Assimilation Of AMSU-B Radiances In HIRVDA

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Outline

Info on the instrument

Quality control
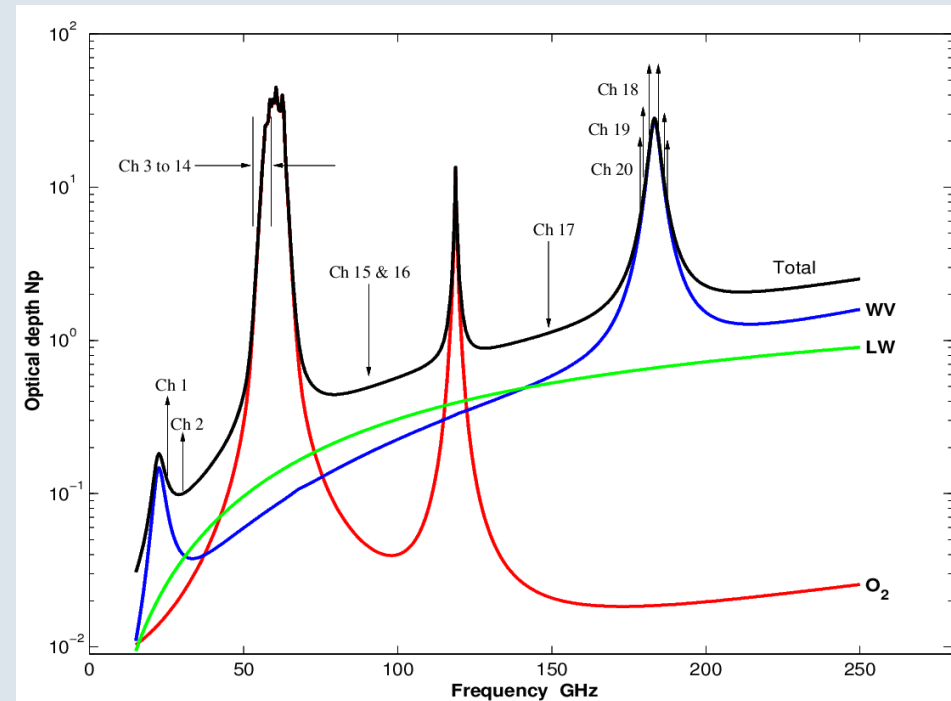
Bias-correction

Experiment period

Results

General Info On Microwaves

- Microwave spectrum: large 'window' regions

- Two strong absorption bands: 57GHz (oxygen) and 183 GHz (water vapour)

- Microwave instruments:
  - works day and night
  - almost unsensitive to clouds
  - precipitation and thin ice cirrus cause scattering
  - have course resolutions compared to IR instruments

General Info On AMSU-B

- A microwave sounder with 5 channels:
  - 2 window channels
  - 3 sounding channels at 183 GHz

- Satellites: NOAA 15,16,17
  AQUA (NASA)
  METOP (European satellite)
  NOAA18, renamed to MHS

- Data from NOAA available via EARS

AMSU-B response functions for two cases
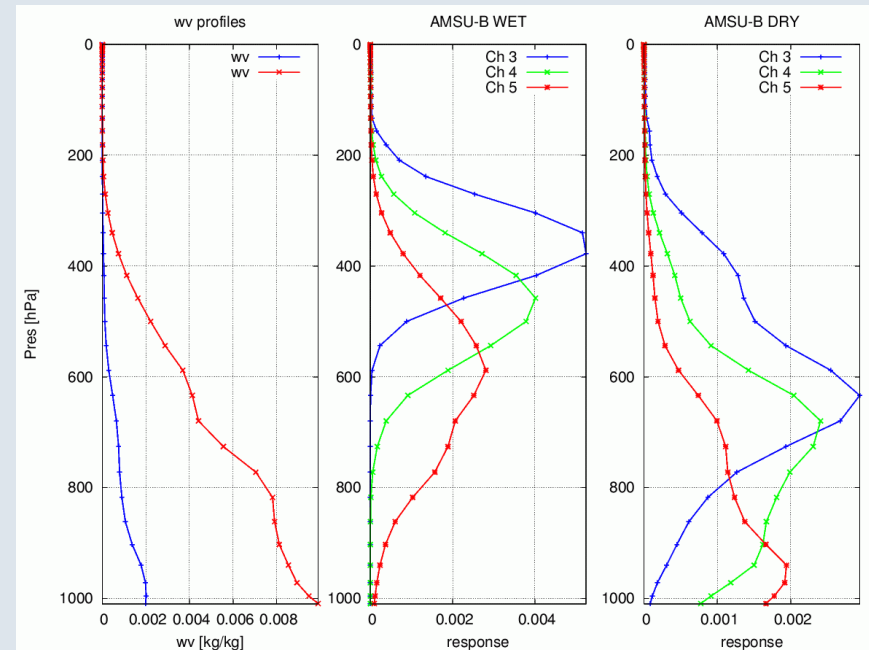
Quality Control: Scattering

Why do we need quality control?

y: observations

H: observation operator, may not model
   scattering accurately

x_b: HIRLAM profile. Inaccurate representation
     of fields that cause scattering (rain, ice-particles etc)

$$(\mathbf{y\text{-}Hx}_b)$$

- Several indexes available to spot 'contaminated' radiances

- Most of them use the window channels

- Some requires data from AMSU-A to be mapped onto the AMSU-B grid:
  difficult to implement inside HIRVDA

- The difference between AMSU-B Ch1 and Ch2 (89 and 150 GHz) can be
  used as a crude index over sea
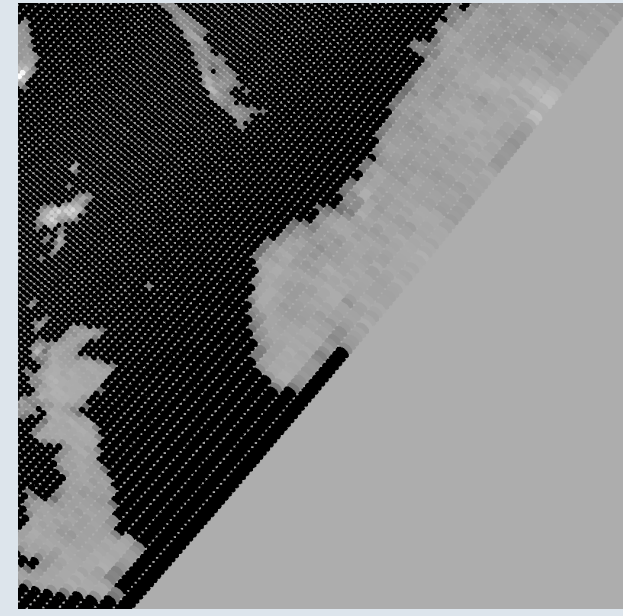
Quality Control: Scattering

NOAA17 3/5-2006 11:52UTC
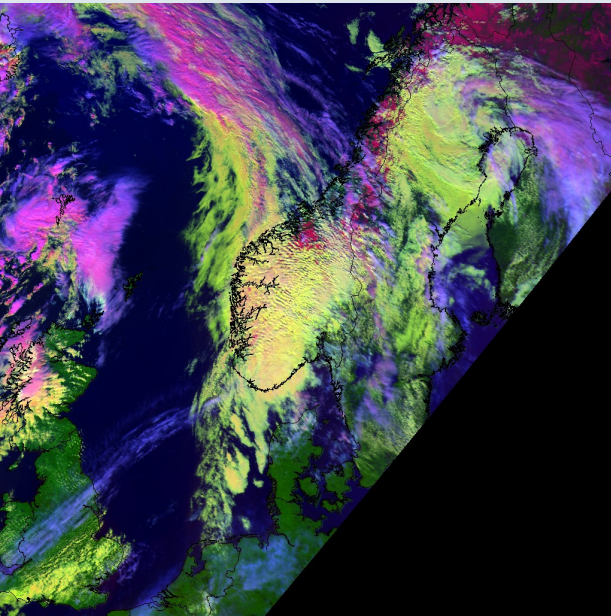
AVHRR RGB image Ch 1,3,4
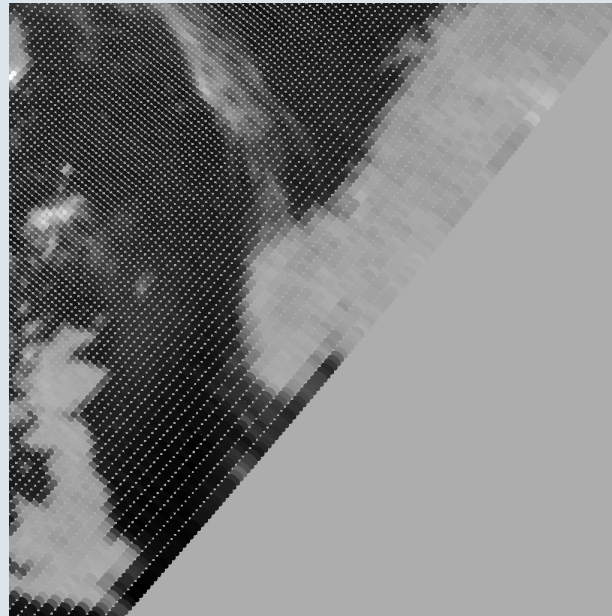
AMSU-B Ch1-Ch2

AMSU-B
Ch1-Ch2 >-15K

Pictures from Adam Dybbroe, SMHI

Bias Correction

- A large sample of obs minus first guess statistics show a bias

$$(\mathbf{y}\text{-}\mathbf{Hx}_b)$$

- The biases (we want to correct) originate from
  - y: the observations. This is characterized by scan-dependency.
  - H: the observation operator (RTTOV)

$$corr = p_0 + \sum_{j=1}^{N} c_j P_j$$

- A simple linear regression model is used to correct the biases originating from y and H

The correction model

p_0: constant

c : coefficients calculated from a reference data-set

P : predictors

- The predictors used for AMSU-B are:
  - mean temperature 1000-300hPa
  - mean temperature 200-50hPa
  - the scan-angle
  - the square of the scan-angle

Observation Errors

|	Approximated Background error BGOS	Observation error	Weight given in analysis σ_b/σ_o
Ch 3	3.5K	2K	1.75
Ch 4	2K	2K	1.0
Ch 5	1.5K	2K	0.75

Experiment Setup

- 33km horizontal resolution
- 40 vertical levels
- hirlam version 6.3.5
  - Kain-Fritsch
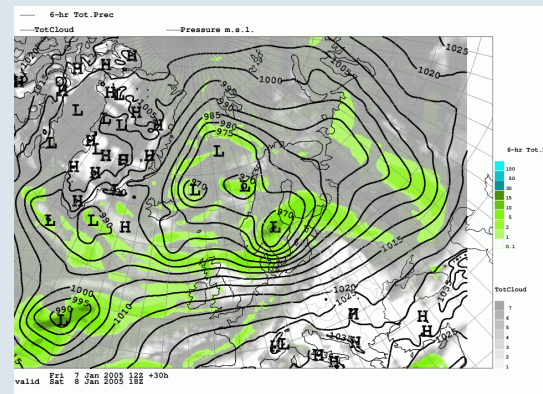 - Rasch-Kristjanssen
  - CBR
  - ISBA

- HIRVDA version 6.2.1
- FGAT
- 6h assimilation cycle
- +48h forecasts each cycle
- Period: January 2005

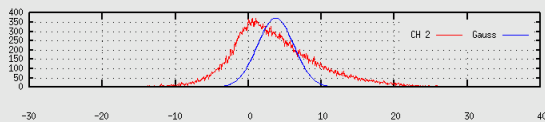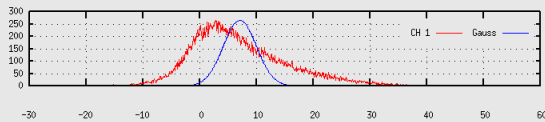REF: Conventional observations
      + AMSU-A
EXP: REF+AMSU-B Ch 3,4,5 over sea
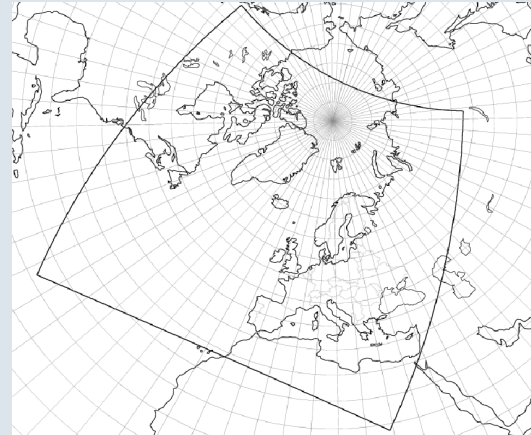
Model domain

Windstorm Erwin
(Gudrun) Jan 8 2005

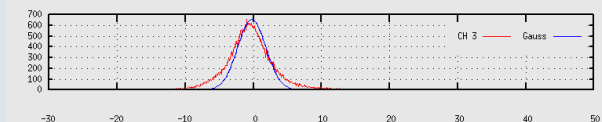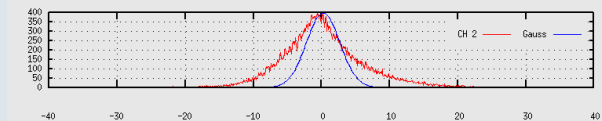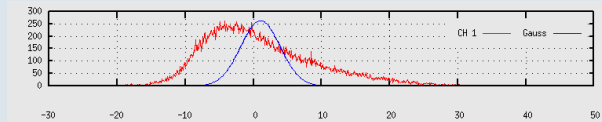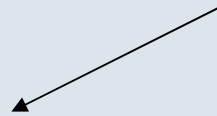# Performance of the Bias-Correction

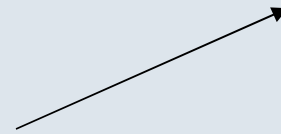Bias-correction coefficients were determined from a data-set of 1 month: December 2004

Data sample from January 2005
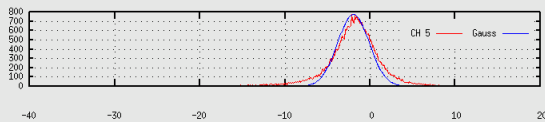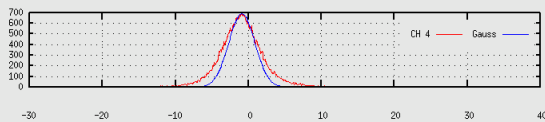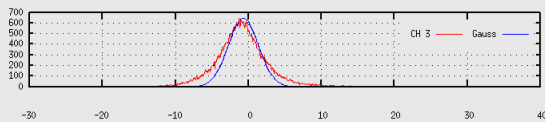
Distribution of uncorrected innovations
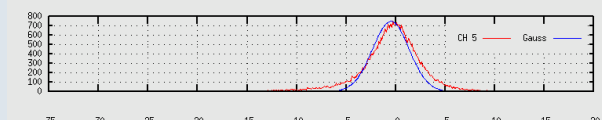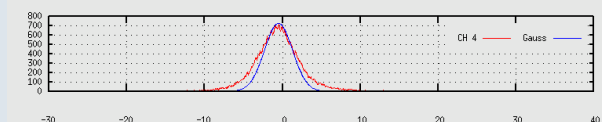
Distribution of bias-corrected innovations

x-axis: $(\mathbf{y}-\mathbf{Hx}_b)$ [K]

y-axis: number of samples

Blue: overlayed gaussian curve

Red: data distribution

Results Compared To Radiosondes: EWGLAM List

- A humidity increment may change the humidity and the wind-field

- Some of the initial changes in the humidity field are likely overrun by the model dynamics

- The initial humidity changes may however spread to other variables (clouds, radiation etc) which in turn effects the mass-field

+48h
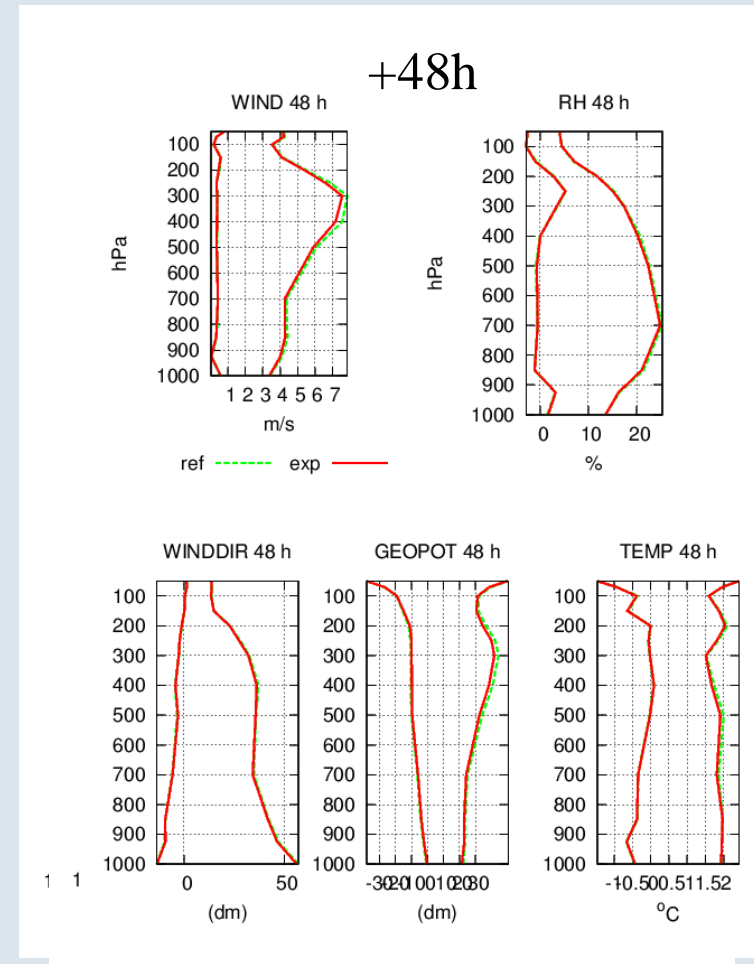
Results Compared To Synops: EWGLAM List
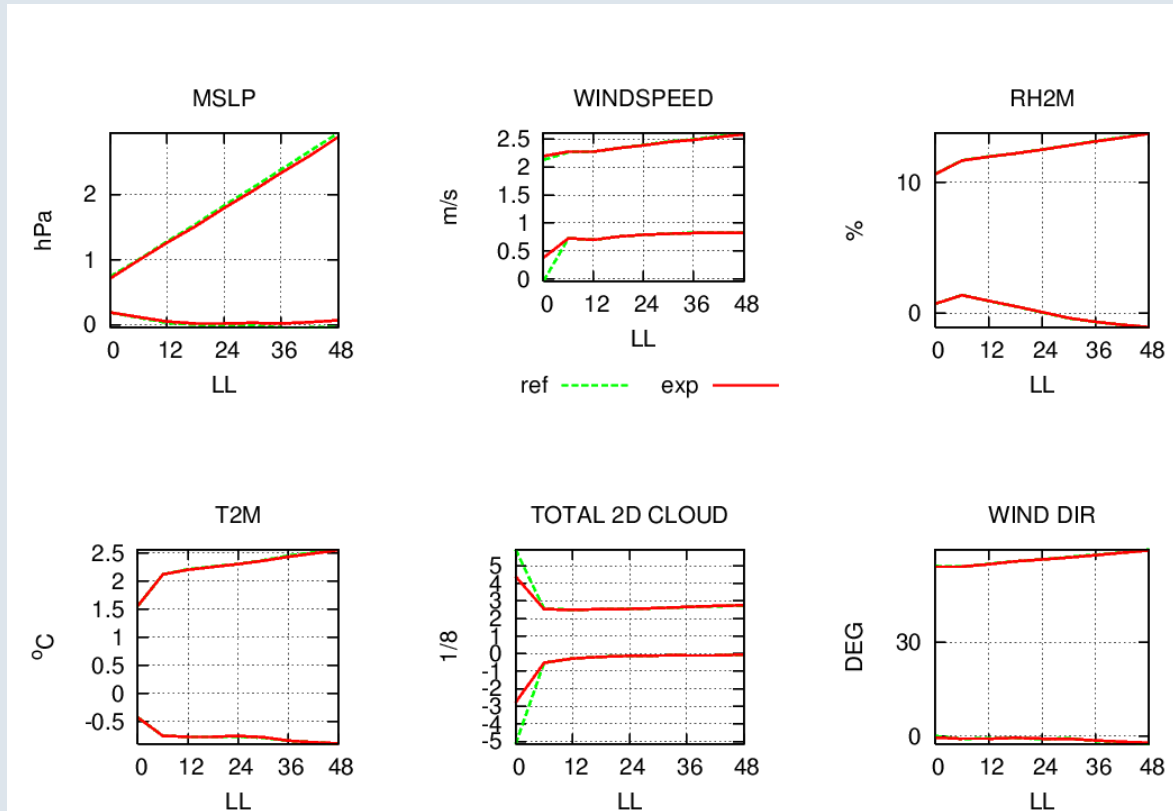
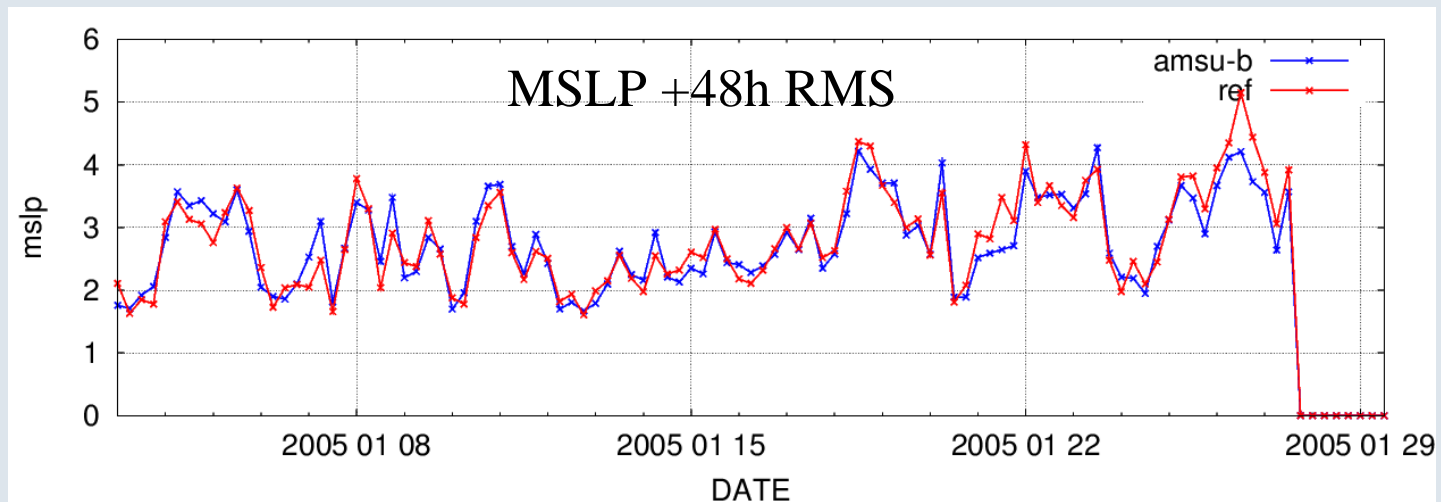# The cloud and precipitation patterns have changed
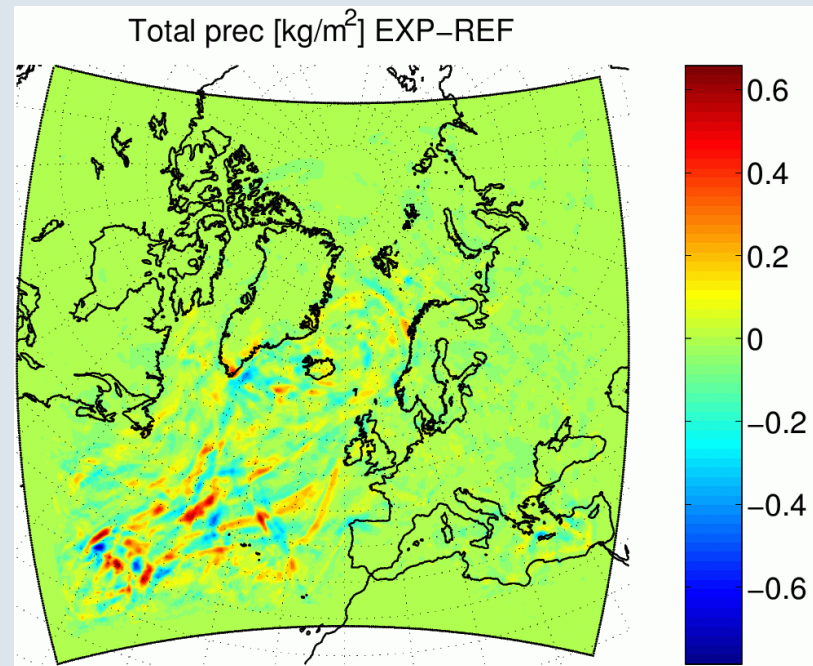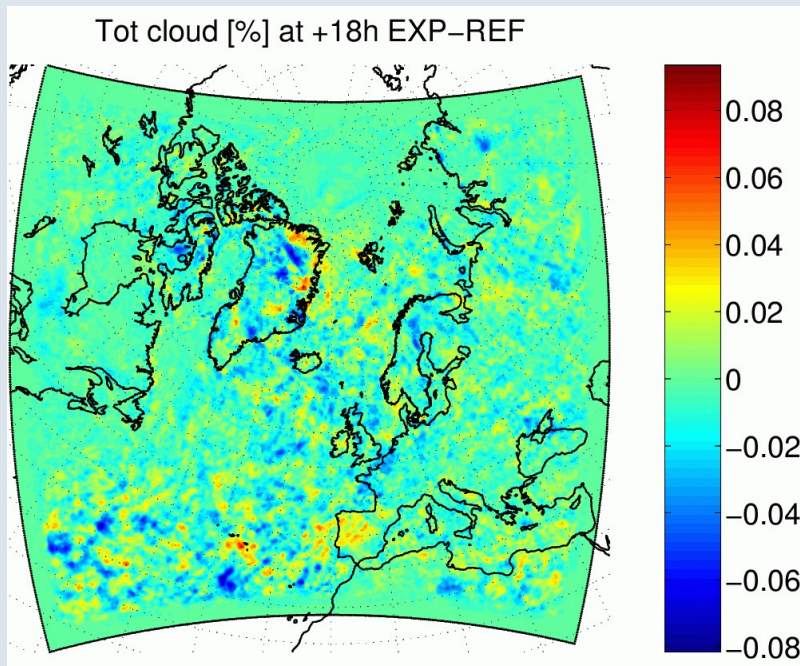
Difference in:

Mean cloudiness for +18h forecasts

Total difference: -0.00038 %

Difference in:

Total 6h precipitation for +18h forecasts

Total difference: 0.0038 mm

Timescore

- Minor differences in RMS of mslp

x-axis show the valid time of forecasts

Summary

- AMSU-B has been assimilated over sea

- The Bias-correction uses only air-mass predictors + the scan correction

- A simple index is used for quality control over sea

- Results were positive for January 2005