q, Ts, O_3, surface emissivity, cloud

for every IASI pixel separately

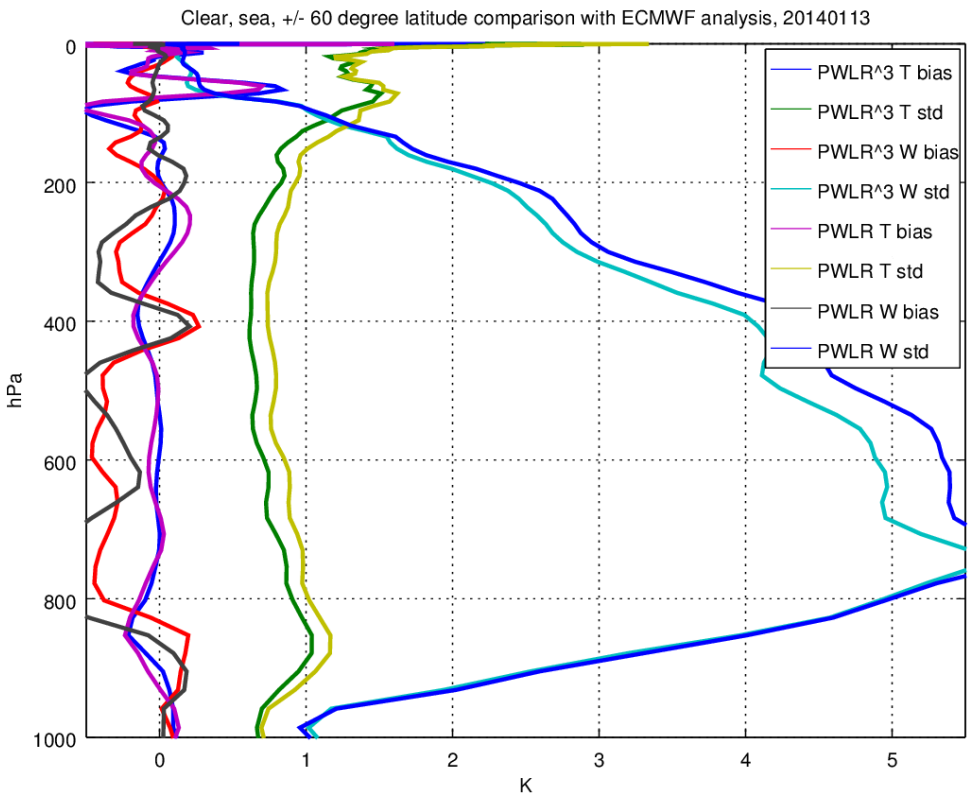
Exploiting horizontal correlation

IASI L2 – ECMWF ANA 20140113

All-sky, global

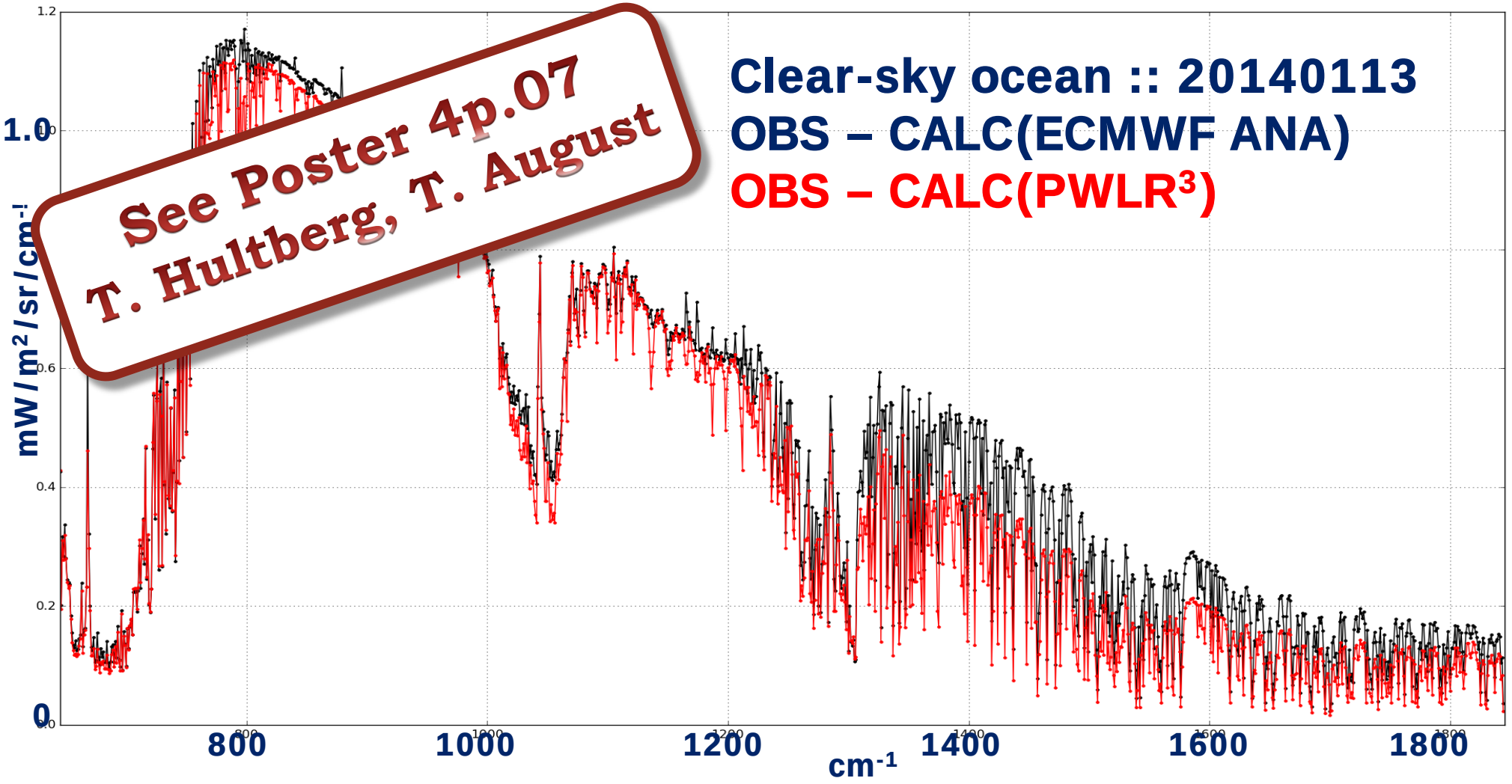


Clear-sky, sea



3. IASI L2 developments

Exploiting horizontal correlation



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3. IASI L2 developments

Outlook to future versions

	FG	Final T,q	Final AC
Inputs	IASI + AMSU + MHS	IASI PC-rec'd radiances *+AMSU +MHS* +PWLR^3	IASI L1c + L2 T,q,O_3
Params	T, q, Ts, *LSE, clouds, TRG*	T, q, Ts, *LSE, clouds* + AK	CO, O_3, HNO_3 +AK SO_2
Methods	PWLR^3 (statistical)	Radiance fit OEM	OEM (FORLI)
Scope	"All-sky" Yield ~85%	"All-sky" Yield ~85%	Clear & Clear-enough pixels Yield ~20%

Will it still be needed ?

Summary

- ✓ **IASI L2 v6** processor offers **terrific sounding capabilities** (yield and precision) **at the IASI footprint resolution**
- ✓ **MW+IR** allow **nearly all-sky T,q** statistical retrievals: ~85% useful yield
- ✓ **T & q profiles** significantly **improved**, especially in the **low troposphere** in clear and cloudy pixels (precision of T<1K, H_2O<1.2g/kg)
- ✓ **Full retrieval error** estimate provided (→ **AK** can be derived)

  ➔ *full details in "IASI L2 v6 Validation Report" EUM/TSS/REP/14/776443, 290pp*

- ✓ New atmospheric composition products, starting now with **CO profiles.** SO_2 and HNO_3 to follow.

- ➢ The **IASI L2 v6** is **reaching out new users** and is showing **potential for new applications**, not envisaged in the beginning of the mission: in climate, atmospheric composition and nowcasting.
- ➢ **PWLR³**: New generation of statistical retrieval, **taking advantage of correlations in adjacent pixels**. Extremely fast (1day processed in 8mn on a desktop PC) and **even more accurate products**, being extended to more geophysical parameters.
- ➢ Plans to **extend EARS-IASI** to include **IASI L2 v6 in regional processing**

Thank you for your attention!

thomas.august@eumetsat.int