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The operational NWP system

The DMI operational NWP system is based on the HIRLAM reference version 6.3.5, and it includes adaptations to the computational and operational environment at DMI. The operational model suite currently consists of the three models DMI-HIRLAM-T15, DMI-HIRLAM-S05 and DMI-HIRLAM-Q05 with horizontal mesh sizes of 0.15°, 0.05° and 0.05°, respectively. The first two models have been running operationally since 14th June 2004, and the DMI-HIRLAM-Q05 model was added at 31st May 2005. This happened in connection with a major upgrade of the system. The most recent upgrade happened at 9th November 2005. The model domains are shown in Fig. 1, and Table 1 lists some properties of the latest model setup.

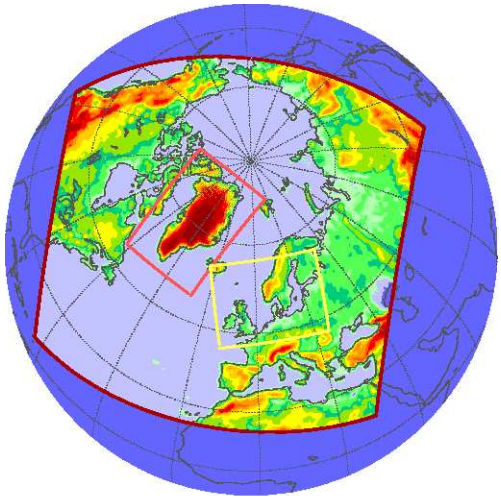

Figure 1. Operational model domains at DMI: T15 (dark red), S05 (yellow) and Q05 (light red).

Model	T15	S05	Q05
gridpoints	610x568	496x372	550x378
vert. levels	40	40	40
mesh size	0.15°	0.05°	0.05°
time step	450s	150s	150s
boundary age (FC)	6 h	0 h	0 h
boundary age (DA)	0–6 h	0 h	0 h
host model	ECMWF	T15	T15
boundary freq.	1/(3h)	1/(1h)	1/(1h)
DA cycle	3 h	6 h	6 h
forecast length	60 h	54 h	36 h
forecasts per day	4	4	2

Table 1. Model setup

Furthermore, the following model features are used in the operational suite at DMI:

- HIRLAM 6.2.3 physics with recent extensions (some of which are mentioned below)
- Semi-Lagrangian dynamics
- Digital Filter initialisation
- 3D-VAR for T15
- Implicit 6th-order horizontal diffusion
- Turbulence parameterization based upon turbulent kinetic energy (TKE): CBR scheme as of HIRLAM 6.2.5
- ISBA (Integrated Soil Biosphere Atmosphere) surface scheme and surface analysis

  However, SST- and ice analysis have been changed, so that ECMWF SST and ice-data are used more efficiently in the SST update and ice cover analysis, which is particularly important at coastal areas. In addition SSTs from the Ocean & Sea Ice SAF are used.
- STRACO convection parameterization scheme
- Adjustment of the diagnosis of 10m wind, 2m temperature and relative humidity

– Improved algorithm for the calculation of the reduction from surface pressure to mean sea level pressure

– Modified *vegetation* roughness and *thermal* roughness over land

– Adaptation of the analysis increment method for the high-resolution models S05 and Q05, using analysis from T15

The most recent operational upgrade at 9th November 2005 includes among others the following changes:

– Changes in the reassimilation cycle (now 4 times a day, see Table 2)

– incremental spatial filtering in the reanalysis, which blends large scale analysis from ECMWF and high-resolution DMI-HIRLAM analysis

– use of locally derived structure functions based on archived T15 predictions

– increased use of AMSU-A data and more AMDAR from GTS included

– increase of time steps from 360s to 450s (T15) and from 120s to 150s (S05, Q05), possible due to improvements in the time integration scheme

– further tuning of physical parameterization (mixing length, thermal roughness, separation of convective rainfall over land and over sea)

The operational schedule for the daily forecast production is shown in Table 2. The left table shows the old schedule from before the upgrade on 9th November, and the right table shows the new schedule. The leftmost column in each table shows a time line (UTC) for the start of processing. The other columns in each table depict the models. The specifications read as follows: The first character is the model indentifier, followed by two digits specifying the valid time for the analysis and the initial time of the forecast. This is followed by a "+" and the forecast length. T00+60h thus means the 0 UTC analysis for T15 followed by a 60 hour forecast.

UTC	T15	S05	Q05
1:37	T00+60h		
2:20		S00+54h	
3:05			G00+36h
ECMWF 00 UTC			
7:37	T06+60h		
8:20		S06+54h	
9:05			G06+6h
ECMWF 06 UTC			
11:45	T_E00+05h T03+05h T06+05h T09+05h		
13:37	T12+60h		
14:20		S12+54h	
15:05			G12+36h
ECMWF 12 UTC			
19:30	T18+60h		
20:29		S18+54h	
21:05			G18+6h
ECMWF 18 UTC			
23:50	T_E12+05h T15+05h T18+05h T21+05h		

UTC	T15	S05	Q05
1:37	T00+60h		
2:20		S00+54h	
3:05			G00+36h
ECMWF 00 UTC			
7:00	T_E00+09h		
7:37	T06+60h		
8:20		S06+54h	
9:05			G06+6h
ECMWF 06 UTC			
11:45	T_E06+09h		
13:37	T12+60h		
14:20		S12+54h	
15:05			G12+36h
ECMWF 12 UTC			
19:00	T_E12+09h		
19:30	T18+60h		
20:29		S18+54h	
21:05			G18+6h
ECMWF 18 UTC			
23:50	T_E18+09h		

Table 2. Operational time schedule at DMI before (left) and after (right) the upgrade at 9th November 2005

The time schedules in Table 2 show that the long forecasts are run 4 times a day for T15 and S05: at 00, 06, 12 and 18 UTC. In the new schedule, there are four reassimilation cycles run daily for T15 instead of two in the old schedule. For S05 and Q05 6-hourly updates are made, and no reassimilation. The reassimilation cycles include the restart run T_E from ECMWF 3D-VAR analysis (0.45°). In the new schedule, this includes blending of the large scale analysis from ECMWF with the high-resolution DMI-HIRLAM analysis.

Other operational activities based on HIRLAM

- road condition model and a road condition observation network
- pollen- and air-pollution modelling and applications
- ocean wave prediction for Danish waters and beyond

Computer environment

The current computer configuration at DMI used for the operational forecasting system consists of an NEC SX-6 supercomputer with an adjoint TX-7 scalar server, and several Linux scalar servers for data processing. The data archive consists of an IBM Hierarchical storage management system (HSM) based on disks and tapes. A sketch of the data flow is shown in Fig 2.

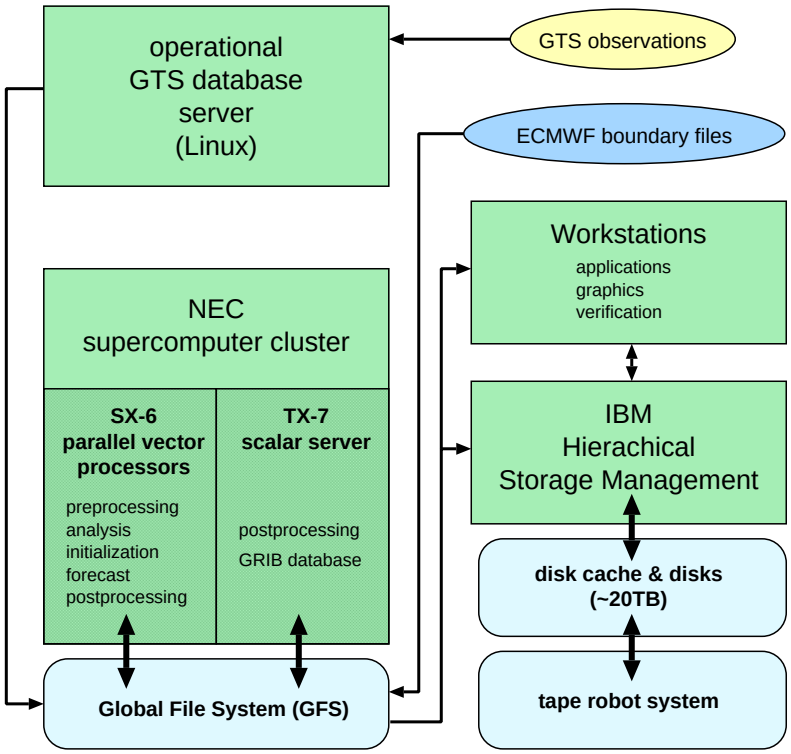

Figure 2. Operational forecasts at DMI: computers and data flow

HIRLAM research activities

The DMI activities within the HIRLAM collaboration comprise:

- data assimilation, 3D-VAR and 4D-VAR
- dynamics, (SL scheme)
- surface (ISBA)
- turbulence
- physiography
- non-hydrostatic model (HIRLAM-ALADIN, HIRALD)

DMI's invlovement in the new collaboration between Météo France and the HIRLAM consortium (HIRLAM-ALADIN, HIRALD) include the following recent activities:

- High resolution ALADIN setup (cycle 29t2) named HIRALD has been established at the hpcd computer at ECMWF
- Climate system for generation of new areas is now also available (implementation by Météo-France)
- HIRLAM work has made it possible to run the system using boundary forcing from HIRLAM instead of ARPEGE
- Setup of a double nested HIRALD system (Fig 3) to be run daily on a test basis at DMI on NEC-SX6. The physics are from standard ALADIN. The innermost model covering southern Scandinavia has a grid size of 2.5 km
- Preparations for parallel daily runs with HIRLAM physics is in progress
- The current status connected to HIRALD including relevant documents can be seen on http://science.dmi.dk

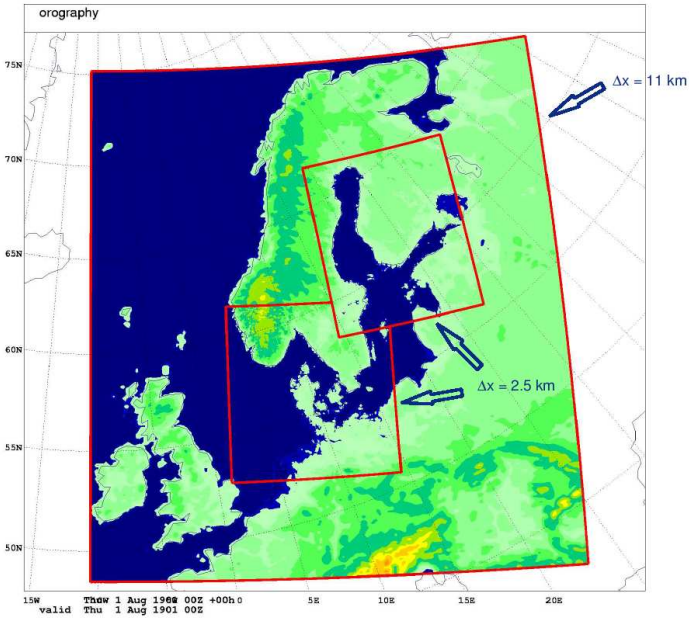

Figure 3. HIRALD model areas.