Royal Netherlands
Meteorological Institute
Ministry of Infrastructure
and Water Management

HIRLAM (HARMONIE-AROME) physics developments

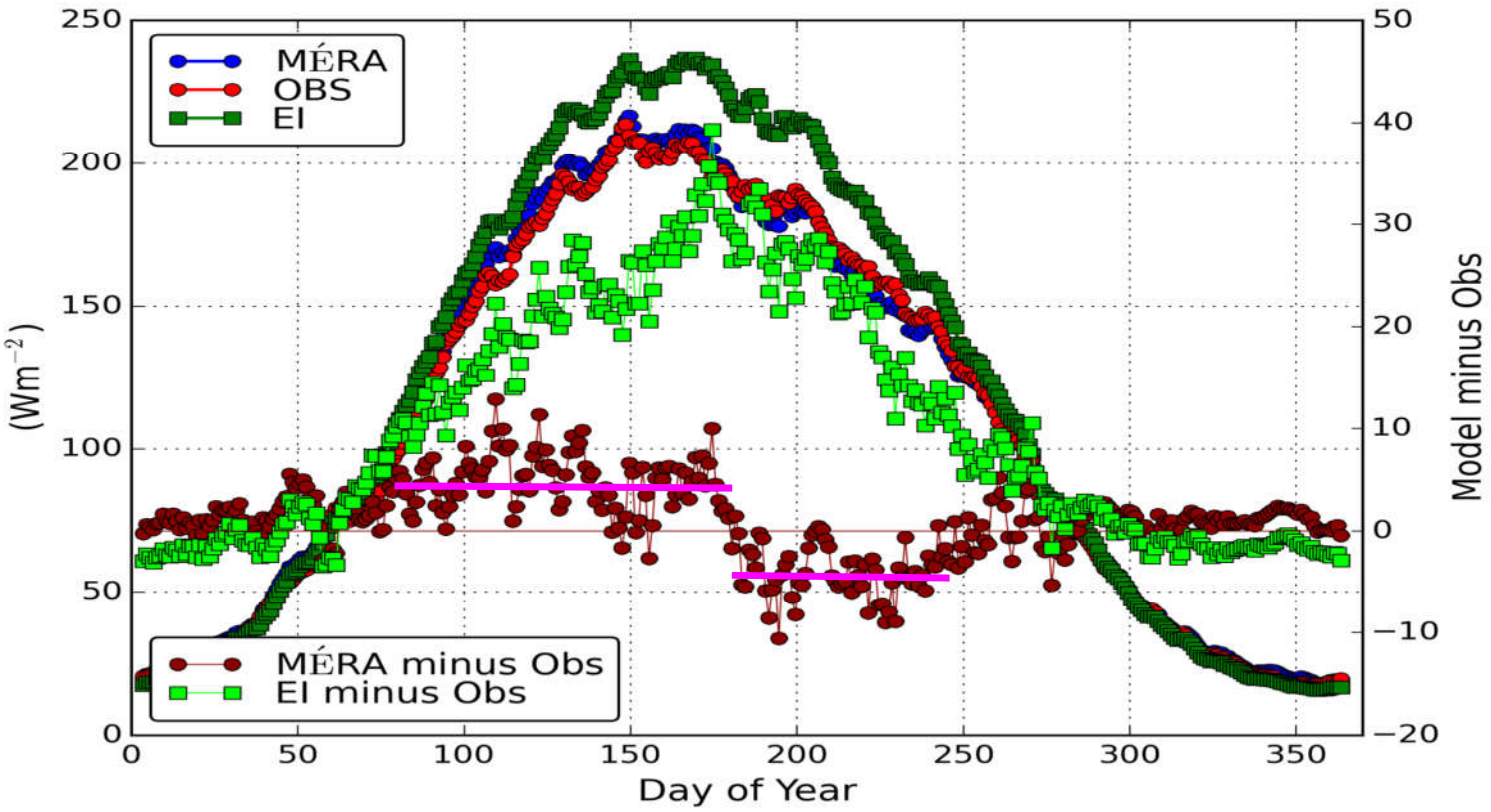
Sander Tijm (contribution from many colleagues)

Overview

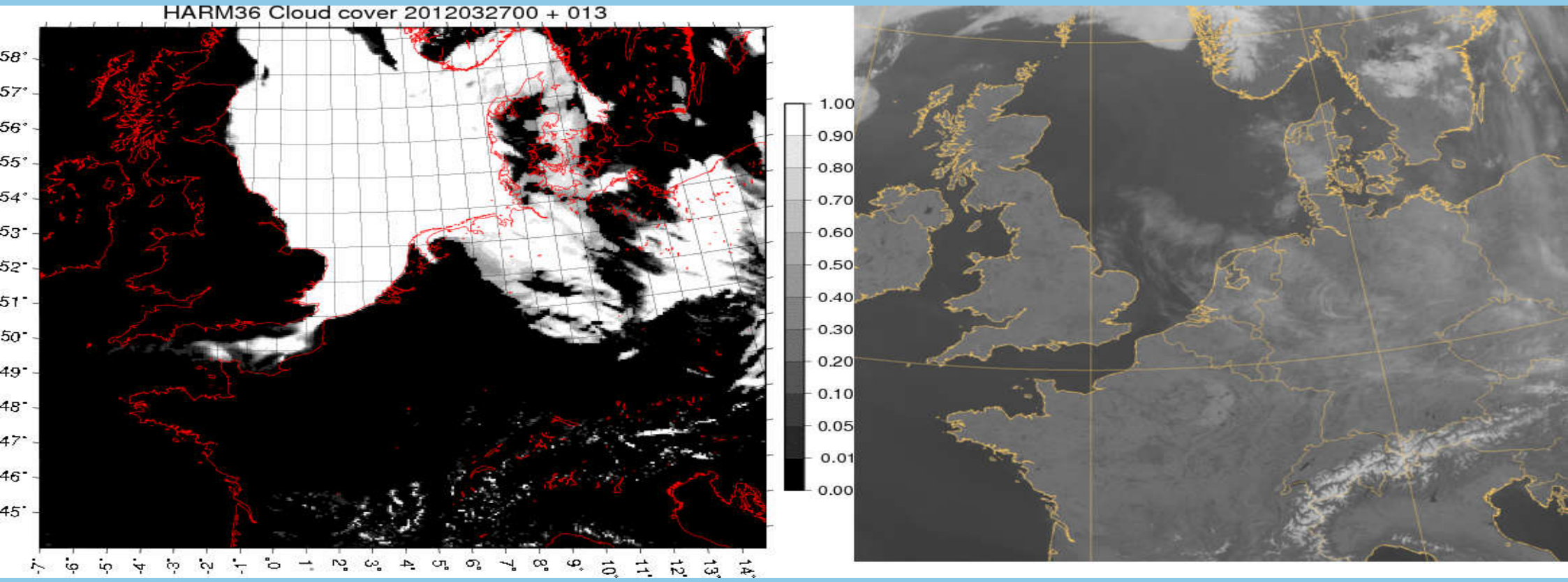
- Radiation
- Low Clouds
- Precipitation

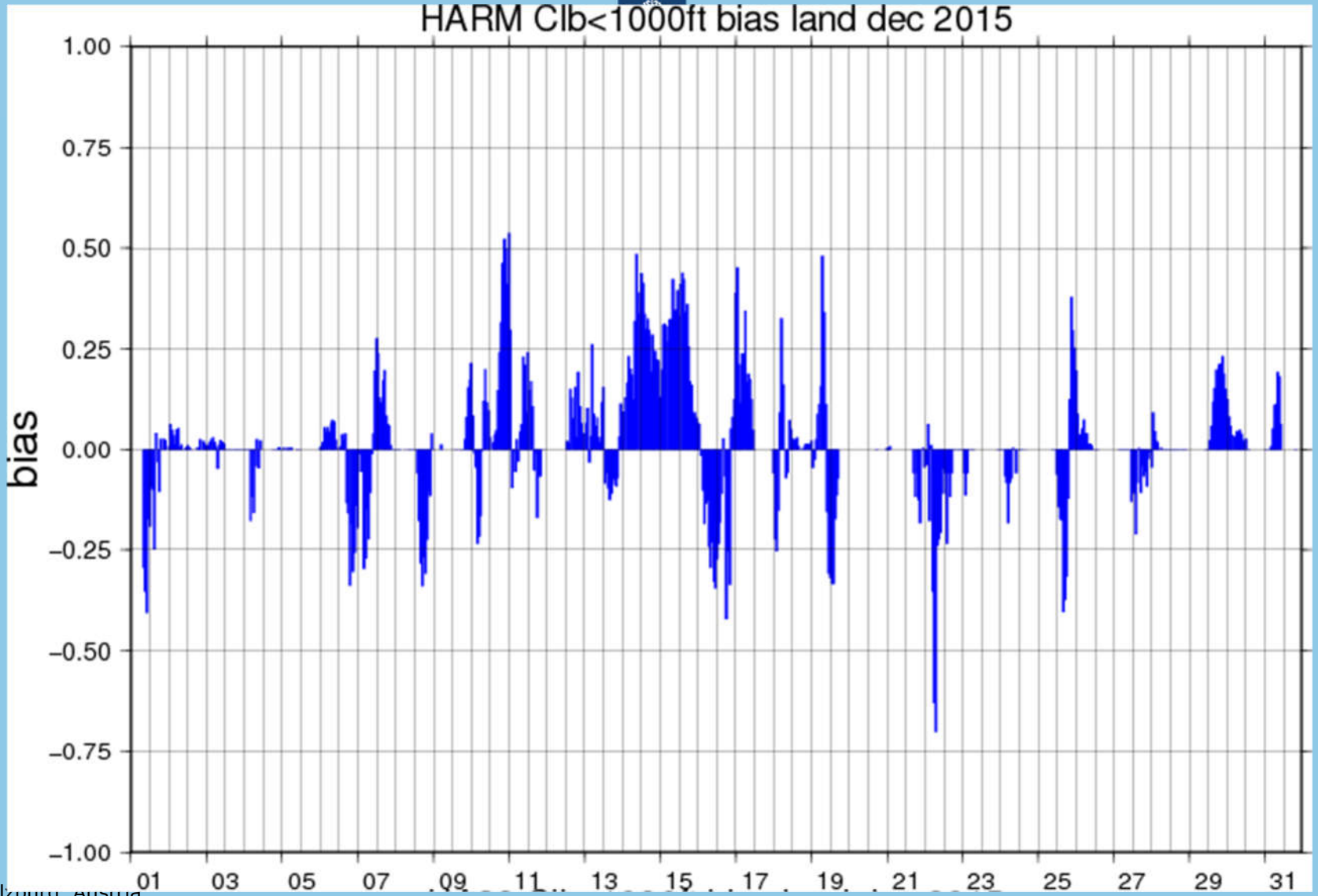
- Possible solutions?

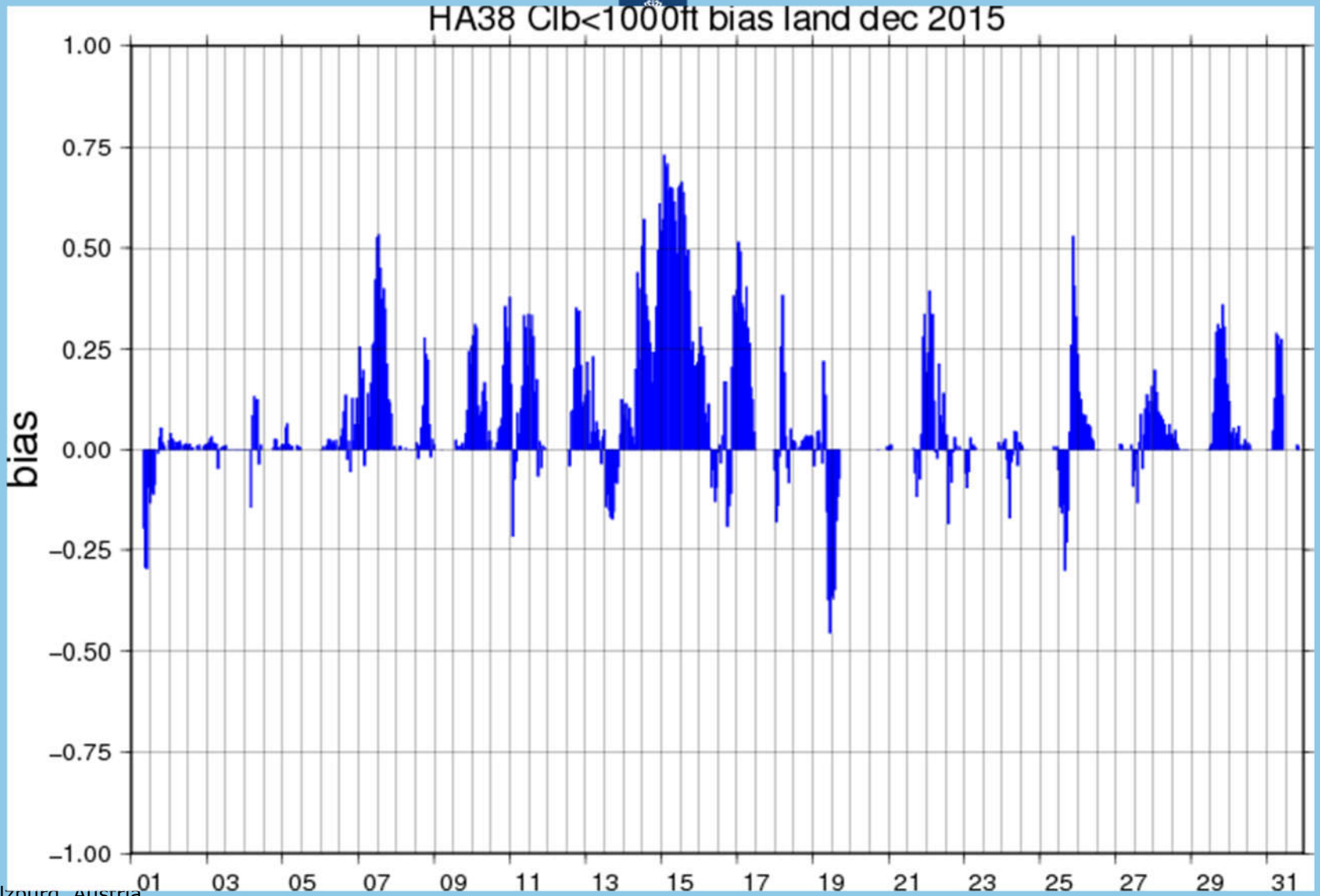
Comparison of reanalysis products for Ireland



Nielsen (DMI) & Gleeson (Met Eireann), (Atmosphere 2018)


HARM36 Cloud cover 2012032700 + 013
58°
57°
56°
55°
54°
53°
52°
51°
50°
49°
48°
47°
46°
45°
-10°
-9°
-8°
-7°
-6°
-5°
-4°
-3°
-2°
-1°
0°
1°
2°
3°
4°
5°
6°
7°
8°
9°
10°
11°
12°
13°
14°
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.05
0.01
0.00

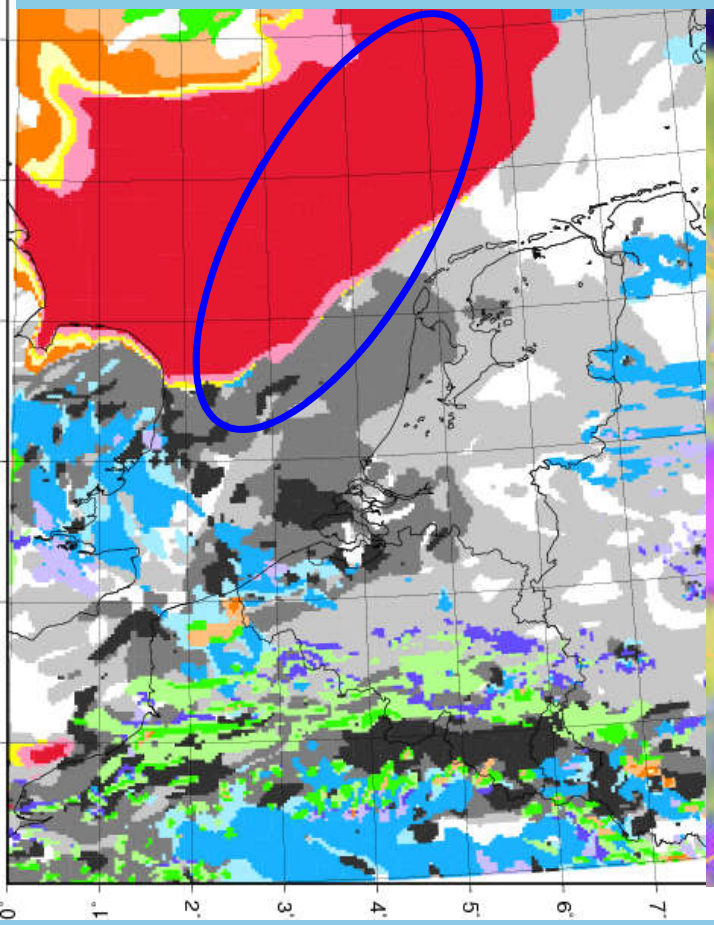

HARM Clb<1000ft bias land dec 2015
bias
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
01
03
05
07
09
11
13
15
17
19
21
23
25
27
29
31

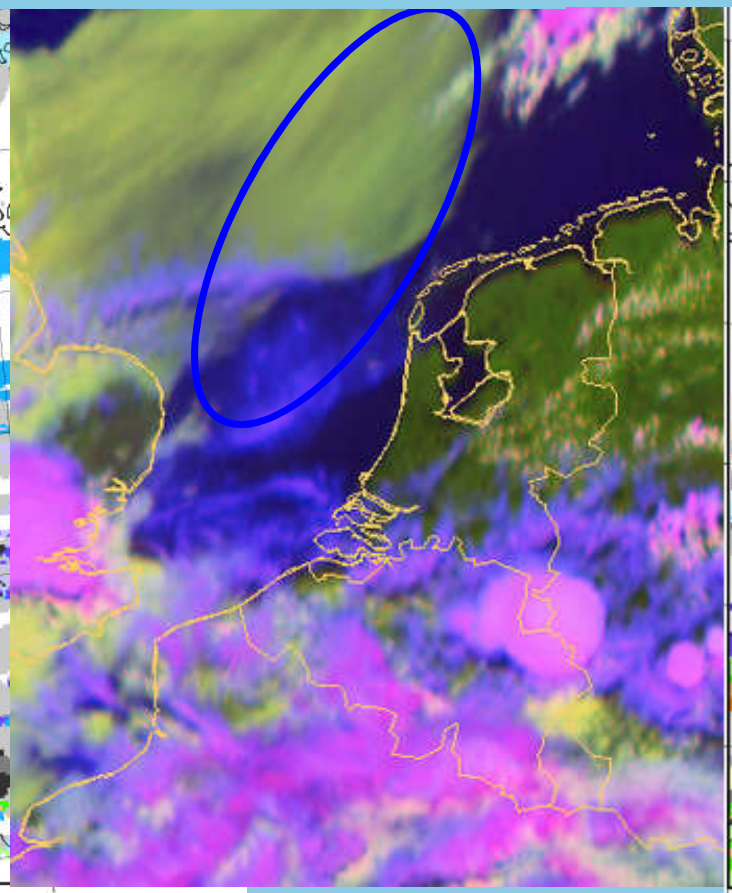

HA38 Clb<1000ft bias land dec 2015
bias
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
01
03
05
07
09
11
13
15
17
19
21
23
25
27
29
31

Fog and low clouds

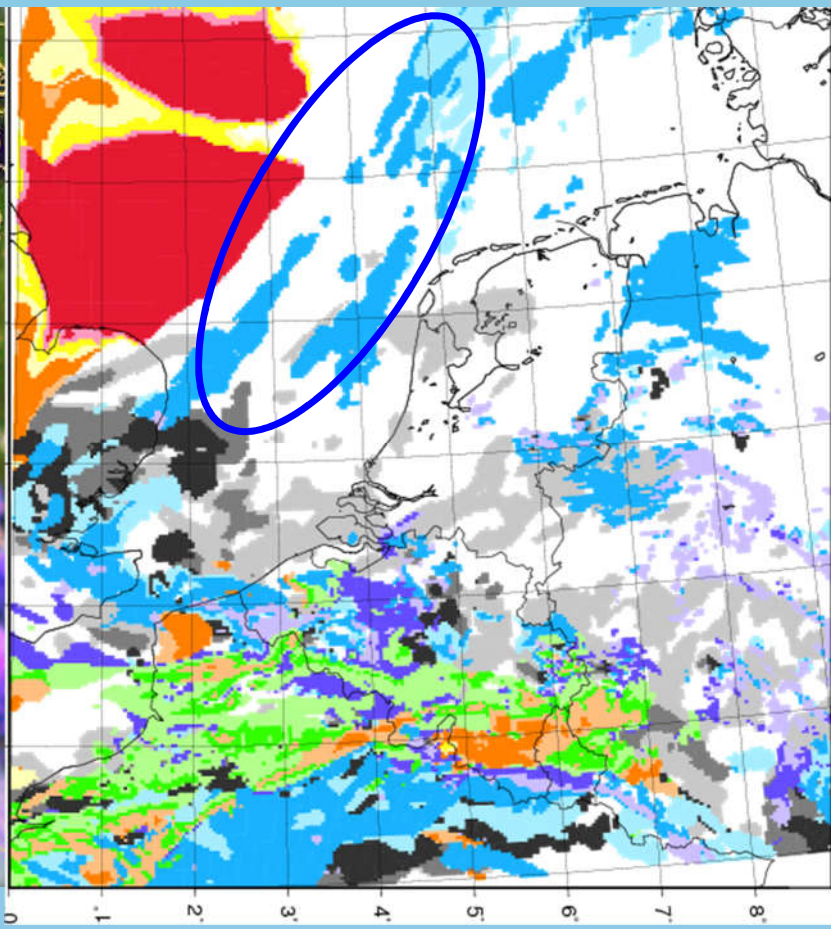
Fog and Low clouds 29 May

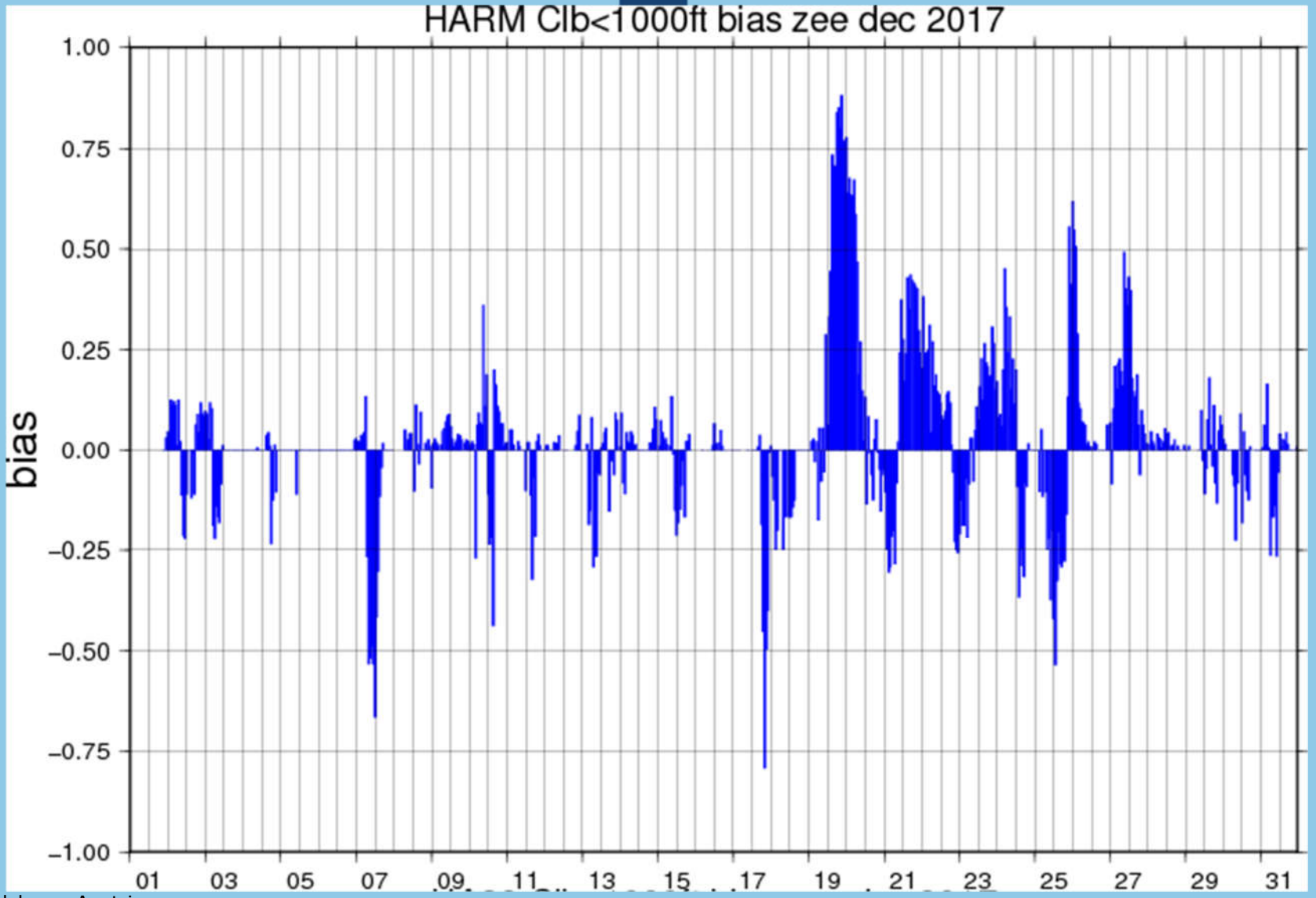
HA36

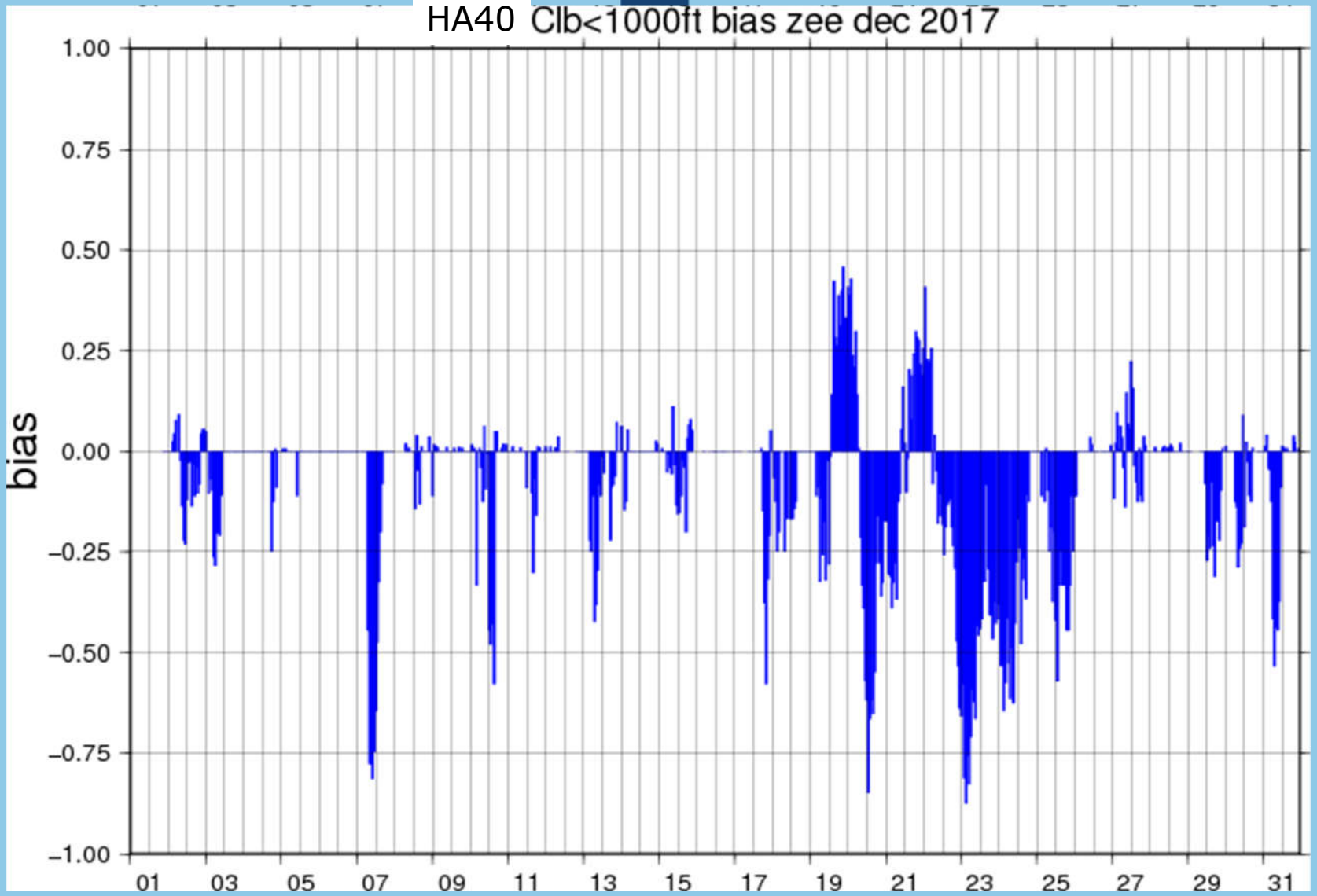




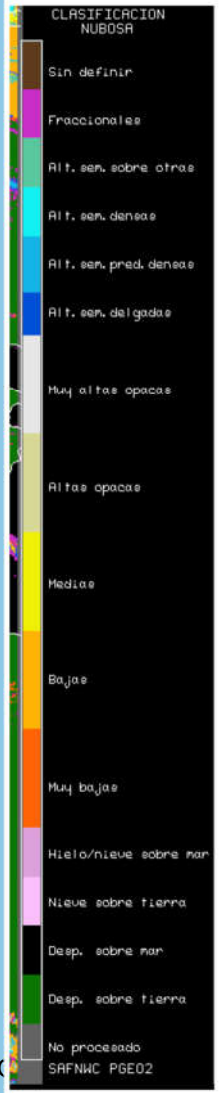
HA40

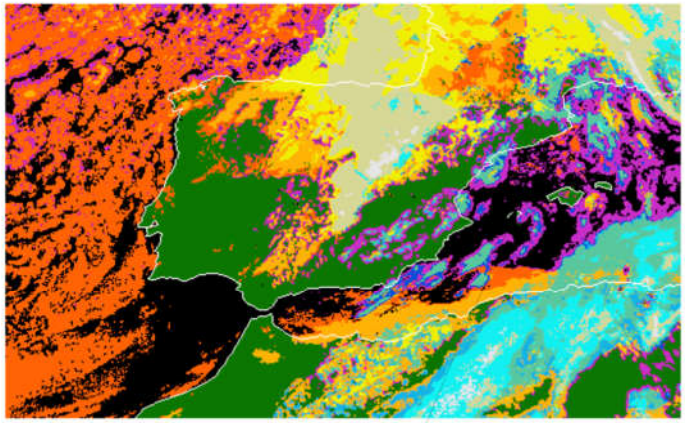



HARM Clb<1000ft bias zee dec 2017
bias
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
01
03
05
07
09
11
13
15
17
19
21
23
25
27
29
31

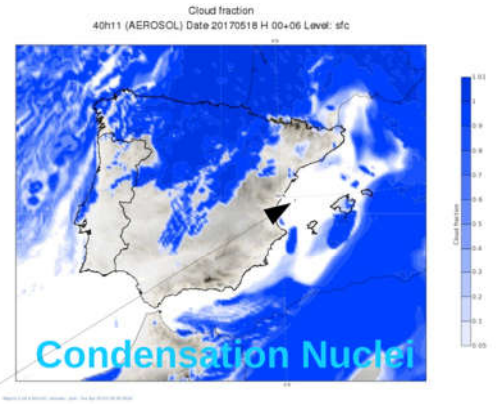

HA40 Clb<1000ft bias zee dec 2017
bias
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
01
03
05
07
09
11
13
15
17
19
21
23
25
27
29
31

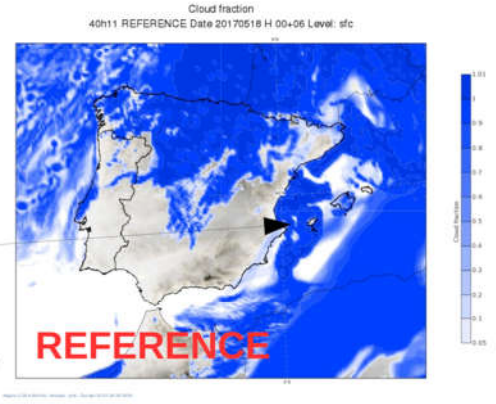
Case study. 20170518.





Cloud Types from NWC SAF:
2017051806





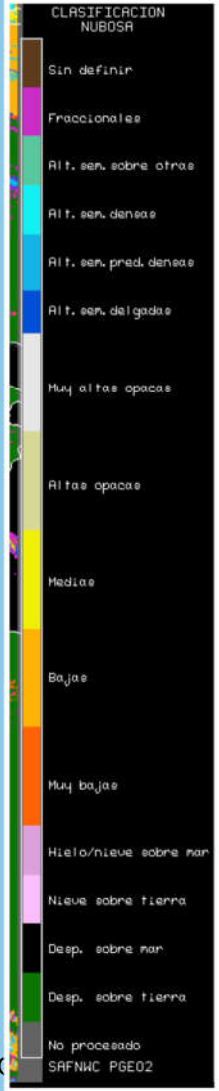
- Cloud fraction. Clouds over the mediterranean are not formed when the aerosol from CAMS are considered.
- In the satellite image only a few high clouds appear in that area (light blue).

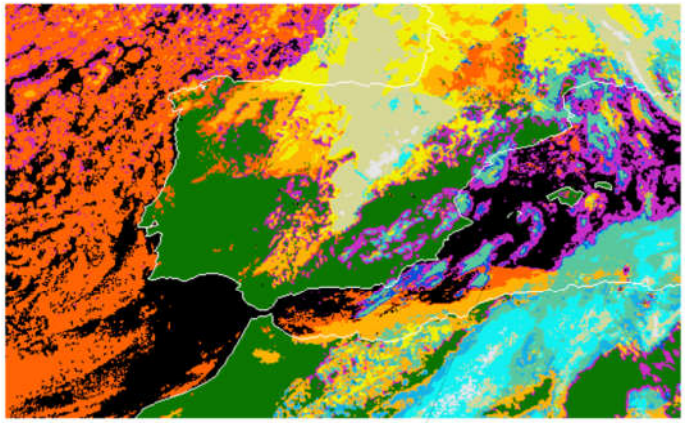
The EUMETSAT Network of Satellite Application Facilities

NWC SAF
Support to Nowcasting and Very Short Range Forecasting

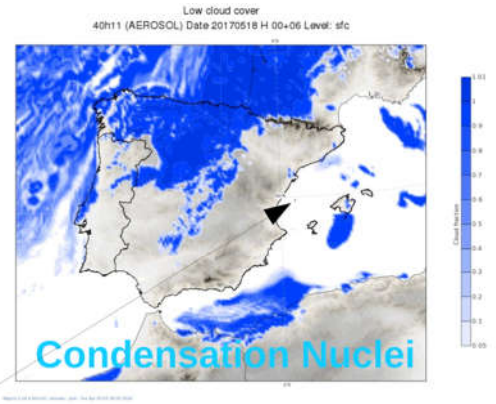
Martin (AEMET)

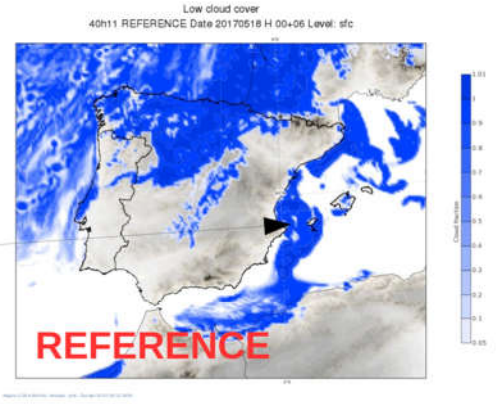
Case study. 20170518.





Cloud Types from NWC SAF:
2017051806





- Low cloud cover.
- Low clouds are formed in the REFERENCE model due to wrong values of cloud condensation nuclei.

The EUMETSAT Network of Satellite Application Facilities

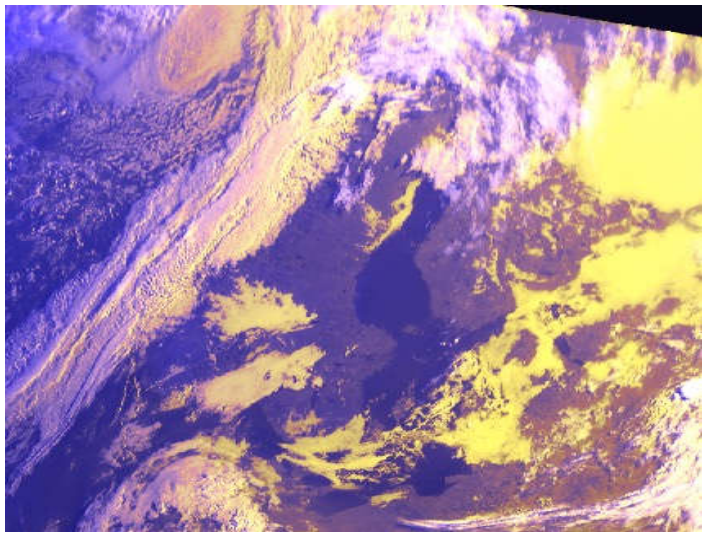
NWC SAF
Support to Nowcasting and Very Short Range Forecasting

Martin (AEMET)

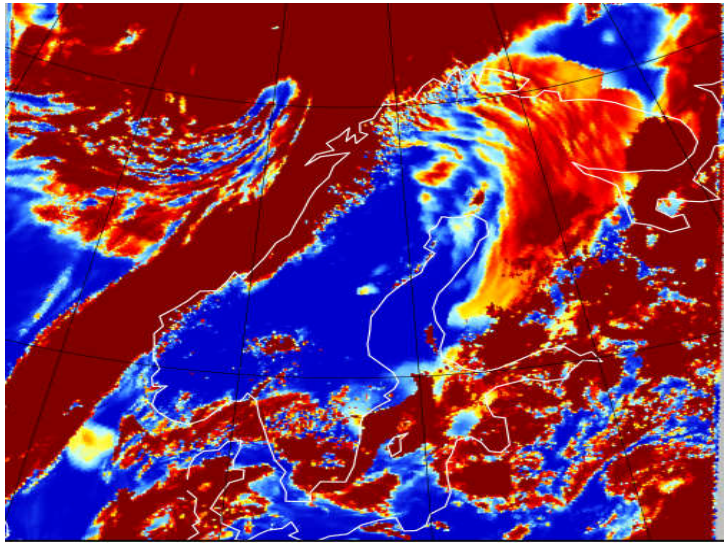
MNWC – MSG Cloud assimilation

Gregow
(MetCoOp/FMI)

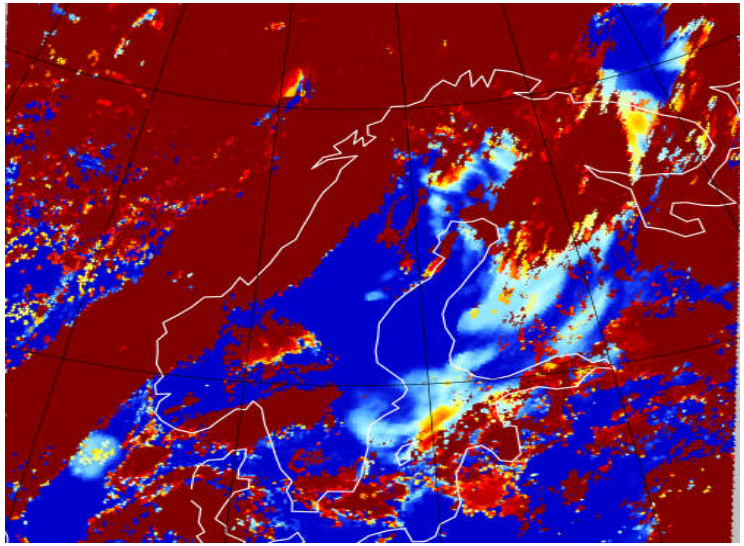
Satellite
2018-09-03, 06Z



MNWC-Preop
fc06Z+00h

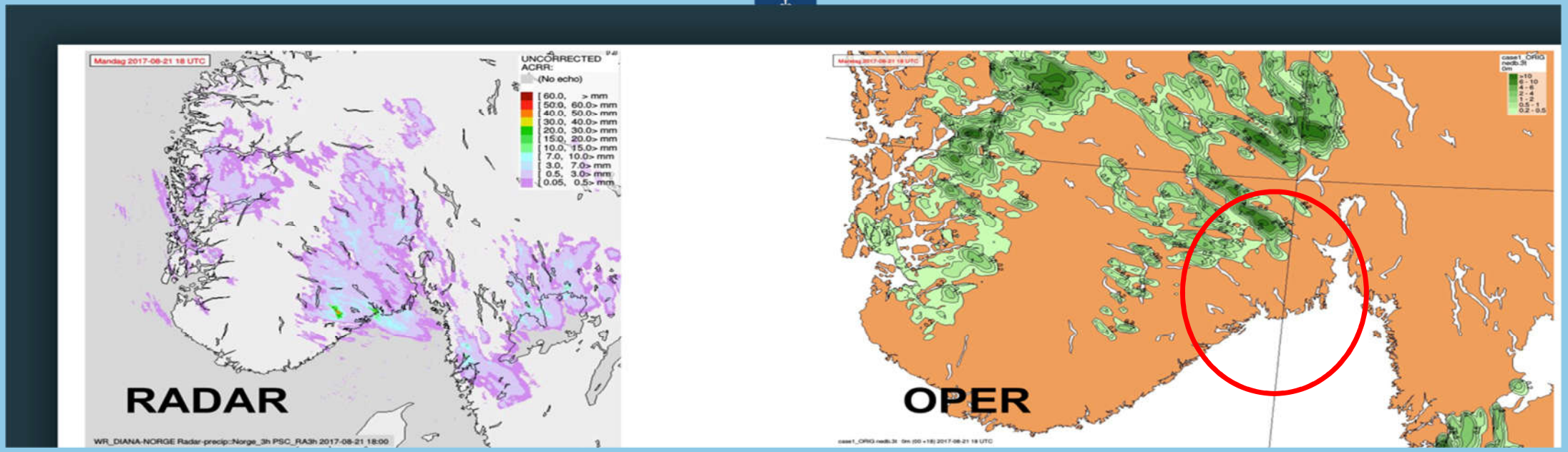


MNWC-MSG_ingest
fc06Z+00h



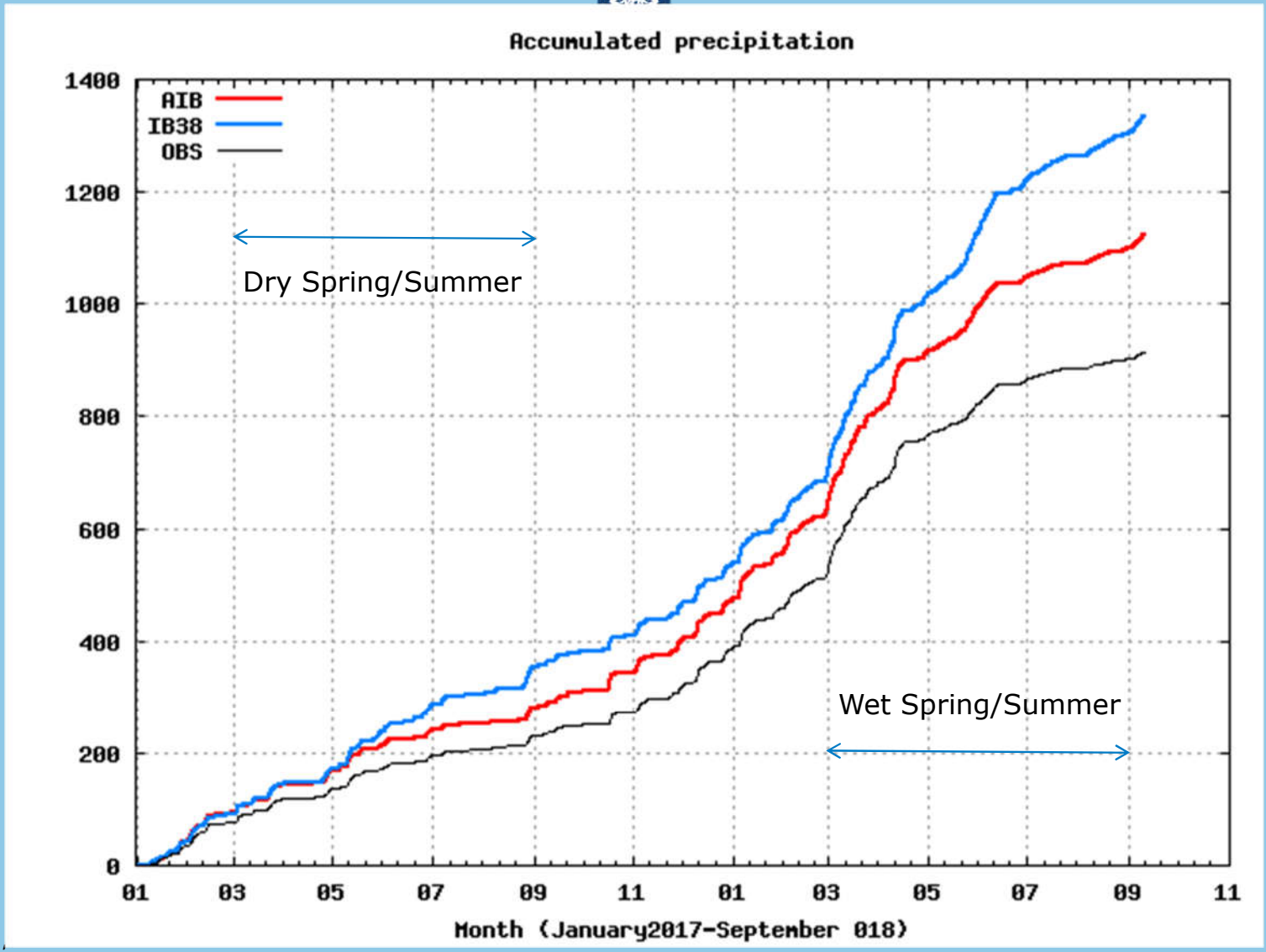
Cloud-fraction

Back to convection

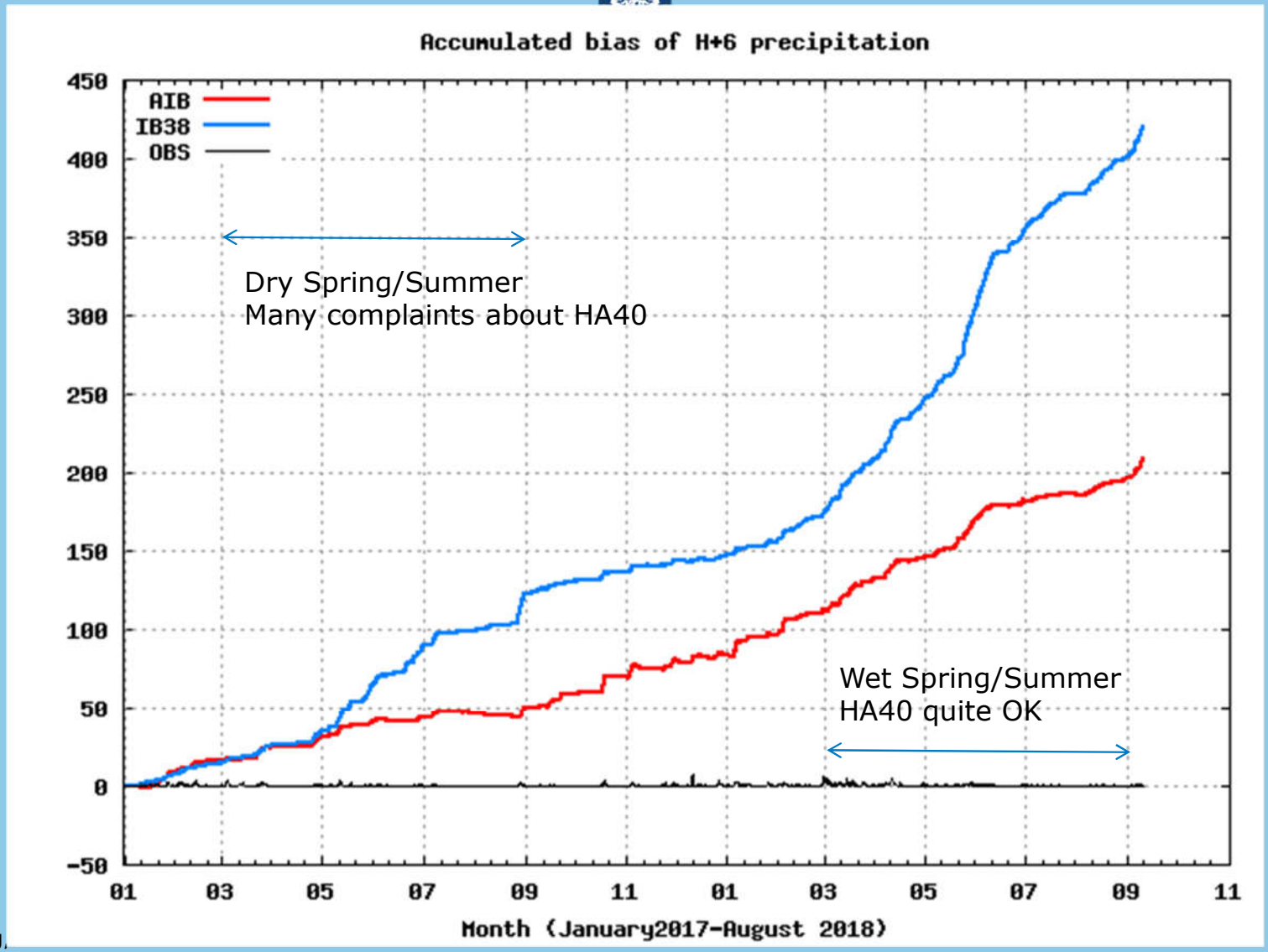


Significant area with deep convection missed

Koltzow & Bjorge (MetCoOp, Met.no)

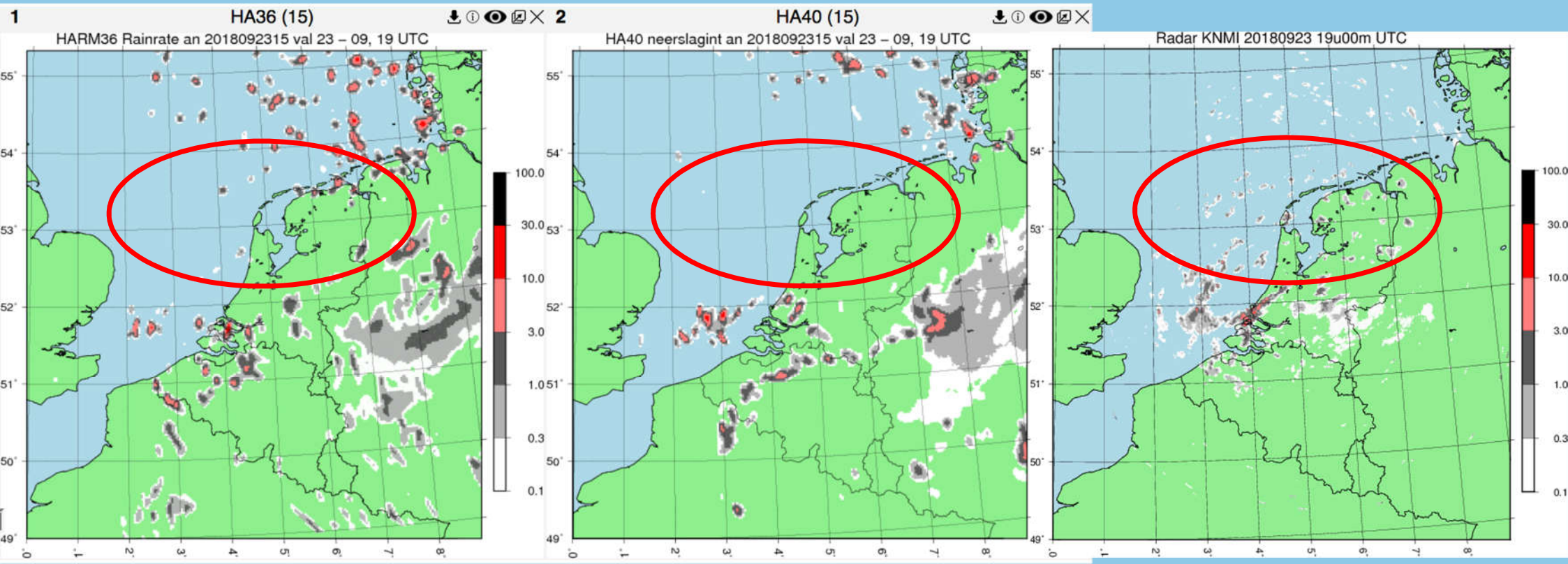

Accumulated precipitation
AIB
IB38
OBS
Dry Spring/Summer
Wet Spring/Summer
1400
1200
1000
800
600
400
200
0
01
03
05
07
09
11
01
03
05
07
09
11
Month (January2017-September 018)

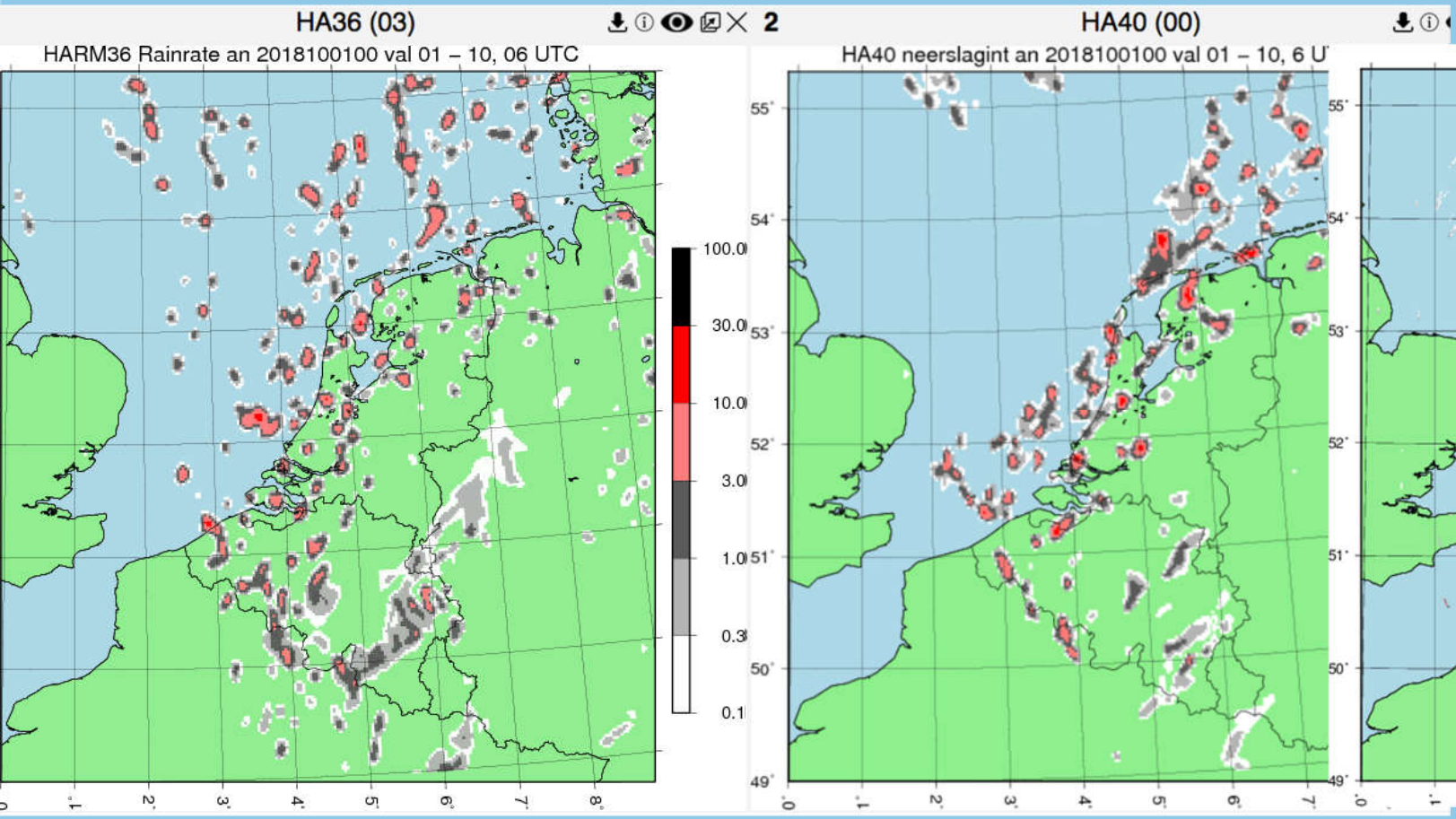
Calvo (AEMET)


Accumulated bias of H+6 precipitation
AIB
IB38
OBS
Dry Spring/Summer
Many complaints about HA40
Wet Spring/Summer
HA40 quite OK
450
400
350
300
250
200
150
100
50
0
-50
01
03
05
07
09
11
01
03
05
07
09
11
Month (January2017-August 2018)

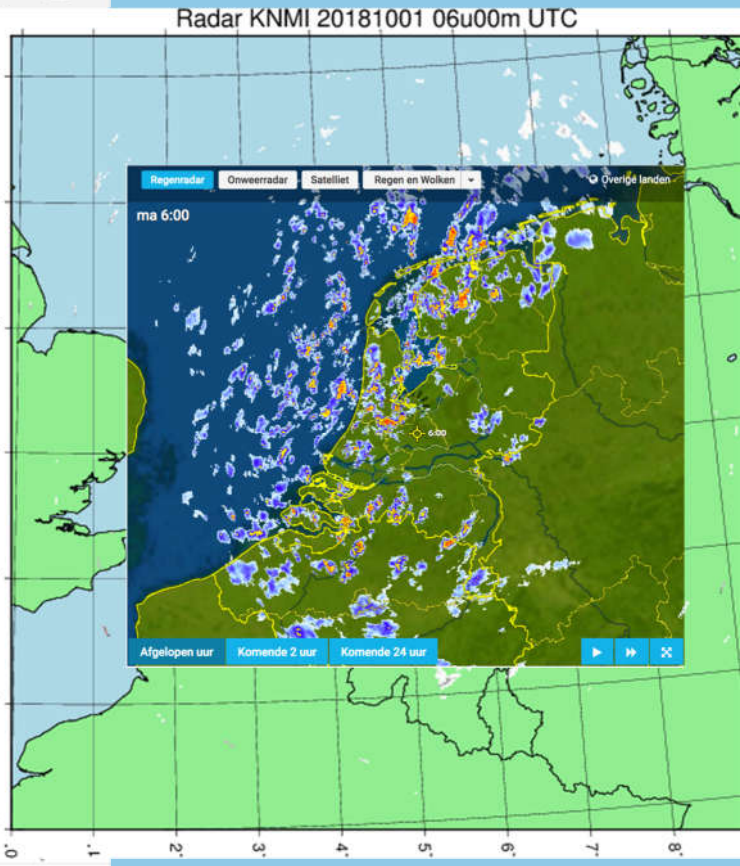
Calvo (AEMET)

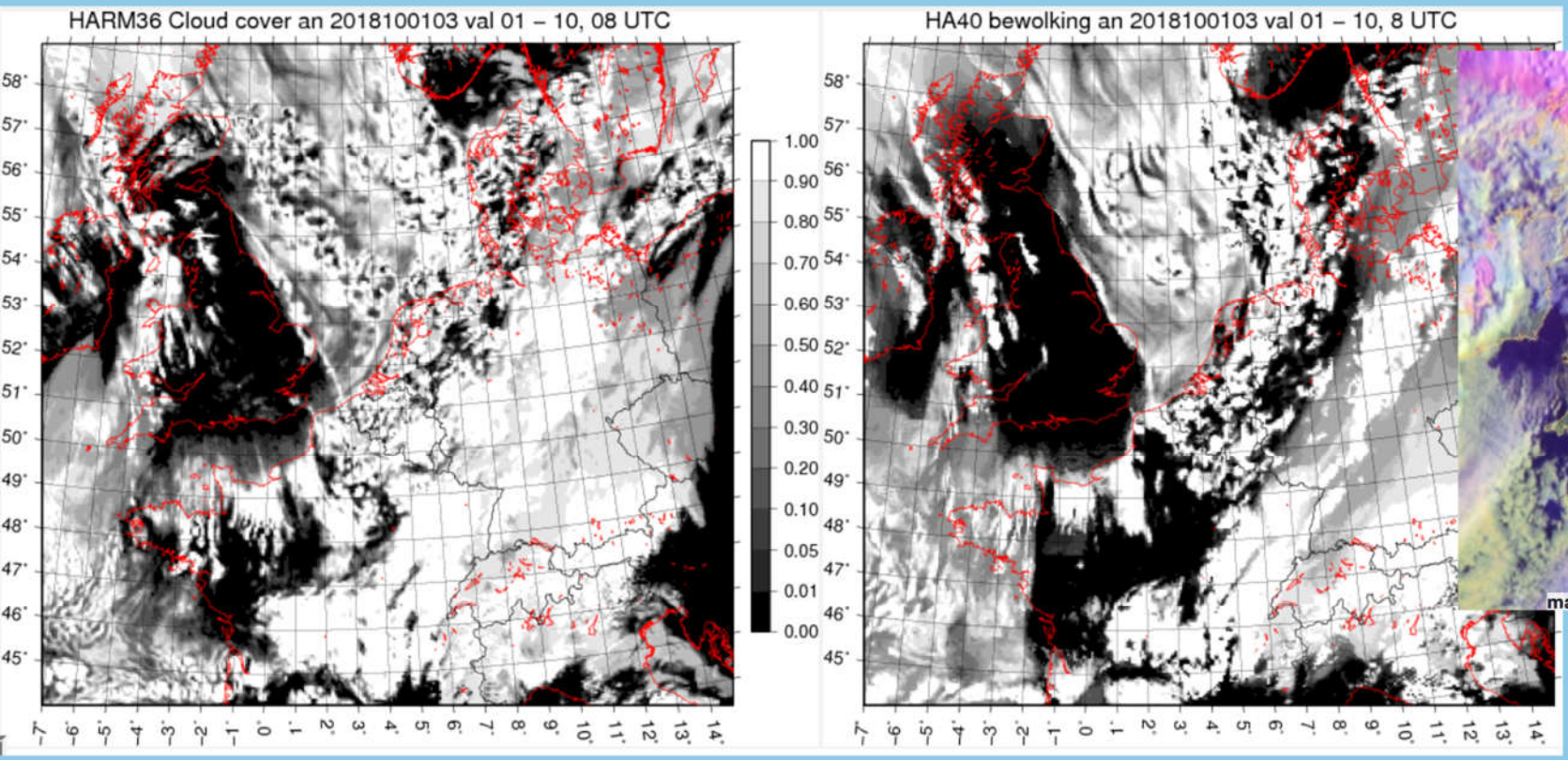
Operational E-suite Obs

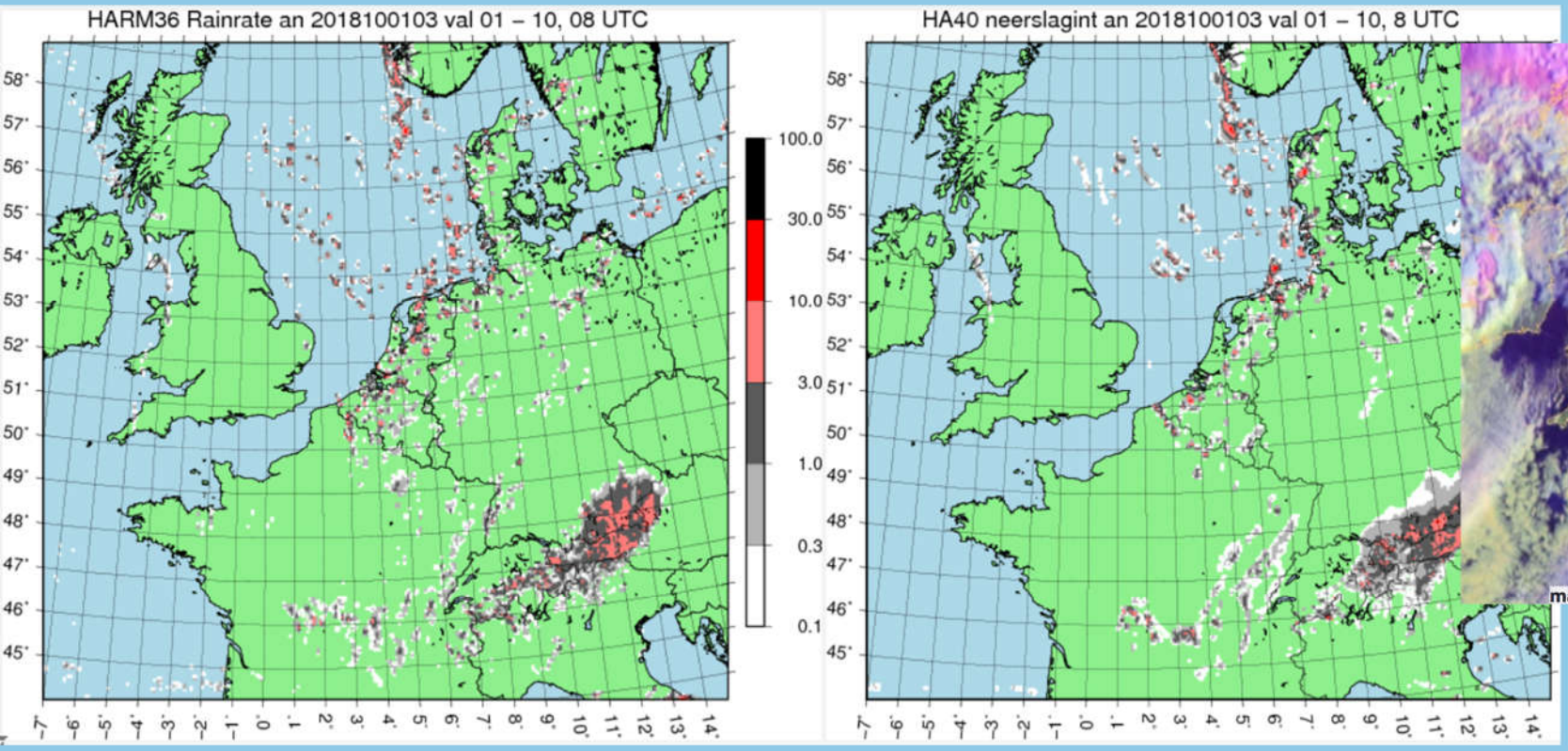


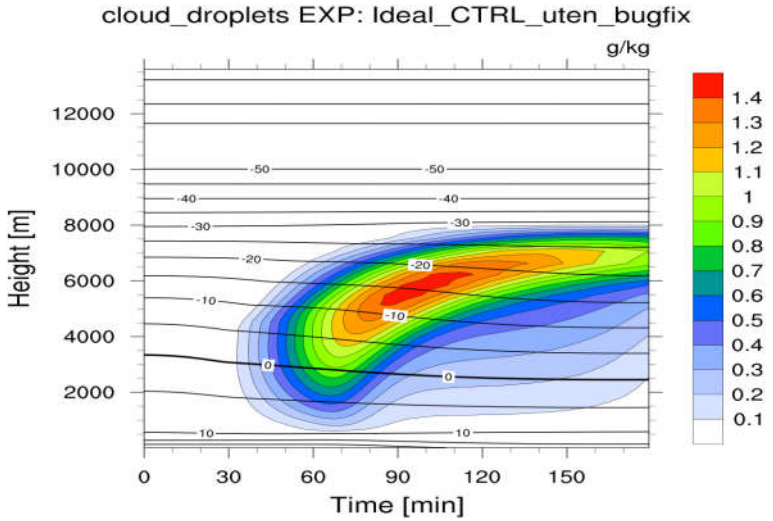

HA36 (03)
HARM36 Rainrate an 2018100100 val 01 – 10, 06 UTC
100.0
30.0
10.0
3.0
1.0
0.3
0.1
55°
54°
53°
52°
51°
50°
49°
0°
1°
2°
3°
4°
5°
6°
7°
8°

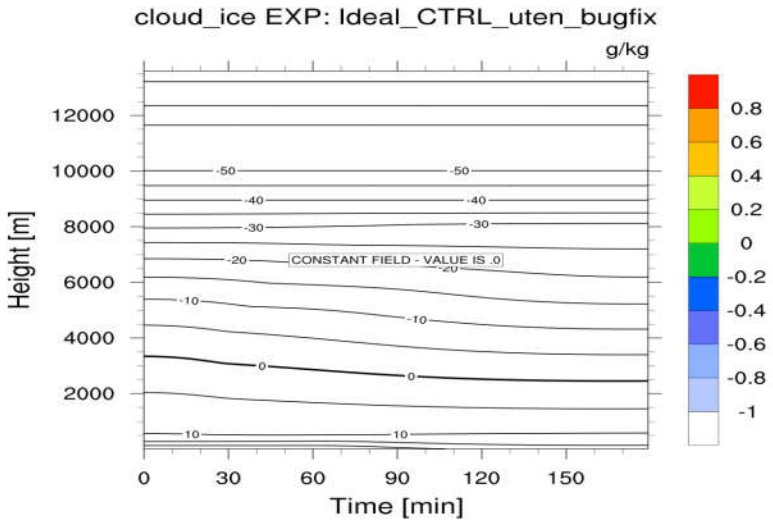
HA40 (00)
HA40 neerslagint an 2018100100 val 01 – 10, 6 U
55°
54°
53°
52°
51°
50°
49°
0°
1°
2°
3°
4°
5°
6°
7°
8°


Radar KNMI 20181001 06u00m UTC
Regenradar
Onweerradar
Satelliet
Regen en Wolken
Overige landen
ma 6:00
Afgelopen uur
Komende 2 uur
Komende 24 uur


HARM36 Cloud cover an 2018100103 val 01 – 10, 08 UTC
HA40 bewolking an 2018100103 val 01 – 10, 8 UTC
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.05
0.01
0.00
ma01 0800z [00]

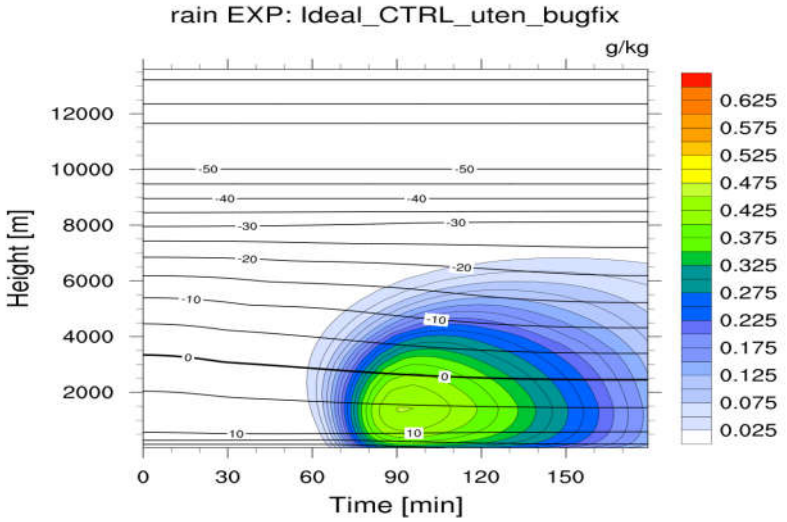

HARM36 Rainrate an 2018100103 val 01 – 10, 08 UTC
HA40 neerslagint an 2018100103 val 01 – 10, 8 UTC
100.0
30.0
10.0
3.0
1.0
0.3
0.1
ma01 0800z [00]

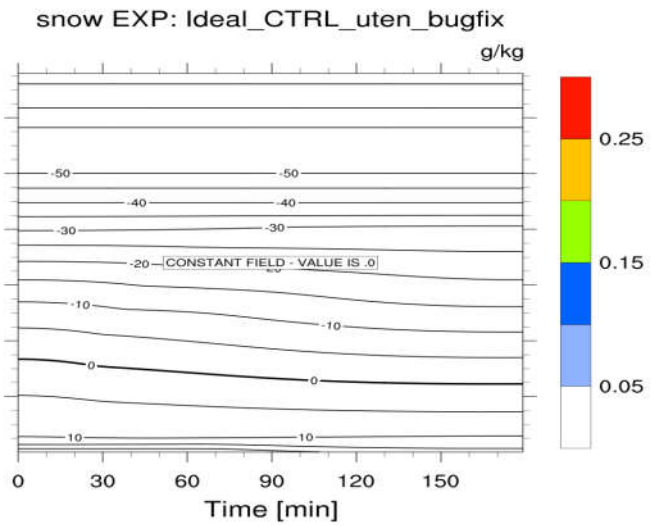


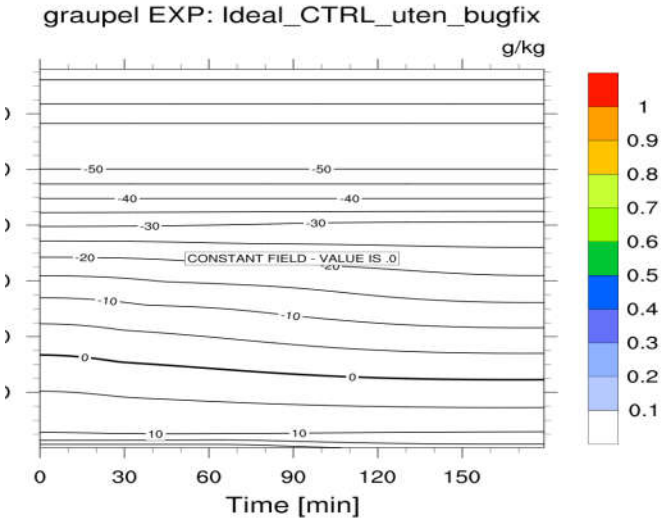


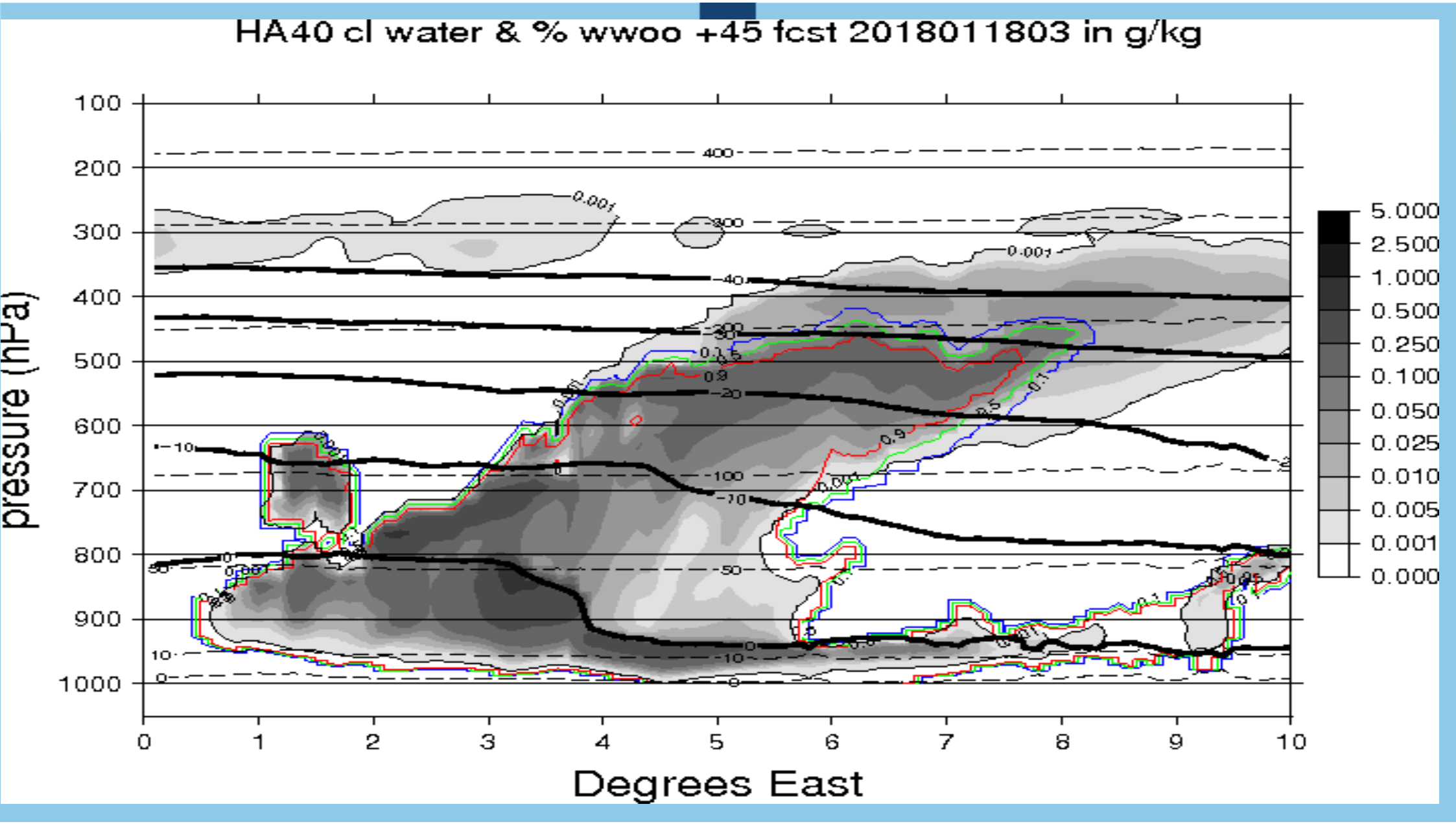
Engdahl (Met.no)

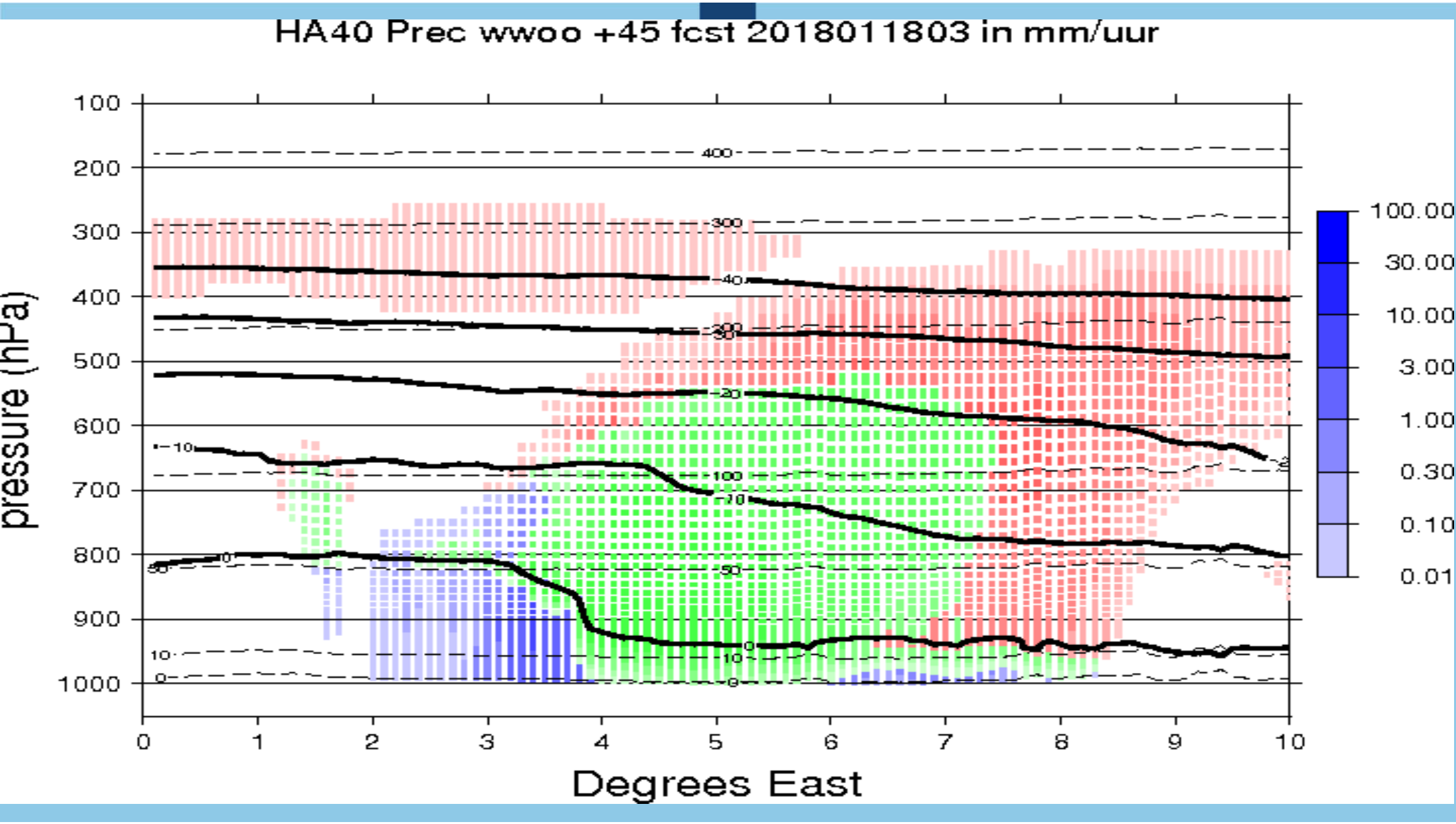
HARMONIE-AROME microphysics does not allow ice to be formed for T>-35° C
When cloud ice is present (snow falling trough column) water will freeze to ice

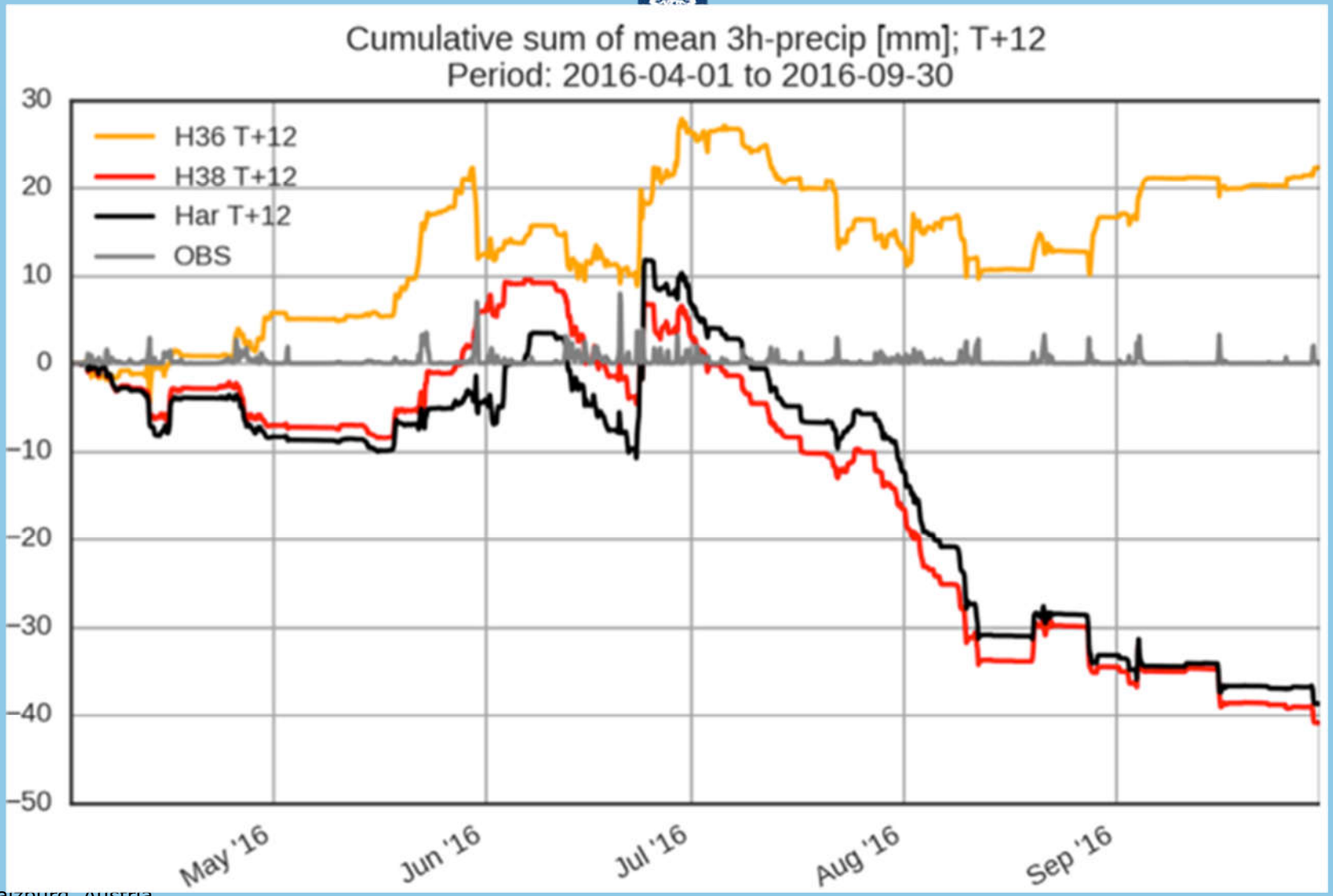







HA40 cl water & % wwoo +45 fcst 2018011803 in g/kg
pressure (hPa)
Degrees East
100
200
300
400
500
600
700
800
900
1000
0
1
2
3
4
5
6
7
8
9
10
5.000
2.500
1.000
0.500
0.250
0.100
0.050
0.025
0.010
0.005
0.001
0.000

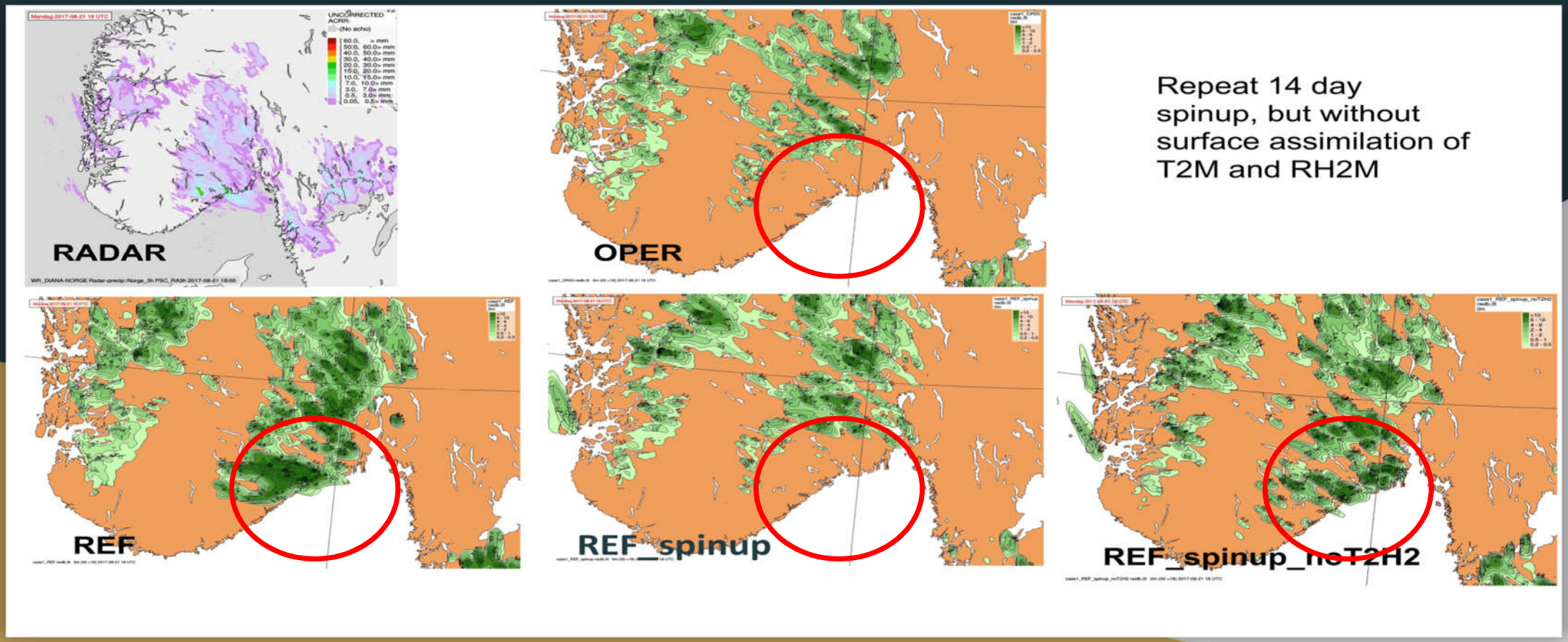

HA40 Prec wwoo +45 fcst 2018011803 in mm/uur
pressure (hPa)
100
200
300
400
500
600
700
800
900
1000
0
1
2
3
4
5
6
7
8
9
10
Degrees East
100.00
30.00
10.00
3.00
1.00
0.30
0.10
0.01



De Vries (KNMI)

Model deficiencies

- Too much precip on average (Spain), bias depending strongly on season
- Light and relatively warm (T>-15°C) showers missed, no open cell convection
- Some deep convection completely missed
- Stratiform precipitation from convection fizzles out too quick



Surface DA has a detrimental effect on convection development

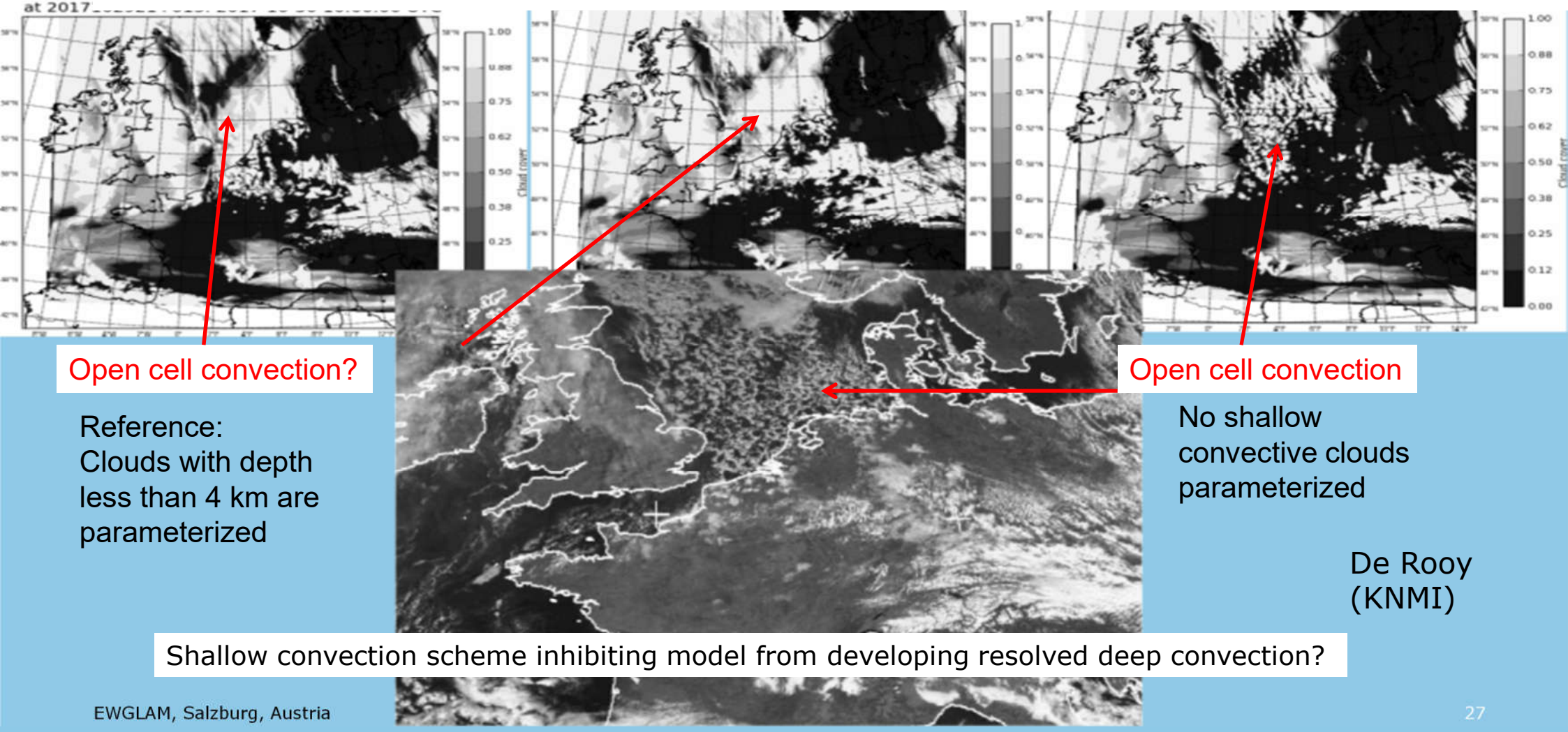
Improvements: reduction of evaporation, reduction of soil moisture increments

Koltzow & Bjorge (MetCoOp)

Reference 40h1.1

LTOTPREC

No shallow convection



Open cell convection?

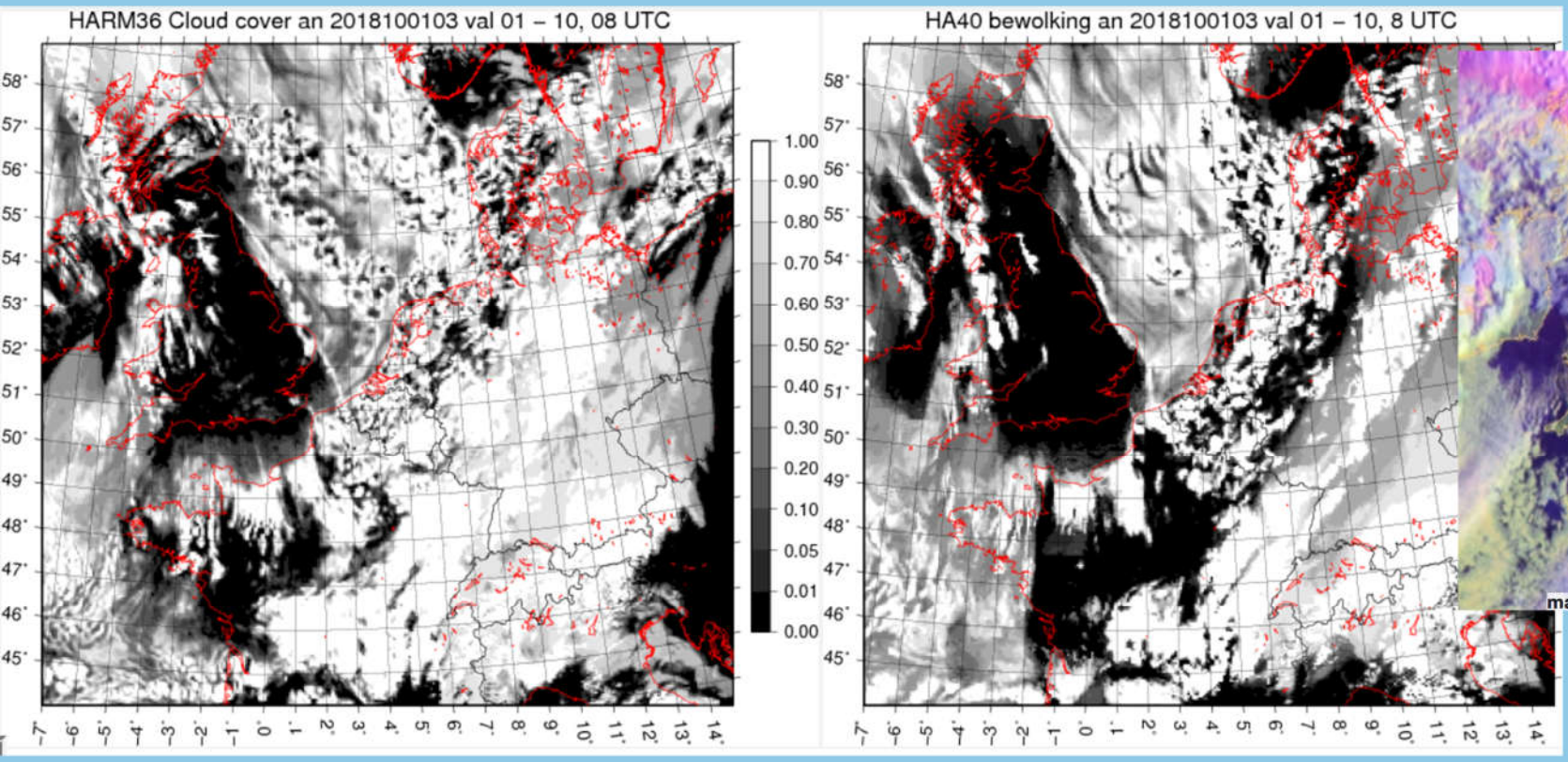
Open cell convection

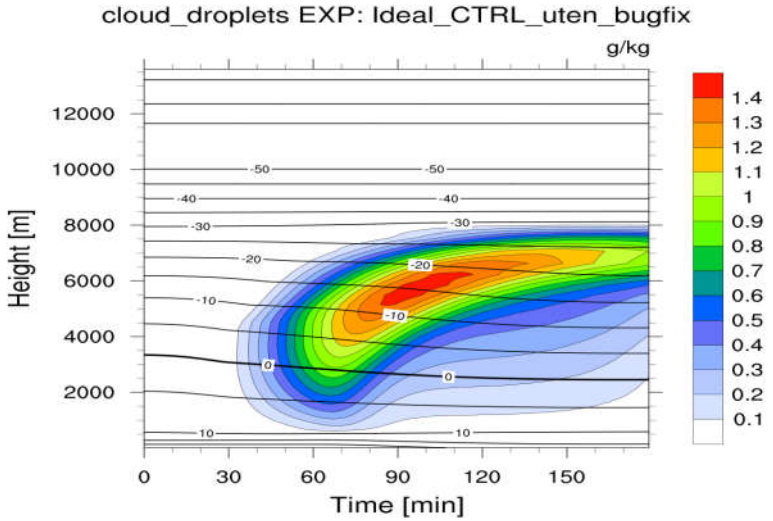
Reference:
Clouds with depth less than 4 km are parameterized

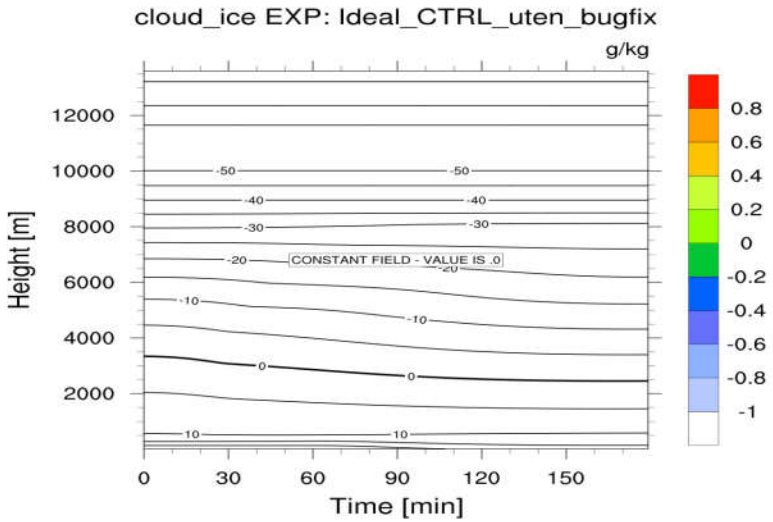
No shallow convective clouds parameterized

De Rooy (KNMI)

Shallow convection scheme inhibiting model from developing resolved deep convection?

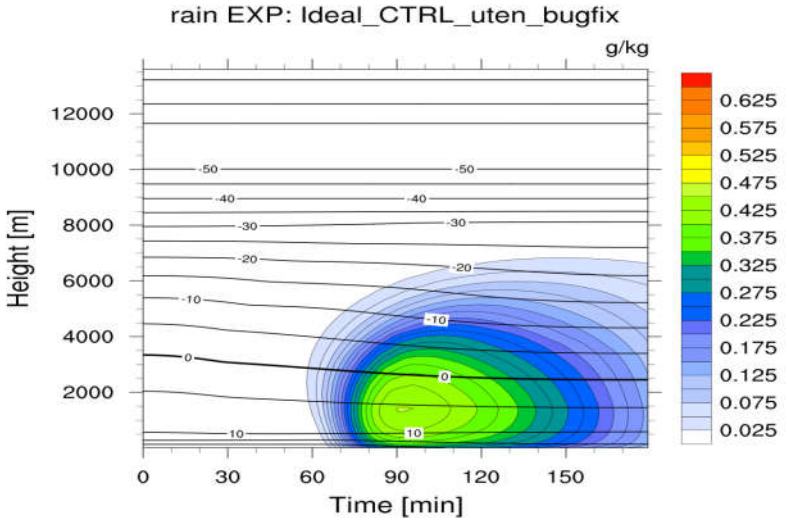

HARM36 Cloud cover an 2018100103 val 01 – 10, 08 UTC
HA40 bewolking an 2018100103 val 01 – 10, 8 UTC
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.05
0.01
0.00
ma01 0800z [00]

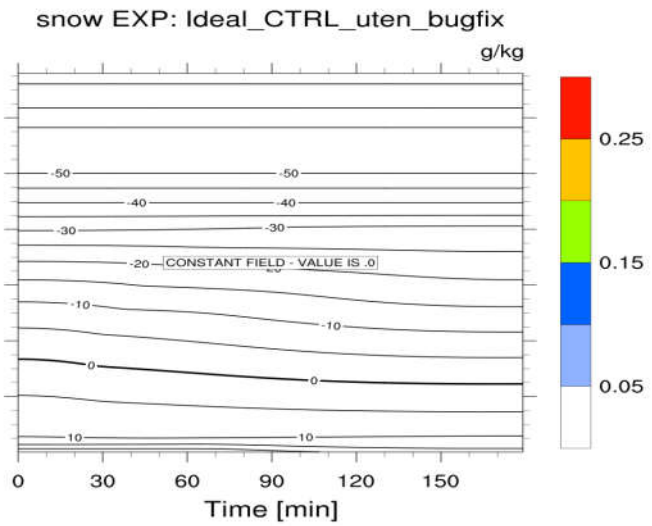


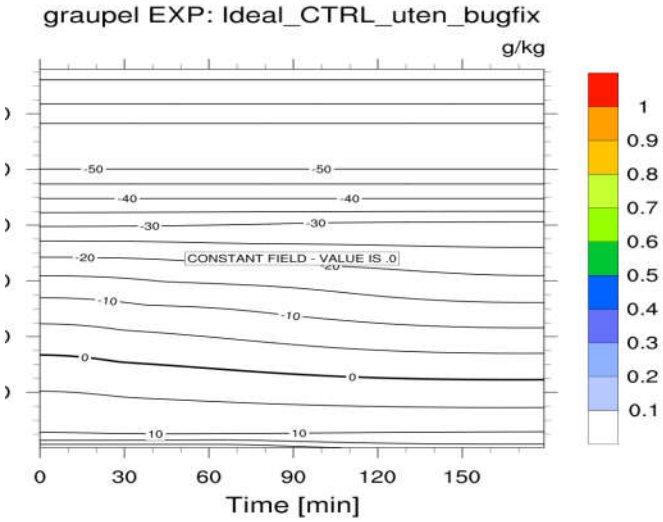


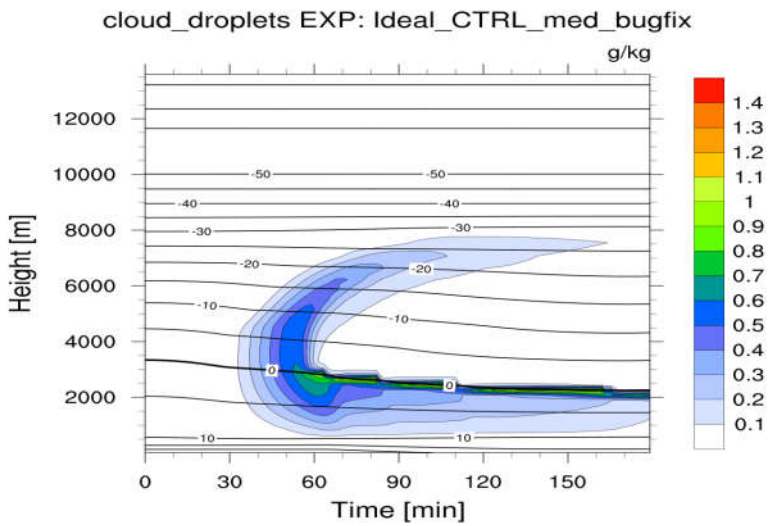
Engdahl (Met.no)

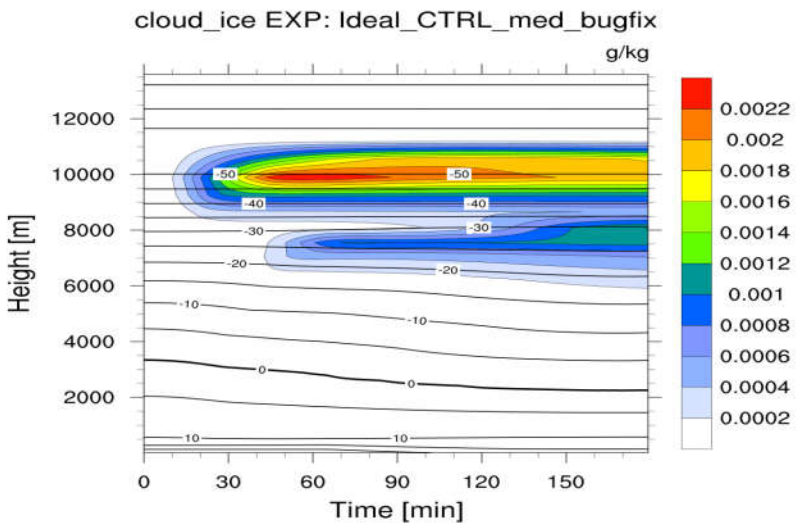
HARMONIE-AROME microphysics does not allow ice to be formed for T>-35° C
When cloud ice is present (snow falling trough column) water will freeze to ice





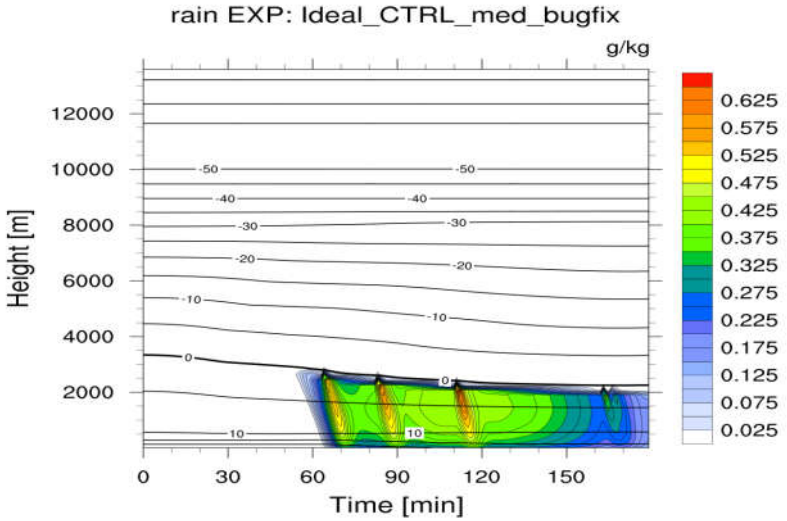


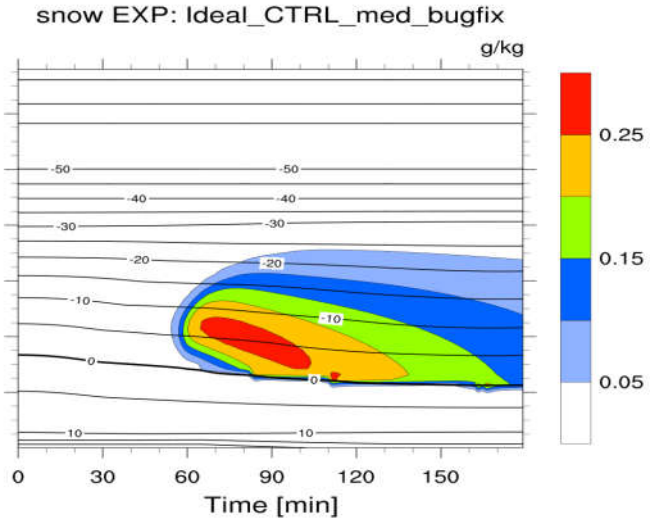


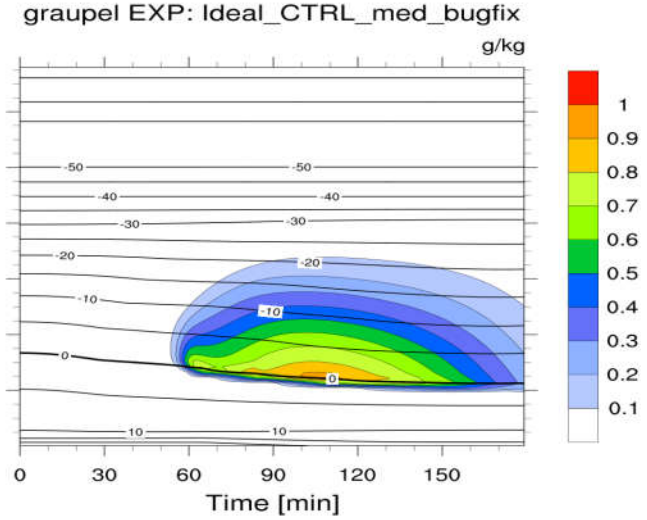


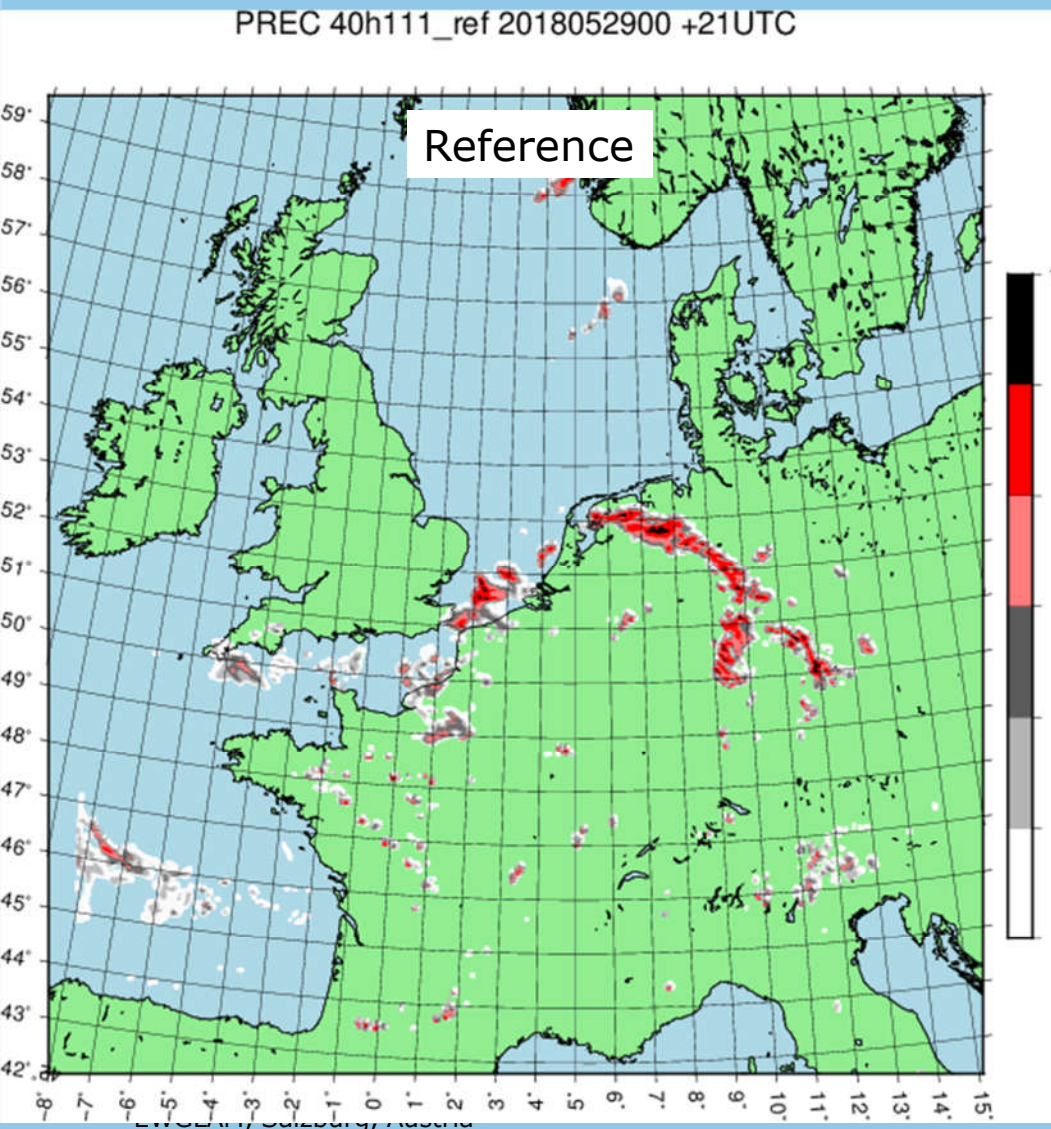
Engdahl (Met.no)

With a fix of this bug you can see that cloud water and cloud ice are formed
And snow and graupel can form, as you would expect in a case with w<0.5 m/s








PREC 40h111_ref 2018052900 +21UTC
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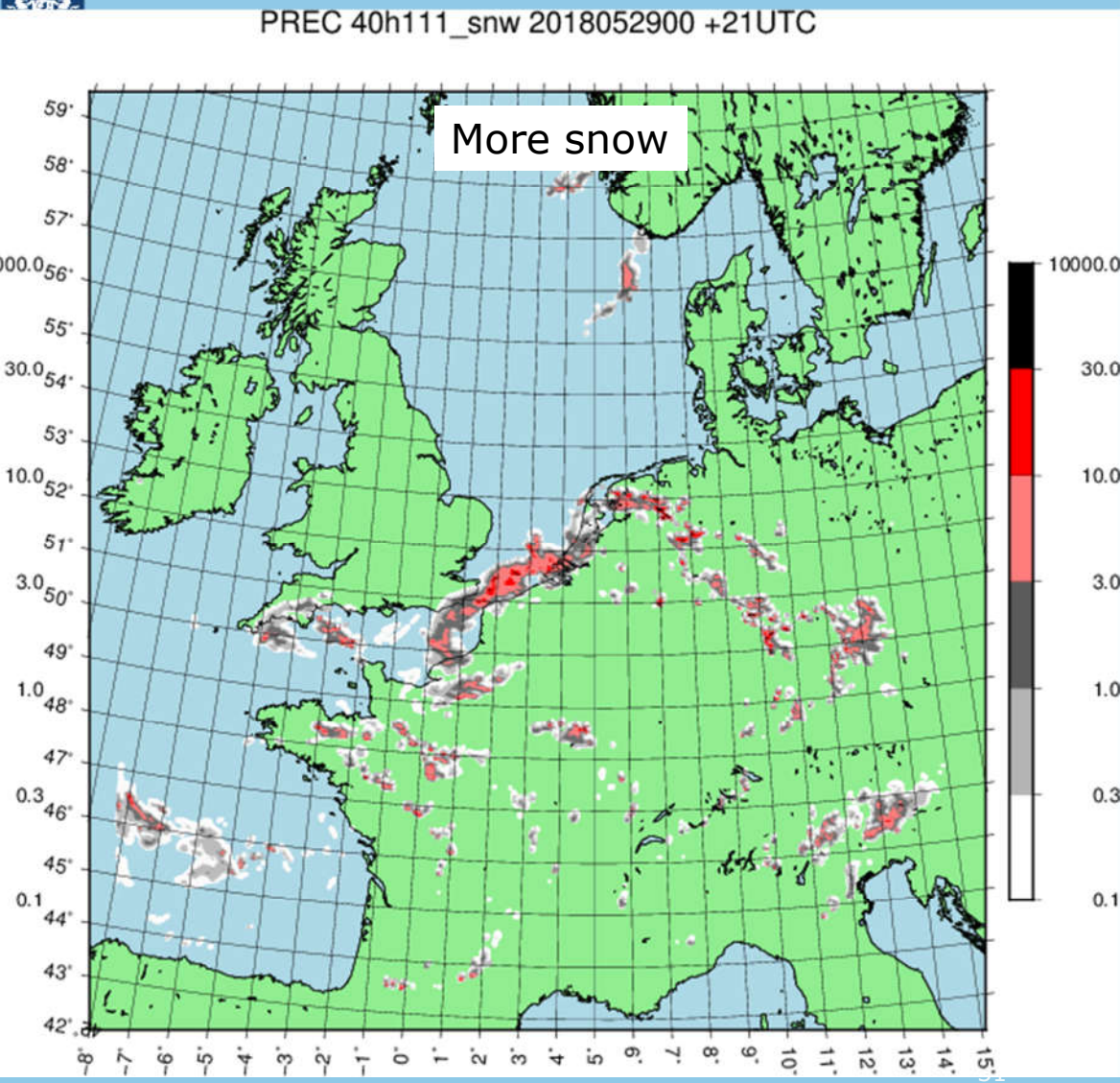
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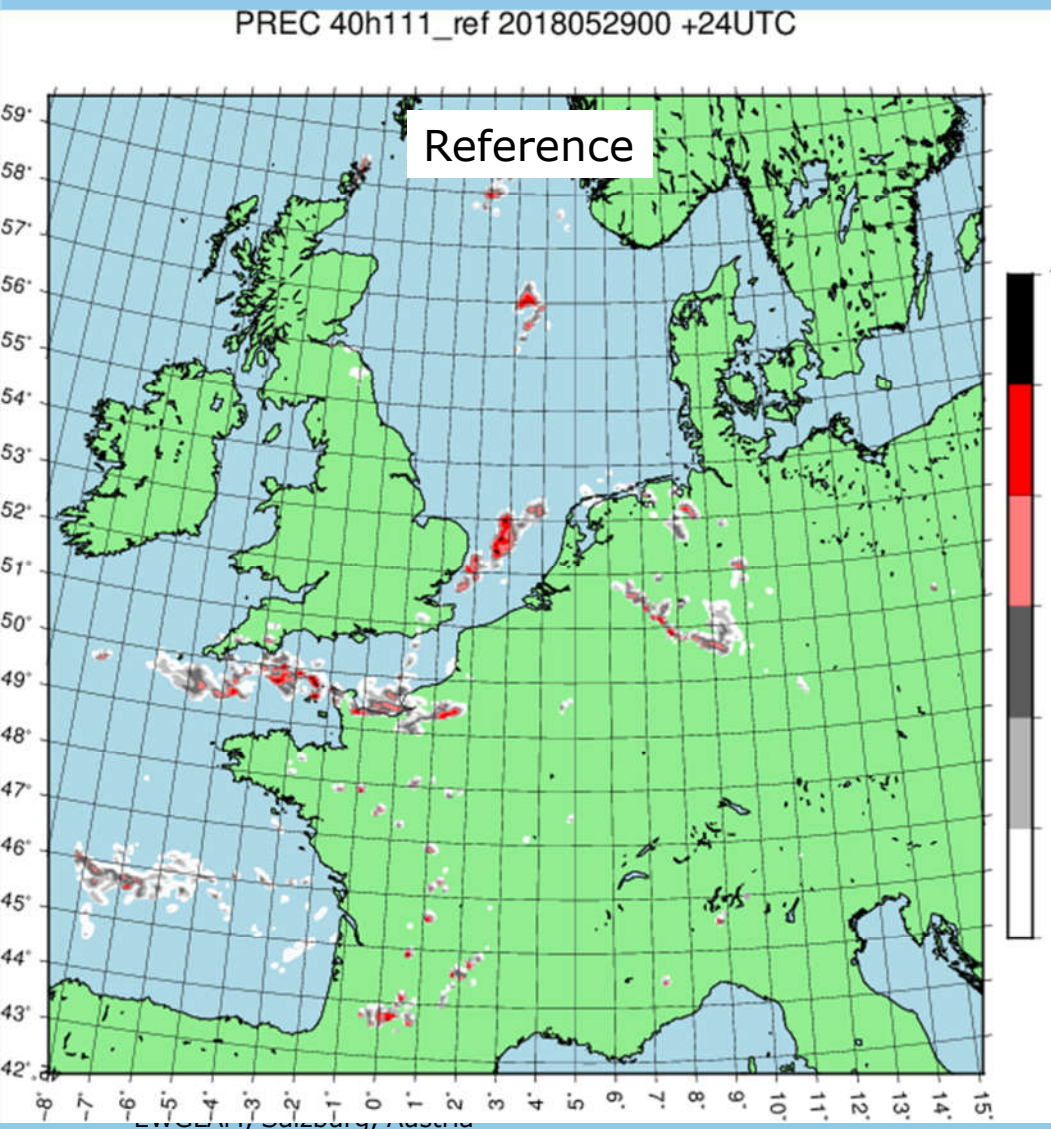
More snow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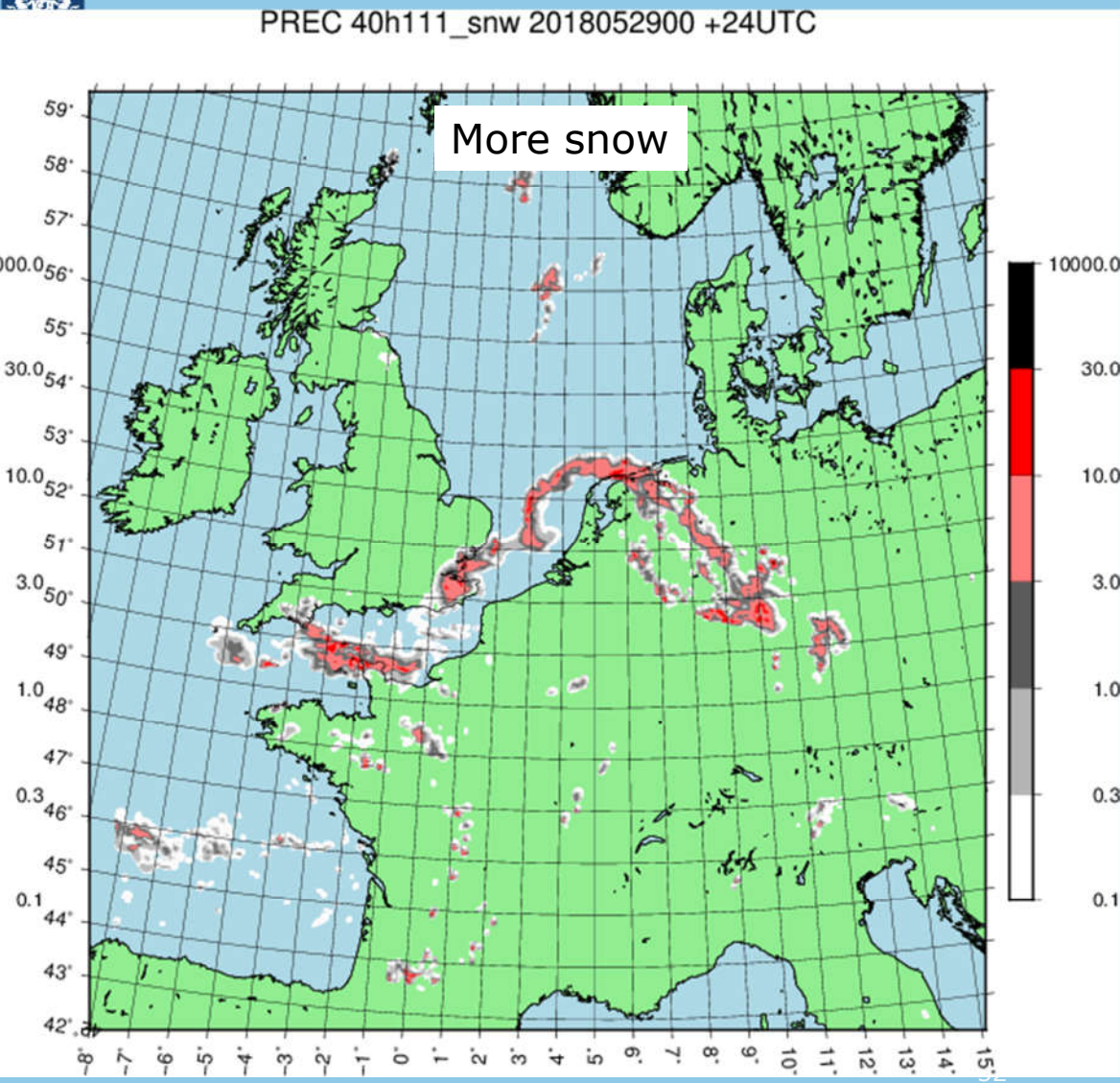
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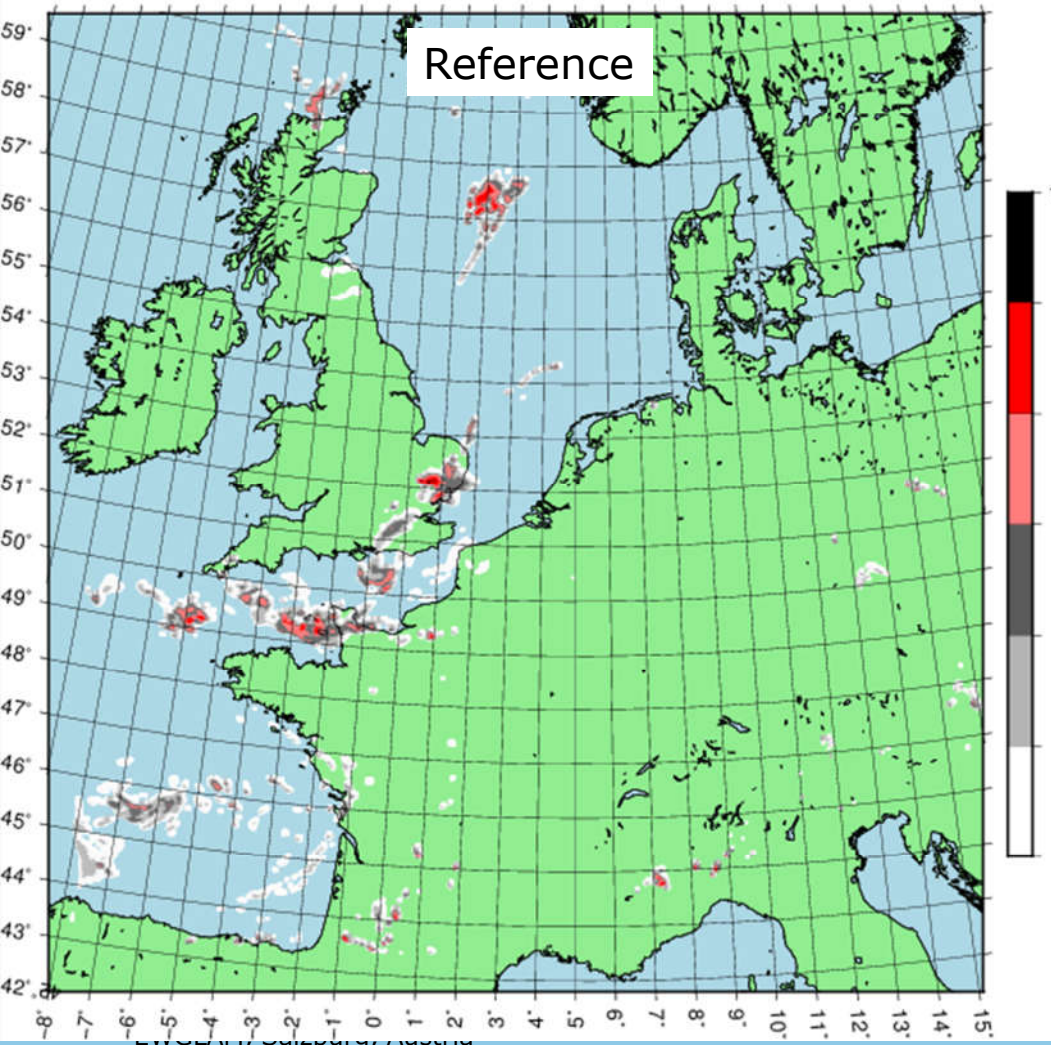
More snow

PRECSUM 40h111_ref 2018052900 +27UTC



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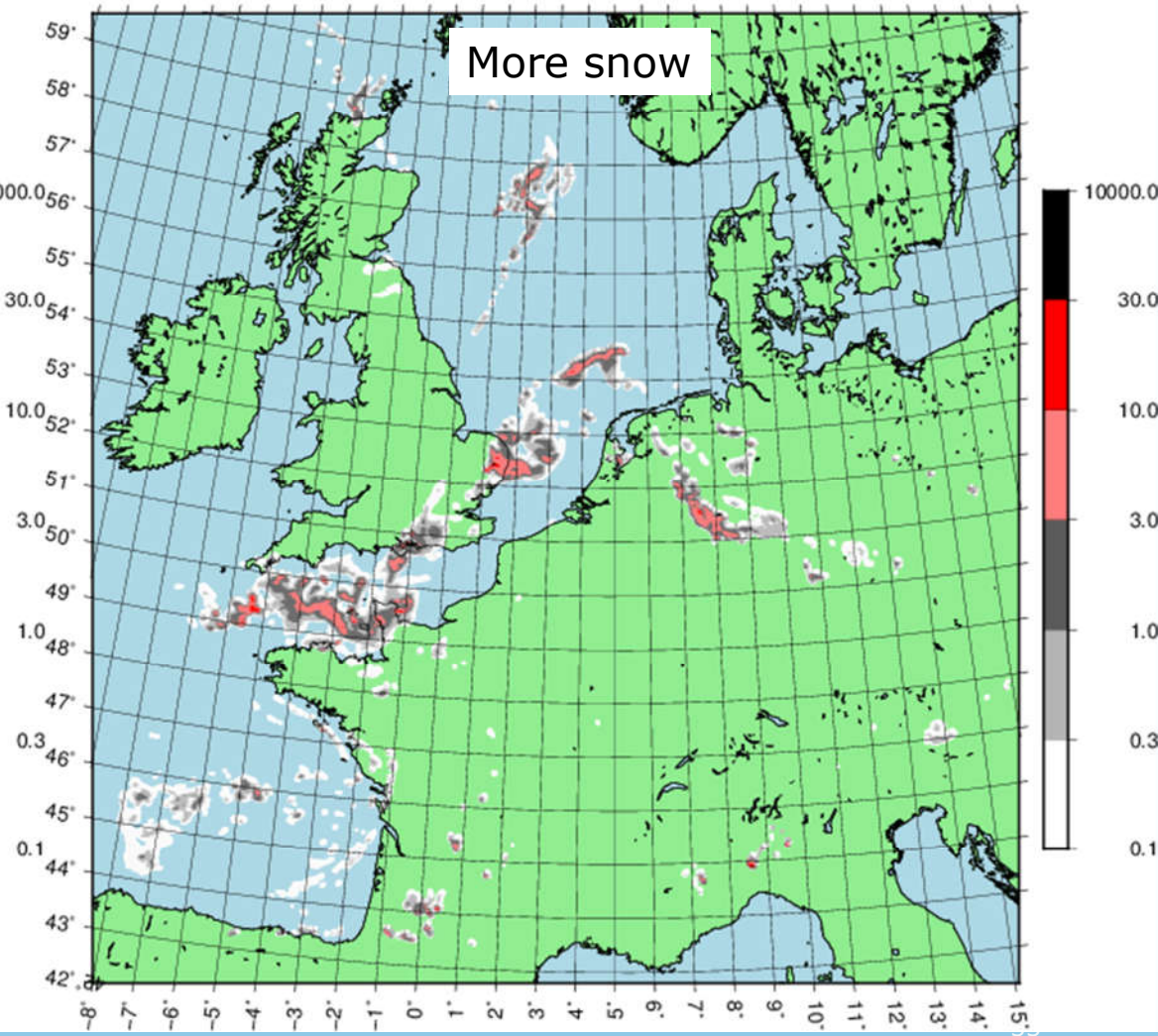

Conclusions

- Problems with convection not caused by on single issue
- Surface data assimilation important
- Microphysics problem with too much cloud water at low temps
- Shallow convection scheme limiting development of resolved scale showers

- Low clouds and fog problem flipped from overprediction to underprediction
- Cloud initialization and use of forecasted aerosols ingredients for improvement