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Optimisation of cloud initialisation in HARMONIE and verification results

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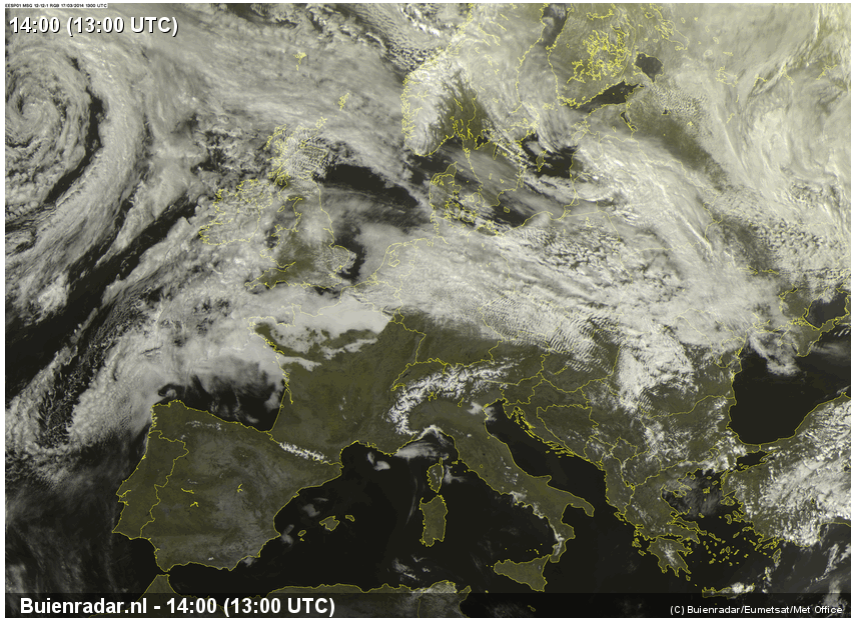
Cloud initialisation in Harmonie

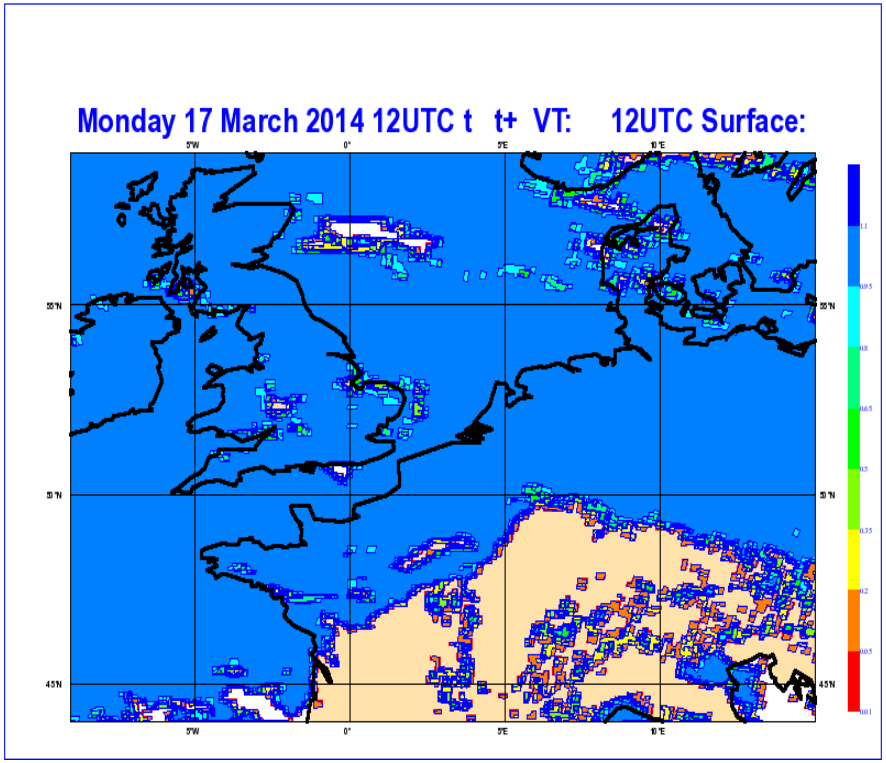
Motivation and context

- Use geostationary satellite images (both VIS and IR) for initial clouds
- Better forecasts of clouds (including fog) and precipitation

- Works well in Hirlam RUC: better clouds *and* precipitation *(as well as other parameters)*



MSG VIS image



MSG cloud mask

Important issues:

1) Keep dynamical balance

(*both hydrostatic and non-hydrostatic)*

2) Balance water vapour - microphysics

Procedure

1) Construct initial 3D cloud fields

2) translate 3D cloud fields to Harmonie model fields

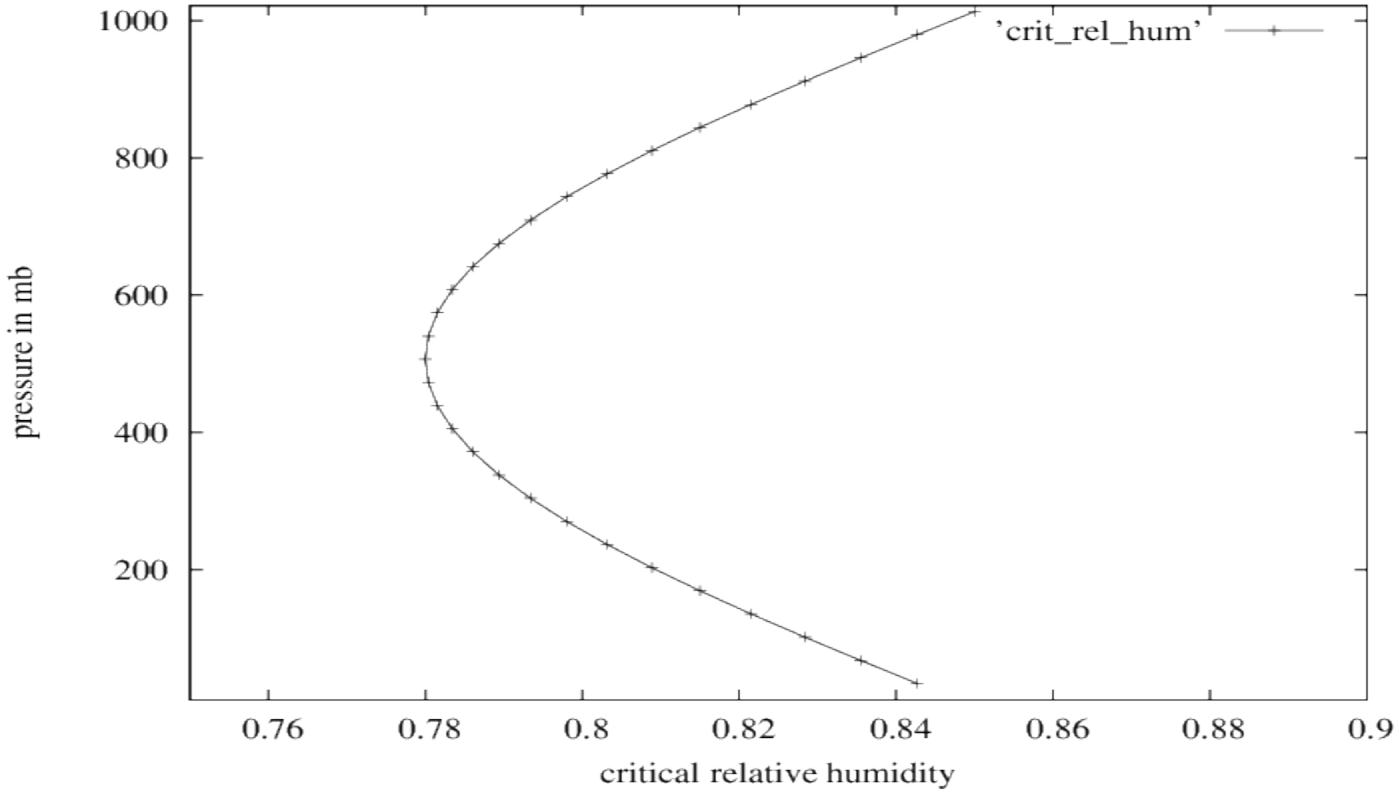
Simplest procedure

3D cloud field:

1 cloud top and 1 cloud base

Translation to Harmonie:
apply only to water vapour (q)

Define critical relative humidity C above which clouds are supposed to form



$$q_m = q_s.((1-C).\sqrt{N} + C)$$

Tuning C

Min	Max
0.90	0.93
0.81	0.88
0.85	0.92
0.78	**0.85**

Preserve buoyancy when changing humidity (keep virtual T constant)

$$T_v = T(1 + 0.61 q_m - q_l - q_i - q_r - q_s - q_g)$$

Correction:

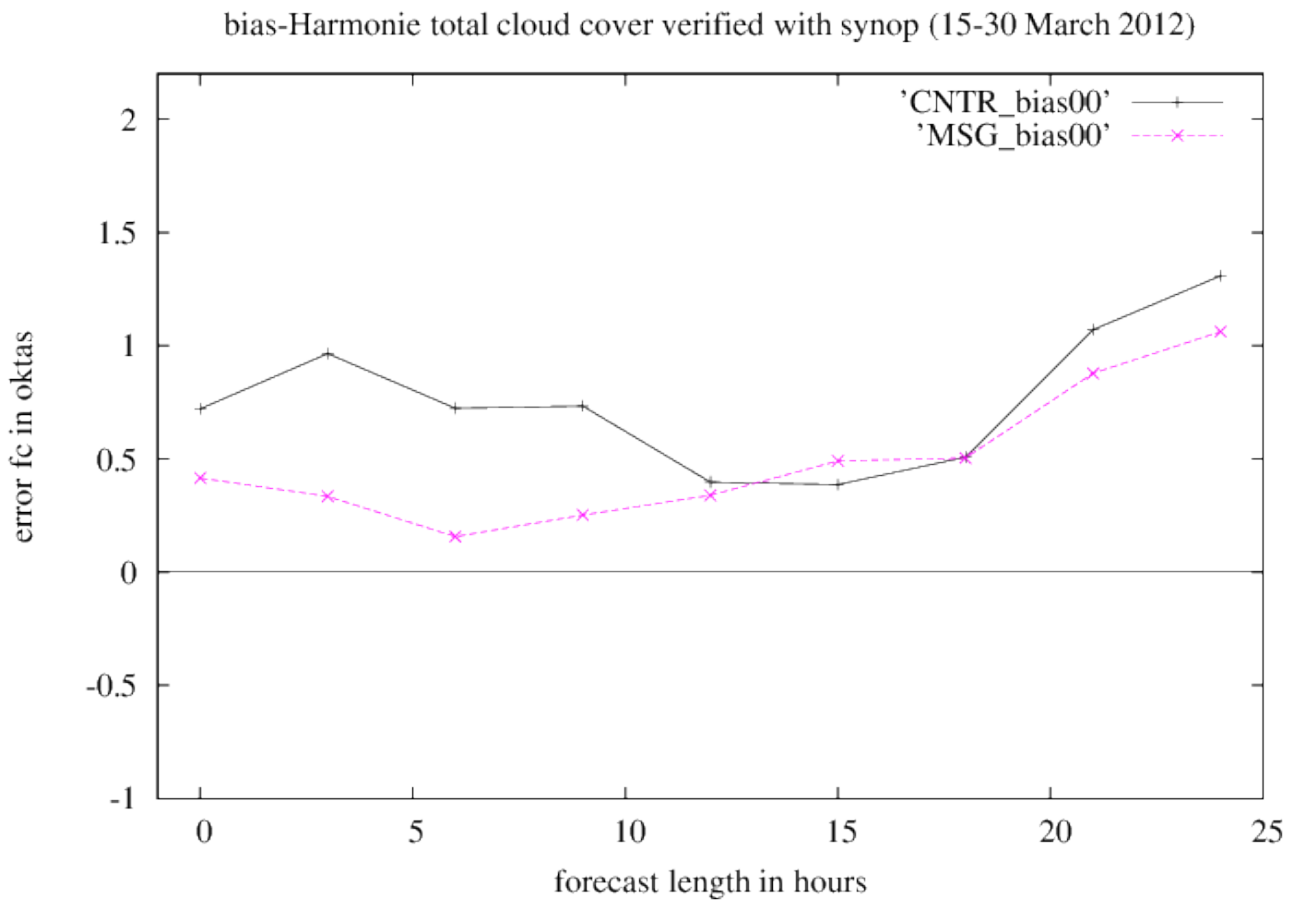
$$T = T_v / (1 + 0.61 q_m - q_l - q_i - q_r - q_s - q_g)$$

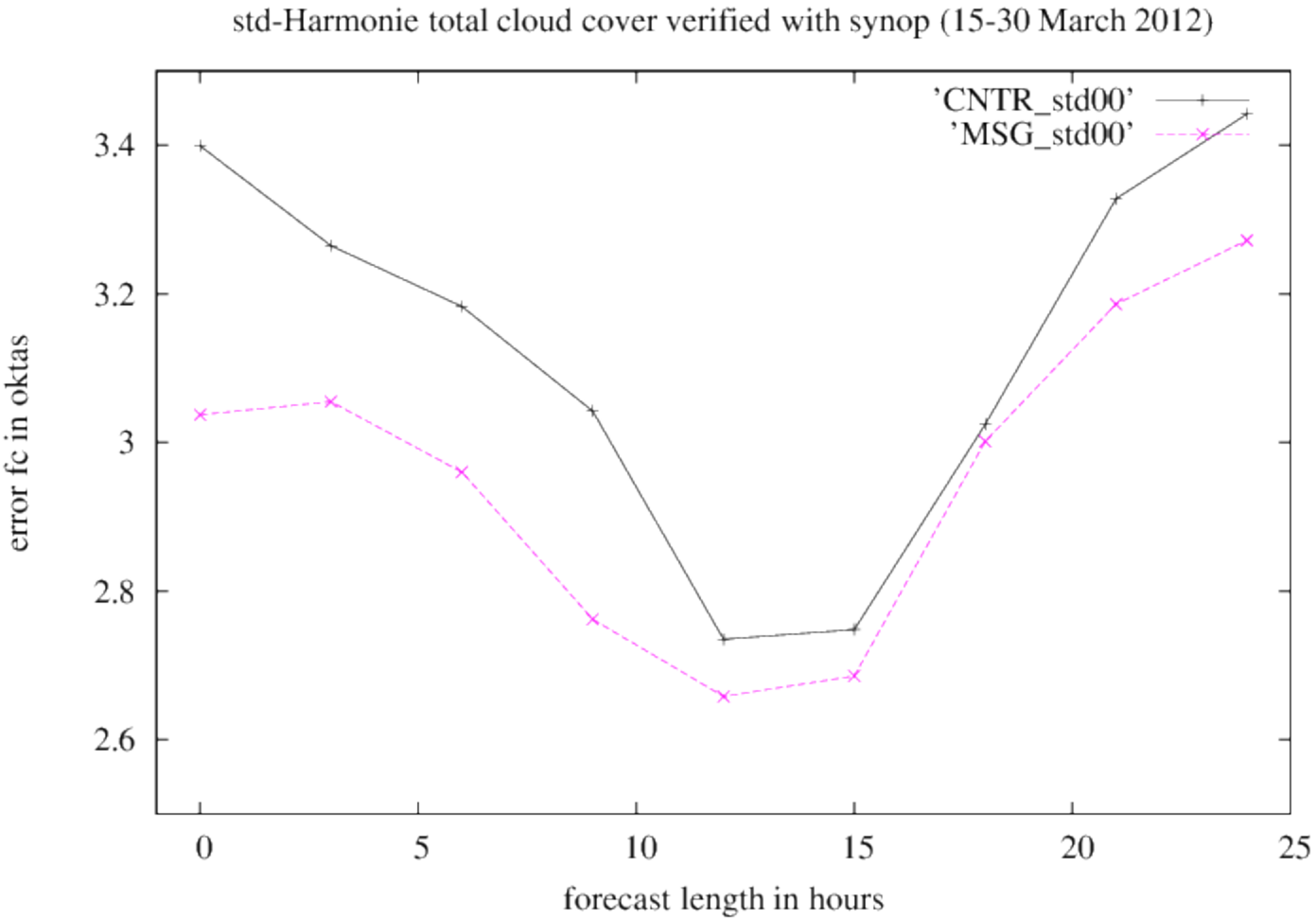
Verification of predicted cloud cover *(control and MSG run)*

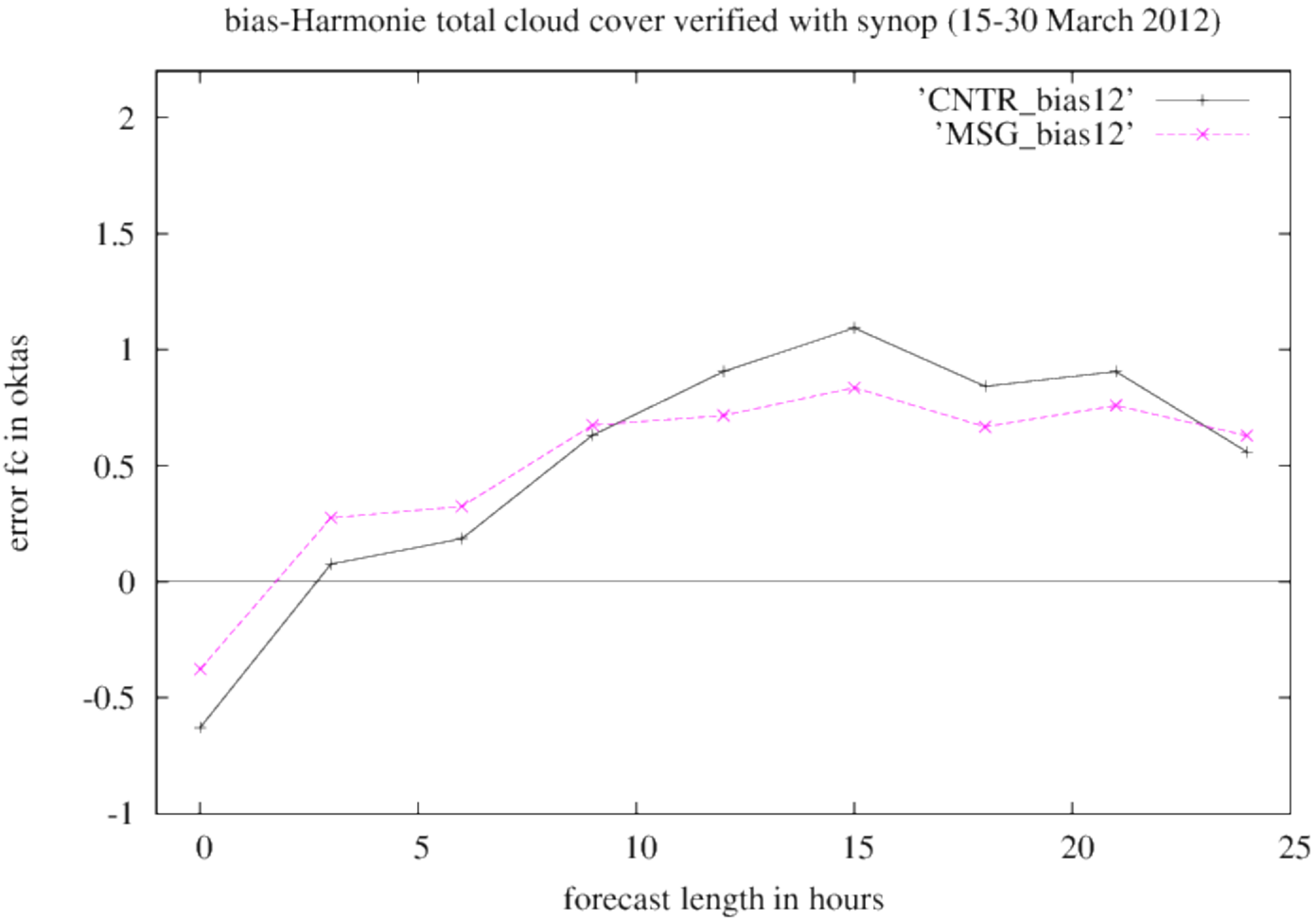
- 2 periods of each 2 weeks:

- Compare mean of 7 x 7 model elements with synoptic observations

March 2012 (ECMWF run)




std-Harmonie total cloud cover verified with synop (15-30 March 2012)
'CNTR_std00'
'MSG_std00'
error fc in oktas
3.4
3.2
3
2.8
2.6
0
5
10
15
20
25
forecast length in hours


bias-Harmonie total cloud cover verified with synop (15-30 March 2012)
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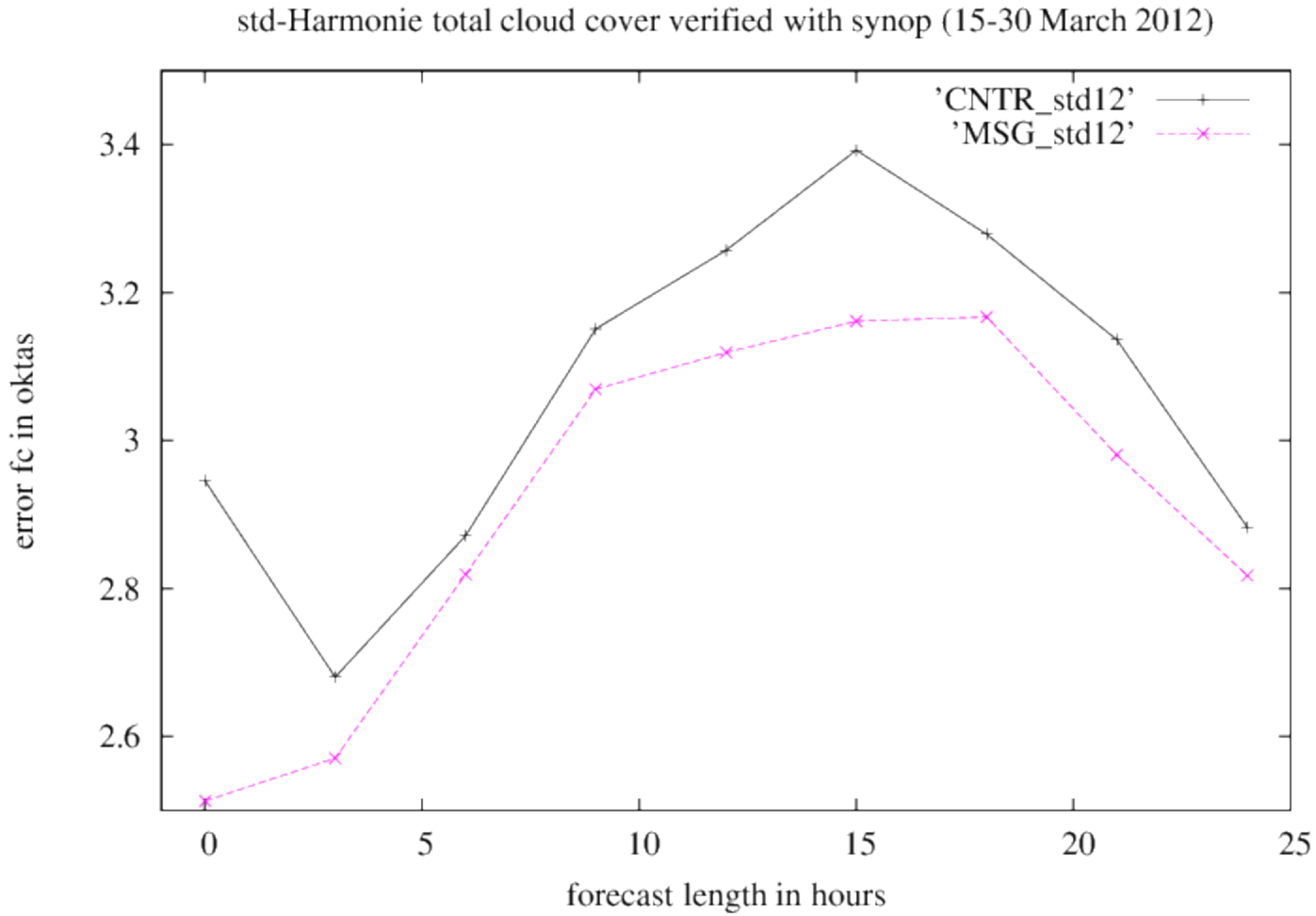
'MSG_bias12'
error fc in oktas
forecast length in hours
2
1.5
1
0.5
0
-0.5
-1
0
5
10
15
20
25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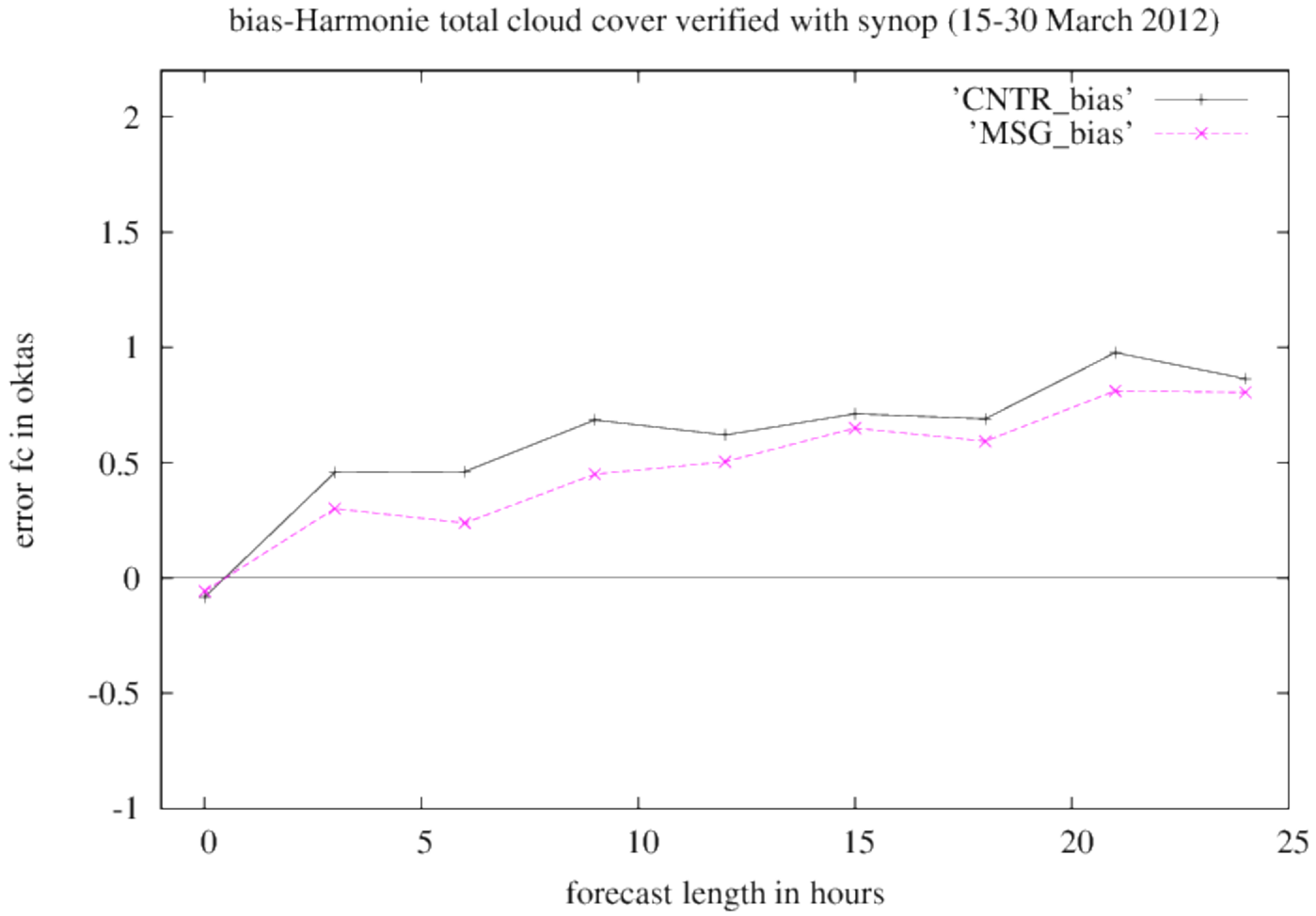
forecast length in hours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error fc in oktas
forecast length in hours
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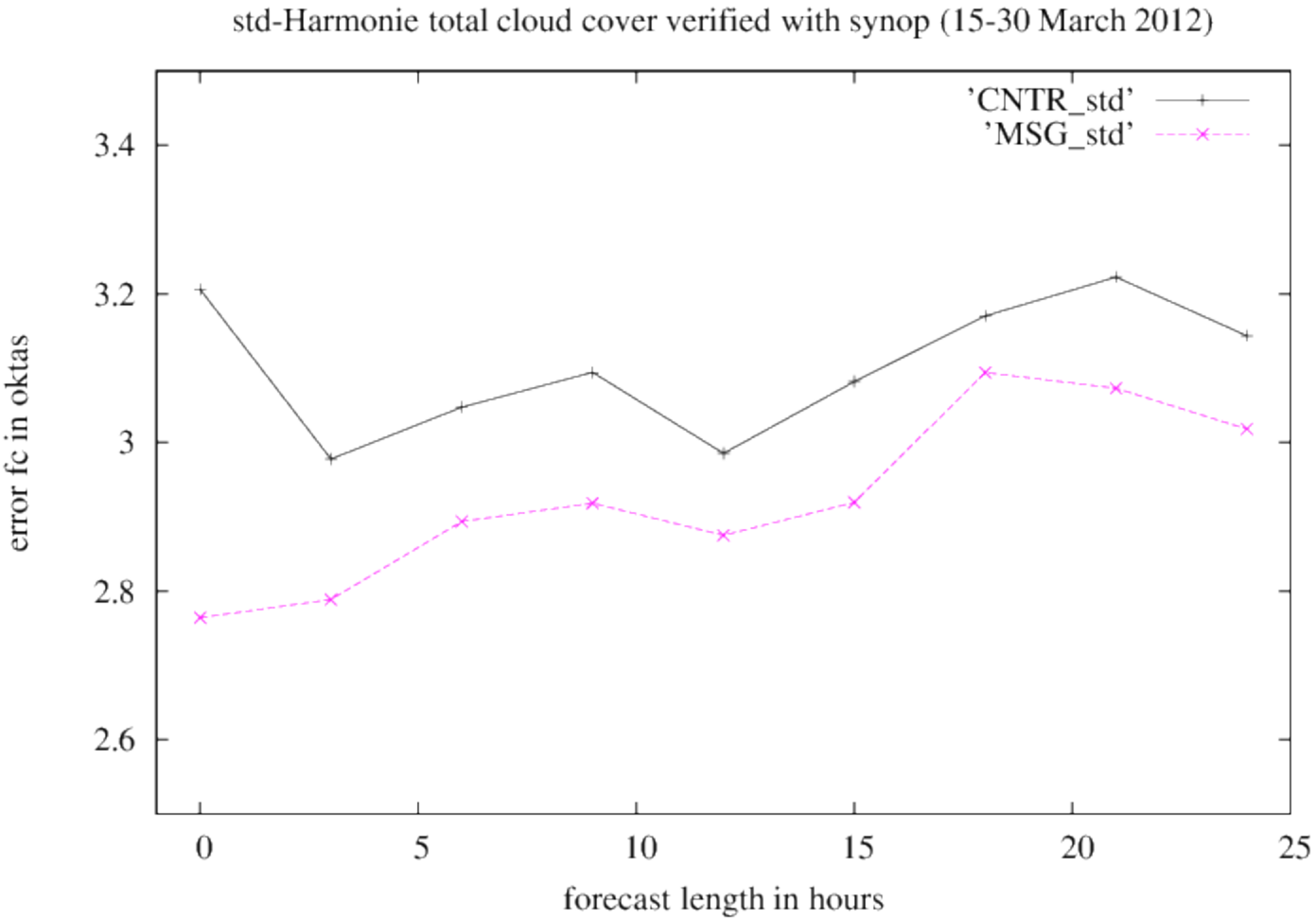
std-Harmonie total cloud cover verified with synop (15-30 March 2012)
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error fc in oktas
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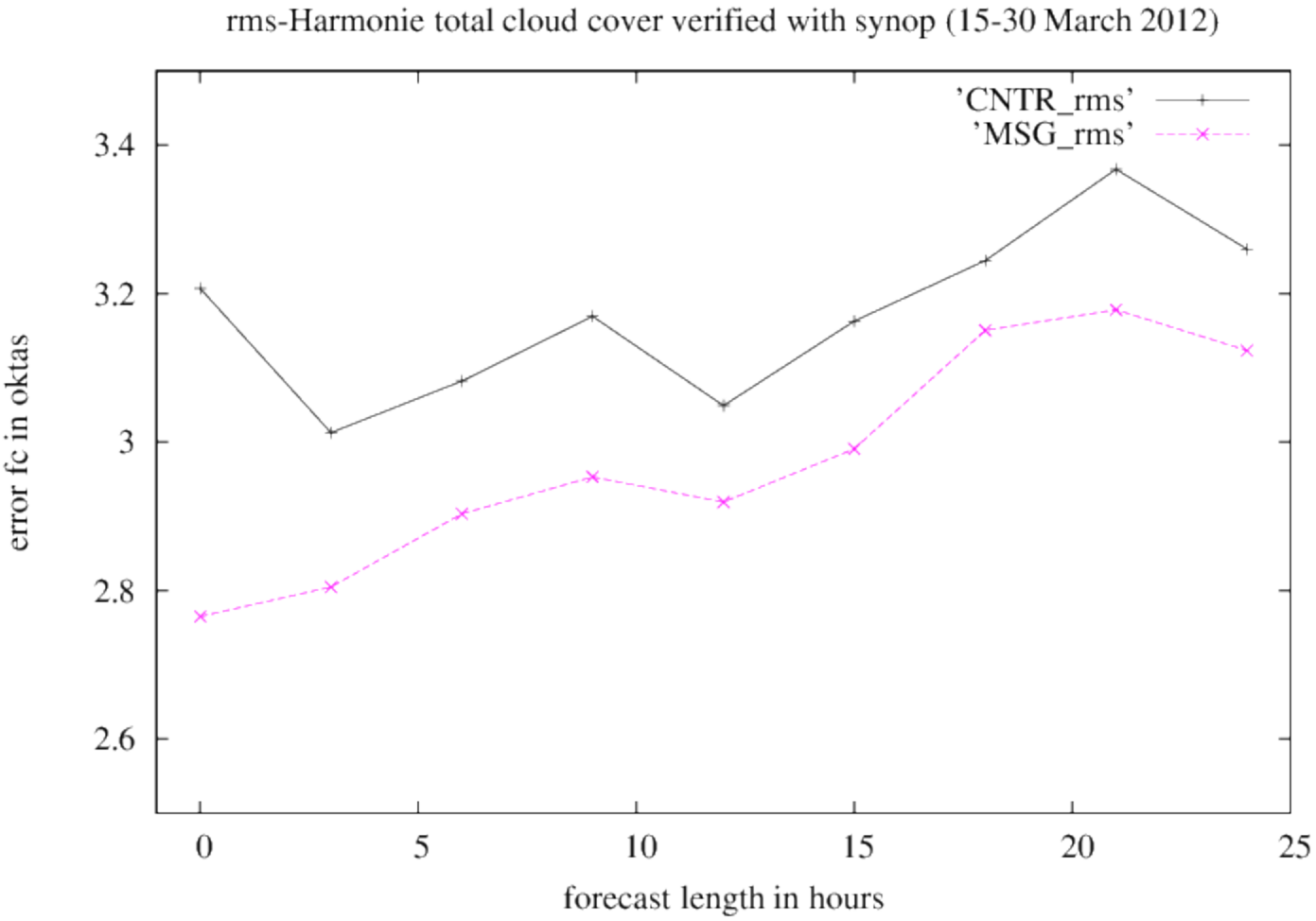
forecast length in hours


rms-Harmonie total cloud cover verified with synop (15-30 March 2012)
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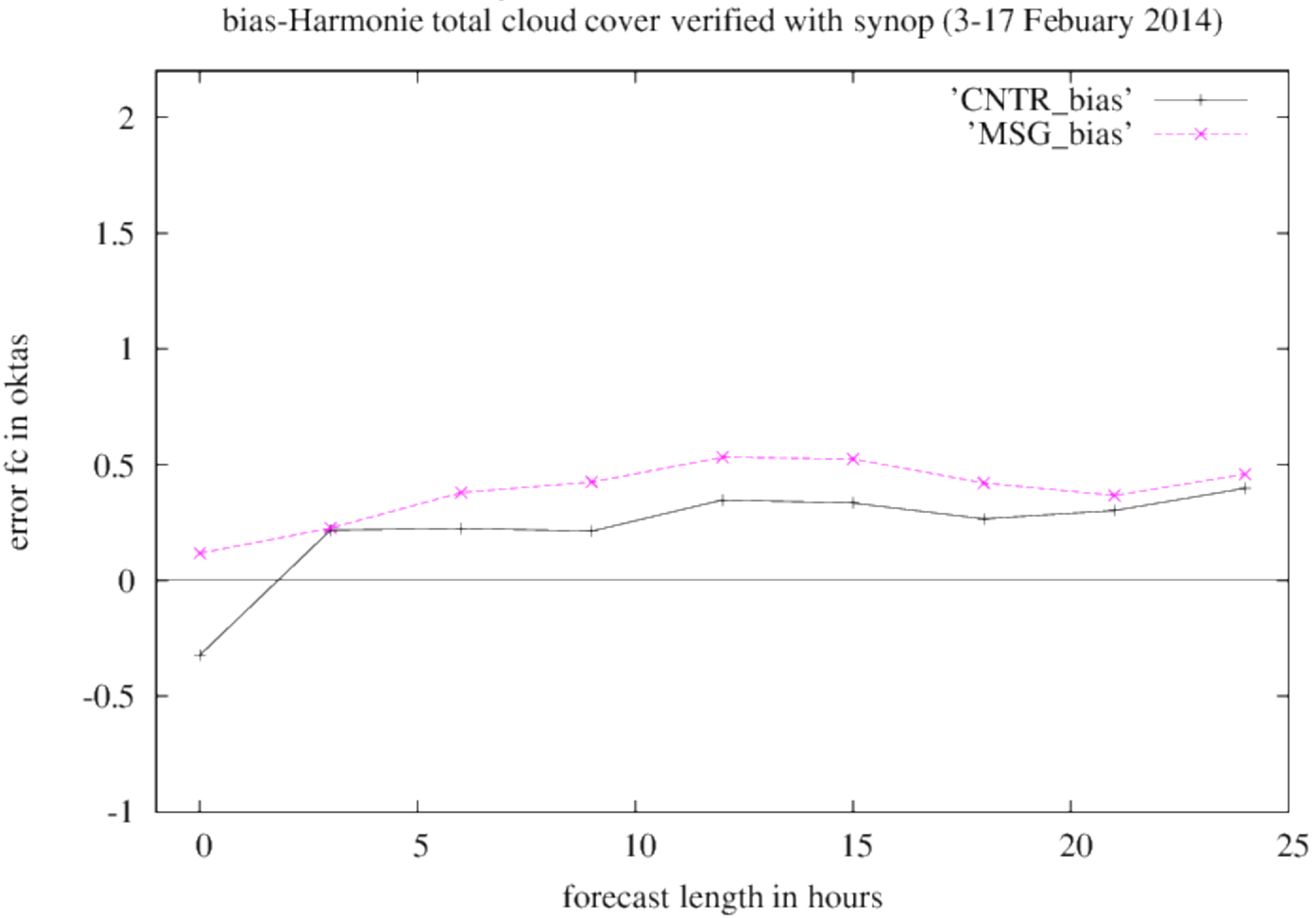
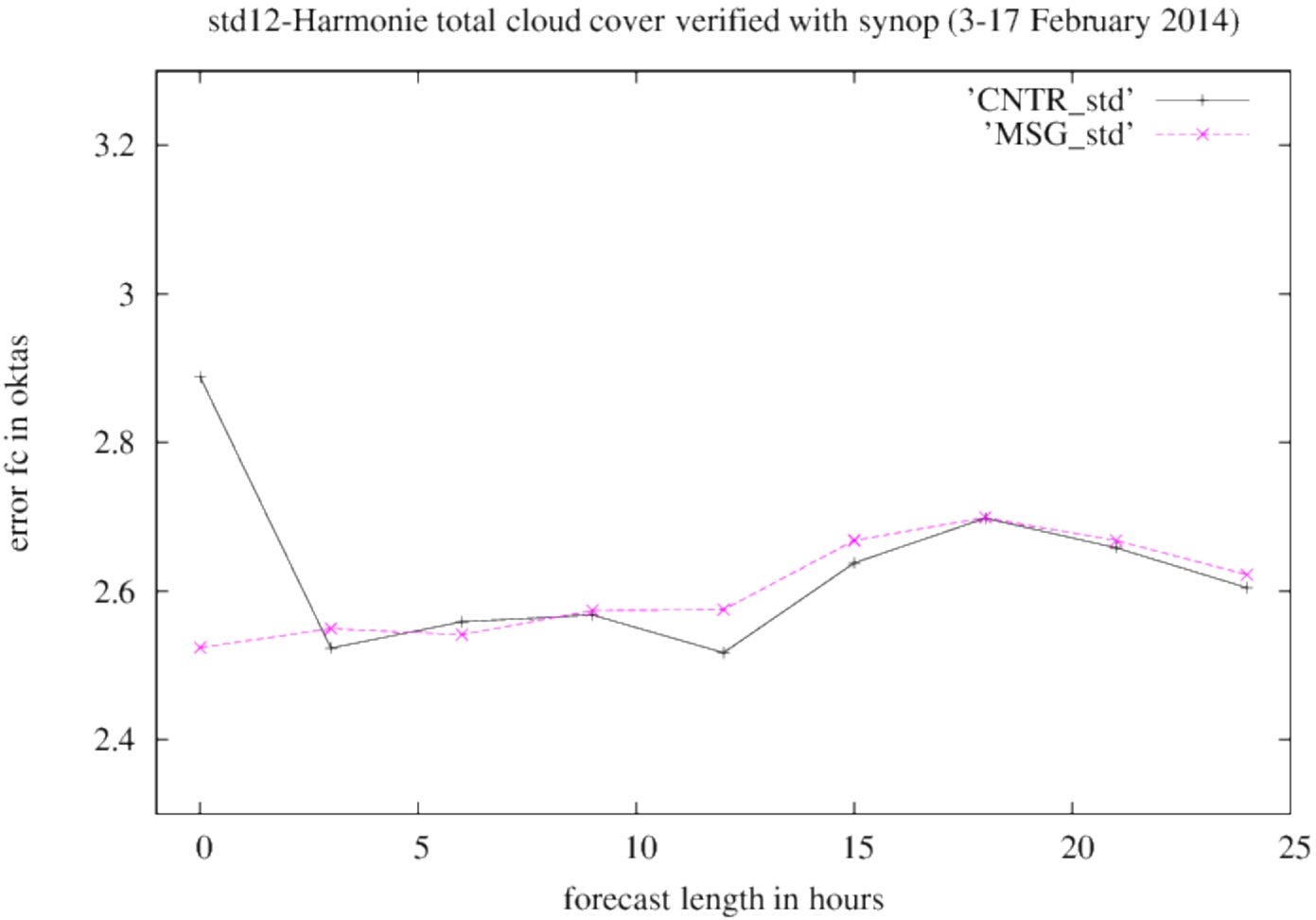
'MSG_rms'
3.4
3.2
3
2.8
2.6
error fc in oktas
0
5
10
15
20
25
forecast length in hours

February 2014 ECMWF run




std12-Harmonie total cloud cover verified with synop (3-17 February 2014)
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'MSG_std'
error fc in oktas
3.2
3
2.8
2.6
2.4
0
5
10
15
20
25
forecast length in hours

KNMI Bull run since winter 2014 *(control on ECMWF)*

- No comparison with control yet
- Maybe too much moisture added?

Moisture/clouds:

- sometimes too much rainfall

- too high q

- Smaller std cloud cover errors

(very preliminary conclusions !)

If true, this may have been caused by:

Dry layers between clouds are made cloudy

3D cloud observations needed…

Microphysics: medium level clouds are transferred to ice too rapidly

Can be solved…

Plans for near future:

1. Study verification results

2. Adapt microphysics

3. Improve 3D cloud initialisation

4. Introduce in HarmonEPS

5. Merge with Data Assimilation
(if beneficial)

CI / DA (1)

Plan to use many more cloud observations, such as:

- cloud type
- liquid water path
- phase
-drop effective radius

-use GPS

-different layers from ceilometers

Aim: optimised 3D field of clouds

Possibly also part of SCFIVI project (EU), initiated and led by SMHI (Sweden)

(Solar energy, Water resource management, Arctic clouds)

CI / DA (2)

Need better translation of 3D cloud field to microphysical variables of Harmonie fields. Taken into account:

(sub-grid variability of) water vapour
(sub-grid variability of) of temperature
(partly) overlapping of clouds

(*Complex, but feasible)*

Change:
water vapour (and T)
liquid and frozen hydrometeors

Summary CI in Harmonie:

- Verification shows positive impact on cloud cover (duration of impact limited in case of strong winds)
- Other model fields still need to be verified

- Improve initial 3D clouds
- (maybe) Adapt microphysics
- Merge with DA (4DVAR)