

Observation usage in Météo-France data assimilation systems

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GMAP/OBS

with contributions from :

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Ramond



Outline

- Main observation types in ARPEGE
 - Operational configuration
 - Current experimental suite
- Main observation types in AROME
 - Current experimental suite
 - Planned evolutions (new HPC + various programmes)

Computing platforms

Two identical clusters (operations/research)

Each cluster :

- 10 nodes

- 16.3 Tflops max

On each node :

- 16 vector processors

- 1 Tb of memory

- 2 Tb of local disks



NEC SX9 (Q4 2009 -> Q1 2014)

Two identical clusters :

-> operations (Q1 2013) – CNC Météopole

-> research (Q3 2013) - ECA

Each cluster :

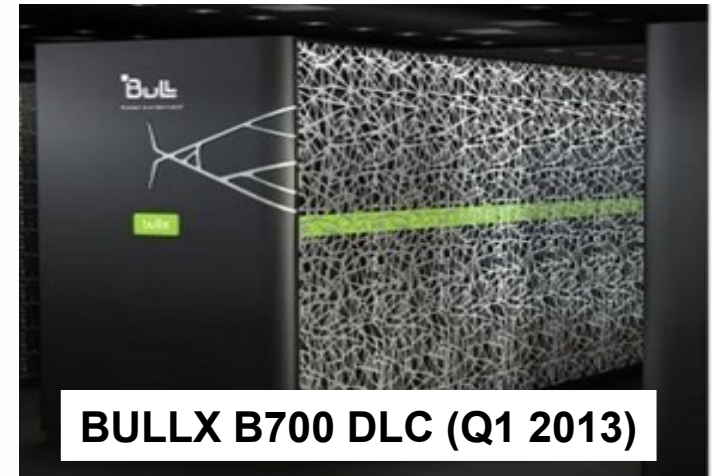
- 990 nodes

- 475 Tflops max

On each node (2 sockets) :

- 24 scalar processors (Broadwell Intel)

- 32 Gb of memory

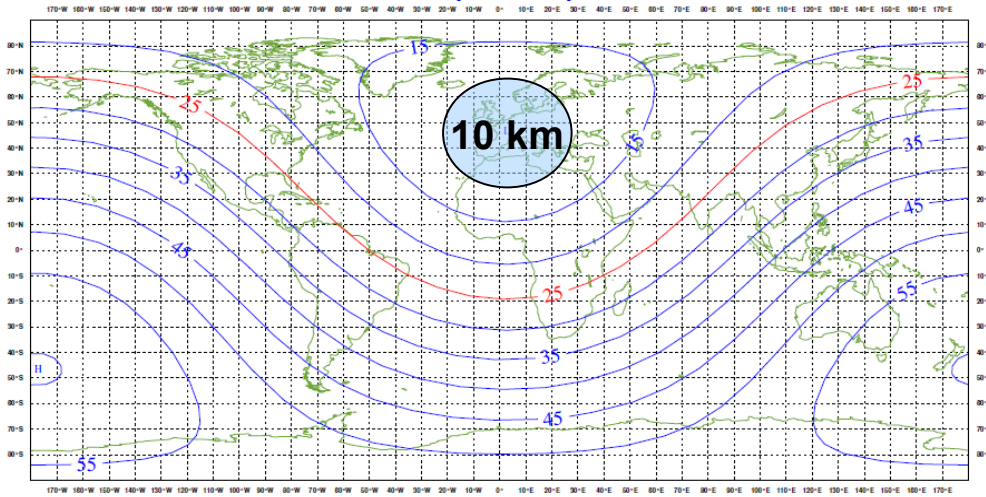


BULLX B700 DLC (Q1 2013)

Operational models at Météo-France (1)

Global model ARPEGE

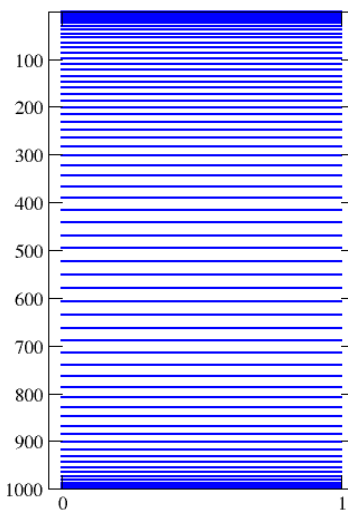
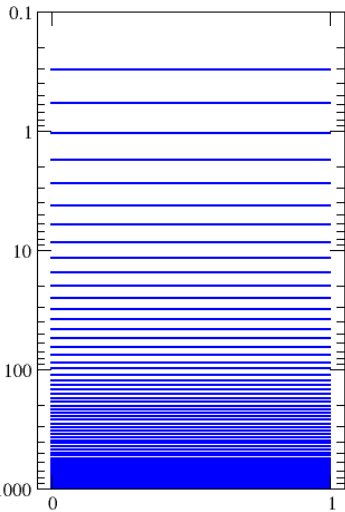
Horizontal resolution: between 10 and 60 km



70 vertical levels

logarithmic pressures

linear pressures



4D-Var

6h

Limited area model

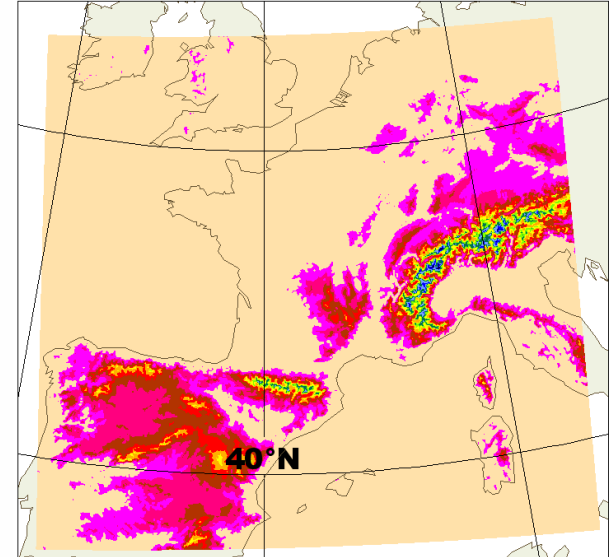
AROME

2.5 km horizontal mesh

60 vertical levels

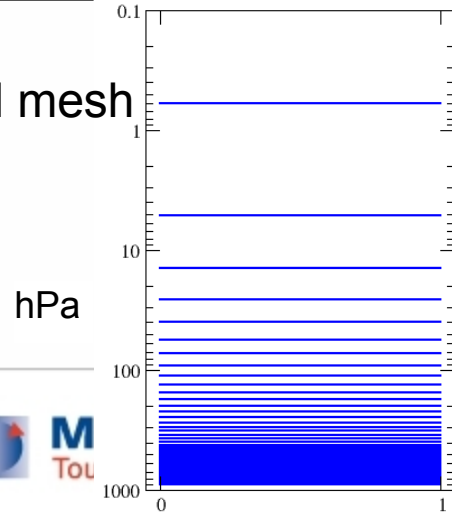
3D-Var

3 h



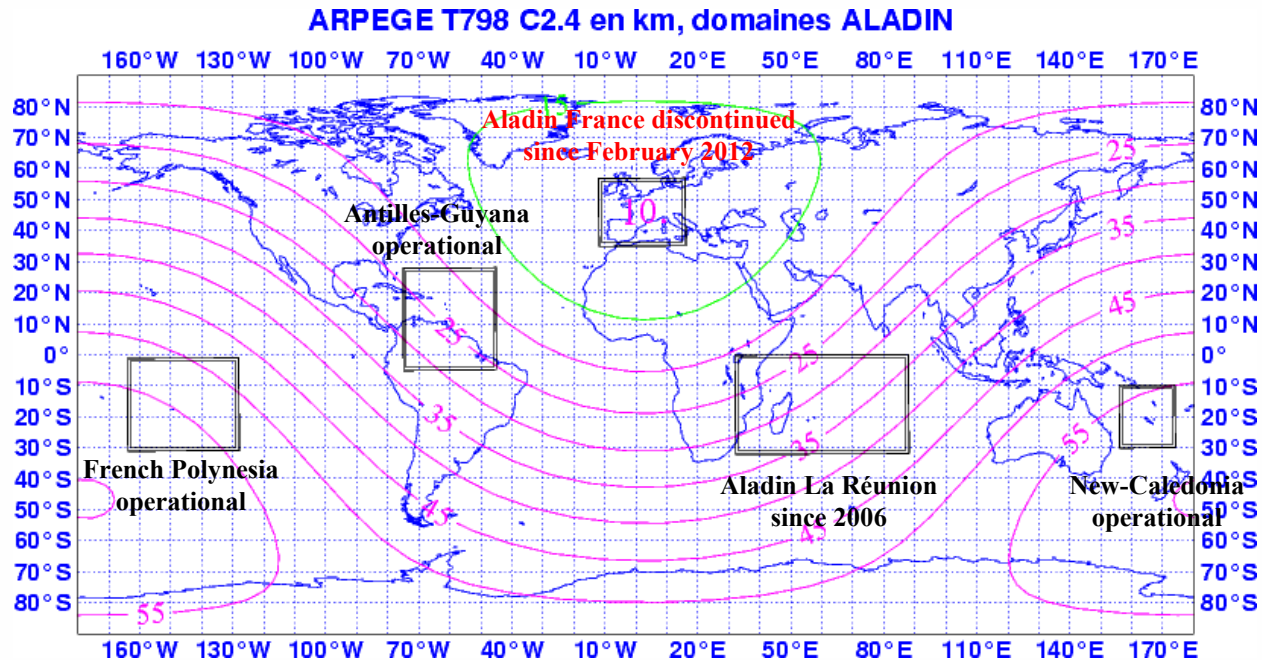
0°

logarithmic pressures



Operational models at Météo-France (2)

- Spectral limited area models : ALADIN « overseas »
- 70 levels from 17m to 0.5 hPa, horizontal resolution 7.5 km
- 3D-Var assimilation (6h window) :
 - Same data as ARPEGE plus bogusing for tropical cyclones
- Current operational domains :

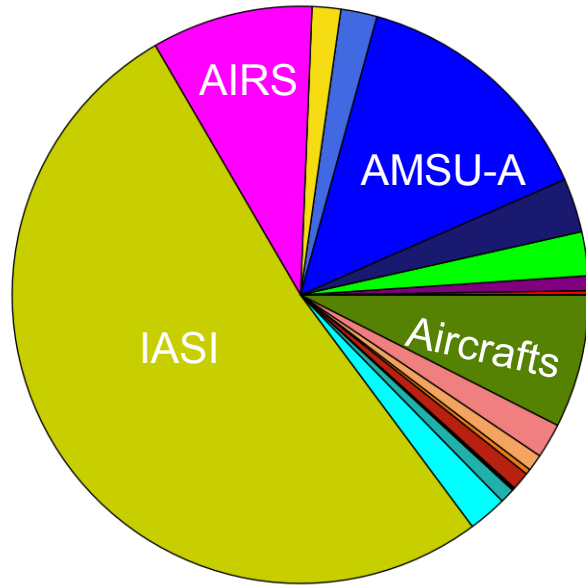


Main features of CY37T1 (OBS) - oper

- Optimisation of observation errors for AMSU-A, IASI, GPS-RO, ASCAT winds, TEMP, AIREP and WINDPROF
- Additional tropospheric (sea) and stratospheric (all surfaces) IASI channels (from 77 to 119)
- Assimilation of cloudy radiances from IASI (CO2-slicing)
- Increased number of ground based GPS (E-GVAP)
- Use of 4 ASCAT ambiguous solutions – modified threshold for sea-ice detection (SST 5°C -> -1°C)
- EARS IASI + RARS ASCAT

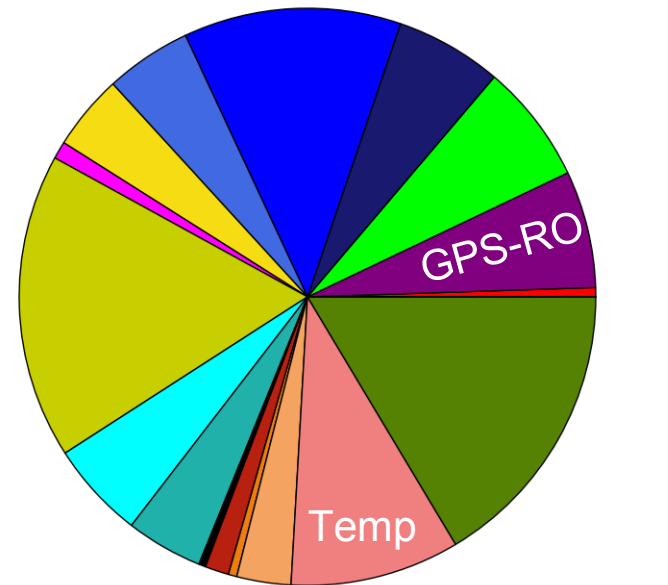
Current usage of observations in ARPEGE

Proportions des nombres d'observations utilisées par type d'obs
analyses cut-off long - ARPEGE metropole dbl
observations conventionnelles et satellites
cumul du nombre d'observations utilisées sur la période 2012081400 - 2012081418 : 8917083



Number of observations

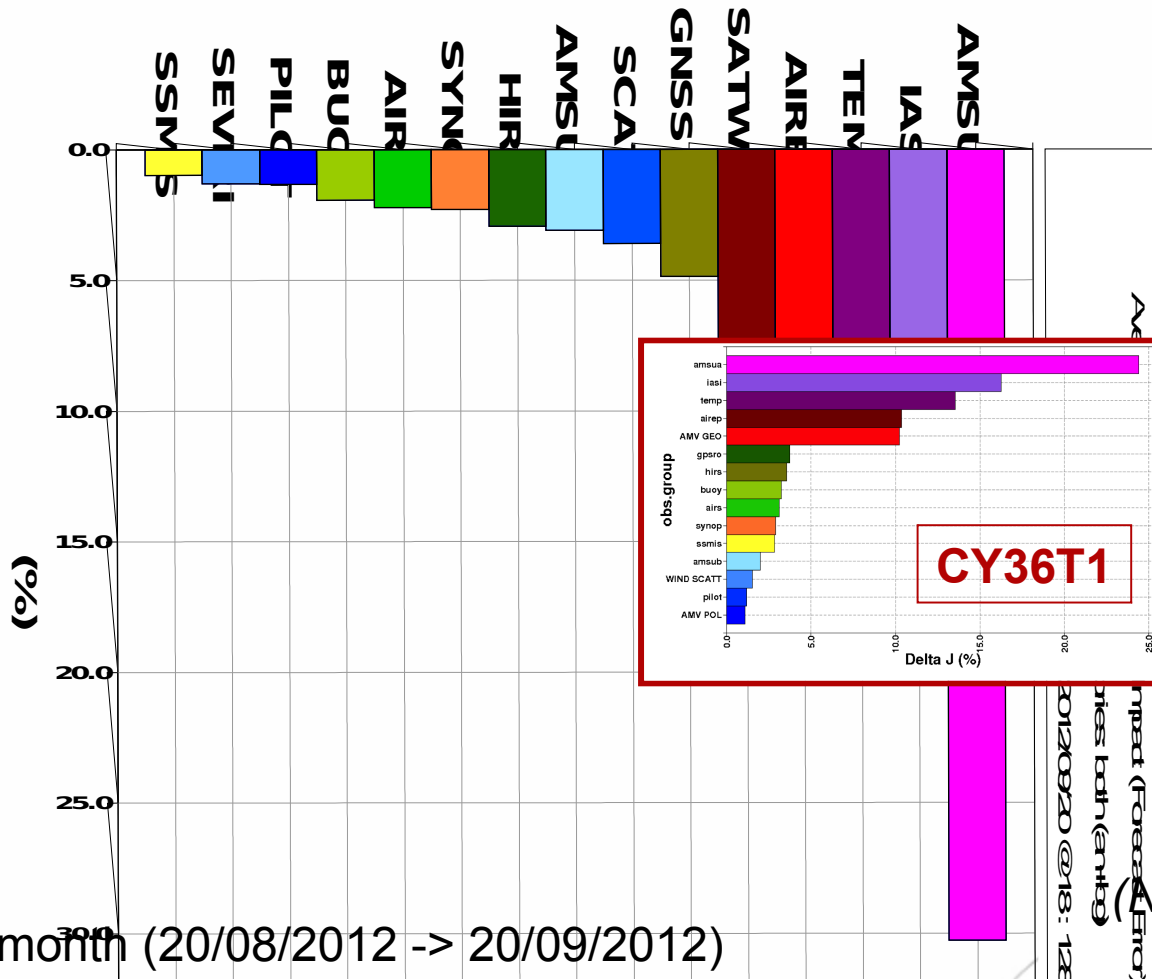
Part des DFS par type d'obs
analyses cut-off long - ARPEGE metropole dbl
observations conventionnelles et satellites
cumul du DFS sur la période 2012081400 - 2012081418 : 199955



Fractional DFS

Forecast Sensitivity to Observations

CY37T1



One month (20/08/2012 -> 20/09/2012)
 J = 24h forecast error (dry energy norm)

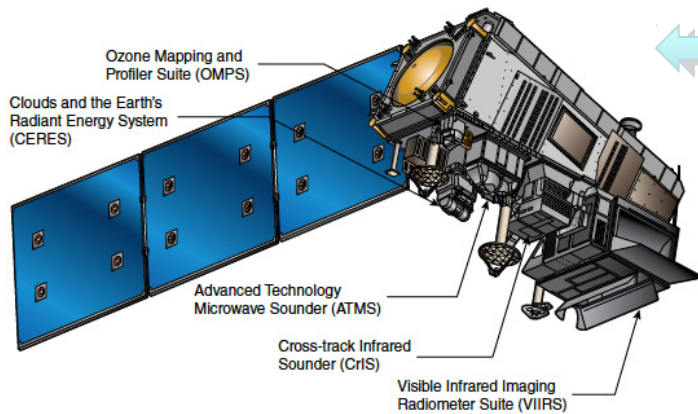
Saint-Ramond)

Main features of CY38T1 (OBS) – e-suite

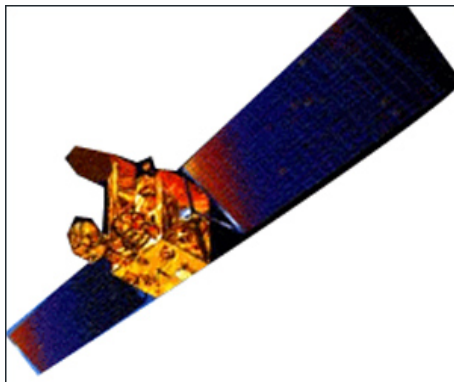
- New instruments from NASA-NOAA/**Suomi-NPP**, ISRO/**Oceansat-2**, EUMETSAT/**MetOp-B**
- Increased usage of existing instruments :
 - AIRS (over land + additional upper tropospheric channels)
 - IASI (WV channels)
 - GNSS-RO (reduced vertical thinning)
 - Clear sky radiances (1 WV channel) from GOES-E and W
 - Channels 4 and 5 from MHS/NOAA19

=> Increase of data by a factor of 2.5 (in assimilation cycles)

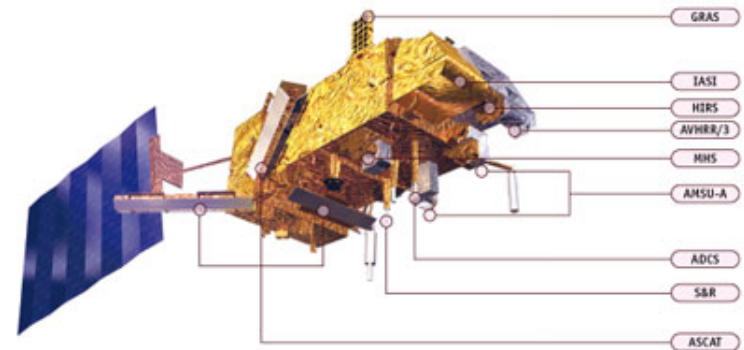
New instruments



Suomi-NPP (launched 28/10/2011)
 -Advanced Technology Microwave Sounder (**ATMS**)
 -Cross track Infrared Sounder (**CrIS**)



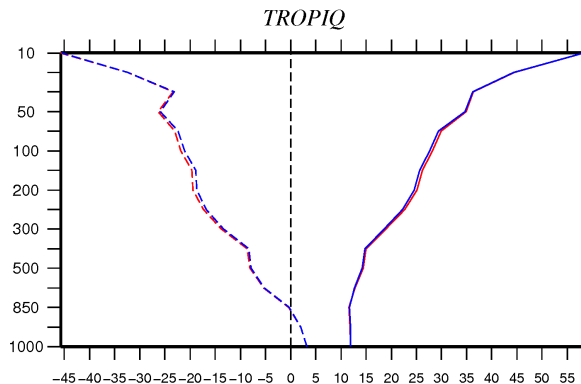
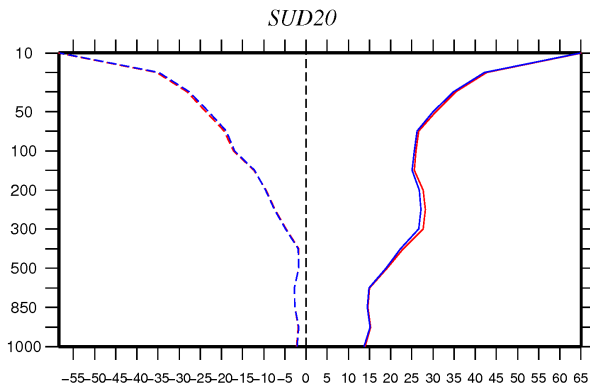
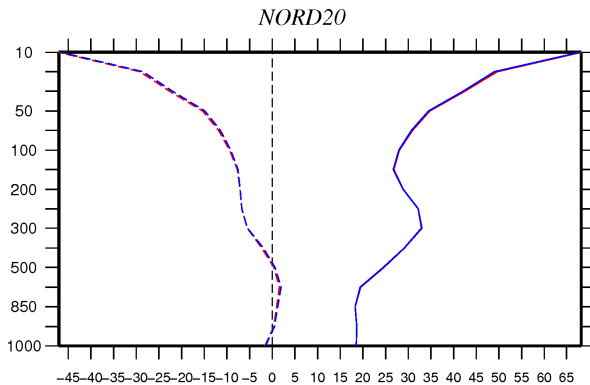
OCEANSAT-2 (launched 09/2009)
 - **OSCAT**(Ku-band scatterometer)



MetOp-B (launched 09/2012)
 - **IASI**
 - **ATOVS (AMSU-A, MHS, HIRS)**
 - **GRAS**
 - **ASCAT**

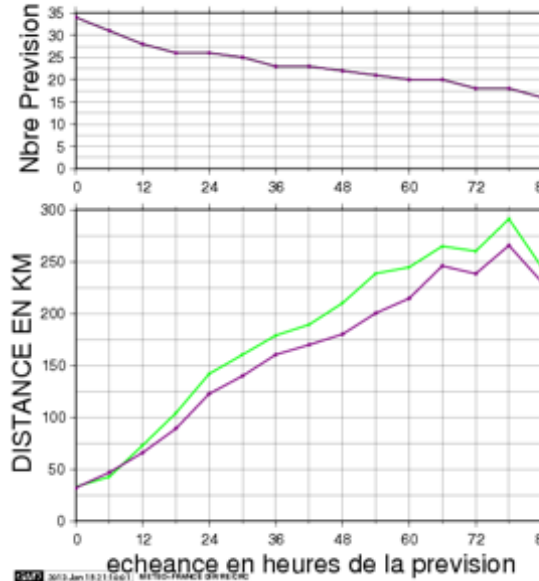
Impact of OSCAT winds on forecast scores

Trajectory of tropical cyclones in ALADIN Réunion



-- OSCAT / -- CONTROL

ERREUR DIRECTE DE POSITION bassin:SWIO saison:20112012



population statistique
homogene

-- OSCAT

-- CONTROL

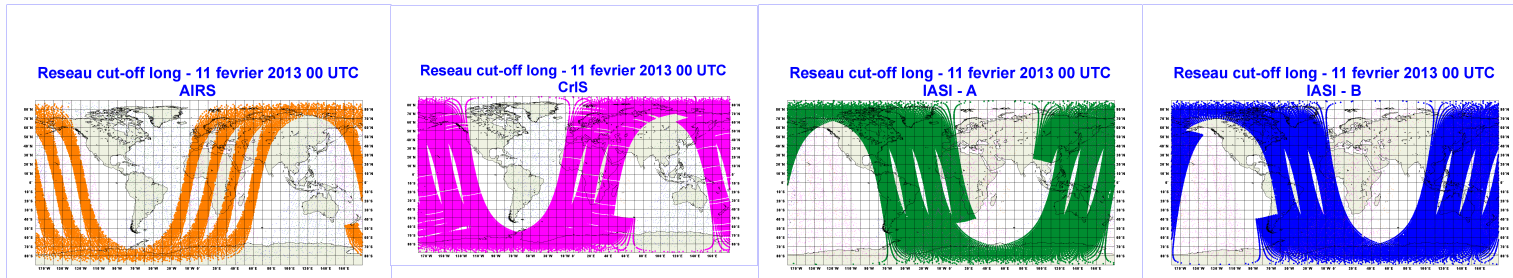
Geopotential at
72h in ARPEGE

Ref = TEMP

24 cases

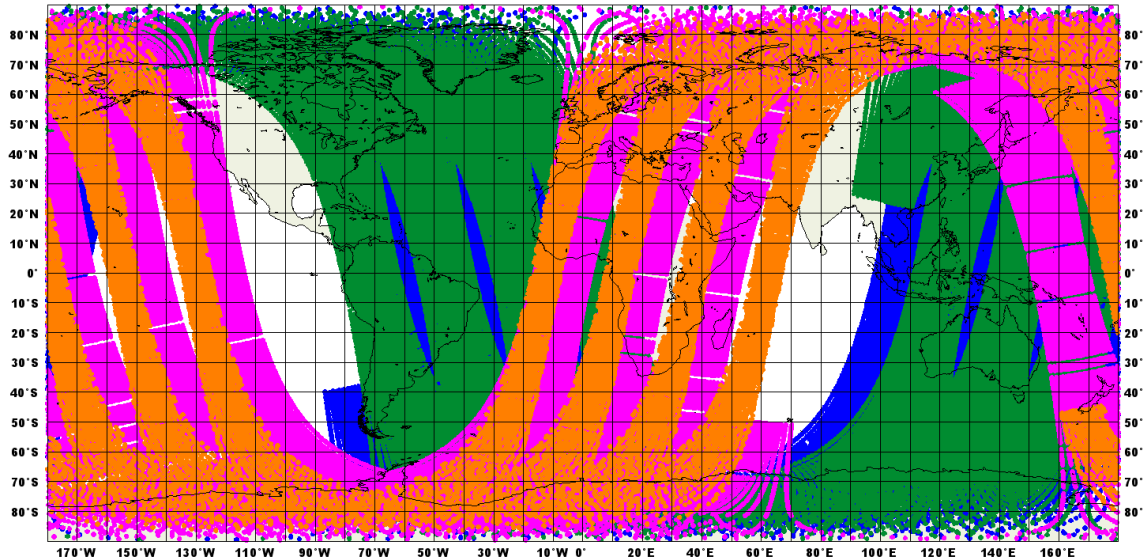
(C. Payan)

Coverage of IR hyperspectral instruments



Reseau cut-off long - 11 fevrier 2013 00 UTC

- IASI-B
- IASI-A
- CrIS
- AIRS

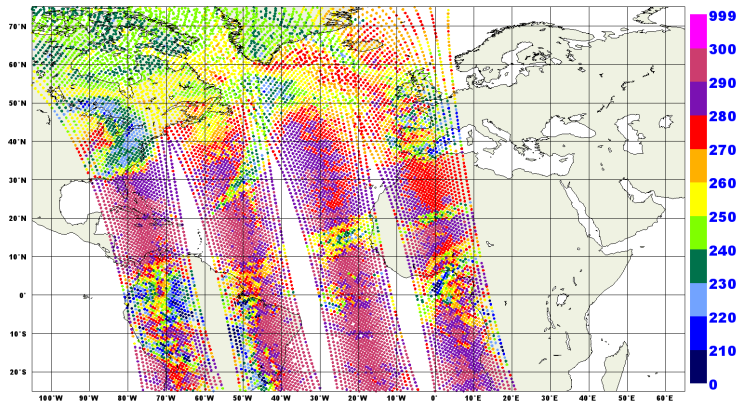


IASI-A
AIRS
CrIS
IASI-B

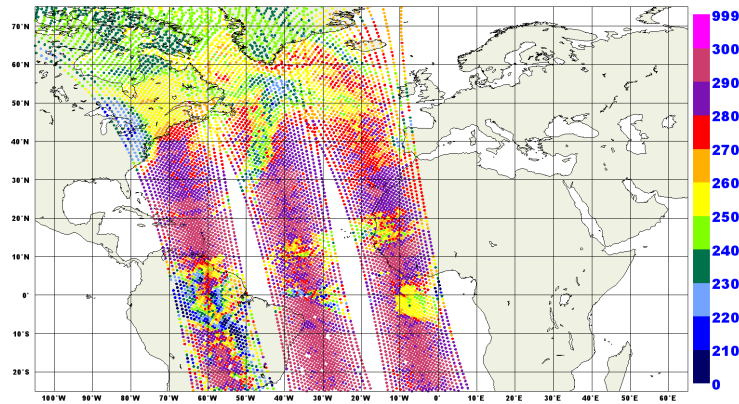
(V. Guidard)

Combined use of MetOp-A and B IASI data

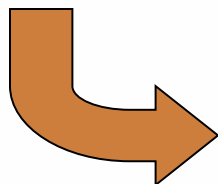
IASI window channel 0921
20120211 00 - MetopA only



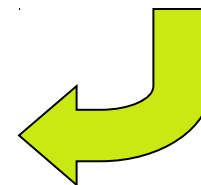
IASI window channel 0921
20120211 00 - MetopB only



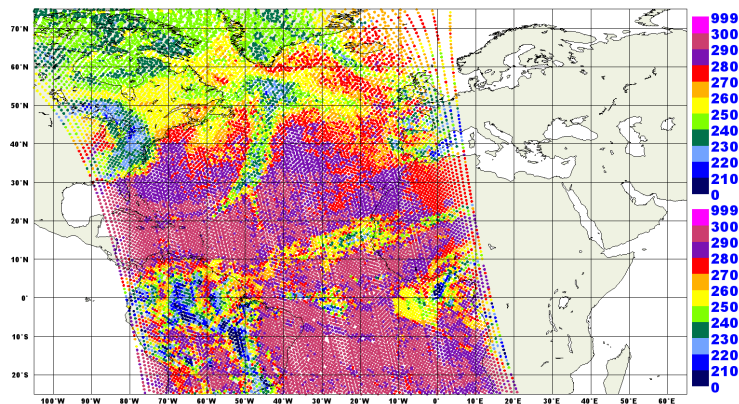
METOP -A



METOP -B

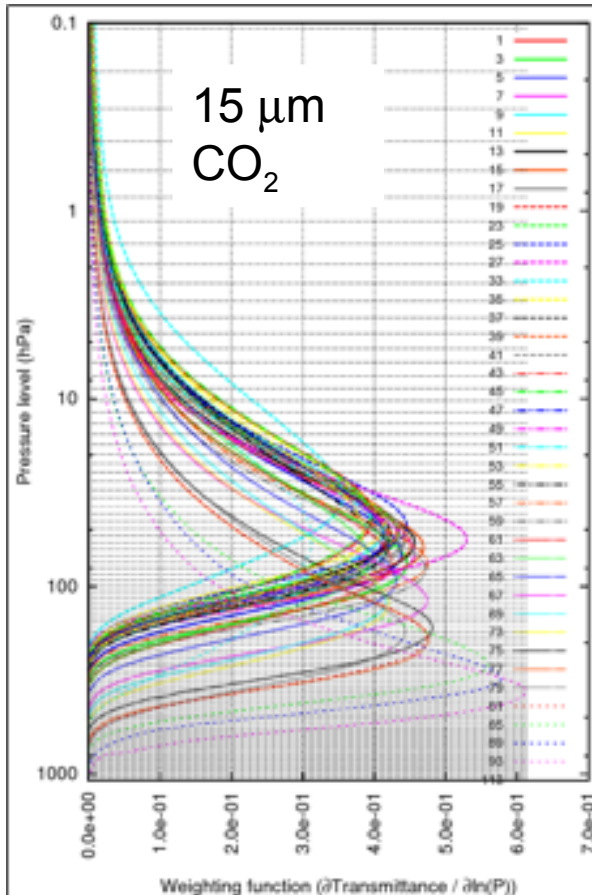


IASI window channel 0921
20120211 00 - MetopA + MetopB

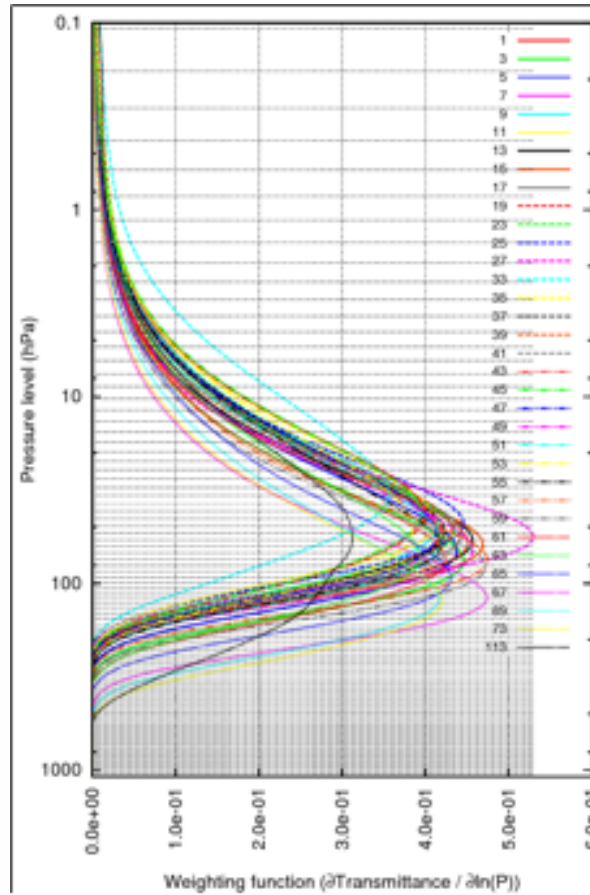


(V. Guidard)

Cross track Infrared Sounder (CrIS)



Sea
41 channels

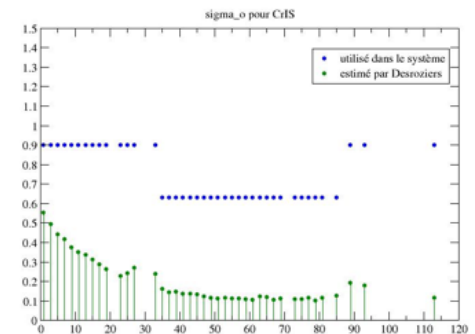


Land
35 channels

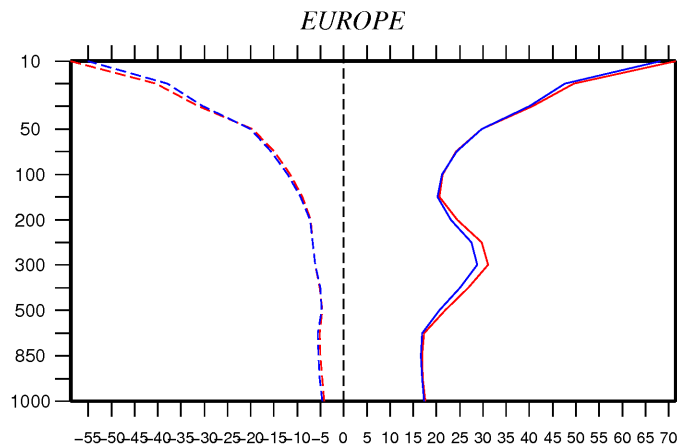
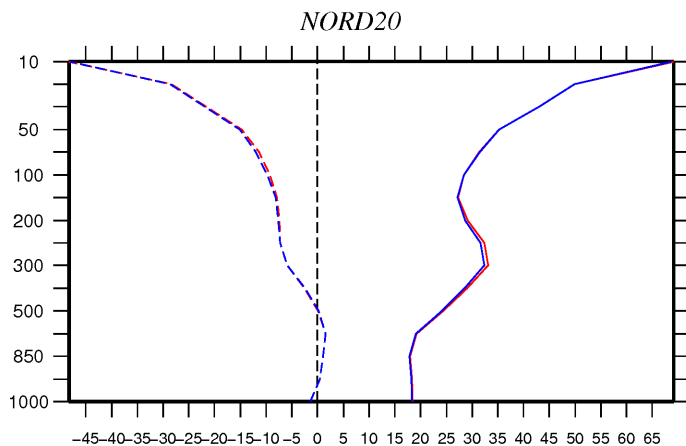
Fourier transform spectrometer with 1305 channels (3 ranges)
 $\Delta\nu=0.625$ to 2.5 cm^{-1}

2200 km swath with 30 FOR

1 FOR = 9 FOV
FOV = 3x3 array (14 km)

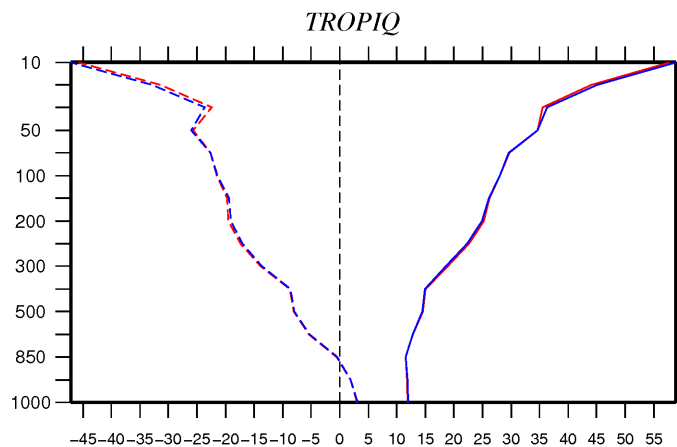
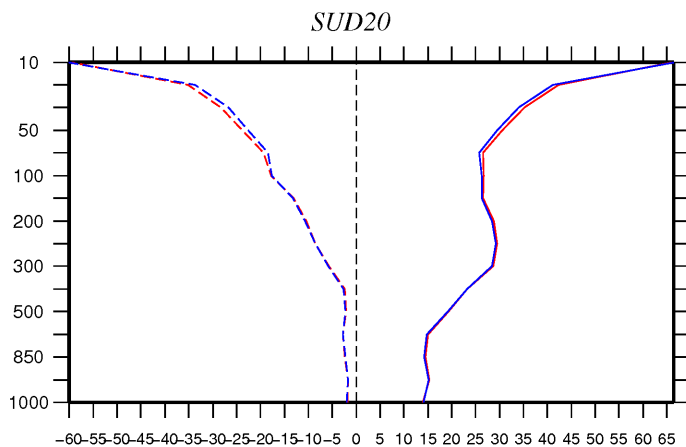


Impact of CrIS on forecast scores



-- CrIS

-- REF



(V. Guidard)

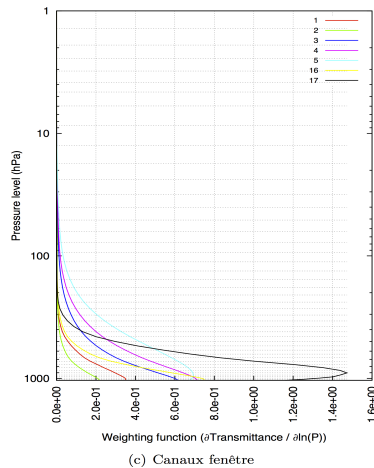
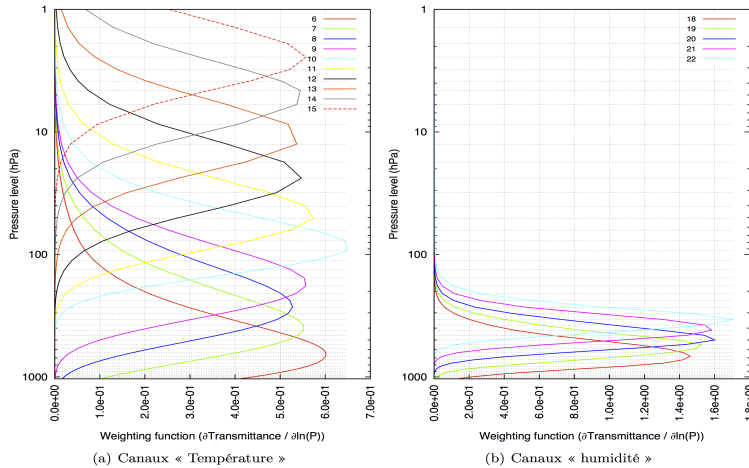
Geopotential FC+72h against TEMP – 19 days
(28/11/2012 -> 20/12/2012)

Advanced Technology Microwave Sounder

Instrument similar to AMSU-A1, AMSU-A2 and MHS (single package)
 22 channels with frequencies between 23 and 183 GHz :

- 16 channels for T (15 for AMSU-A)
- 7 channels for H₂O (5 for MHS)

Swath = 2600 km (2200 km AMSU/MHS)



Fonctions de poids des 22 canaux ATMS

Frequency	ATMS	AMSU/MHS
23/31 GHz	5.2 (1.1)	3.3 (3.3)
50-60 GHz	2.2 (1.1)	3.3 (3.3)
89 GHz	2.2 (1.1)	1.1 (1.1)
160-183 GHz	1.1 (1.1)	1.1 (1.1)

(L.-F. Meunier)

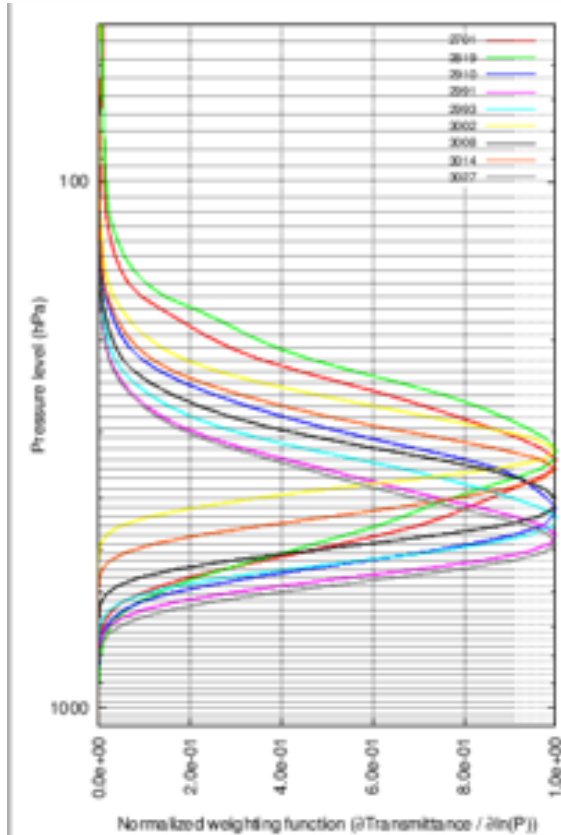
Beamwidth (degrees) / Sampling (degrees)

Specificities of ATMS

- Instrumental noise (NeDT) : between x2 and x3 wrt AMSU/MHS noise
- Averaging procedure over 3x3 pixels for temperature channels
- Less angular dependency of measurements along the swath
- Assimilation over land and sea-ice surfaces using the dynamical emissivity retrieval from Karbou et al. (2006)
- Channel assimilated :
 - Temperature : 6 -> 14 (AMSU-A equivalent : 5 to 13)
 - Humidity : 18 -> 22 (MHS equivalent : 3 to 5)
- New quality controls : LWP, Scattering Index, Stdev of averaging procedure

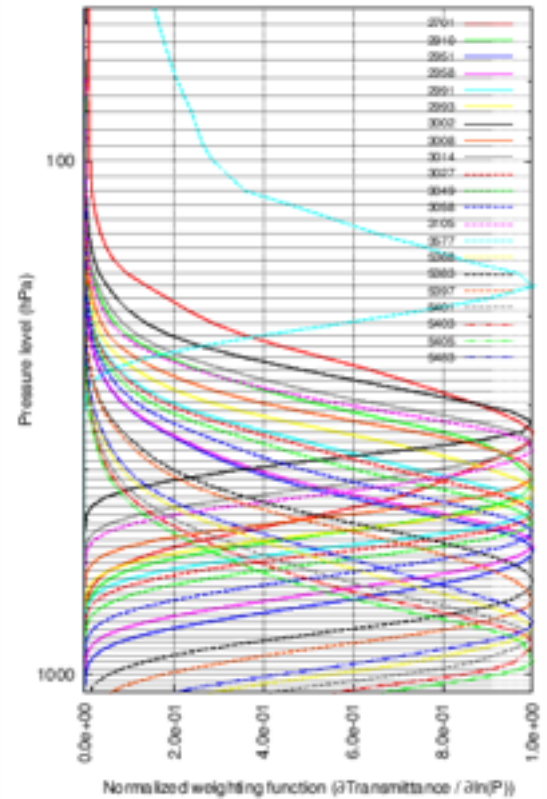
Additional IASI water vapour channels

Operational configuration



9 channels

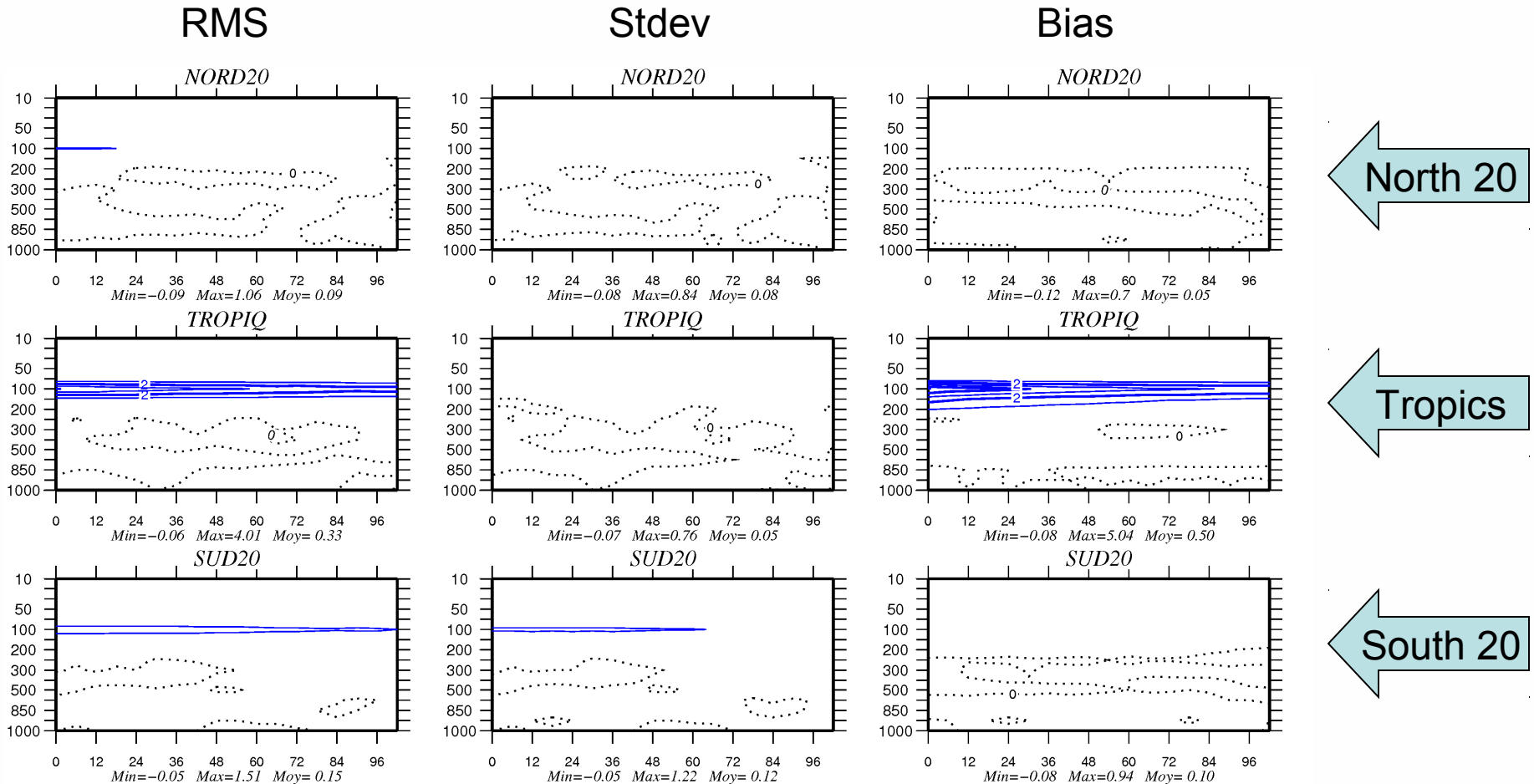
Revised configuration



22 channels

(N. Fourrié)

Impact of WV IASI channels on forecast scores



Scores in humidity against ECMWF analyses
13 days (13/03/2012 -> 29/03/2012)

Use of observations in AROME (CY38T1)

- Same additional observations as in ARPEGE
- Assimilation of additional SEVIRI channels over land (Ts retrieval + use of LandSAF emissivity atlas)
- AMSU-A : channels 9 and 10 + thinning at 80 km
- Doppler wind from X band radar (Mt Maurel from RHYTMME)
- Increase of observation number by 115 %

Plans for AROME

- Revised version on new HPC : $\Delta x=1.3$ km and 90 levels (top at 10 hPa) => revised choice of channels for satellite data
- Possibly one hour assimilation cycle for RUC 3D-Var
- Additional X band radars : Mont Colombis
- Inclusion of VARBC for ground based GPS
- Use of BUFR TEMP with (lon, lat, height) information
- AROME WMED reanalyses (SOP1) : Spanish and italian radars, ASCAT high resolution coastal winds, additional TEMP MOBIL
- Preparation on the use of OPERA radar data when improved DOW and Z are available

Thank you for your attention !

