Assimilation of IASI reconstructed radiances from Principal Components in AROME model

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CNRM-GAME (Météo-France and CNRS)

October 30th, 2015

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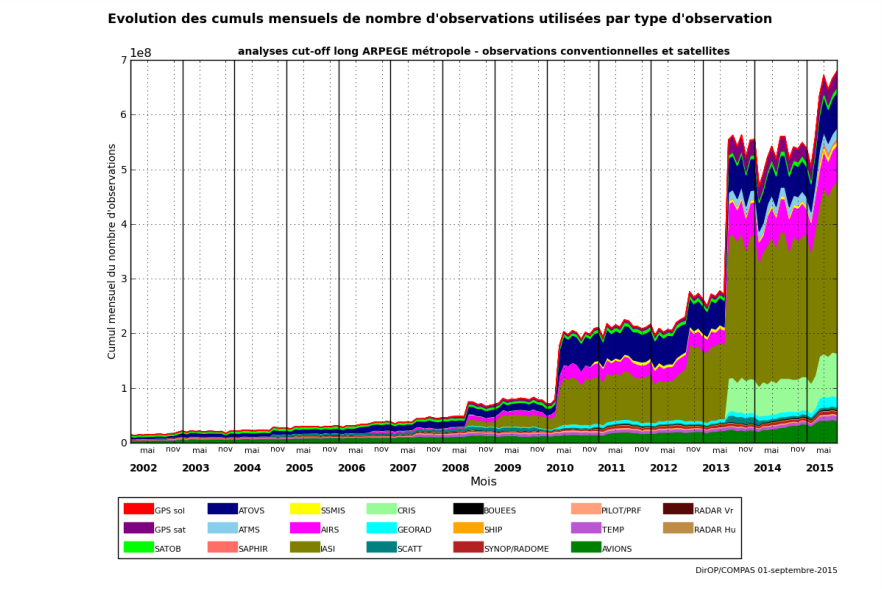
METEO FRANCE

Outline

Background



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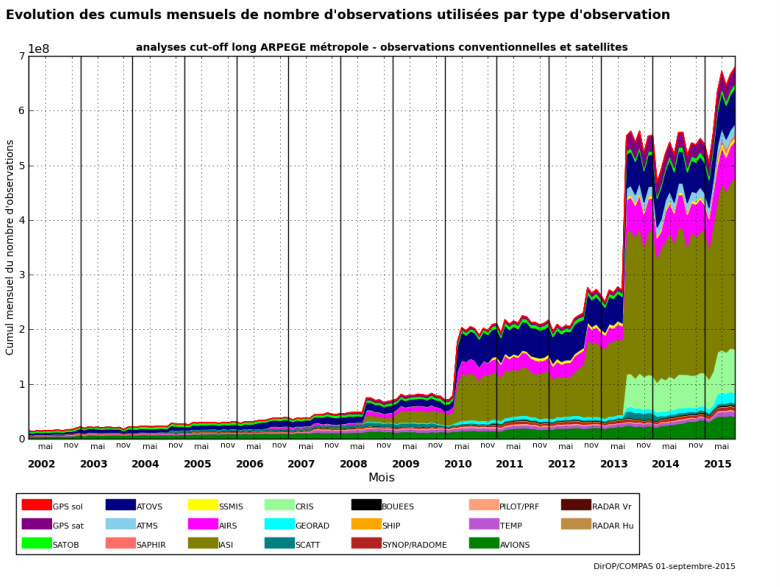
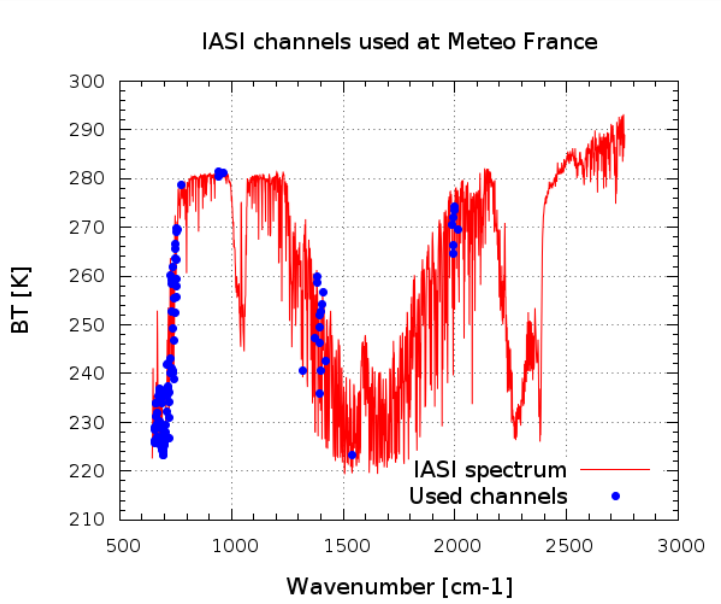
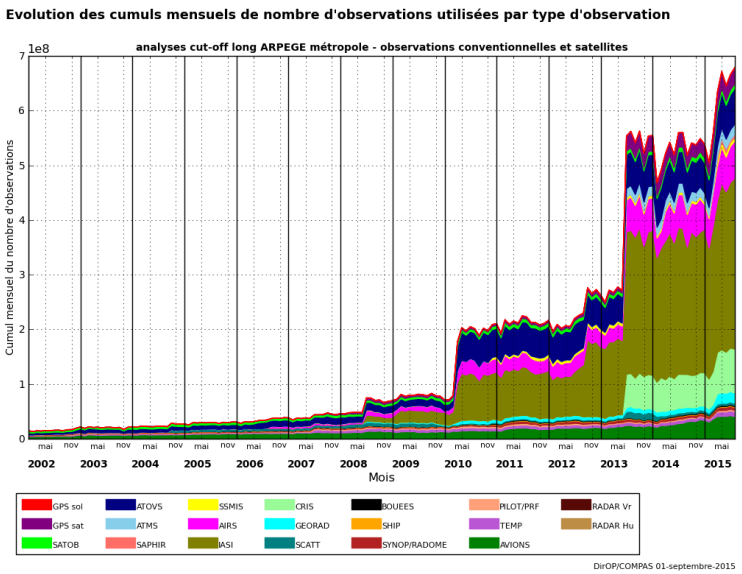
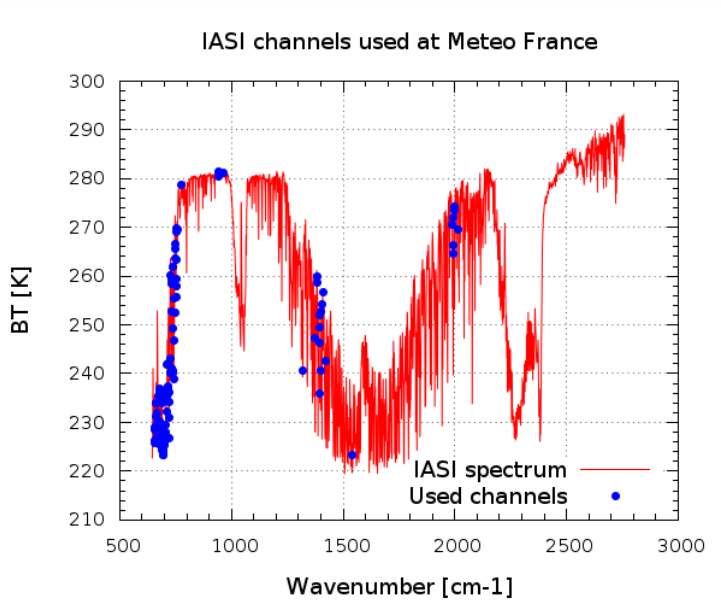

Evolution des cumuls mensuels de nombre d'observations utilisées par type d'observation
analyses cut-off long ARPEGE métropole - observations conventionnelles et satellites
1e8
Cumul mensuel du nombre d'observations
Mois
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
GPS sol
GPS sat
SATOB
ATOVS
ATMS
SAPHIR
SSMIS
AIRS
IASI
CRIS
GEORAD
SCATT
BOUEES
SHIP
SYNOP/RADOME
PILOT/PRF
TEMP
AVIONS
RADAR Vr
RADAR Hu
DirOP/COMPAS 01-septembre-2015


IASI channels used at Meteo France
BT [K]
Wavenumber [cm-1]
IASI spectrum
Used channels

Background





Why Principal Components Analysis (PCA) compression?

- Use PCs instead of Radiances (RAD) => Use more information from each observation
- Data from future Infrared sounders will be disseminated in this format
- Reduction of data dissemination volume by a factor around 50 (IASI case)

Basic ideas about PCA theory

- *PCA allows the reduction of the dimensionality of a problem by examining the linear relationship between all the variables contained in a multivariate dataset*

- The original set of correlated variables, y^{obs}, is replaced a smaller number of uncorrelated variables called principal components, x^{pcs}. A corresponds with the eigenvectors matrix:

$$x^{pcs} = A * y^{obs}$$

- To return to the original space it is only need to make the following multiplication:

$$y^{pcs} = A^T * x^{pcs}$$

- These new variables retain most of the information contained in the original dataset (most of the gaussian noise is filtered):

$$y^{obs} = A * x^{pcs} + residuals = y^{pcs} + residuals$$

Météo France AROME model

AROME is the operational convective-scale limited area Numerical Weather Prediction (NWP) model used at Météo France

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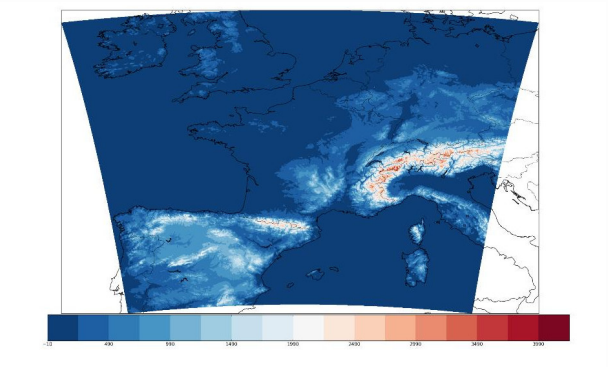
Geographical domain



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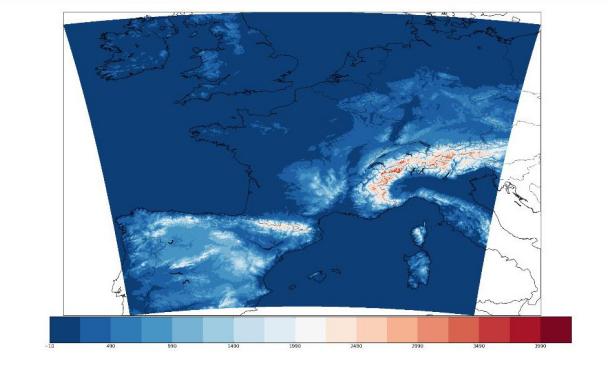

Up to 04/2015	
Levels	60
Mesh grid	2.5 km
Model top	1 hPa
Assim. cycle	3 h

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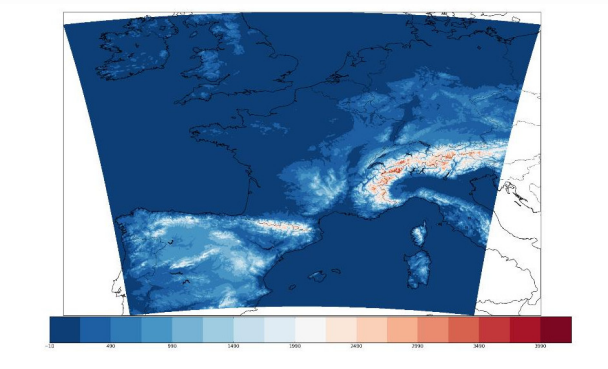

Up to 04/2015	
Levels	60
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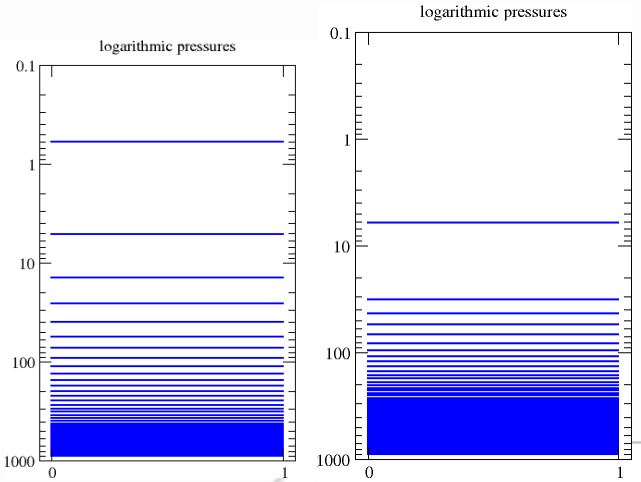
Model top	1 hPa
Assim. cycle	3 h

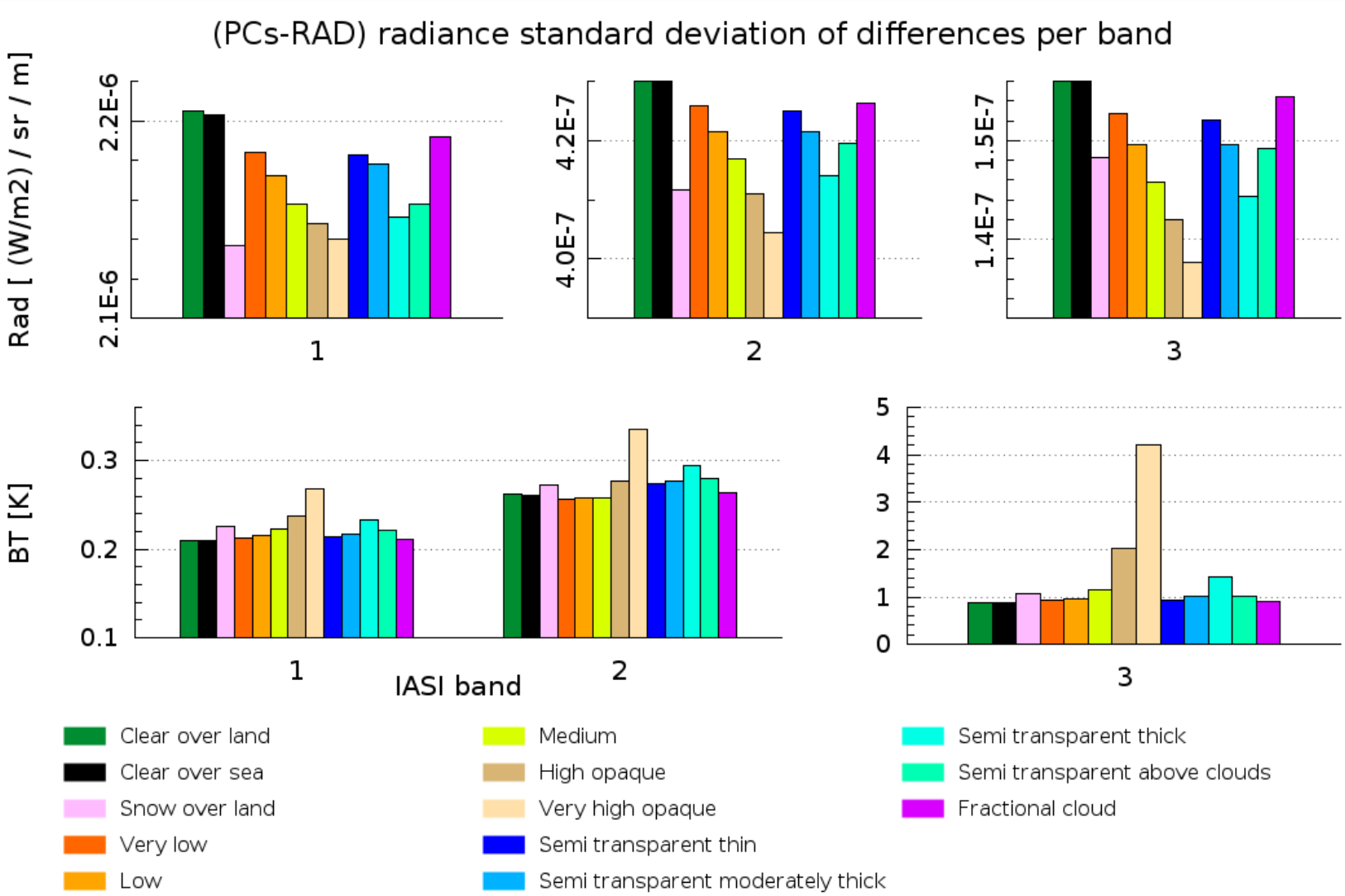
⇒ In April 2015, a new version became operational:

	AROME	AROME-HR
Mesh grid	2.5 km	1.3 km
Assim. cycle	3 h	1h
Levels	60	90
Model top	1 hPa	10 hPa



Outline

Standard deviation of PCs-RAD radiances differences



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Impact of PCs assimilation: experiments description

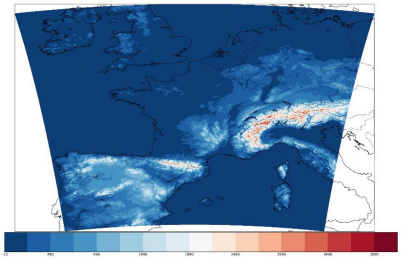
AROME

Operational configuration of AROME model

1. B58N: Reference, assimilation of radiances
2. B5AJ: Experiment, assimilation of RR

Assimilation cycle: 3 hr, mesh grid: 2.5 km, levels: 60

Time window: 20141108 to 201411208



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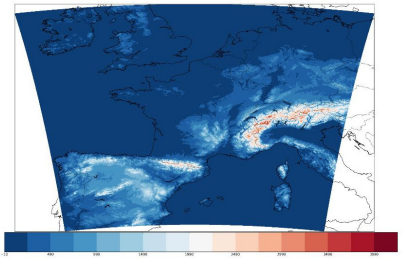


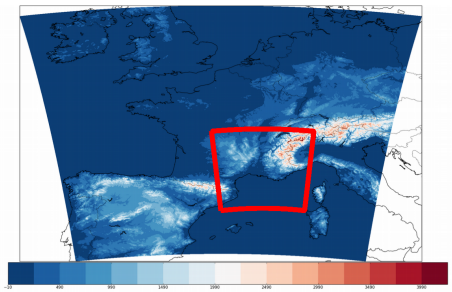
AROME-HR reduced version

Operational configuration of AROME-HR model

1. B59V: Reference, IASI rad. from RAD
2. B5CH: Experiment, IASI rad. from PCs

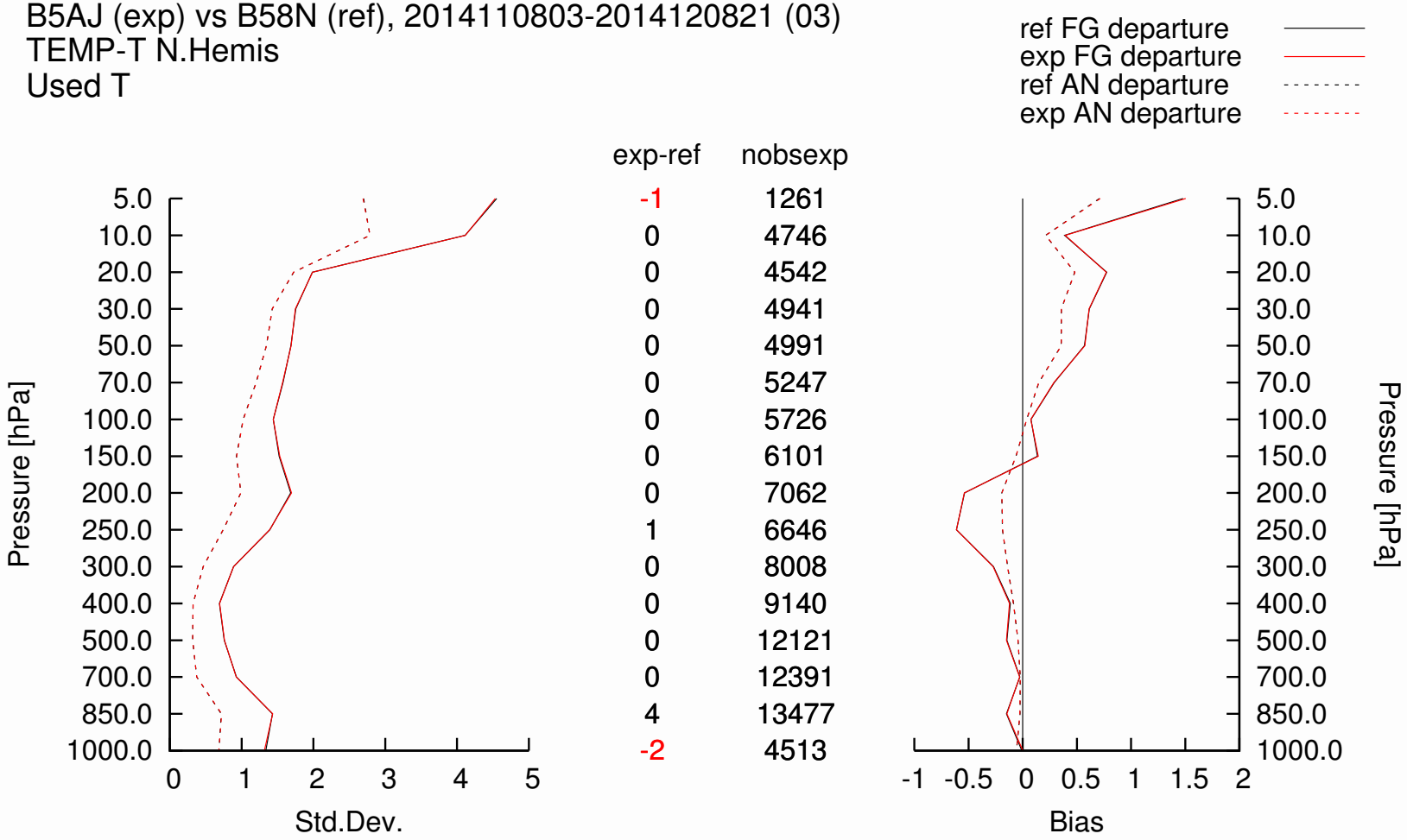
Assimilation cycle: 3 hr, mesh grid: 1.3 km, levels: 90

Time window: 20150616 to 20150716

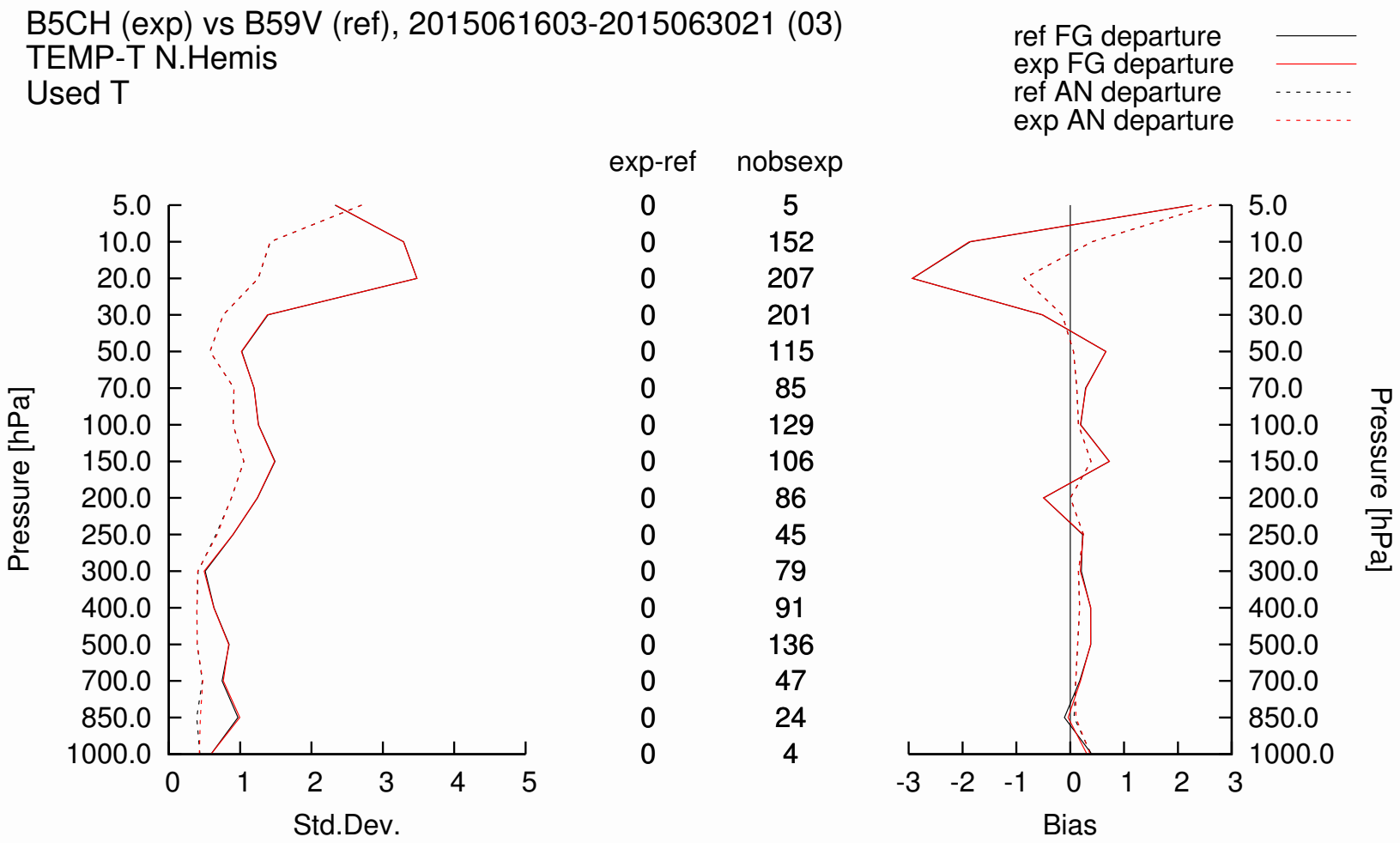


AROME Obs. assim. statistics: T from radiosoundings

B5AJ (exp) vs B58N (ref), 2014110803-2014120821 (03)
TEMP-T N.Hemis
Used T

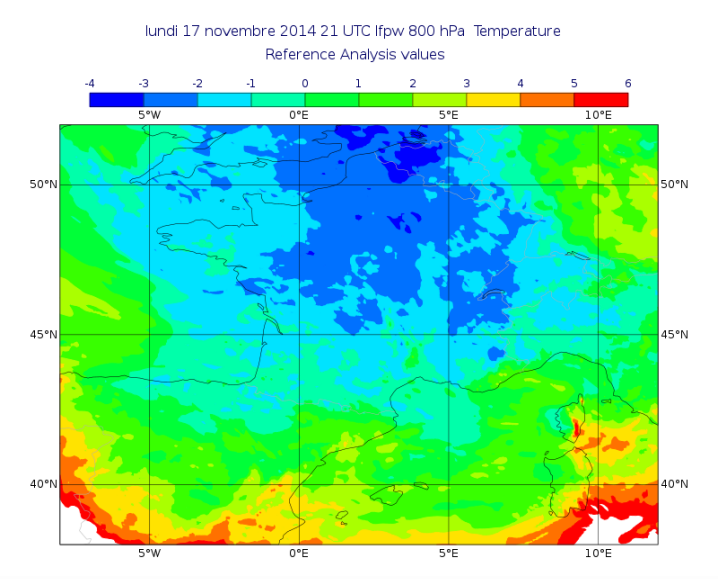


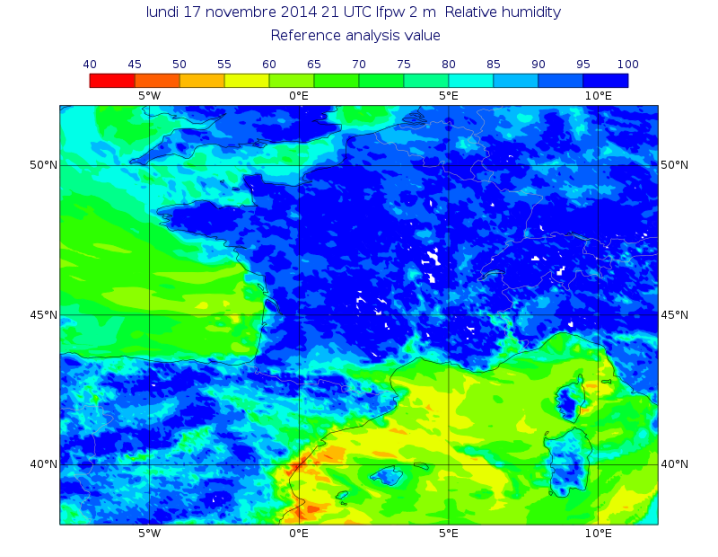
AROME-HR Obs. assim. statistics: T from radiosoundings



AROME Differences in forecast fields - T at 800 hPa, RH at 2 m

20141117 21:00 + 00h, forecast analysis fields





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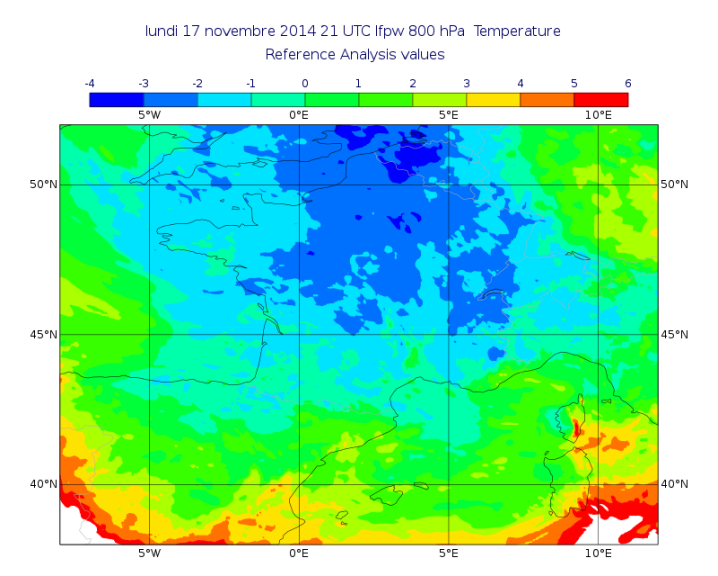

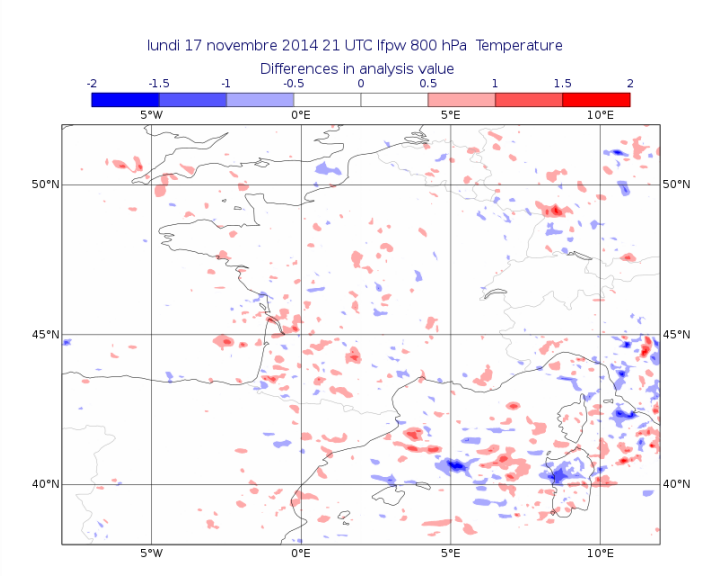

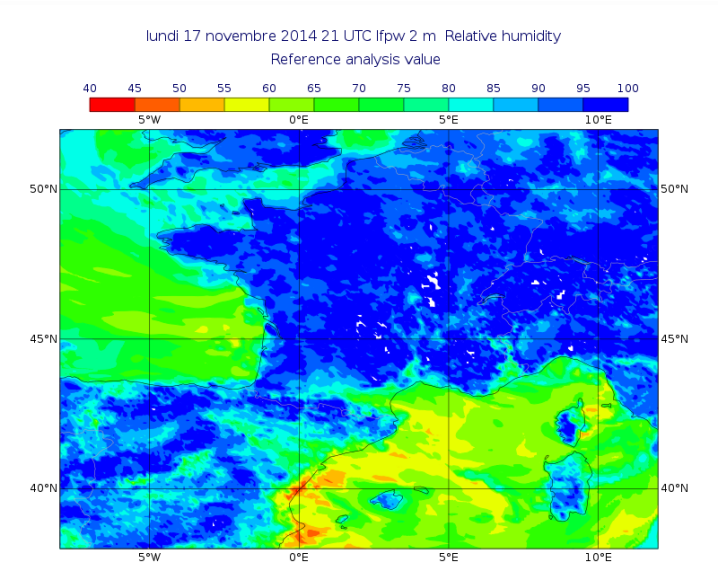

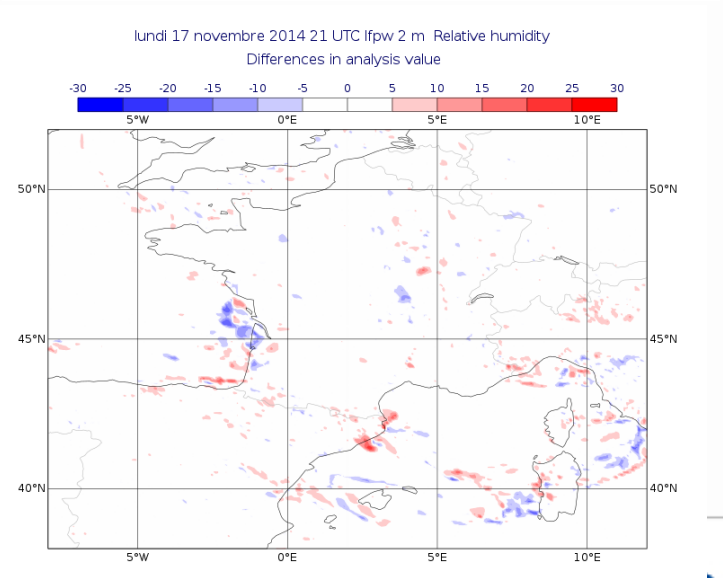

Conclusions and open questions

1. PCs-RAD radiance differences
   - Small PCs-RAD differences in the radiance space and first two bands in the BT space. Differences up to 4 K in Band 3
   - Differences in BT space: High and very high clouds, O3 B1 and CO2 B3 (not shown), IASI band 3. Not a problem for the moment
2. Assimilation of PCs in precedent AROME model
   - Neutral impact on other (not IASI) observation assimilation statistics
   - Neutral impact on forecast fields
3. Some open questions
   - Finish quantification the impact of using RR in AROME-HR, with a lower model top (Experiments currently running)
   - Can we improve NWP forecasts using RR from IASI band 3?
   - Direct assimilation of PCs instead of RR (RTTOV version 11.3)

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Thank you for your attention

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