Operational HIRLAM at the Danish Meteorological Institute 2000/2001

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1 Introduction

This is a short overview of the operational HIRLAM set-up at DMI. For more details please refer to Sass *et al* (2000).

2 Summary of changes

The major change in the operational HIRLAM set-up at DMI last year was the introduction of HIRLAM 3D-VAR analyses for DMI-HIRLAM-G and the transition to a module based script system based on PERL5 in autumn 2000.

Additional updates includes 4 long DMI-HIRLAM-G forecasts per day (previously we only made 2 long forecasts per day for DMI-HIRLAM-G), 3 hour data assimilation cycling for the four model versions and use of incremental analyses (discussed below) for DMI-HIRLAM-D.

3 Model set-up

The operational DMI-HIRLAM is a triply nested system with a coarse resolution model covering all of Europe, the northern Atlantic and some of North America (DMI-HIRLAM-G), finer resolution models over Europe (DMI-HIRLAM-E) and Greenland (DMI-HIRLAM-N) and a high resolution model over Denmark (DMI-HIRLAM-D). The domains of the models are shown in figure 1.

4 Computational set-up

The operational models run on a 16 cpu NEC SX-4/16 computer with two 4 cpu SGI origin200 machines as operational scalar servers for storing of input data in form of ECMWF boundaries and observations from GTS and handling of output data from the models. Operational data are archived on a 2 cpu HP9000 machine with a Unitree tape system.

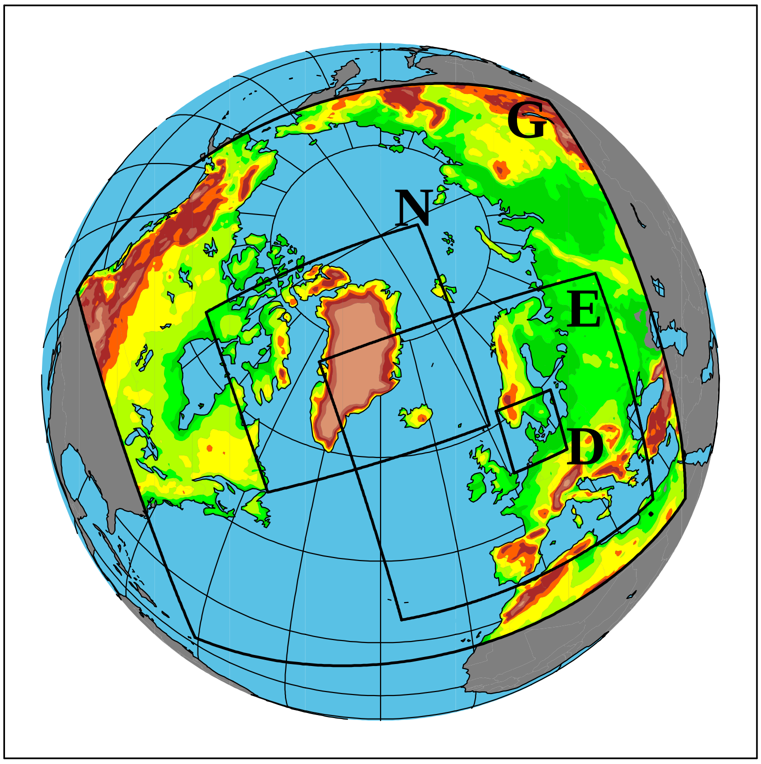

Figure 1: Operational areas

5 Analysis set-up

One major upgrade in 2000 was the change from HIRLAM optimum interpolation to HIRLAM 3D-VAR for the DMI-HIRLAM-G model. Another data-assimilation feature is the application of an incremental analysis scheme for DMI-HIRLAM-D which takes the large scales from DMI-HIRLAM-E and the fine scales from the first guess of DMI-HIRLAM-D. A schematic figure of the method is shown in figure 2. The basic idea is that we want a field which has the same large scales as the DMI-HIRLAM-E model but at the same time we want to keep the fine scales from the high resolution model. The incremental method is also applied to merge ECMWF analyses with DMI-HIRLAM-G analyses twice a day (at 0 and 12 UTC) in order to produce fields which have the same large scales as the ECMWF analyses. These fields are used for restart runs for the DMI-HIRLAM-G model.

In summary we currently run the following analysis systems for the different models:

1. HIRLAM 3D-VAR for DMI-HIRLAM-G with ECMWF increments twice a day for restart runs
2. HIRLAM OI for DMI-HIRLAM-E
3. HIRLAM OI for DMI-HIRLAM-N
4. Increments from DMI-HIRLAM-E for DMI-HIRLAM-D

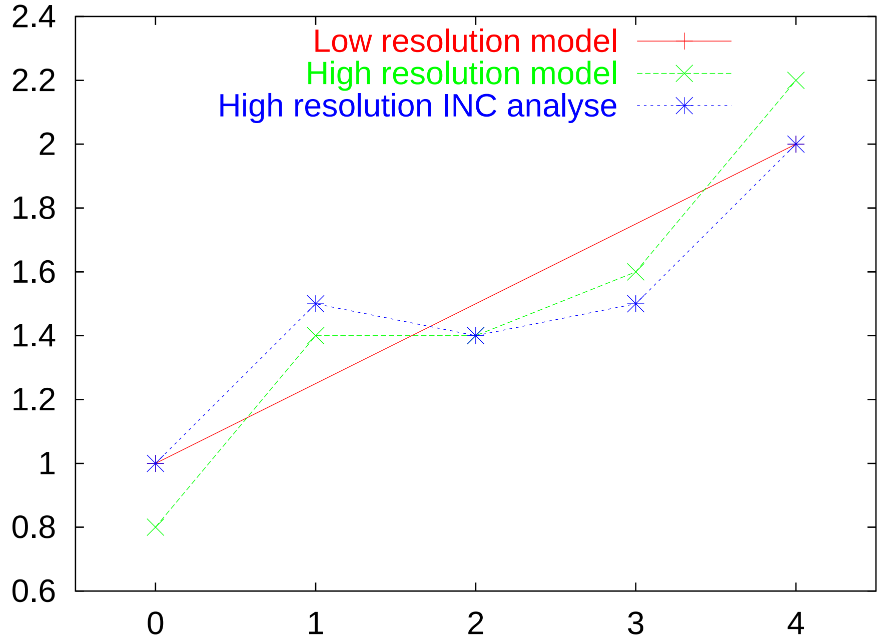

Figure 2: The incremental analyse scheme

We are currently using the following observations: SYNOP, SHIP, DRIBU, AIREP, PILOT and TEMP with a ± 90 min observation window and AMDAR and ACARS with a ± 30 min observation window.

We are currently not using any surface analysis.

6 Forecast model set-up

In our operational runs we use Eulerian time integration. We use longer physics time steps compared to dynamics time steps as described by Sass *et al* (2000). For physics parameterization we use the CBR turbulence scheme and the STRACO convection/condensation scheme.

7 Operational set-up and schedule

An overview of the operational set-up is given in table 1. The meaning of the various quantities is as follows:

mlon and mlat are the number of horizontal grid-points.

nlev is the number of vertical levels in the model.

horiz. res. is the horizontal resolution of the model.

dt (dynamics) and dt (physics) are the time-steps used for the dynamics and the physics respectively.

Model	**G**	**N**	**E**	**D**
mlon	202	194	272	182
mlat	190	210	282	170
nlev	31	31	31	31
horiz. res.	0.45^o	0.15^o	0.15^o	0.05^o
dt (dynamics)	240s	100s	100s	36s
dt (physics)	720s	600s	600s	216s
boundaries	ECMWF	G	G	E
bnd. res.	$1.50^o/19$	$0.45^o/31$	$0.45^o/31$	$0.15^o/31$
bnd. age	6-12h	0h	0h	0h
bnd. update	6h	1h	1h	1h
bnd. cycle	12h	3h	3h	3h
analysis scheme	3D-VAR/INC	OI	OI	INC
data ass. cycle	3h	3h	3h	3h
fcst. len	60h	36h	48h	36h
long fcsts/day	4	2	4	2

Table 1: Overview of DMI's operational HIRLAM set-up (for details see text)

boundaries is the model providing boundaries for the run

bnd. res. is the boundary horizontal resolution and number of vertical levels in the boundaries.

bnd. update is the time between each forecast file used for boundary update.

bnd. cycle is the time between the boundary cycles.

analysis scheme is the assimilation scheme used. 3D-VAR denotes HIRLAM 3D-VAR, OI denotes HIRLAM OI and INC denotes the incremental set-up described above.

data ass. cycle is the time between subsequent analyses.

fcst. len is the length of the long forecast of the model. The length of the short forecasts used to provide new first-guesses is equal to the assimilation cycle period (3h in all models).

long fcsts/day is the number of long forecasts per day.

Our operational schedule is given in table 2. For reasons of efficiency we run our 06/18 UTC DMI-HIRLAM-G and DMI-HIRLAM-E runs with a 6 hour old first guess in order to save some analysis runs. The second 00/12 UTC DMI-HIRLAM-G run with an ECMWF restart is done after receiving the 00/12 UTC ECMWF analysis followed by 3 hour cycling to provide a good first-guess for the 12/00 UTC runs.

In addition we update our sea surface temperature and fraction of ice fields from ECMWF fields (1.5^o) twice a day in connection with the 03 UTC runs.

Time	Model	Ana	Len (h)	Remark
0140-0220	G	00	60	
0142-0220	E	00	48	
0230-0250	D	00	36	
0255-0315	N	00	36	
0740-0820	G	06	60	6h FGS
0742-0820	E	06	48	6h FGS
1000-1001	G	00	3	ECMWF inc + restart
1001-1010	G	03	3	
1010-1020	G	06	3	
1020-1030	G	09	3	
1030-1035	E	03	3	
1035-1040	E	06	3	
1040-1045	E	09	3	
1045-1050	D	03	3	
1050-1055	D	06	3	
1055-1100	D	09	3	
1100-1105	N	03	3	
1105-1110	N	06	3	
1110-1115	N	09	3	
1340-1420	G	12	60	
1342-1420	E	12	48	
1430-1450	D	12	36	
1455-1515	N	12	36	
1940-2020	G	18	60	6h FGS
1942-2020	E	18	48	6h FGS
2245-2246	G	12	3	ECMWF inc + restart
2246-2255	G	15	3	
2255-2305	G	18	3	
2305-2315	G	21	3	
2315-2320	E	15	3	
2320-2325	E	18	3	
2325-2330	E	21	3	
2330-2335	D	15	3	
2335-2340	D	18	3	
2340-2345	D	21	3	
2345-2350	N	15	3	
2350-2355	N	18	3	
2355-2400	N	21	3	

Table 2: DMI's operational HIRLAM schedule

8 Plans

In the spring of 2001 we plan to increase the resolution of the received ECMWF boundaries 1.5^o with 19 vertical levels to 1.0^o with 30 vertical levels (every second ECMWF level). In addition we plan to increase the resolution of the received ECMWF sea surface temperature and ice fields used to update the sea surface temperature and ice fields from 1.5^o to 1.0^o.

Later (in the fall of 2001) we plan to replace all OI analysis runs with 3D-VAR analyse runs (DMI-HIRLAM-E and DMI-HIRLAM-N). We also plan to upgrade the convection scheme and the climate fields to new fields based on Global Land Cover Characteristics version 2.0.

References

Sass, Bent Hansen, Nielsen, Niels Woetmann, Jørgensen, Jess U., Amstrup, Bjarne, and Kmit, Maryanne. 2000. *The operational HIRLAM system at DMI - October 2000 -*. DMI Technical Report 00-26. Danish Meteorological Institute. Available from http://intranet.dmi.dk/f+u/publikation/Tr00−26.pdf.