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SMHI HARMONIE DATA ASSIMILATION USING LOCAL OBSERVATIONS

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Structure

- Data assimilation in SMHI operational HIRLAM
- Pre-operational SMHI HARMONIE system
- Functionality of components
- Results from an extended HARMONIE data assimilation experiment
- Conclusions

High Resolution Limited Area Model Hirlam

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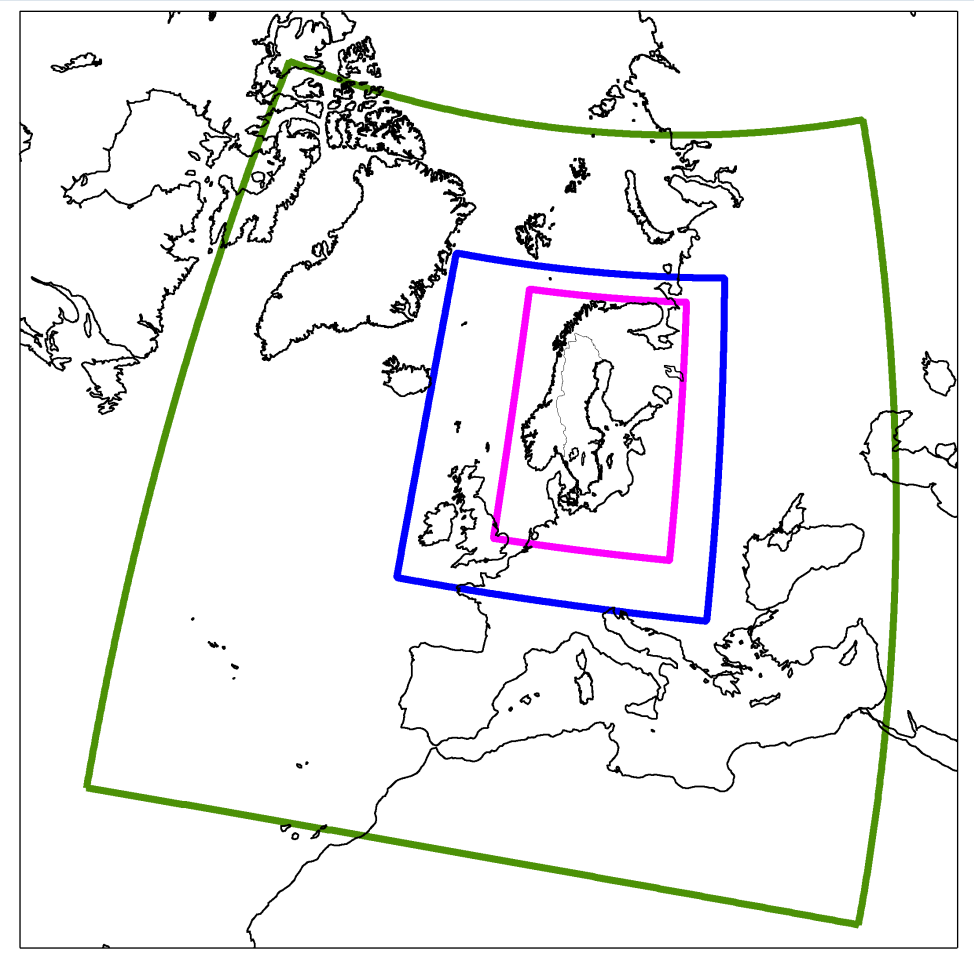
Operational HIRLAM versions at SMHI



SMHI C22 (4D-VAR)

SMHI E11 (3D-VAR)

SMHI G05 (3D-VAR)

SMHI pre-operational HARMONIE version with data assimilation (cy35h1)

Area: corresponding to E11
Horizontal resolution: 5.5 km
Number of vertical levels: 60
Forecast length: 0-36 h
Data assimilation: ALADIN 3D-VAR
Model: ALADIN
Dynamics: Hydrostatic
Physics: ALARO
Lateral boundaries: ECMWF

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SMHI HARMONIE 3D-Var

Observations (from GTS):

- SYNOP land / SYNOP SHIP / BOYS (surface pressure)
- AIREP/AMDAR (wind, temperature)
- PILOT ballon (vertical profile of wind)
- Radiosondes (vertical profile of wind, temperature and humidity)

Apriori error statistics:

- Background error statistics calculated from HARMONIE forecasts, started from analyses belonging to ECMWF ensemble data assimilation experiment. Lateral boundary conditions are taken from corresponding ECMWF forecasts. Background error standard deviations are scaled.
- Observation error statistics from the HARMONIE system (slightly different from the statistics in the ALADIN export package).

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Data assimilation components in general HARMONIE system

- **In HARMONIE mini-sms**

- **Analysis is composed of:**

AnSFC-Canari surf. assim. (not SST)

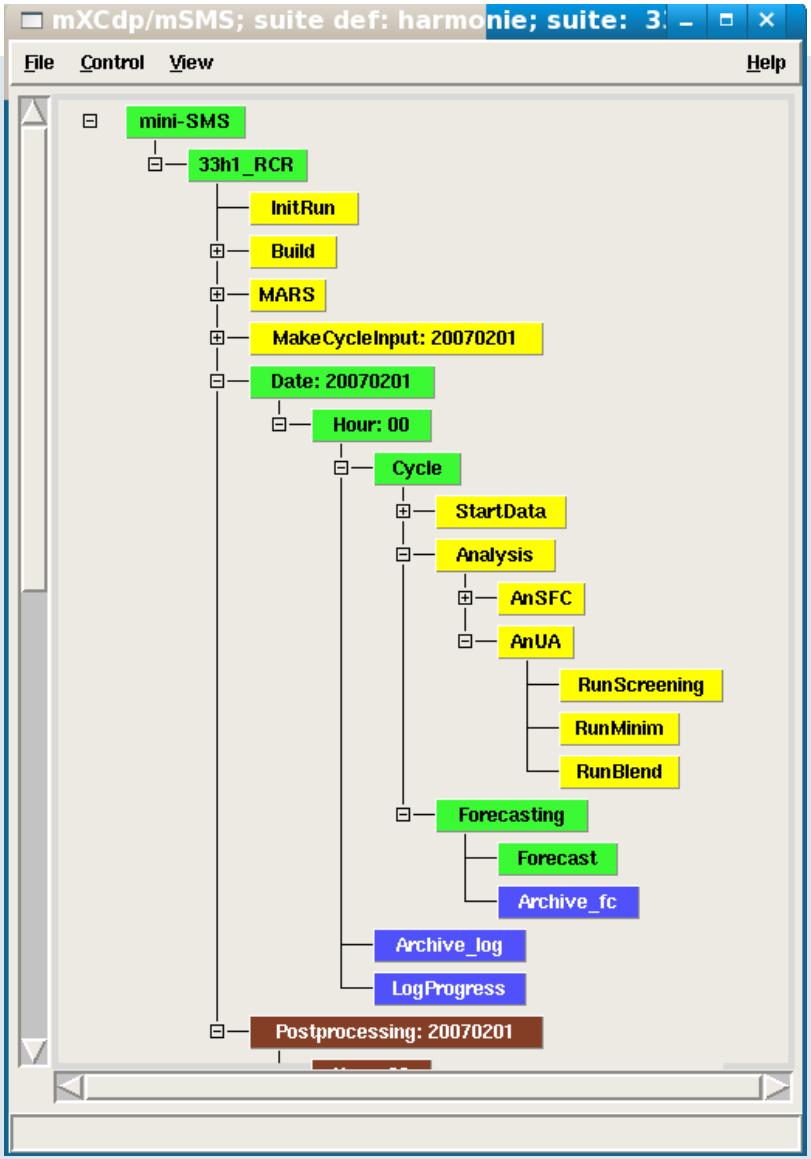
AnUA-ALADIN 3D-VAR analysis (including SCREENING, Minimization and a BLENDING step)

- **Pre- and Post-processing for DA:**

Preparation of observations

Monitoring of observation usage

Calculation of observation fit statistics



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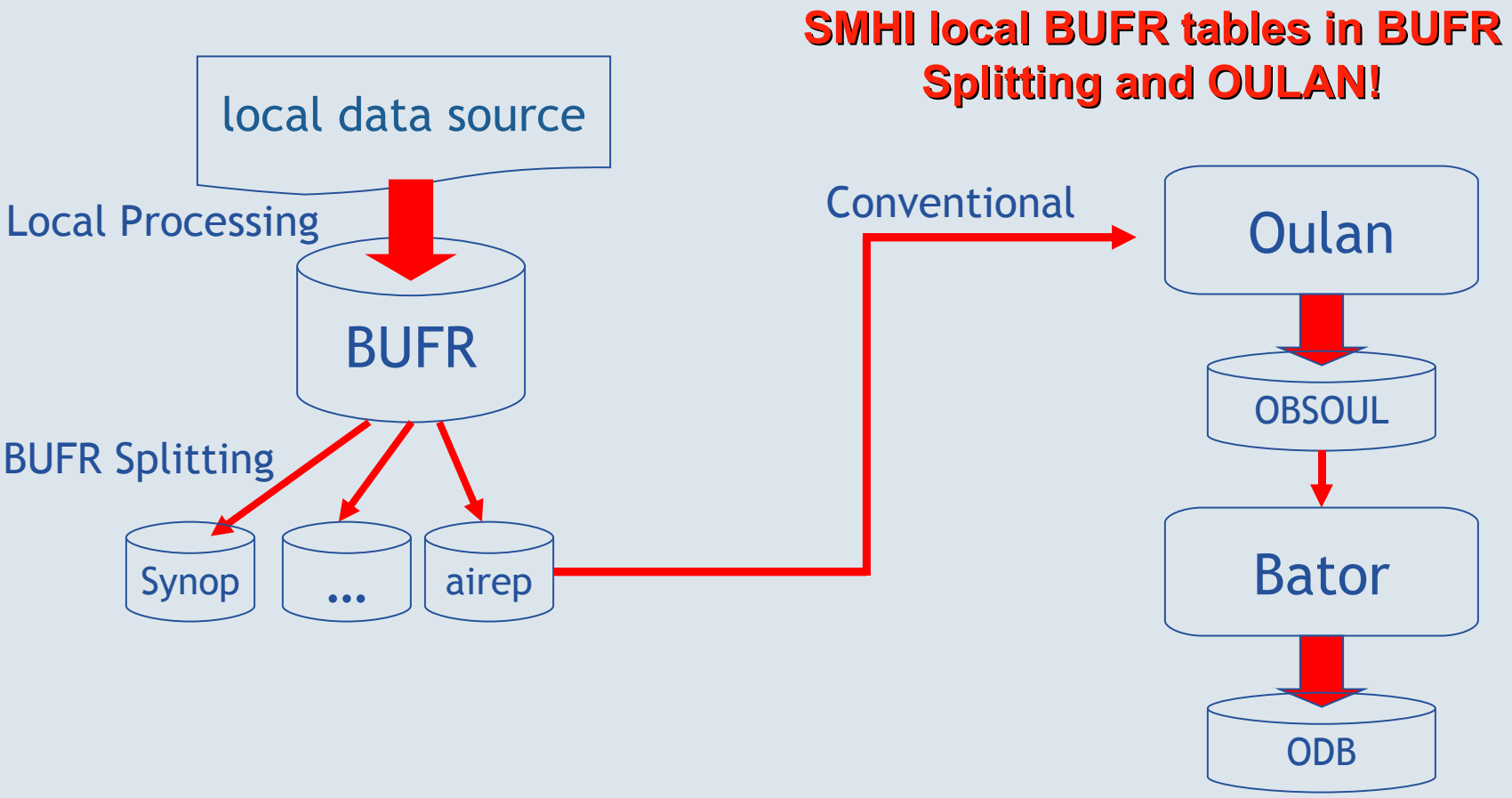
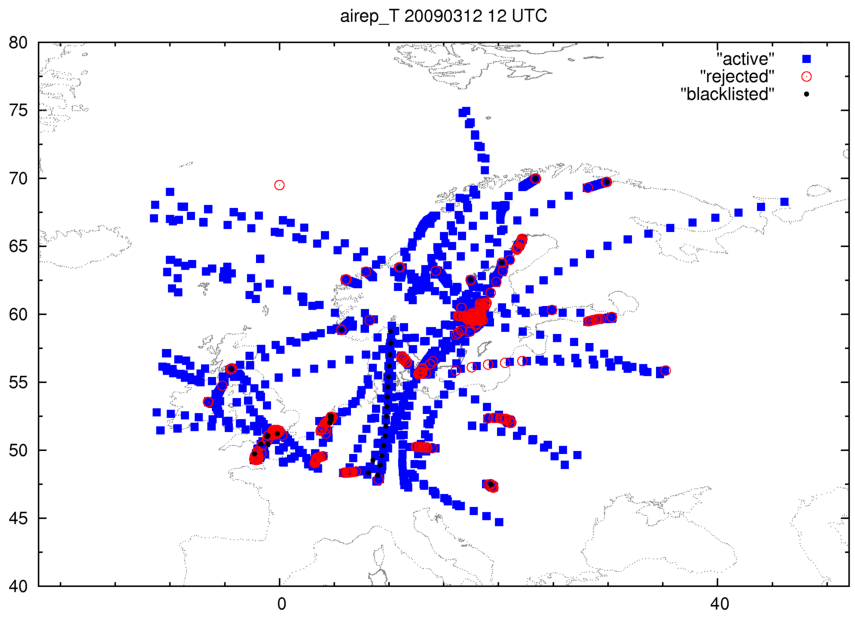
SMHI HARMONIE data pre-processing for DA observation preparation

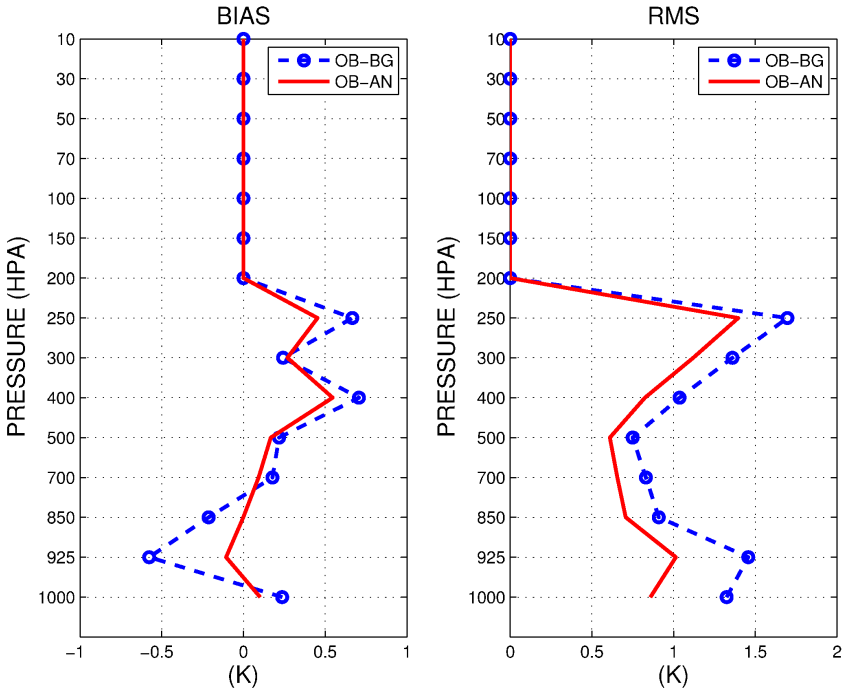


SMHI HARMONIE data post-processing for DA
Data usage and observation fit statistics
Example: temperature observations from aircrafts for 20090312 12 UTC

Data usage



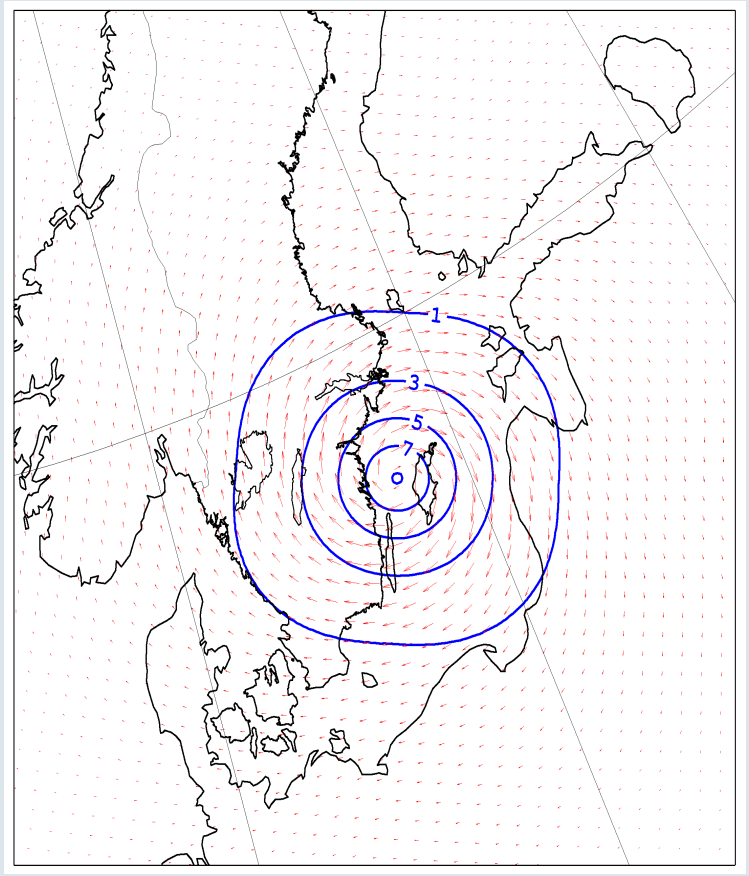
Observation fit statistics



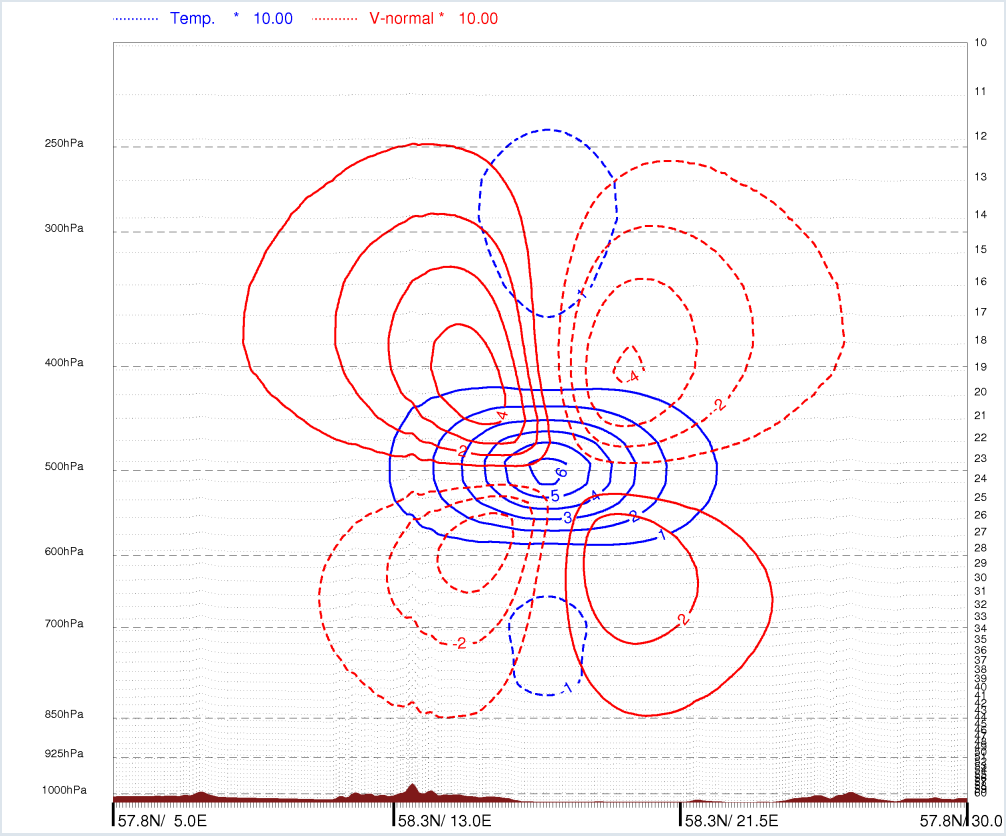
Influence of one single temperature observation in SMHI HARMONIE 3D-VAR

2 K warmer than corresponding background value and located over the Baltic Sea at the 500 hPa level

Horisontal



Vertical

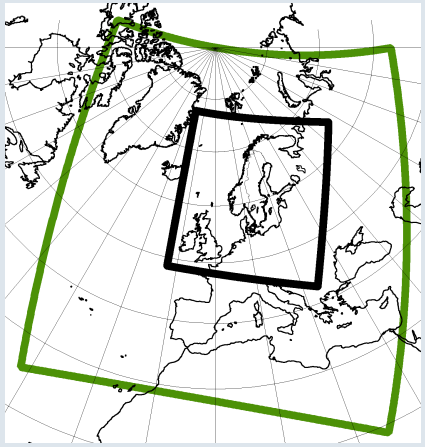


Temperature (tenths of K) **Wind (tenths of m/s)**

Extended SMHI HARMONIE data assimilation and forecast experiment

Period: 20090210-20090320
Forecast length: 0-30 h
Lateral boundaries: 6 h old SMHI HIRLAM C22 forecasts (+6 to +36 h forecast range)

Experiment 1: HARMONIE with data assimilation (6 h data assimilation cycle)
Experiment 2: HARMONIE without data assimilation (HARMONIE forecasts started from 6 h old SMHI HIRLAM C22 +6 h forecast)



SMHI HARMONIE

SMHI HIRLAM C22 (LBC)

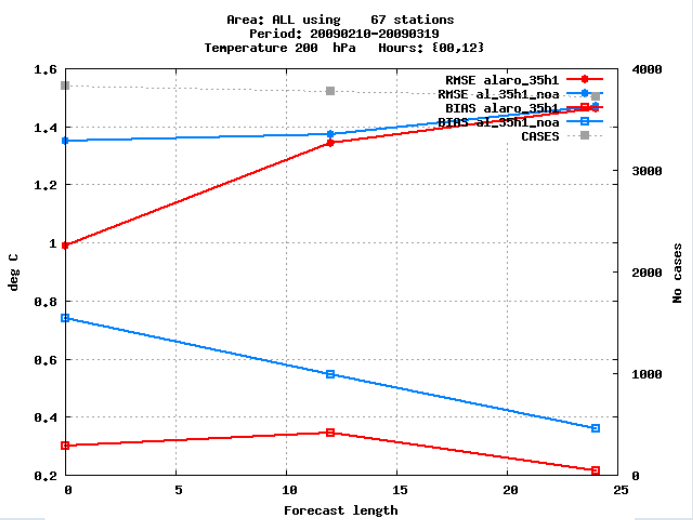
Scores for verification of forecasts against observations

(20090210-20090320)

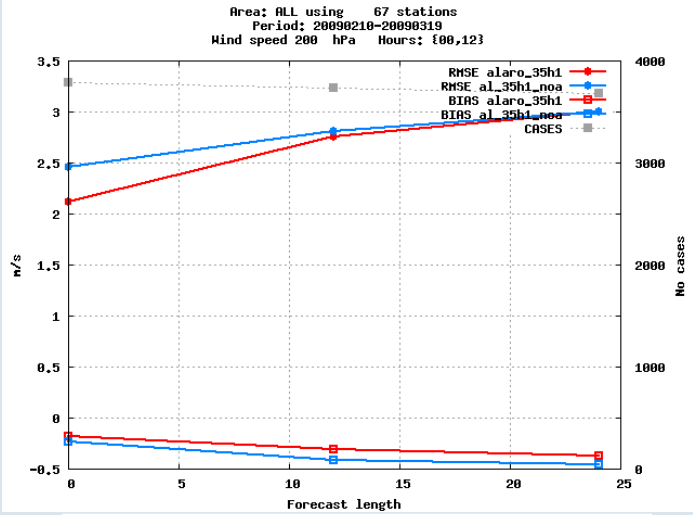
HARMONIE with data assimilation

HARMONIE without data assimilation

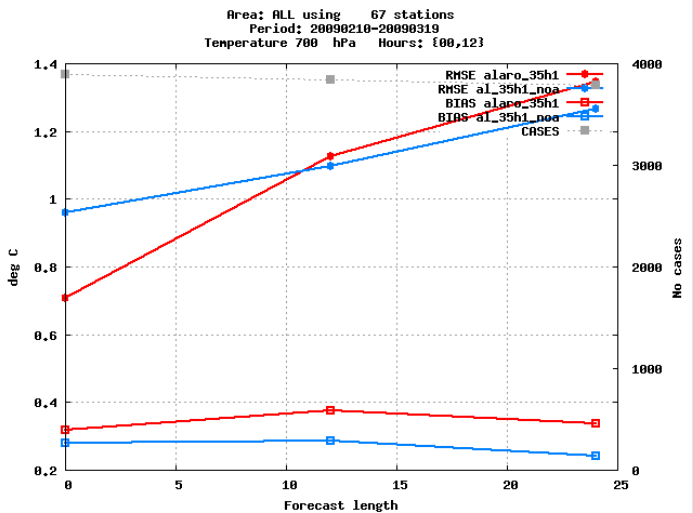
Temperature at 200 hPa



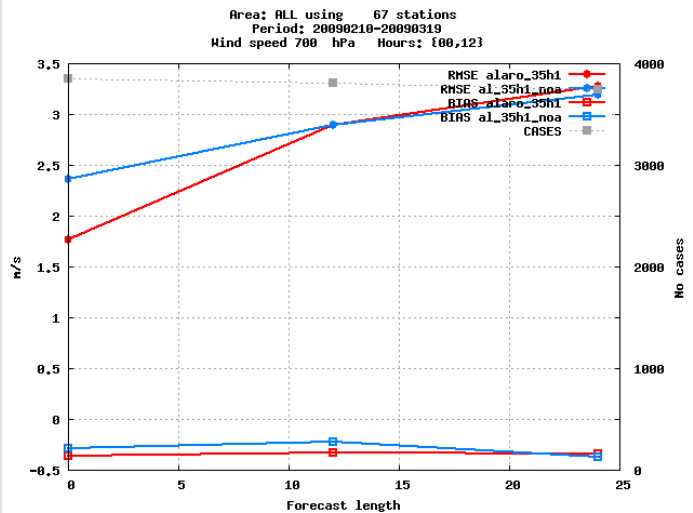
Wind speed at 200 hPa



Temperature at 700 hPa



Wind speed at 700 hPa



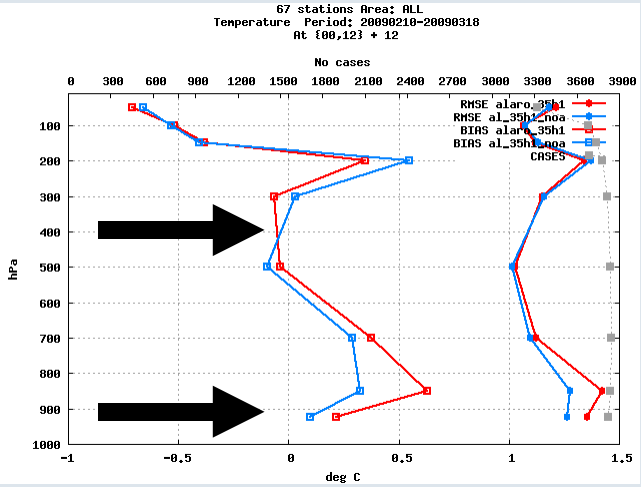
Scores for verification of forecasts against observations

(20090210-20090320)

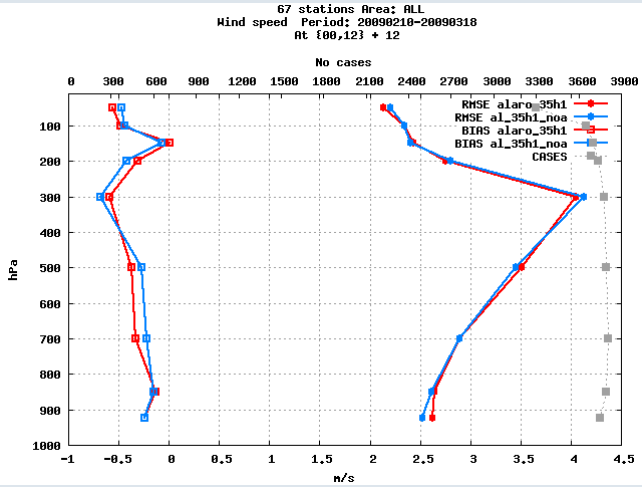
HARMONIE with data assimilation

HARMONIE without data assimilation

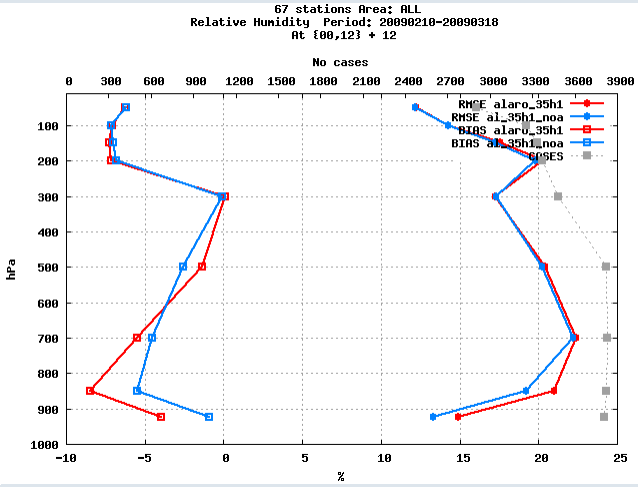
Vertical profile of +12 h temperature forecast score



Vertical profile of +12 h wind speed forecast score

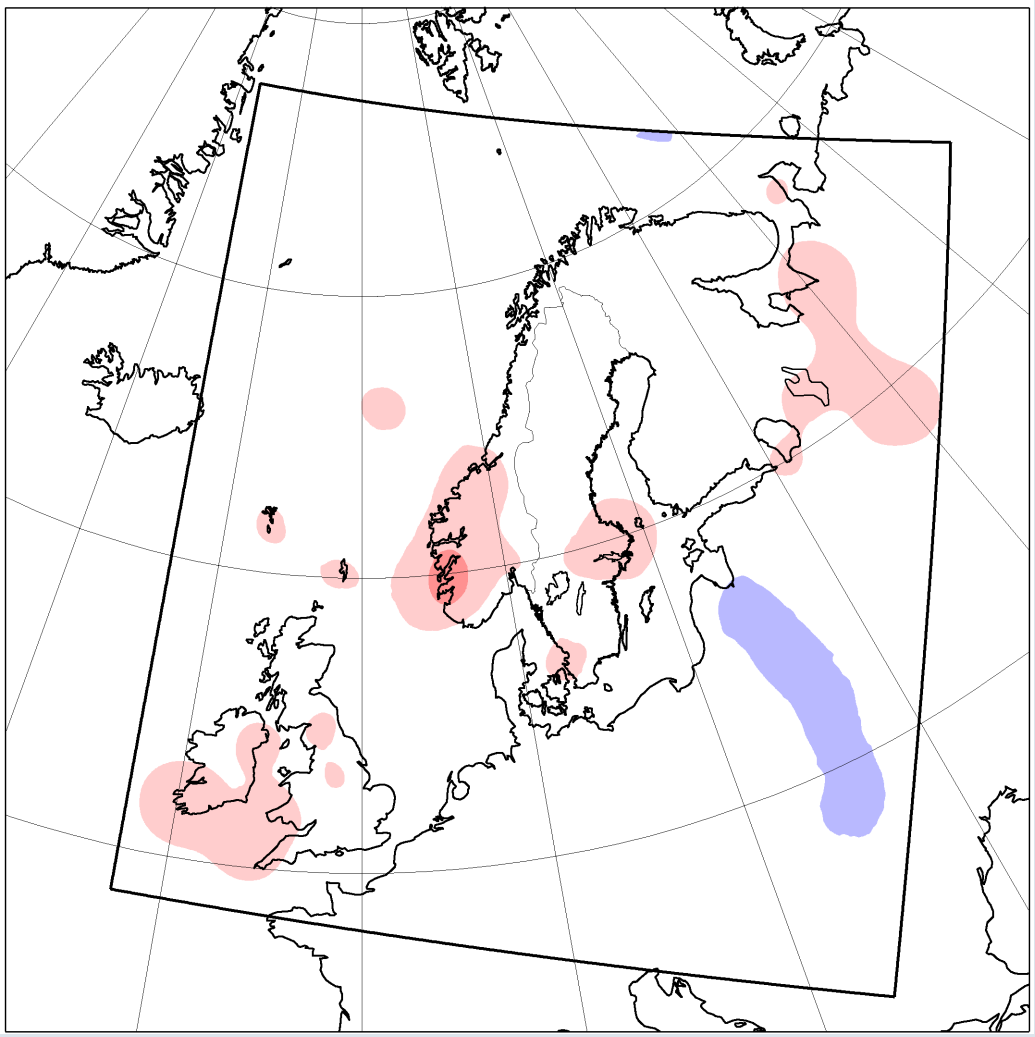


Vertical profile of +12 h Relative Humidity forecast score

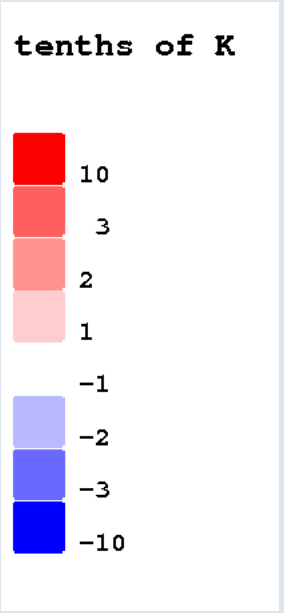


Mean analysis increment

(20090210-20090319)
(accumulated over 00, 06, 12, 18 UTC)



Temperature at model level 20
(close to 400 hPa)

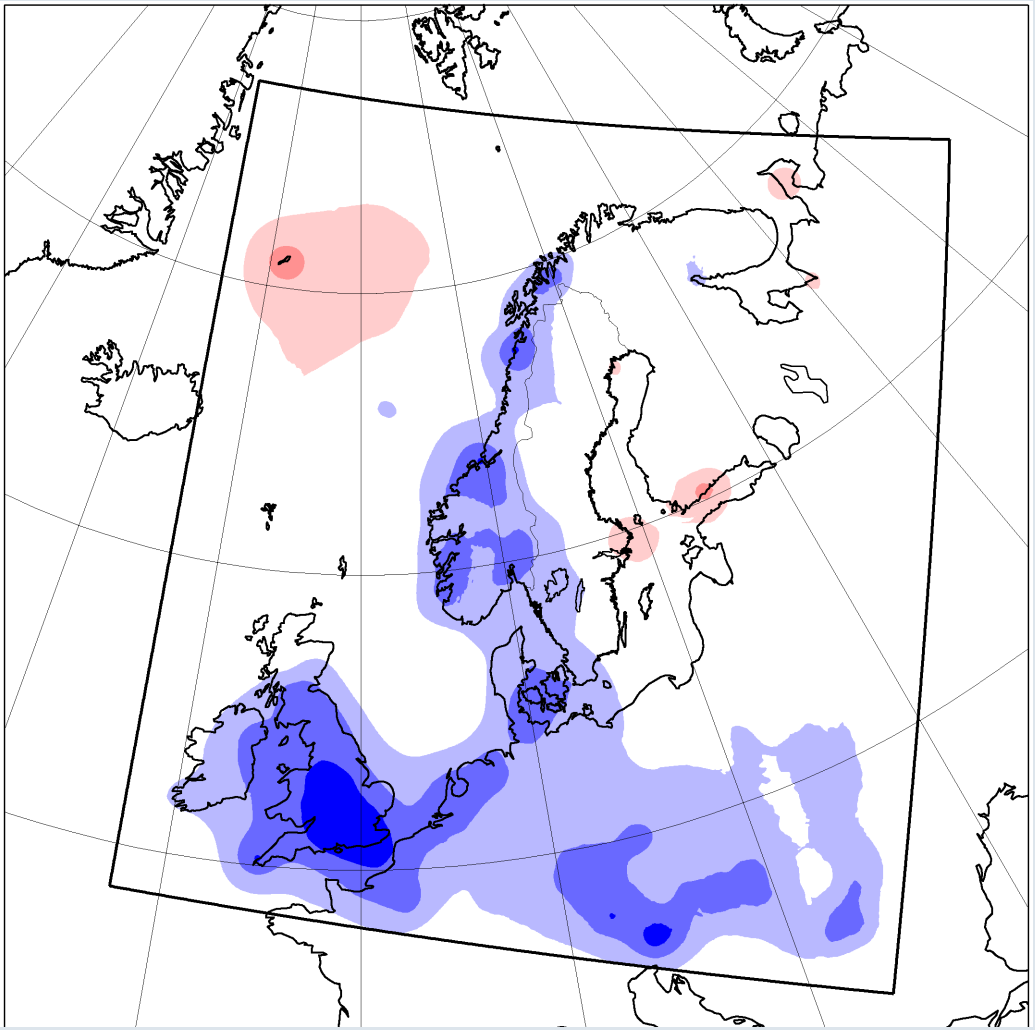


No systematic differences between observations and +6 h HARMONIE forecast

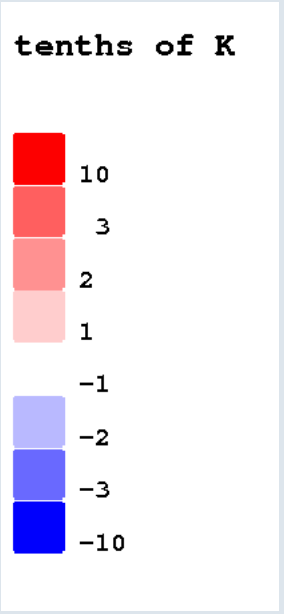
Mean analysis increment

(20090210-20090319)

(accumulated over 00, 06, 12, 18 UTC)



Temperature at model level 60
(close to ground)

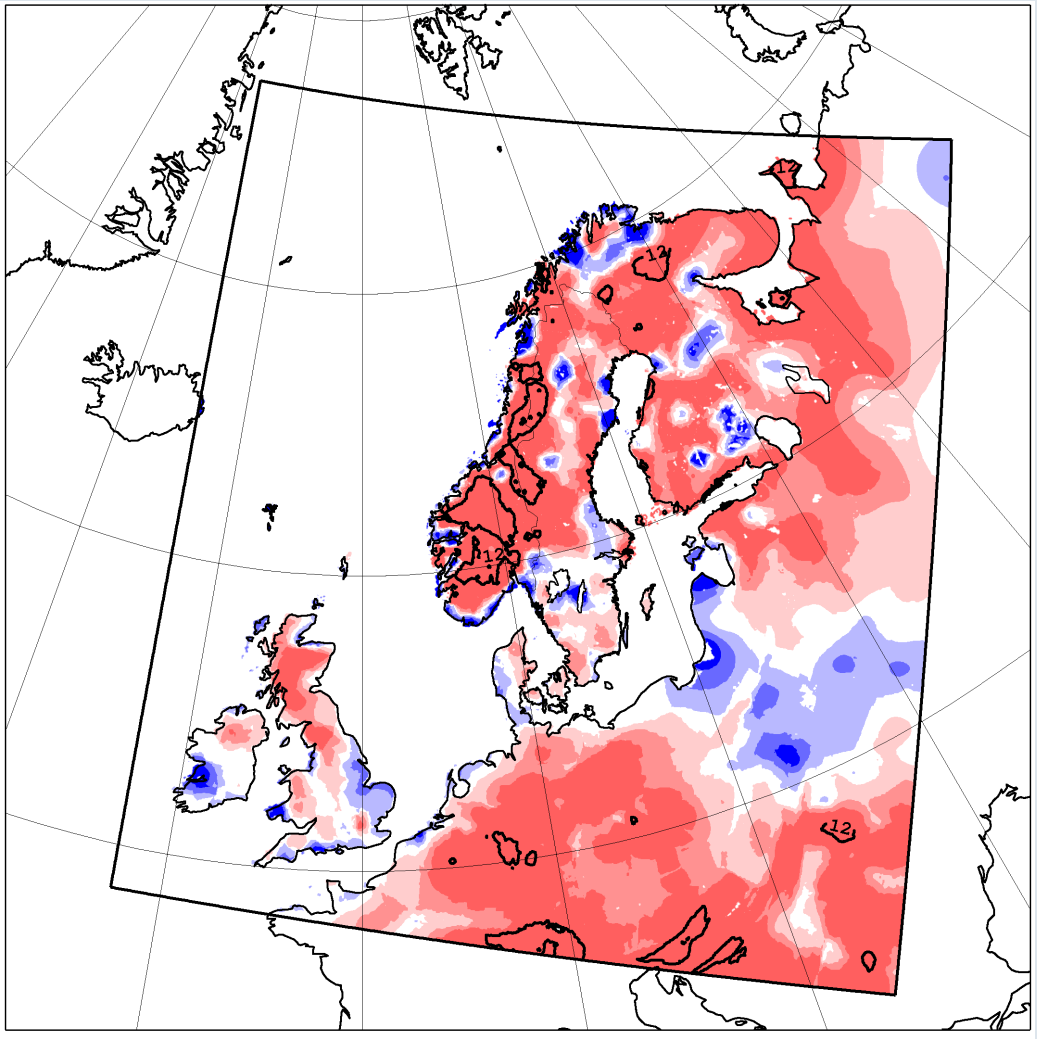


+6 h HARMONIE forecast
systematically too warm

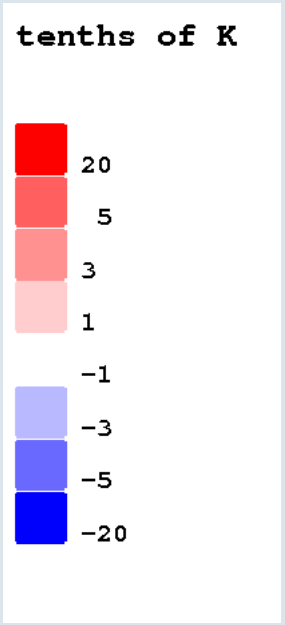
Mean analysis increment

(20090210-20090319)

(accumulated over 00, 06, 12, 18 UTC)



Surface temperature

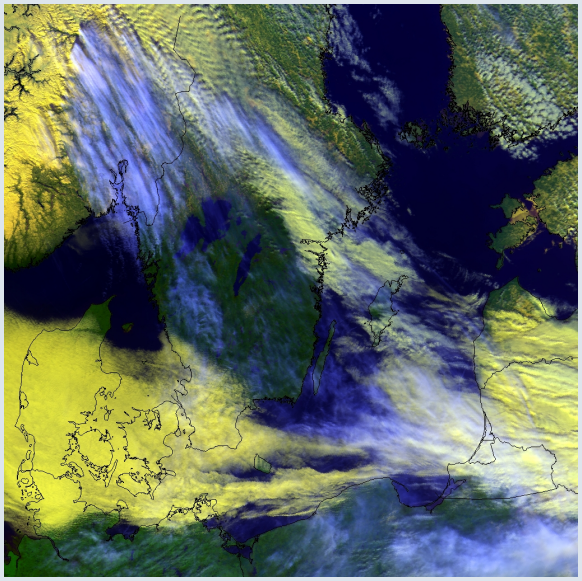


+6 h HARMONIE forecast systematically too cold

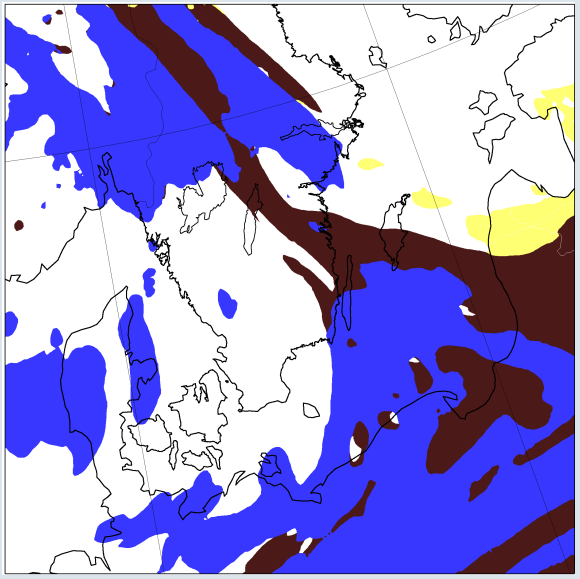
Case Study

SMHI HARMONIE and HIRLAM E11
+12h cloud forecasts valid at 20090321 12 UTC

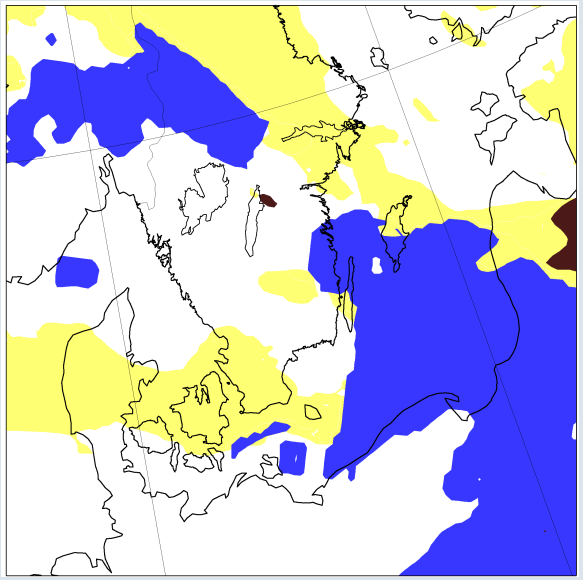
Satellite picture
20090321 11.54 UTC



HARMONIE cloud
20090321 12 UTC



HIRLAM E11 cloud
20090221 12 UTC



Low clouds

Medium high clouds

High clouds

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Conclusions

- A HARMONIE version with data assimilation is running pre-operationally at SMHI.
- The functionality of various data assimilation components have been investigated.
- Objective verification scores from an extended experiment show forecast bias in lower troposphere.
- Subjective verification indicate less low level clouds in HARMONIE forecasts than in HIRLAM forecasts.
- Further work related to HARMONIE forecast biases in lower troposphere is needed.

High Resolution Limited Area Model Hirlam

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