TOWARDS HOMOGENEOUS REFERENCE DATASETS FOR LONG-TERM CLIMATIC VARIABLE TIME SERIES FROM METOP-A AND METOP-B VALIDATED OBSERVATIONS

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The interest for homogeneous reference datasets has been clearly expressed within the NOAA/NASA Pathfinder Programme (mid '90) and WMO a long time ago.
At the core of this concern are e,g, GEWEX's and GSICS's needs to gain insight into a number of satellite and/or atmospheric/surface variables products now being constructed for climate applications.
Our involvement in the quality control of level1 satellite data and the validation of the retrieval of level2 products has led us to maintain and regularly upgrade radiative transfer models (4A) and build and update robust auxiliary databases (TIGR, ARSA, GEISA). Associated to these models and databases, the internationally recognized high stability of IASI radiances offers the capability to help homogenizing other simple or composite satellite, atmospheric or surface datasets.

Quality assessment of satellite L1 and L2 data : Ongoing work at LMD/IPSL
Three complementary approaches : Stand Alone + Relative + Double differences
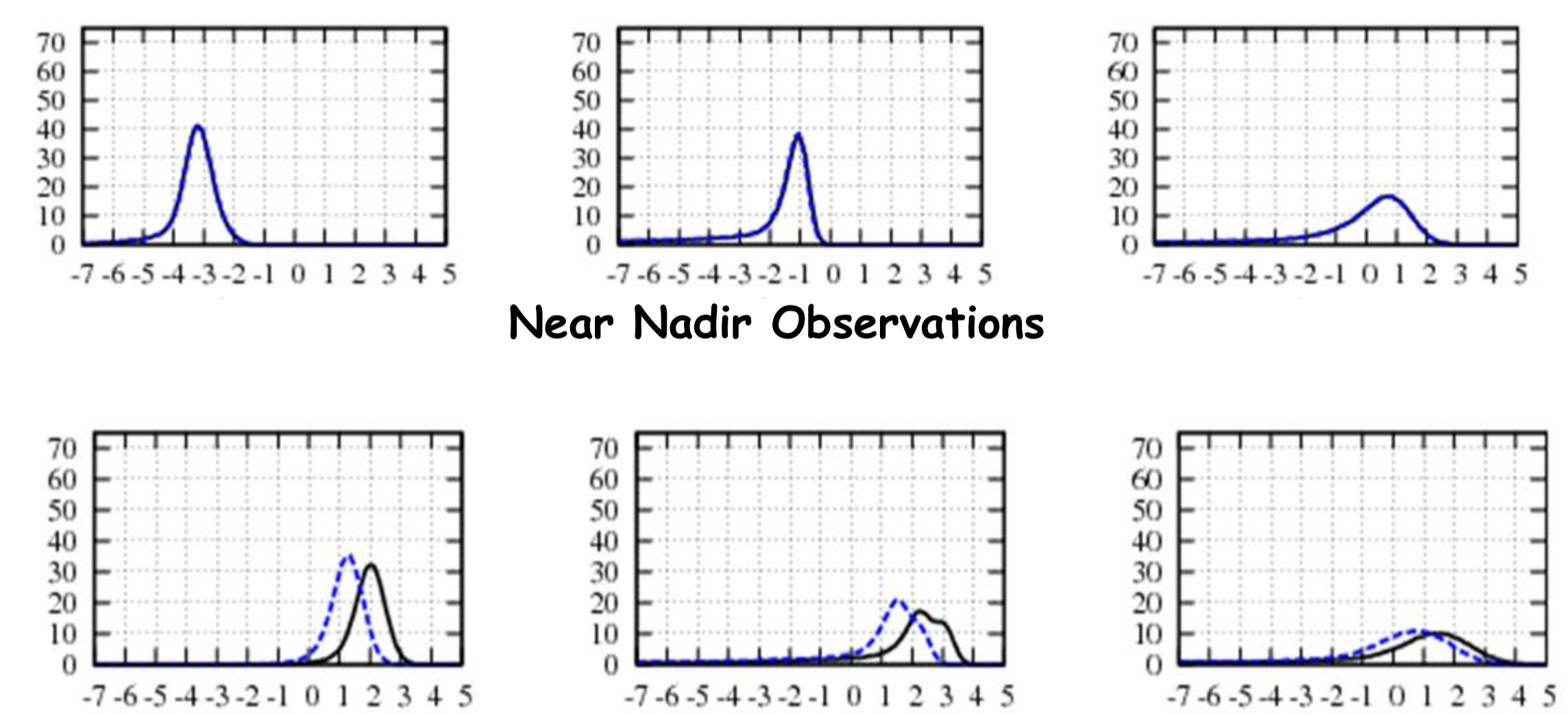## Study of residuals and time series of residuals and observations
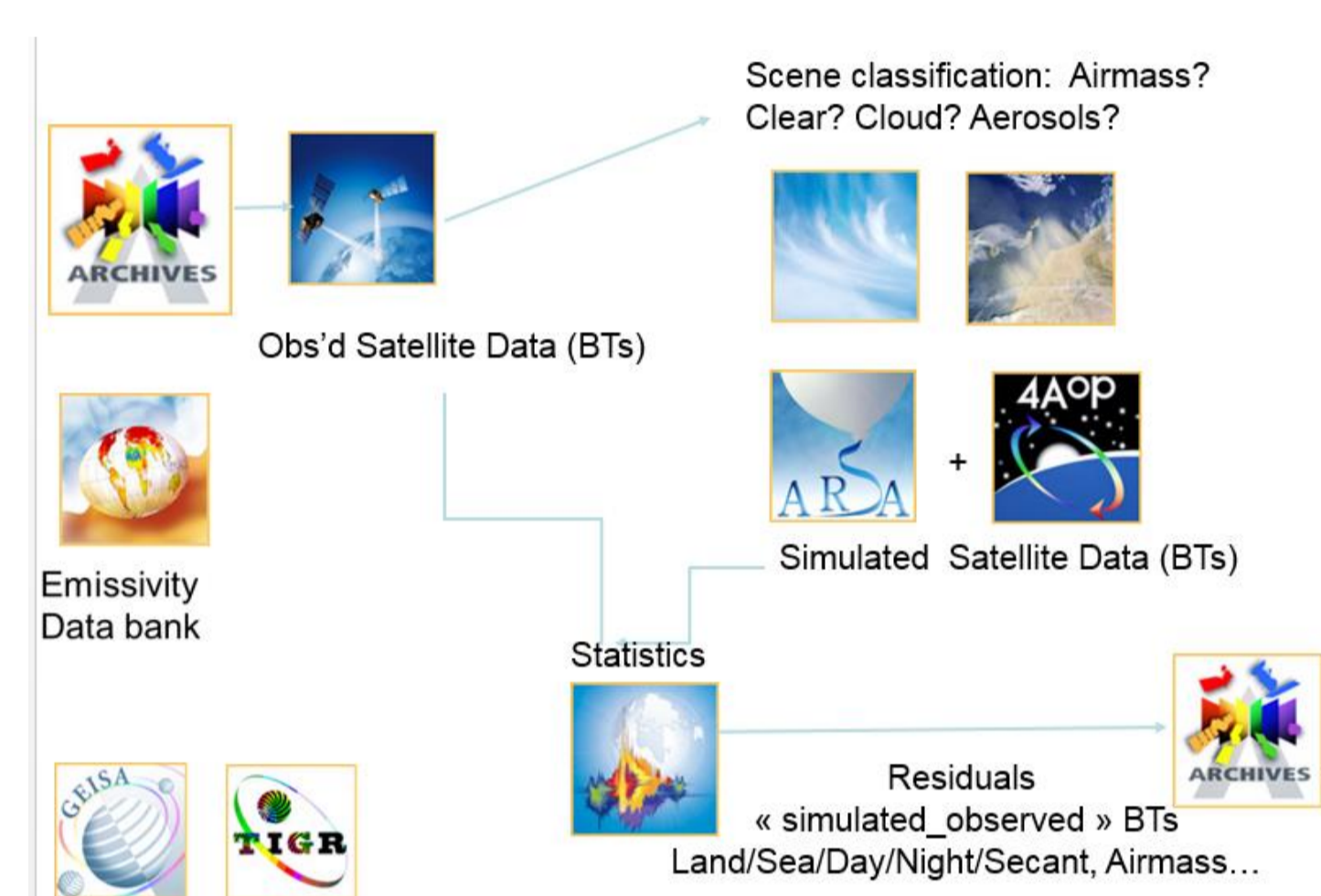
Time series of BTs, BT differences and residuals

LEO/LEO : IASI, AMSU, HIRS, MHS METOP-A and METOPB, from July 2007 onwards, Global
LEO/LEO/GEO : IIR/Calipso +Modis/Aqua + Seviri/MSG, from July 2006 onwards, Global

Related Research :
From January 1979 onwards : Constitution and validation of ARSA (Analyzed RadioSounding Archive) "Clear/cloudy/aerosols" screening

Scene classification: Airmass? Clear? Cloud? Aerosols?
Obs'd Satellite Data (BTs)
Simulated Satellite Data (BTs)
Emissivity Data bank
Statistics
Residuals « simulated_observed » BTs Land/Sea/Day/Night/Secant, Airmass…

IASI residuals to improve the representation of the water vapor profile in the ARSA (Analyzed RadioSoundings Archive) database

The ARSA database
- elaborated, from observations made by worldwide distributed **radiosonde stations** (from ECMWF archive) and combining them with surface **and other auxiliary obserrvations (ERA_Interim, ACE FTS level2)** in order to have a complete description of the surface and atmospheric state up to 0.0026hPa.
From January 1979, and extended onwards on a monthly basis, ARSA contains more than 5 millions of quality controlled profiles.

IASI data
Residuals
Simulated IASI BTs
4A/OP Radiative Transfer model
ARSA : Specification of the surface/atmospheric state

Current version of ARSA combines water vapor info from :
+ 1) severely quality controlled controlled raobs measurements (from surface to 350 hPa)
+ 2) Era_interim above from 350 to 0.1 hPa
+ 3) Empirical adjustment of Era_interim water vapor profiles between 150 and 350hPa has led to

OVERALL IMPROVEMENT OF THE RESIDUALS BIASES (in K)
FOR IR AND MWV METOP AS WELL AS FOR NOAA SERIES INSTRUMENTS
« 1+2 » ➔ left part of each segment « 1+2+3 » ➔ right part of each segment

METOP (July 2007 to June 2009)
HIRS-11 HIRS-12 MHS-3 MHS-4 MHS-5

NOAA-10 NOAA-11 NOAA-15
Two years of HIRS 11, HIRS 12

Land Day
Land Night
Sea Day
Sea Night

NOAA-15
NOAA-10   NOAA-11

HIRS11 HIRS12 MHS3 MHS4 MHS5
HIRS11 HIRS12 HIRS11 HIRS12 HIRS11 HIRS12

ARSA plays an important role in our radiative transfer community (forward and inverse) based on its exhaustive and continuous validation process.

Based on the improvements of the values of the BTs residuals in water vapor dependent channels of various instruments/ periods/ platforms, ARSA is a potential reference dataset in particular for GEWEX/GVap

IASI observations to highlight an AMSUA scan asymmetry

Histograms of the differences between collocated oberved values of IASI and AMSU companion channels highlight an asymmetric behavior of AMSU along the scan track
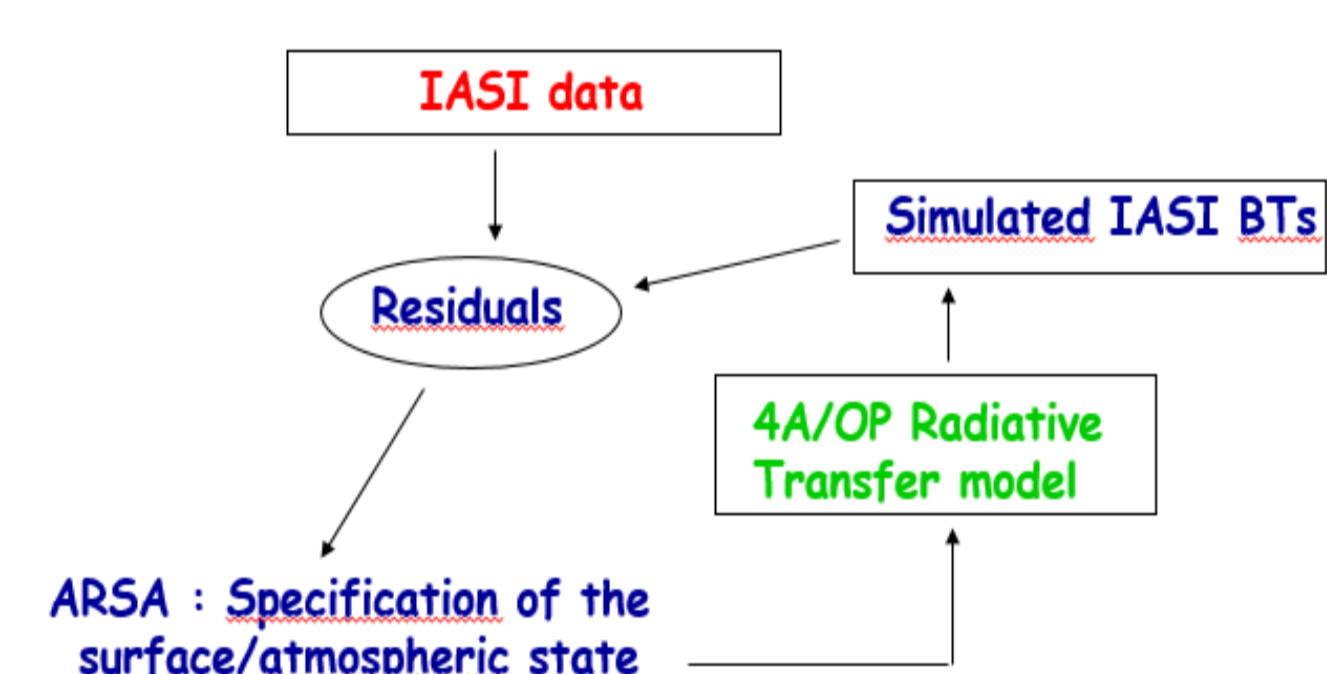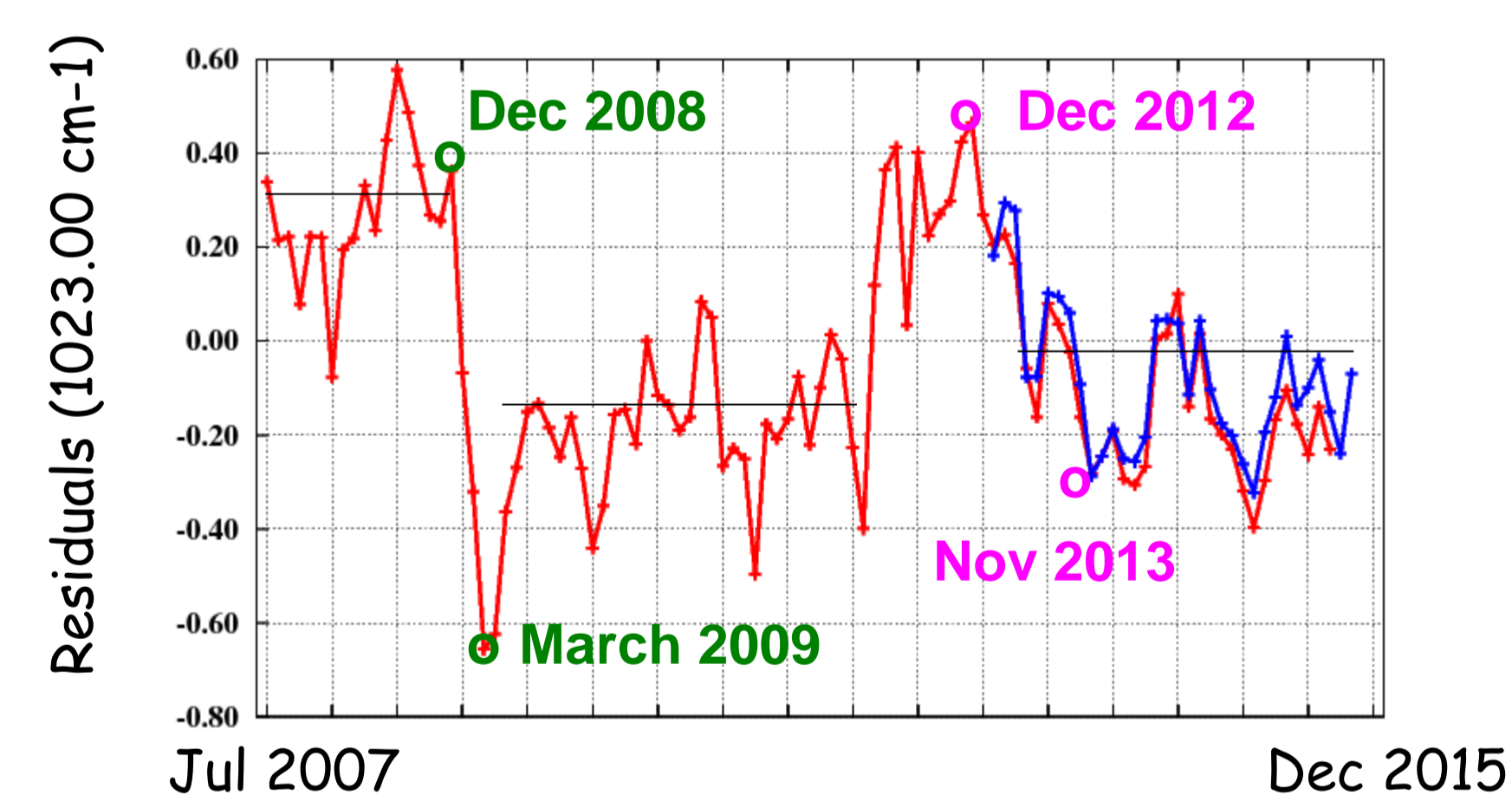
Near Nadir Observations

Secant 15 observations (blue dotted line ➔ left part of the scan)

TEST	IASI CHANNEL # - AMSUA CHANNEL #	WAVENUMBER (CM^{-1})
1	0193 - AMSUA 8	693.00 - AMSUA 8
2	2634 - AMSUA 6	1303.25 - AMSUA 6
3	6343 - AMSUA 5	2230.50 - AMSUA 5

From left to right

Time series of IASI residuals (METOP-A and METOP-B) to highlight a discontinuity in the Era_Interim ozone product

Time series of monthly averaged BT residuals for ozone channels
In red : METOP-A   In Blue : METOP-B

Residuals (1023.00 cm-1)

Dec 2008   Dec 2012
March 2009   Nov 2013
Jul 2007   Dec 2015

NB : A 1.0K peak to peak gap between Dec 2008 and March 2009
Question:
• Is it related to the assimilation of ozone data? (OMI, Sciamachy, MLS)?
Answer:
Yes, Confirmed by R. Dragani, (priv. Comm., April 2012) pointing a change in assimilation of MLS, OMI, Sciamachy at this period (Dec 2008).

Question:
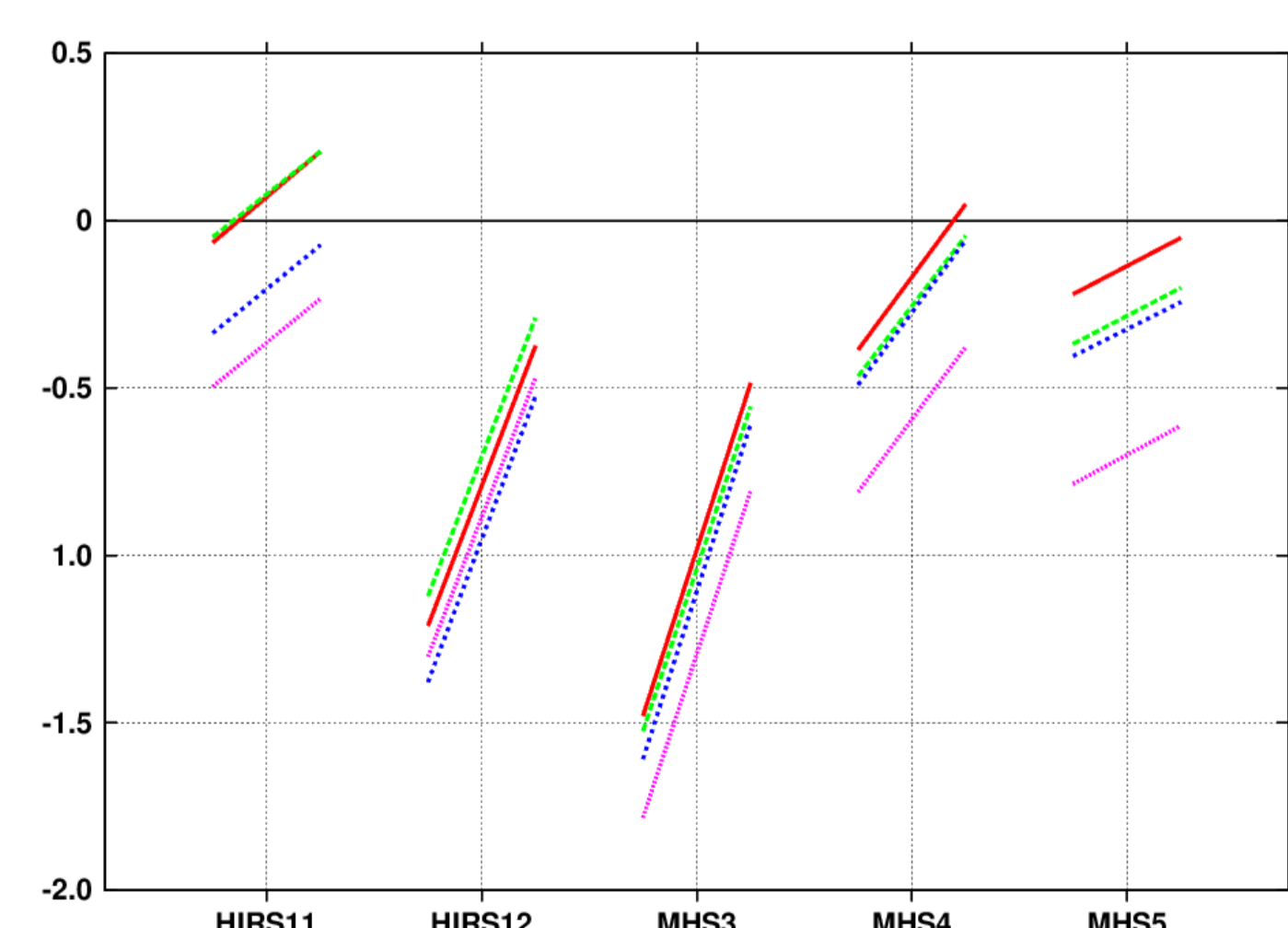Something similar December 2012 ➔ November 2013?

Conclusion and Perspectives for work on Homogenization and Reference datasets at LMD

These results confirm - if proof were still needed - the importance of continuing an interactive program of homogenization of the satellite data, radiosondes and reanalyses for applicability to climate studies data on a global scale.
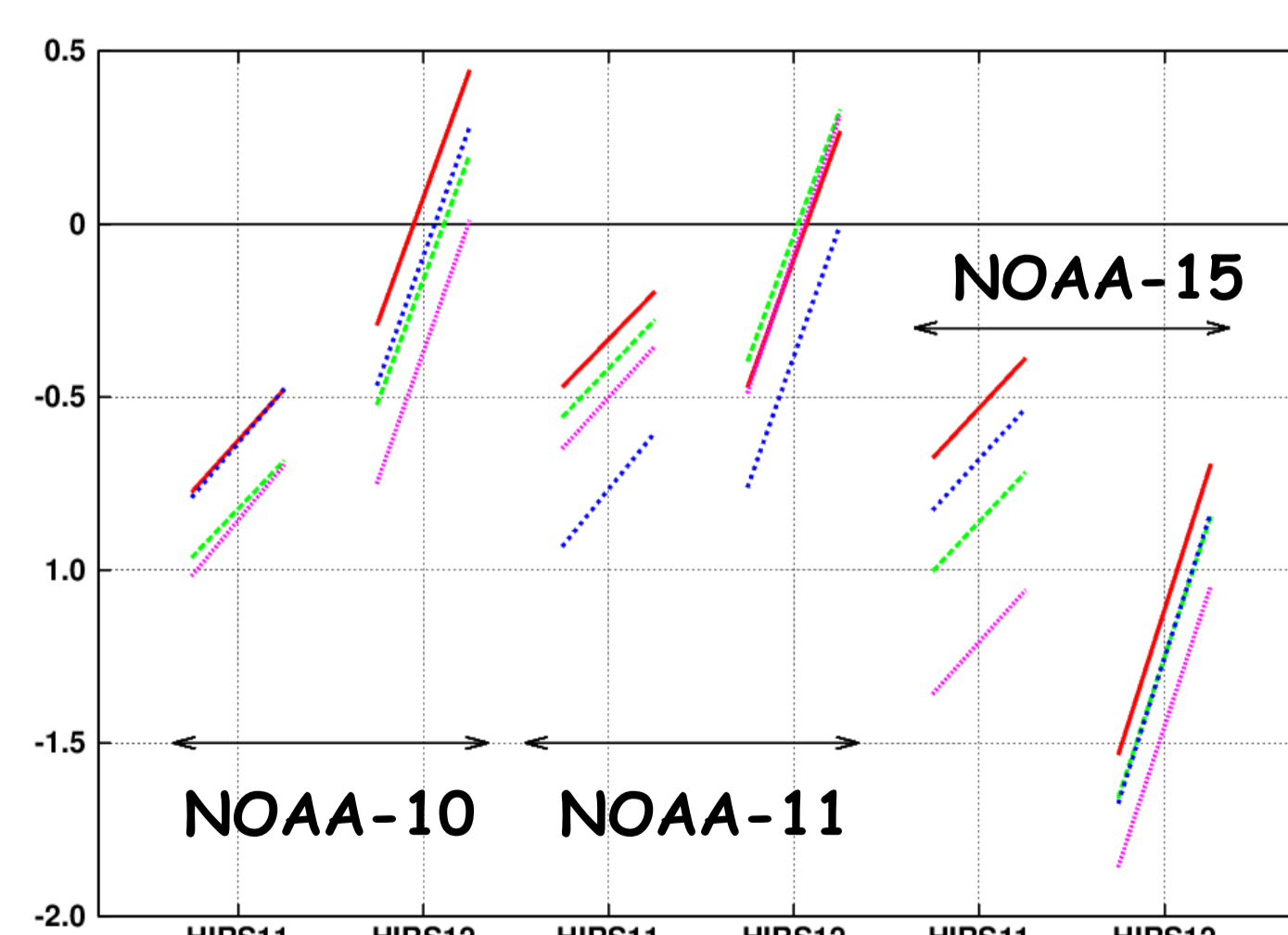Eventually :
Satellite data have to be followed all along the instrument/satellite life time, looking and correcting for: Unstabilities , Spurious Trends, Night/Day differences Asymetric behavior along scan line, …while preserving natural variability, natural trends
Radiosounding humidity records contain large errors and biases and are notoriously inhomogeneous due to difficulties in accurately measuring humidity, changes in hygrometers and observing practices, changing methods of converting relative humidity (RH) to DPD
Reanalyses can exhibit discontinuities related to changes in the assimimilation of e.g. satellite data

As the ARSA database appears to be very well suited to improve on the high accuracy climate record from high resolution IR spectra, our plans are to further examine a process of homogenization based on the remarkable radiometric stability of the METOP/IASI instrument – and later on of the METOP series B, C, IASI-NG - and on the reliability of our RT model(4A/OP) and databases (GEISA, TIGR,…).