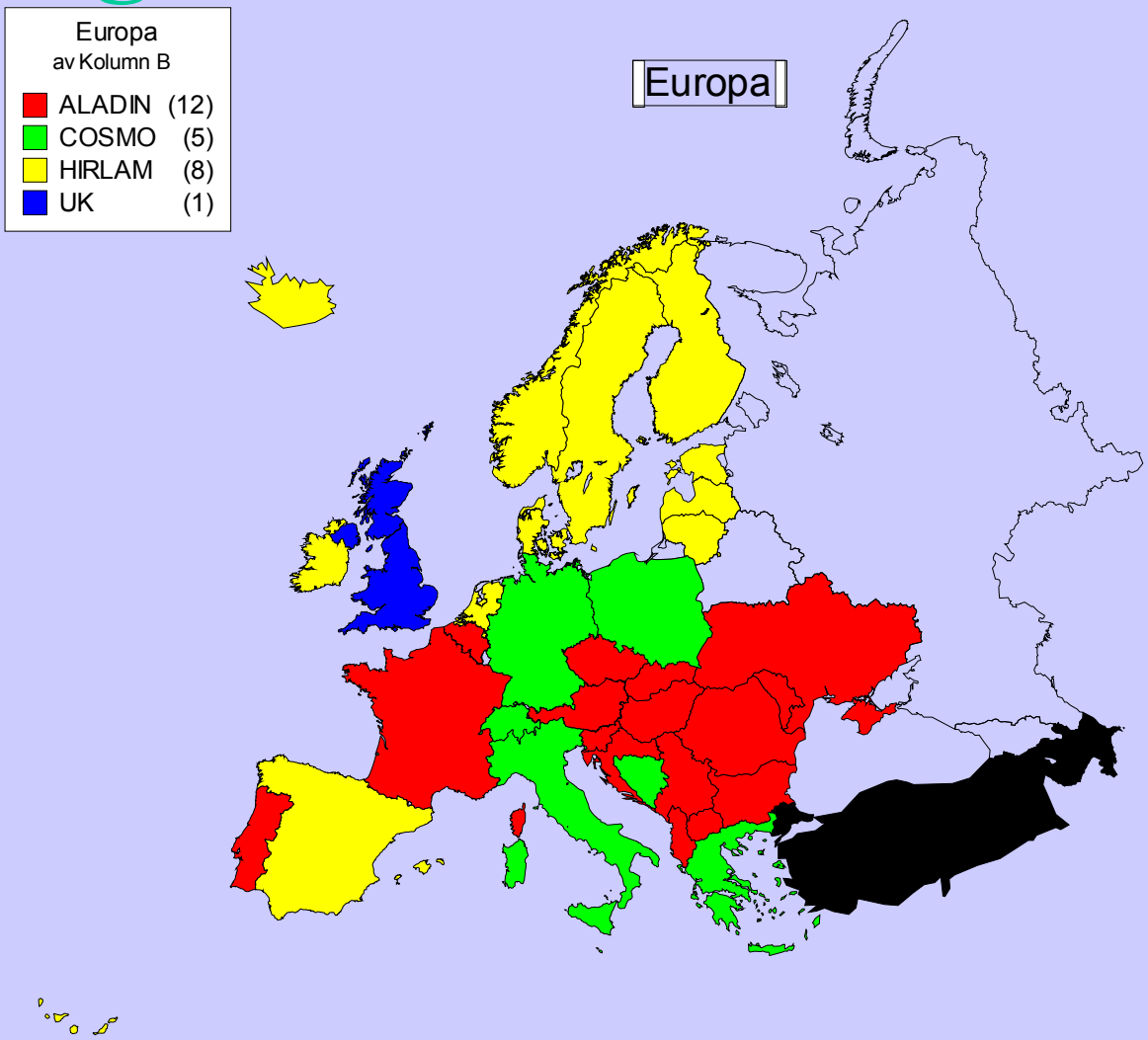
The Strategy the new HIRLAM Programme



Per Undén

HIRLAM-6

HIRLAM Programme definition

- Projects 1985- -- 2005 ; Programme 2005-2010 with poss. extension
- Objectives
  - Provide state-of-the art high quality (competitive) LAM NWP modelling system to members
  - HIRLAM shall be one of the 4-5 centres in European NWP
  - Provide expertise in NWP
  - Foster scientific collaboration between members and with other NWP groups
- Activities
  - Synoptic modelling
  - Meso-scale modelling
  - Probabilistic forecsting
  - Support for earth-system and climate modelling

HIRLAM long term strategy
2005-2015

- General development in the environment:
  - Increased international cooperation and coordination
  - Synoptic scale LAM will be needed even beyond 2010
  - Meso-scale 3-1 km models will be operational
    - New demands for nesting, assimilation, initialisation, postprocessing and probabilistic forecast products
  - Short range EPS developed and in use
  - Earth system modelling – support for chemistry, bio- and hydrosphere

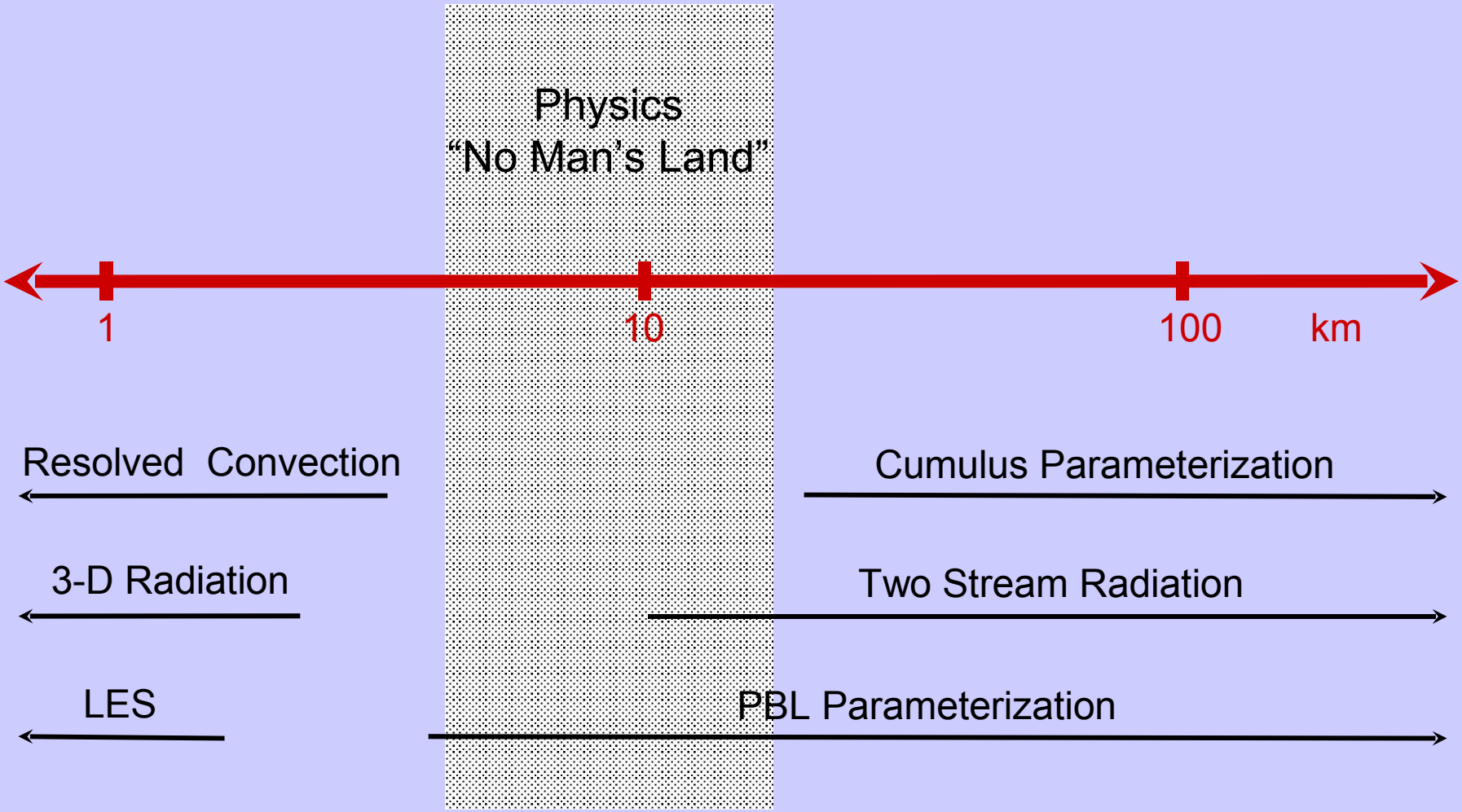
Meso-scale forecasting system

- Best available 2.5 km meso-scale modelling system operational in most of the HIRLAM countries 2010 – for parts or all of the territory – and applicable for 1 km **BECAUSE it is**
  - Necessary for forecasting in mountainous regions
  - Needed for very-short range prediction of severe weather, particularly with convection
  - Needed for high resolution applications, air quality, dispersion, disastrous releases etc.

The meso-scale forecsting system requires:

- Non-hydrostatic (non approximated equations) and efficient dynamics (long time steps possible)
- Advanced meso-scale physics, particularly for clouds and precipitation species and turbulence (convection mainly resolved except shallow)
- Advanced data assimilation that initialises particularly the moist processes (rain and clouds) and that can utilise many new data sources – Takes time …..
- Probabilistic forecasting and integrated system for estimating the probabilities
- Transparent boundary treatment

Model Physics in High Resolution NWP



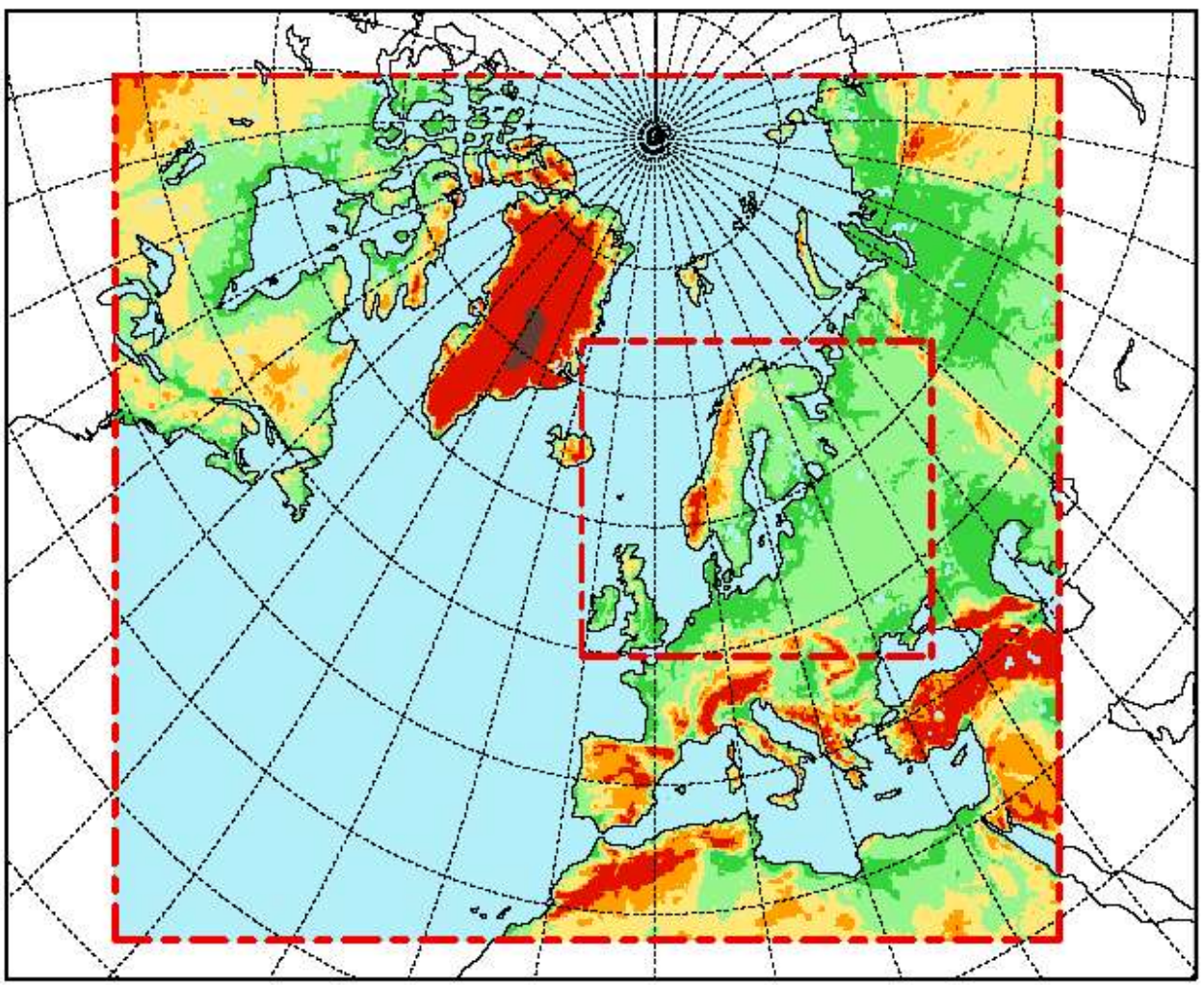
Klemp (2002) Dublin WS

Synoptic scale 10 km model

- Model for regional forecasting tightly coupled to ECMWF (will not be done by ECMWF <2015)
- To provide best forecasts of synoptic disturbances with short data cut off **
- To provide a comprehensive (high resolution in space and time) set of forecast variables for applications and other models
- To provide coupling to the meso-scale model with high resolution in space and time
- Consistent physics with meso-scale model
- EPS may have to be at 8-10 km for long time!

**) depends on developments at and for ECMWF, too

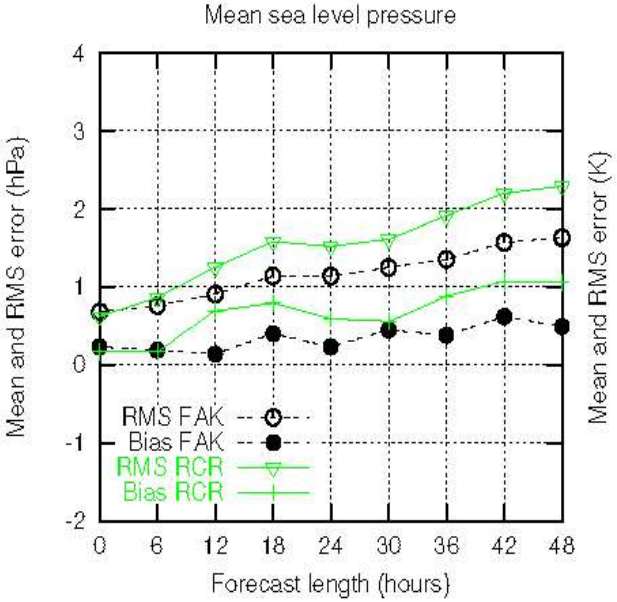
Areas of different HIRLAM suites at FMI/RCR

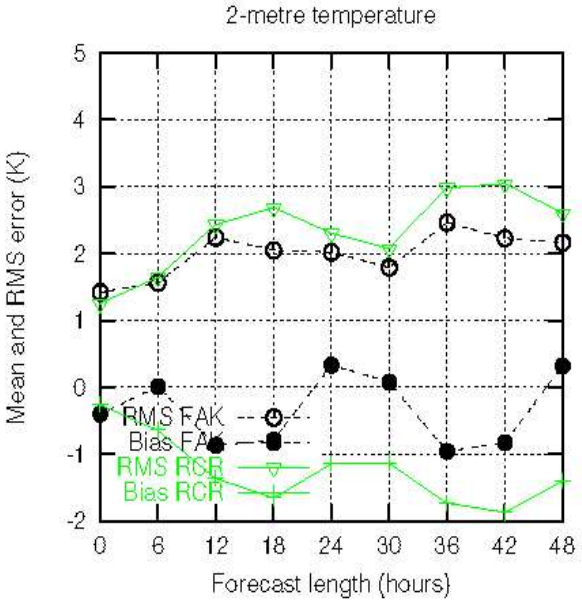


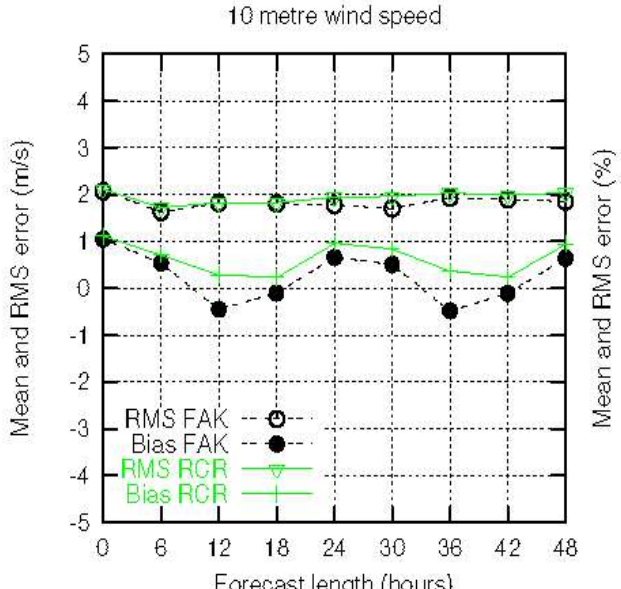
Synoptic HIRLAM work 2005

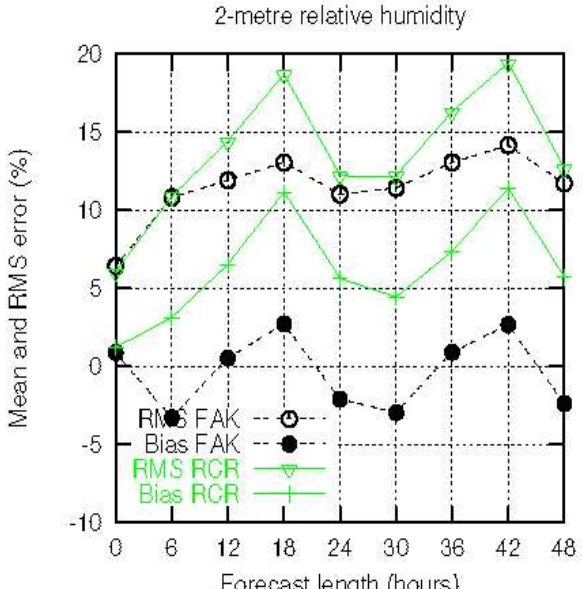
- 3D-VAR improvements
- 4D-VAR to be made operational (almost)
- More satellite use
- Surface analysis SST , ice, SAF products
- Turbulence developments and moist version
- Surface scheme, fluxes, new snow scheme
- Meso-scale / sub-grid scale orography
- KF convection, statistical cloud scheme
- SL dynamics
- Transparent boundary conditions
- Verification and diagnostics
- CVS code maintenance and unification -HIRLAM

Time: 2004070100 - 2004073118 Domain: EWG Forecast from 00

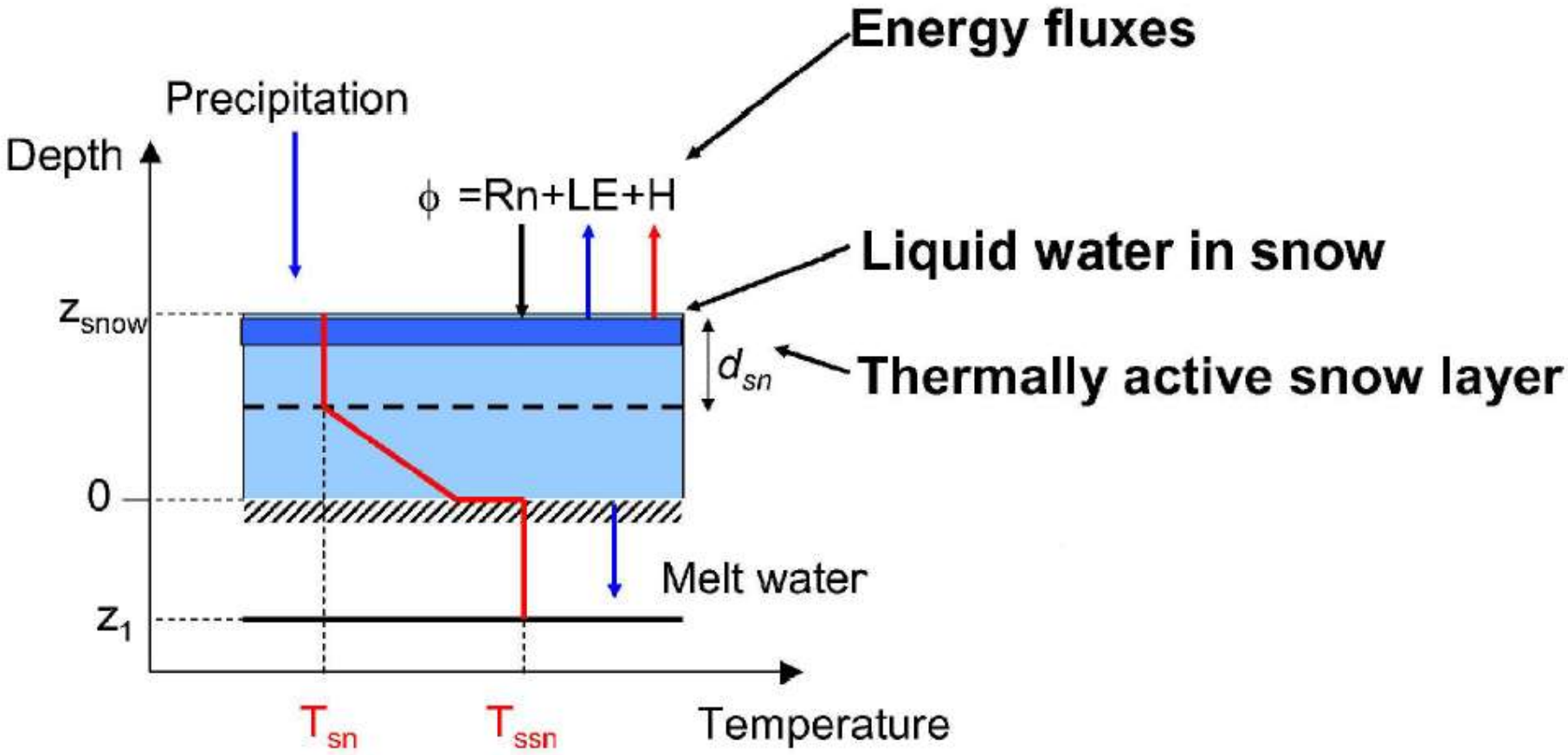








New snow scheme

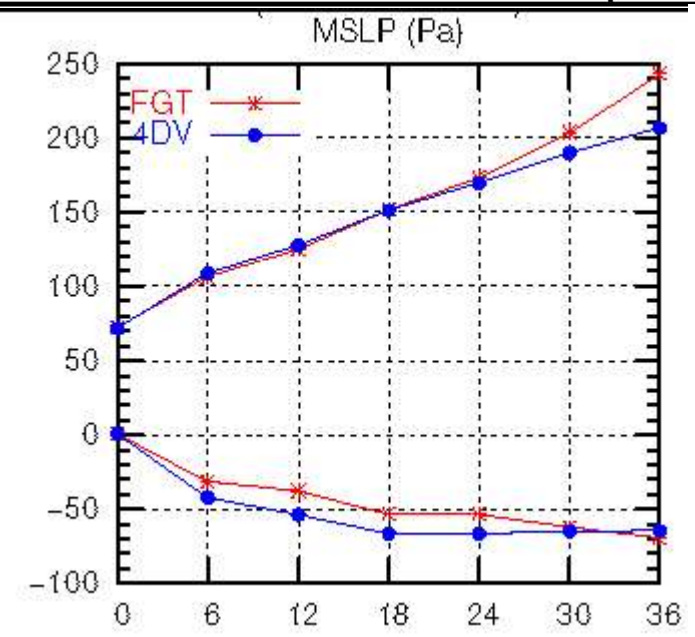


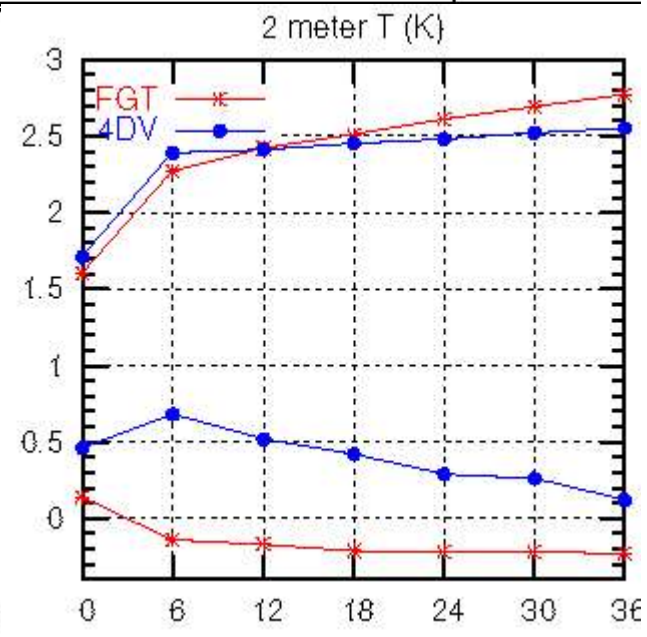
4D-VAR argument

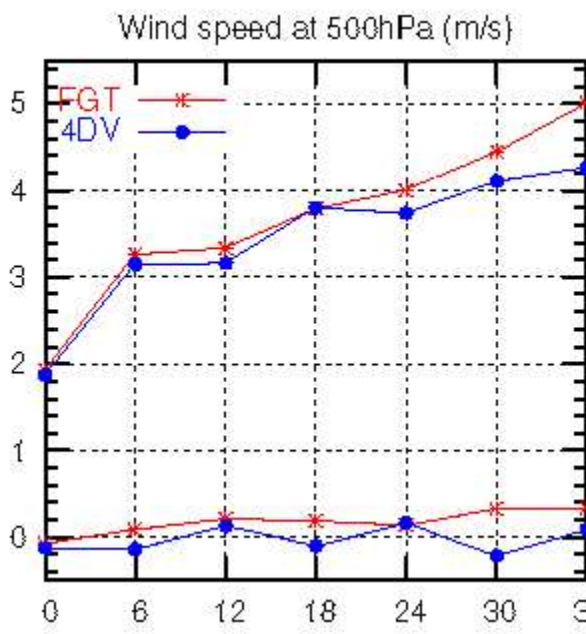
- Optimal solution in time including all information
  - Enables high time resolution of data and time sequence can be utilised - e.g. radar
- Iterativ method enabels non-linear operators -
    - possible in 3D too, **but** :
  - Non-linear analysis can transfer a vortex
- The model analyses non-observed quantaties
  - Possible to use integrated observations
- Model generated structure functions
    - necessary for meso-scale

4D-VAR feasibility tests (X Yang, N Gustafsson)

Procedure	4DV Peak memory use	4DVAR Elapse time	3DVAR Elaps
trajectory fcst 1	20 GB	330s	-
1st inner-loop minimization	21 GB	1410s	
3DVAR analysis (x 2)			760s
trajectory fcst 2	20 GB	380s	-
surface analysis	7 GB	290s	580s
2nd inner-loop minimization	23 GB	4800s	-
5 hr forecast			400s
subtotal for the analysis	23 GB	7300s	1740s
60 hr forecast	20 GB	3700s	3970s







Develop EPS for all time ranges

- First for synoptic forecasting 24-48 (-72) h
  - (Almost no HIRLAM-5 and -6 resources given (officially)) – requires more resources –
  - Science not really developed for short range –
  - Natural for Operational collaboration between institutes (GRID)
  - Pursue in a wider European context – similar work in several places and of operatoinal kind, exchanges
- Absolutely necessary for meso-scale
  - Very expensive
  - Science not at all developed
  - Alternative methods (probabilistic postprocessing, using something from EPS at larger scales ?)

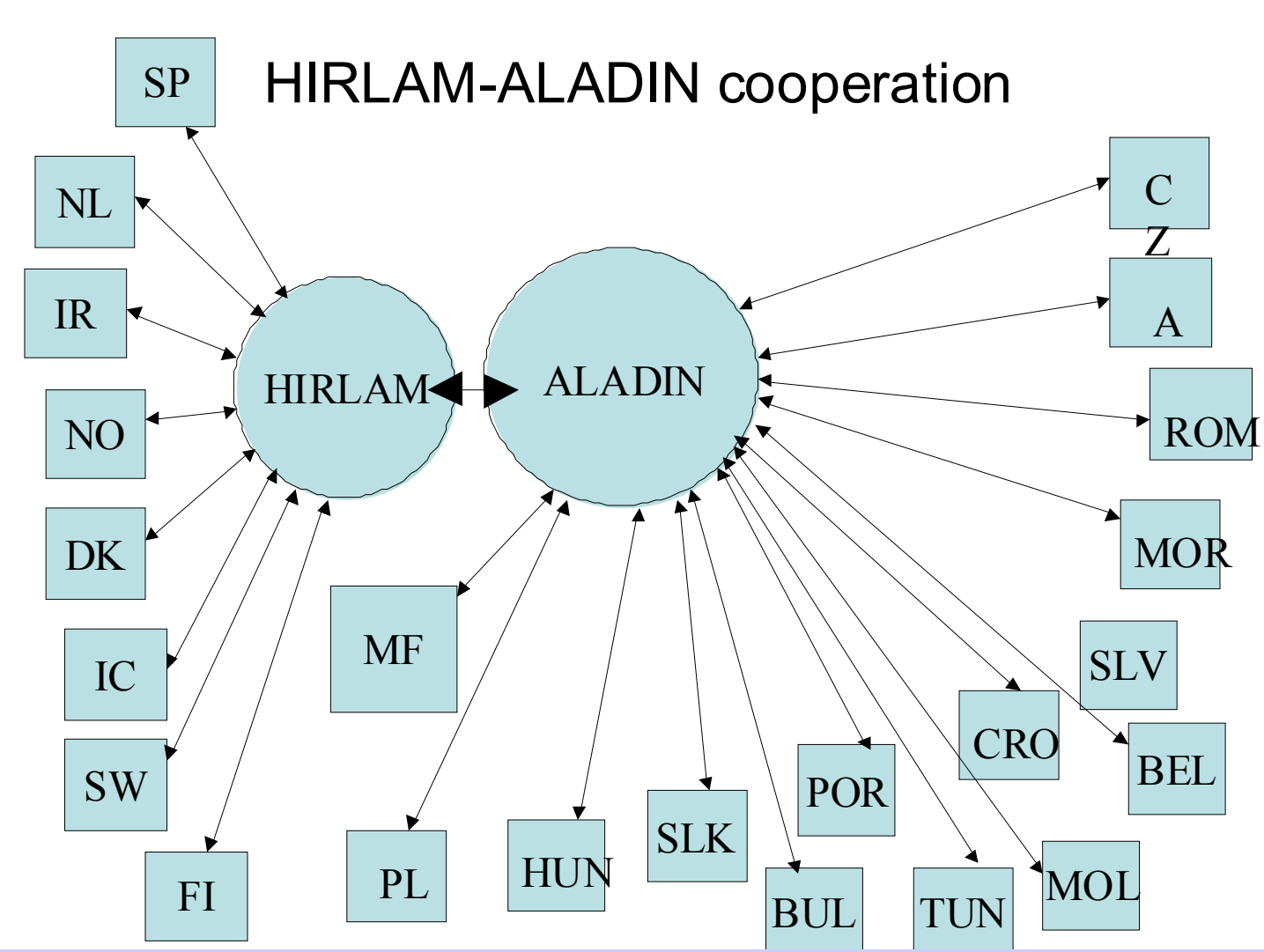
Requires more resources

- More activities – meso –synoptical- EPS !
- Achieved through:
  - Collaboration
    - With ALADIN/MF shared code (meso-scale first)
    - Indirectly with ECMWF through the IFS code, Met Office scientific exchange, intercomparison through met.no ‘s runs
    - Other European exchange of ideas and results
  - Synoptic model to be transferred to ALADIN/IFS with HIRLAM options
  - Synergy between meso- och synoptic scale work
  - Synergy with Nowcasting !
  - External funding (not under direct HIRLAM control)
  - Staff increases may be possible for specific purposes
  - Operational cooperation ! SMHI WS in autumn!

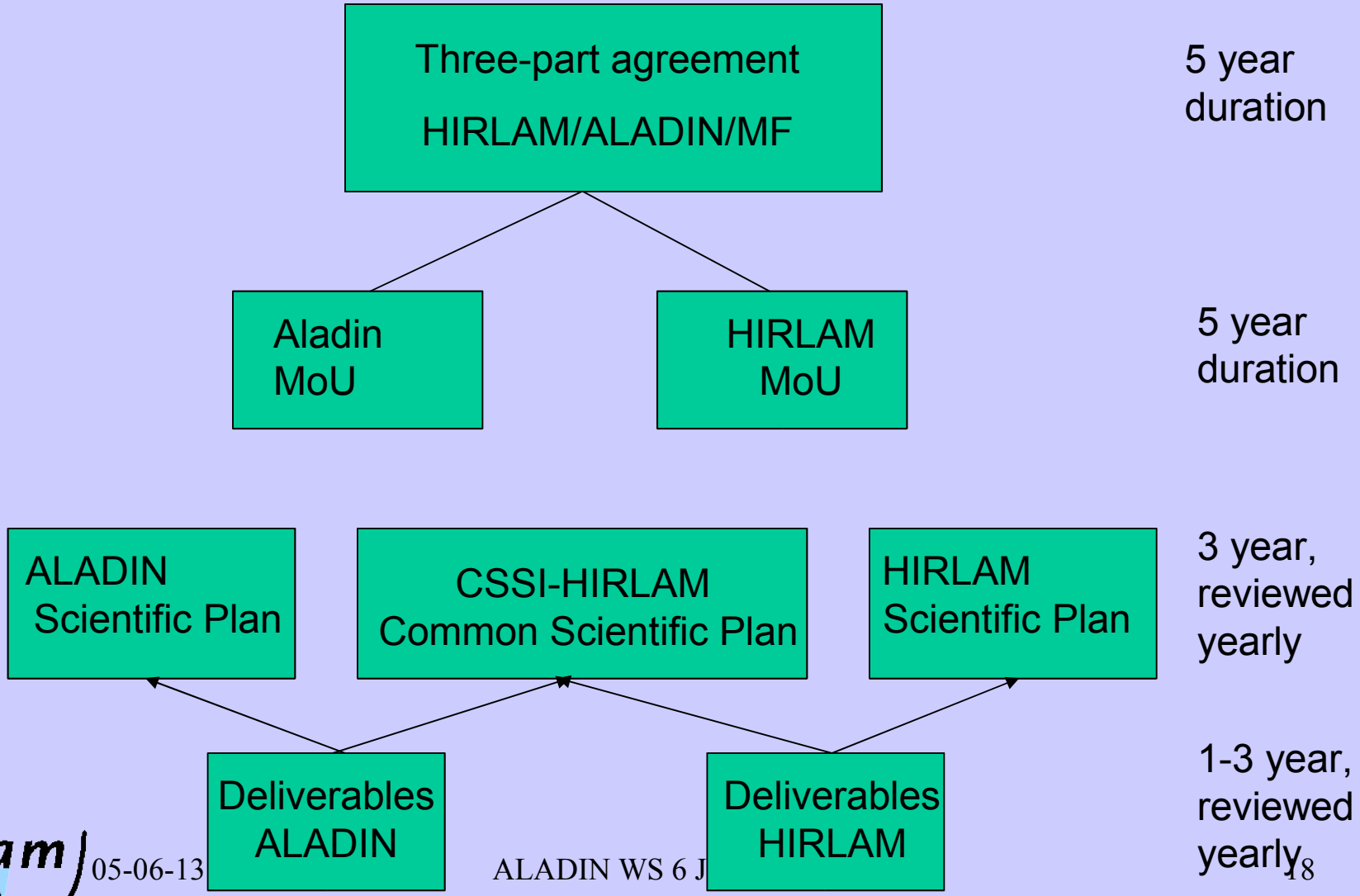
HIRLAM-7 organisation:

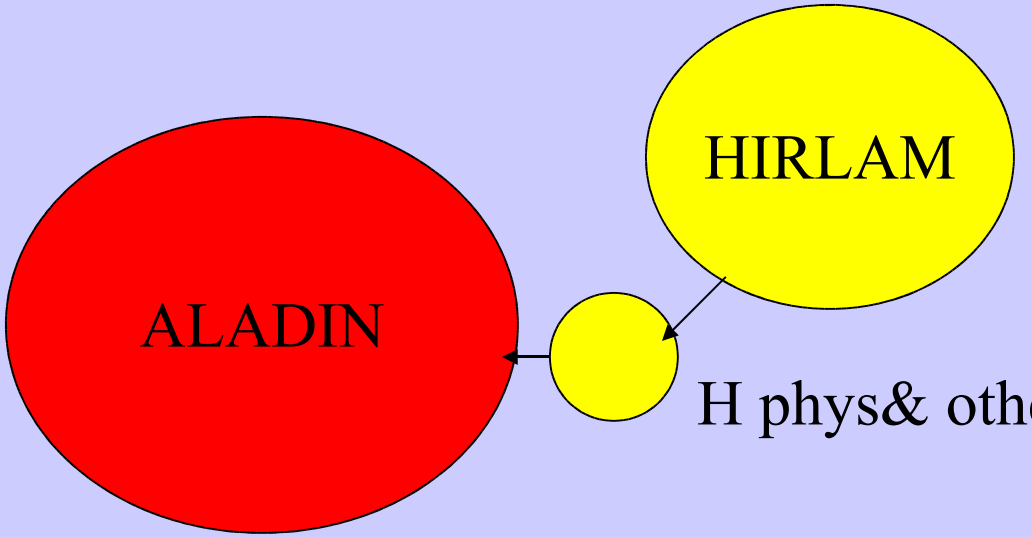
- Some more staff
- Better control from the Programme
- More full time:
  - Core group members 100% 1/member(=7 or 8) or funded financially
  - 1 Progr Manager 100%
  - 1 part time Scientific Secretary
  - 4 Project leaders >75%
    - Applications
    - DA and observations
    - Synoptic model and EPS
    - Meso-scale modelling
- Extent of activities to be decided

HIRLAM – ALADIN organisation

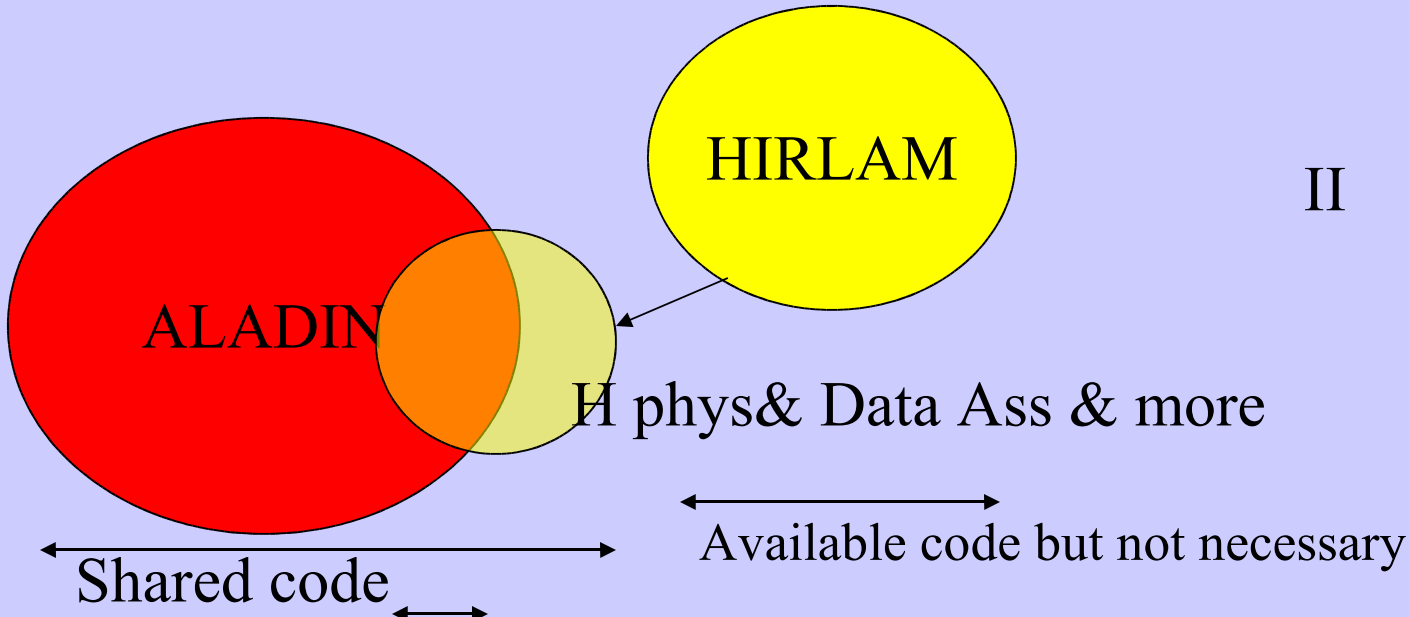


Structure of the Agreements

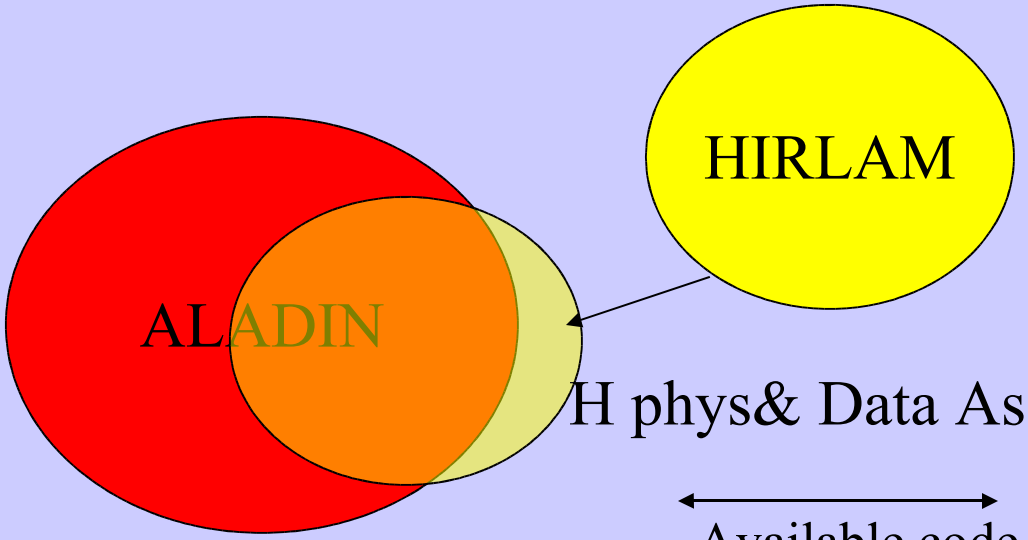



HIRLAM
ALADIN
H phys& others

I


HIRLAM
ALADIN
H phys& Data Ass & more
Available code but not necessary
Shared code
Common code

II



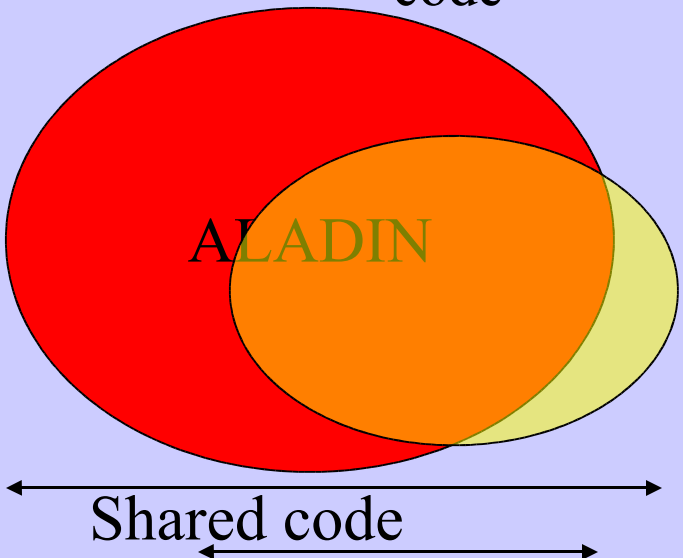
III

H phys& Data Ass & more

Available code but not necessary

Shared code

Common code



IV

Shared code = LAM dynamics, Pre- and post processing, support, much AROME physics, ARPEGE Physics, some ALADIN/AROME Data Ass., sing. vect., much obs. processing

Common code = HIRLAM physics, HIRLAM developm. In AROME physics and Data Ass. and obs. processing

Shared code

Common code

HIRLAM in ALADIN/IFS

- Establish that hydrostatic model equivalent:
  - Spectral hydrostatic dynamics, extension zone, variational analysis equivalent
- Establish HIRLAM physics package under switches in ALADIN / AROME
- Use HIRLAM physics as appropriate for synoptic system and parts for meso-scale? – Synoptic model migrated to ALADIN/IFS , bef. 2010
- Meso-scale work and contributions on AROME physics + HIRLAM physics
- Possible to collaborate and contribute with HIRLAM physics for the 10 km AROME (ALARO)

HIRLAM in ALADIN/IFS (cont)

- Data assimilation merge BIG step technically
  - Large code
  - ODB
  - ➢ A large potential for HIRLAM contribution in a joint system – and expectations e.g. 4D-VAR, radar, satellite data, …
  - ➢ To be planned in November - hybrid 4D-VAR system ?

HIRLAM components for Meso-scale

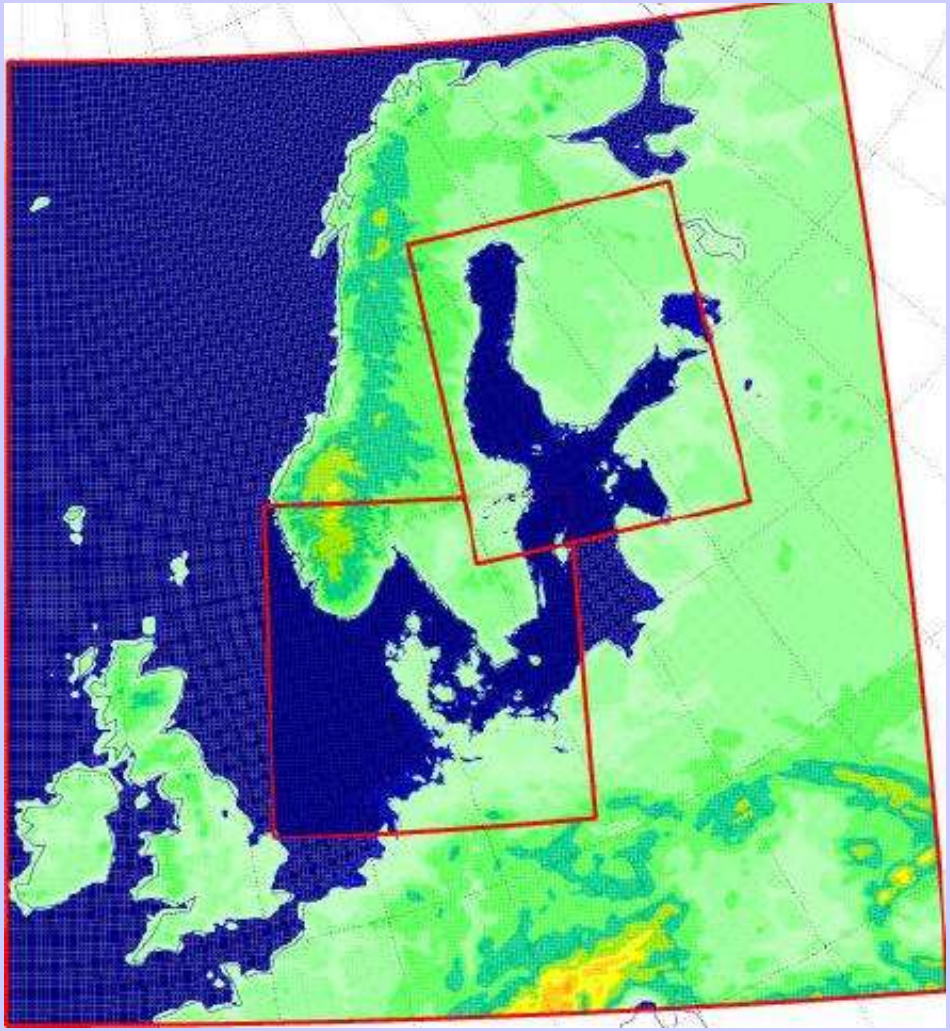
- Surface scheme – ISBA, snow, soil models
  - Still mainly horizontally uncoupled – upper air flow couples but flux aggregation ?
  - Tiled or untiled ? – tiles still exist below 1 km
- Turbulence scheme – CBR TKE - moist
  - 1D or 3D ? 1D at 3 km and 3D at 1 km?
  - Interactions with cloud scheme and convection
  - Shallow convection ?
- Radiation scheme – slopes considered
  - 3D ? - More advanced – more species
- Cloud scheme – more advanced and more species
- MSO/SSO
  - MSO relaxed but SSO needed at 1 km

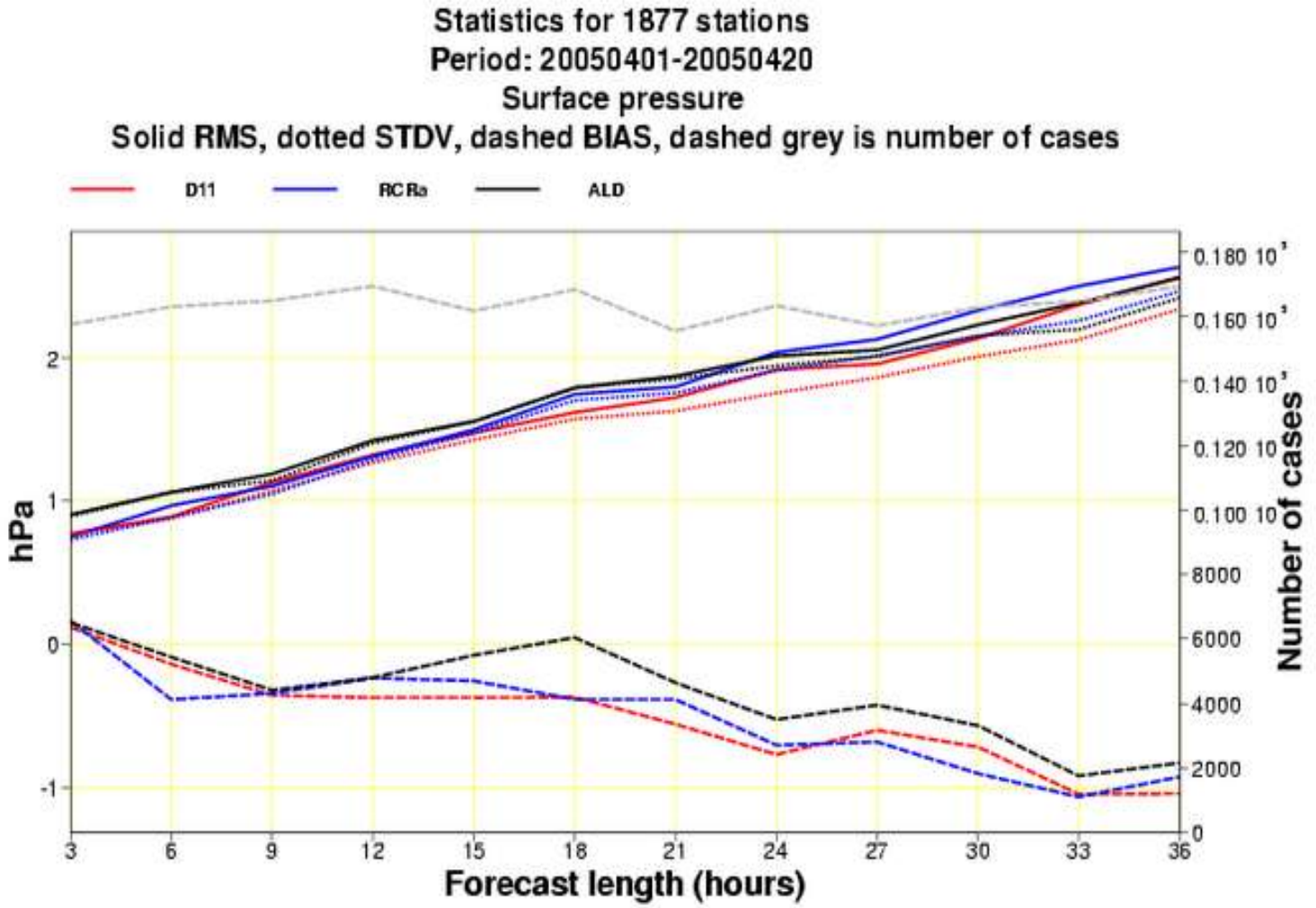
AROME and ALADIN components

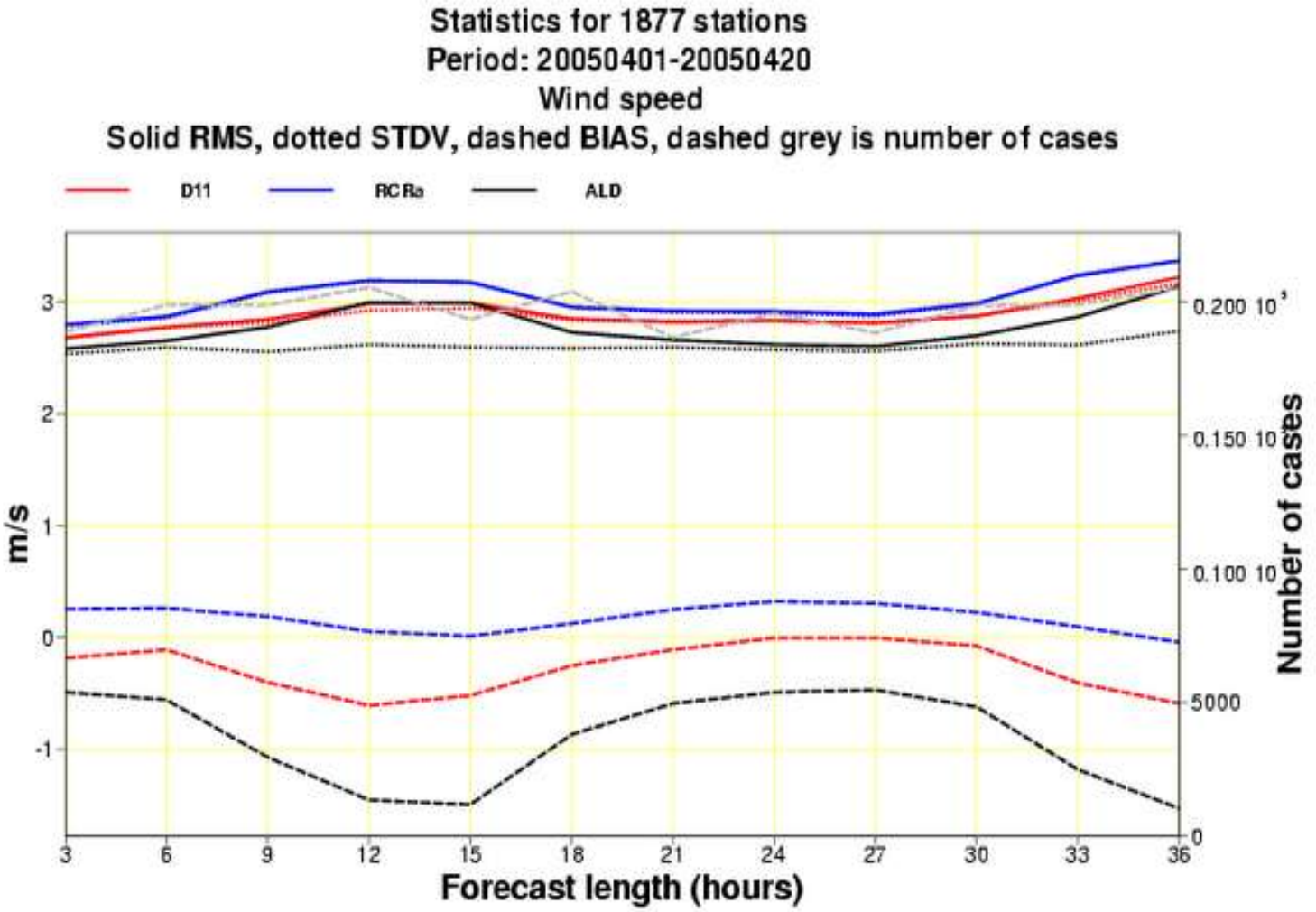
- Turbulence CBR – HIRLAM 1d
- Externalised ISBA – HIRLAM tiled
- (Kain-Fritsch – synoptic scale - HIRLAM)
- Town model
- Advanced cloud physics
- Radiation scheme (Morcrette, ECMWF)
- Chemical modelling

HIRLAM work with ALADIN in 2005

- Make experiments at 11 and 2.5 km
- Interface HI -ALADIN coupling-boundaries
- Interface some HI physics
- Implement climate generation software
- Introduce AROME system
- Experience from AROME from events -evaluate some HI physics
- Develop meso-scale diagnostics




Statistics for 1877 stations
Period: 20050401-20050420
Surface pressure
Solid RMS, dotted STDV, dashed BIAS, dashed grey is number of cases
D11
RCRa
ALD
hPa
2
1
0
-1
3
6
9
12
15
18
21
24
27
30
33
36
Forecast length (hours)
0.180 10³
0.160 10³
0.140 10³
0.120 10³
0.100 10³
8000
6000
4000
2000
0
Number of cases


Statistics for 1877 stations
Period: 20050401-20050420
Wind speed
Solid RMS, dotted STDV, dashed BIAS, dashed grey is number of cases
D11
RCRa
ALD
m/s
3
2
1
0
-1
0.200 10³
0.150 10³
0.100 10³
5000
0
Number of cases
3
6
9
12
15
18
21
24
27
30
33
36
Forecast length (hours)

HIRLAM research topics for the coming years
Strong contributions to ALADIN in collaboration

- HI physics improvements
- HI physics interfacing, 2005
- Meso-scale physics choices 2006-2007
- Synoptic scale 4D-VAR 2005-2007
- Meso-scale 3D-VAR 2005-2006
- Meso-scale 4D-VAR 2007-

- Meso-scale observations
  - radar winds 2005-
  - reflectivity 2006 -
  - GPS moisture 2005-
- Surface and SST assimilation
- Cloud imagery
- Large scale coupling
- Meso-scale validation
- Short range EPS / prob

minimum staffing in HIRLAM research

Year	Synoptic DA	Synoptic model	Meso DA	Meso model	Synoptic/ Meso EPS	Systems/ Verification	Total
2005	6 (+4)	5	0	5	1(+1)	5	22(27)
2006	5(+5)	5	2	6	1(+1)	5	24(30)
2007	5(+5)	5	2	7	1(+2)	5	25(32)
2008	4(+5)	4	3	9	1(+2)	5	26(33)
2009	3(+3)	4	4(+2)	9	1(+2)	5	26(33)
2010	2(+1)	3	5(+4)	10	1(+2)	5	26(33)

Summary

- Long term MoU and strategy
- More active areas – more resources
- Collaboration necessary – ALADIN – and also merge other components
- HIRLAM profile in joint code AND and active contributor and corresponding influence
- HIRLAM with authority over staff