Recent developments of the Rasch-Kristjansson scheme in Hirlam

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Brussels

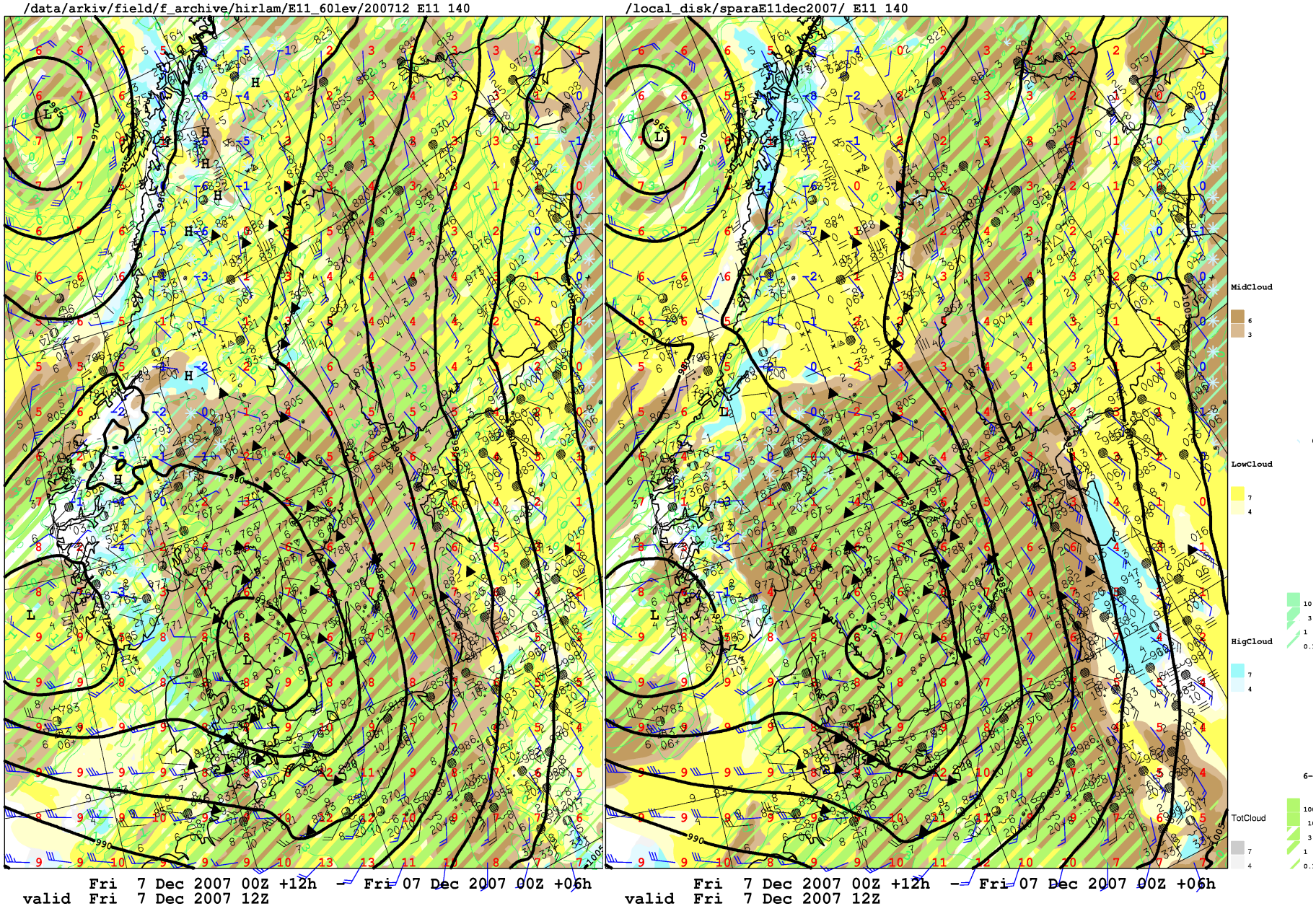
In this presentation:

- Problems with the Hirlam 7.1.2 RK version
- Short presentation of the new RK (CAM3) version
- Prognostic cloud ice.
- Verifications
- Remaining problems and future work

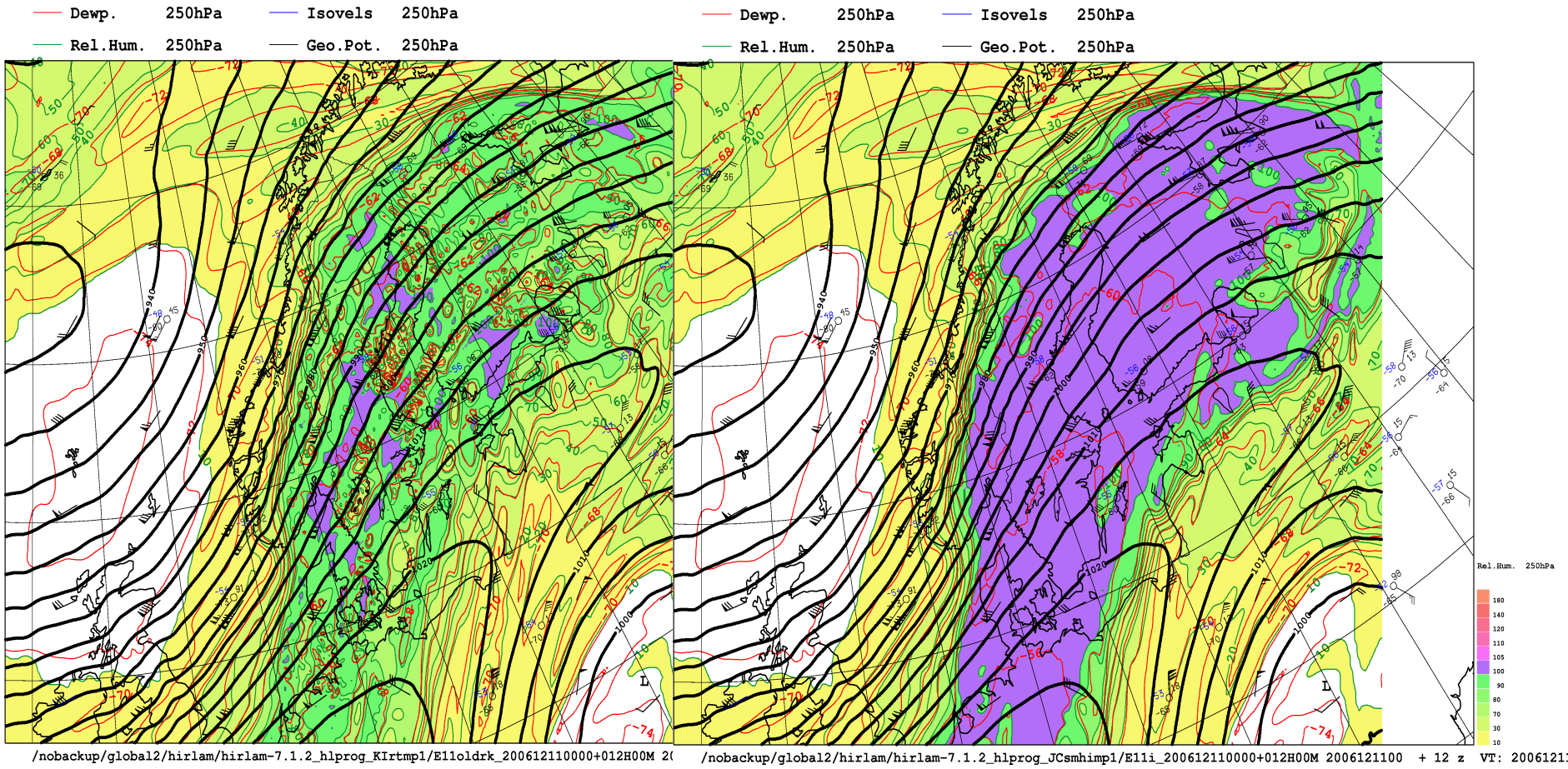
The present Hirlam 7.1.2 RK-version works mainly good but...

- Small (light) precipitation too often
- Middle level cloud amount too often near 4 octas (gives good RMS error, but duty forecasters are not always happy)
- In case of strong jet-streams, there might be “noisy” cirrus cloud field
- Too less amount of low clouds in the new 7.1.2 reference set up. (Was not a big problem in reference version 6.3.5)

Left : Example of too much light precipitation and middle level cloud amounts that are too often near 4 octas. Right :New scheme.



Left :Noise at 250hPa RH (Td) fileds at old RK . Right: Not present with new RK. (11 km 6 min timestep)



Principal differences between old and new RK scheme:

- OLD: (RK98)The change of cloud condensate is computed directly from the local change of cloudcover + other things as well.

- NEW: (RK02) Local change of cloudcover not used. Replaced by a new set of equations.
- Sedimentation of cloudwater och -ice included (from Cam3 code)
- Reduced number of tuning coefficents in cloud fraction calculations, and make it dependent on vertical resolution of the model.
- Filtering of ”freaky” tendencies for noise reduction.

New things: From where?

- Cam3 RK is based on Zhang et al (2002)
- Sedimentation of cloud condensate (Phil Rasch's own code in Cam3 – should not be limited by the CFL-criteria)
- Cirrus super saturation : Kärcher,Lohmann,(2002)
- Prognostic cloud ice calculation: Rotstayn ,(2000)
- Filtering – Karl-Ivar
- Cloud fraction : Cam3 + Javier, Karl-Ivar mod.

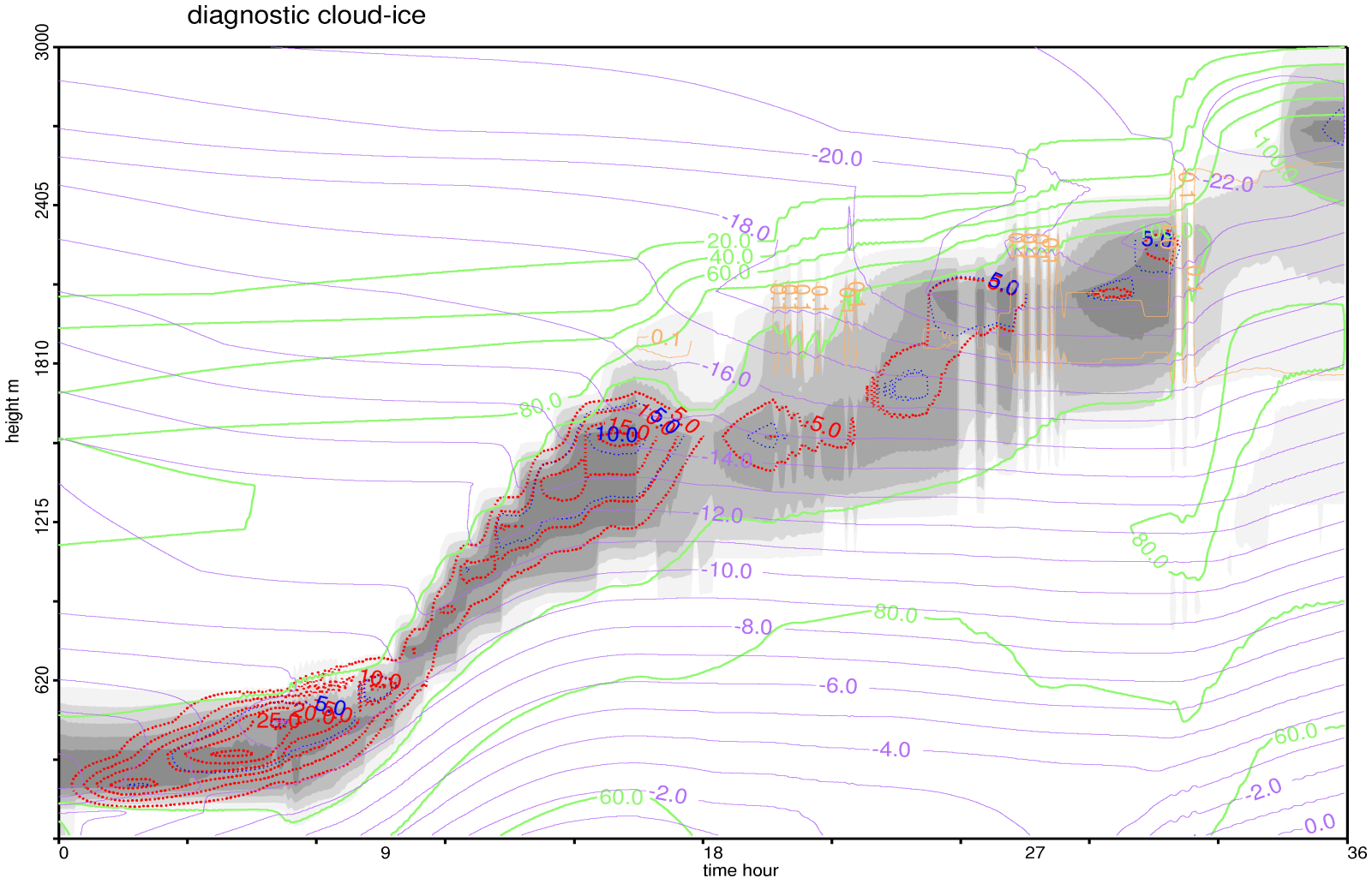
Separate prognostic treatment of cloud water and ice in Hirlam

possible advantages :

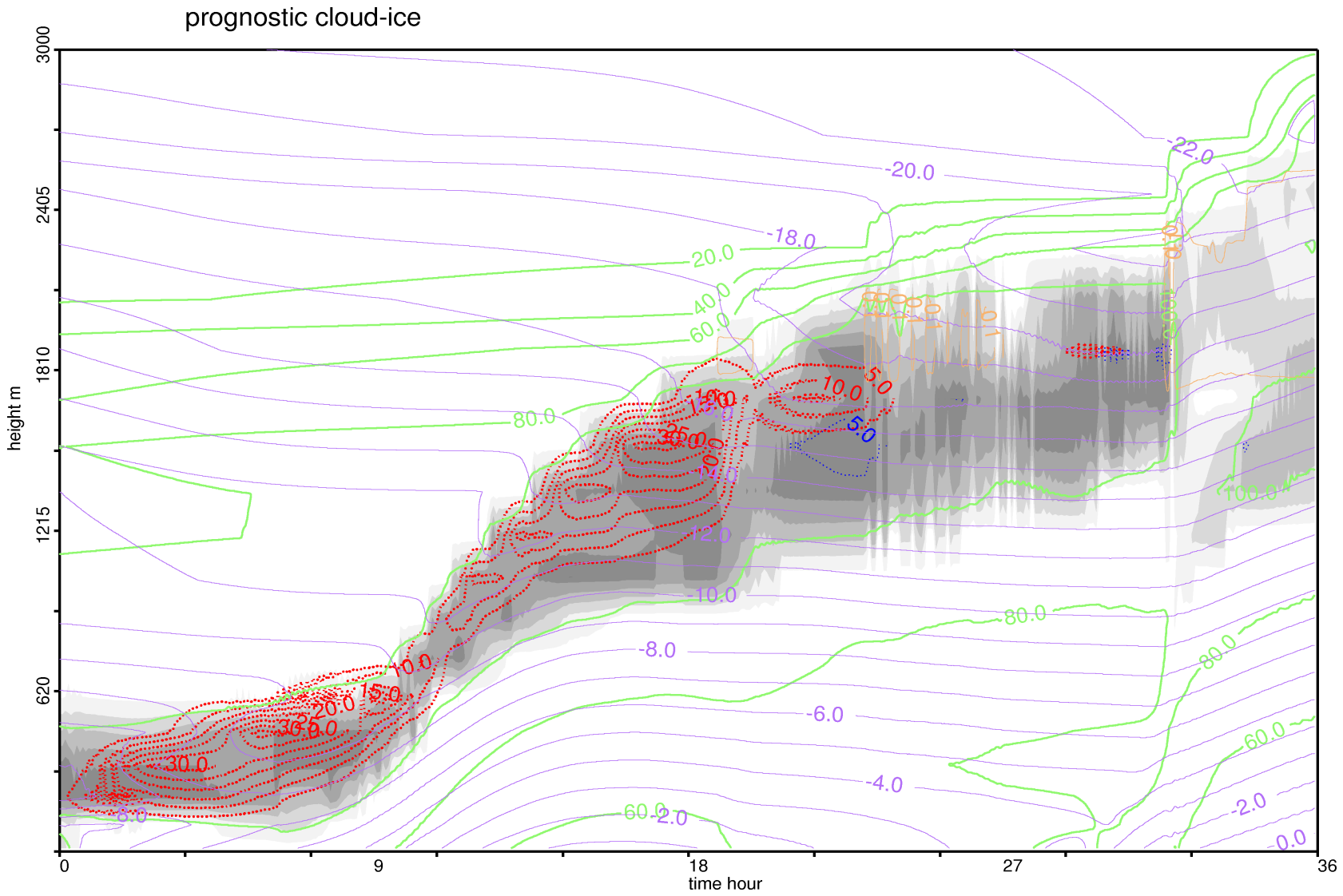
- Simulate the life cycle of mixed-phase clouds (Initial supercooled water, later ice)
- Better spatial distribution of the cloud field:
- Spatial distribution of new clouds more related to relative humidity with respect to water.
- Spatial distribution of old clouds more related to relative humidity with respect to ice.
- Better use of detailed micro-physics.
- Principal method : Cloud water is converted to cloud ice by using a crystal growth equation.
- The Bergeron-Findeisen effect is accounted for by computing a characteristic time-scale of the ice crystals to grow big enough to fall out as precipitation.

Diagnostic fraction of the cloud condensate that is ice. (1-D – example)

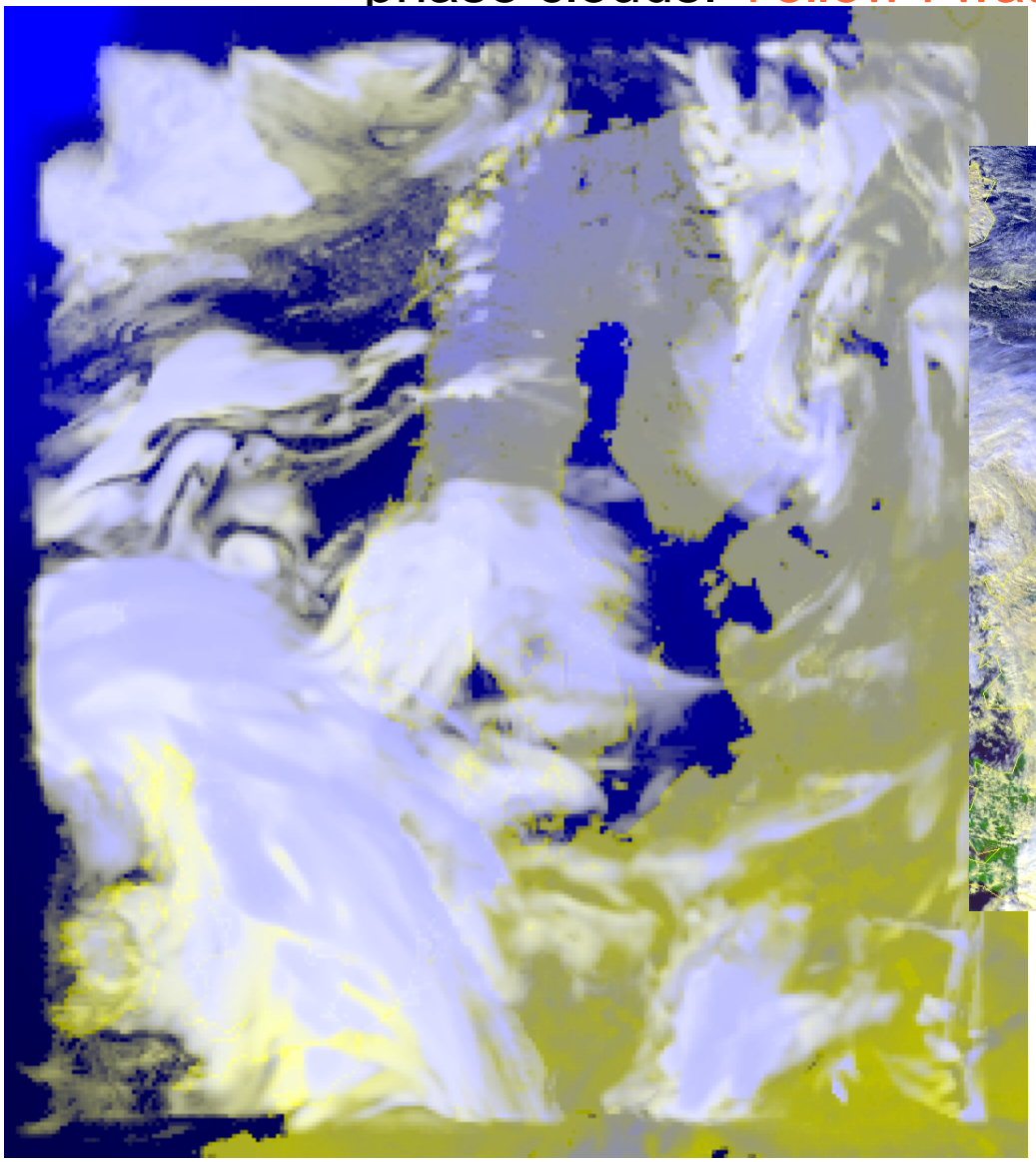
Red dots = cloud water, blue dots = cloud ice, grey shading = clouds

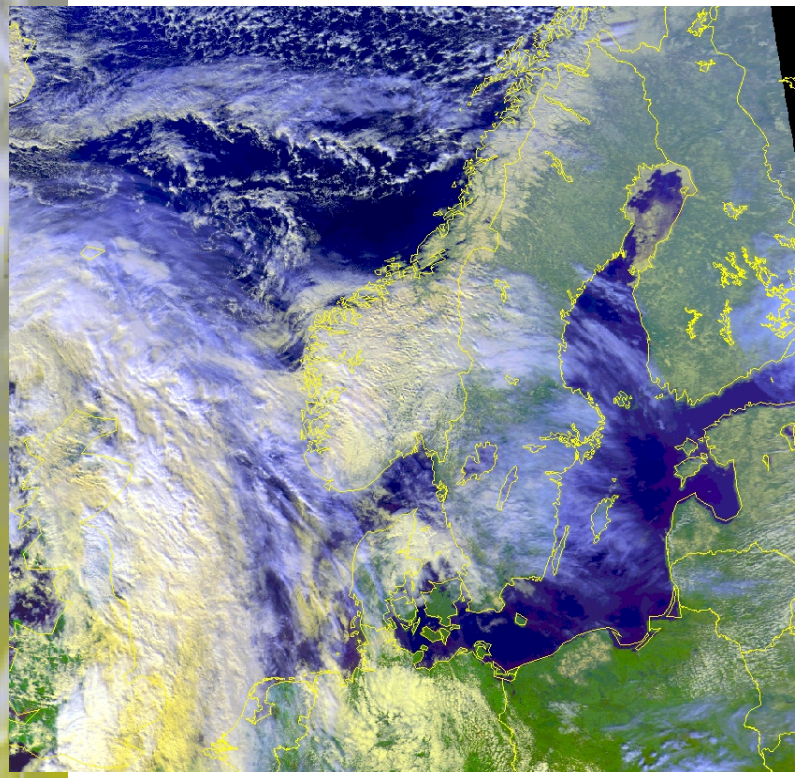


Prognostic amount of cloud condensate that is ice.

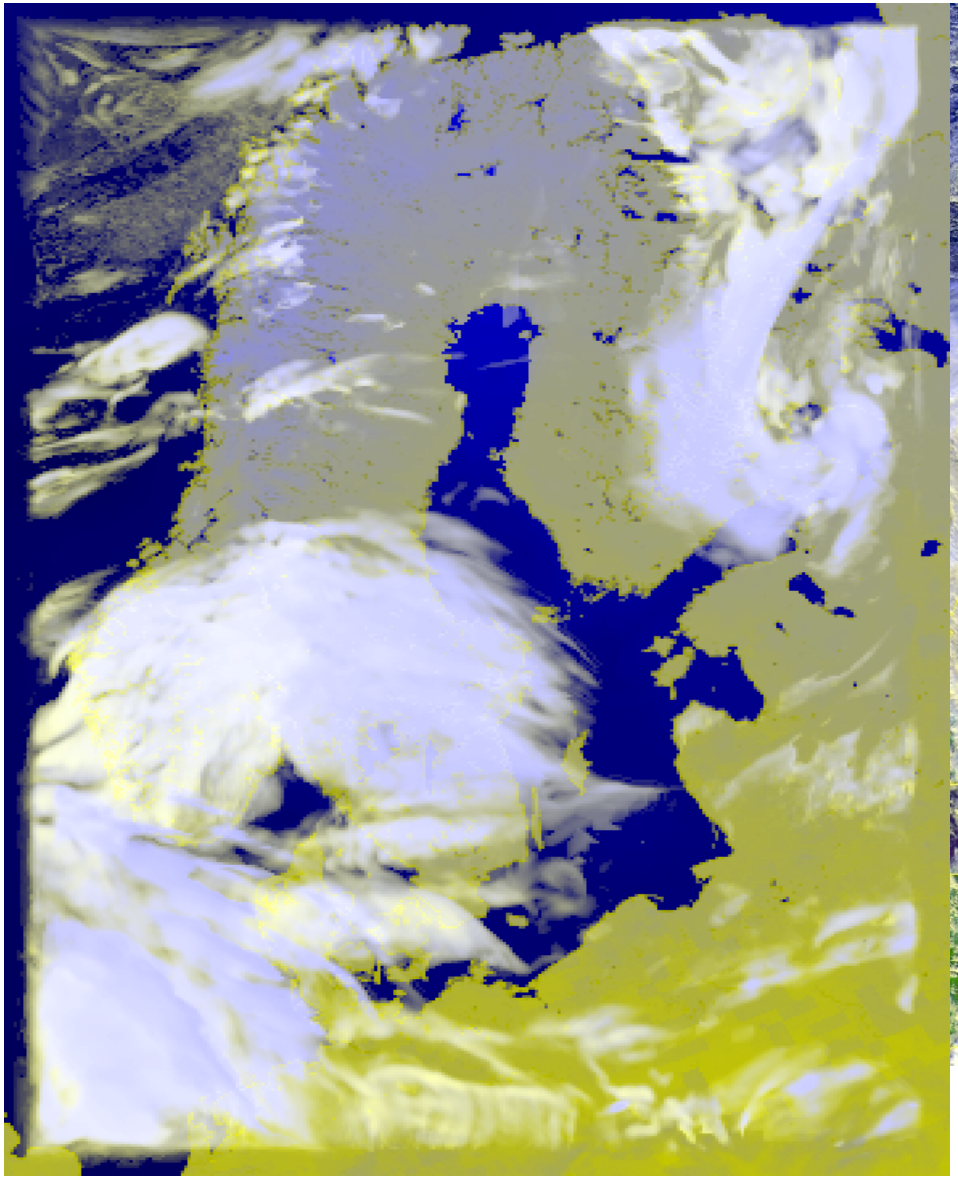


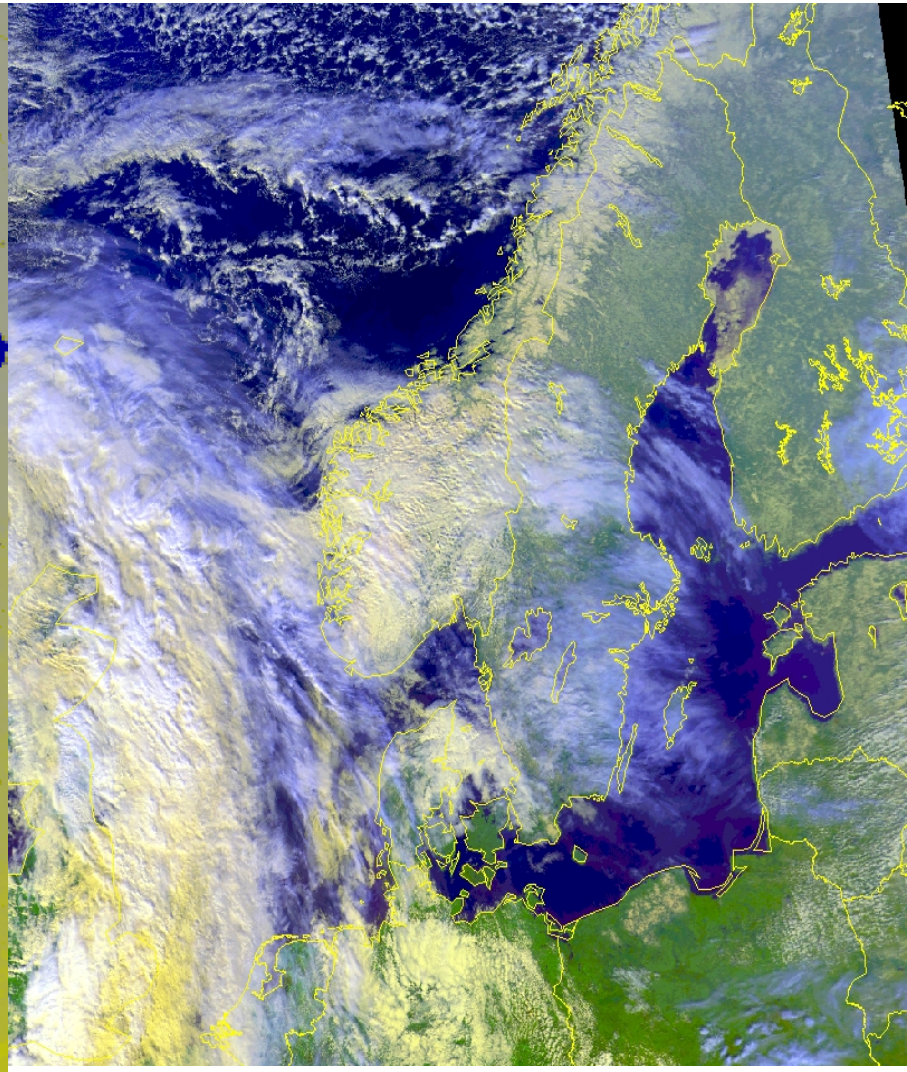
Pseudo-satellite picture (2008-03-28-12z, obs. Sat. picture from 12:20z) Blue : thin ice cloud, white : thick ice clouds or mixed-phase clouds. Yellow : water clouds.





Same for 5.5km resolution

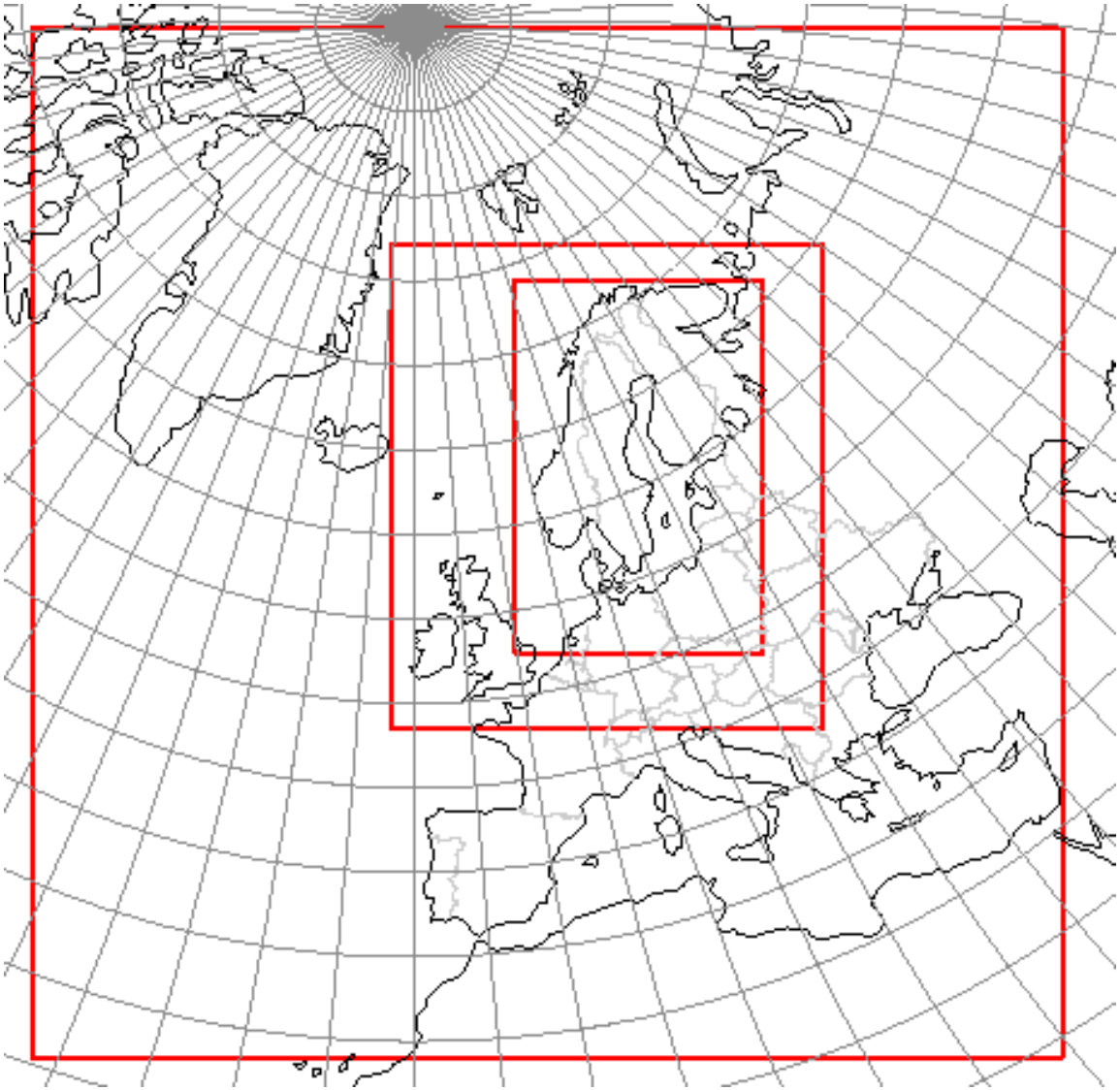




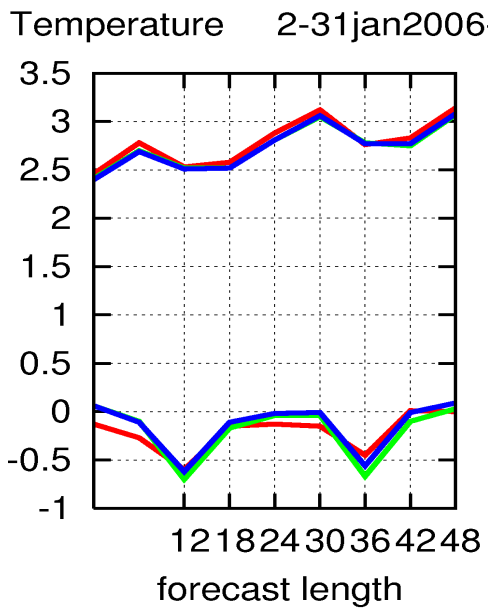
Verification

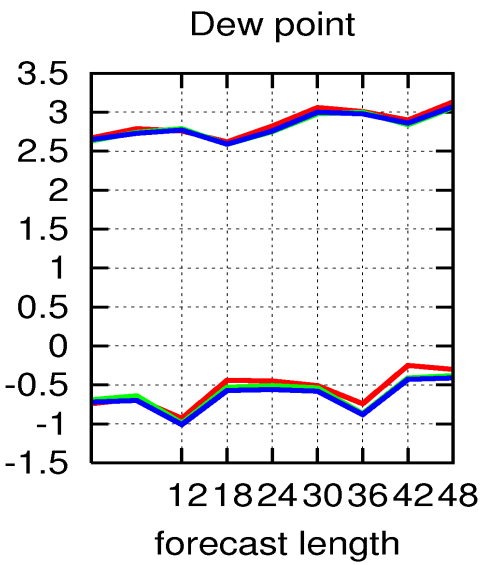
- Only ”clean” comparisions between new and old RK have been done together with the new surface scheme

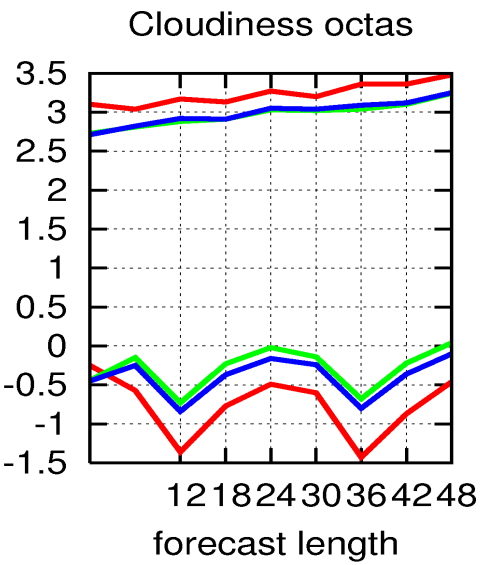
Model domain

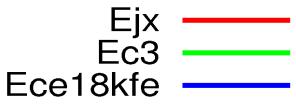


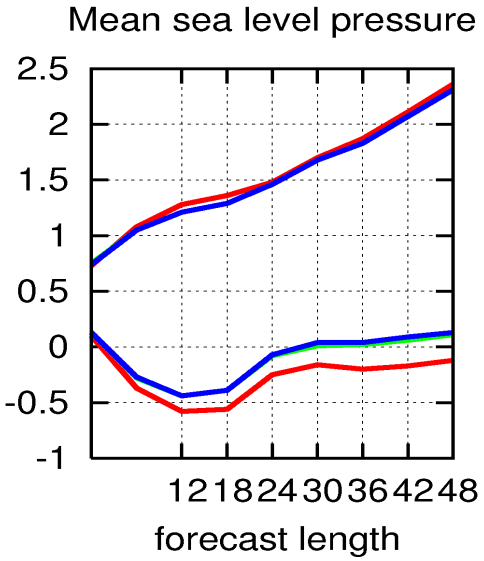
Newsnow 200601: Ejx old RK-scheme , Ec3d: Cam3 etc. Ece18kfe : Cam3 etc + KF-eta

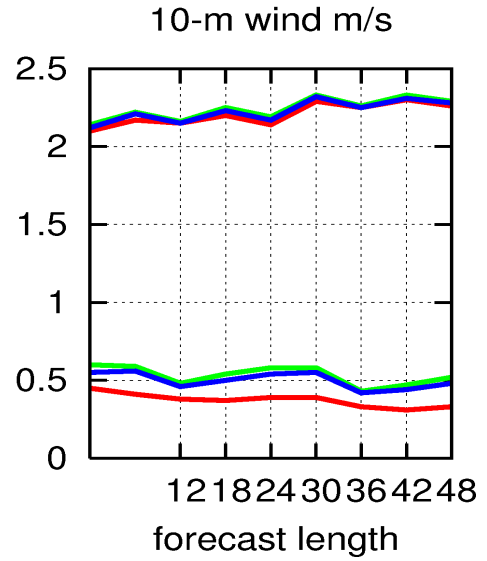




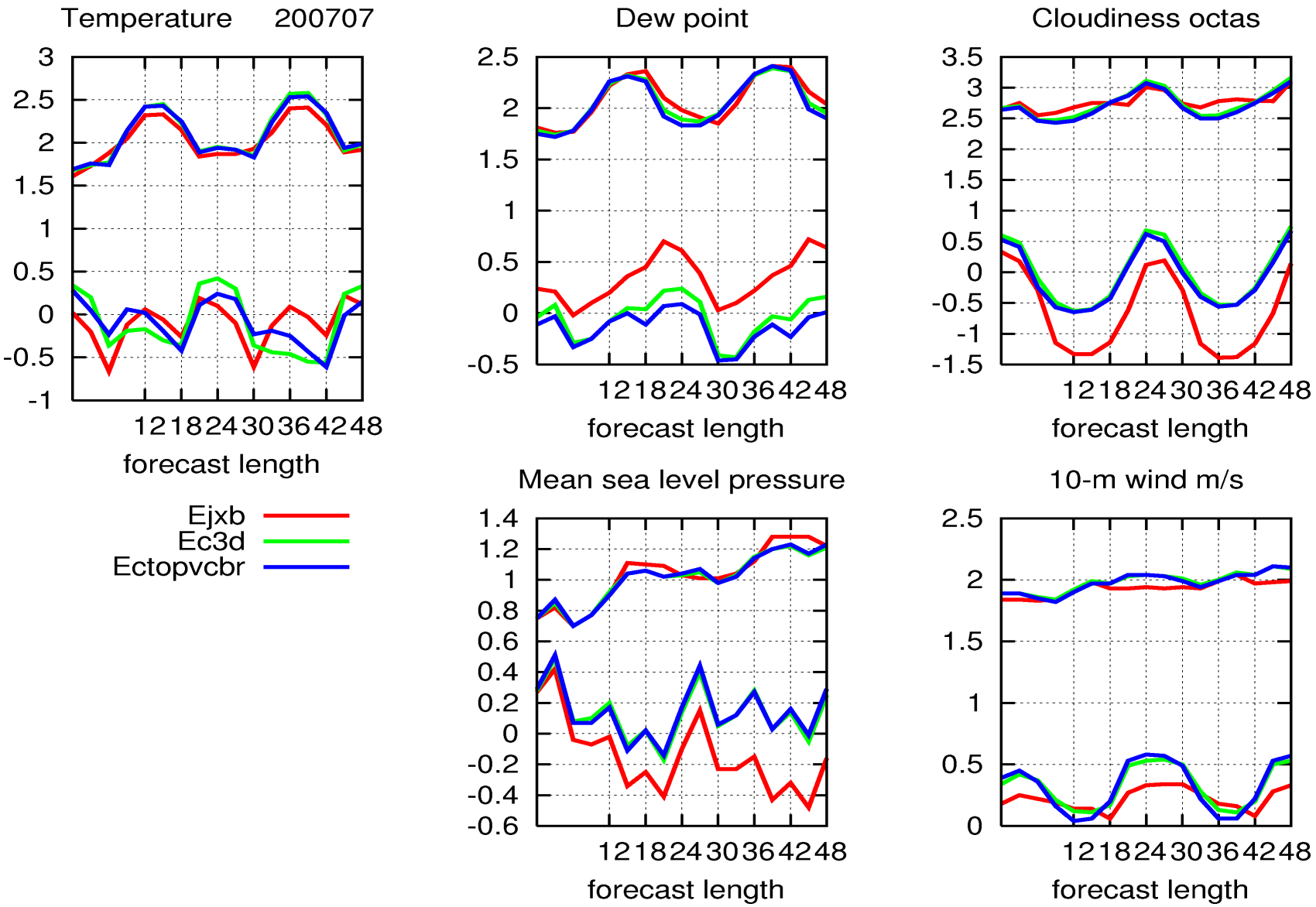


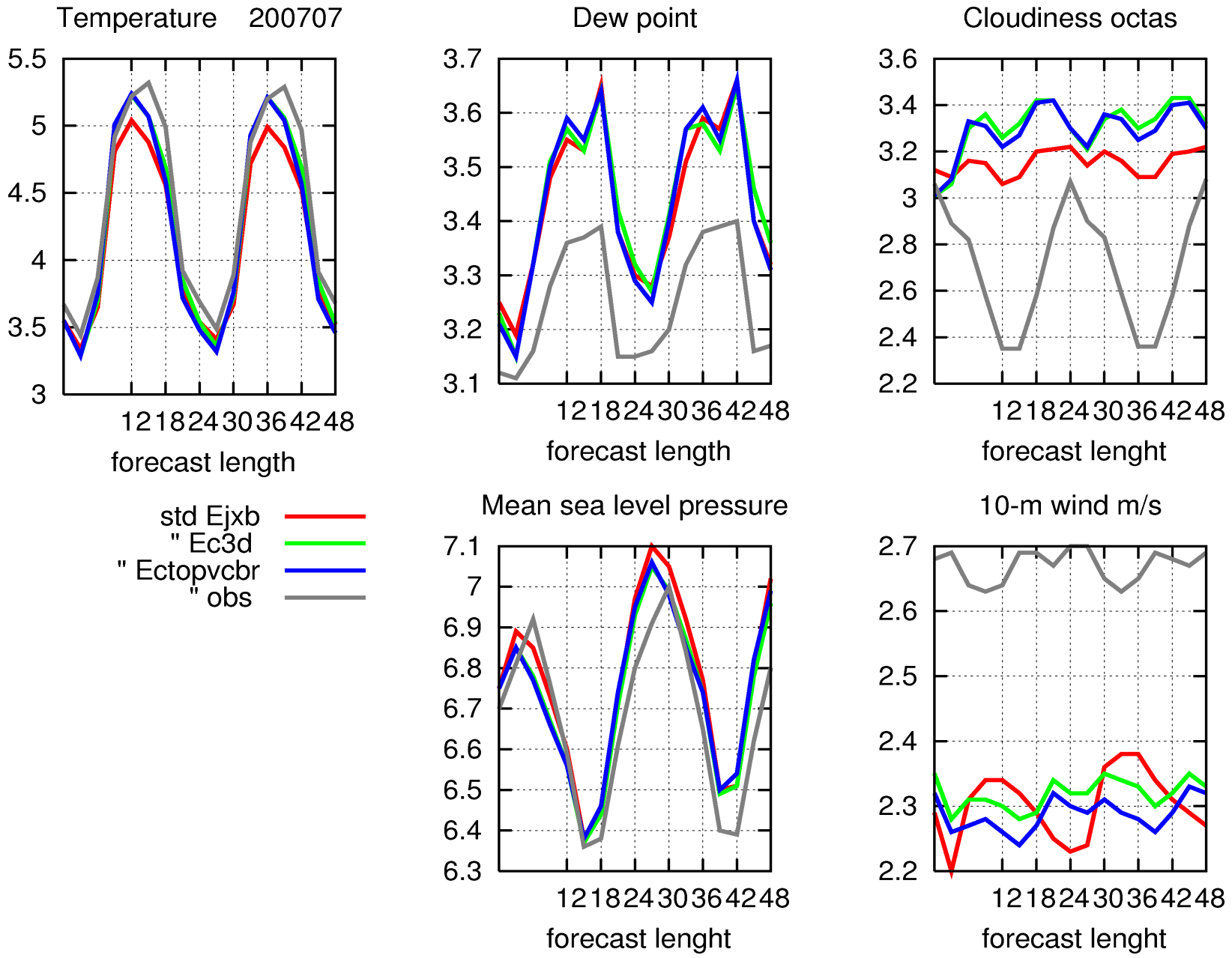






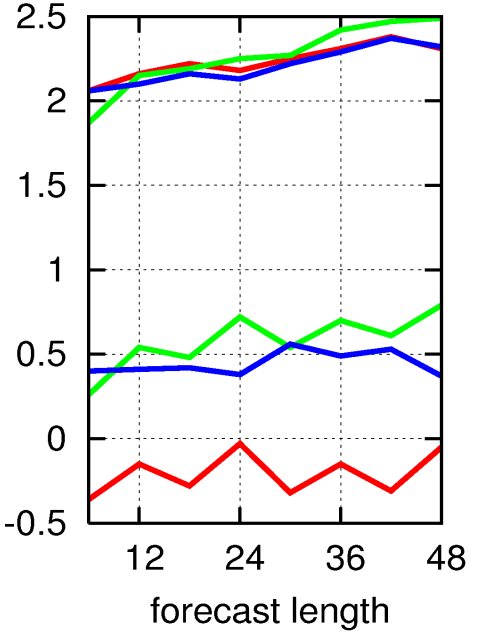
Newsnow 200707: Ejx : old RK-scheme , Ec3d: Cam3 etc. Ectopvcbr : Cam3 etc + oper. hlvcbr + reduced head conduction for low vegetation




Temperature 200707
5.5
5
4.5
4
3.5
3
12 18 24 30 36 42 48
forecast length
std Ejxb
" Ec3d
" Ectopvcbr
" obs
Dew point
3.7
3.6
3.5
3.4
3.3
3.2
3.1
12 18 24 30 36 42 48
forecast length
Cloudiness octas
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
12 18 24 30 36 42 48
forecast lenght
Mean sea level pressure
7.1
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
12 18 24 30 36 42 48
forecast lenght
10-m wind m/s
2.7
2.6
2.5
2.4
2.3
2.2
12 18 24 30 36 42 48
forecast lenght

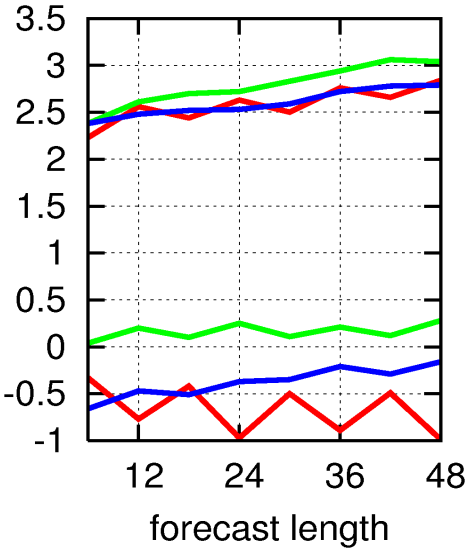
March 1-28 -newsnow semi-operational ECM=ECMWF, E11=oper. Hirlam 11, Es3 = As E11 but with newsnow surface scheme.

Temperature 1-28mars

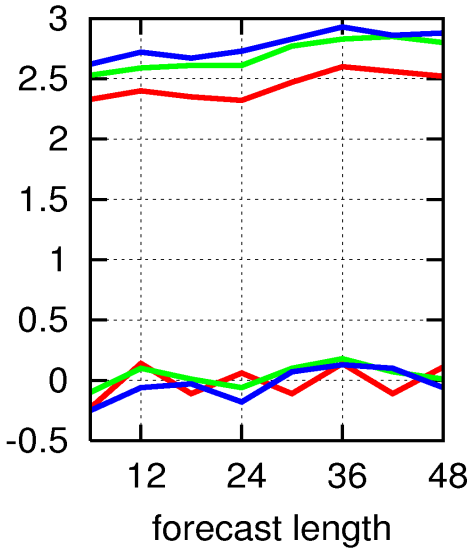


ECM Es3
E11

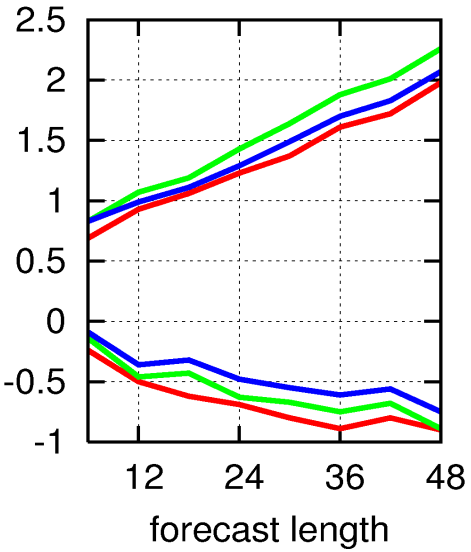
Dew point



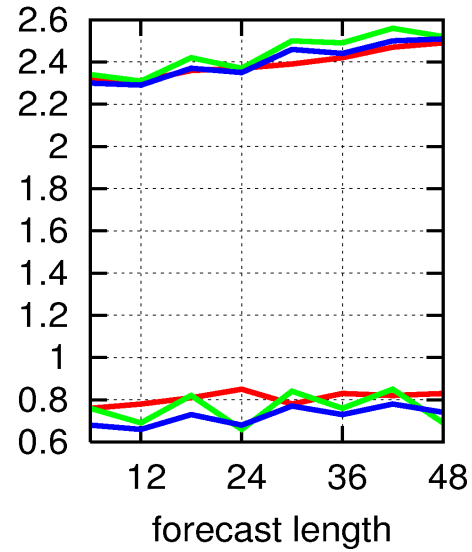
Cloudiness octas



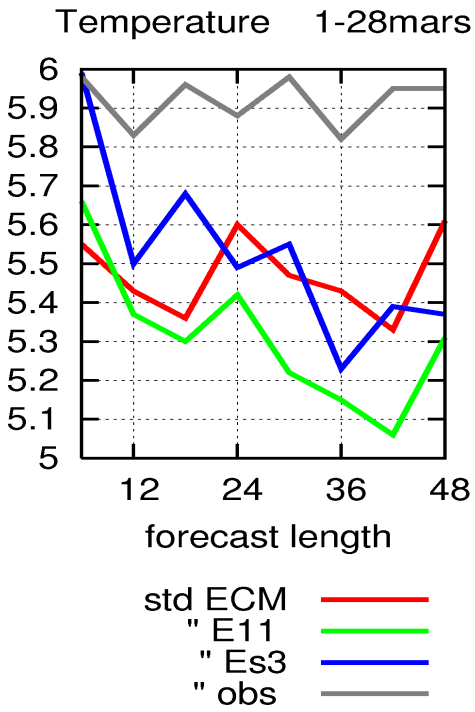
Mean sea level pressure

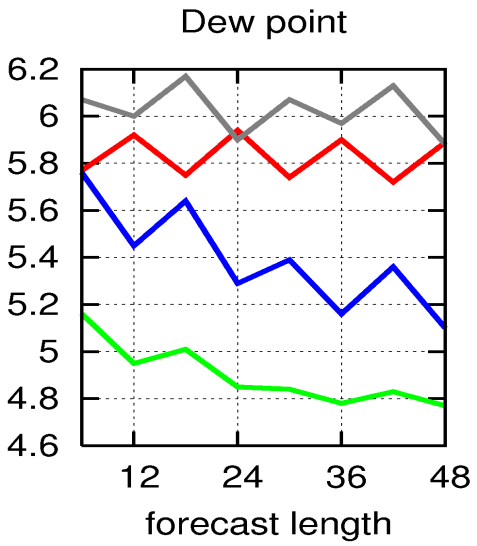


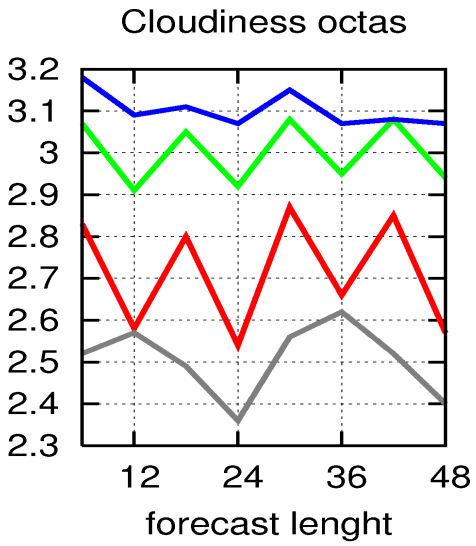
10-m wind m/s

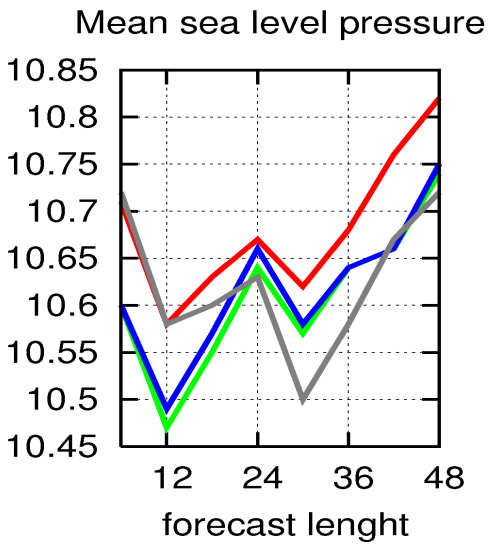


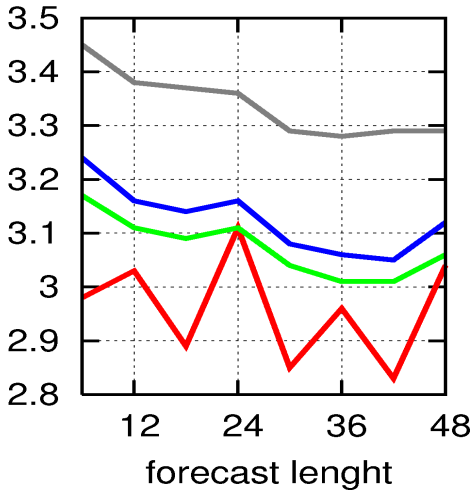
Standard deviations, grey = obs.

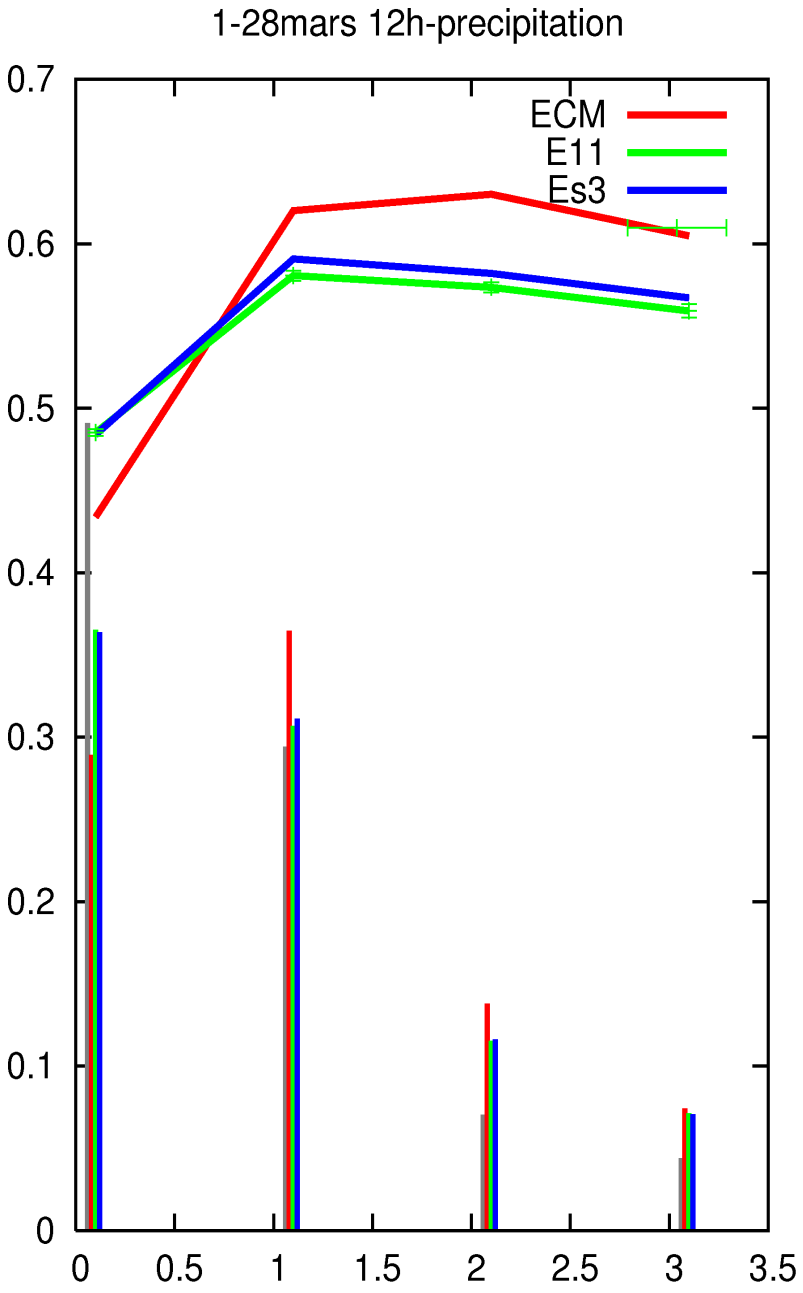


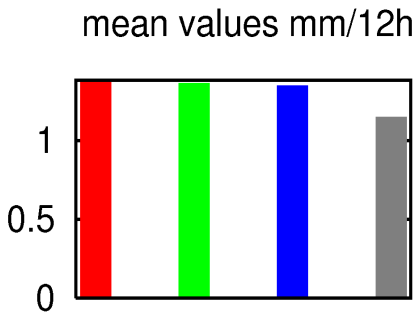


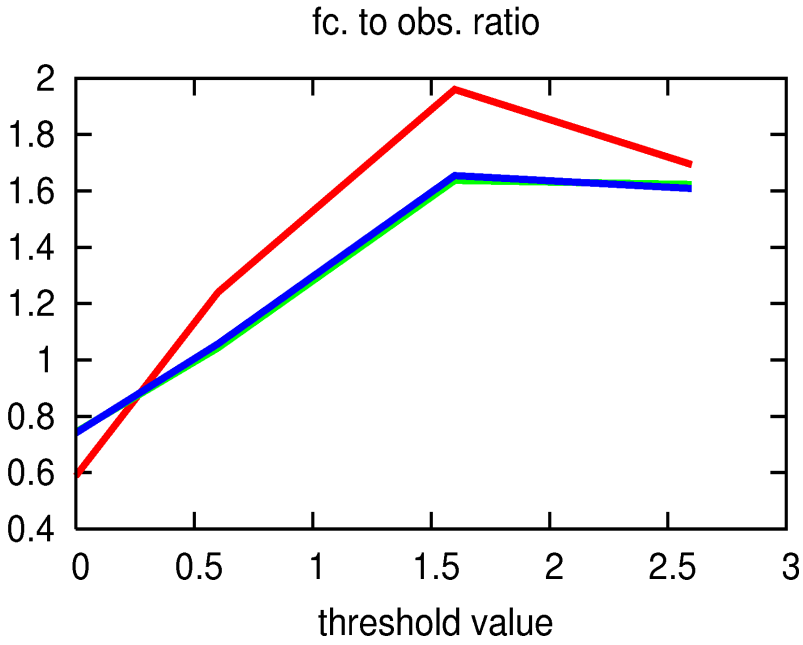


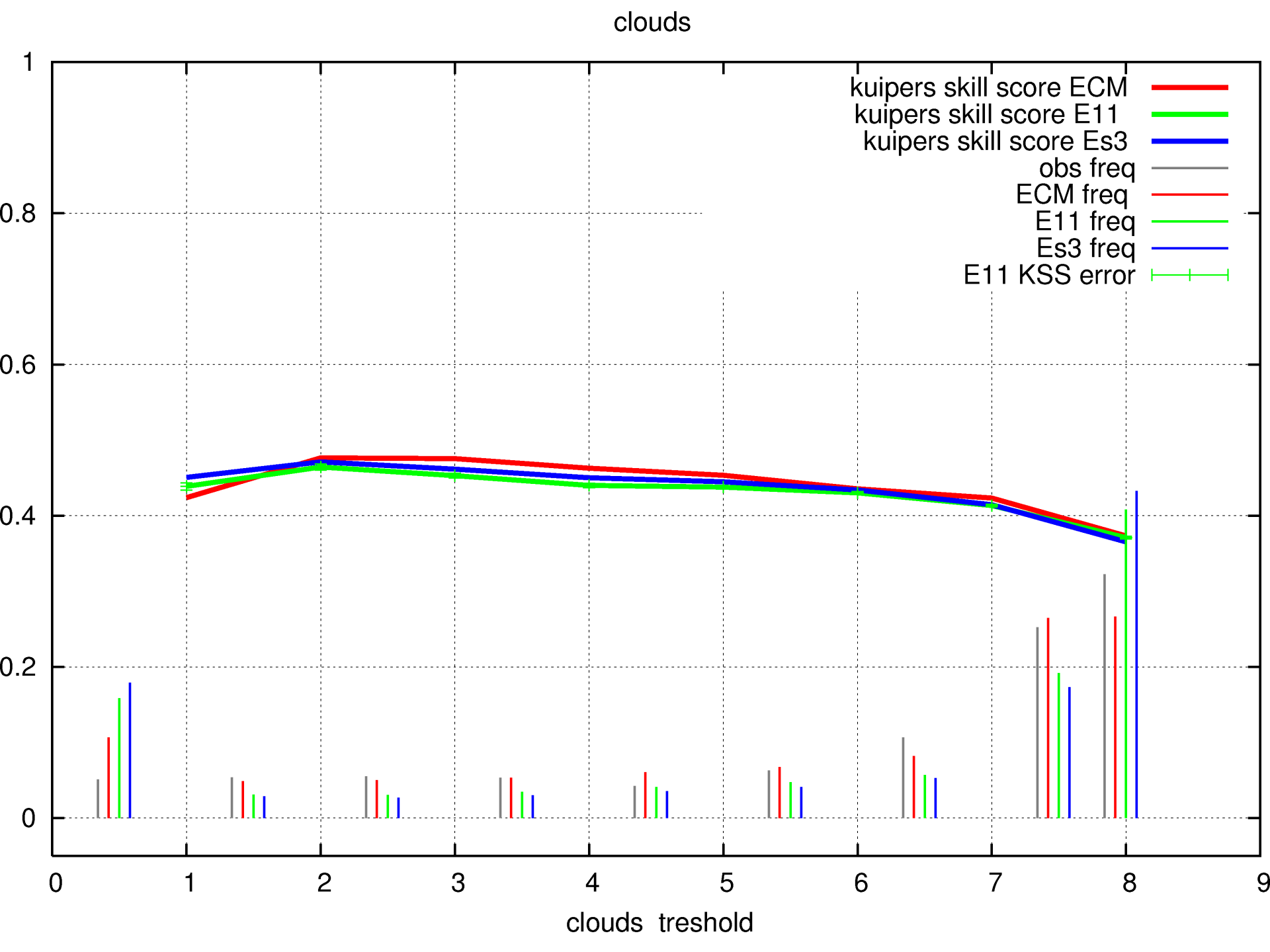




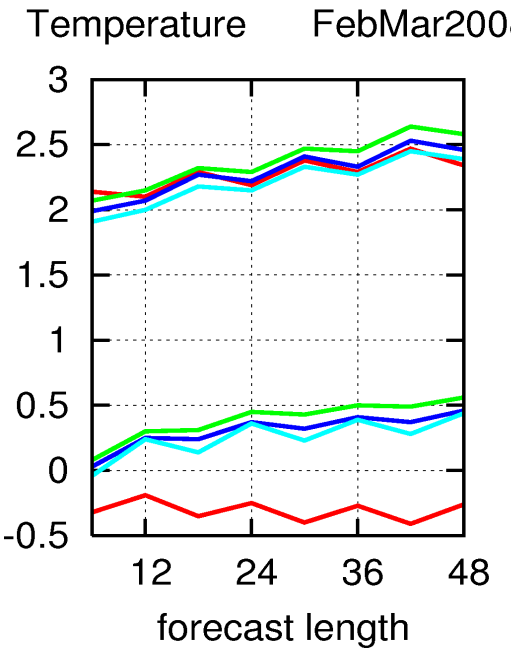

1-28mars 12h-precipitation
ECM
E11
Es3
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5

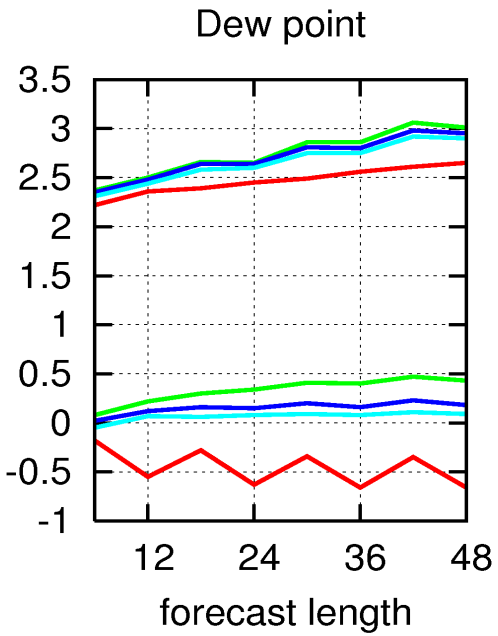

mean values mm/12h
1
0.5
0

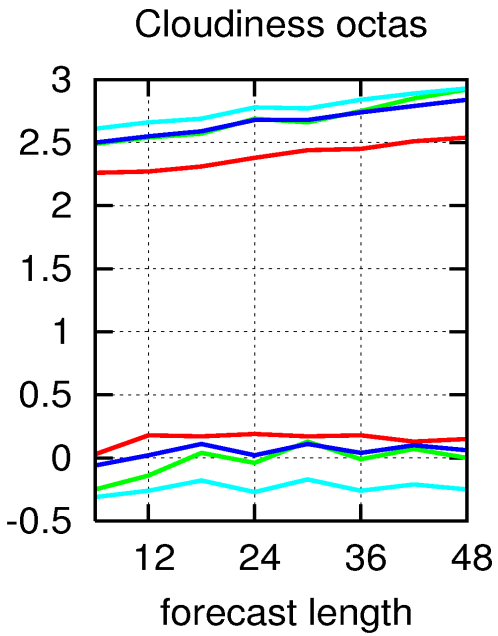

fc. to obs. ratio
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0
0.5
1
1.5
2
2.5
3
threshold value

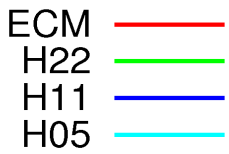

clouds
kuipers skill score ECM
kuipers skill score E11
kuipers skill score Es3
obs freq
ECM freq
E11 freq
Es3 freq
E11 KSS error
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9
clouds treshold

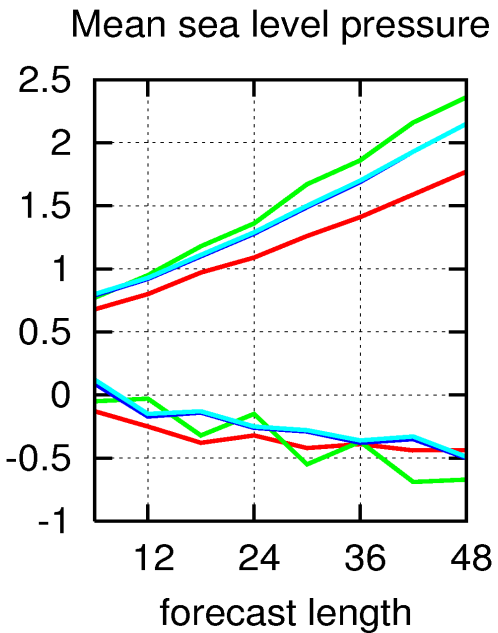
February-March 2008

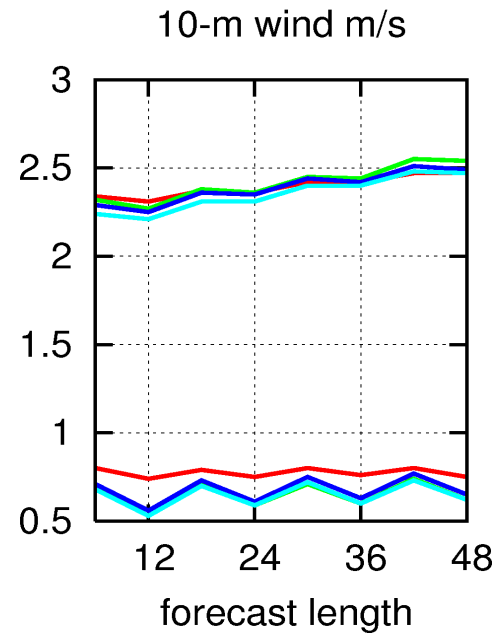


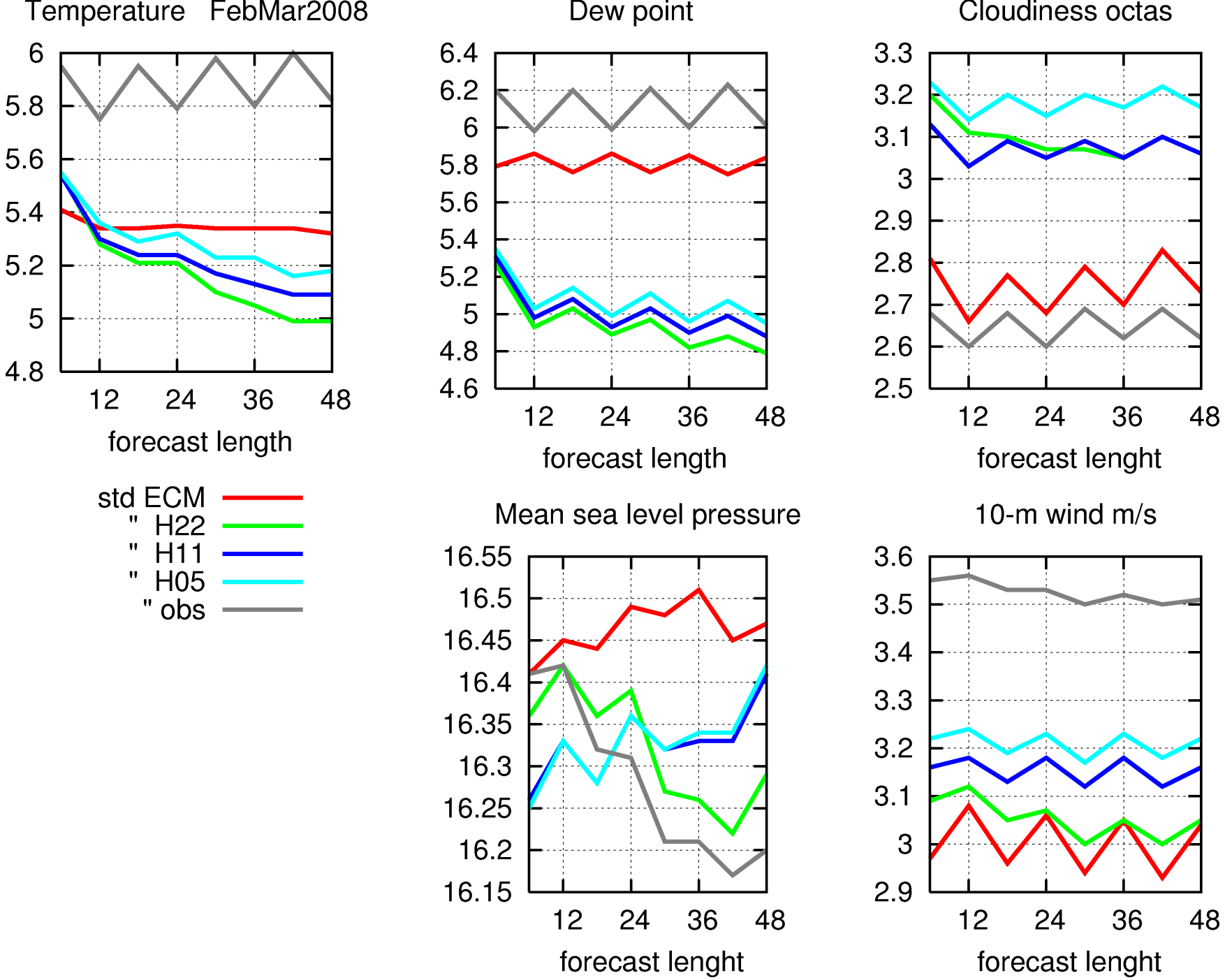











Temperature FebMar2008
6
5.8
5.6
5.4
5.2
5
4.8
12
24
36
48
forecast length
std ECM
" H22
" H11
" H05
" obs
Dew point
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
12
24
36
48
forecast length
Cloudiness octas
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
12
24
36
48
forecast lenght
Mean sea level pressure
16.55
16.5
16.45
16.4
16.35
16.3
16.25
16.2
16.15
12
24
36
48
forecast lenght
10-m wind m/s
3.6
3.5
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3.1
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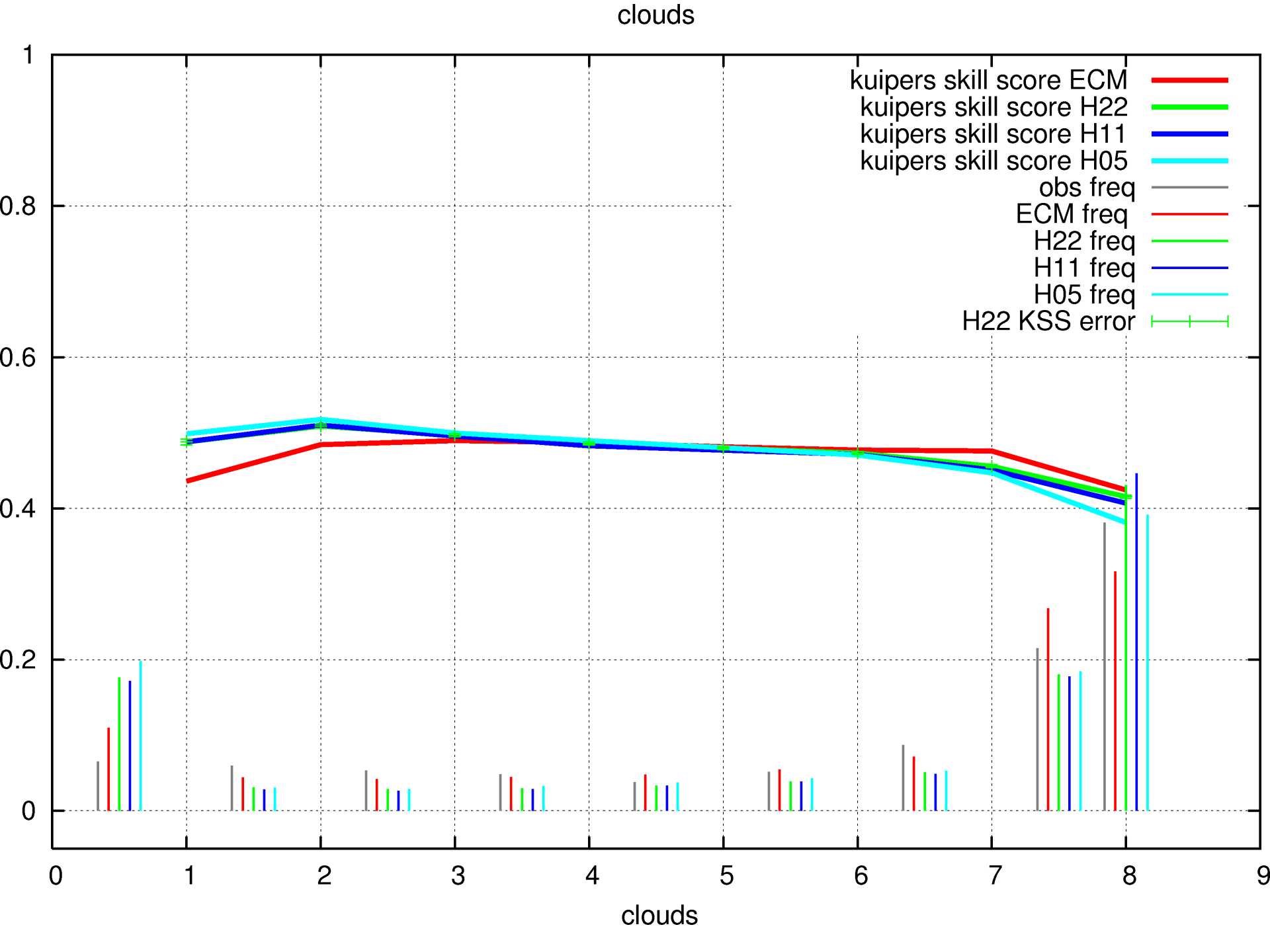
2.9
12
24
36
48
forecast lenght


clouds
kuipers skill score ECM
kuipers skill score H22
kuipers skill score H11
kuipers skill score H05
obs freq
ECM freq
H22 freq
H11 freq
H05 freq
H22 KSS error
1
0.8
0.6
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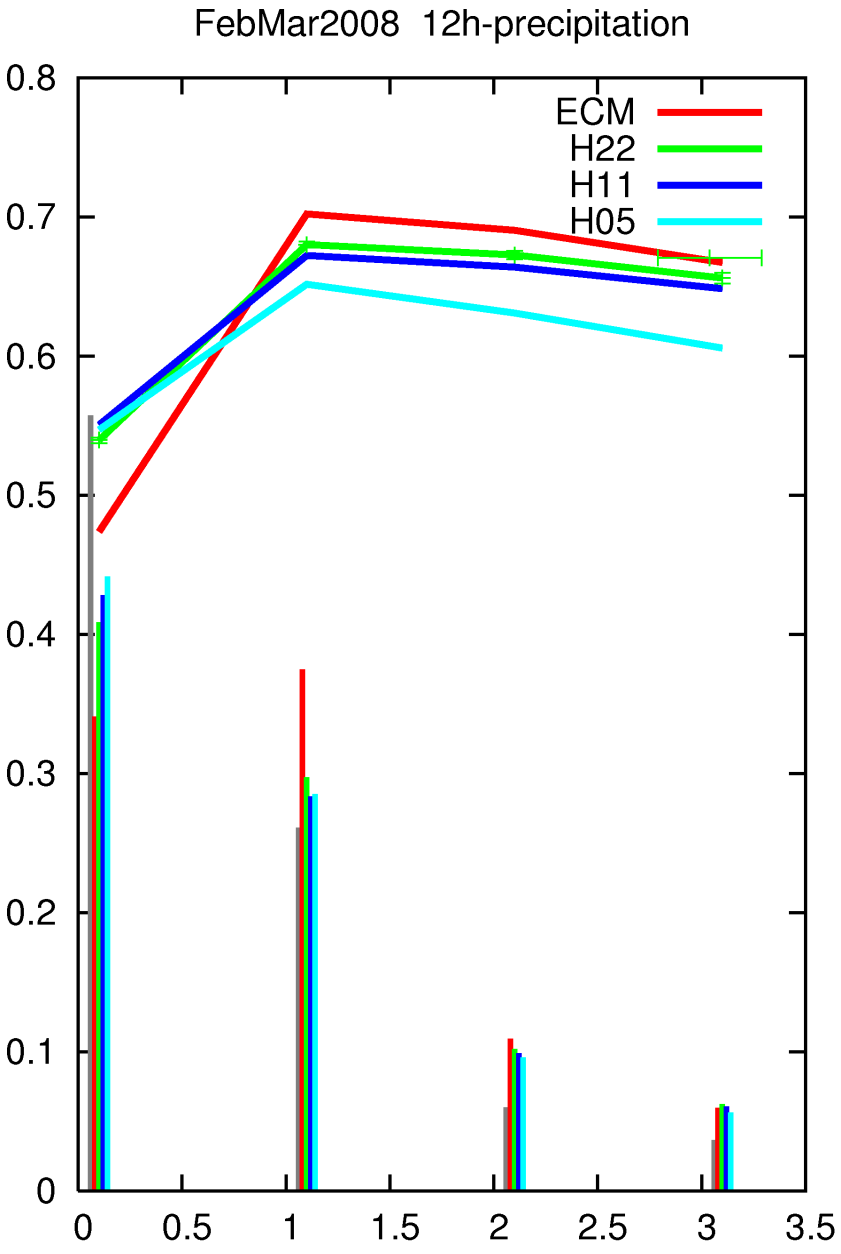
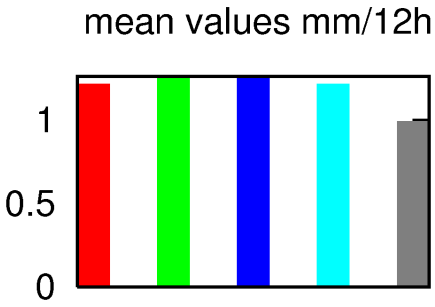
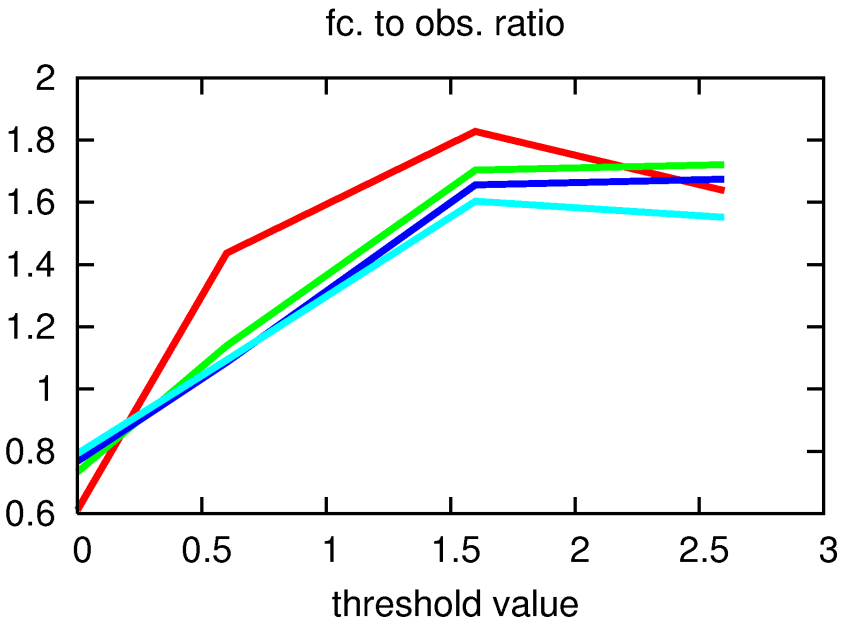
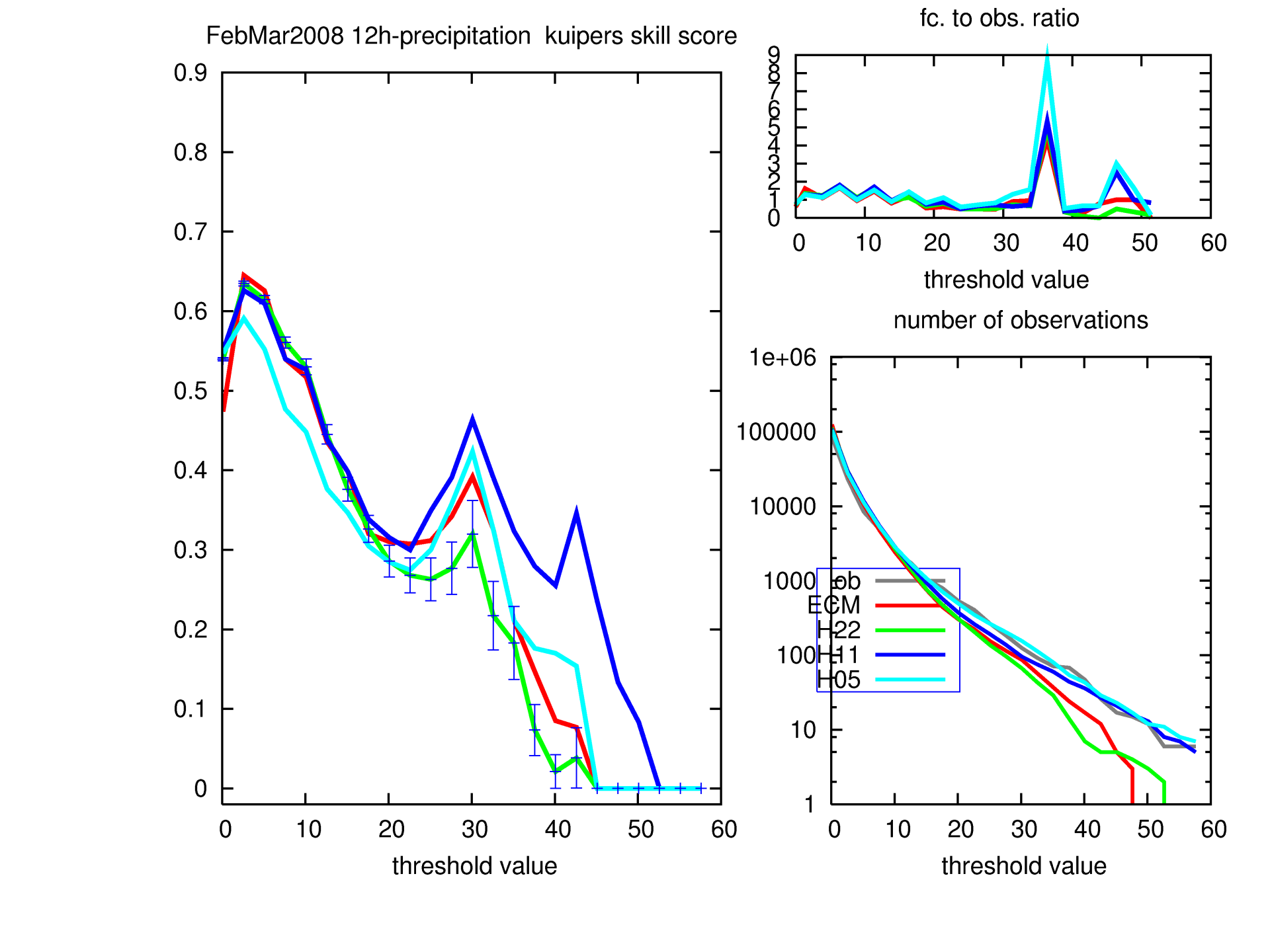
3
4
5
6
7
8
9
clouds


FebMar2008 12h-precipitation
ECM
H22
H11
H05
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5


mean values mm/12h
1
0.5
0


fc. to obs. ratio
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0
0.5
1
1.5
2
2.5
3
threshold value

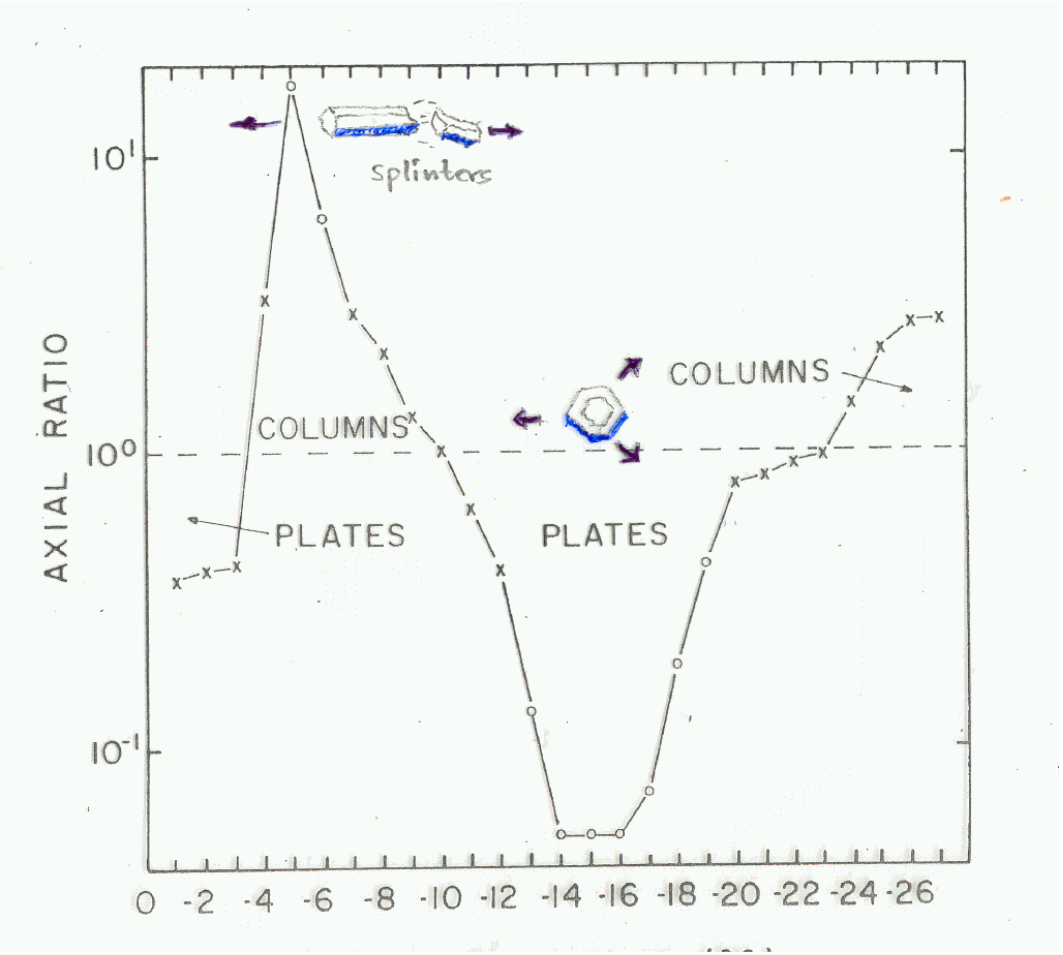

FebMar2008 12h-precipitation kuipers skill score
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
threshold value
fc. to obs. ratio
9
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
60
threshold value
number of observations
1e+06
100000
10000
1000
100
10
1
0
10
20
30
40
50
60
threshold value
ob
ECM
H22
H11
H05

Remaining problems and future work

- Work : IFS -coding
- Problem :Ice-clouds too often near 0 or 8 octas
- Solution : Adjust how the ice content affects the cloud cover calculation.
- Problem : Too little amount of low clouds when KF-eta is used.
- Solution : Adjust rhcrit.
- Other things:
- Introduce the dependence of different crystal habits
- KF at 5-10 km. Lisa Bengtssons modifications
- Prognostic CCN ? - May lead to better low clouds in cold season and better precipitation forecasts.

Crystal habits

The growth of ice crystals is faster near -5C and -15C due to the shape of the ice crystals. Splinters may increse the number of ice crystals near -6C and to some extent also near -15C.



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