

Latest updates of the cloud- and condensation parametrizations (ICE3) in HARMONIE/AROME (hirlam/metcoop)

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Outline:

- Graupel
- Supercooled rain
- Reducing fog
- Bug fix cy-40 (OCND2)
- Other issues

Graupel

- Graupel : ww code 77 (Small white balls falling from stratus, not bouncing) and ww = 87 (a little larger white balls mostly falling from convective clouds, bouncing)
Hail and hail like precipitation: ww=79,88-90
- According to those definitions, there seems to be too much graupel compared to ordinary snow with ICE3

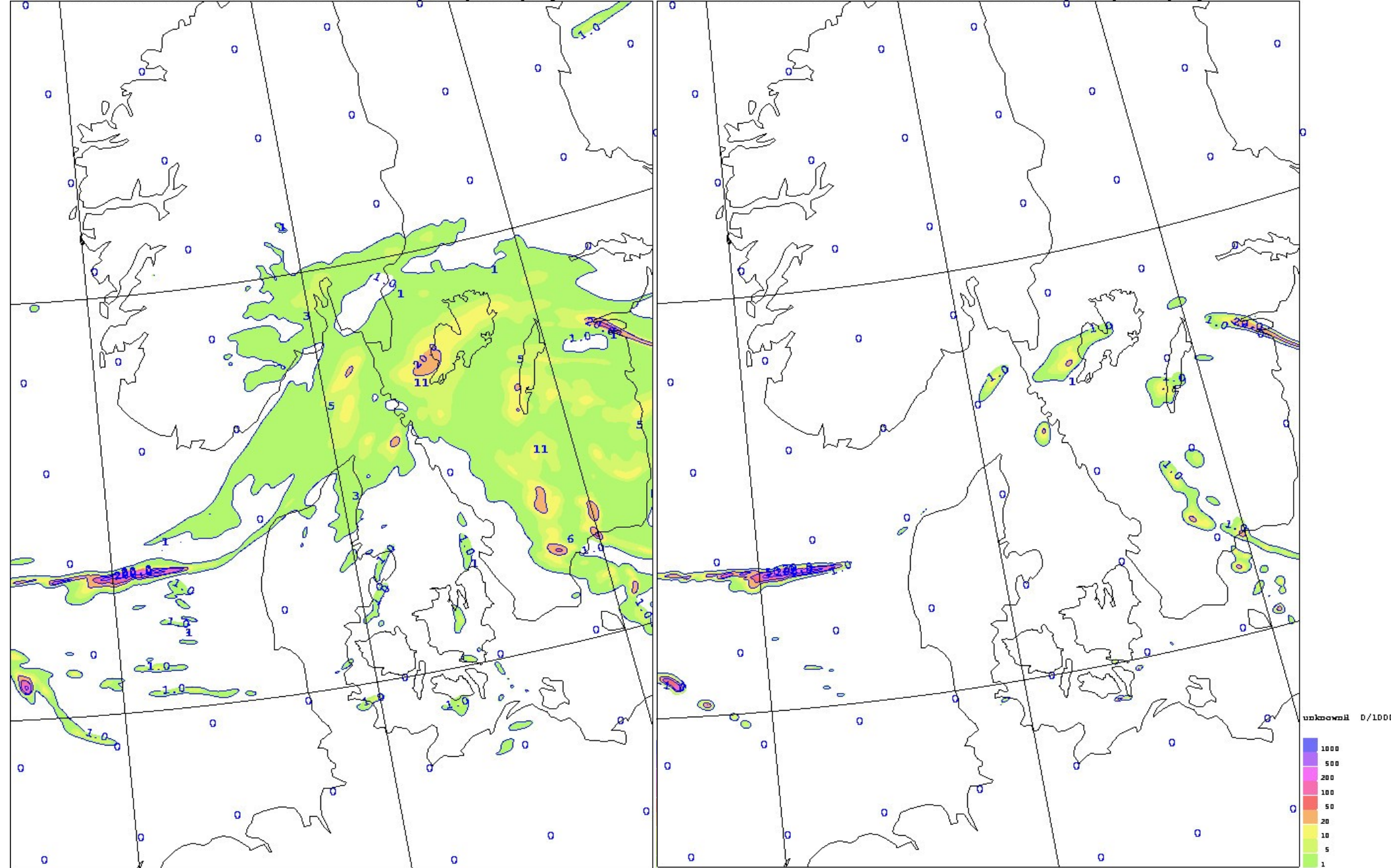
Assume a possibility for small graupels to become snowflakes in case of high ice supersaturation (LGRSN option)

- When graupel mixing ratio ~ 0 and relative humidity with respect to ice $\geq 115\%$: turn all graupel to snow since the graupels are assumed to be very small. With high supersaturation, snow-flake-like crystal growth on those graupels is likely.
- If relative humidity with respect to ice $\leq 100\%$ **OR** mixing ratio $\geq 1.0 \text{ e-}7$, assume **no** conversion to snow.
- Bilinear transition graupel \rightarrow snow

Intense snowfall over southern Sweden. Integrated graupel. November 2010. Left: original. Right: test.

/run/media/a000460/1.5TE4/201011_KI38h12H KI38h12H integrated graupel

/run/media/a000460/1.5TE4/201011_KI38h12I KI38h12I integrated graupel

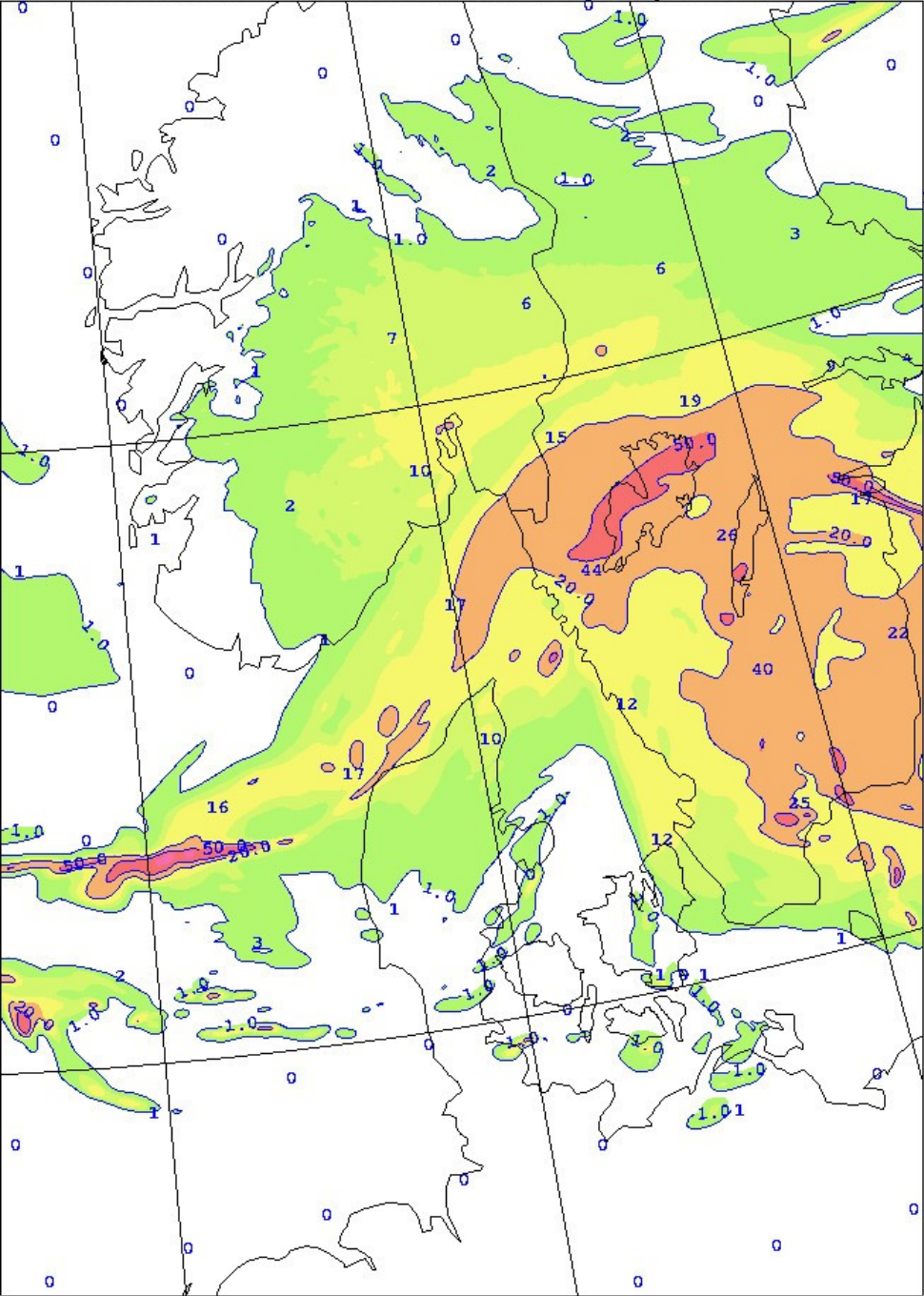


Sat 27 Nov 2010 12Z +24h
valid Sun 28 Nov 2010 12Z

Sat 27 Nov 2010 12Z +24h
valid Sun 28 Nov 2010 12Z

Same for integrated snow

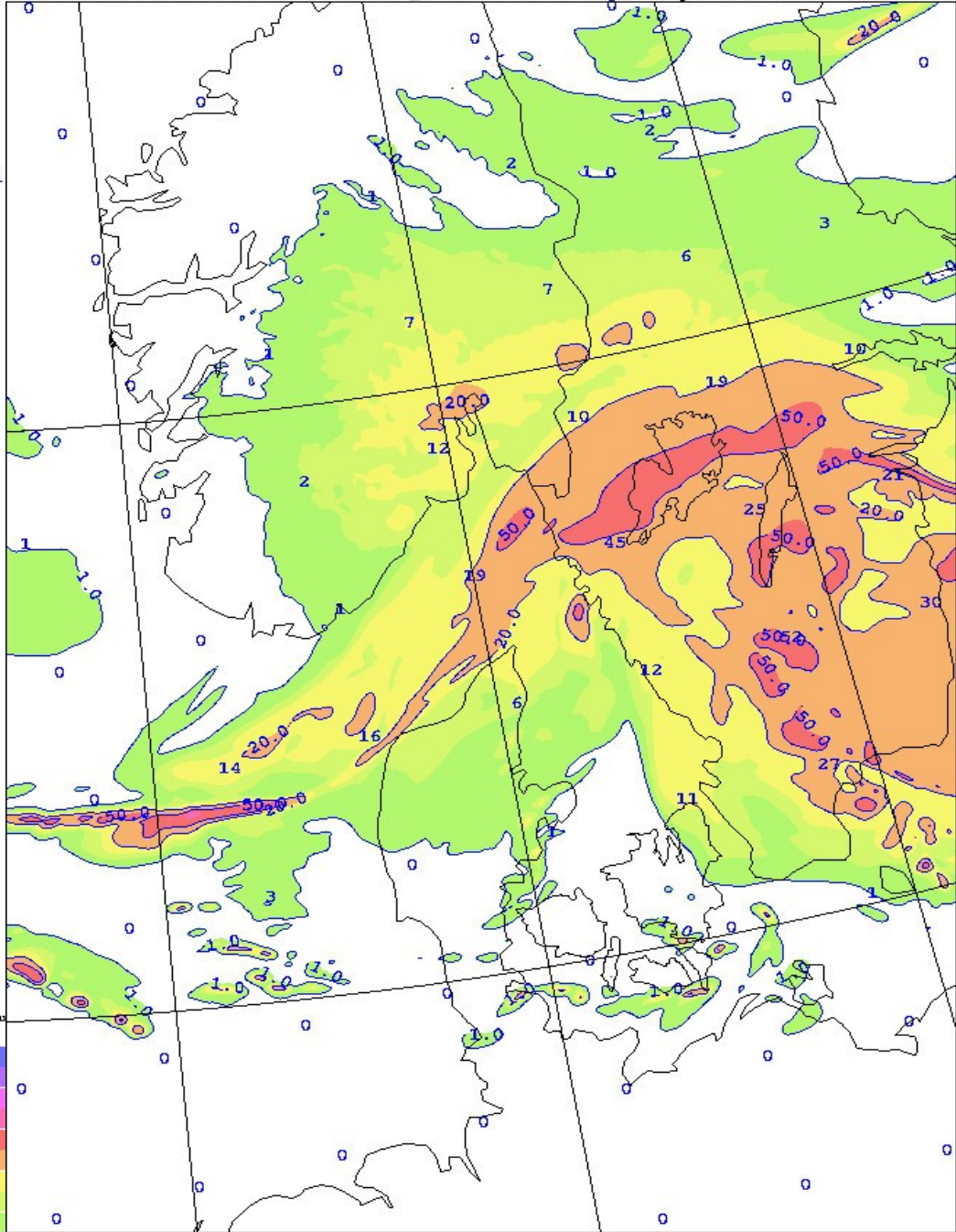
/run/media/a000460/1.5TE4/201011_KI38h12H KI38h12H integrated snow



Sat 27 Nov 2010 12Z +24h

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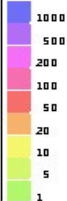
/run/media/a000460/1.5TE4/201011_KI38h12I KI38h12I integrated snow



Sat 27 Nov 2010 12Z +24h

valid Sun 28 Nov 2010 12Z

unknown



Verification summary (LGRSN=T)

- Tested 20 November-10 December 2010 (cy 38)
- Marginally better regarding cloudiness parameters and T2m
- Marginally worse precipitation.
- Somewhat more moisture in lower troposphere, leading to marginally more clouds and a little less long wave radiation from the ground
- Tested also for a summer period, (cy 38) and a winter period (cy 40), small impact, but not clean tests

Supercooled rain

- **Not** forecast properly in AROME
- Reason : too quick refreezing of supercooled rain
- Solution tested: When there is only small amounts of snow, graupel, cloud ice and ice nucleus, do not refreeze.

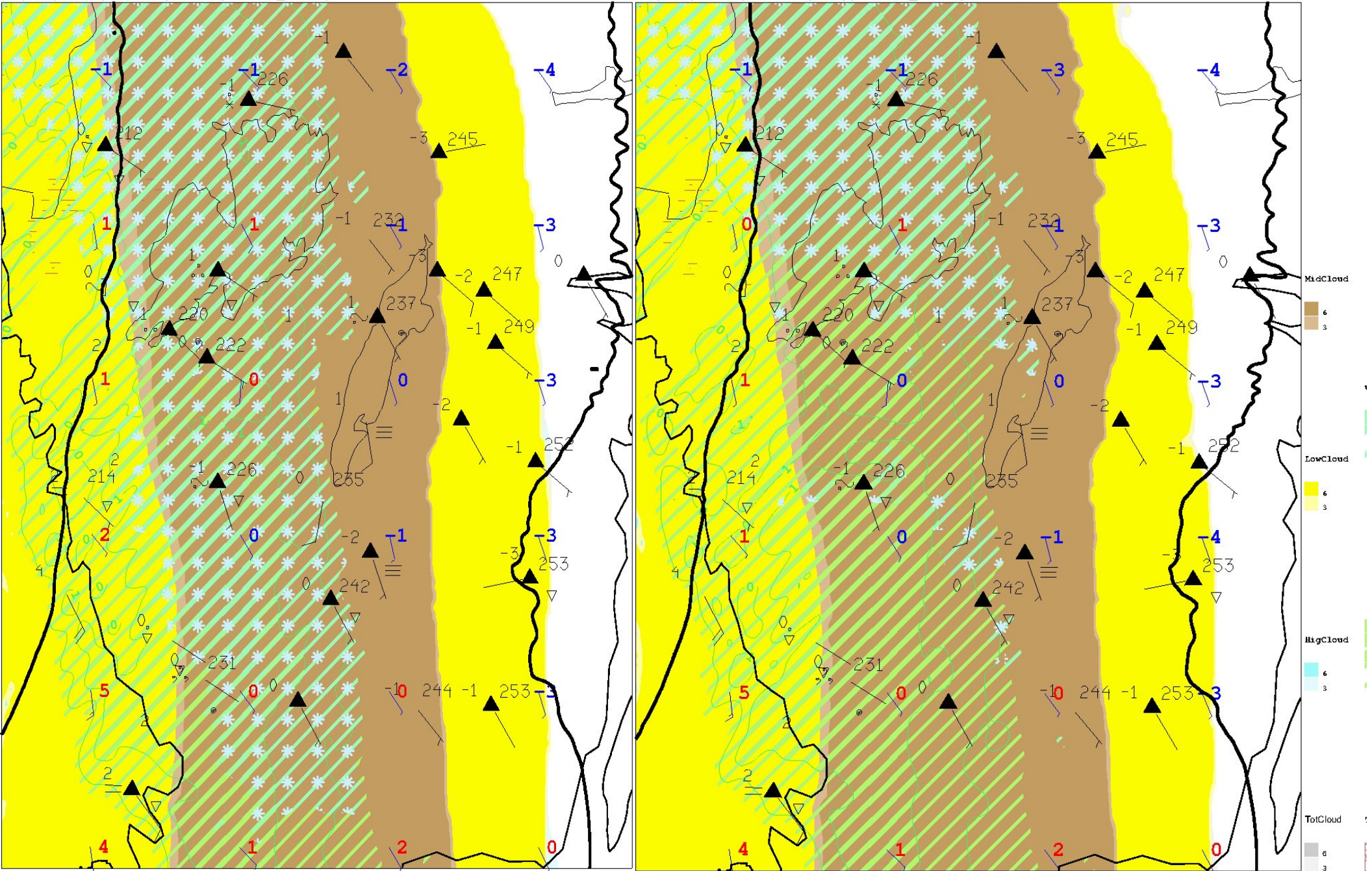
Explanation of 'PMP'-like maps

- **Yellow** : low clouds
- **Brown** : middle level clouds
- **Blue** : high clouds
- **Green lines**: rain
- **Green lines with light blue stars** : **Snow or rain+snow**
- Filled circles / triangles : Observed overcast
- Partly filled circles / triangles : partly overcast
- Unfilled circles / triangles : clear sky or undected clouds

Left: original right : test (southern Sweden 2016-01-01 UTC)

/run/media/a000460/1.5TE4/201601_KI40E/ KI40E 011

/run/media/a000460/T2N//201601_KI40F/ KI40F 011



Thu 31 Dec 2015 12Z +12h

valid Fri 1 Jan 2016 00Z

Thu 31 Dec 2015 12Z +12h

valid Fri 1 Jan 2016 00Z

Verification result

- Very small impact except for the supercooled rain, but only tested in winter

Reducing fog

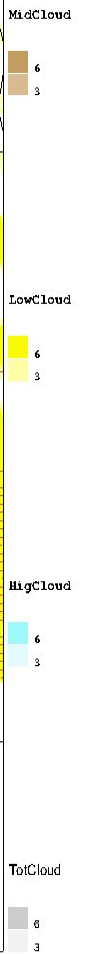
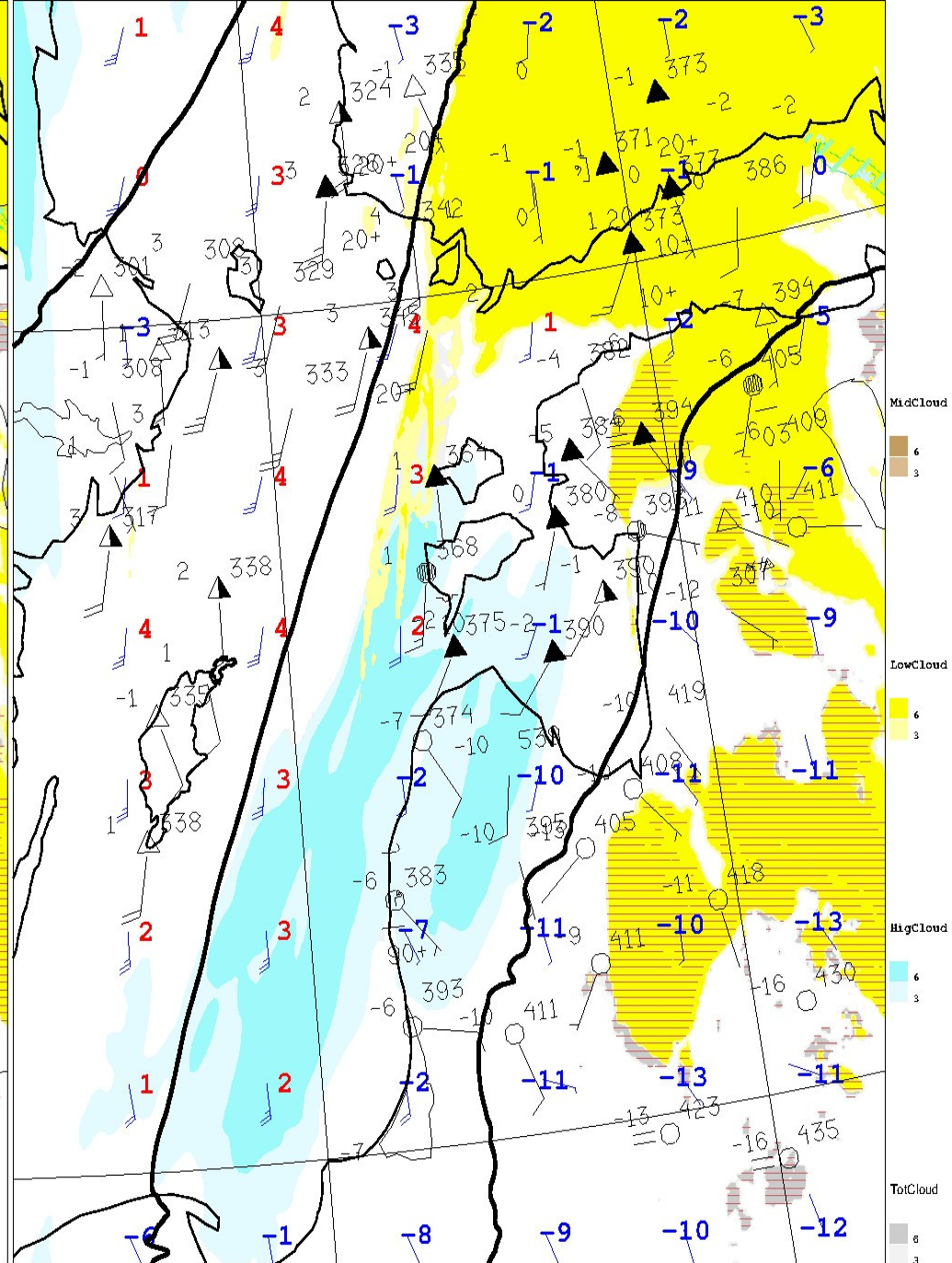
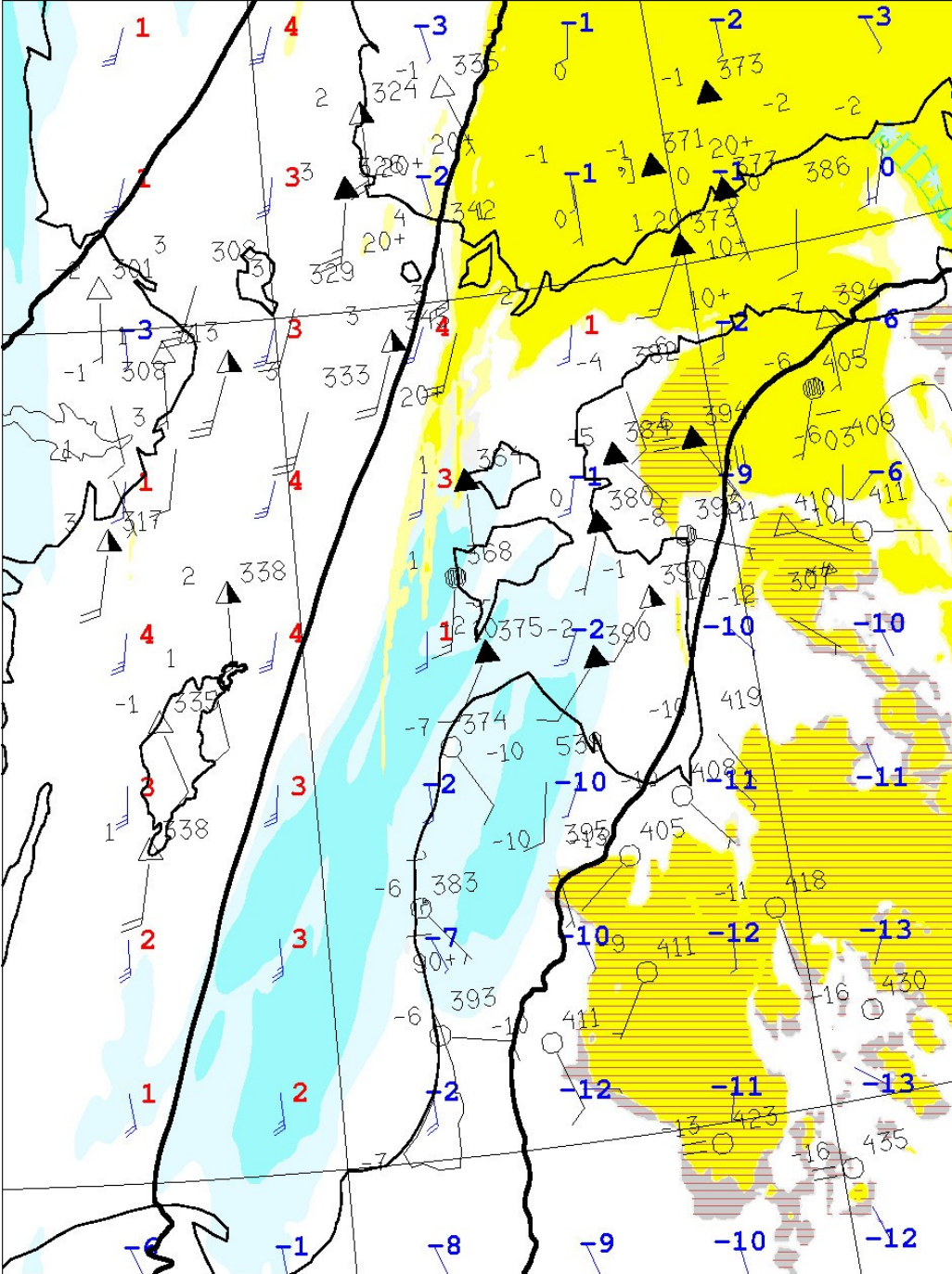
Method:

- Assume lower cloud condensation nuclei (CCN) at the lowest levels.(reducing factors: 0.15 at lowest level, 0.4 a second lowest-)
- This gives both faster transition of cloud liquid to rain and a faster sedimentation of cloud liquid.

Left : original, right test (winter case, Baltic states)

/run/media/a000460/T2N/201601_KI40F KI40F 011

/run/media/a000460/T2N/201601_KI40G KI40G 011

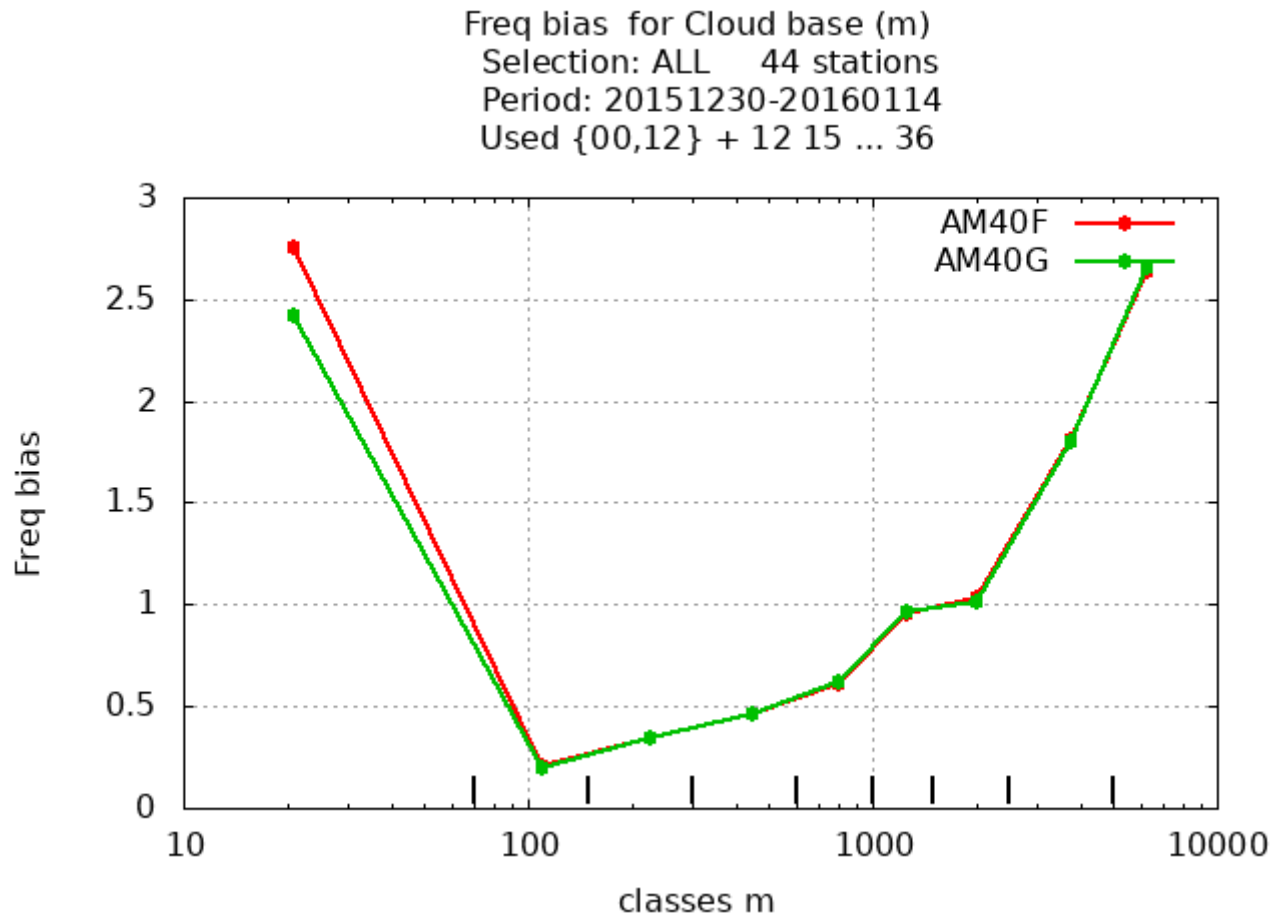


Wed 30 Dec 2015 00Z +24h
valid Thu 31 Dec 2015 00Z

Wed 30 Dec 2015 00Z +24h
valid Thu 31 Dec 2015 00Z

Verification result (only a short winter period)

- Very small impact except for cloud base near ground (red=original, green =test)



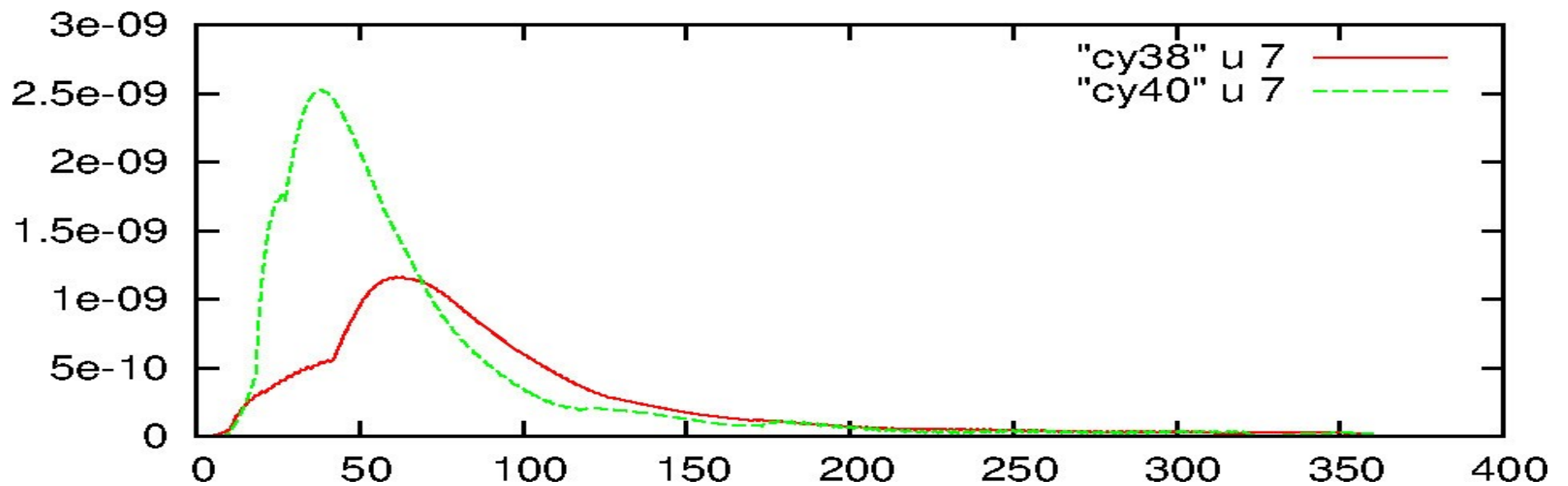
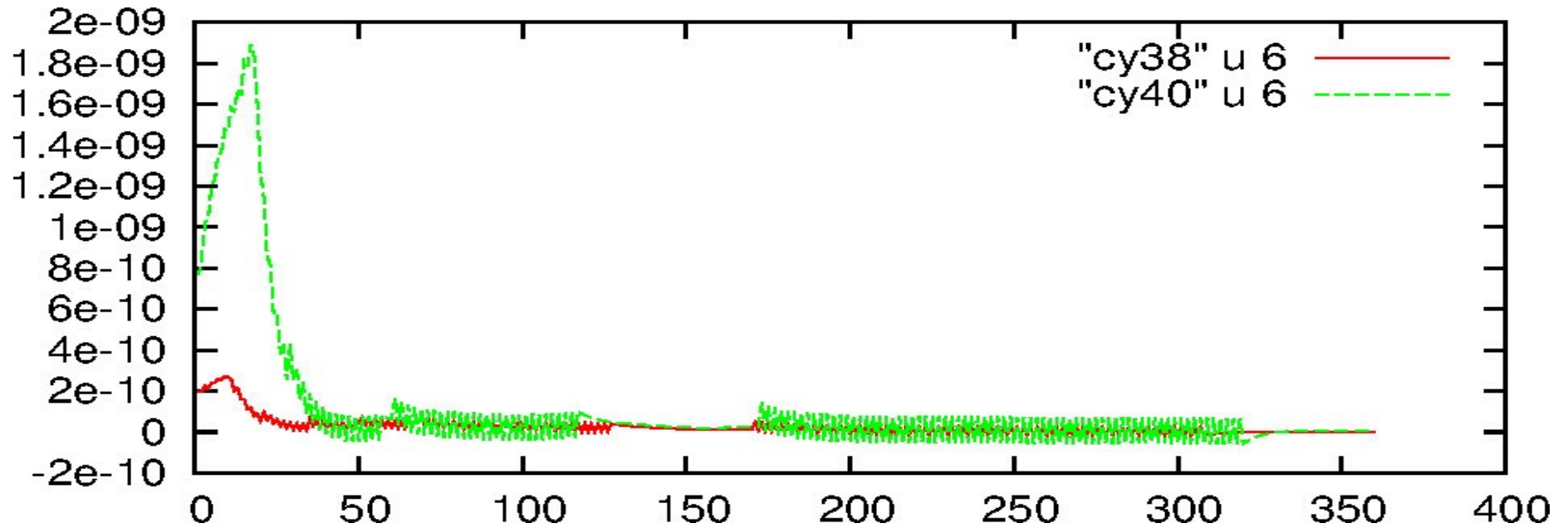
Bug fix (OCND2)

- Problem :

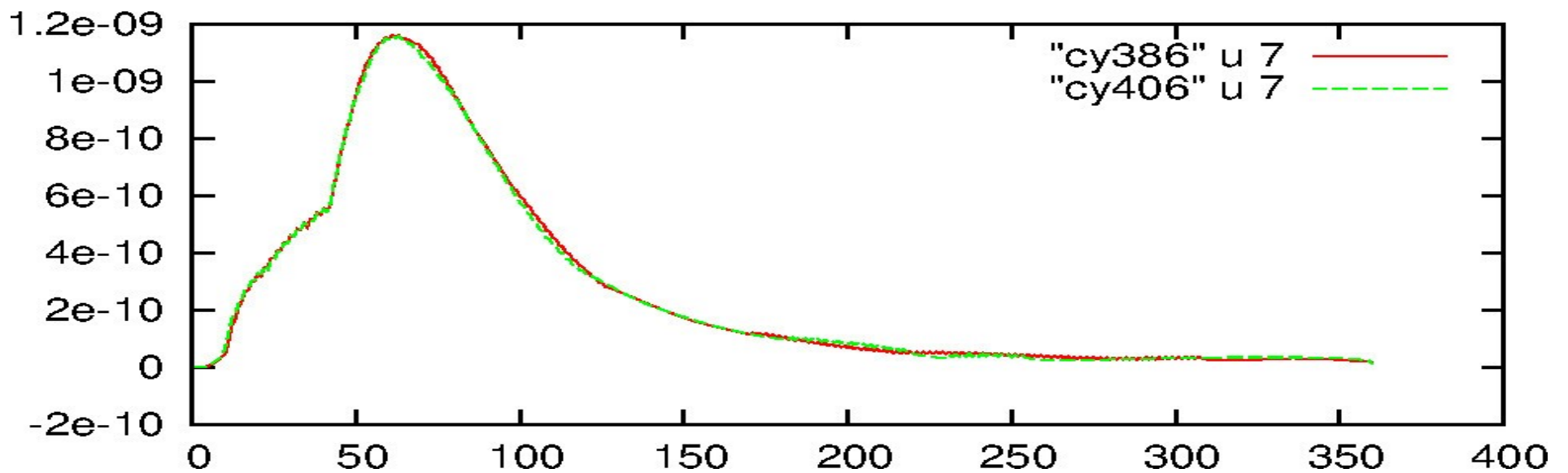
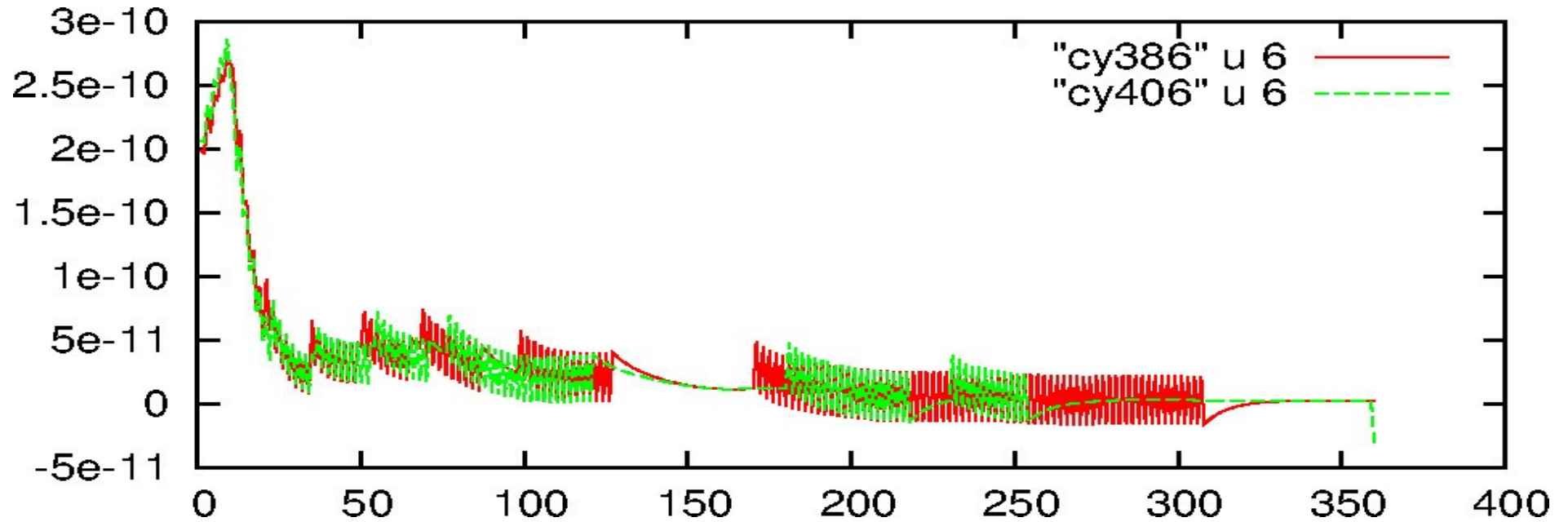
cy40 found to be considerably drier than cy38 in case of temperatures below freezing, also if all known differences between c38-c40 are taken into account (HARATU on/off etc.)

Tendencies from ice physics (aro_rain_ice) MUSC run, level 20, Upper plot: cloud ice , below: snow)

cy38, cy40



The same figures after correction of do-loop for model height calculation



Verification summary, bug fix:

- The differences between cy 38 and 40 become much smaller. More low clouds in winter and less- or no negative bias for 2m-temperature. This is especially beneficial when HARATU set to true.

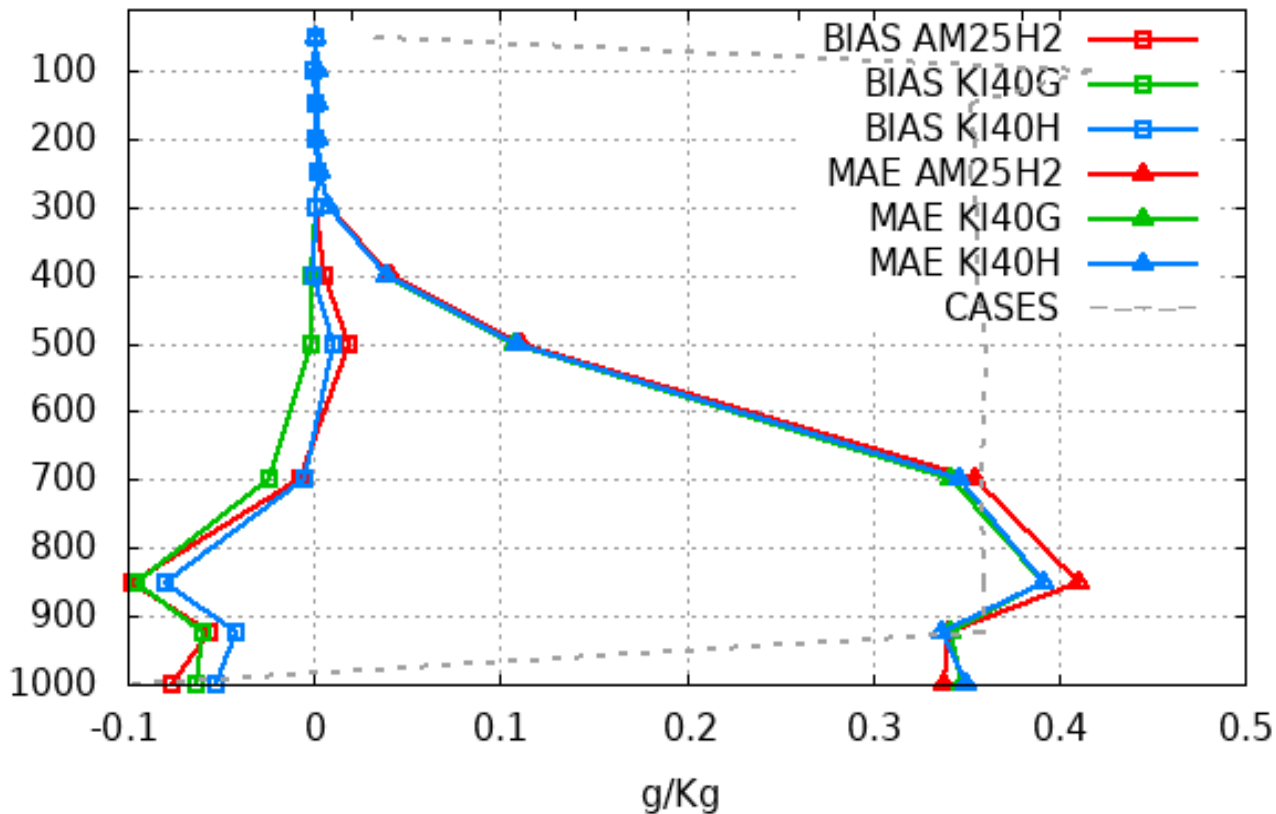
19 stations Selection: ALL

Specific humidity Period: 20151230-20160129

Used {00,12} + 36 42 48

No cases

1000 1200 1400 1600 1800 2000



Oper cy 38

cy 40 Haratu

cy 40 Haratu + bug fix

Other issues

- **Crashes in AROME Arctic.** Reason: Sudden stratospheric warming, leading to occasions when saturation pressure $>$ air pressure. **Solved.** Verification shows a marginally increased amount of low cloud cover in winter (Expected and OK)
- Better coupling radiation – cloud physics: Use the different subgrid fractions for cloud water/ice used in microphysics also for radiation instead of cloudcover. **Tested in 1D.**
- Make the IN-concentration dependent on PBL layer height. A way to improve the partition of cloudcondensate into water/ice **Tested in 1D.**
- Locally very high precipitation amount (graupel) in one or a few grid points. Weather conditions: weak winds and moist unstable. **Not solved**