SMHI NWP modelling – operations, development and research

Main Operational HIRLAM runs

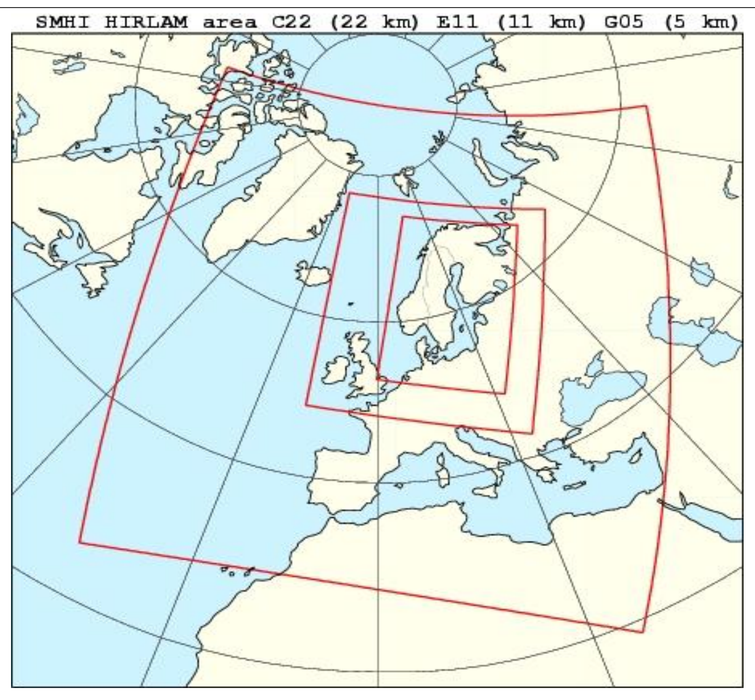
4 analyses and forecasts per day. 00, 06, 12, 18

HIRLAM C 11km – 4D-VAR 2 loop LSMIX +60 h
2 hours data cut-off
HIRLAM E 11 km – 3D-VAR no LSMIX+72 hours
1 hour 15 min data cut-off
ECMWF rotated HIRLAM grid boundaries for both
ECMWF GTS -> BUFR obs preprocessing
SYNOP,SHIP,TEMP,PILOT,
BUOY,AIREP,AMDAR
BUFR AMDAR
ATOVS AMSU-A radiances – EARS

Other operational and semi-operational HIRLAM

4 analyses and forecasts per day

HIRLAM G 05 km 3D-VAR + 24 hours
Used for certain products
HIRLAM E 05 km + 48 hours
Experimental and
HIRLAM 7.3

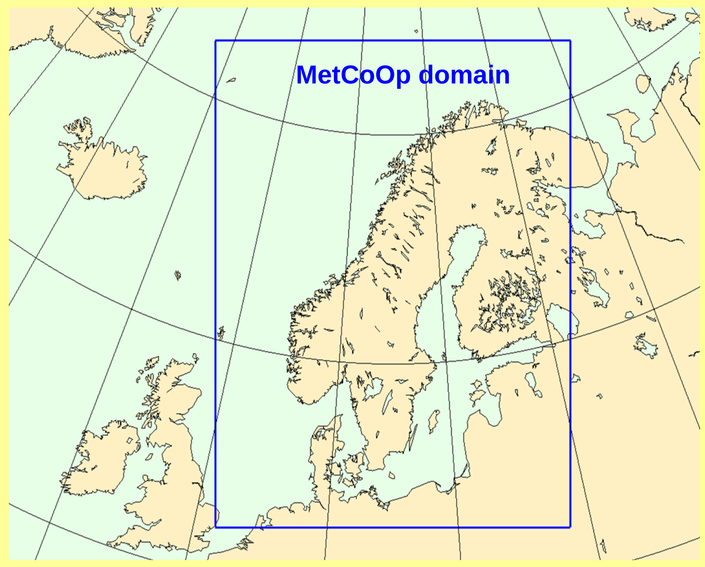


Towards a joint Swedish-Norwegian NWP production

MetCoOp – Meteorological co-operation on Operational NWP

Model setup: HARMONIE Arome

- AROME currently cycle 38h1.b2
- 2.5 km, 750x960 grid points, 65 levels
- 3D-VAR 3h-RUC, forecast length +60 hours
- 4 analyses and 4 forecasts per day
- Conventional observations
- ATOVS (passive currently)
- Radar (in test)
- Surface data assimilation with CANARI-OI_main



Shared HPC resource
At start of operational production in spring 2014:
Vilje at NTNU in Trondheim
(place 68 in TOP500 in June 2013)

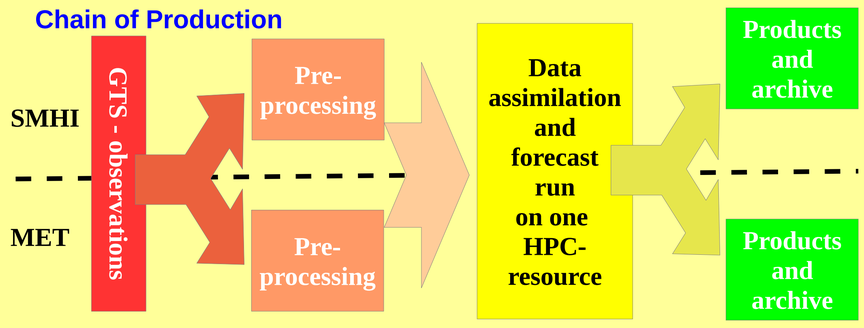
Next HPC resource will be procured by SMHI for production from 2015.

Current milestone
Pre-operational model setup

Next milestones:
- Operational organization
- Common operations
from 03-2014

HARMONIE-RCR for cy38h1
MET and SMHI will jointly run the "regular cycle with the reference" for the HIRLAM-consortium.

Chain of Production



MetCoOp Technical Memorandum Series: http://metcoop.org/memo

HIRLAM system
Based on HIRLAM version 7.1.2

Large Scale Mixing (LSMIX)
4DVAR on C11-domain. 2 outer loops.
3D-VAR FGAT on E05-domain
Incremental DFI (initialisation)
ISBA (surface scheme)
moist CBR (turbulence)
Kain-Fritsch from CAM3 (convection)
Rasch-Kristjansson (large scale)

Parallel run next HIRLAM system
Based on HIRLAM 7.3 or 7.4 soon

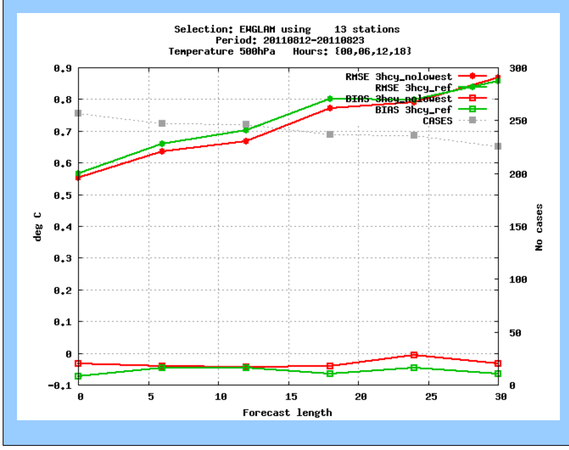
Meso-scale sub scale orography
New snow and soil scheme
RTTOV-8 and more satellites
4D-VAR optimisations
65 levels in 7.4 !

4DVAR
operational since 2008013006

3 (or 2) dx linear grid (66 / 33 km grid)
SL, SETTLS
vert. diff. + large scale cond.
Linearised simplified physics
weak digital constraint
linear propagation of assim. increments
statistical balance background
constraints
2 outer loops

Version/res	status	gridpoints	levels	timestep	Assimilation	Boundaries
C11	Oper	606x606	60	300 s	4D-Var	ECMWF
E11	Oper	256x288	60	150 s	3D-Var	ECMWF
G05	Limit oper	294x441	60	150 s	3D-Var	HIRLAM
E05	pre-oper	506x574	65	150 s	3D-Var	HIRLAM
ARO 02	Pre-oper	750x960	65	60 s	3D-Var 3h-RUC	ECMWF

Positive impact for Swedish/Norwegian Radar reflectivities



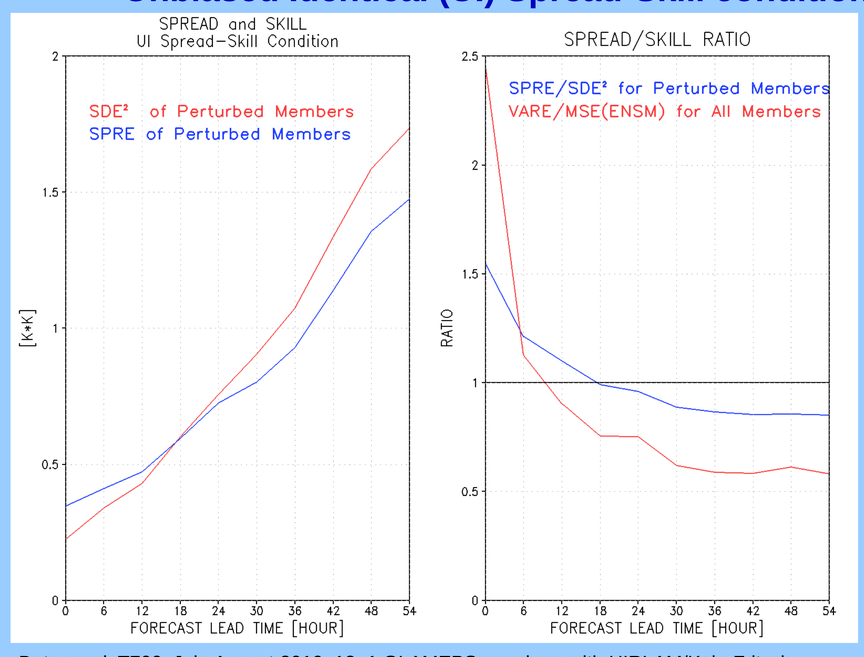
- Using volume scans
- Pre-processing with BALTRAD for Swedish and PRORAD for Norwegian data
- Humidity pseudo observation by 1d-Var

-> Positive impact in forecasted humidty and temperature fields

- Next: Assimilation of Radar winds, more straightforward, but dealising needed

Contact: Martin Ridal (SMHI)

Unbiased Identical (UI) Spread-Skill condition for EPS



Data used: T700, July-August 2010, 12+1 GLAMEPS members with HIRLAM/Kain-Fritsch.
DA on control member with hybrid ensemble 3D-Var.

Problem: Underdispersive EPS with less spread than skill.

Aim: Find a statistically more consistent comparison by
1. removing bias from skill calculation, thus **unbiased,**
2. Removing control member, thus only member with **identical** statistics.

$RMSE^2=SDE^2 + B^2$

All Members = Control Member
+ Perturbed Members

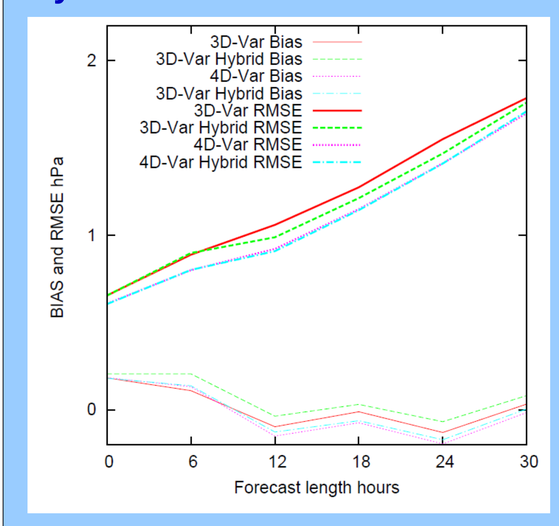
SPRE=2 VARE

$$SPRE = \frac{1}{N(N-1)} \sum_{j=1}^{N-1} \sum_{k=j+1}^{N} (x_j - x_k)^2$$

Result: Development of a more appropriate spread-skill relationship.

Contact: Åke Johansson (SMHI)

Hybrid variational ensemble data assimilation in HIRLAM



Bias and standard deviation verification scores for mean sea level pressure forecasts over a Scandinavian domain averaged over the period 19 January - 29 February 2008.

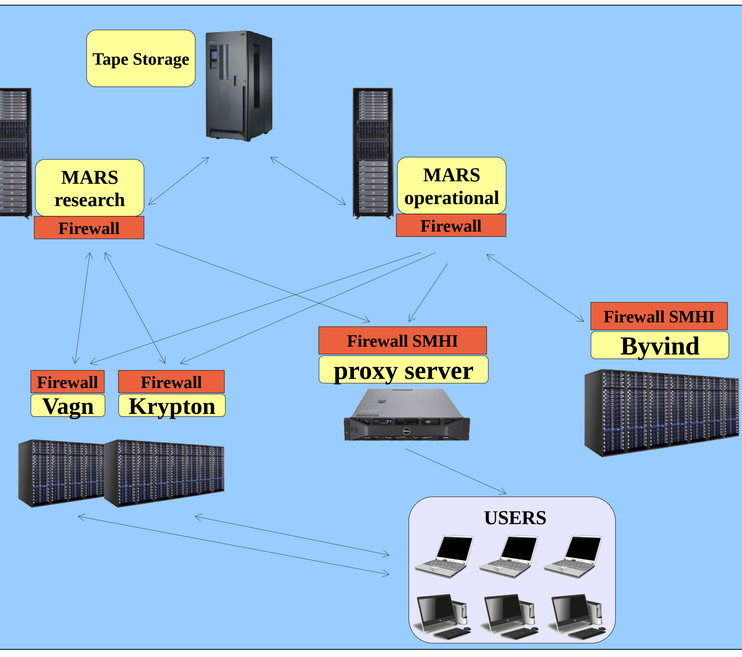
- Possibility for flow-dependent background error covariance
- Augmentation of control variable with localized weights assigned to ensemble member perturbations.
- Preliminary tests also with 4D-Ens-Var
- Performance ranking from worst to best:

3D-Var < 3D-Var hybrid < 4D-Var ≈ 4D-Var hybrid < 4D-Ens-Var

Contact: Nils Gustafsson (SMHI)

Archiving on MARS at SMHI

- MARS at SMHI for storage of:
  - Operational NWP output
  - Air quality model output
  - Regional reanalysis (EURO4M)
  - Research experiments with Harmonie
- Server stationed at computing centre NSC. Proxy server for direct access from SMHI is still working progress.



Contact: Sébastien Villaume

A Large Scale Host Model Constraint in a Limited Area 4D-Var

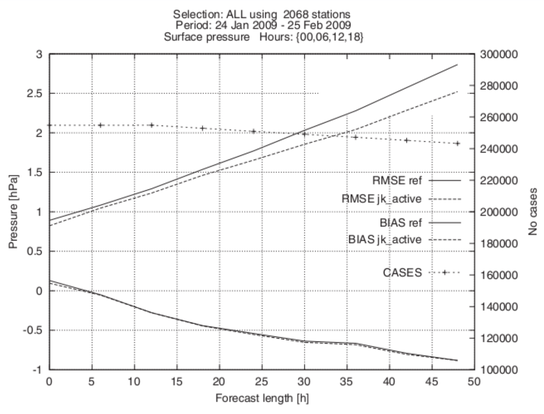


Fig. 11. Verification of forecasts compared with observations of mean sea level pressure (MSLP). Upper lines are the Root Mean Square (RMS) error and the lower lines show the mean error, or bias. Full line: reference experiment (i.e. the host model constraint is not activated). Dotted line: same as reference except that J_k is now actively used. The amount of observations used in the statistics is also shown using the right hand y-axis.

Problem: Include host model uncertainty in LAM data assimilation.

Method: Additional term J_k in cost function with the large-scale background error covariance B_{ls}. $\mathbf{B}_{ls}$ contains the error covariances of $\mathbf{x}_{ls}$ in the regional model geometry.

Results: Clear positive impact on surface pressure and temperature profiles.

Contact: Per Dahlgren

European Reanalysis and Observations for Monitoring

Re-analysis with HIRLAM 3D-Var (60 lev, 22 km) -> MESAN 2D-OI 1989 - 2010

ERA-Interim | HIRLAM 22 km | HIRLAM first guess | MESAN 2D, 5 km