Toward a better retrieval of fine water vapor atmospheric structures using IASI

Lydie Lavanant.
Météo-France/CMS/R&D

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Motivation behind this study

The first results (ITSC-16 Conf 2008) of humidity profile retrievals with IASI were much less accurate than expected from simulations done before the launch of IASI.

It was discussed of whether it was possible to retrieve fine atmospheric structures from IASI data which were not present in the first guess

An intercomparison of clear-sky sea retrievals was performed from JAIVEx data, conducted by F. Hilton (Eumetsat Conf 2009).

- 9 teams have performed a retrieval with the scheme they normally use
- Conclusions:
  - no scheme works really well for every profile.
  - better is the guess, better is the retrieval
  - often the temperature and humidity retrievals compensate in ways which add incorrect structures elsewhere

Additional study on Jaivex data to understand what parameters/method in the retrieval scheme can be updated (with in mind computer calculation times of a real-time package) in order to improve the retrieval of fine water vapor structures

Data and Method

Jaivex (Joint Airborne IASI Validation Experiment): 3 marine clear sky cases in the Gulf of Mexico in 2007 (25 IASI obs/ 9 dropsondes)

Retrieval scheme:

- Levenberg-Marquardt 1dVar method. 10 iterations max.
- Guess: ECMWF 12h and 18h forecasts 0.5x0.5 resolution
  spatial interpolation
  temperature: time interpolation. humidity: time nearest field
- ECMWF background covariance matrix
- RTTOV v9.3
- 43 rttov levels

- Adapt Surface Temperature to observation with Bt(obs-cal)_875cm-1 = 0
- Bias correction: mean values of obs – computed (with dropsonde) for the 25 IASI fovs

Retrieval tests

Experiments:

1. « Standard run »:

   178 channels, same as used in ECMWF operational runs (A. Collard)

   Rmat Obs covariance matrix: constant values @280K

2. 178 channels

   Rmat=CNES NeDt level 1c band matrix

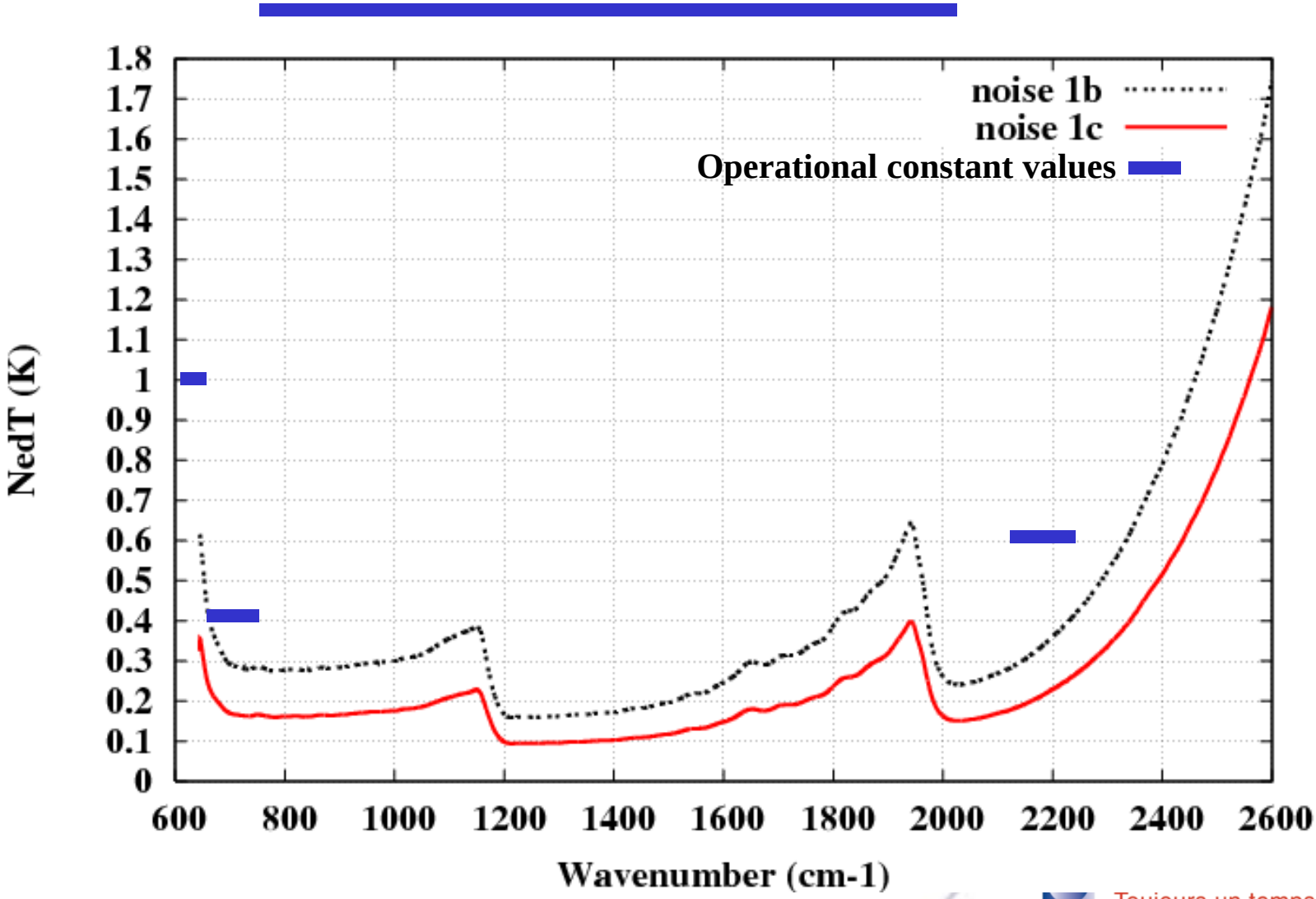
3. In-line Rodgers selection weighted by Δtb(guess-obs) residuals instead of IASI spectrum

   ->150 channels in the 366 ECMWF sub-set

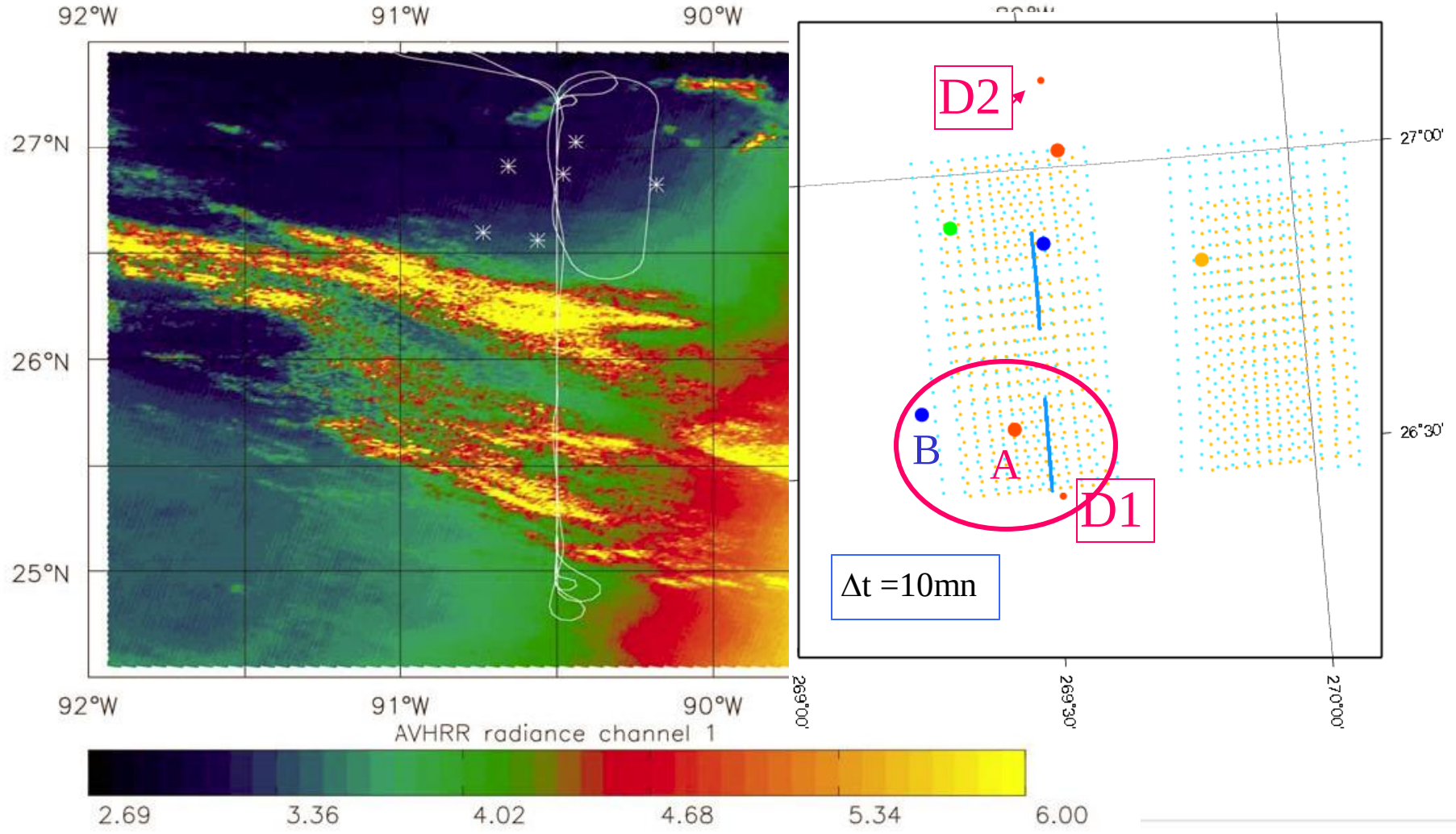
   Rmat as 2)

4. Same as 3) but in a sub-set of 1700 channels in bands1,2 sensitive to T,q

Iasi NeDt Noise



Jaivex : 29/04/2007.



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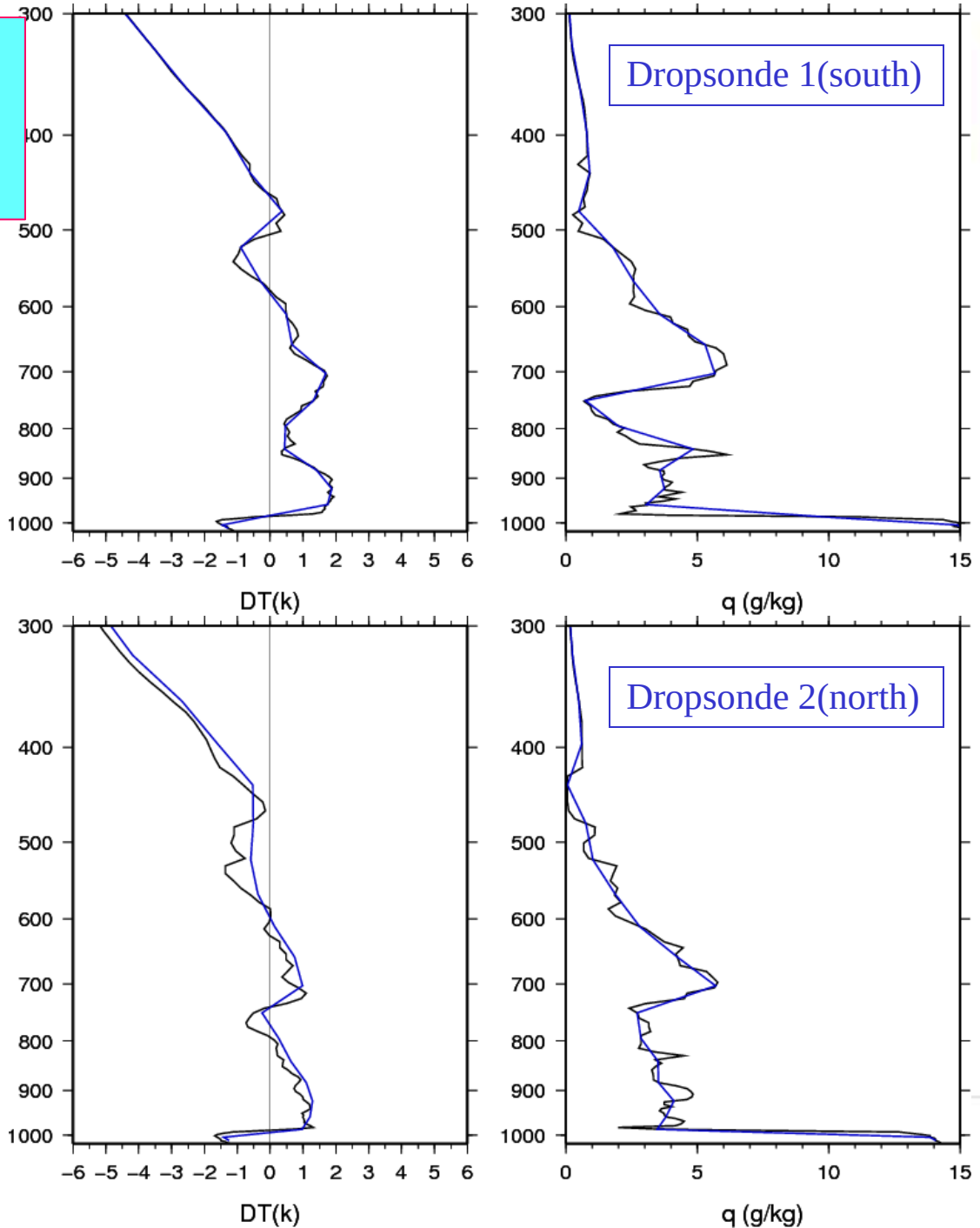
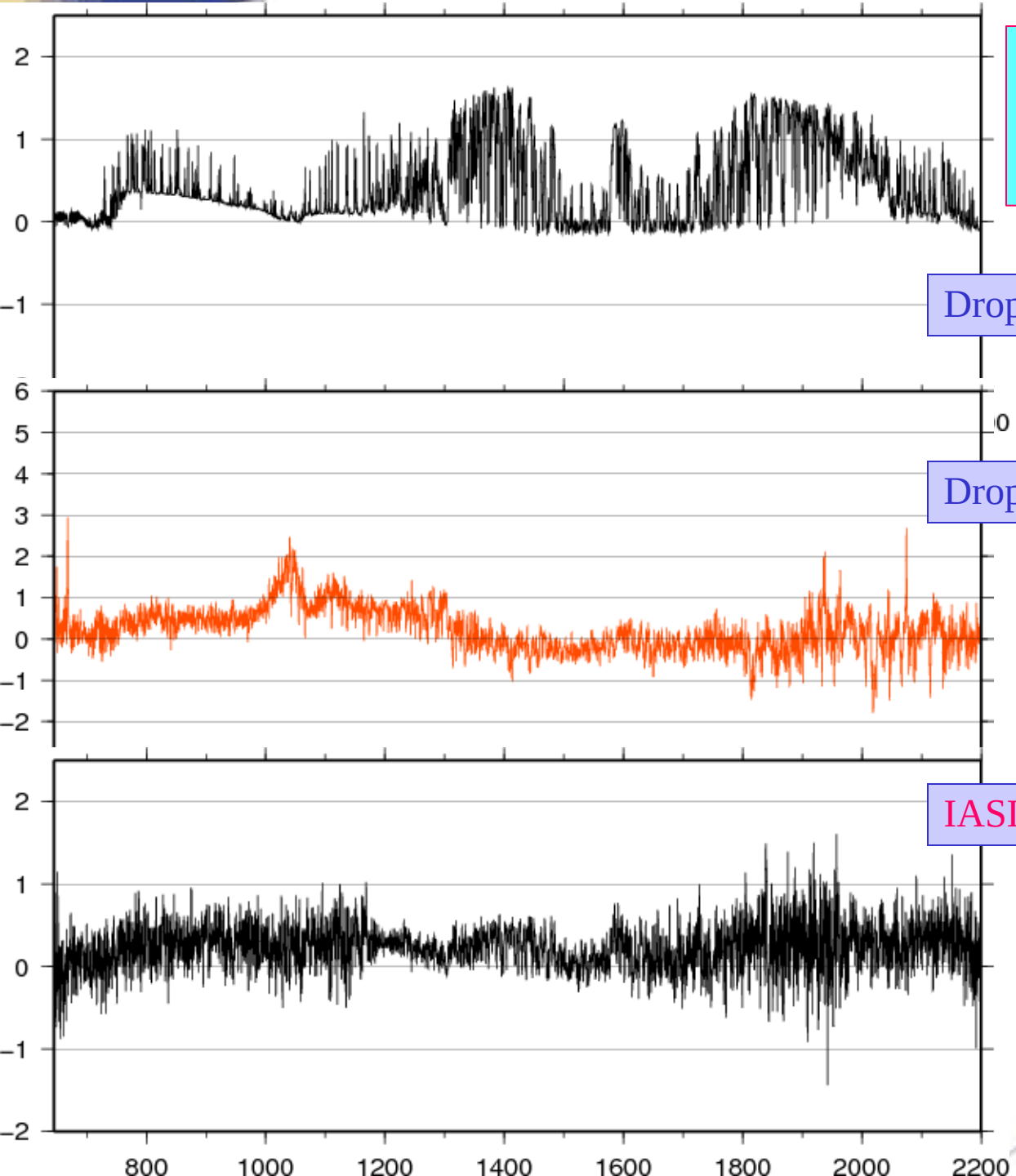
29/04/2007 : Dropsonde 1 and Dropsonde 2 differences

Temperature: same adiabatic constant removed

About 10mn and 60-70km departure

Black= dropsonde
Blue: Plog interpolation on the 43 rttov levels





29/04/2007 :
RTTOV Bts departures
Residuals@280K

Dropsonde 1(south) - Dropsonde 2

Dropsonde 1(south) - IASI obs A

IASI obs A – IASI obs B

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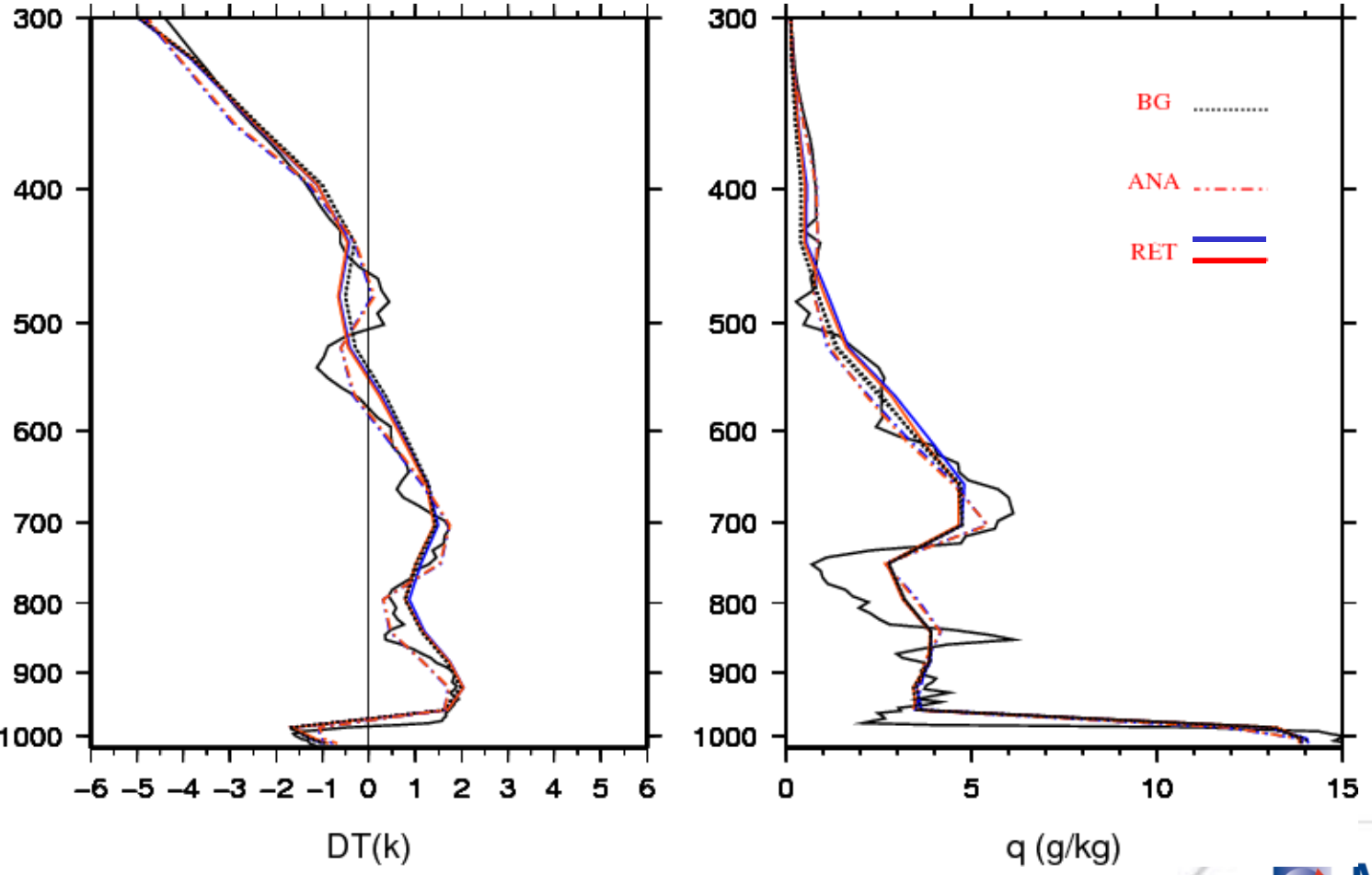
29/04/2007. Dropsonde south
Test 1: 178 ECMWF channels. Rmat=Cst values

Temperature: adiabatic constant removed



IASI obs A
IASI obs B

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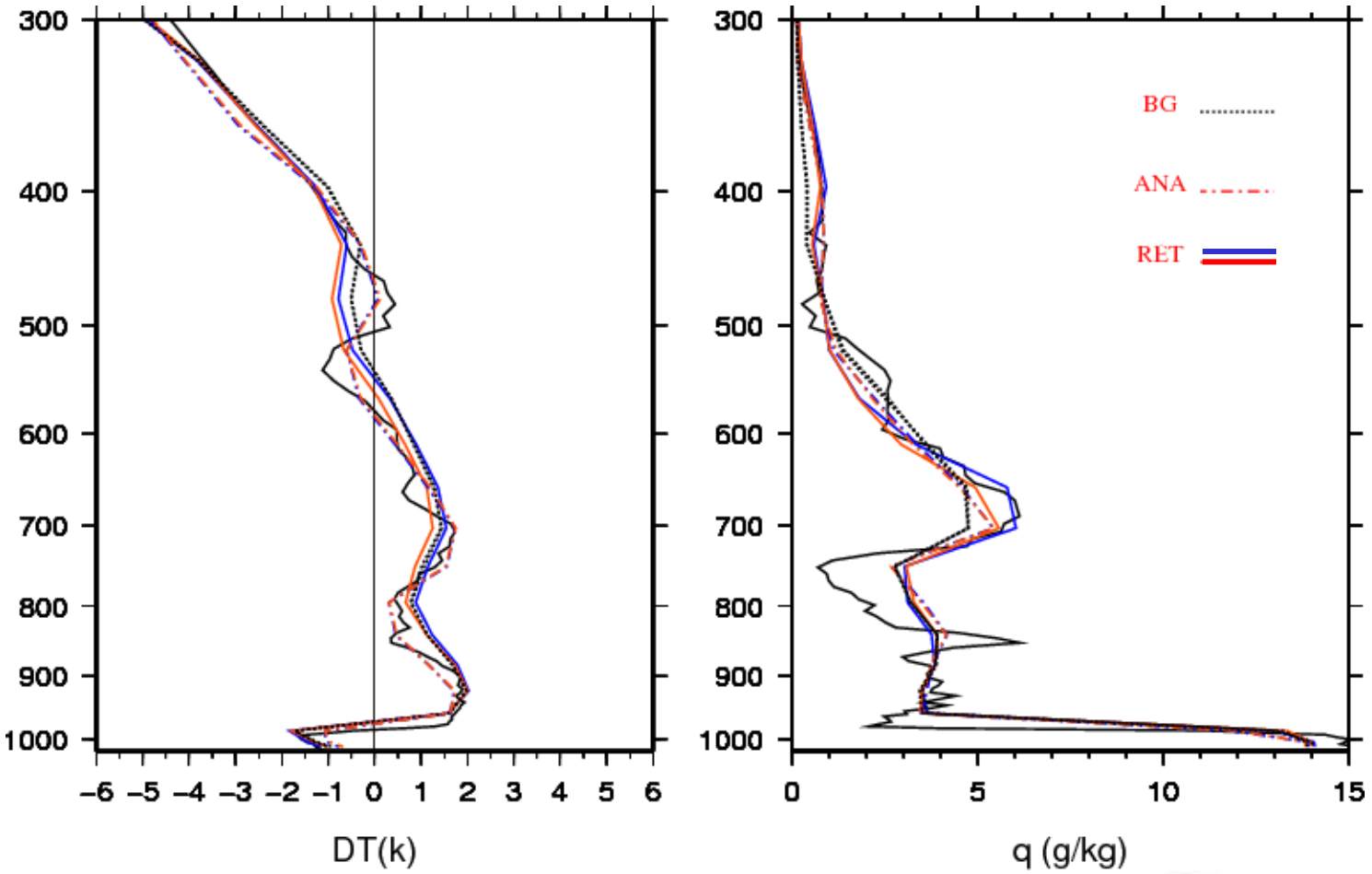
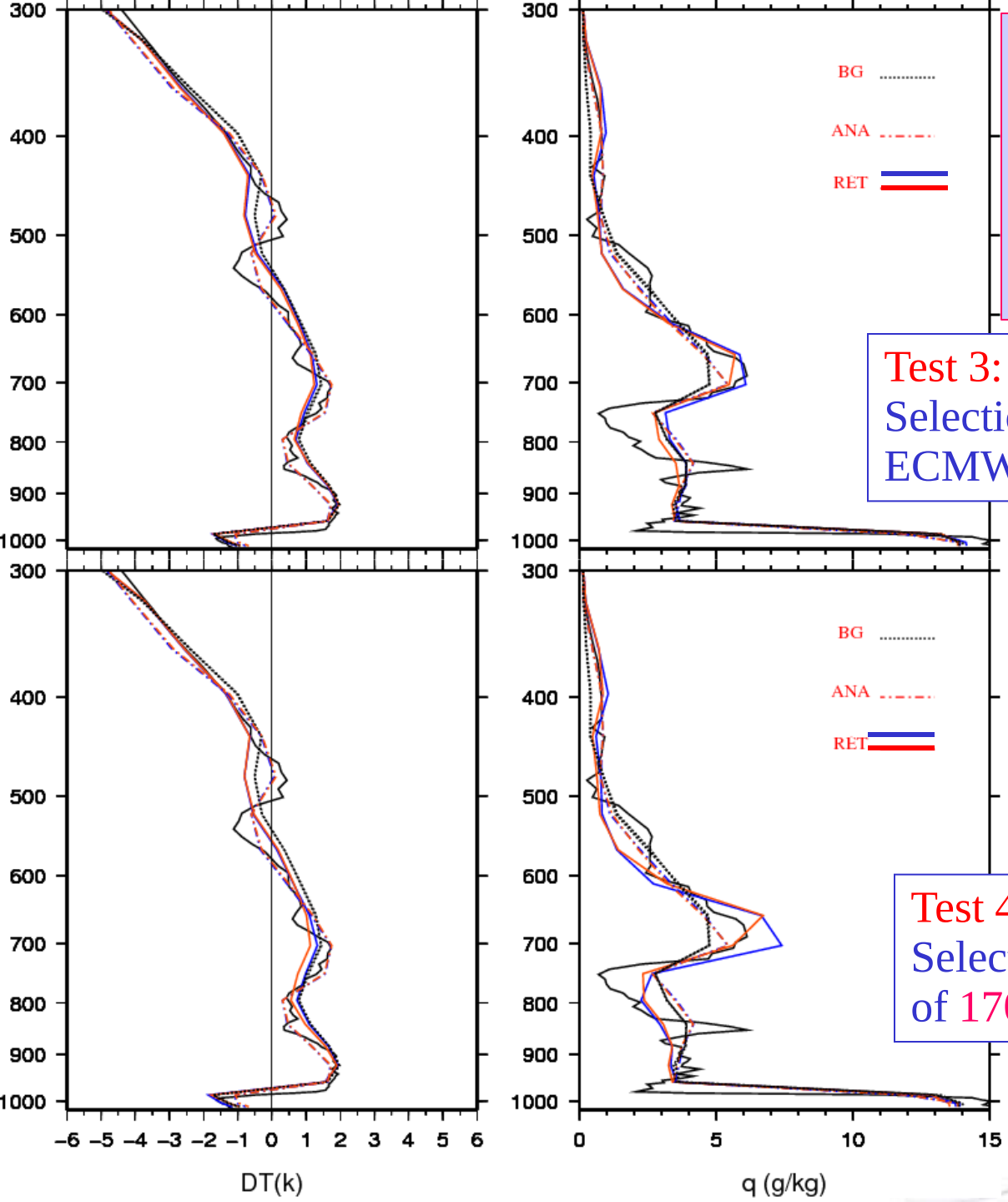
Test 2:

- 178 ECMWF channels.
- Rmat= CNES NeDt + band matrix + estimated RTTOV noise





29/04/2007 Dropsonde 1

Dynamic channel selection using Rodgers method on RTTOV ΔBts=
(Bts forecast – Bts IASI Obs)

Test 3:
Selection of 150 channels in the ECMWF set of 366 channels.

Test 4:
Selection of 150 channels in a set of 1700 channels.

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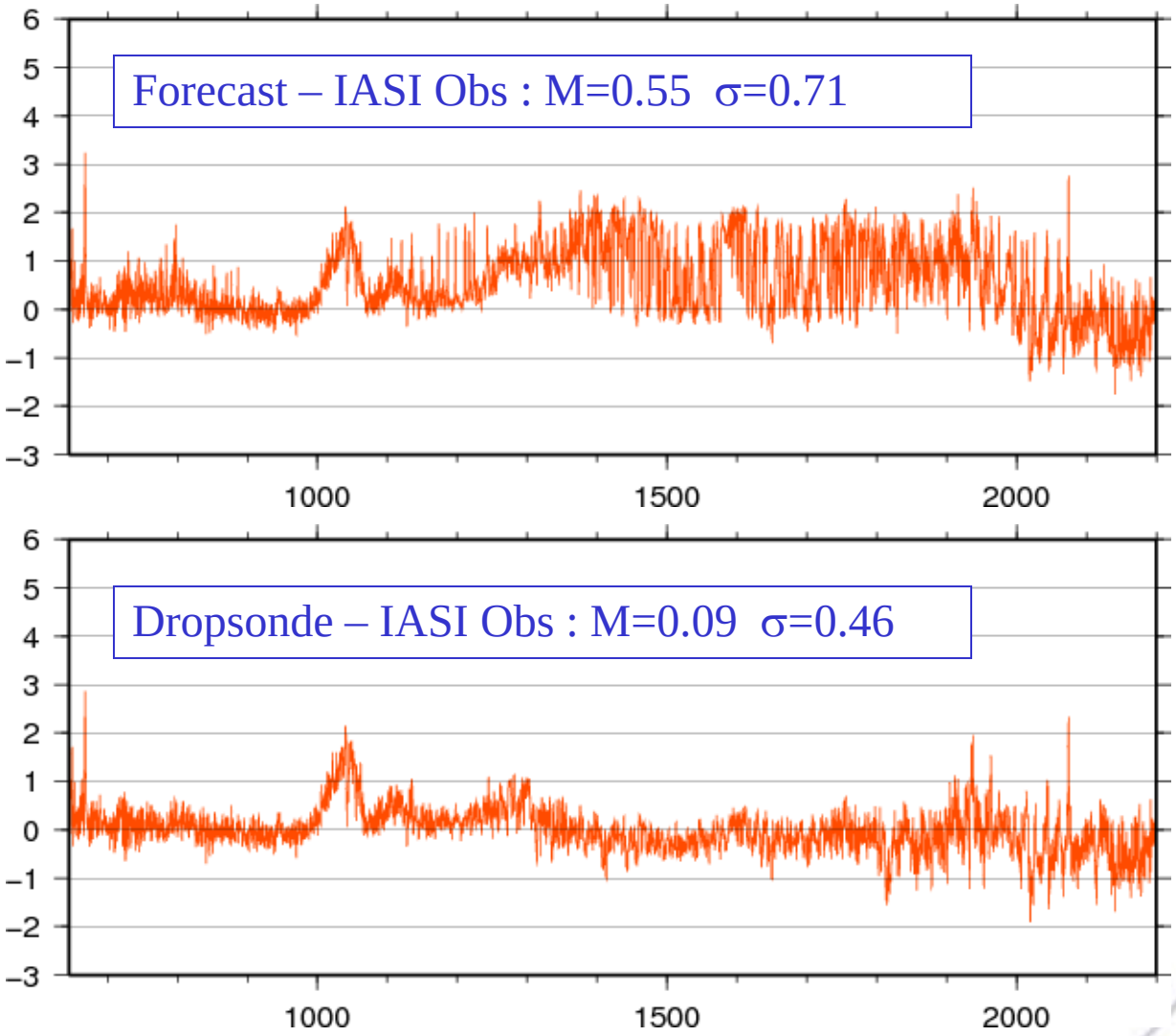
29/04/2007 Dropsonde 1
RTTOV Bts residuals with IASI Obs A



Residuals@280K
Before bias correction

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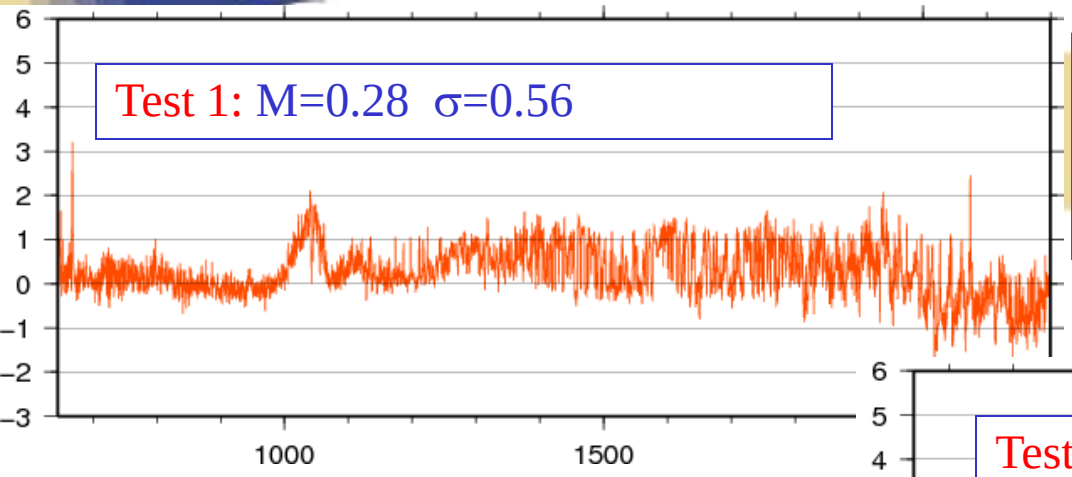
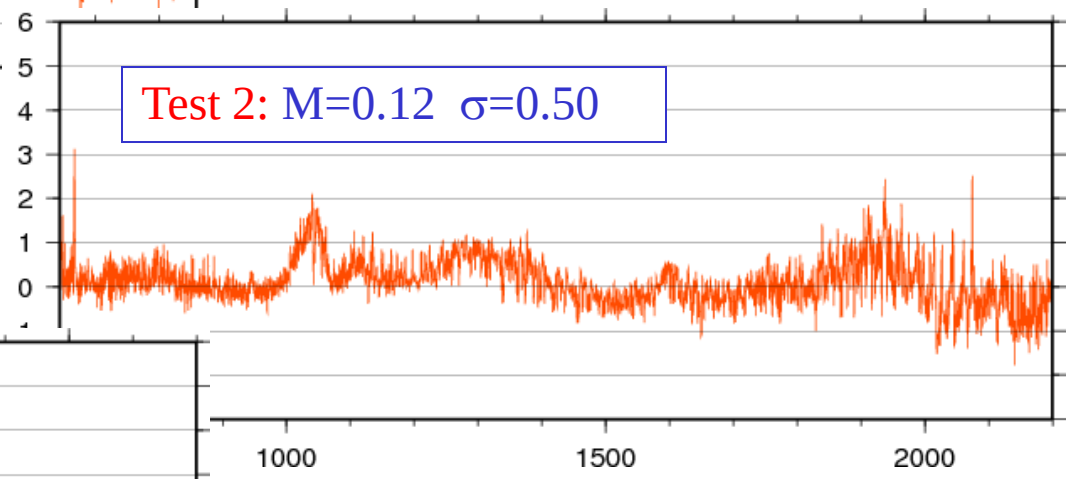
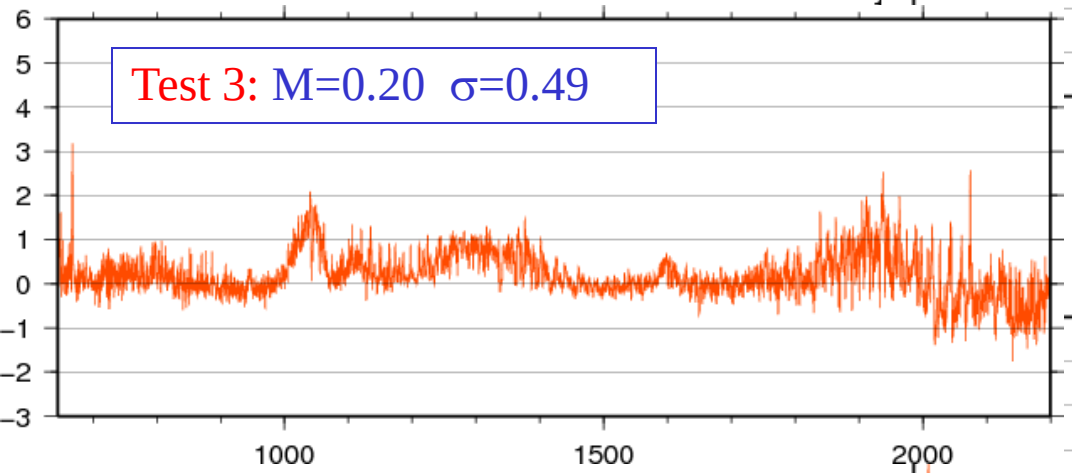
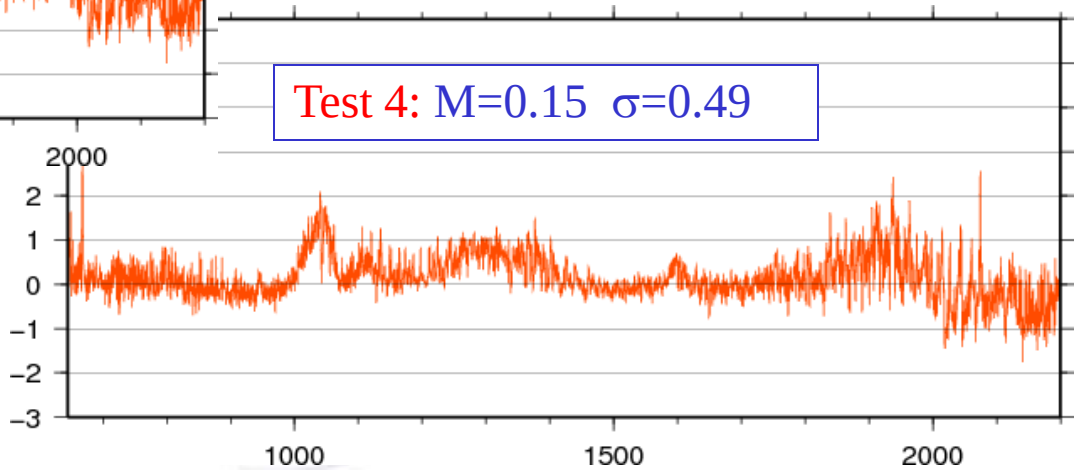
29/04/2007
RTTOV Bts Retrieval- IASI A
Residuals@280K





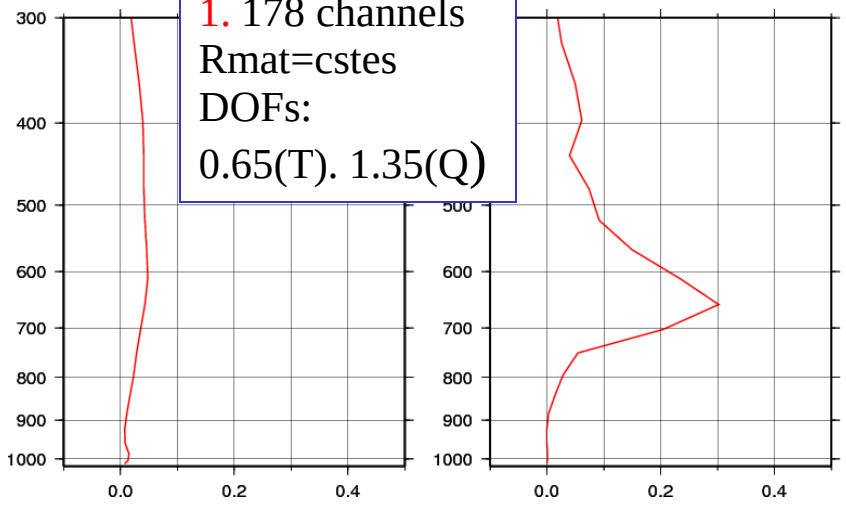




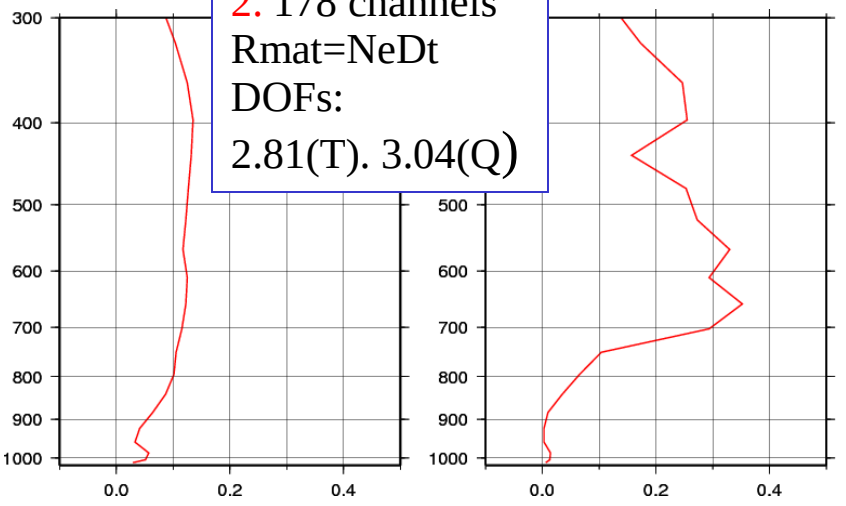
29/04/07. Dropsonde 1

Averaging kernels area: Information coming from IASI in the retrieval

1. 178 channels
Rmat=cstes
DOFs:
0.65(T). 1.35(Q)

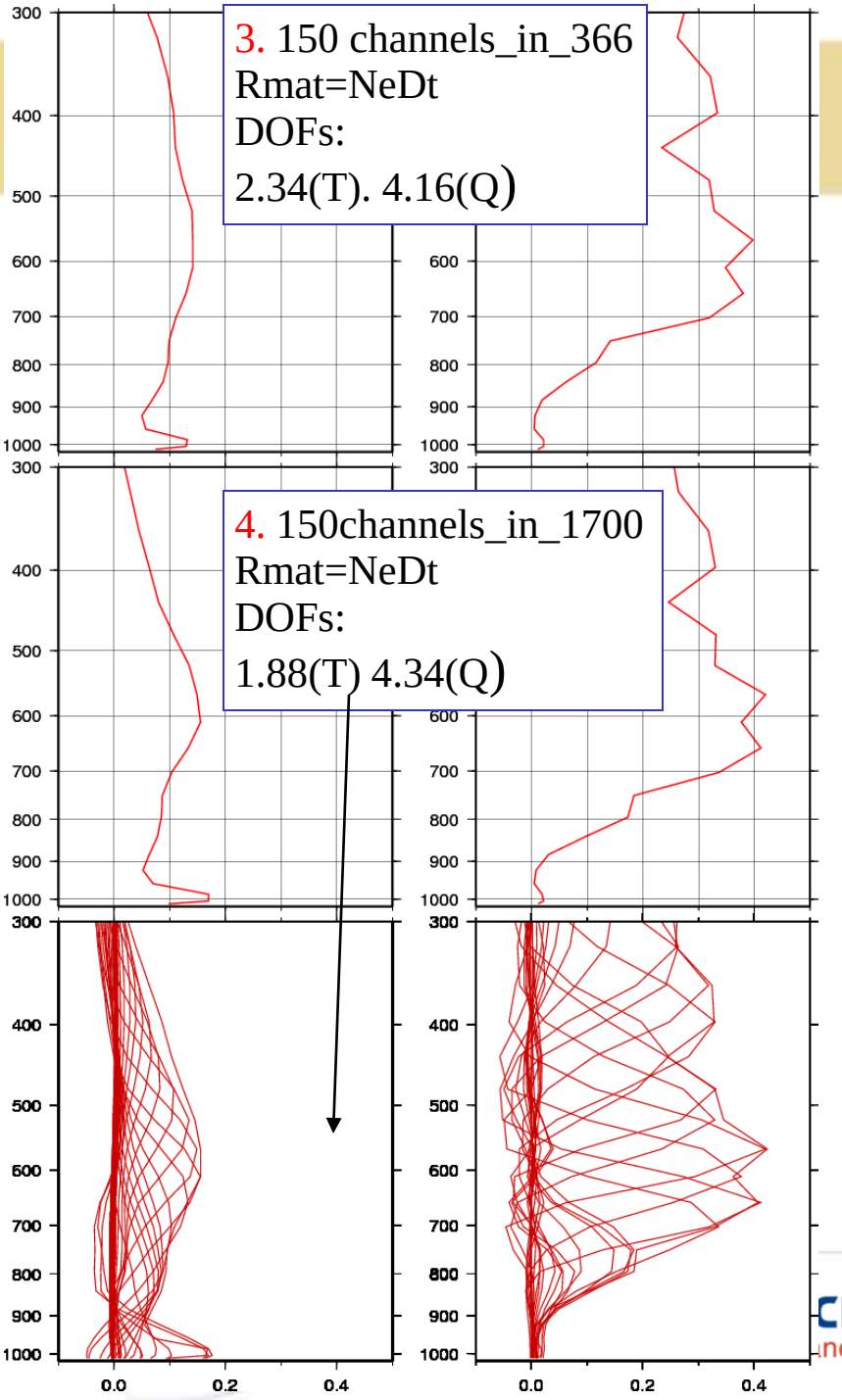


2. 178 channels
Rmat=NeDt
DOFs:
2.81(T). 3.04(Q)



3. 150 channels_in_366
Rmat=NeDt
DOFs:
2.34(T). 4.16(Q)

4. 150channels_in_1700
Rmat=NeDt
DOFs:
1.88(T) 4.34(Q)

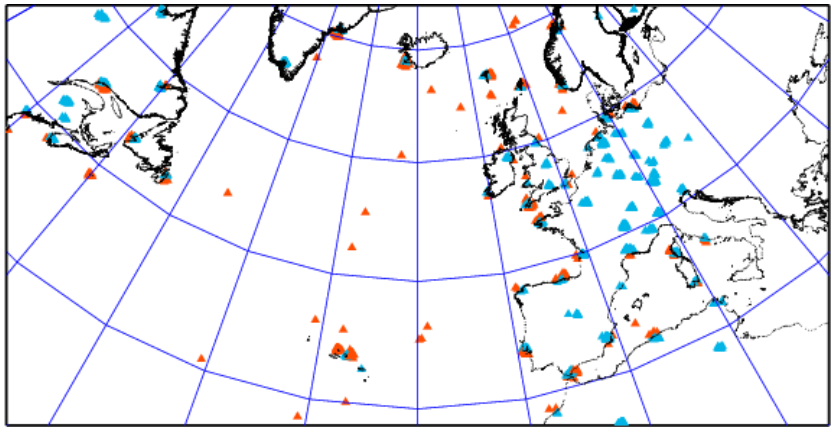


Test on IASI / Radiosonde CMS matchup file (preliminary)

Colocation dataset of radiosonde and nearest IASI Observation with

Distance <50km, time difference < 1h.

Compilation since the 1th of June 2009



« Standard » method:

- 114 channels in 366 ECMWF sub-set
- Ts from AVHRR. Not in 1dVar
- Rmat= constant values

« Tested » method:

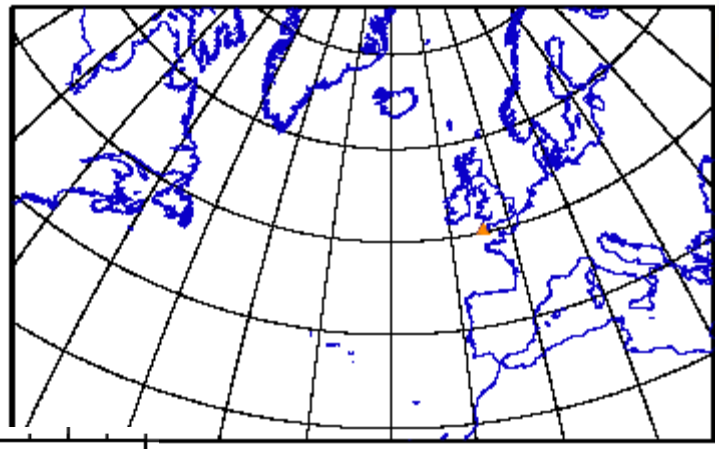
Dynamic Rodgers selection weighted by ΔBt(guess-obs) in the 366 ECMWF sub-set.

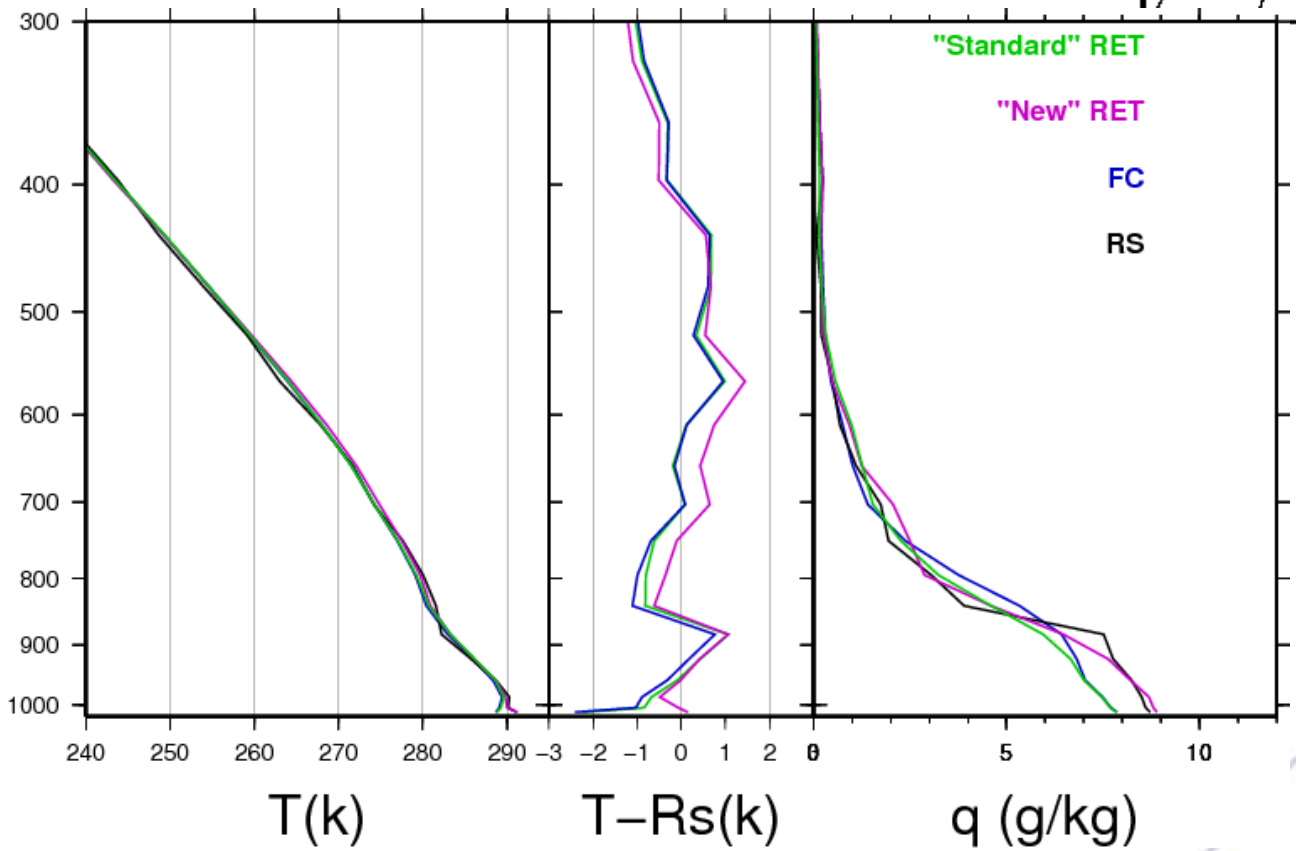
Rmat=NeDt level 1c Cnes Band matrix + rttov noise

1. Temperature profile only + Ts
   with 50 channels and Background matrix relaxed at surface
2. T, q profiles with 100 channels

Only clear situations

Preliminary results: example on the dataset first situation





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Conclusions

- Water vapor fluctuations can change quickly in small distances with:
  - impact on the spectrum could be much larger than noise for distances <50km
  - necessity of doing the WV retrieval at the IASI ifov
  - Necessity of careful coregistration of profile and spectrum when doing statistics or testing a new method

- A dynamic in-line selection of channels weighted by ΔBt(guess-obs) helps retrieving WV fluctutations

- Due to
  - T and Q profile retrieval compensations
  - small sensitivity of IASI spectrum to low level humidity profile

  preliminary tests indicate that a first “temperature alone” retrieval help retrieving WV fluctutations

- 43 RTTOV levels are not enough

This work will be persued on RS/IASI coregistrations