



Features of a New Version of the Nudging Code

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- code modifications and new optional features
- modification to spatial consistency check : a case study





- re-structuring of code:
 - modules for reading NetCDF obs input file + obs pre-processing
(+ clean interface to 1DVAR creation of retrievals from satellite radiances;
1DVAR routines will not go into official code due to missing documentation)
 - preparations: observation operators for multi-level reports
→ virtual temperature (instead of T) from RASS used as input in obs operator
- more flexible NetCDF observation input file reading:
 - several files for the same observation type
 - more variables optional instead of mandatory
- optimisations for speed-up on NEC-SX9: nudging part: > 25 % ,
whole nudging run: > 15 % speed-up
- (option:) writing NetCDF feedback (feedobs) files (for LETKF / for verification)
→ additional flags and elements (e.g. solar zenith angle)





- height diff. betw. station / model orography considered in a more consistent way (for grid point assignment, station selection, obs errors, ...)
- new flag words , more consistent setting of flags / monitoring statistics (for a passive obs / report, reason for rejection now always indicated)
- after checking for redundancy, the redundancy check loop is re-run with different settings to put TEMP or PILOT parts A, B, C, D together
- no redundancy between 1 RASS + 1 wind profiler , or 2 different ships
- quality control: no temporal consistency check → 1 case greatly improved
- latitude dependent reduction of geostrophic wind correction introduced, in order to get reasonably small geostrophic increments near the equator
- many bug fixes
 - prevent vertically collocated levels after redundancy check
 - condition to reject AMDAR obs with reported height below model orography: replaced by pressure condition, because reported height is fictitious
 - avoid array bound violations, etc.





- new options:
 - writing NetCDF feedback (feedobs) files (for LETKF / for verification)
 - mobile TEMP / PILOT
 - GPS IWV obs from NetCDF obs input files
 - can specify preference of processing centers
 - scatterometer 10-m wind
 - new balancing: pressure increments balancing wind analysis increments geostrophically (for scatterometer wind (and in-situ 10-m wind))
 - new weighting for multiple observation / observation types :





$$\frac{\partial}{\partial t} \psi(\underline{x}, t) = F(\underline{\psi}, \underline{x}, t) + G_{\psi} \cdot \sum_{k(\text{obs})} W_k \cdot [\psi_k - \psi(\underline{x}_k, t)]$$

weight W_k for model grid point (\underline{x}, t) depends on

- time difference to the observation (w_t)
- space distance to the observation (w_{xy}, w_z)
- observation and model errors (q_k)

$$W_k = \frac{w_k}{\sum_j w_j} \cdot w_k$$

$$w_k = w_t \cdot w_{xy} \cdot w_z \cdot q_k$$

- new weighting for multiple observations

$$W_k = \frac{w_k + 1}{\sum_j w_j + 1} \cdot w_k$$

- compute net increments and weights separately for different pre-specified sets of observing systems

$$\frac{\sum (w_j^2 + w_j c) \cdot [\psi_k - \psi(\underline{x}_k, t)]}{\sum (w_k + c)} = \frac{\sum (w_i^2 + w_i c)}{\sum (w_l + c)} \cdot \frac{\sum (w_k^2 + w_k c) \cdot [\psi_k - \psi(\underline{x}_k, t)]}{\sum (w_j^2 + w_j c)}$$

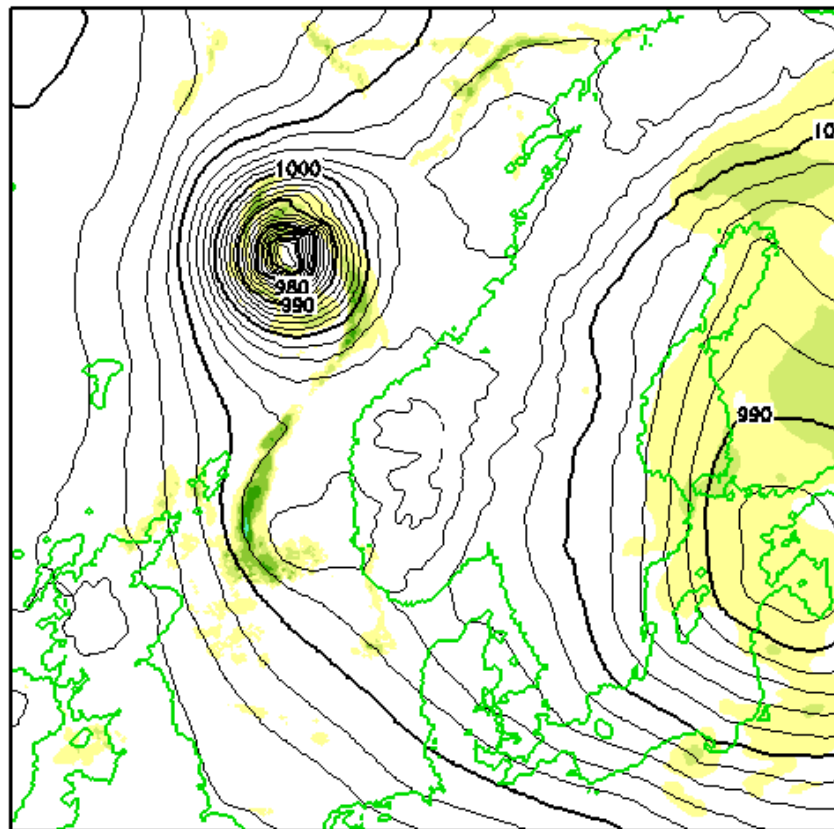
$$= \mu \cdot \Delta_w \psi$$



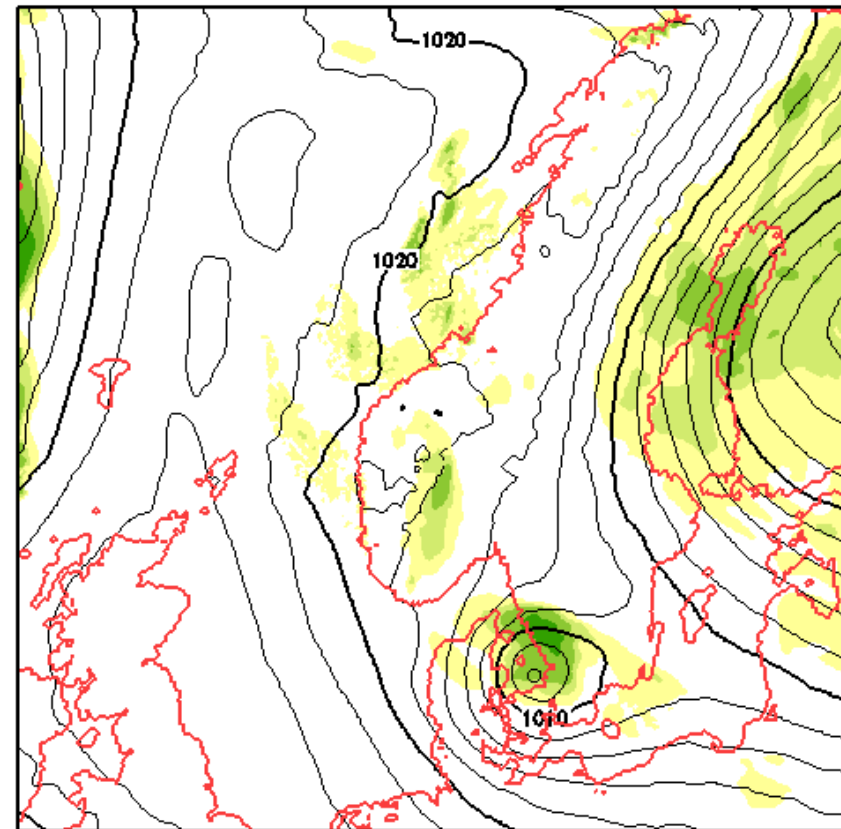
Modification to the quality control : A case study

The problem: large errors in COSMO-EU analyses and forecast on 1 – 2 March 2010
plots by Klaus Stephan

COSMO-EU analysis, 2 March 2010, 0 UTC

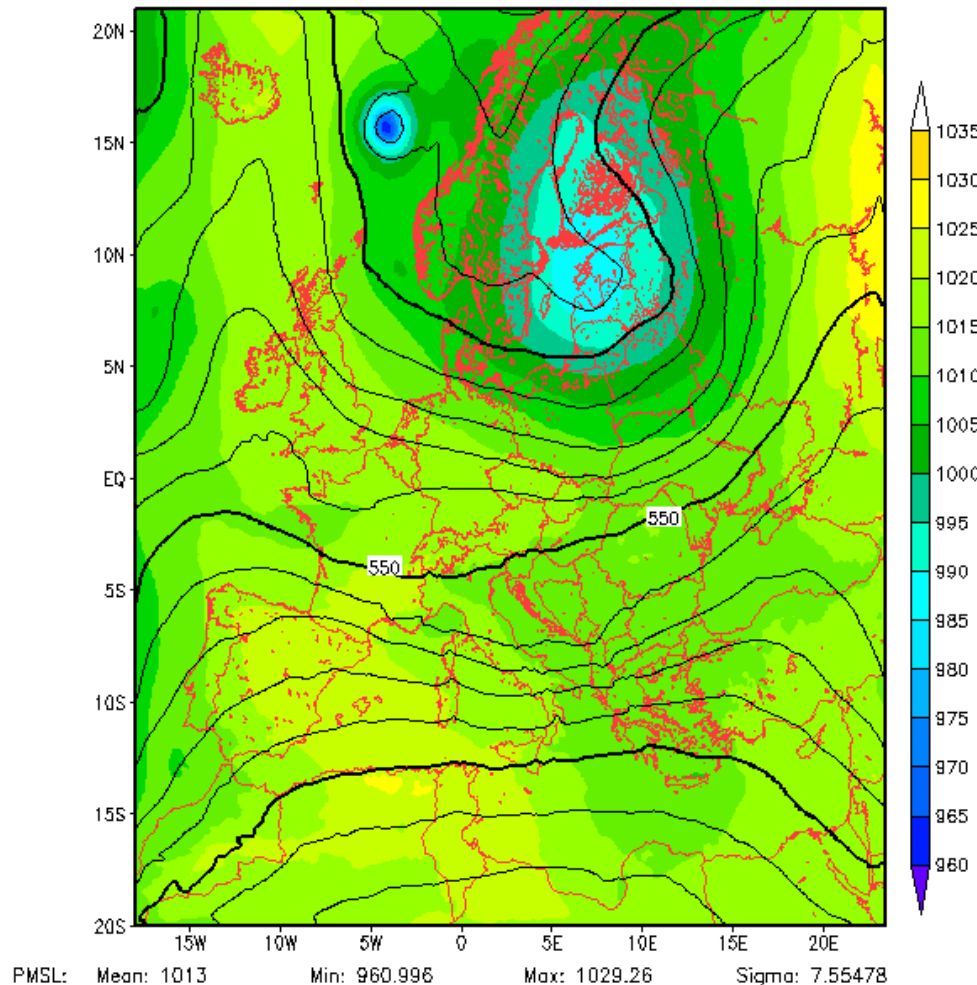


36-h forecast for 3 March 2010, 12 UTC



Modification to the quality control

Start time: 02.03.2010 00:00 UTC COSMO-EU_Parallel
Forecast time: 02.03.2010 00:00 UTC
MSL Pressure [hPa] (shaded) Geopot. at 500 hPa [gpm] (dist. isol. 5gpm)

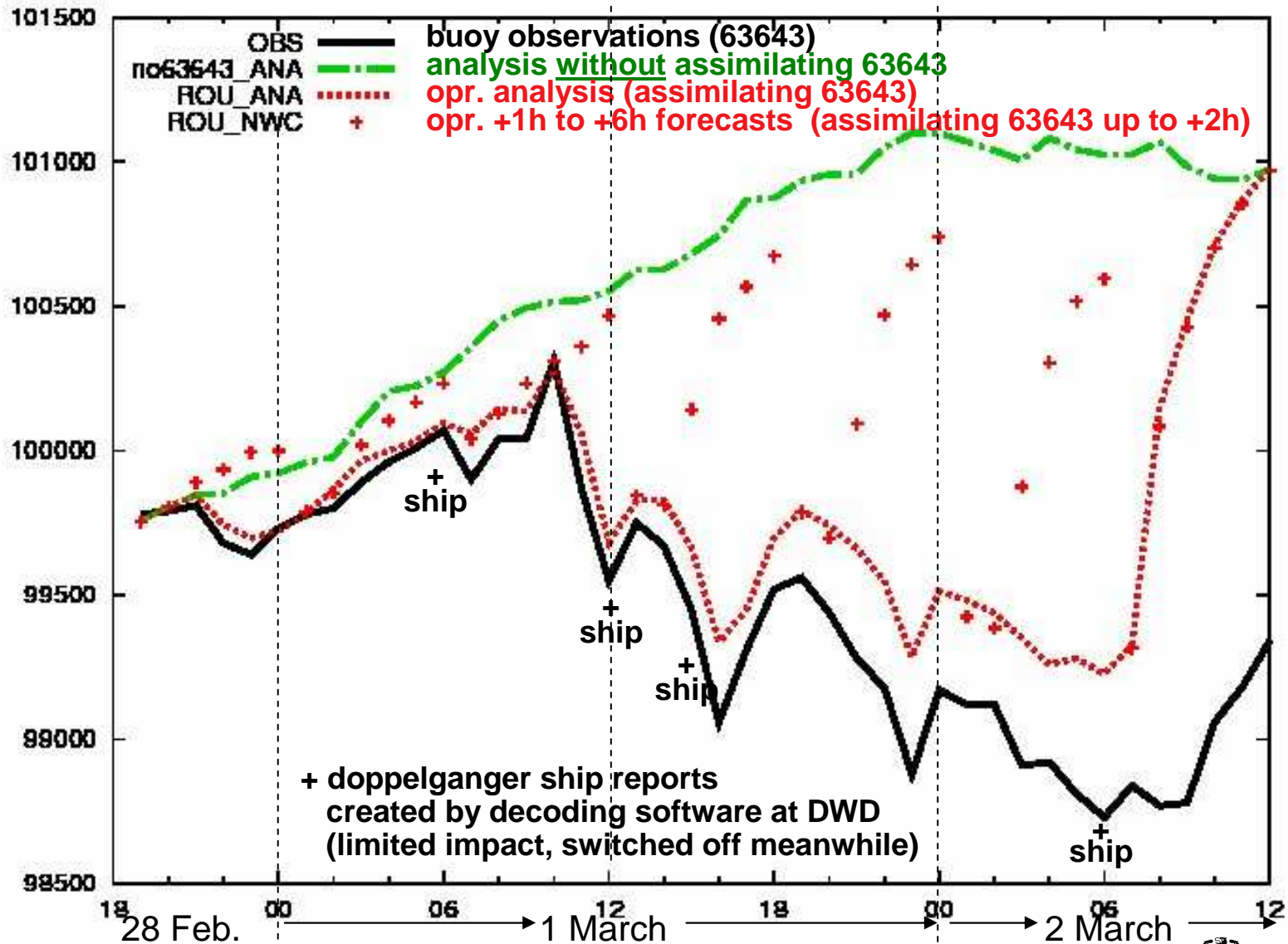


- error in the pressure field (analysis 2 March 2010, 0 UTC) :
 - surface pressure ca. 40 hPa,
 - 500 hPa geopotential ca. 10 gpm→ erroneous polar low
- similar error in the analysis at 2 March 2010, 12 UTC
- no such errors in the GME analyses and forecasts
- reason: assimilation of erroneous observations from buoy 63643

Modification to the quality control



surface pressure
(at the location of buoy 63643)

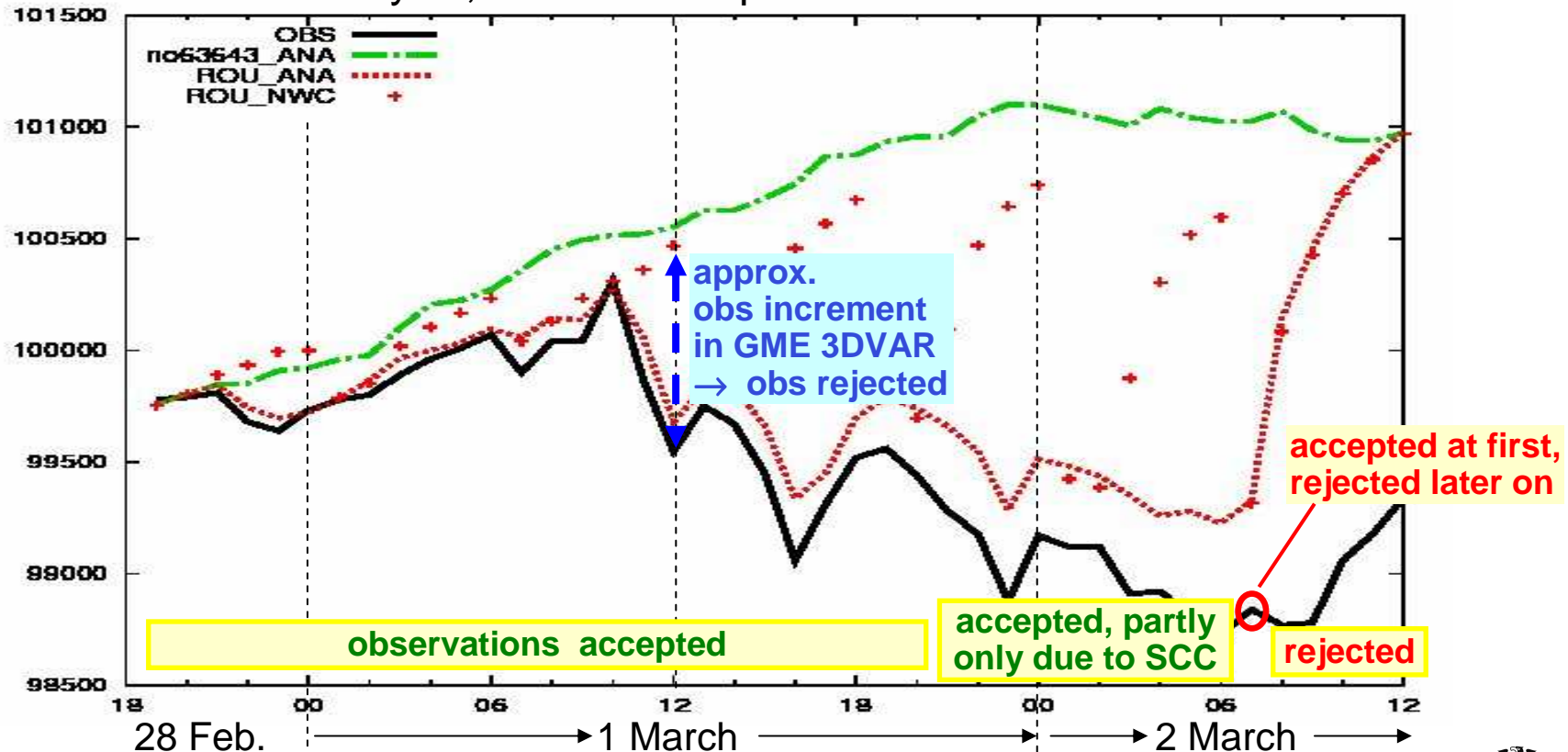


Modification to the quality control : Current quality control



QC checks: deviation of obs from estimate of truth:

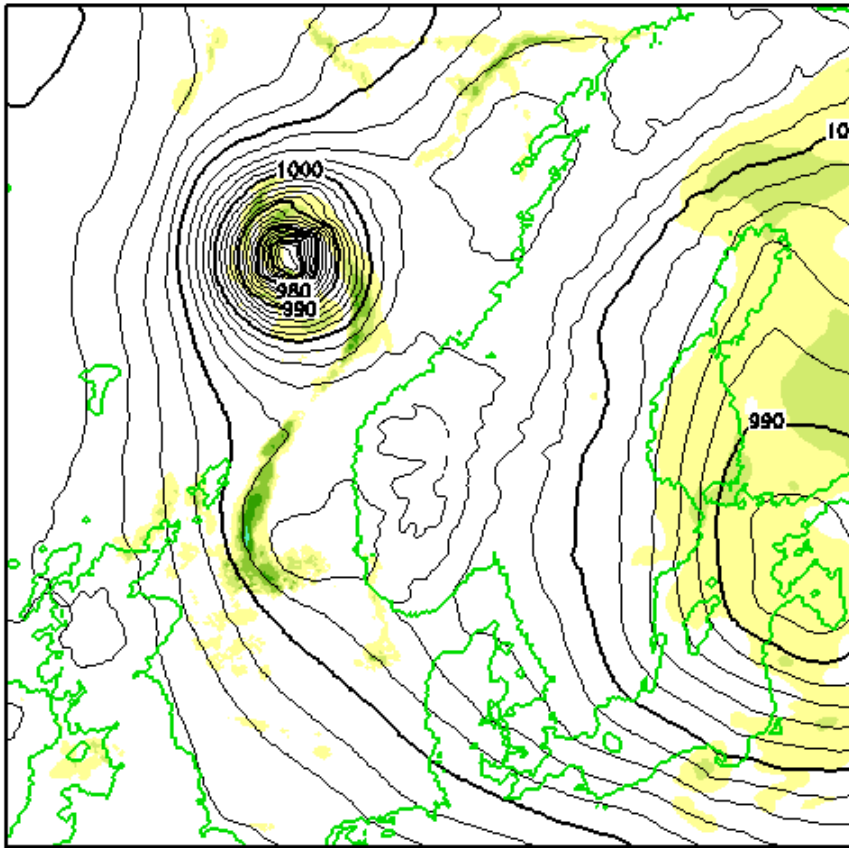
- estimate = model value (first guess) : bad obs flagged
- spatio-temporal consistency check (SCC) :
correct model value by using all obs within $\pm 1h$ except for the obs to be checked
→ ad-hoc analysis, use as an improved estimate



analysis, 2 March 2010, 0 UTC

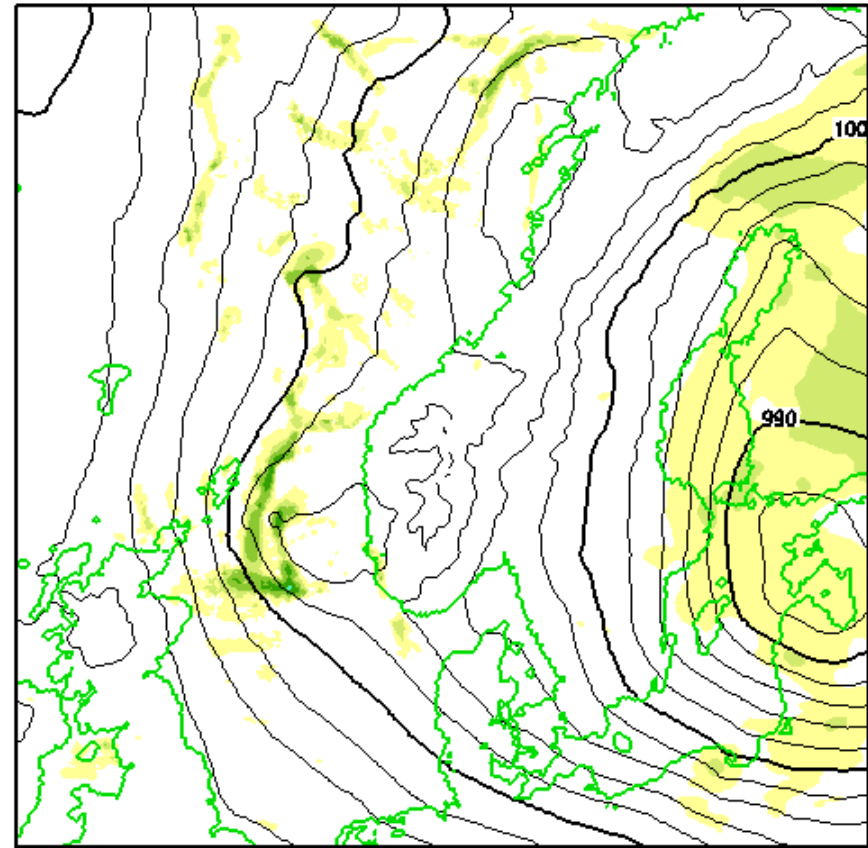
operational

(1) 1h PRECIPITATION (> 0.1 mm) (2) PMSL



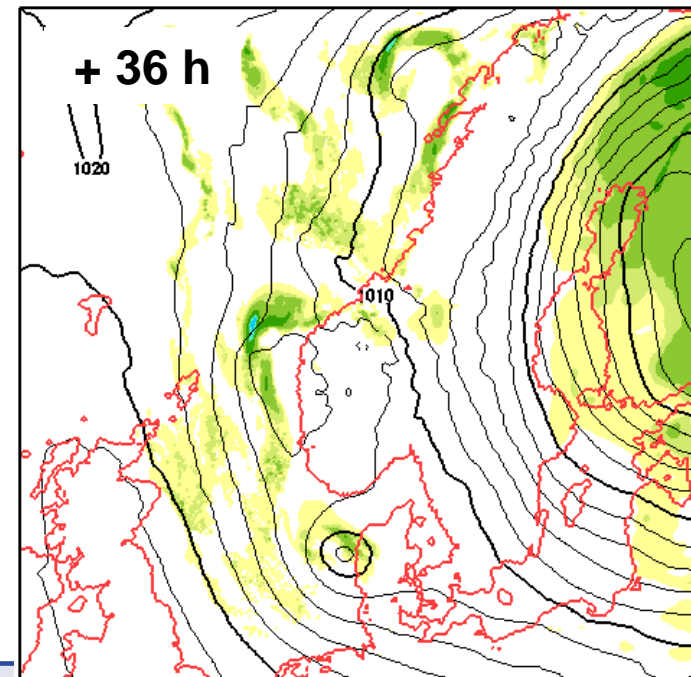
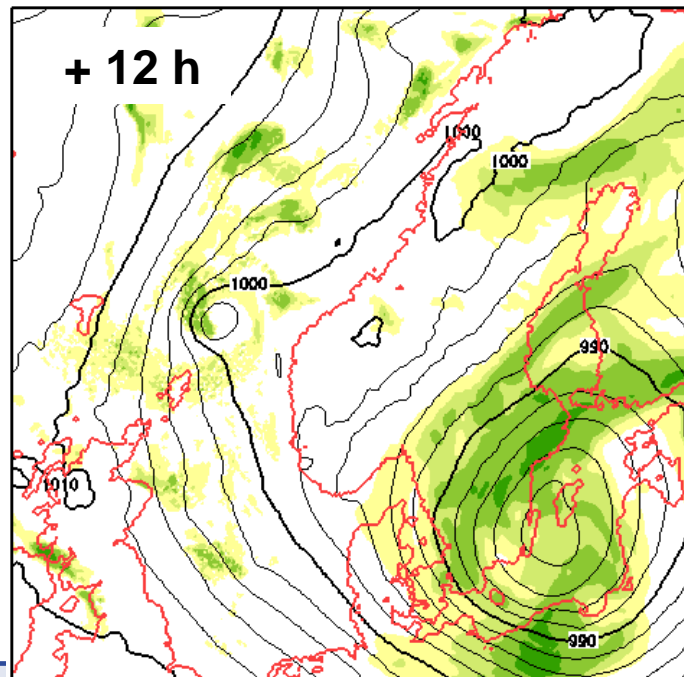
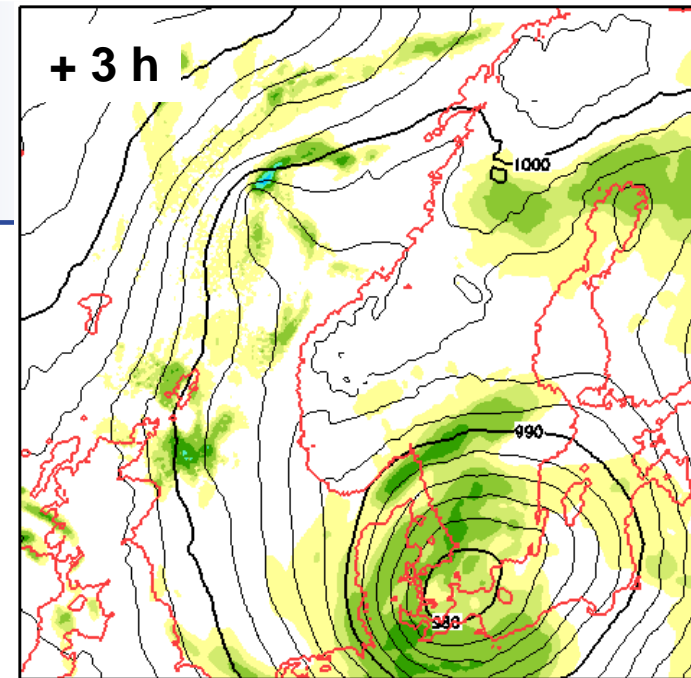
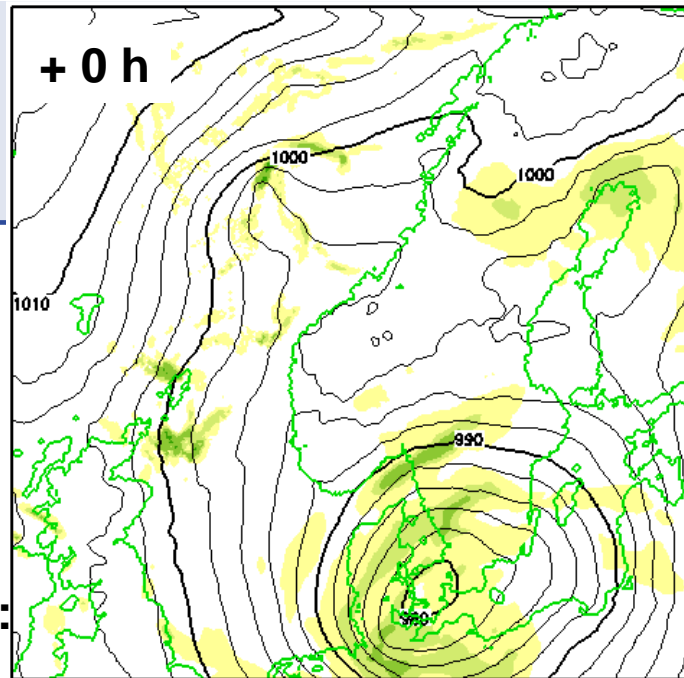
**assimilation from 28 Feb 21 UTC
without 63643**

(1) 1h PRECIPITATION (> 0.1 mm) (2) PMSL



forecast run
starting
1 March 2010,
0 UTC

ps error of
of 63643 at 0 UTC:
~ -1.5 hPa



synoptic
situation
very favourable
for development
of a cyclone

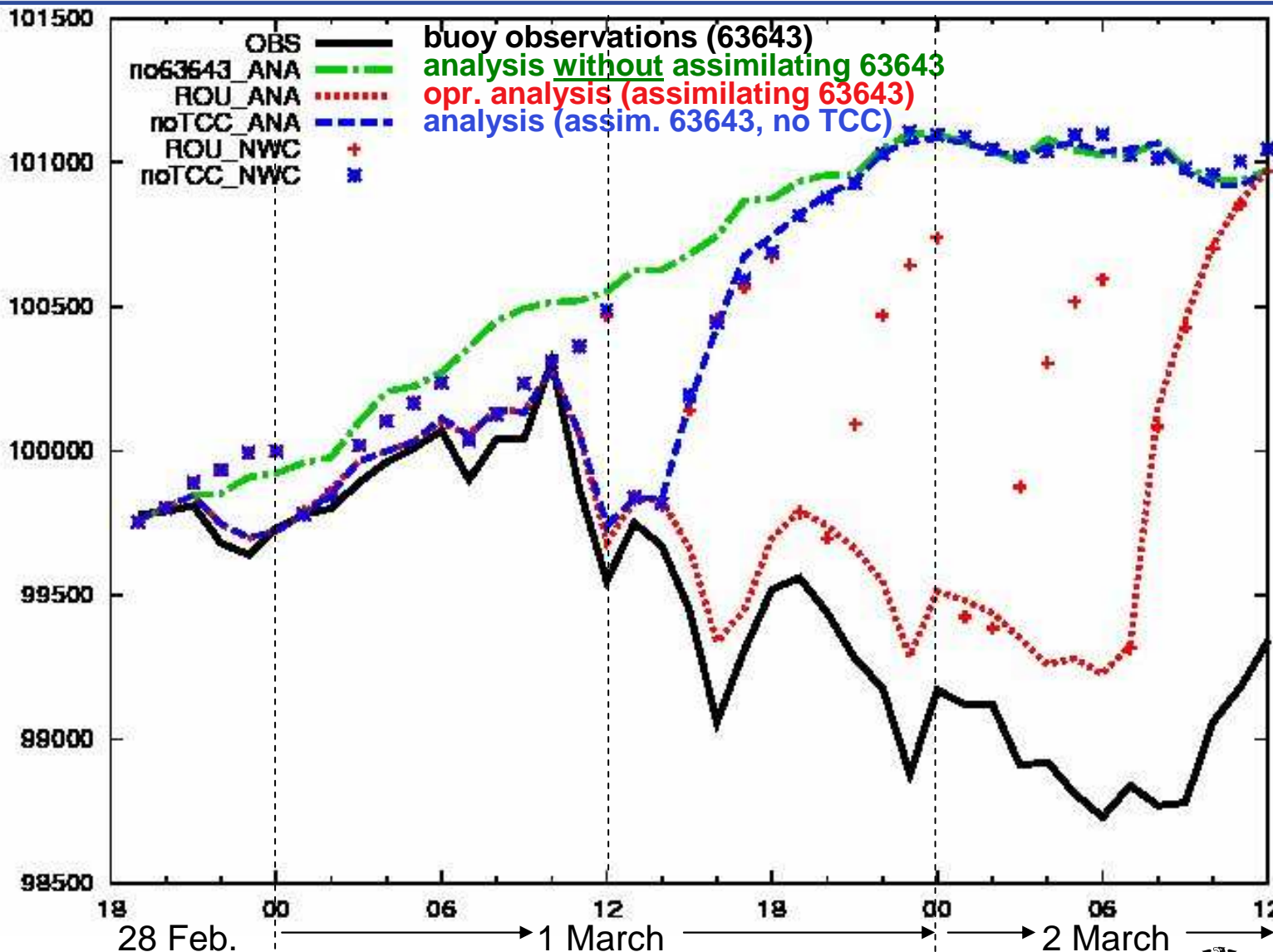


- avoid use of the obs with identical station id from ± 1 h for ad-hoc analysis in the spatial temporal consistency check
 - experiment 'no TCC' : without checking the temporal consistency
- assimilation of scatterometer (10-m wind) data : similar impact as 'no TCC'

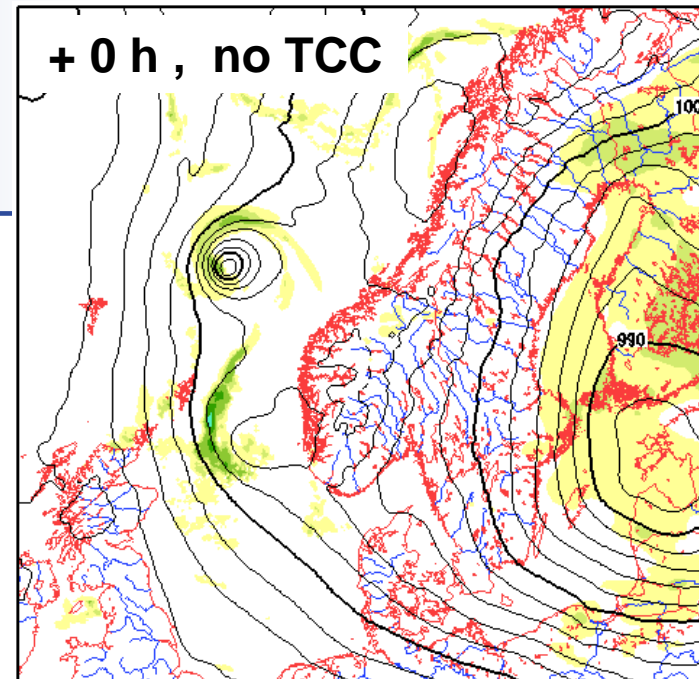
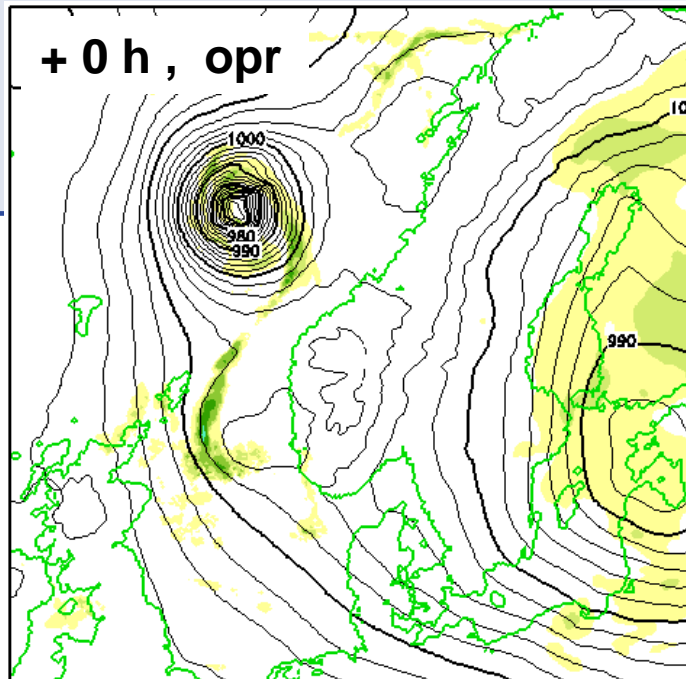
Modification to the quality control



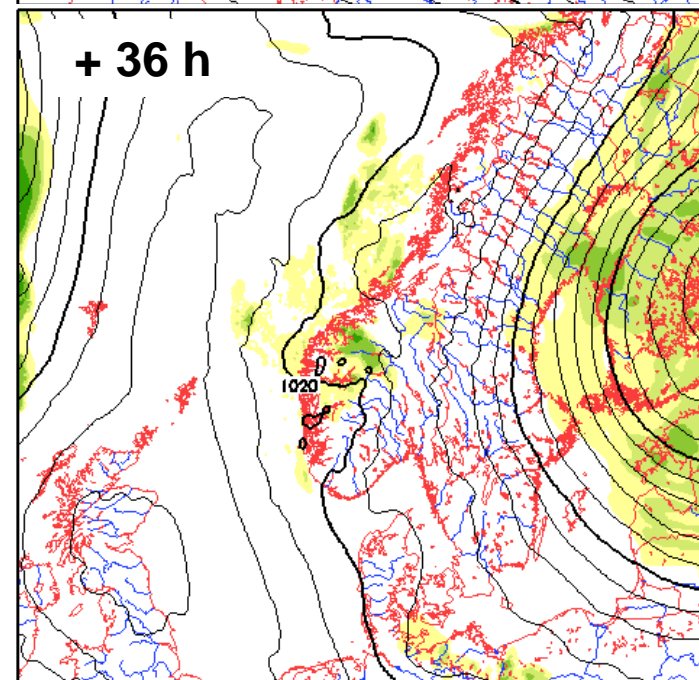
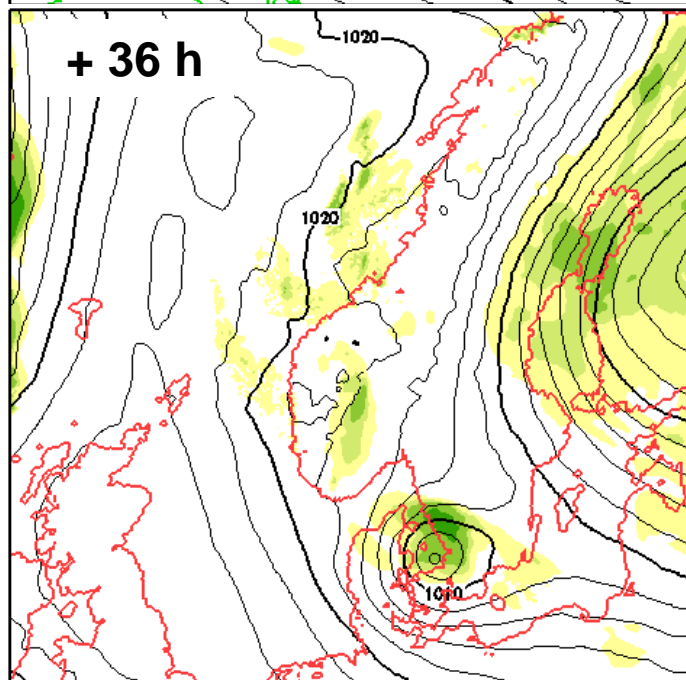
surface
pressure
(at the location
of buoy 63643)



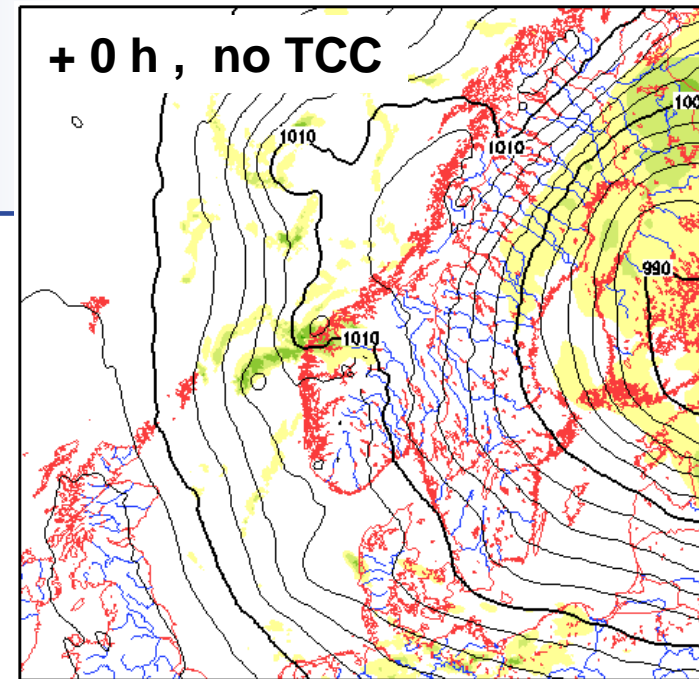
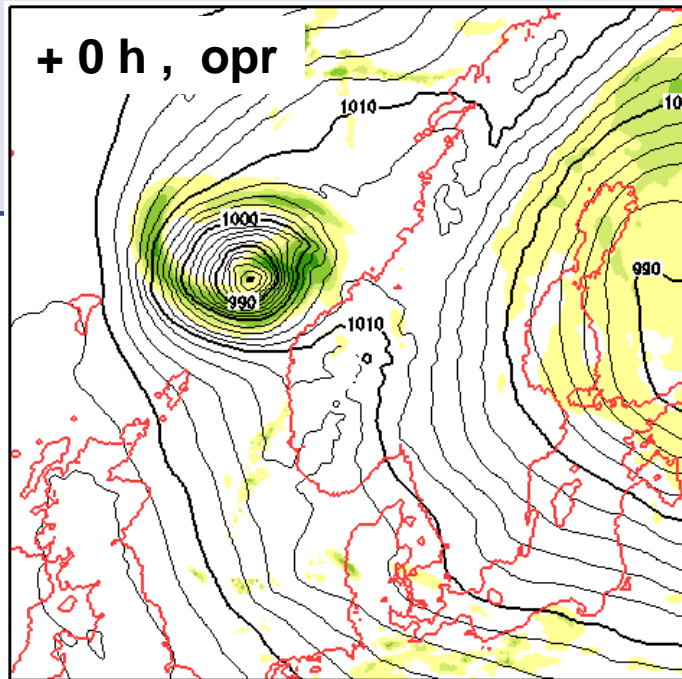
forecast run
starting
2 March 2010,
0 UTC



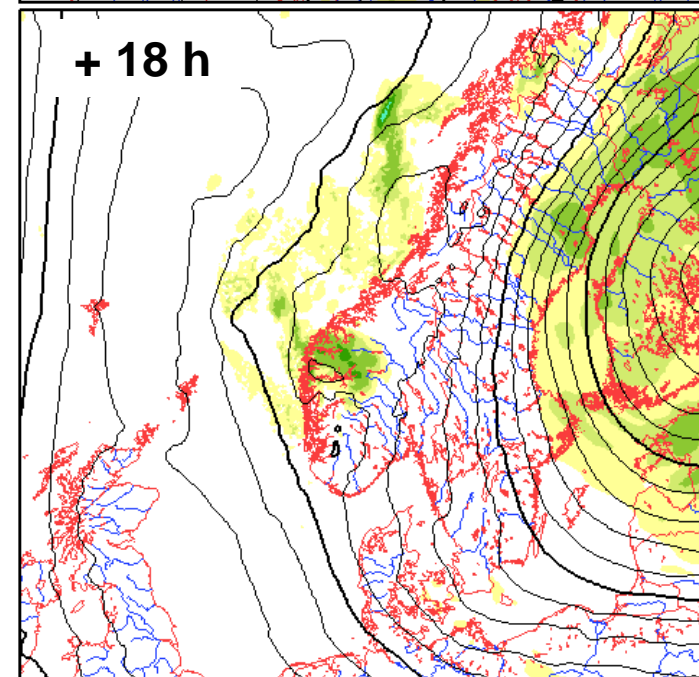
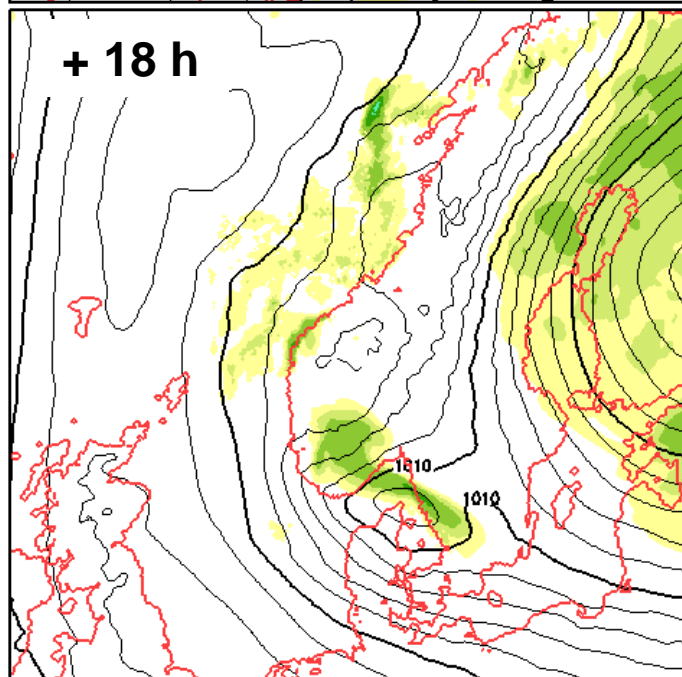
→ without TCC:
error reduction:
analysis:
40 → 12 hPa
36-h forecast:
> 10 → < 2 hPa



forecast run
starting
2 March 2010,
12 UTC



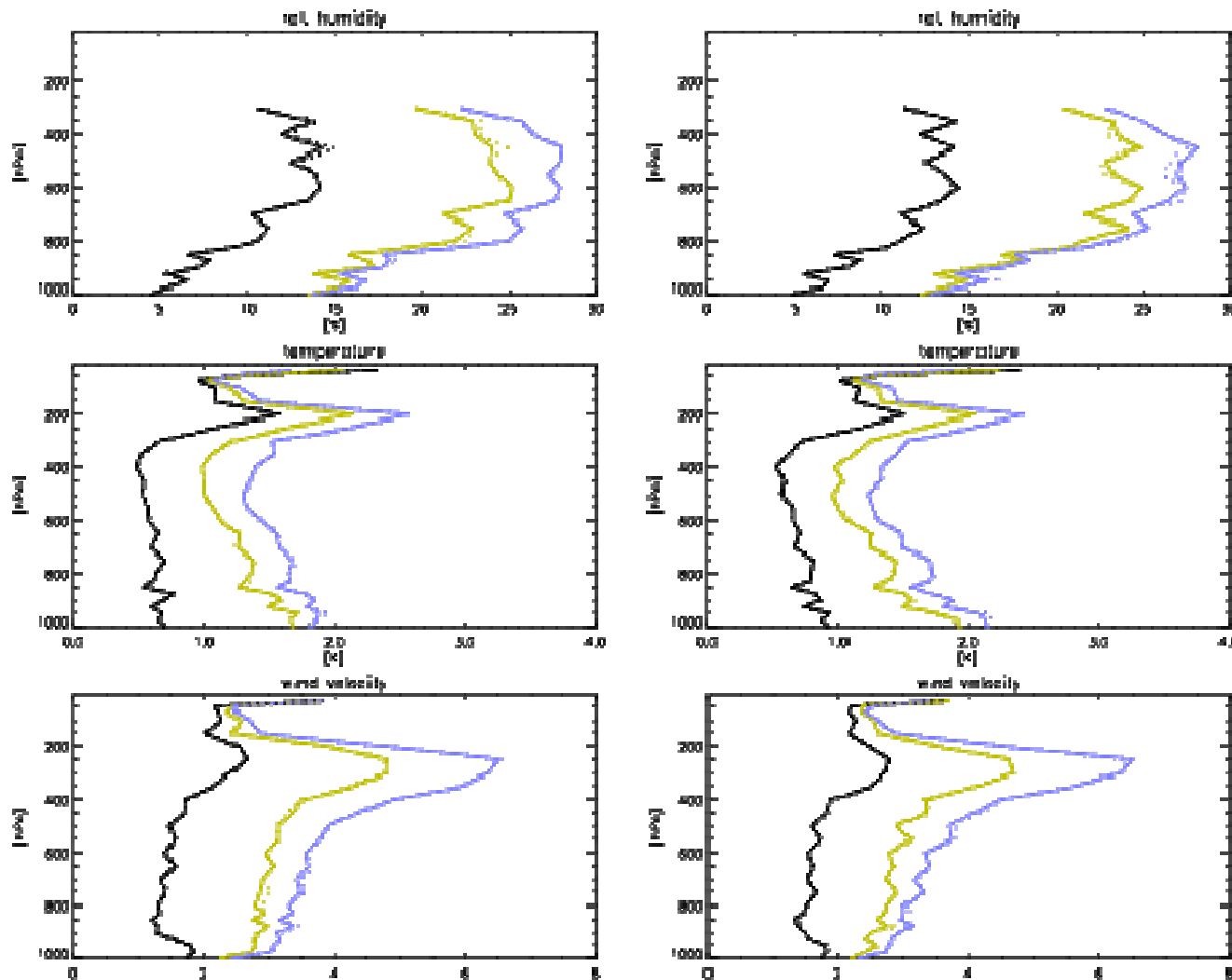
→ without TCC:
error almost
eliminated



verification results for new version of nudging code



00 UTC 1 – 15 July 2011 12 UTC



+ 0 h	———
+ 12 h	———
+ 24 h	———
	opr	new

relative
humidity

temperature

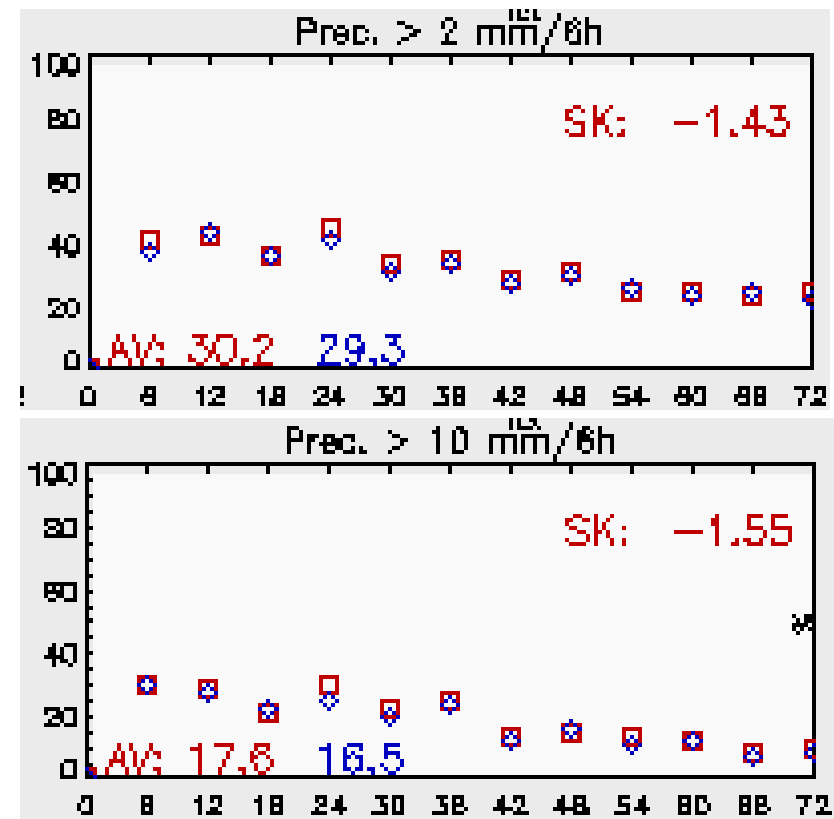
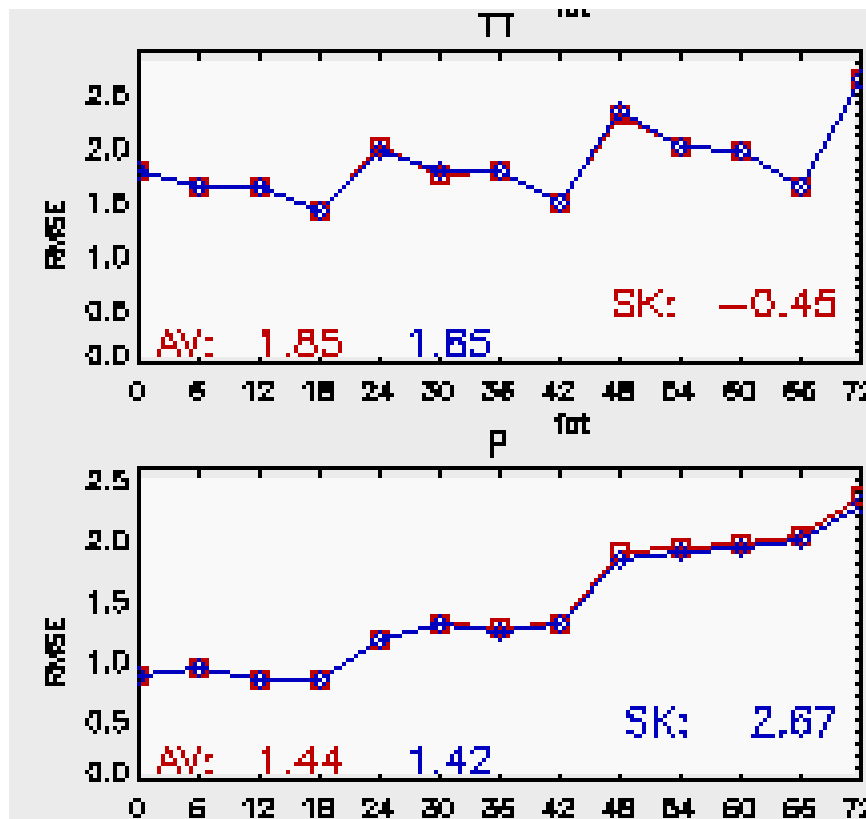
wind
speed



verification results for new version of nudging code

1 – 30 July 2011 , 12-UTC runs

opr
new

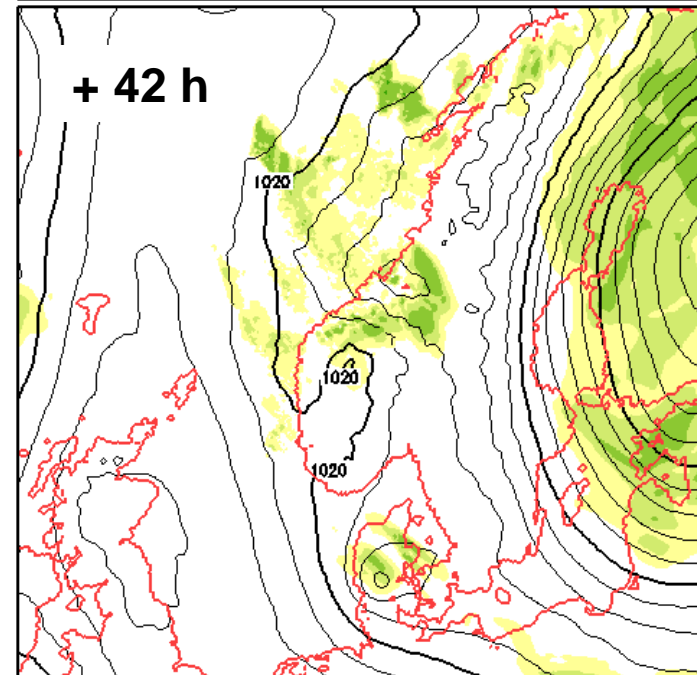
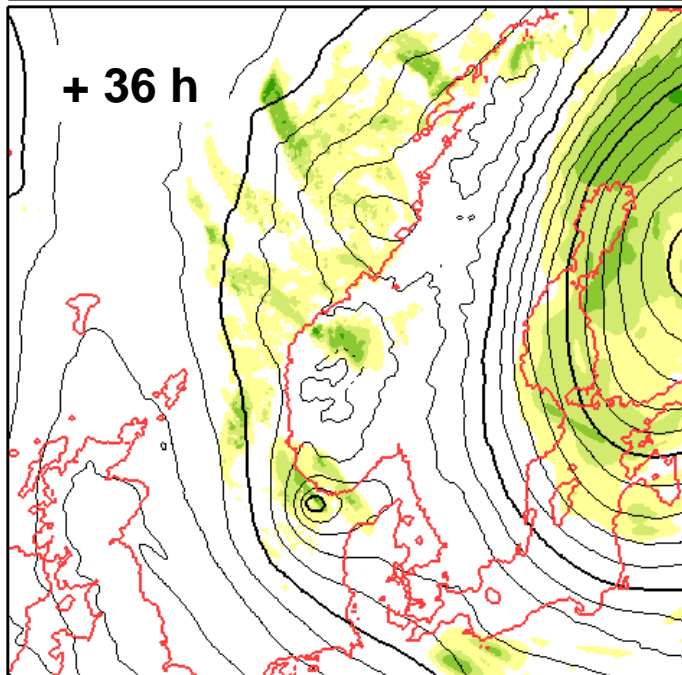
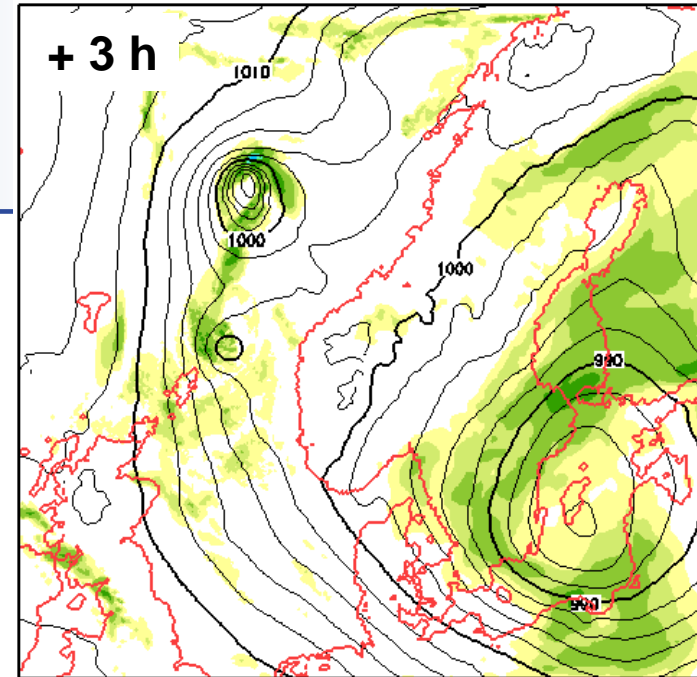
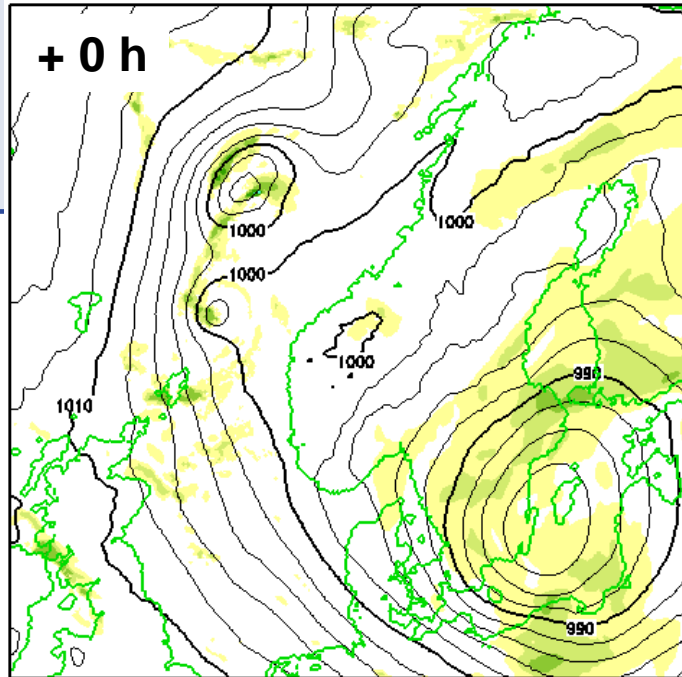


differences in 0 UTC runs are even smaller

→ overall verification result : neutral, as expected



**Vorhersage-
lauf vom
1. März 2010,
12 UTC**



→ 63643 sehr
zeitnah in
Datenbank

→ auch Obs für
+1 h und +2 h
assimiliert
in Hauptlauf-
vorhersagen

**Analysen
für
2. März 2010**

