



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Long-term verification of HIRLAM at FMI

Simo Järvenoja's inheritance

Kalle Eerola

Finnish Meteorological Institute



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Simo Järvenoja (1953 -2007)

- Simo was one of the HIRLAM pioneers, starting in 1985 in Copenhagen
- From the year 1989 he worked with Hirlam at FMI
- In 2004 he moved to the climate project at FMI
- Some of you had the possibility to work with him
- I worked very closely with Simo about 15 years

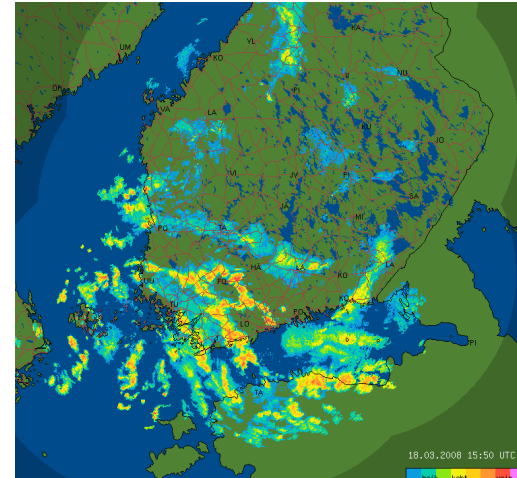


Photo by Pertti Nurmi

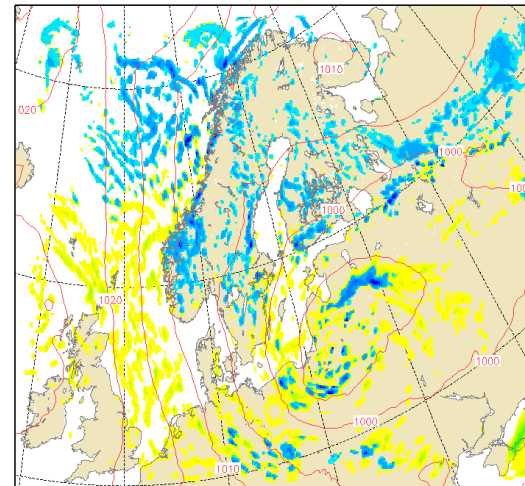


Introduction

- We can see more and more details in our forecasts
- The example is a cold outbreak situation 18 March 2008
- Above is radar picture at 15.55 UTC
- Below hourly precipitation from a +16 h forecast from FMI meso- β HIRLAM ($\Delta x \sim 7.5$ km)
- The forecast gives an impression of probability of showers
- Also in verification focus will go to verify smaller and smaller scales
- New verification methods are needed



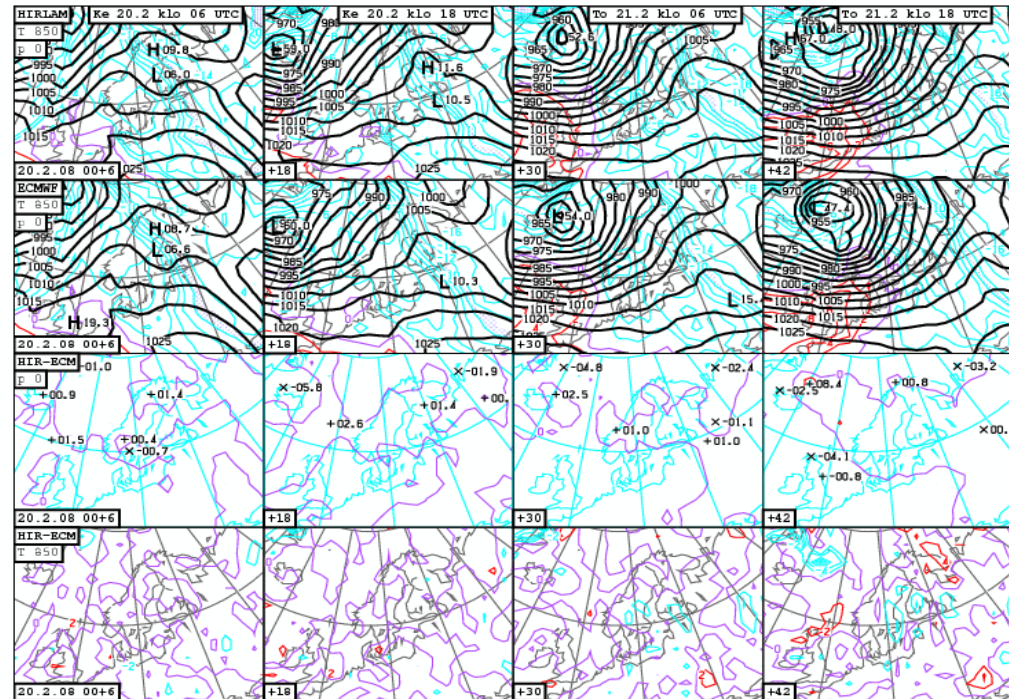
Pmsl and hourly prec. (mm) green:rain blue:snow
initial: 00Z18MAR2008 valid: 16Z18MAR2008





Synoptical scale verification

- However, in this presentation the focus is in synoptic scale
- In this scale there are nowadays typically only minor differences between different models
- Traditional verification scores (bias, rms-error, ...) are used in these scales
- Synoptic scale verification of HIRLAM at FMI is the topic of this presentation

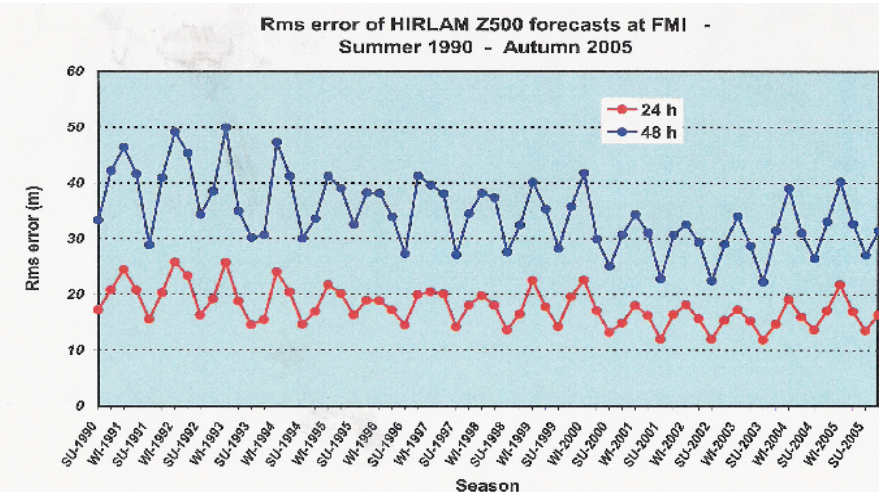
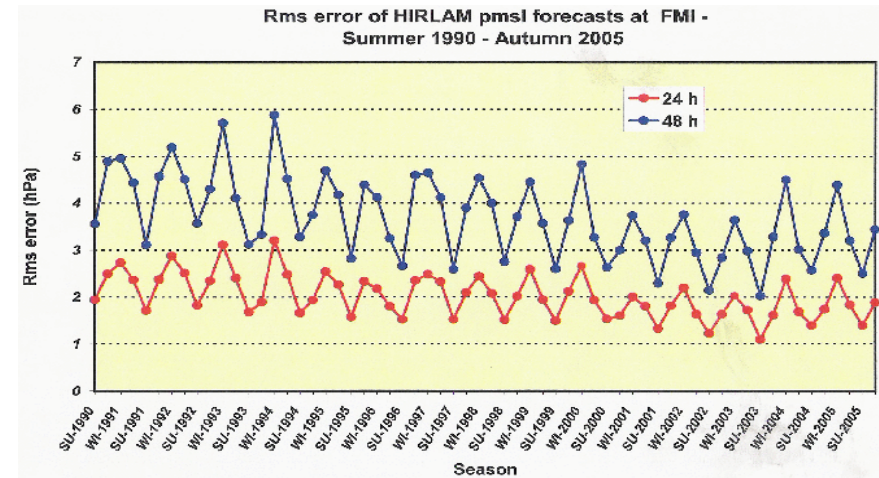


Surface pressure and T850 forecasts from HIRLAM and ECMWF and their differences



Simo Järvenoja's inheritance

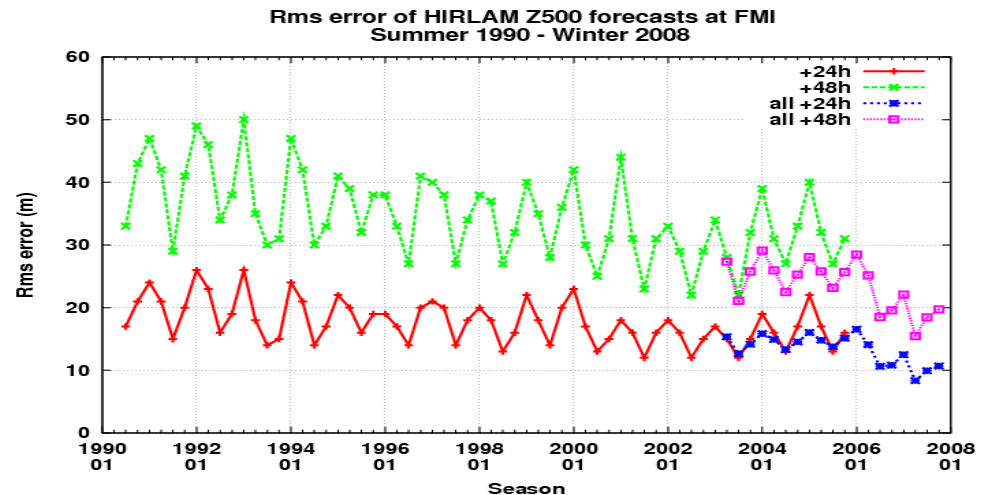
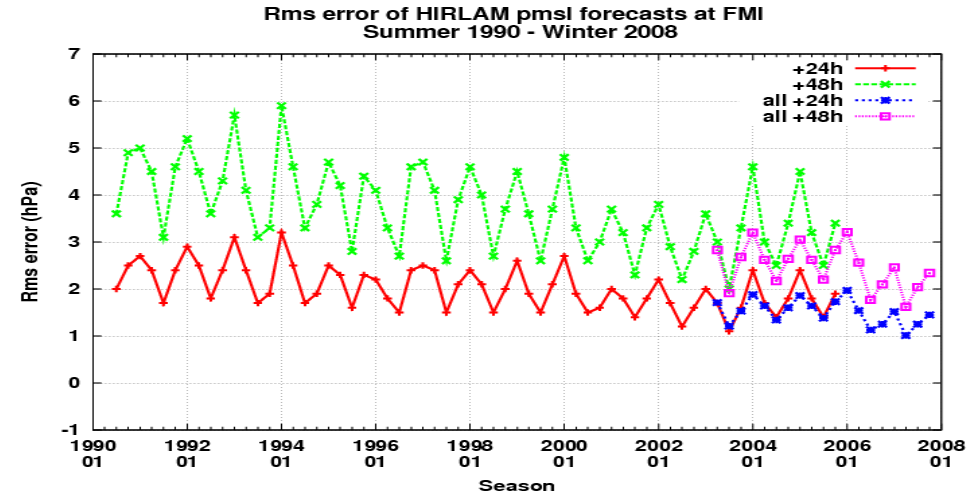
- While going through Simo's papers we find the following sheets of paper
- We knew that they are field verification scores
- Idea: continue the time-series up till now
- I picked up the values by hand
- Computed the corresponding values from RCR archive





Data from RCR archive added

- Field verification for the whole RCR area
- The curves do not fit!
- Something is wrong!
- I remembered discussions with Simo
- Another trial?



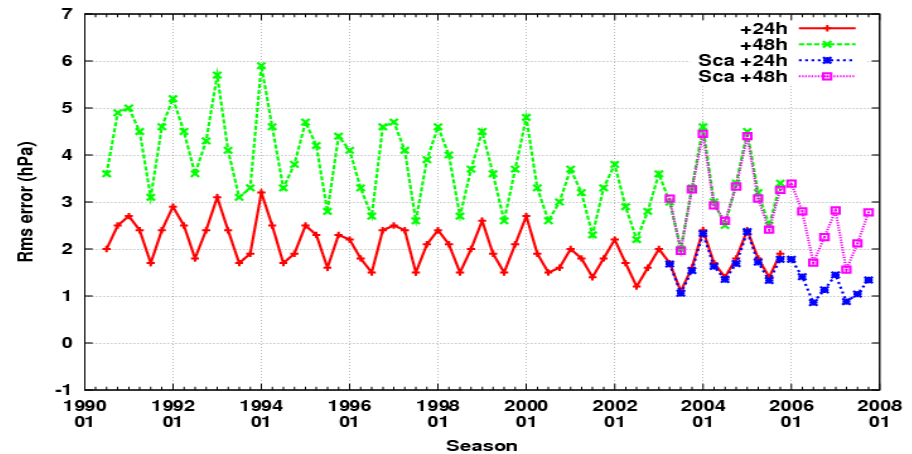


Field verification for Scandinavian area

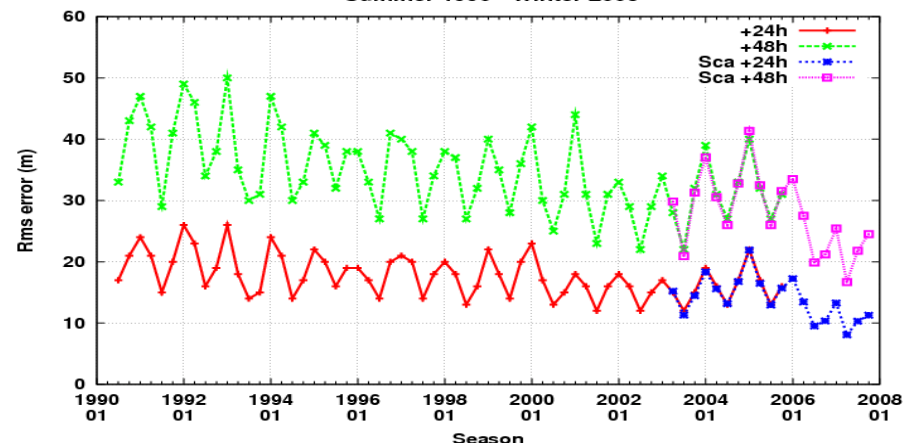
- Now we get quite a good fit
- If these numbers are correct, we have a substantial reduction in error during the latest years
- Resembles the figure from the observation verification

- End of part 1 of Simo's inheritance

Rms error of HIRLAM pmsl forecasts at FMI
Summer 1990 - Winter 2008



Rms error of HIRLAM Z500 forecasts at FMI
Summer 1990 - Winter 2008





Simo's inheritance, part 2

- I got access to the archives transferred from CSC to FMI
- I found the original field verification data gathered by Simo during the years
- Without remembering many discussions with Simo it had been very difficult to handle the data
- Monthly sums of
 - Forecasts, forecasts squared
 - Corresponding analysis and analysis squared
 - Forecasts x analysis
 - +06, +12, +18, +24, +30, +36, +42, +48 hour forecasts
 - Every second gridpoint
 - Binary files written with unformatted write, platform dependent
- Finally I succeeded in reading most of the data, some meso- β HIRLAM data is still unprocessed



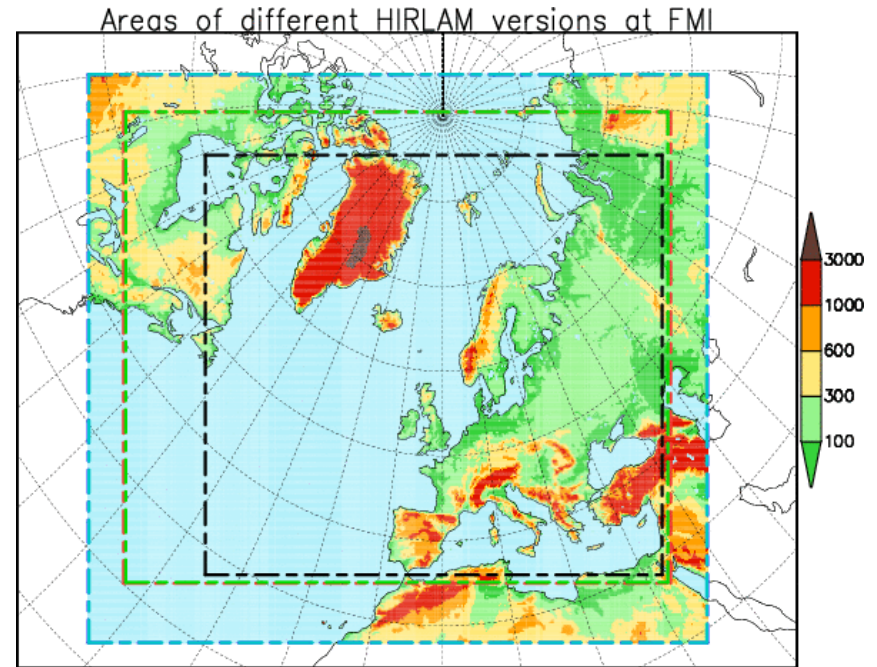
Characteristics of HIRLAMs at FMI 1990-2008

	Period	Duration	nx x ny	No points	DX	No levels	Version	Comments
FIN	01/1990 – 05/1994	53 mo	130 x 100	13 000	0.5	16		
SFI	06/1994 – 08/1996	27 mo	130 x 100	13 000	0.5	31?		
NSF	09/1996 – 08/1997	12 mo	194 x 140	27 160	0.4	31		
ATL	09/1997 – 11/1999	27 mo	194 x 140	27 160	0.4	31	Hirlam 2.5	
ATA	11/1999 – 06/2003	44 mo	194 x 140	27 160	0.4	31	Hirlam 4.6.2	
ATX	03/2003 – 03/2004	13 mo	256 x 186	47 616	0.3	40	Hirlam 5.1.4	3Dvar
V621	02/2004 – 05/2005	15 mo	438 x 336	147 168	0.2	40	Hirlam 6.3	First RCR
V637	06/2005 – 06/2006	13 mo	438 x 336	147 168	0.2	40	Hirlam 6.4	
V641	06/2006 – 03/2007	10 mo	438 x 336	147 168	0.2	40	Hirlam 7.0	
V71	03/2007 – xx/2008	> 12mo	582 x 448	260 736	0.15	60	Hirlam 7.1	



Areas of operational HIRLAMs at FMI

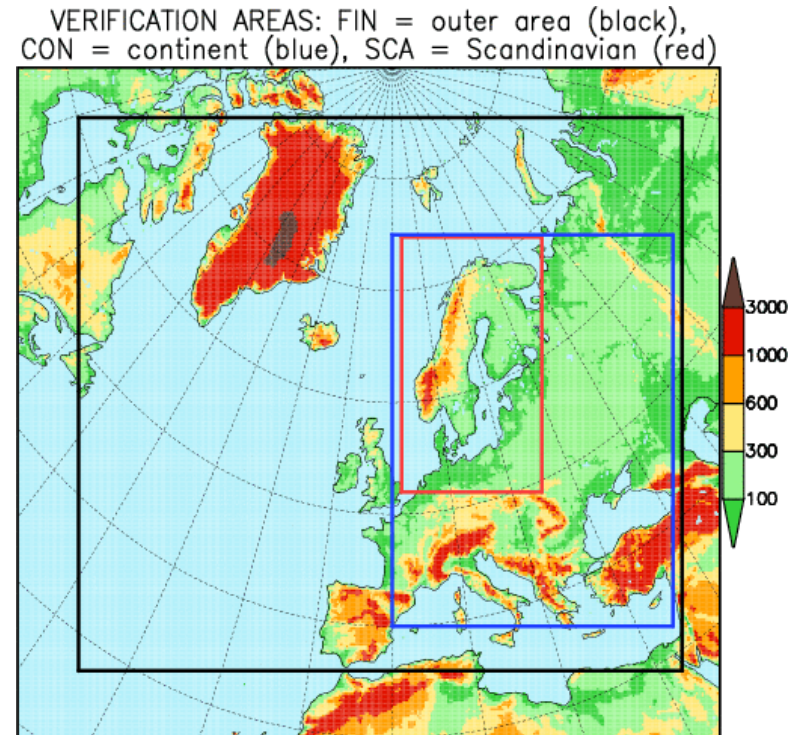
- The area has not changed so much
- Resolution has improved





Data and method

- Monthly bias and rms-error for mslp and constant pressure variables
- 06/1990 – 02/2003: Simo's data
- 03/2003 – 03/2008: Hirlam field verification
- Three areas:
 - **FIN:** black, largest common area
 - **CON:** blue, European continent
 - **SCA:** red, "Scandinavia", original Simo's Scandinavian area





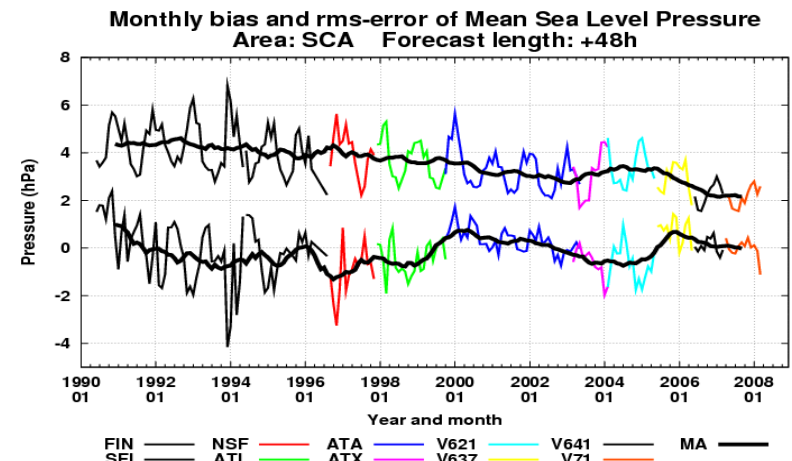
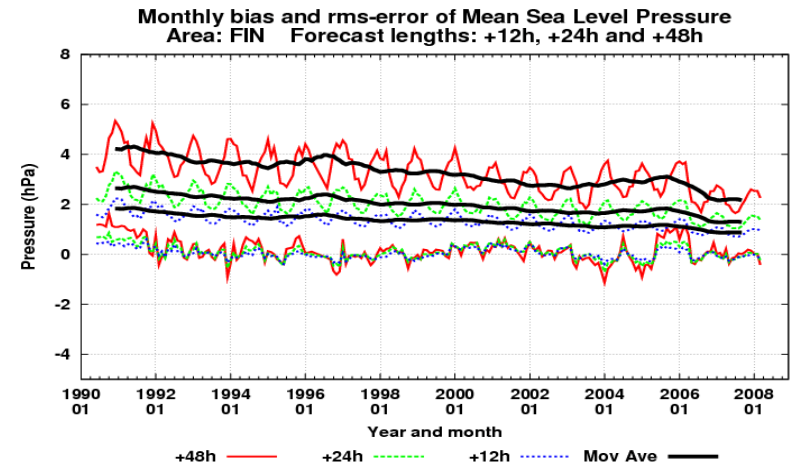
Mean sea level pressure

Large area:

- Rms-error from 4 hPa \rightarrow 2 hPa, in the mean
- Last two years (models version 7): a clear reduction, weather conditions?
- Reduction in seasonal cycle, seasonal cycle smaller in shorter forecasts
- +48h forecasts now better than +24h in early 1990's

Scandinavian area:

- Larger monthly/seasonal variation
- Reduced in the latest years
- V621 \rightarrow V637: turning of surface stress vector implemented





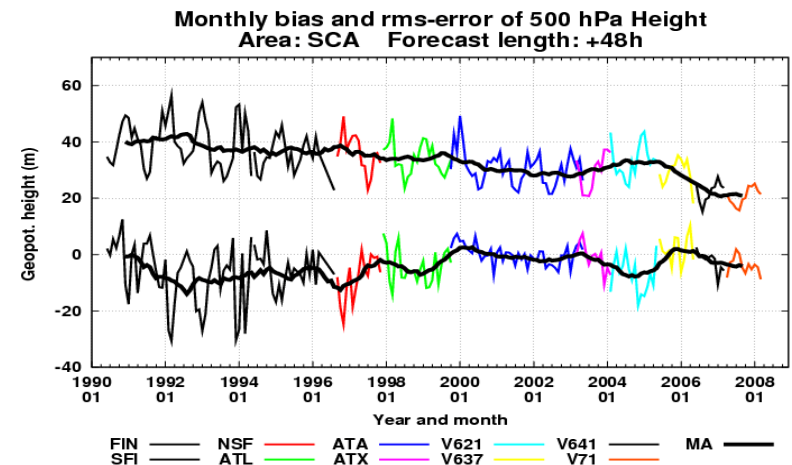
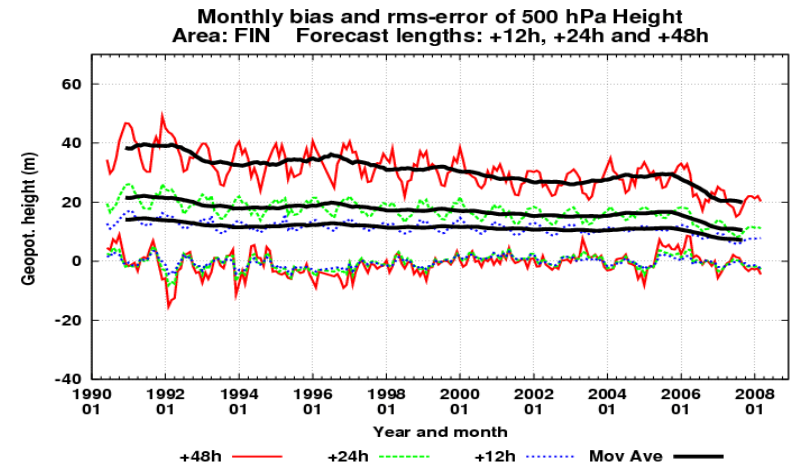
500 hPa height

Large area:

- Rms-error from early years' ~40 m → current ~20 m
- Last two years: reduction in error
- Changing model version can be seen in some cases

Scandinavian area:

- Large month-to-month oscillation reduced
- Last two years:





300 hPa height

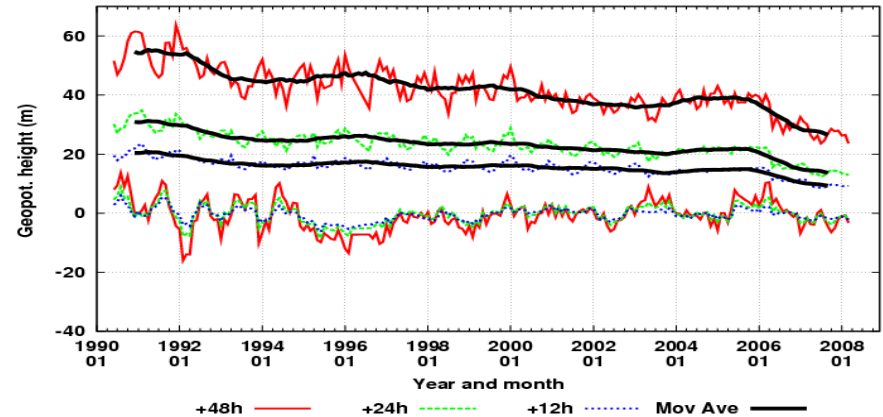
Large area:

- Rms-error from early years' >50 m → current ~30 m
- Last two years: reduction in error
- Changing model version can be seen in some cases

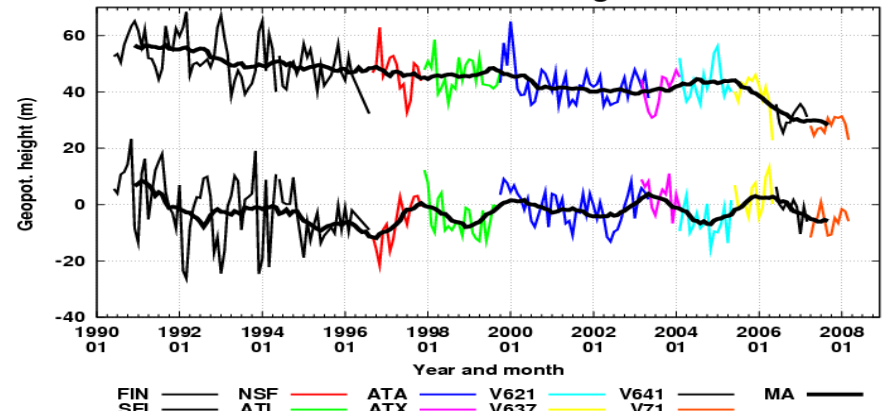
Scandinavian area:

- Large month-to-month oscillation reduced
- Last two years: very good

Monthly bias and rms-error of 300 hPa Height
Area: FIN Forecast lengths: +12h, +24h and +48h



Monthly bias and rms-error of 300 hPa Height
Area: SCA Forecast length: +48h





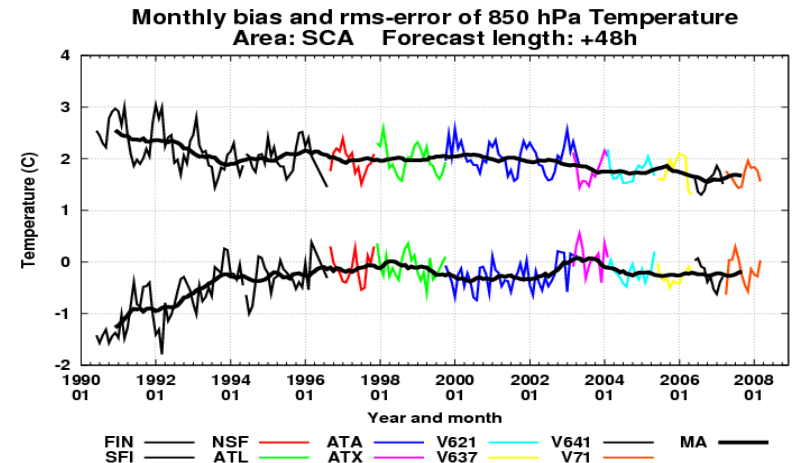
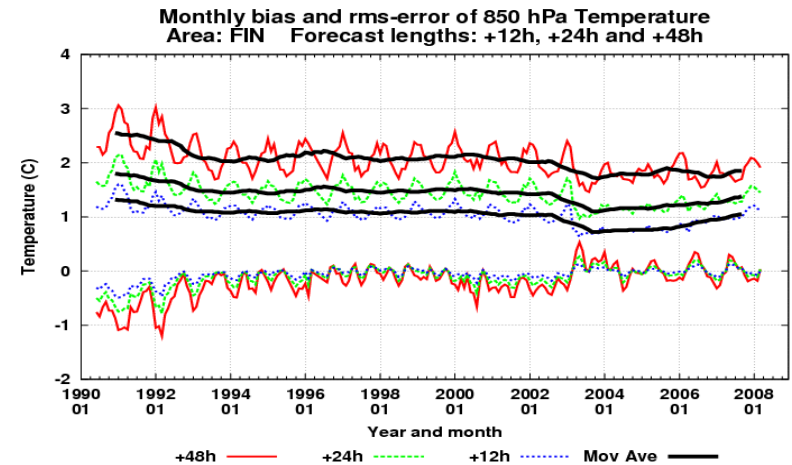
850 hPa temperature

Large area:

- Rms-error reduced and then stable
- ATX-version first 3Dvar-analysis

Scandinavian area:

- Small negative bias most of the time
- First version (FIN): large negative bias
- Savijärvi radiation scheme improved the situation





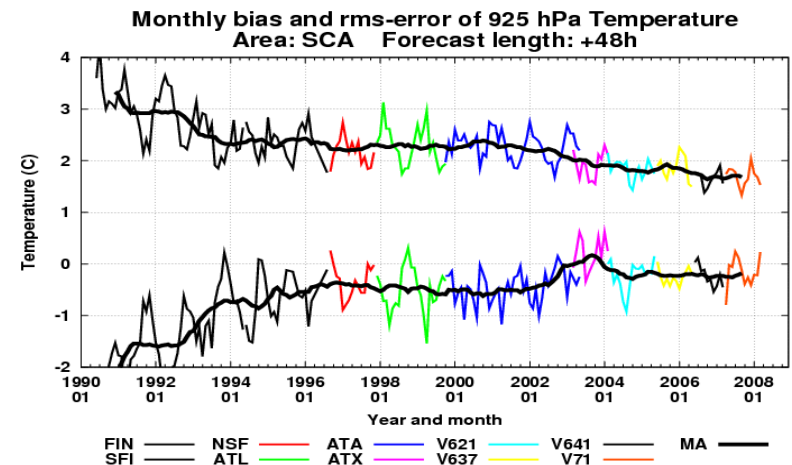
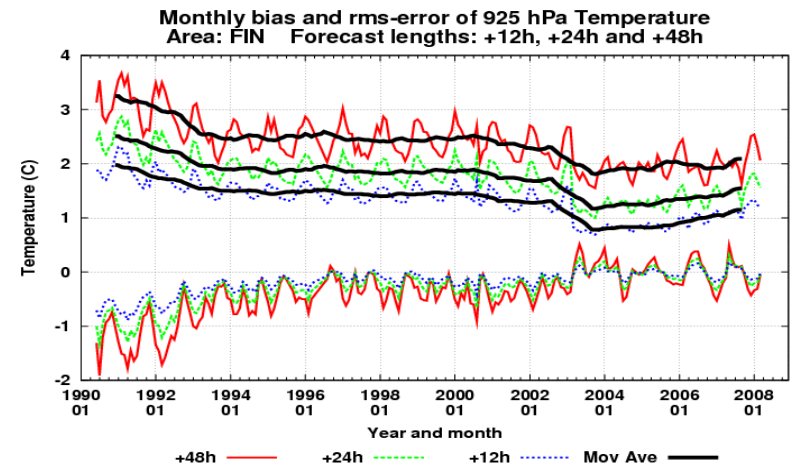
925 hPa temperature

Large area:

- Like 850 hPa, but enhanced
- Rms-error reduced and then stable
- ATX-version first 3Dvar-analysis \leftrightarrow bias

Scandinavian area:

- First version (FIN): large negative bias
- Savijärvi radiation scheme improved the situation
- Small negative bias most of the time
- This was changed in ATX, effect of 3DVAR?





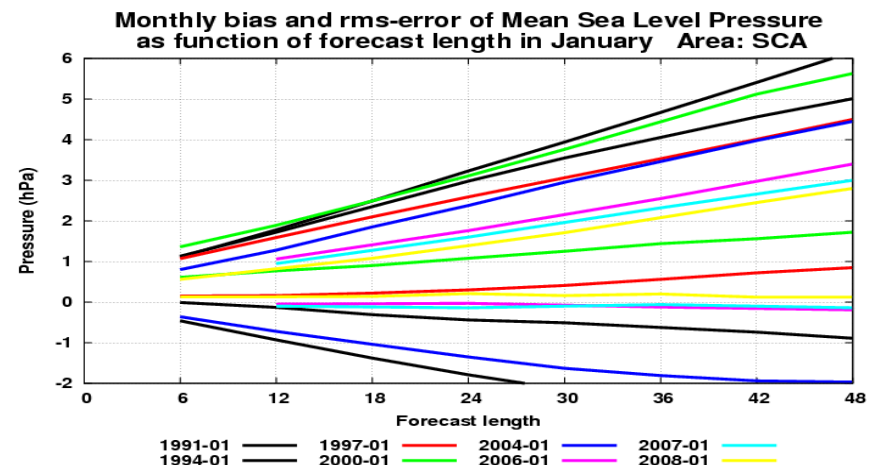
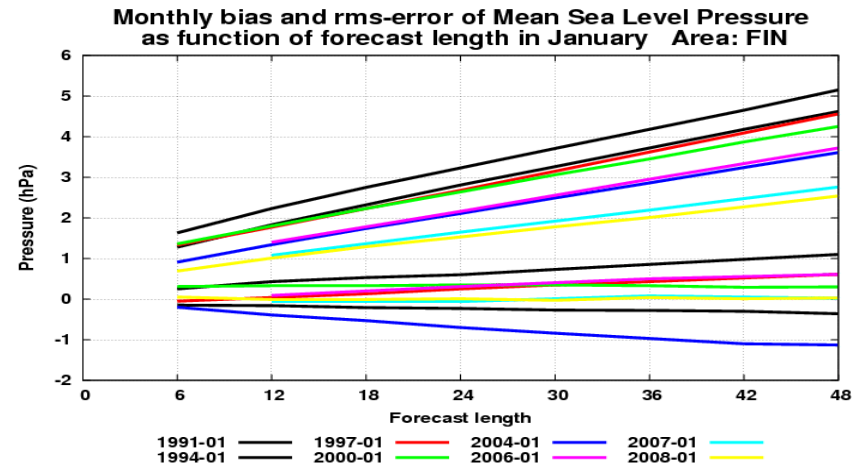
Forecast error as a function of forecast length

- Shown separately for January (winter) and July (summer)
- Eight years selected from the time-series



Mslp in January by forecast length

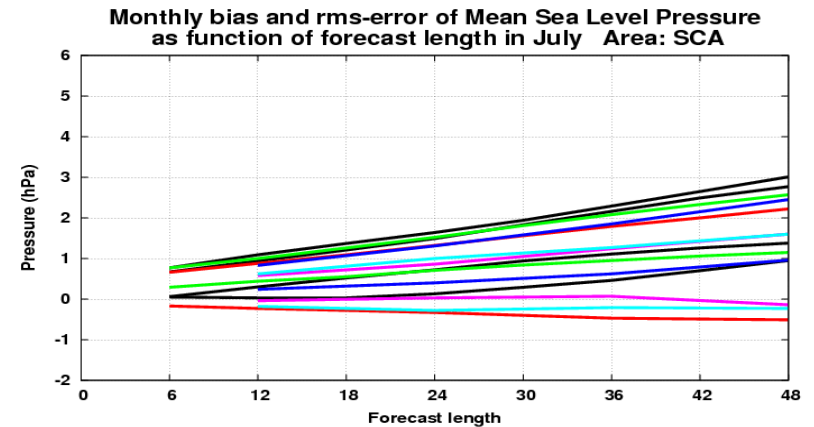
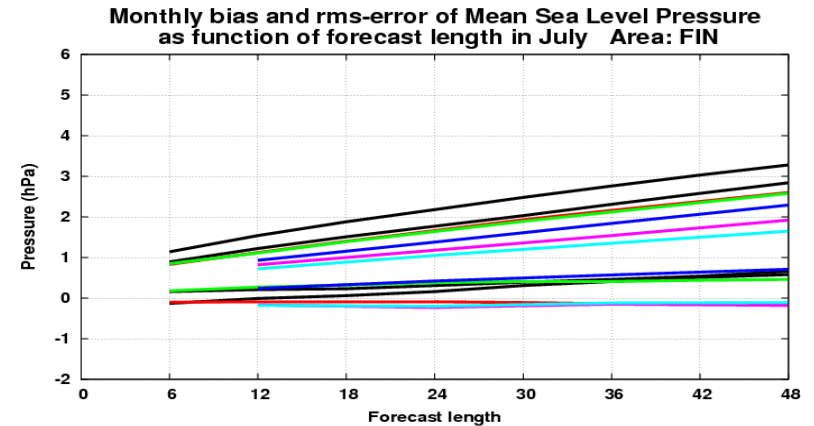
- Monthly bias and rms-error on selected years, large area above, Scandinavian area below
- A clear reduction is seen at all forecast lengths
- Rate of error growth (slope of curves) is reduced
- Especially in Scandinavia the negative bias in earlier models is seen
- Improved in recent model versions
- January 2004 (blue line) is exception from general trend





Mslp in July by forecast length

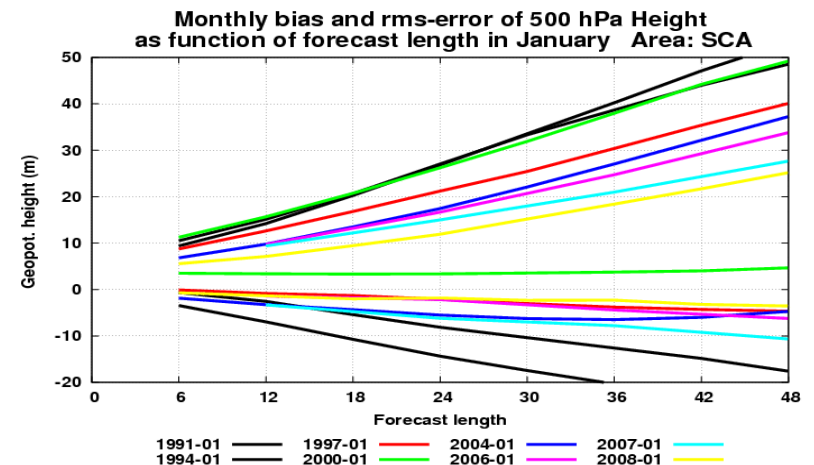
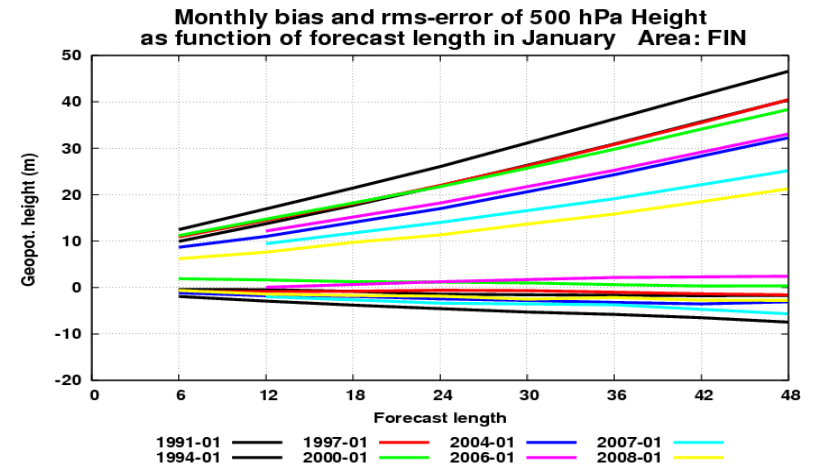
- Absolute values smaller
- So are also the differences between





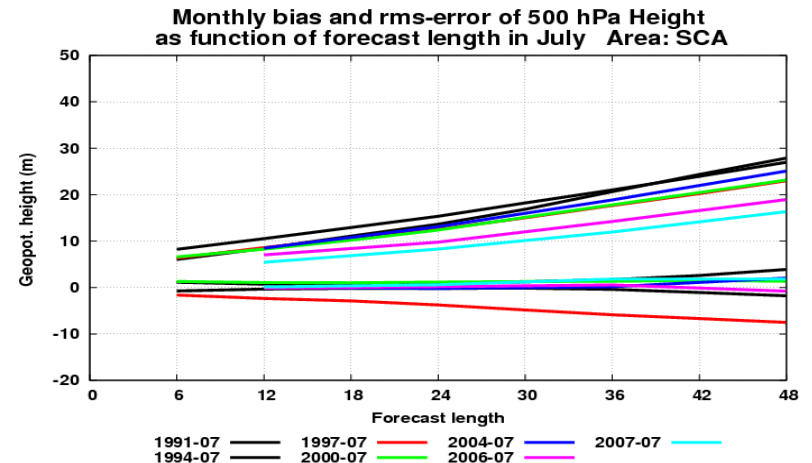
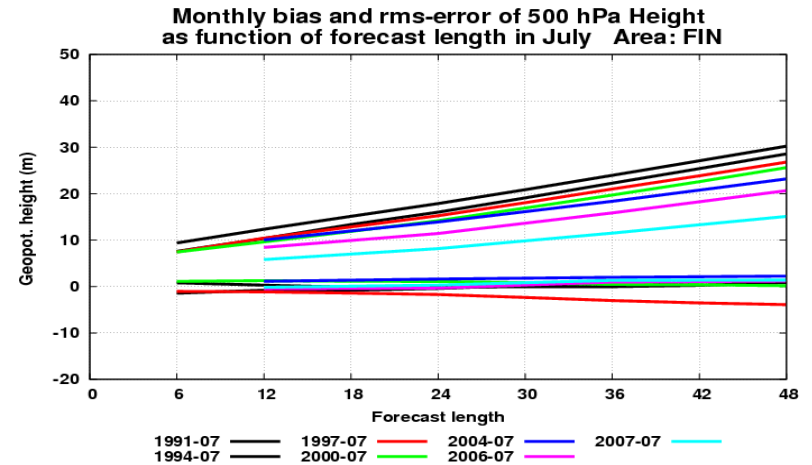
500 hPa height in January by forecast length

- Similar reduction is seen 500 hPa height
- The error growth rate (slope of the curves) has decreased





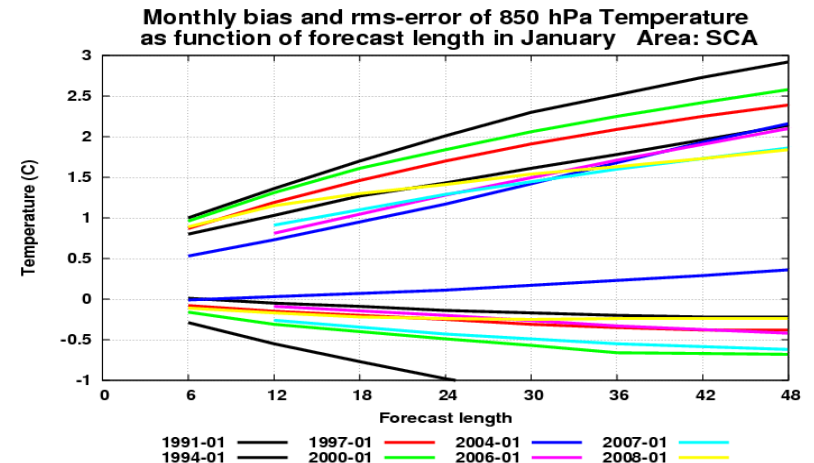
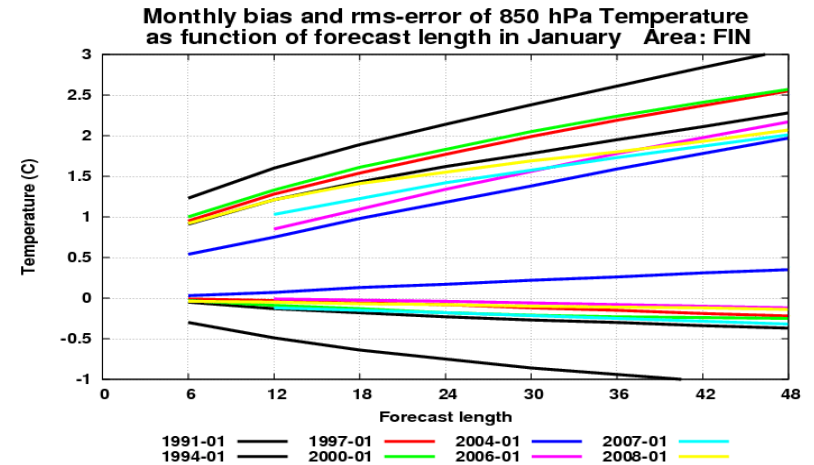
500 hPa height in July by forecast length





850 hPa temp. in January by forecast length

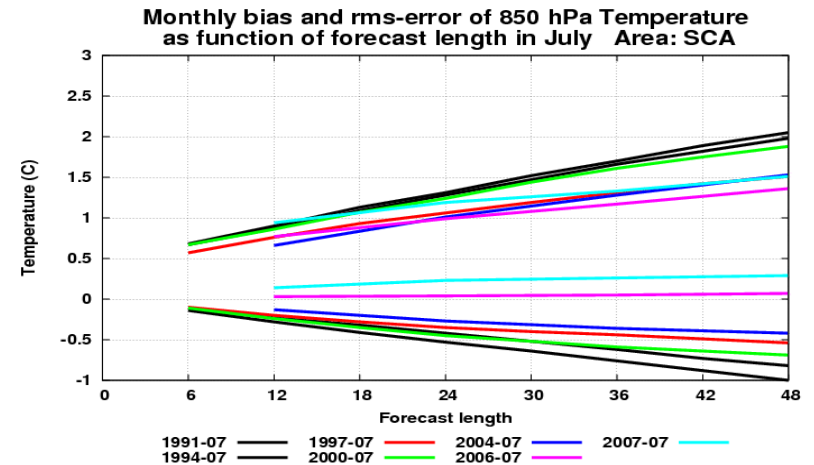
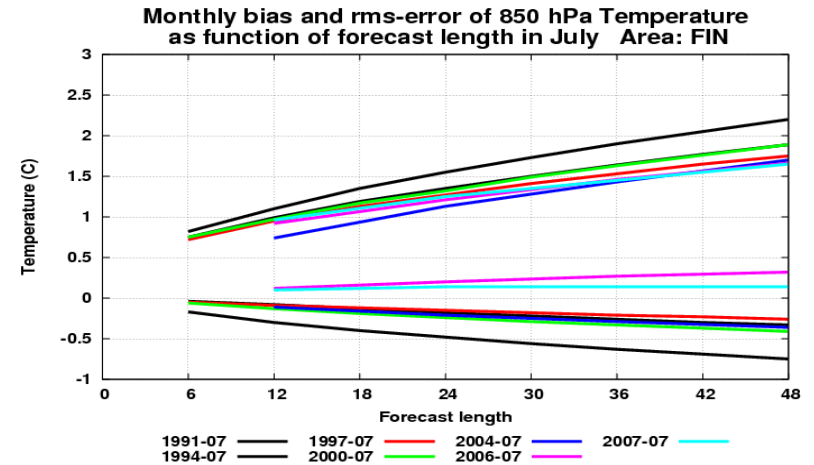
- Not so clear improvements in the latest years





850 hPa temp. in July by forecast length

- Reduction of negative bias





Verification against observations/analysis

Verification against observations

- Observations independent of the model
- Non-uniform spatial distribution, areas of sparse/no obs. coverage
- Differences in the availability at different synoptic hours
- Quality control
- Representativeness (spatial/temporal) obs \leftrightarrow forecasts

Verification against numerical analysis

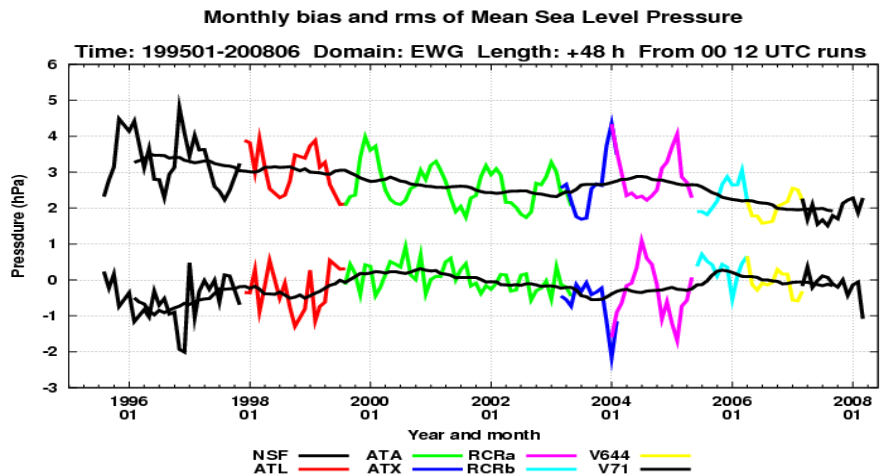
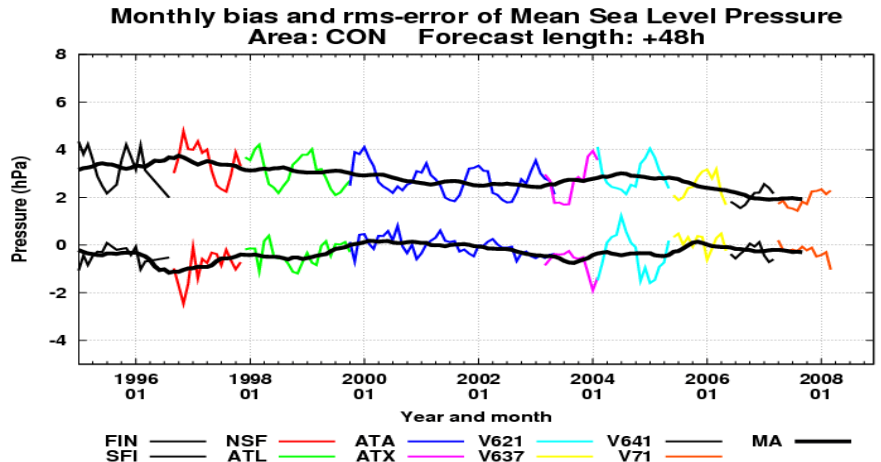
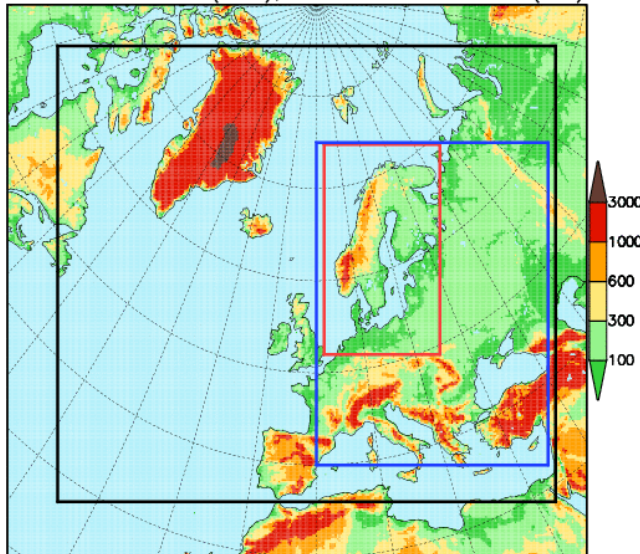
- Analysis may inherit errors of forecast \rightarrow too low error estimate
- Use of analysis, which is from independent data assimilation system
- Analysis close to first guess on areas of low observation coverage
- Tests at ECMWF: minor problem outside tropics, southern hemisphere and high in the stratosphere



Field verif. and obs. verif of mslp 1996- 2008

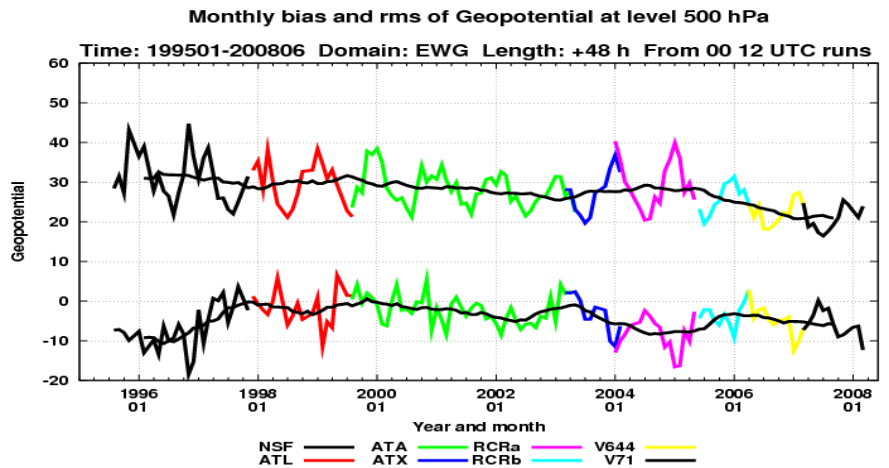
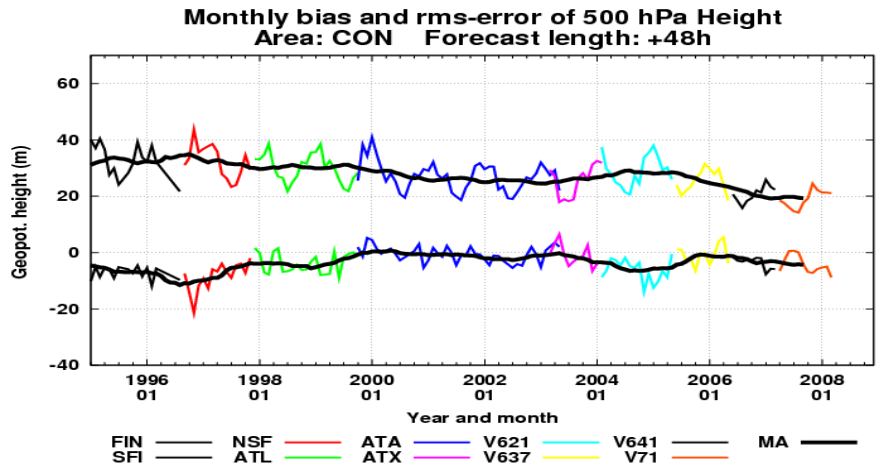
- EWGLAM station list in obs verification
- CON-area (blue): continental area in field verification: larger to the east

VERIFICATION AREAS: FIN = outer area (black),
CON = continent (blue), SCA = Scandinavian (red)





As previous but 500 hPa height





Summary

- This study was initiated by the papers/files found in Simo's archive
- Combined with Hirlam field verification data (computed from RCR archive) it was possible to create time-series of bias and rms-error for the whole HIRLAM time (1990-2008) at FMI
- In synoptic scale the magnitude of rms-error in +48 h forecasts has been halved since 1990
- The rate of error growth as a function of forecast length has decreased
- The progress has been very fast during the latest years
 - In many cases the fruits from many years' work has now become ripe
- **Personally this work has been very special for me:**
 - Many things reminded me about the years when I worked with Simo
 - During those years I learnt a lot from Simo

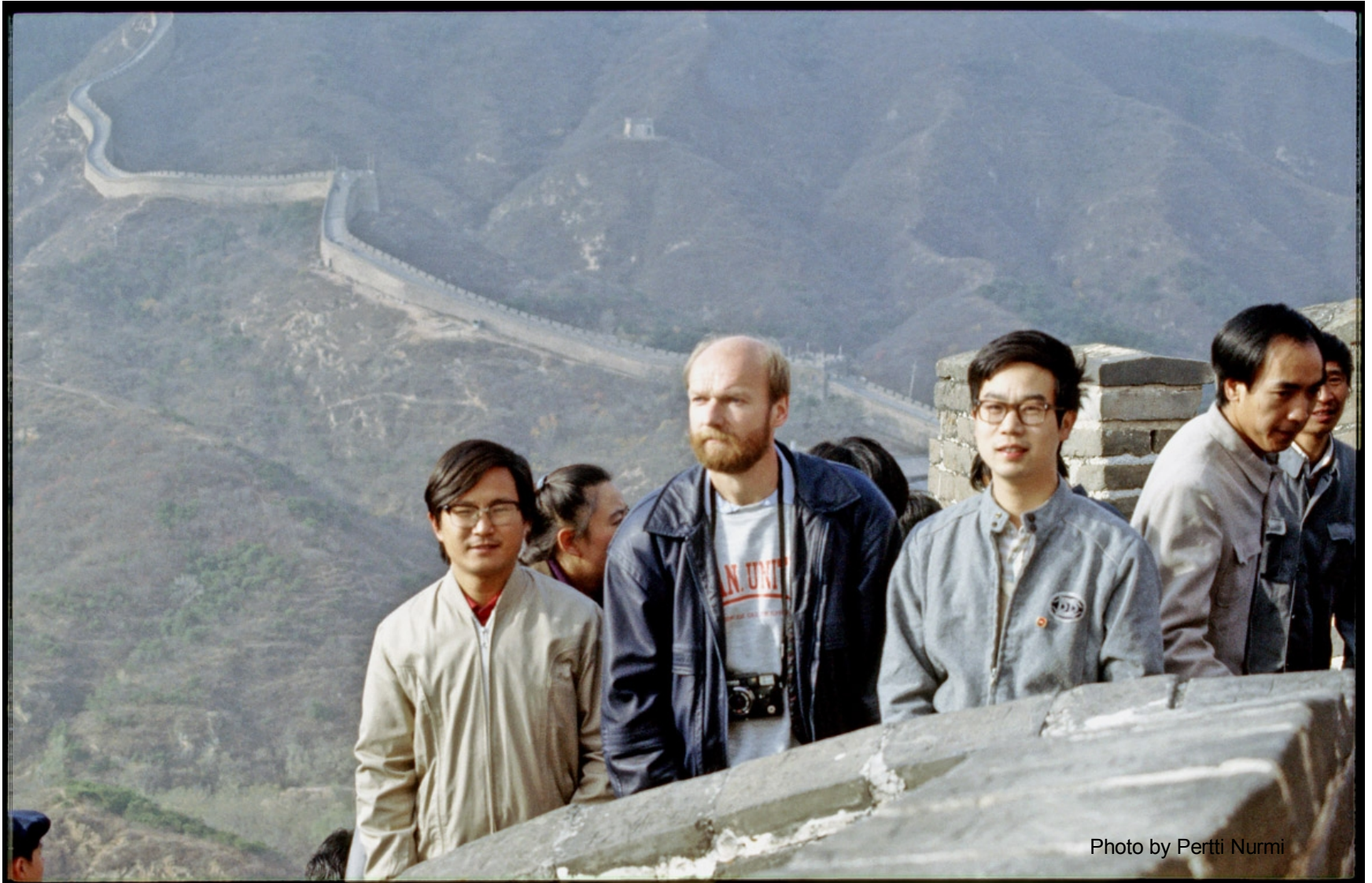


Photo by Pertti Nurmi