Norwegian Meteorological Institute – operational NWP

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HIRLAM models at *met.no*

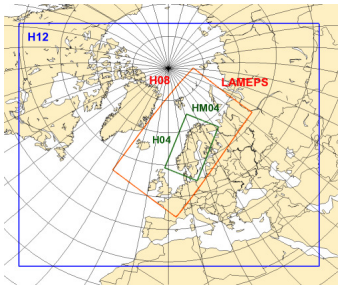
HIRLAM is currently run in 4 different model configurations at met.no, 3 deterministic models and one ensemble prediction system. The ensemble system (LAMEPS) is described in more detail in the box on the bottom right. Below are some facts about the deterministic models together with a figure showing their geographical extent:

H12 (0.108°=12km, 864x698x60 gridpoints, Δt=300s) 3DVAR-FGAT analysis, ECMWF boundaries, runs 00/06/12/18 UTC to +66h.

H08 (0.072°=8km, 344x555x60 gridpoints, Δt=200s) 3DVAR-FGAT analysis, ECMWF boundaries, runs 00/06/12/18 UTC to +66h.

H04 (0.036°=4km, 300x500x60 gridpoints, Δt=100s) Surface analysis, otherwise initial condition and boundaries from H08. Runs 00/06/12 /18UTC to +66h.

All the models are based on HIRLAM version 7.1.4, with some local modifications.



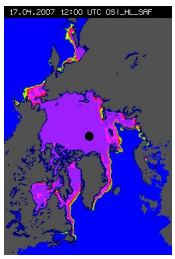
Local modifications to HIRLAM reference version 7.1.4

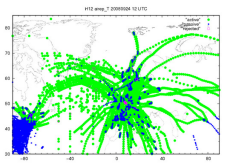
In H12 and H08 we have replaced the direct Helmholtz solver by an iterative version developed at met.no. This avoids the requirement that the number of gridpoints in the model x-direction must be a product of simple primes. Without this solver, the number of passive boundary points would be unacceptably high, or the area or resolution would have to be altered.

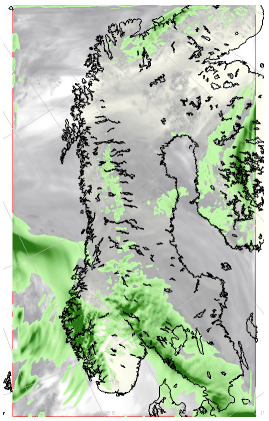
In the surface assimilation, we have replaced the reference SST assimilation by an SST product from the O&SI-SAF (in a separate pre-processing step). The diagnosis of ice cover (from SST) is similarly replaced by an O&SI-SAF ice field. An example of such a field is shown to the right.

In 3D-VAR we assimilate ATOVS AMSU-A over sea, in addition to the normal conventional data. With the help of the IT department we have also been able to increase our use of AMDAR data substantially during the past couple of years. An example of aircraft data coverage during midday is shown in the figure on the right.

Before every cycle, in both H12 and H08 we make a short rerun from the latest ECMWF analysis (blended using an incremental digital filter with our own +6h forecast at the time), in order to create a best possible first guess to our own 3D-VAR analyses. This is similar to the LSMIX option in the reference system.







Experimental mesoscale runs with HARMONIE

Since August 2008 an experimental HARMONIE model, HM04, has been running in routine operation. The model covers almost the same area as H04 (see figure above), but not exactly since the projection is rotated Lambert instead of rotated lat./lon. The resolution is 4km, 289x489 gridpoints horizontally and 40 levels in the vertical with the boundaries coming from the operation H08 model. It is based on HARMONIE version 36h1.1, and runs with non-hydrostatic dynamics, ALARO physics and the externalized surface module SURFEX. A surface analysis is performed in SURFEX with an Optimal Interpolation algorithm for a 3 layer ISBA scheme. Extensive tests have been performed with 3D-Var, different surface options and finer resolution with the AROME physics for intended future operational use.

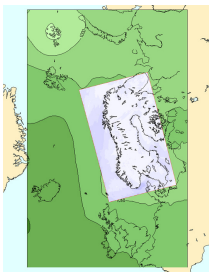
The figure to the left shows an example of a +9h forecast of total cloud cover and 3-hourly precipitation rates (14.09.2010 00UTC) from the model.

Plans for operational HIRLAM

With the release of HIRLAM 7.2, 4D-VAR is now the default assimilation system. The plan is to put version 7.3 with 4D-VAR in as a parallel experiment in the not too distant future, now that the computer system njord has been upgraded. A version 7.3rc2 of H08 is currently run daily on the backup system "bore" (see below). There are also some plans for using the LAMEPS perturbations to create a hybrid B-matrix for the H08 3D-VAR assimilation system. In addition, we want to take advantage of the CIS (Comprehensive Impact Study) developments in HIRLAM, and thus assimilate more remotely sensed observations.

Met Office Unified Model (UM) at *met.no*

Operational use of the non-hydrostatic UM at Norwegian Meteorological Institute is regulated through a partnership based upon a collaboration agreement with the UK Met Office. The agreement includes an operational and research license, and an agreed program of research and development work.



UM 4km

UM at 4km resolution on a 300*500*38 grid (light blue) is nested into Hirlam8 (green) through hourly boundary fields. No assimilation is done in the met.no-setup of the UM system, initial fields are interpolated from the Hirlam8. UM4 runs for 66 hours at 00, 06, 12 and 18utc. Necessary model fields are written every 20 minutes for further nesting of several UM 1km domains.

An experimental setup of UM vn.7.3/7.5 runs on the same horizontal grid, but with 70 vertical levels. At vn.7.5 the possibility to apply Open-MP internally on the computing nodes is currently under evaluation. If feasible the current domain will be extended to move the boundary further away from the coastline.

Initial sub-surface temperature and humidity fields interpolated from Hirlam8 have proven to give less than optimal forecasts of especially T2M. Tests where the initial humidity field is taken from the Met Office global model, and the temperature field is free running, show very promising results. Such a procedure will probably soon be implemented in the operational setup.

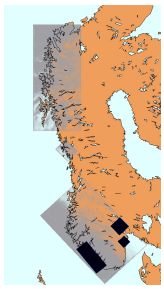
UM 1km

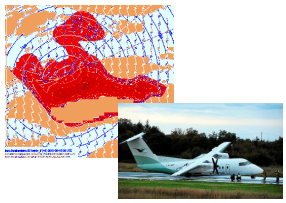
Nested into UM4, with interpolated boundary fields every 20 minutes. Two relatively large (336*752 and 400*656 grid points, both with 70 levels) and a few smaller domains have been set up, mainly to provide input to the specialized nested models

- Simra, for turbulence forecasts
- AirQUIS, for air quality forecasts

The UM1 models, recenlty upgraded to vn.7.3, are started 3 hours into the UM4 run. UM1 runs for 21 hours if the purpose is forcing of the turbulence model, and for 45 hours if the purpose is to provide detailed weather information for air quality calculations.

Results from the UM1 forecasts are used from +6 hours and onwards (i.e. after a 3h spin up period).



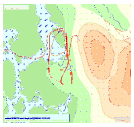


The Simra turbulence model, nested in UM 1km

with a horizontal grid spacing of 200-300m and 40 levels between the surface and 4000m; iteratively solves anelastic equations for 3 wind components, potential temperature, pressure, turbulent kinetic energy and turbulent dissipation once each hour during the forecast. Picture shows plane with broken landing gear, figure shows inflight path and turbulence index as forecasted in the inflight "cone"; both at Sandnessjøen airfield 15/9-2010.

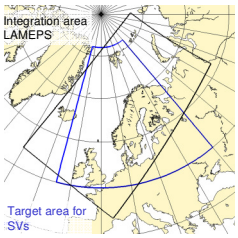
UM1 as input to air quality modelling

Figures show UM1 10 meter wind trajectories of stagnant air last winter in Bergen, picture shows the inversion problem.



NORLAMEPS, The Norwegian ensemble prediction system

Consists of two components: Targeted EPS = TEPS and Limited Area Model (HIRLAM) EPS = LAMEPS
NORLAMEPS=Combination of TEPS & LAMEPS: A simple "multi" model, multi initial condition ensemble. 42 ensemble members [2 times (20+control)]



TEPS – Targeted Ensemble Prediction System

TEPS is a dedicated version of ECMWF EPS. 20 + 1 ensemble members, as opposed to 50+1 for EPS. Target area is Northern Europe and adjacent sea areas, as opposed to NH north of 30°N for EPS. TEPS runs at 00utc and 12utc every day. Forecast length is +72h. SV computation with T42 and 48h optimization time. Using ECMWF model IFS with resolution T639L62 (~50km)‖ TEPS follows the same model upgrades as ECMWF EPS, hence it always runs the same model cycle as EPS

LAMEPS – Limited Area Model Ensemble Prediction System

HIRLAM in ensemble set-up. Running since February 2005. Resolution: 12km (0.108°), 60 vertical levels. 20 members + control. Control is based on Norwegian HIRLAM analysis (12km resolution). 20 initial and lateral boundary conditions from TEPS. Lateral boundary conditions every 3 hour. Runs at 06utc and 18utc, 6hours time lag from TEPS. Forecast length is 60h. The members use alternating two different physics parameterizations.

Computer systems for operational runs and backup

The main computer system, "njord", used for all met.no operational models consists of 192 IBM p575+ 16-way nodes, 1.9GHz dual-core cpu's and 6656 Gb memory. The 192 nodes are divided into 2 login, 186 computeand 4 I/O nodes. For operational use and development met.no has exclusive access to 25% of the total resources. At the moment our different models are running on part of the system for approximately 10 hours a day, utilizing ~80% of our available quota.

As a test of a possible future operational cooperation between SMHI and met.no, SMHI's cluster "Bore" has since July this year been set up as a backup resource for met.no's Hirlam8 and Hirlam12 suites.

Bore/Gimle is a Linux-based cluster with 140 HP ProLiant DL160 G5 and 104 HP Proliant DL170h G6 compute servers with a combined peak performance of 20 Tflops. Each DL160 compute server is equipped with two quad-core Intel® Xeon® E5462 processors while the DL170h compute servers contain two quad-core Intel® Xeon® E5520 each. The installation also includes a total of 7 ProLiant DL380 G5 system servers that handle cluster storage and administration tasks. In total, the cluster has over 4.5 TiB of main memory. The compute nodes communicate over a high-speed network based on Infiniband equipment from Cisco and Voltaire.The compute servers are split between the Bore and Gimle parts of the cluster. The Bore part of the cluster is dedicated to weather forecast production.