The operational IASI L2 v6 products at EUMETSAT: Status, applications and evolutions

T.August, T.Hultberg, M.Crapeau, C.Goukenleuque, A.O'Carroll, D.Klaes, R.Munro *(EUMETSAT)*, C.Clerbaux(LATMOS), P. Coheur, D. Hurtmans *(ULB)*

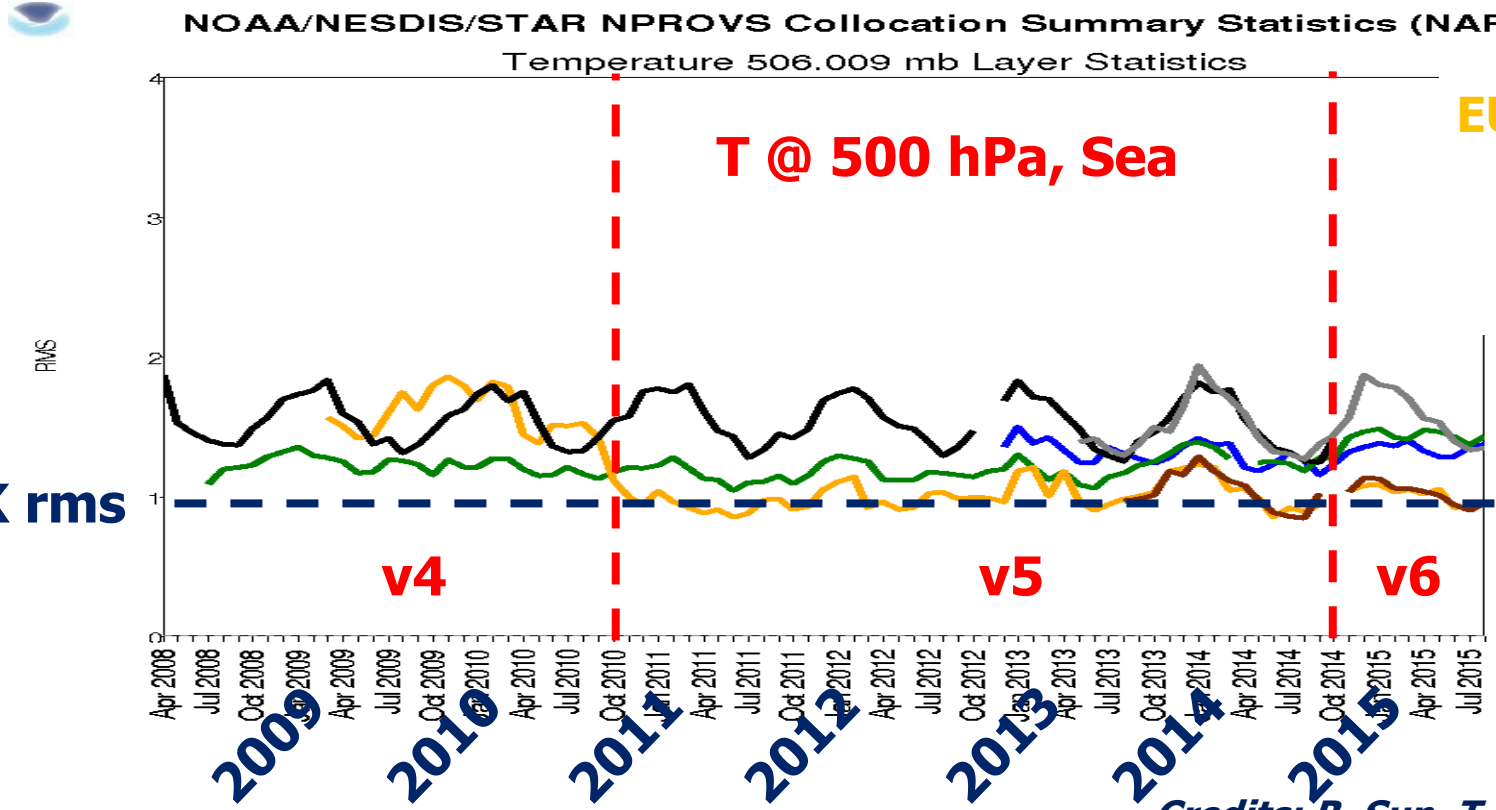
Outlook

1. IASI L2 v6
   Latest evolutions, from v6.0 to v6.2
   Temperature & Water-Vapour products performances
2. New applications & services
3. Atmospheric Composition products

1. IASI L2 v6 performances

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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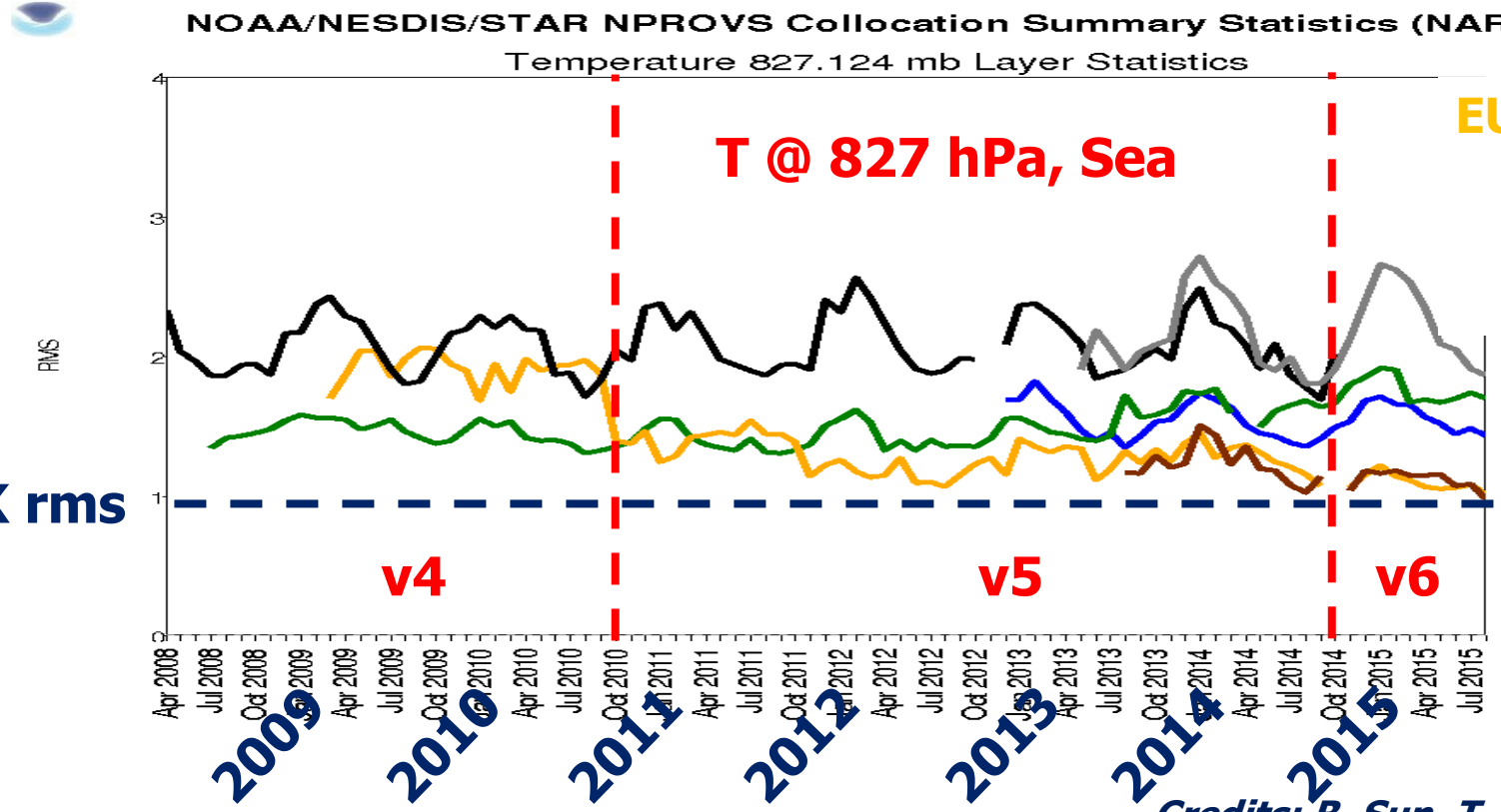

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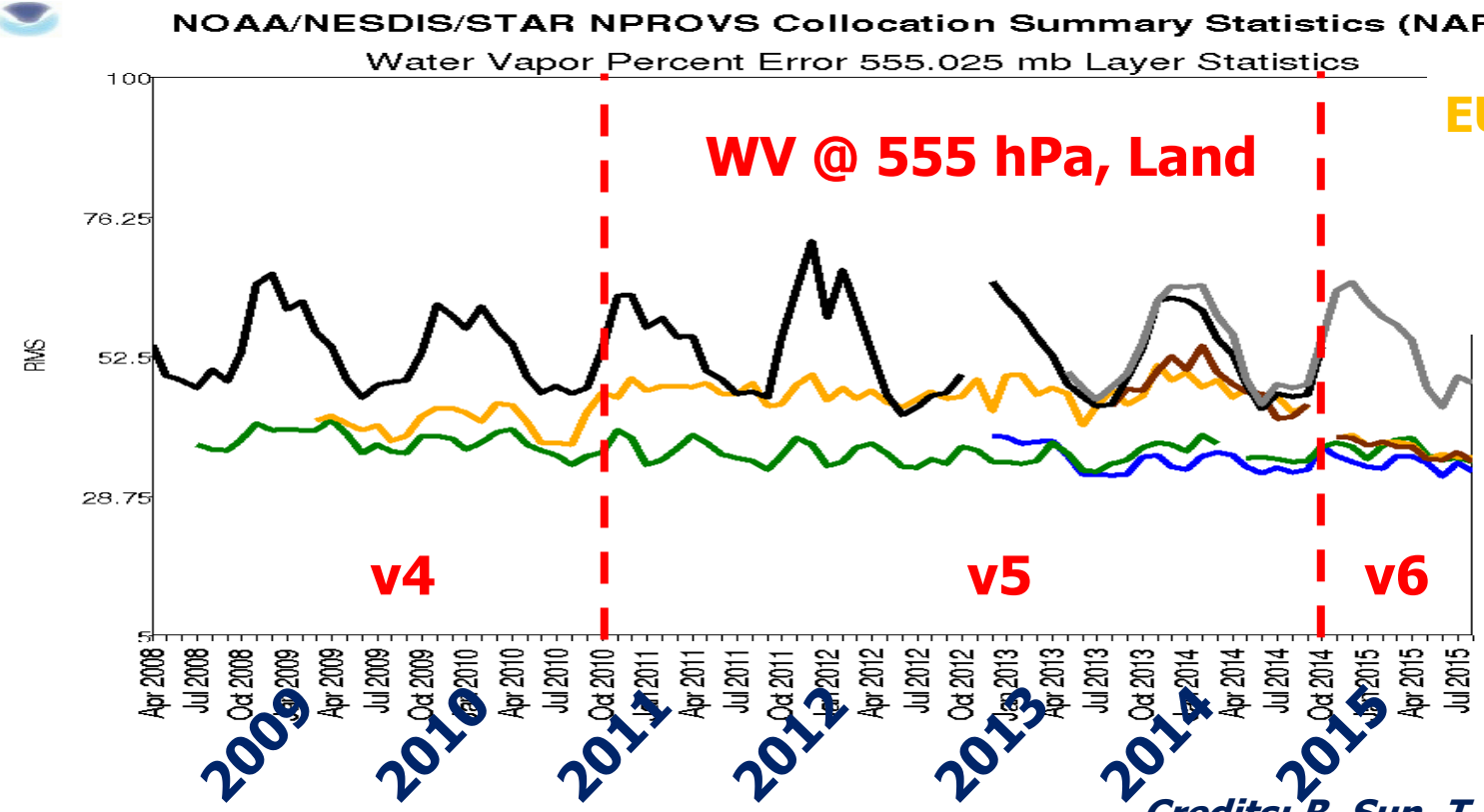

EUMETSAT L2
IASI+MW
Metop-A
Metop-B

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

1. IASI L2 v6 performances

Monitoring with *in situ* data

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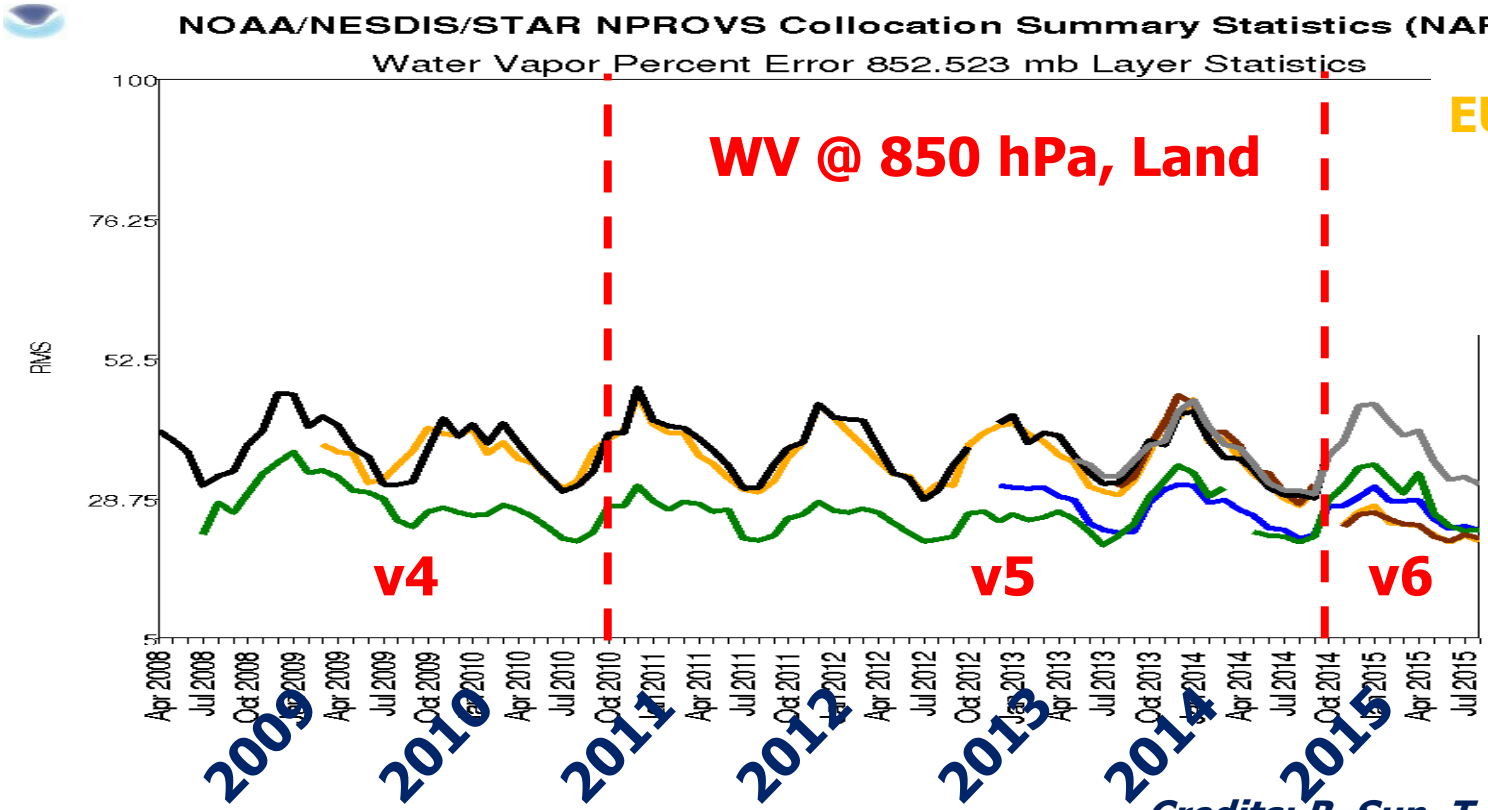


EUMETSAT L2
IASI+MW
Metop-A
Metop-B

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

1. IASI L2 v6 processor

Very high-level overview

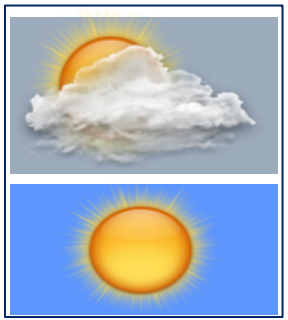
Extremely Fast
MW+IR (nominally)
IR-only (fall-back)

All-sky PWLR regression

IASI L1C

NWP
AMSU/MHS
AVHRR

Conf. data
Static db



OEM

$(x-x_a)^T.S_x^{-1}.(x-x_a)$
+
$(F(x)-y)^T.S_y^{-1}.(F(x)-y)$

Slow
IR-only (so far)

T, H_2O
« All-sky »

IASI L2

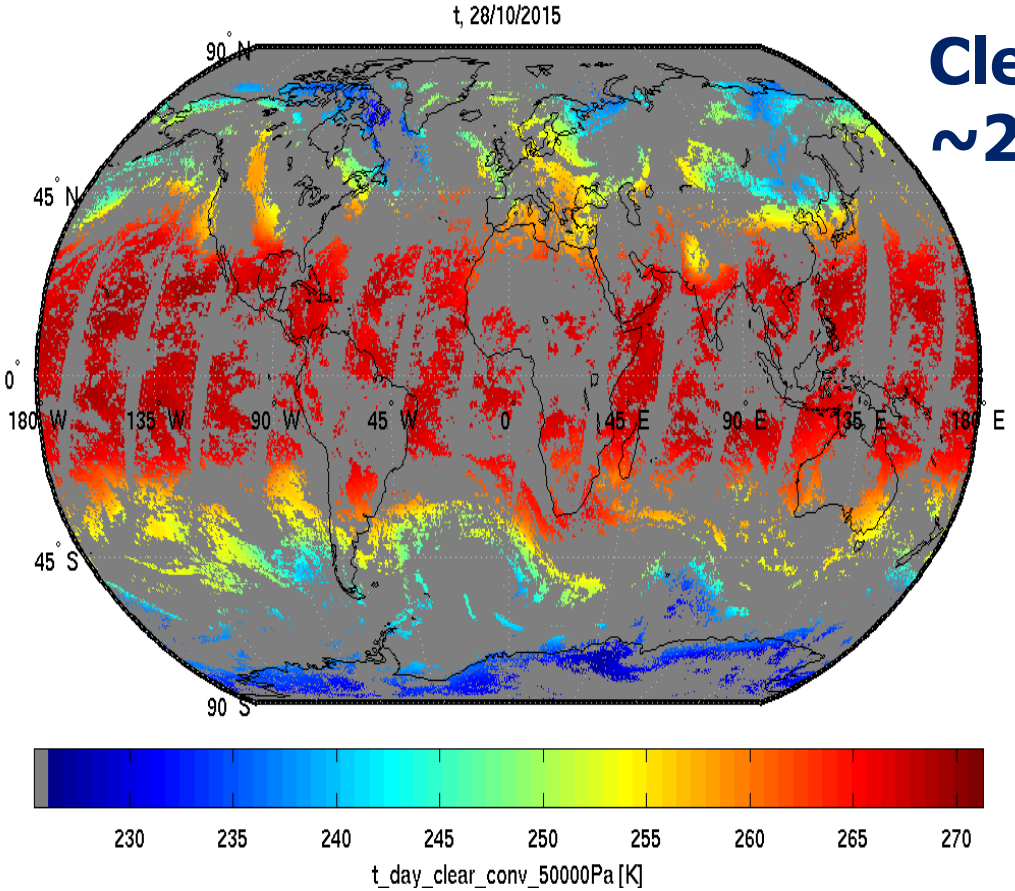
T, H_2O
Clear-sky

1. IASI L2 v6.0 to v6.2 — Incremental changes

- **v6.0**, 30/09/2014
  - New channel selection in OEM
  - Full spectral information through reconstructed radiances
  - New first guess and *a priori* to the OEM:
    - Non-linear retrieval (PWLR)
    - Synergetic use of AMSU+MHS and IASI
- **v6.1**, 24/09/2015 (currently operational)
  - Fixed bias in first-guess LST at daytime
  - Cloud fraction ranges 0..100%
  - FORLI-CO update for operational qualification
- **v6.2**, under qualification (release planned June 2016)
  - First-guess robust against MW data degradation (e.g. Metop-A),
    see poster Marc Crapeau, S10-106
  - Improved first guess (PWLR^3), including land surface emissivity
  - Variable (land/sea) observation error in OEM

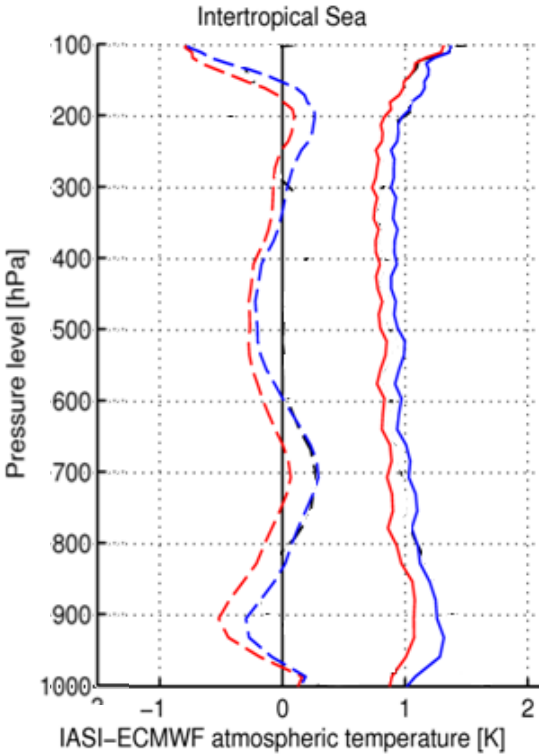
1. IASI L2 v6 T, H_2O products

Typical yield & quality



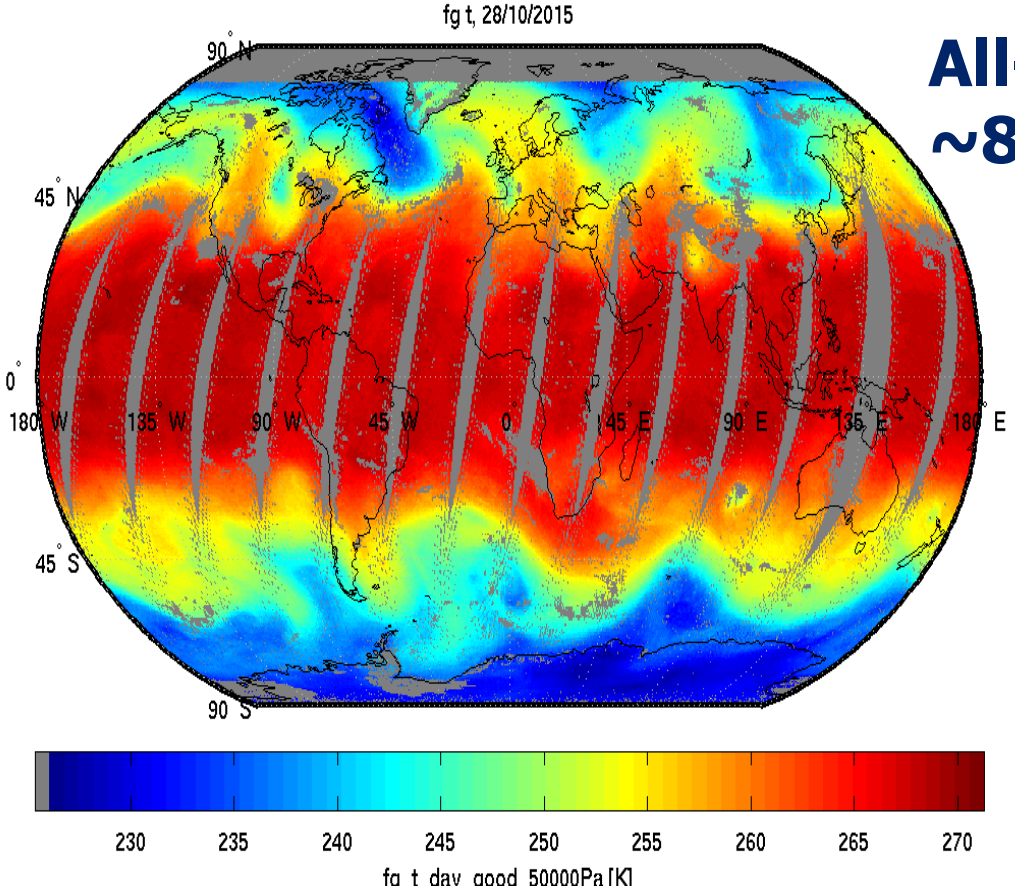
Clear-sky PWLR + OEM

~20%

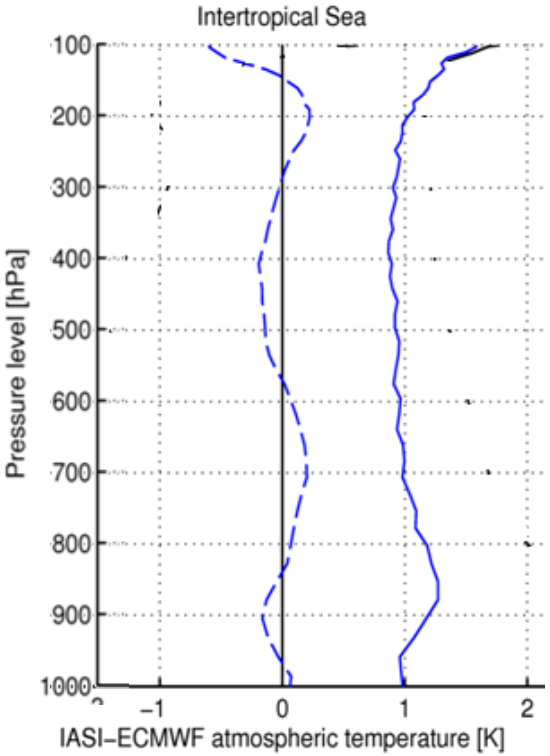


1. IASI L2 v6 T, H_2O products

Typical yield & quality



All-sky PWLR ~85%



Finalising land retrievals

$$J = BG + (y - F(T,WV,emis\ldots))^T \cdot S_y^{-1} \cdot (y - F(T,WV,emis\ldots))$$

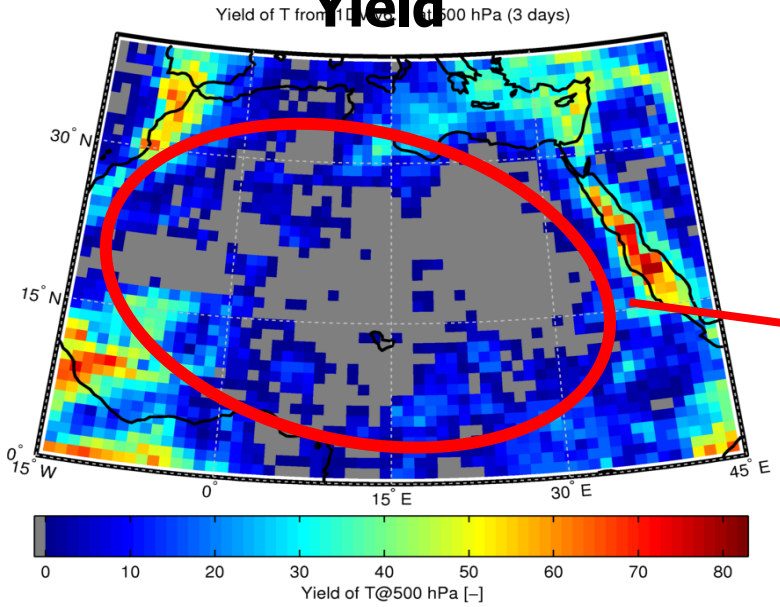
PWLR

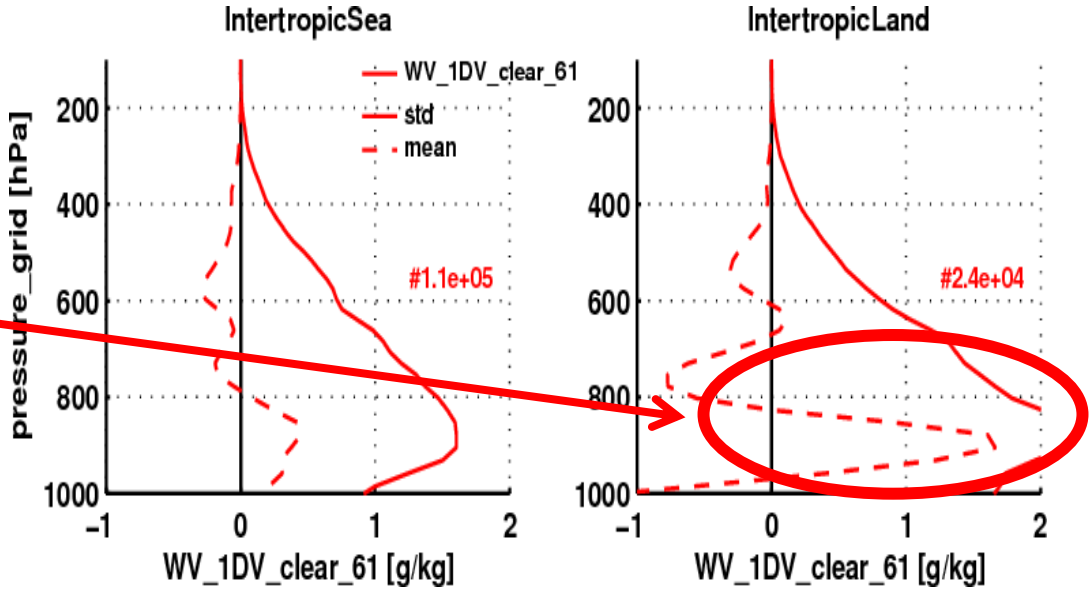
UW Static atlas

Unique Land=Sea

V6.1

Yield





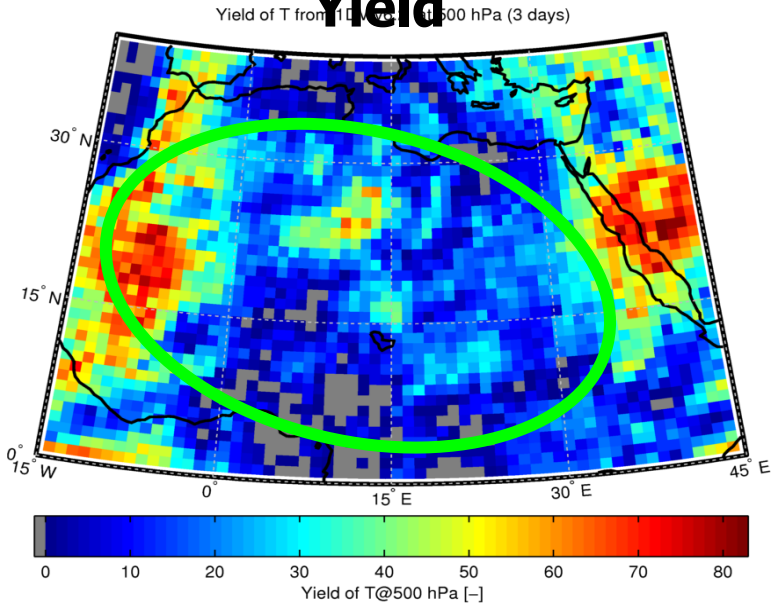
Finalising land retrievals

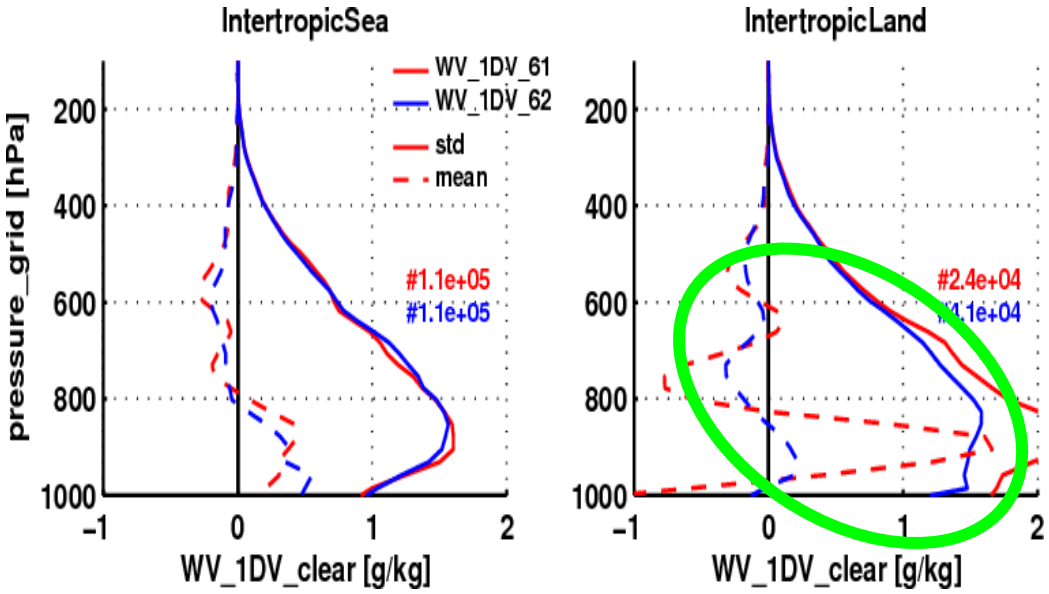
$$J = BG + (y - F(T,WV,emis\ldots))^{T} \cdot S_y^{-1} \cdot (y - F(T,WV,emis\ldots))$$

PWLR³ PWLR³ Variable Land ≠ Sea

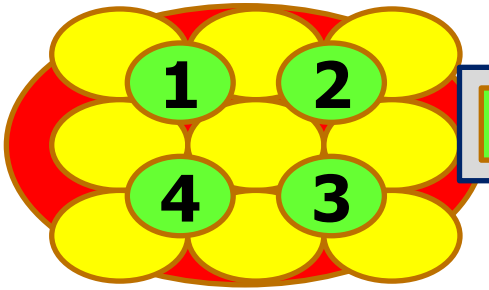
V6.2

Yield

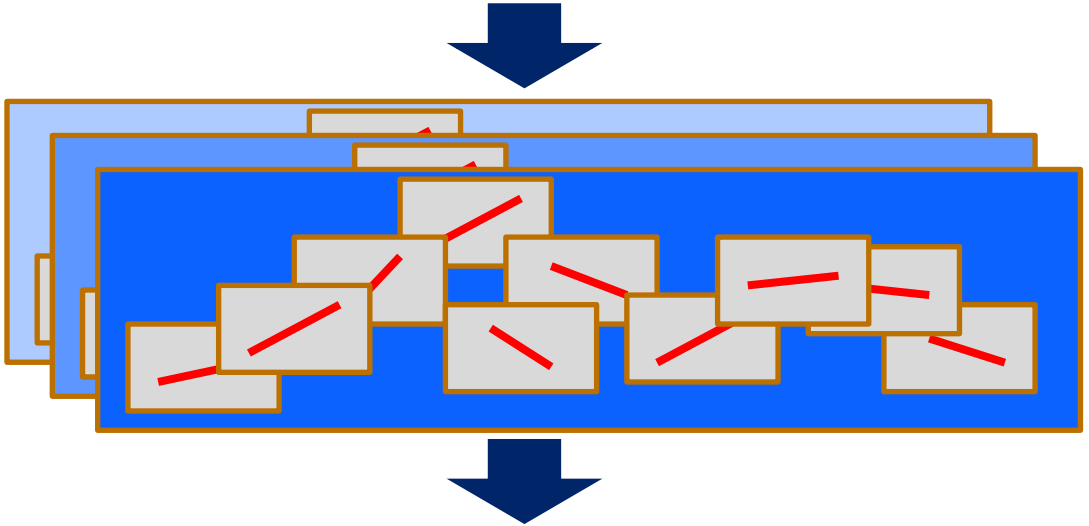




1. IASI L2 v6.2 Exploiting geophysical horizontal correlations



A single input vector with all measurements



PWLR³

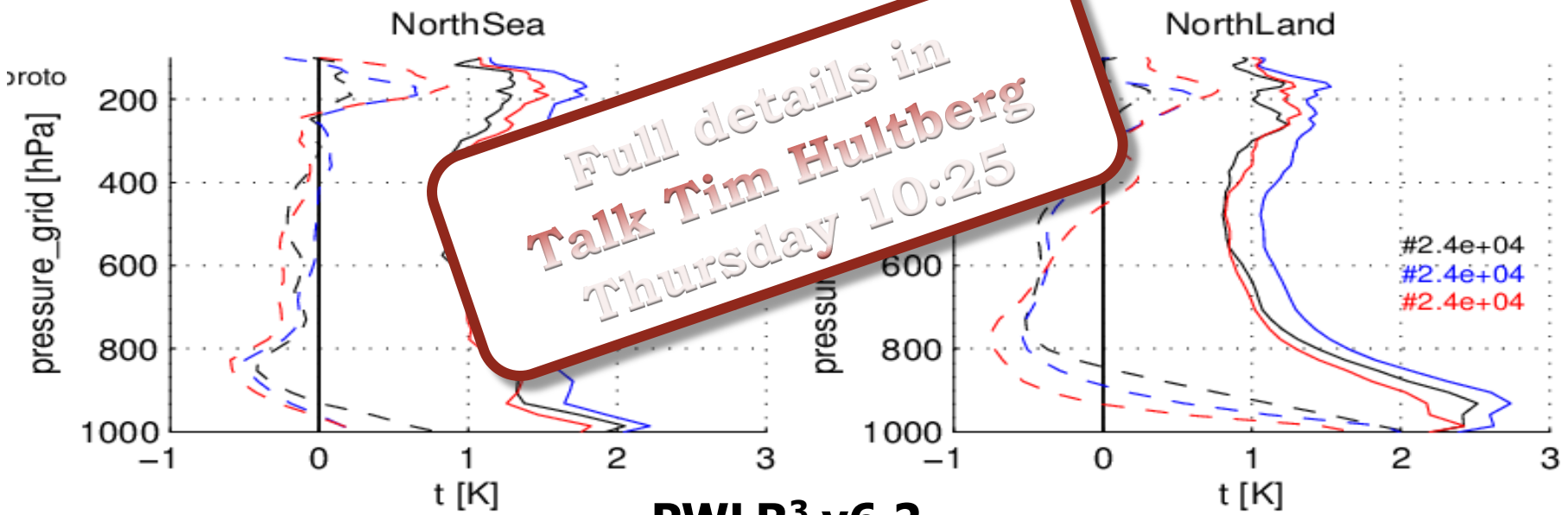
3D Piece-Wise Linear Regression

- 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

Is an OEM still needed?

ECMWF FCT – IASI L2 22/11/2015



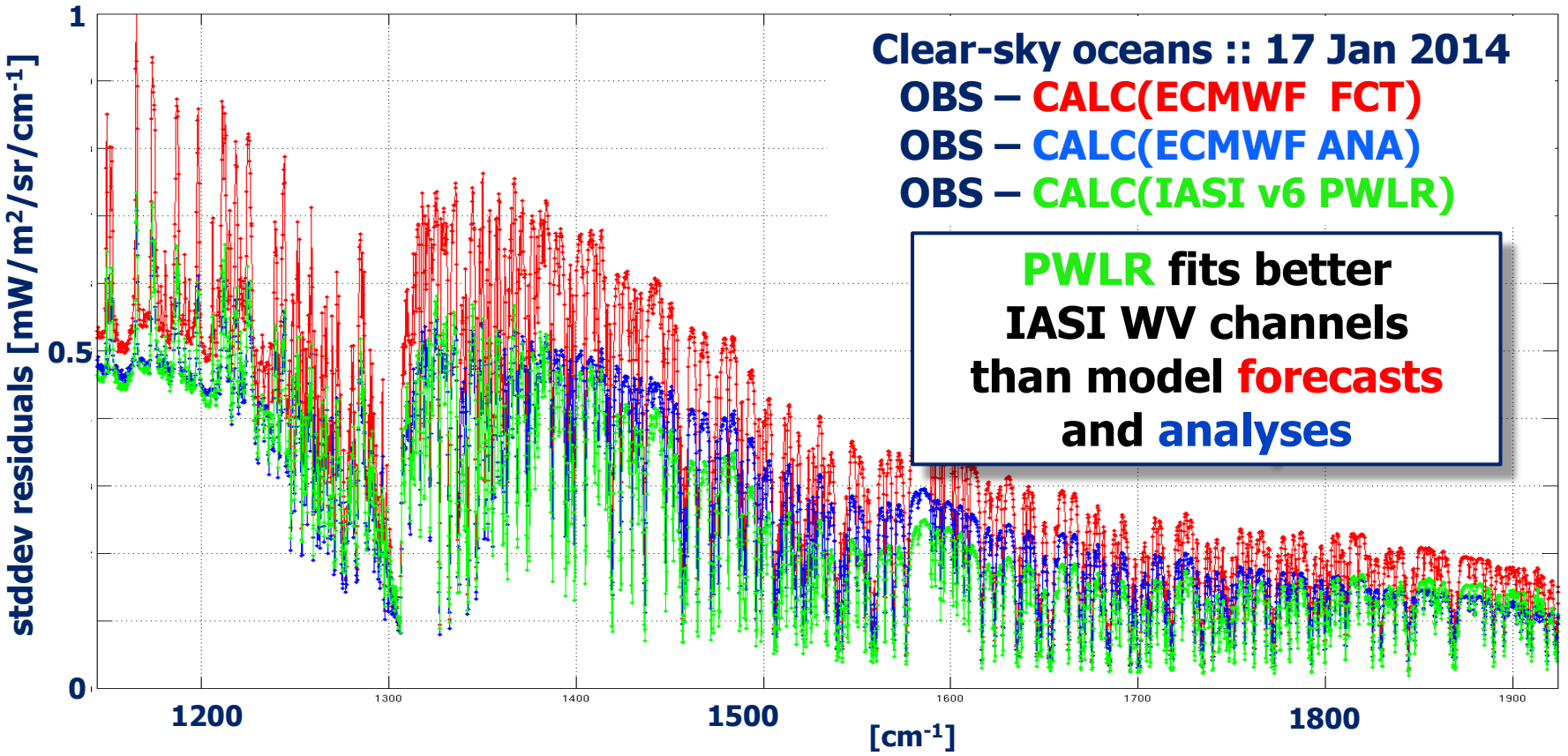
PWLR³ v6.2

OEM v6.1

PWLR v6.1

1. IASI L2 v6 performances

Evaluation in radiance space



Outlook

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   Latest evolutions, from v6.0 to v6.2
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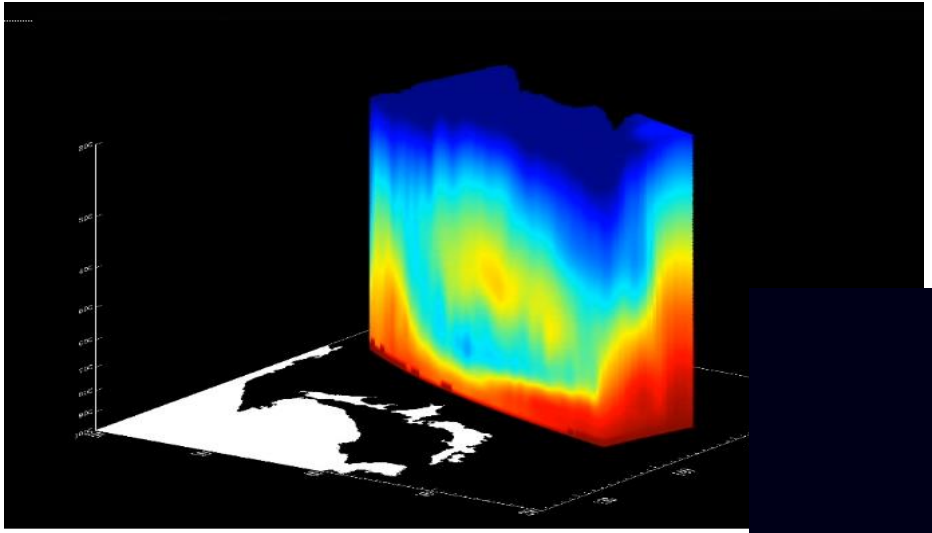
IASI L2 v6, a precise sounding

Example of recent results with IASI L2 v6 products:

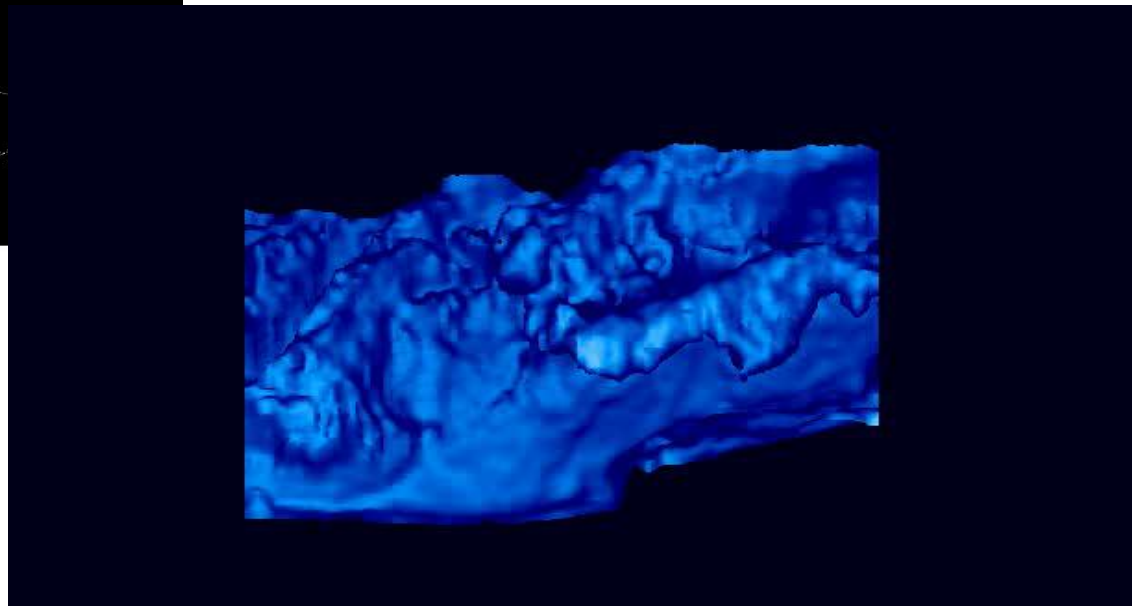
- "Evaluation of surface-based inversions from ERA-Interim and satellite data over Antarctica using dropsonde data from the 2010 Concordiasi Experiment", P. Boylan (NCAR) et al, *submitted*
- "A Global Assessment of NASA AIRS v6 and EUMETSAT IASI v6 Precipitable Water Vapor using Ground-based GPS SuomiNet Stations", J. Roman (U. Wisconsin) et al, *submitted*
- "Assessing the impact of aerosol on the accuracy of IASI SST", T.Trent (U. Leicester), ***Talk Tuesday 17:50***
- "Increasing the utility of real-time IASI moisture and temperature soundings in very-short-range forecasting", R. Petersen (U.Wisconsin), ***Poster S6-121***

2. New utilisations

3D Humidity fields



The PWLR[3] enables accurate “all-sky” retrievals of 3D WV fields, nominally exploiting MW and IR.



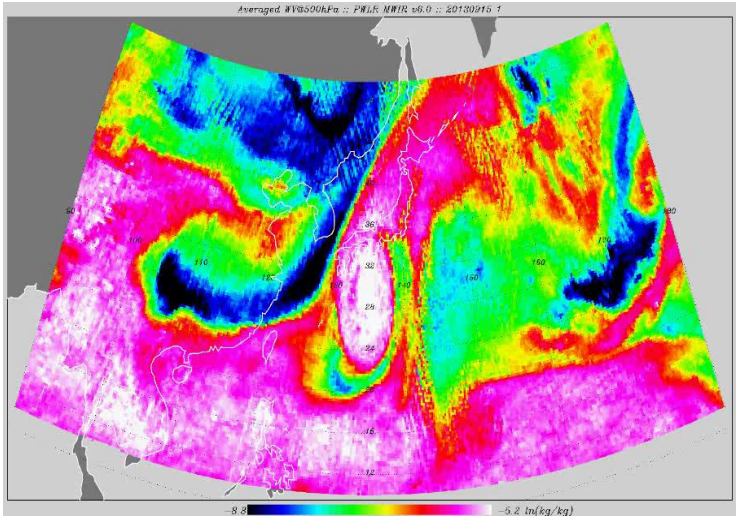
2. New utilisations

Tracking 3D Humidity fields?

The derivation of atmopsheric motion vectors profiles from the water-vapour 3D information is being studied, also taking advantage of the dual coverage with Metop-A and Metop-B

Talk by R. Borde, Thursday 9:20

WV@500 hPa :: Eastern Asia
Sept-Oct 2013

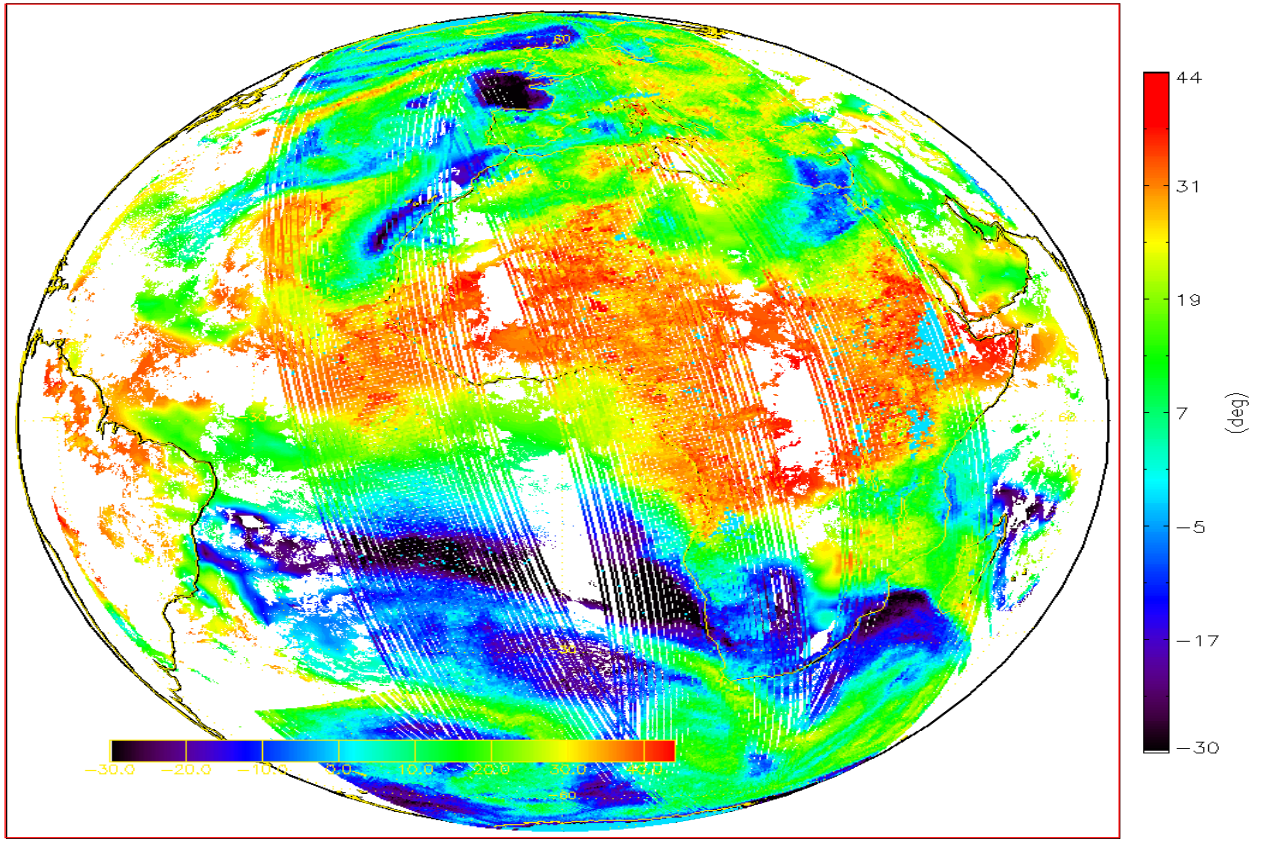


Tracking instabilities

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**.

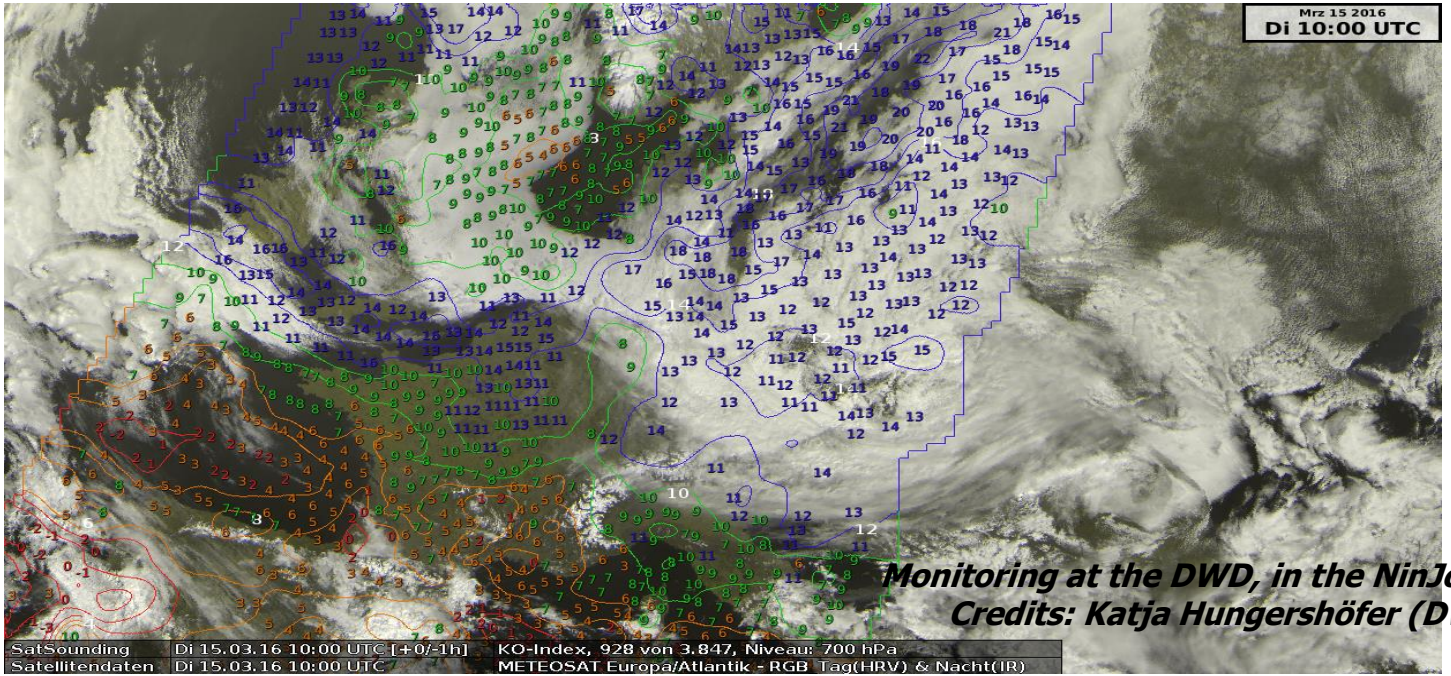
Poster J. Gartzke S9-59



Results: M. Koenig (EUMETSAT)

2. New services

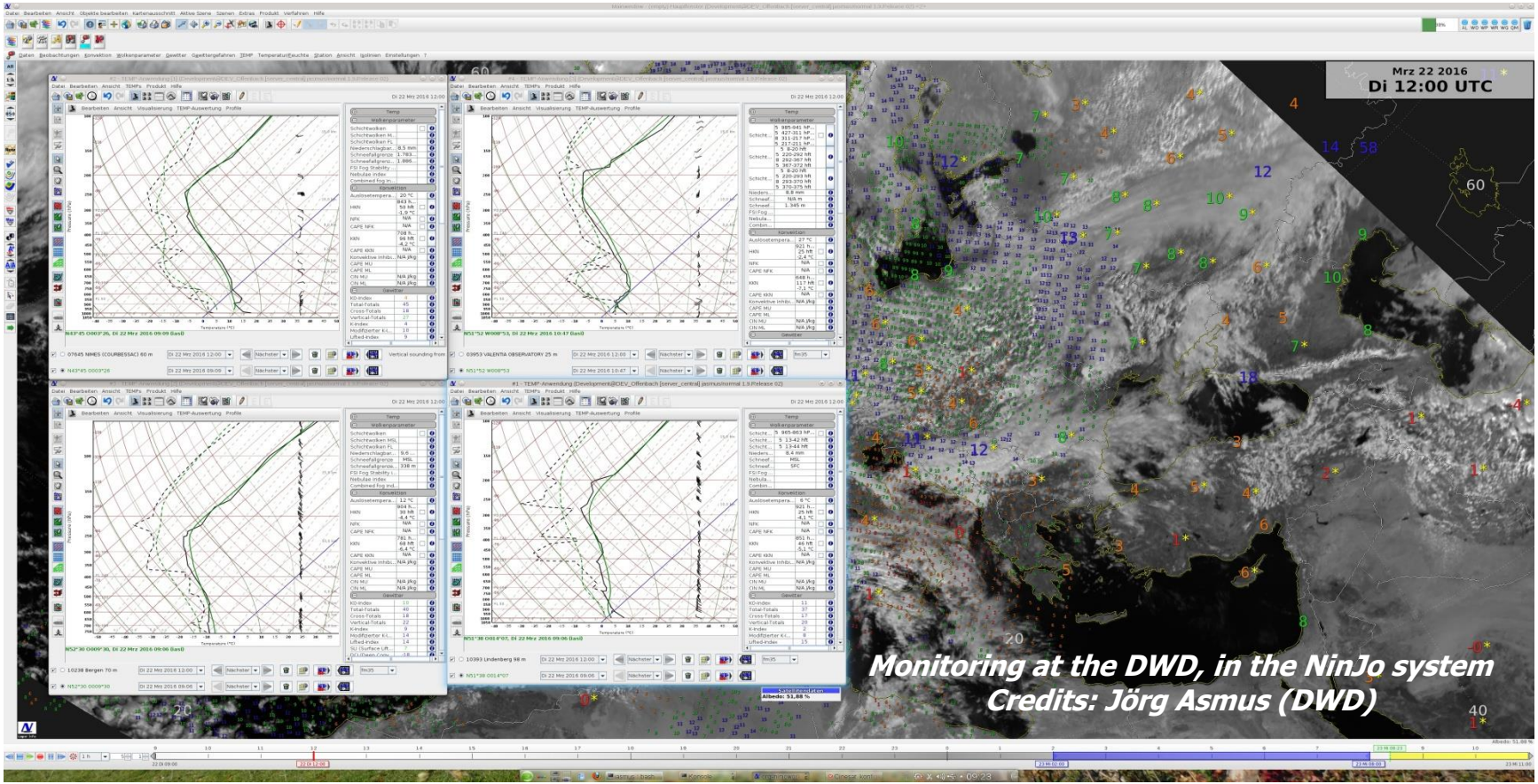
The **value of IASI L2 v6** and their potential for regional applications has been acknowledged by our users and EUMETSAT **Members requested** (OPSWG-38 Sept. 2015) the **delivery** of the IASI L2 products in a **more timely manner (~20-30mn)** than what the central global production currently allows (~1.5h). Plans are to **extend EARS-IASI** to include the **"all-sky" sounding** from statistical retrieval for **regional processing**.



Monitoring at the DWD, in the NinJo system
Credits: Katja Hungershöfer (DWD)

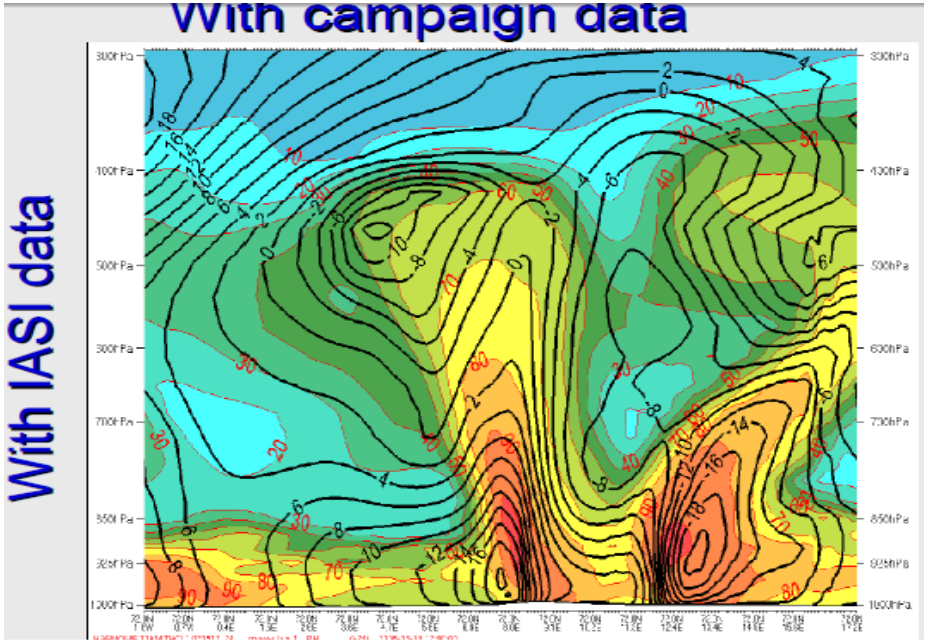
2. New services

Monitoring at DWD in NinJo



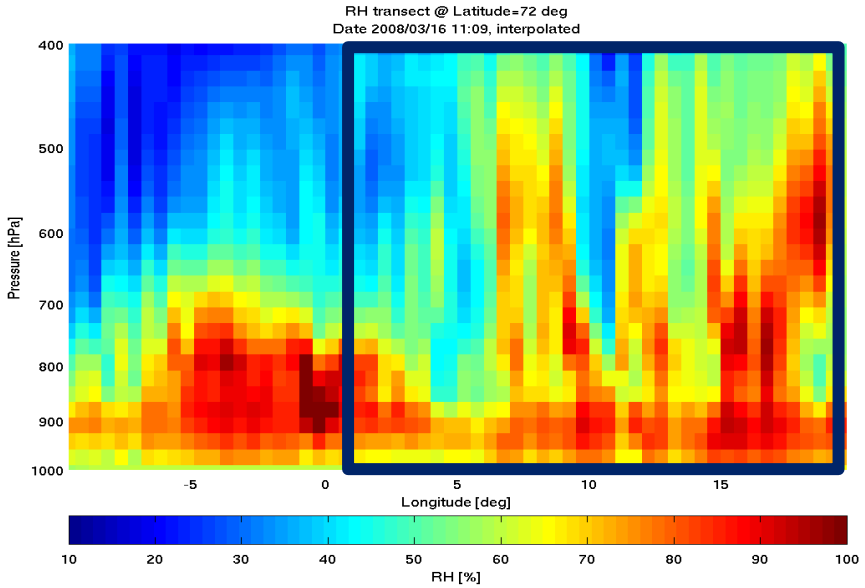
2. New utilisations

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
(1h difference)



To be discussed in the international workshop on Polar Low at LMD Paris 28-29/04/2016

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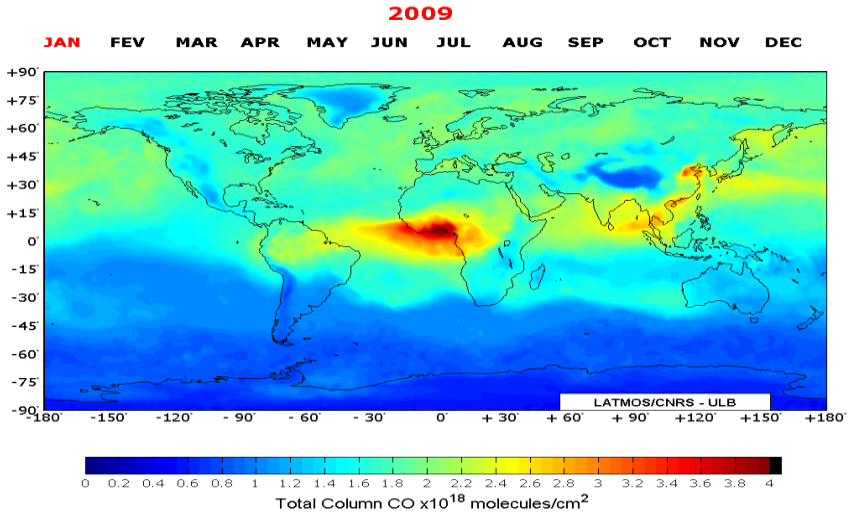
O3M-SAF CDOP-2 (2012-2017)

Integration in the EPS ground segment of a series of atmospheric composition products developped by ULB and LATMOS.

Algorithm: **FORLI** (Fast Optimal Retrievals on Layers for IASI, *Hurtmans et al., JQSRT 2012*)

- **CO profiles + averaging kernels**

The IASI L2 v6.2 contains the latest FORLI update. It is the baseline for operational validation with O3M-SAF. The research feed will then be discontinued.



Credits: ULB/LATMOS Coheur, Clerbaux et al.

Next steps, verification & validation:

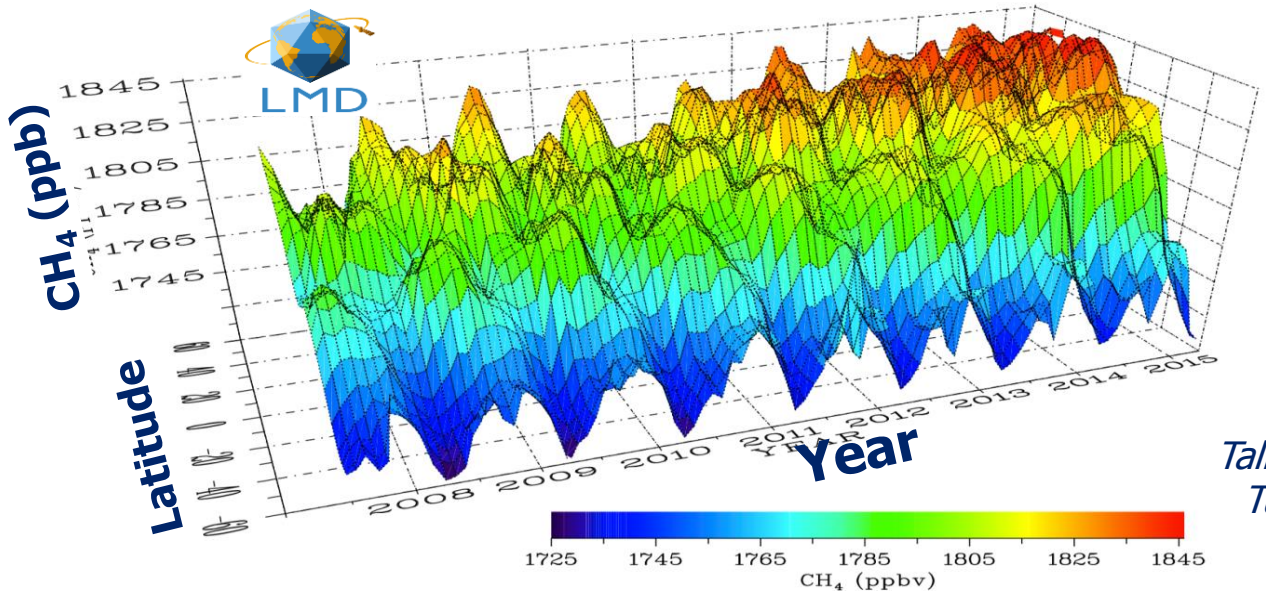
- **BRESCIA-SO_2 products**
- **FORLI-O_3 profiles**
- **FORLI-HNO_3 profiles**

Cf. Talks Tuesday M. George (11:00), S. Saffediene (9:15), G. Ronsmans (14:55)

3. Atmospheric Composition

Methane

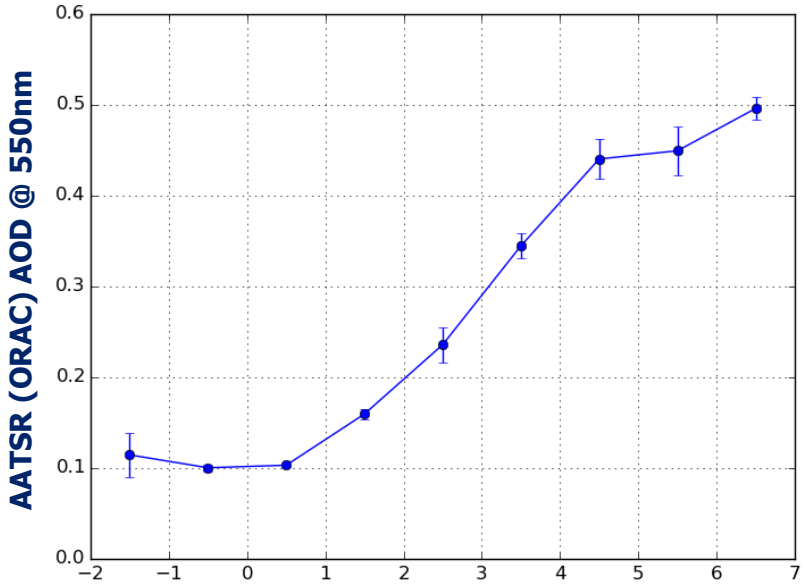
As a result of an external study concluded in 2015 and performed by the LMD Palaiseau, the applicability of the pre-existing research methane product was extended to higher latitudes (from [30°S;30°N] to [60°S;60°N]).
The integration and verification work are planned to start in 2016, aiming at operational production and data feed to Users, e.g. CAMS.



Talk C. Crevoisier
Tuesday 11:40

3. Atmospheric Composition

Dust index and SST accuracy

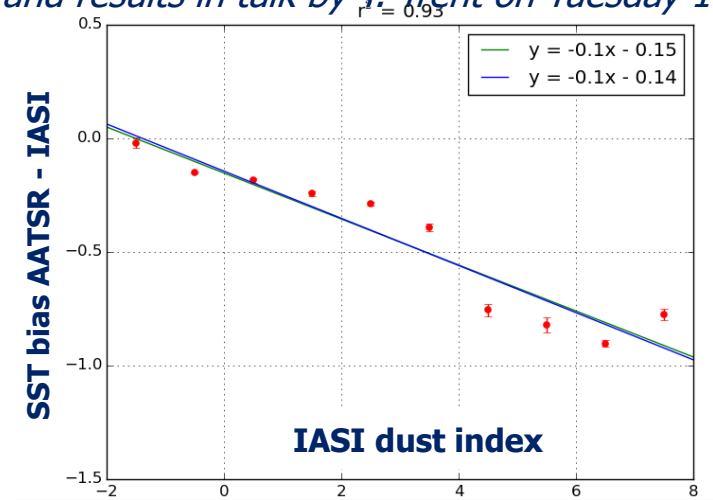


IASI dust index by Clarisse et al., talk Wednesday 14:55

A multi-year dataset of AATSR sea-surface temperature & aerosol products collocated to IASI measurements was procured through a study with University of Leicester.

It allows the assessment of aerosol indicators derived from IASI measurements and of the impact of the presence of dust on the accuracy of the IASI L2 SST product, for possible first-order correction in the operational IASI L2 processor.

Full details and results in talk by T. Trent on Tuesday 17:50



Summary

- ✓ **IASI L2 v6** processor offers **unprecedented sounding capabilities** (yield and precision) **at the IASI footprint resolution**
- ✓ First-guess (PWLR) nominally **MW+IR:** allows **nearly all-sky T,q** statistical retrievals: **~85% useful yield**
- ✓ **IASI L2 v6** is a **well established operational product**, running since September 2014
- ✓ Full product validation results in "*IASI L2 v6 Validation Report", EUM/TSS/REP/14/776443, 290pp*

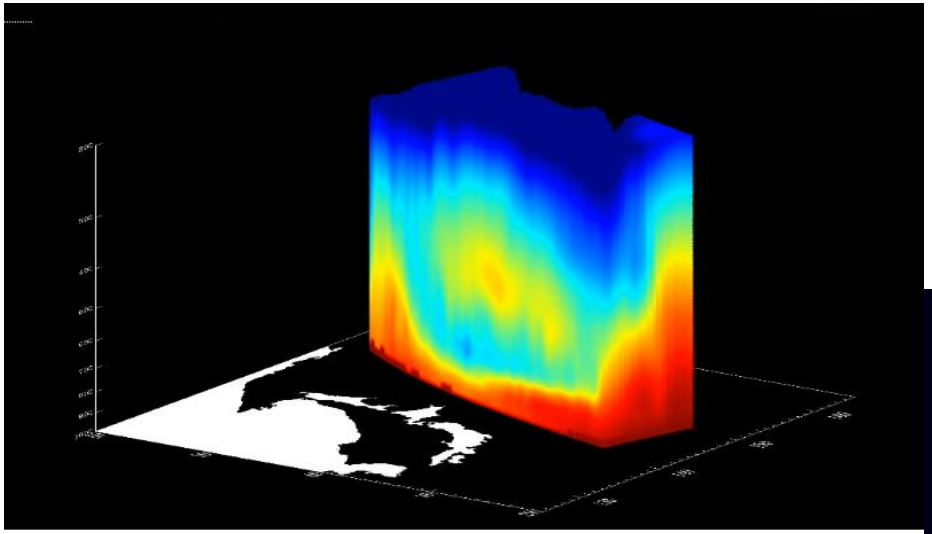
The version v6.2 includes (operational release planned June 2016):

- ➢ **PWLR^3**: New generation, exploits **geophysical correlations in adjacent pixels**. Extremely fast (1 day processed in 8mn on a desktop PC) and **even more accurate products**. As PWLR, it provides **forecast-free** sounding products.
- ➢ **PWLR^3**: re-enables **MW+IR synergetic use with Metop-A** (after loss of AMSU channel 8 in Sept. 2015)**.** Offers more robustness and flexibility against potential further MW instrument degradations.
- ➢ **Updates to FORLI**, completing the **overall quality information** needed by Users and addressing a minor bias in CO concentrations. Operational status expected as a conclusion of the delta-ORR (Q3-2016).
- ➢ Improved surface emissivity products

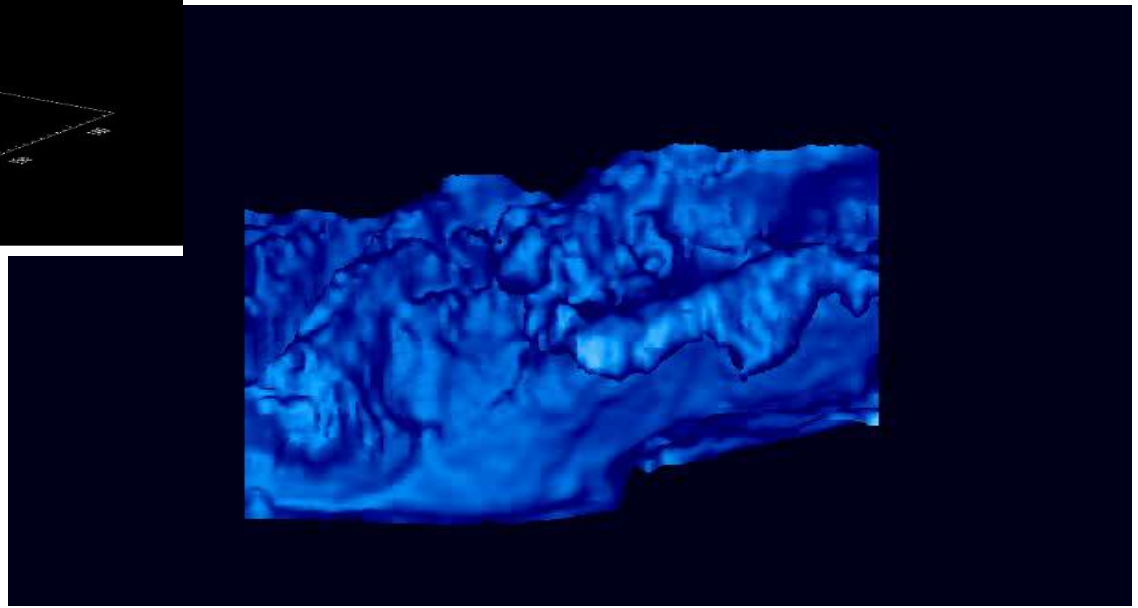
➢ IASI L2 v6 is showing growing potential for new applications. Plans are to **extend EARS-IASI to Level 2, initially over Europe and with the all-sky PWLR^3**, to serve regional users closer to NRT from regional data dumps.

Future plans:

- **Extend atmospheric composition products** (SO_2, O_3, HNO_3, CH_4). Provide operational data feed to Users, e.g. CAMS
- **Integrate dust flag** and complete the **IASI L2 SST** products provided to the Group for High Resolution SST (**GHRSST**) with additional quality information and possible correction, see Poster S5-115
- **Optimal estimation of clouds** from IASI measurements, first step before studying **all-sky MW+IR OEM retrievals**
- **Reinvest** the experience made with the **operational IASI** processors into **prototype IASI-NG L1D (PC) and L2**.



Thank you for your attention !



Questions & Feed-back

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ops@eumetsat.int