



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
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Validation of Hirlam 7.1

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Institute**



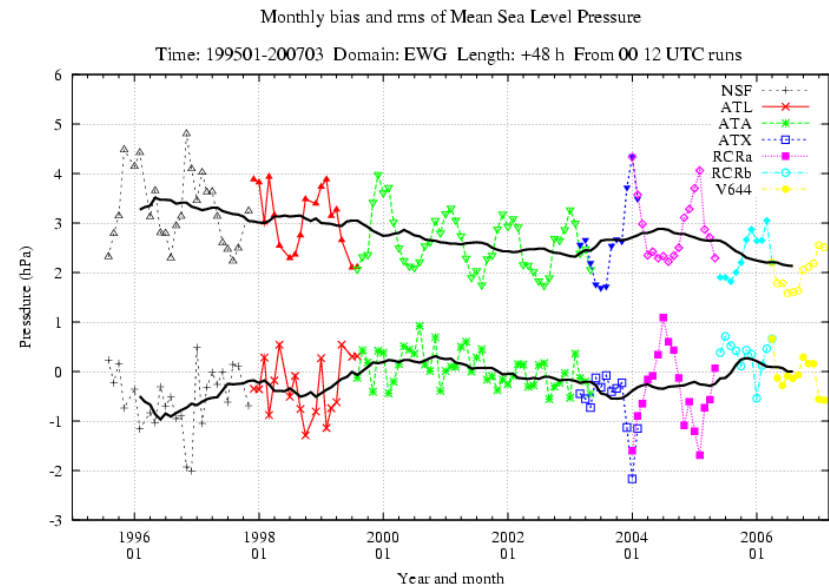
Menu

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- **Highlights of Hirlam 7.1**
- **Validation of Hirlam 7.1**
 - Experiments
 - Surface pressure
 - 2m-temperature
 - 10m-wind speed
 - Upper-air verification
 - Precipitation
 - Lowest and highest model levels
- **Summary**
- **For this audience**
 - I can show both progress and problems



Introduction

- **Hirlam reference system 7.1 was introduced 28 March 2007**
- **In the same day it became operational RCR at FMI**
- **Reference system and RCR**
 - The reference systems better tested because they must be ready for operational use (RCR)
 - More careful testing
 - Safer to implement as it is
 - Shorter parallel test periods required
- **Status of the reference system higher than earlier**





Highlights of Hirlam 7.1

- **Increased model resolution**
 - Horizontal resolution **0.15** degrees (previous **0.20**) on rotated coordinate
 - 60 vertical levels (previous 40 levels)
- **3D-VAR with 6 h assimilation cycle**
 - New background error structure functions
 - Minimization at full model resolution
 - Conjugate gradient minimization
 - Quality control limits re-defined

Heights of the lowest levels

| | 40 levels Height (m) | 60 levels Height (m) |
|---------|-------------------------|-------------------------|
| Nlev-12 | 1920 | 950 |
| Nlev-11 | 1654 | 855 |
| Nlev-10 | 1411 | 764 |
| Nlev-9 | 1192 | 678 |
| Nlev-8 | 992 | 596 |
| Nlev-7 | 814 | 516 |
| Nlev-6 | 654 | 440 |
| Nlev-5 | 513 | 367 |
| Nlev-4 | 388 | 297 |
| Nlev-3 | 279 | 227 |
| Nlev-2 | 183 | 160 |
| Nlev-1 | 101 | 95 |
| Nlev | 32 | 32 |



Highlights of Hirlam 7.1

- **Moist CBR and tuned STRACO**
 - In STRACO, prognostic cloud water and cloud ice is introduced instead of prognostic cloud condensate
 - In CBR scheme, moist conserved variables are mixed implying radically different treatment of clouds due to turbulence parameterization
 - In STRACO convective cloud cover has been updated and tuned
 - The optional condensation package, Kain Fritsh Rasch Kristjansson scheme, has been updated
- **Statistical balance structure function**
- **No filtering of cloud water/ice in digital filter initialization**
- **Improved wind maxima at model top.**



Highlights of Hirlam 7.1, technical

- **Extended post-processing stream**
 - more diagnostic parameters such as CAPE, precipitation type, gust wind, visibility, screen-level wind and temperature maxima/minima etc.
- **Revised standard forecast output stream**
 - Templates of output streams
 - User can more easily define his/her own output streams
- **Revised archiving strategy**
 - by default put significantly less data into archive
- **An enhanced ECMWF MARS data retrieval**
- **MSO/SSO parameters in climate generation**
- **HPCE as the standard platform on ECMWF**
- **Many bug fixes in climate generation to avoid data holes or round-off errors**
- **Bug fixes, code/scripts cleaning**



Highlights of Hirlam 7.1, built-in but not default

- **4D-VAR analysis for upper air data assimilation**
- **Optional SL-SETTLS advection scheme**
- **HIRLAM ensemble forecast generation scripts**
- **Optional surface relative humidity assimilation module**
- **AMV assimilation module to assimilate Atmospheric Motion Vector data from polar satellite (MODIS) and geostationary satellites (Meteosat 8).**
- **Optional analysis strategy NOUA**

- **New surface scheme (Nordic temperature problem)**
 - As a separate branch in the Hirlam system
 - Due to technical reasons cannot be an option in the reference system



Validation of Hirlam 7.1

- **Can't show all the test results**
- **Concentrate on three months**
 - March 2006
 - June 2006
 - January 2007
- **This presentation does not touch the benefit/drawback of higher resolution**
- **Main conclusions very similar for all periods**



Experiments

- **March 2006**

| | ECM701 | ECM71rc1 |
|-------------|-------------|-------------|
| Platform | ECMWF | ECMWF |
| Version | 7.0.1 | 7.1rc1 |
| Domain | RCR 7.0 | RCR 7.1 |
| Resolution | 0.2 / 40 | 0.15 / 60 |
| LSMIX | Yes | Yes |
| MIXINT | 12 | 12 |
| FGAT | yes | yes |
| FCINT | 03 | 06 |
| Obs. | ECMWF | ECMWF |
| BD Strategy | operational | operational |
| BDINT | 03 | 03 |
| NDTIME | 450 | 360 |

- **June 2006 (Xiaohua)**

| | ECM701 | ECM71 |
|-------------|-------------|-------------|
| Platform | ECMWF | ECMWF |
| Version | 7.0.1 | 7.1rc2 |
| Domain | RCR 7.0 | RCR 7.0 |
| Resolution | 0.2 / 40 | 0.2 / 40 |
| LSMIX | yes | yes |
| MIXINT | 12 | 12 |
| FGAT | yes | yes |
| FCINT | 03 | 06 |
| Obs. | ECMWF | ECMWF |
| BD Strategy | operational | operational |
| BDINT | 03 | 03 |
| NDTIME | 450 | 450 |



Experiments

- **January 2007**
 - Oper. RCR vs. 7.1rc1

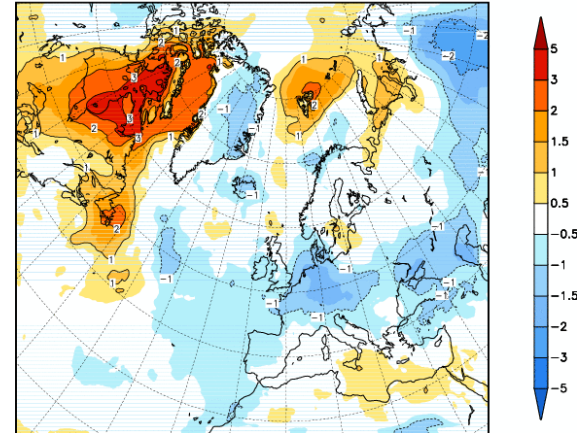
| | V644 | FMI71rc1 |
|-------------|--------------|--------------|
| Platform | FMI | FMI |
| Version | 7.0 | 7.1rc1 |
| Domain | RCR 7.0 | RCR 7.1 |
| Resol | 0.2 / 40 | 0.15 / 60 |
| LSMIX | Yes | Yes |
| MIXINT | 6 | 6 |
| FGAT | yes | yes |
| FCINT | 03 | 06 |
| Obs | RCR | RCR |
| BD Strategy | RCR-parallel | RCR-parallel |
| BDINT | 03 | 03 |
| NDTIME | 360 | 360 |



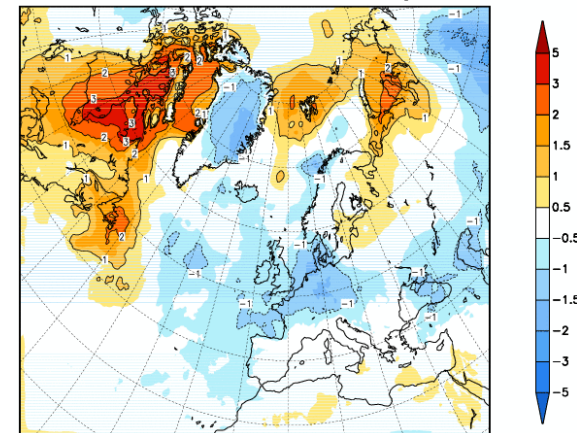
Surface pressure

- **Results from field verification**
- **Very similar for obs. verification**
- **Typical HIRLAM patterns after LSMIX implementation**
- **January 2007**
 - Negative bias in Central Europe
 - Positive over Canada and Arctic Sea
- **Basic features similar in both experiments**

Bias of Surface Pressure hPa Ident: V644 NO: 31
First date: 2007010100 Init. time 00 Length +48



Bias of Surface Pressure hPa Ident: FM171rc1 NO: 31
First date: 2007010100 Init. time 00 Length +48

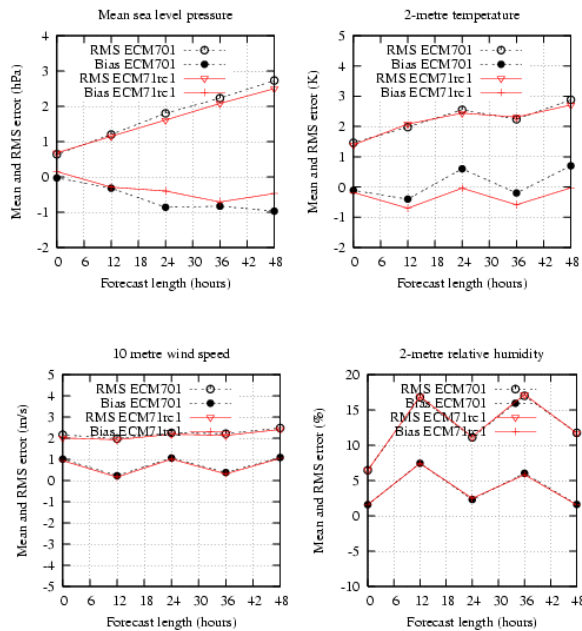




Surface pressure, EWGLAM

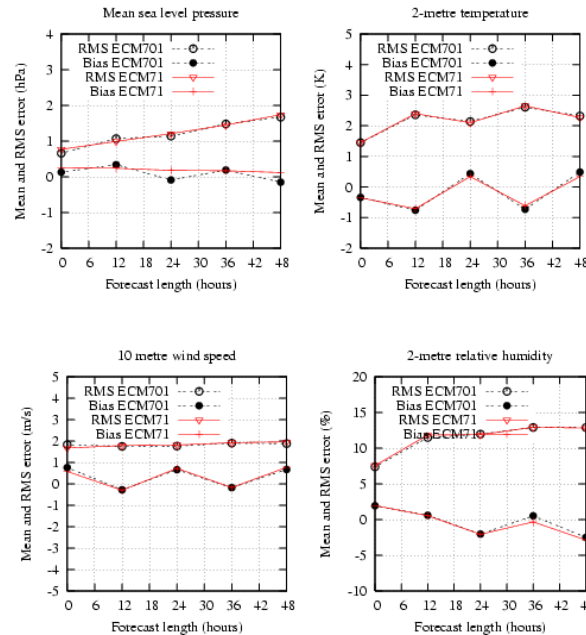
Verification against observations EXP: ECM701 ECM71rc1

Time: 2006030100 - 2006033118 Domain: EWG Forecast from 00



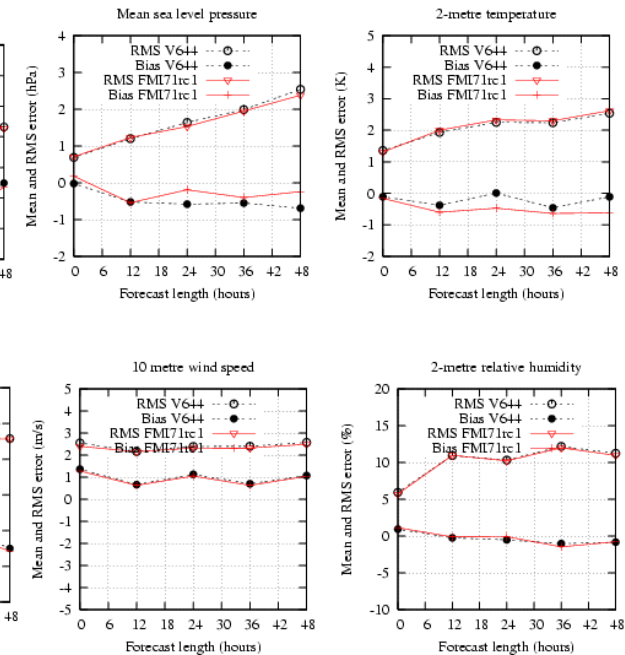
Verification against observations EXP: ECM701 ECM71

Time: 2006060100 - 2006063018 Domain: EWG Forecast from 00



Verification against observations EXP: V644 FMI71rc1

Time: 2007010100 - 2007013118 Domain: EWG Forecast from 00

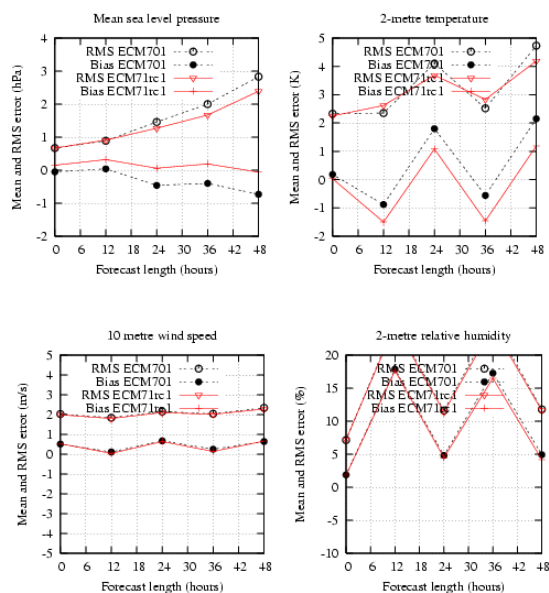




Surface pressure, EWGLAM

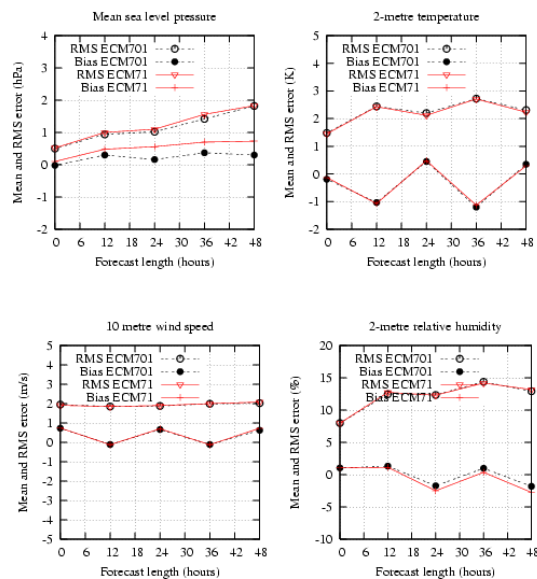
Verification against observations EXP: ECM701 ECM71rc1

Time: 2006030100 - 200603118 Domain: Son Forecast from 00



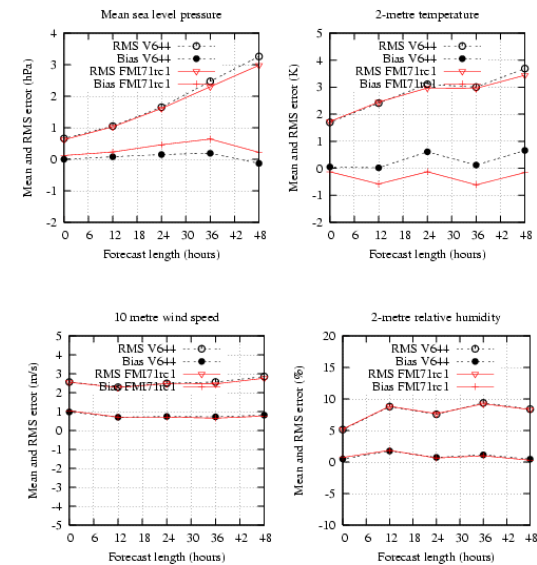
Verification against observations EXP: ECM701 ECM71

Time: 2006060100 - 2006063018 Domain: Son Forecast from 00



Verification against observations EXP: V644 FMI71rc1

Time: 2007010100 - 2007013118 Domain: Son Forecast from 00

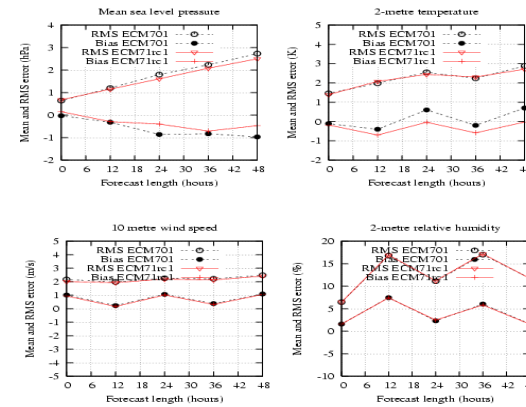




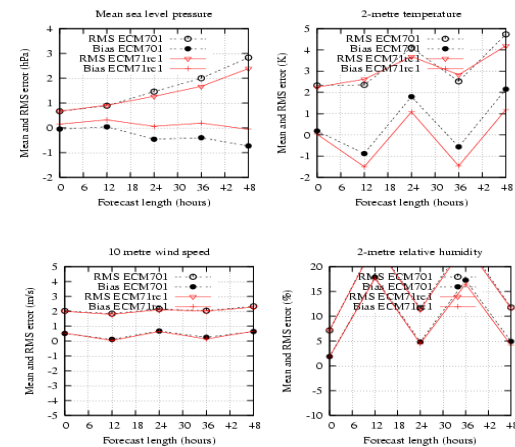
2-metre temperature and humidity

- **March 2006, EWG (upper) and Scn (lower)**

Verification against observations EXP: ECM701 ECM71rc1
Time: 2006030100 - 2006033118 Domain: EWG Forecast from 00



Verification against observations EXP: ECM701 ECM71rc1
Time: 2006030100 - 2006033118 Domain: Scn Forecast from 00



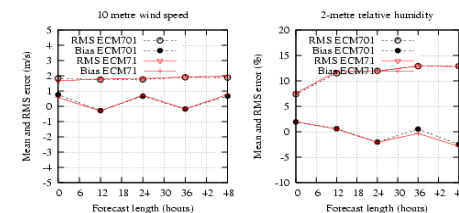
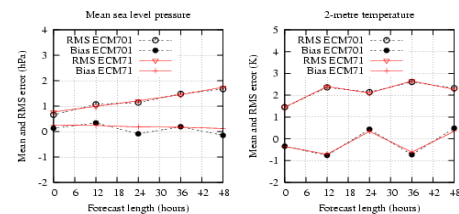


2-metre temperature and humidity

- June 2006, EWG (upper) and Scn (lower)
- Very little differences

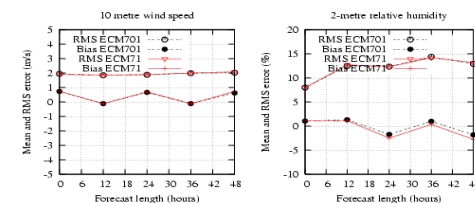
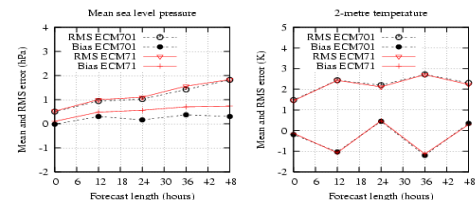
Verification against observations EXP: ECM701 ECM71

Time: 2006060100 - 2006063018 Domain: EWG Forecast from 00



Verification against observations EXP: ECM701 ECM71

Time: 2006060100 - 2006063018 Domain: Scn Forecast from 00



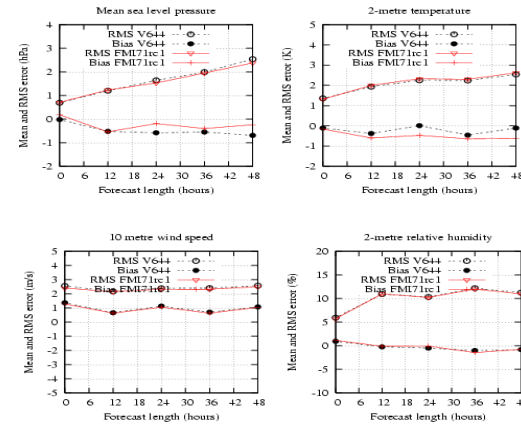


2-metre temperature and humidity

- **January 2007, EWG (upper) and Scn (lower)**

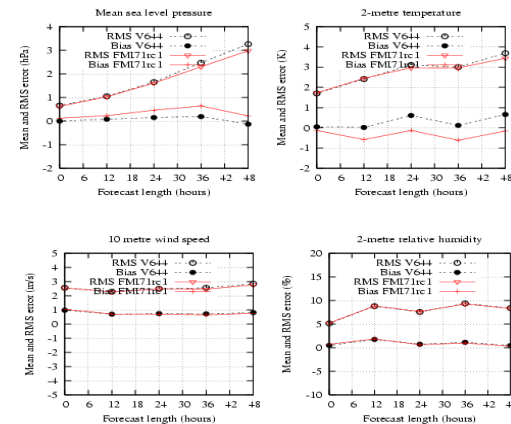
Verification against observations EXP: V644 FMI71rc1

Time: 2007010100 - 2007013118 Domain: EWG Forecast from 00



Verification against observations EXP: V644 FMI71rc1

Time: 2007010100 - 2007013118 Domain: Scn Forecast from 00





10-meter wind

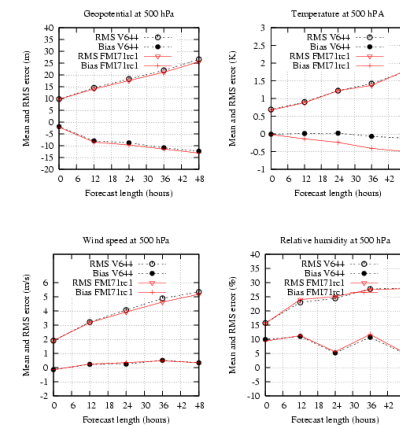
- **Very similar in both systems**



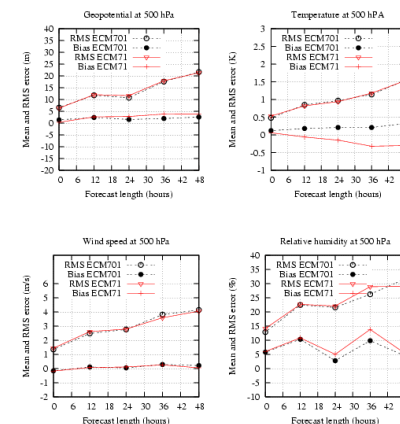
Upper air conditions

- 500 hPa for EWG and Scn
- Negative bias in temperature
- Reflected in geopotential in upper levels
- Similar in all periods

Verification against observations EXP: V644 FMI71rc1
Time: 2007010100 - 2007013118 Domain: EWG Forecast from 00



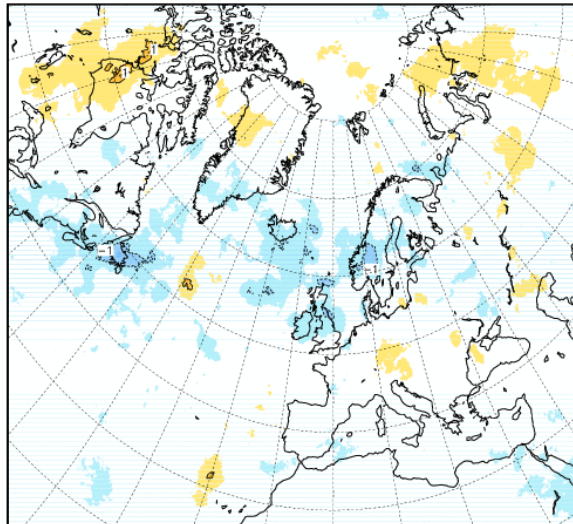
Verification against observations EXP: ECM701 ECM71
Time: 2006060100 - 2006063018 Domain: Scn Forecast from 00



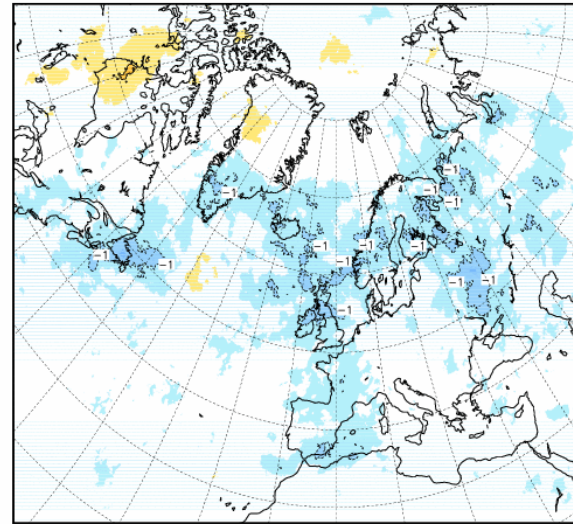


Temperature at 500 hPa

Bias of Temperature Level 500 hPa Ident: V644 NO: 31
First date: 2007010100 Init. time 00 Length +48



Bias of Temperature Level 500 hPa Ident: FMI71rc1 NO: 31
First date: 2007010100 Init. time 00 Length +48

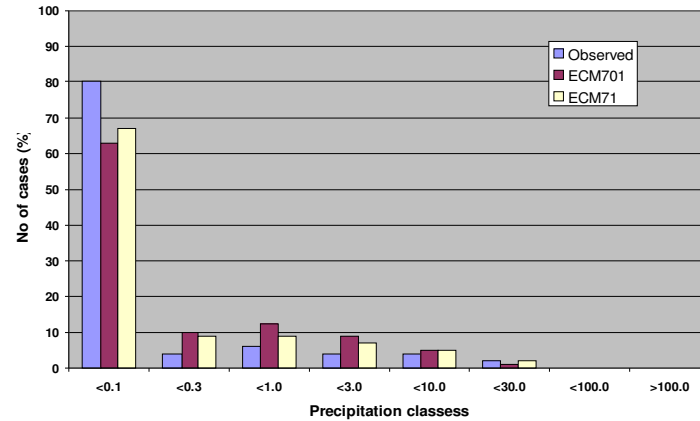




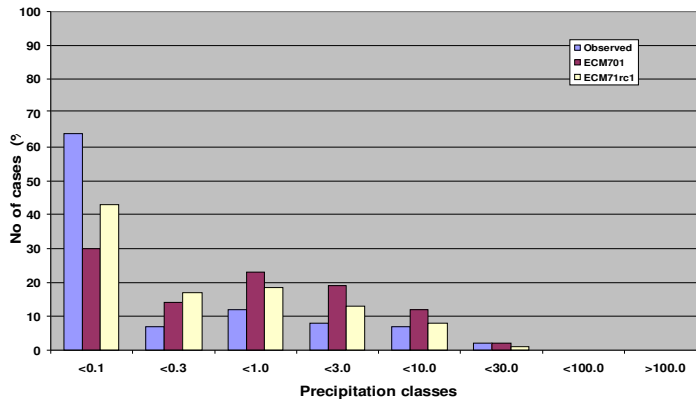
Precipitation

- **Number of observed/forecast cases (in % of all cases)**
- **EWGLAM stations**
- **+42 hour forecasts, previous 12 hour precipitation**

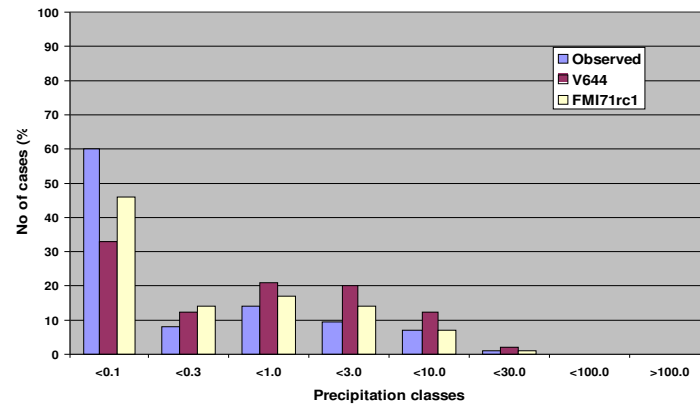
Obs. and forecast rain, June 2006, EWGLAM



Obs. and forecast rain, March 2006, EWGLAM stations



Obs. and forecast rain, Jan 2007, EWGLAM stations

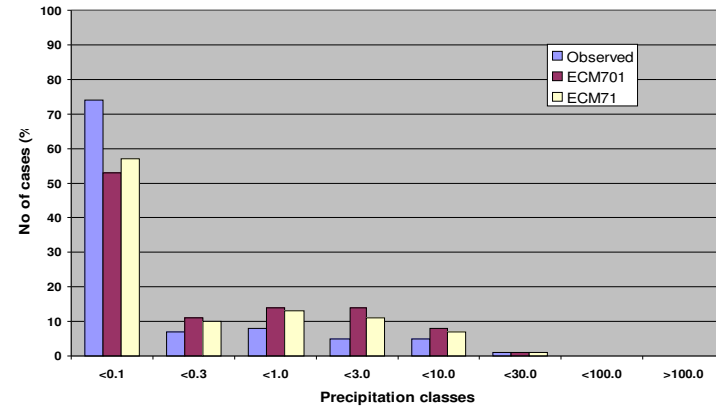




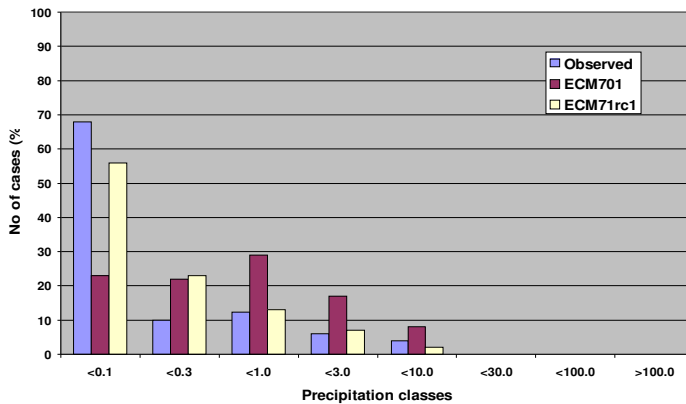
Precipitation, continued

- As previous, but for Scandinavian stations

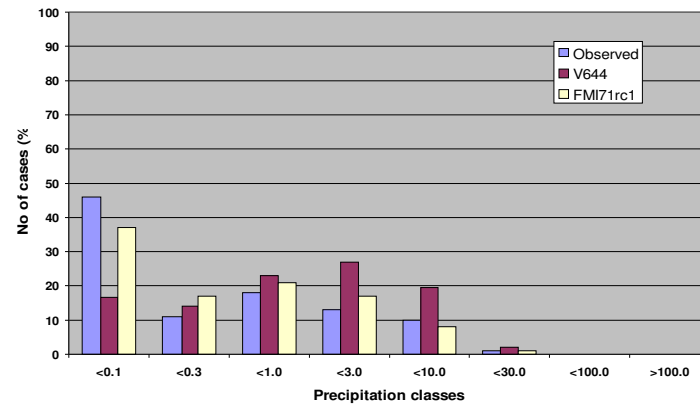
Obs. and forecast rain, June 2006, Scn stations



Obs. and forecast rain, March 2006, Scn stations



Obs. and forecast rain, Jan 2007, Scn stations

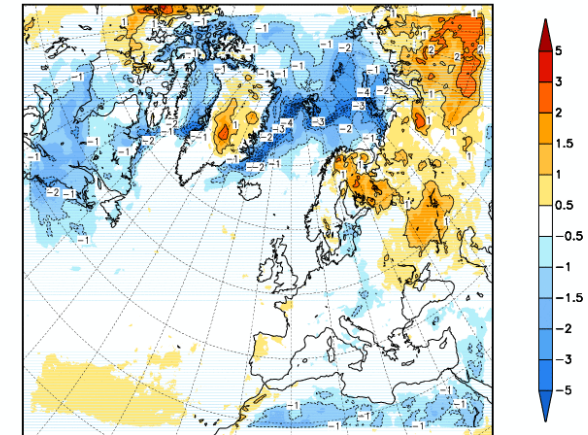




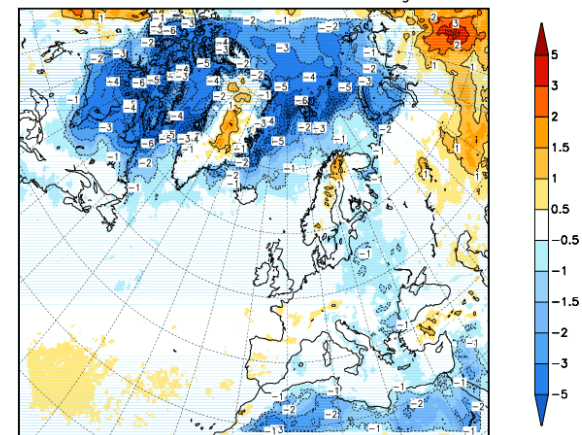
Lowest model level temperatures

- **Mean difference of +48 hour forecast of lowest model level from analysis**
- **ECMWF analysis affects the Hirlam analysis**
- **Drift from the analysis**
 - Towards cold over the ice-covered Arctic areas
 - Towards warm in Siberia, especially in March
- **Imbalance between the EC-blended analysis and Hirlam forecast “climatology”**
- **Old surface scheme, how in new surface scheme?**
- **Not seen in summer**

Bias of Temperature Model level 60 Ident: ECM71rc1 NO: 33
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Bias of Temperature Model level 60 Ident: FM71rc1 NO: 31
First date: 2007010100 Init. time 00 Length +48

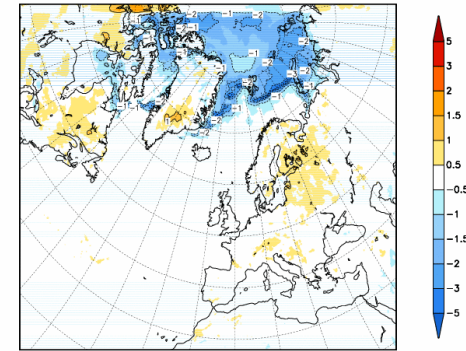




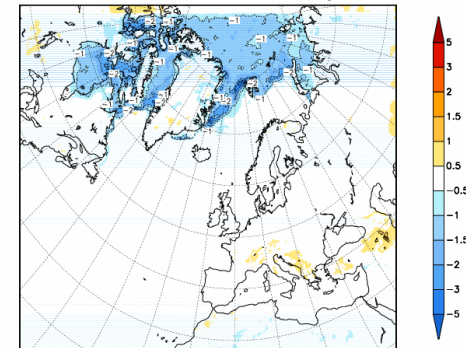
Lowest model level temperatures

- **Mean difference of +6 hour forecast of lowest model level from analysis**
- **Starts to drift from the analysis**

Bias of Temperature Model level 60 Ident: ECM71rc1 NO: 30
First date: 2006030106 Init. time 00 Length +06



Bias of Temperature Model level 60 Ident: FMI71rc1 NO: 30
First date: 2007010106 Init. time 00 Length +06

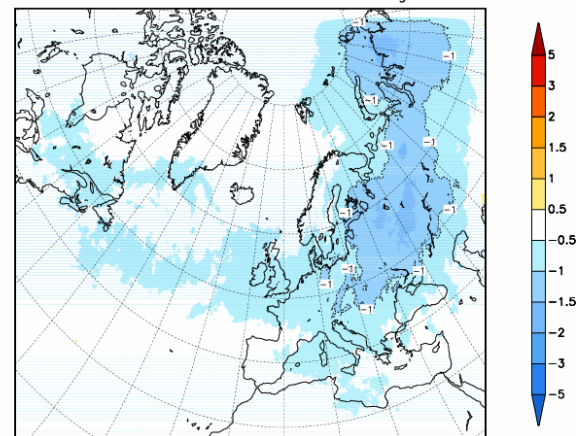




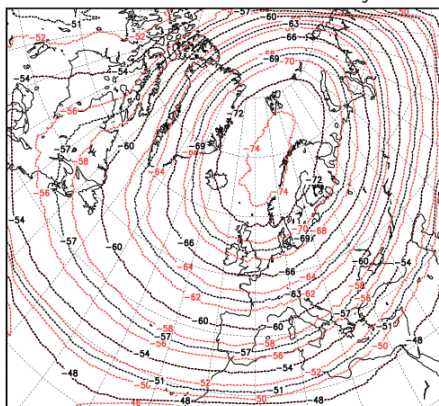
Highest model level temperature

- **Bias of temperature on highest level at +06 and +48 hour forecasts (left)**
- **Climatology below**
- **Cold bias (drift) is related to warm temperatures and cold bias (drift) to cold temperatures**
- **The role of EC-blending**
- **Does it creep downwards?**
- **Do we need upper boundary relaxation?**

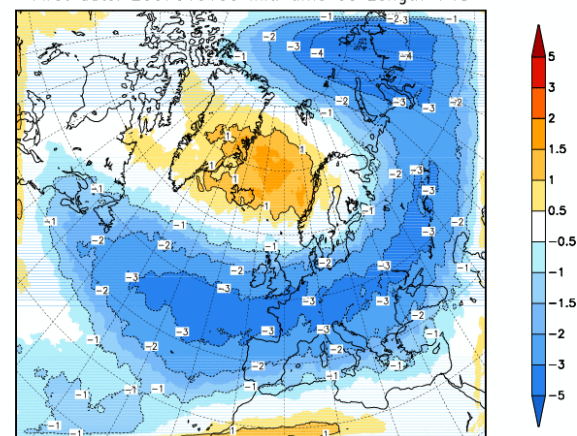
Bias of Temperature Model level 1 Ident: FMI71rc1 NO: 30
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Climat. of Temperature Model level 1 Ident: FMI71rc1 NO: 30
First date: 2007010100 Init. time 00 Length +06



Bias of Temperature Model level 1 Ident: FMI71rc1 NO: 31
First date: 2007010100 Init. time 00 Length +48





Summary

- **Reviewed the most important changes in Hirlam 7.1**
 - Resolution
 - CBR and Straco modifications
 - New post-processing features
 - Bug-fixes, technical developments, cleaning
- **A lot of tests have been run, meteorologically safe to implement**
- **March 2006, June 2006 and January 2007 experiments**
- **Improvements in no-precipitation/light precipitation forecasts**
- **Cold bias in temperature in mid-troposphere**
- **Bias in lowest model level temperatures**
 - Hopefully improved in new surface scheme
- **Bias in highest model level temperatures**
 - Need for upper boundary relaxation to ECMWF model?
- **FMI (or at least me) was not afraid of implementing Hirlam 7.1 as RCR and operational system of FMI**



Yhteystiedot

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