Precipitation from shallow convection, microphysics evaluation, and RACMO turbulence in HARMONIE-AROME-MetCoop

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This poster contains three projects: 1) A parameterization for variable maximum cloud-depth of shallow convection in EDMF-m, 2) Evaluation of cloud liquid and ice against ground based remote sensors. 3) Results from the RACMO turbulence scheme in MetCoop.

1. Shallow convection

The study was motivated by lack of precipitation (snow) falling along the northern coast of Norway when shallow convection was present.

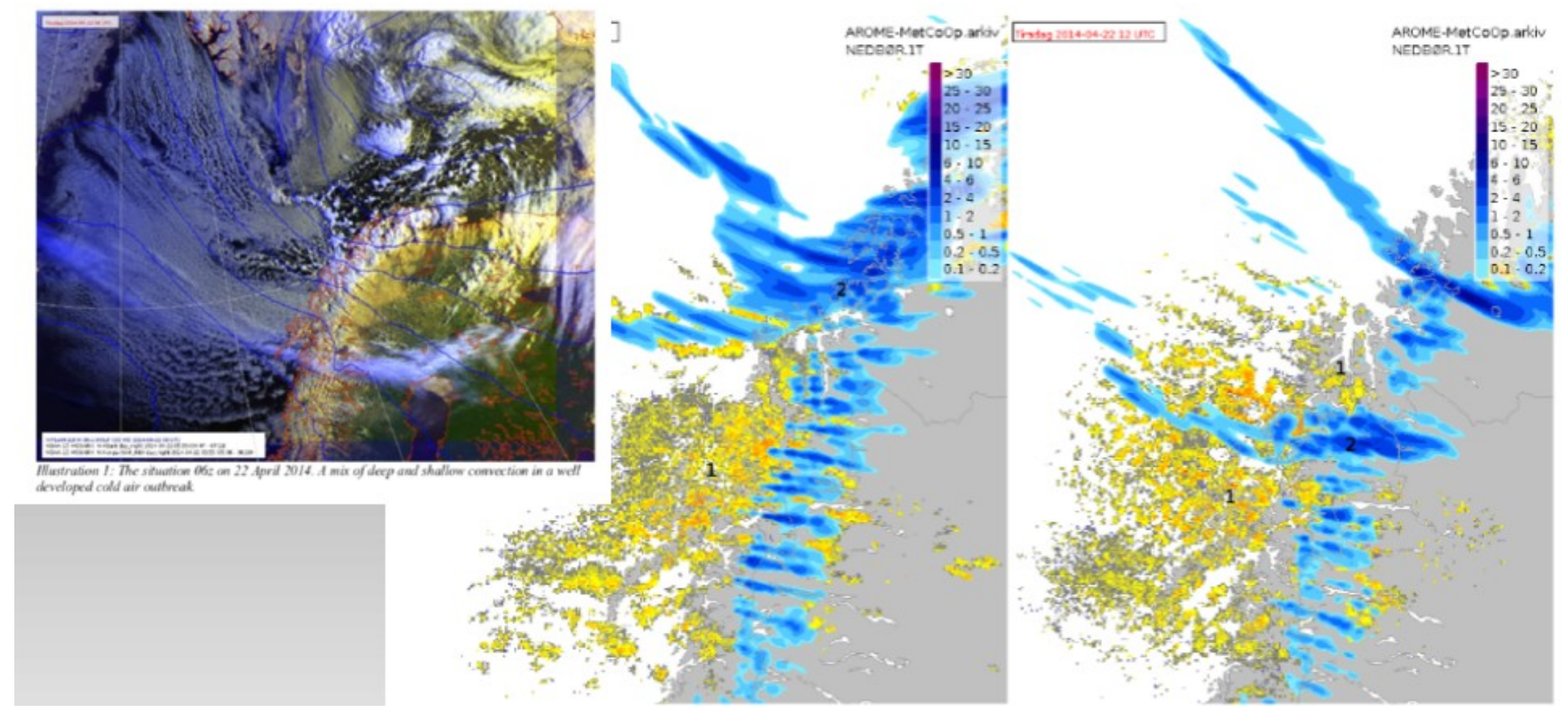

Figure 1: *Harmonie-MetCoop 1 h accumulated precipitation compared with Andöya radar (yellow) and satellite (Gunnar Noer, Met)*.

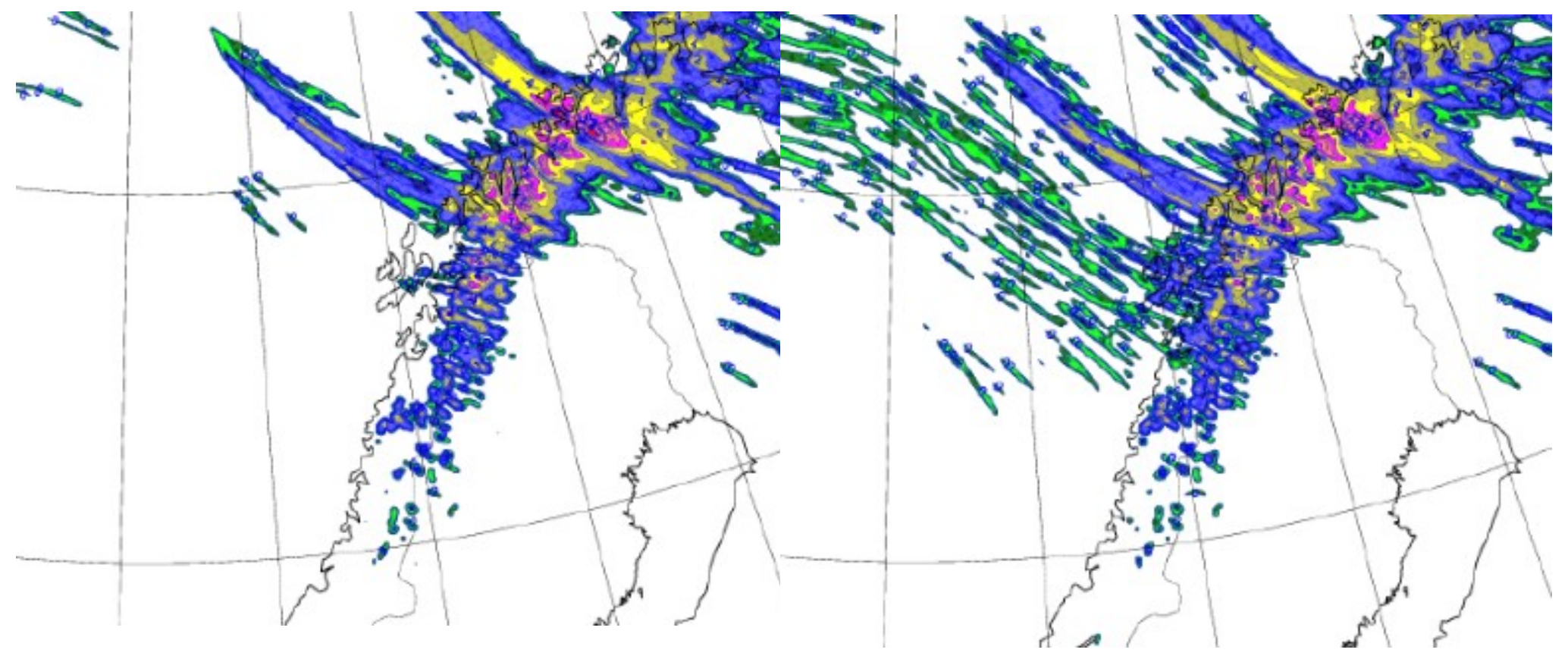

Figure 2: *6 h acc precip. Left, EDMF-m, Right, EDKF*

In EDMF-m, if the convective cloud thickness is 4 km or less, it is considered shallow, and only very little precipitation can be generated. (Anything above 4 km is considered deep convection and is not parameterized). However significant snowfall can come from clouds that are only around 1-2 km deep.

Precipitation production is likely to be favoured by active ice-phase processes, so that when cloud-base temperature is close to 0 C, precipitation is possible with relatively shallow convective clouds.

Following Kain, 2004 a variable maximum cloud thickness for shallow convection was introduced:

$D = 4000$ $\quad T_{LCL} > 20$ C
$D = 1200$ $\quad T_{LCL} < 0$ C
$D = 1200 + 140T_{LCL}$ $\quad 0C <= T_{LCL} <= 20C$

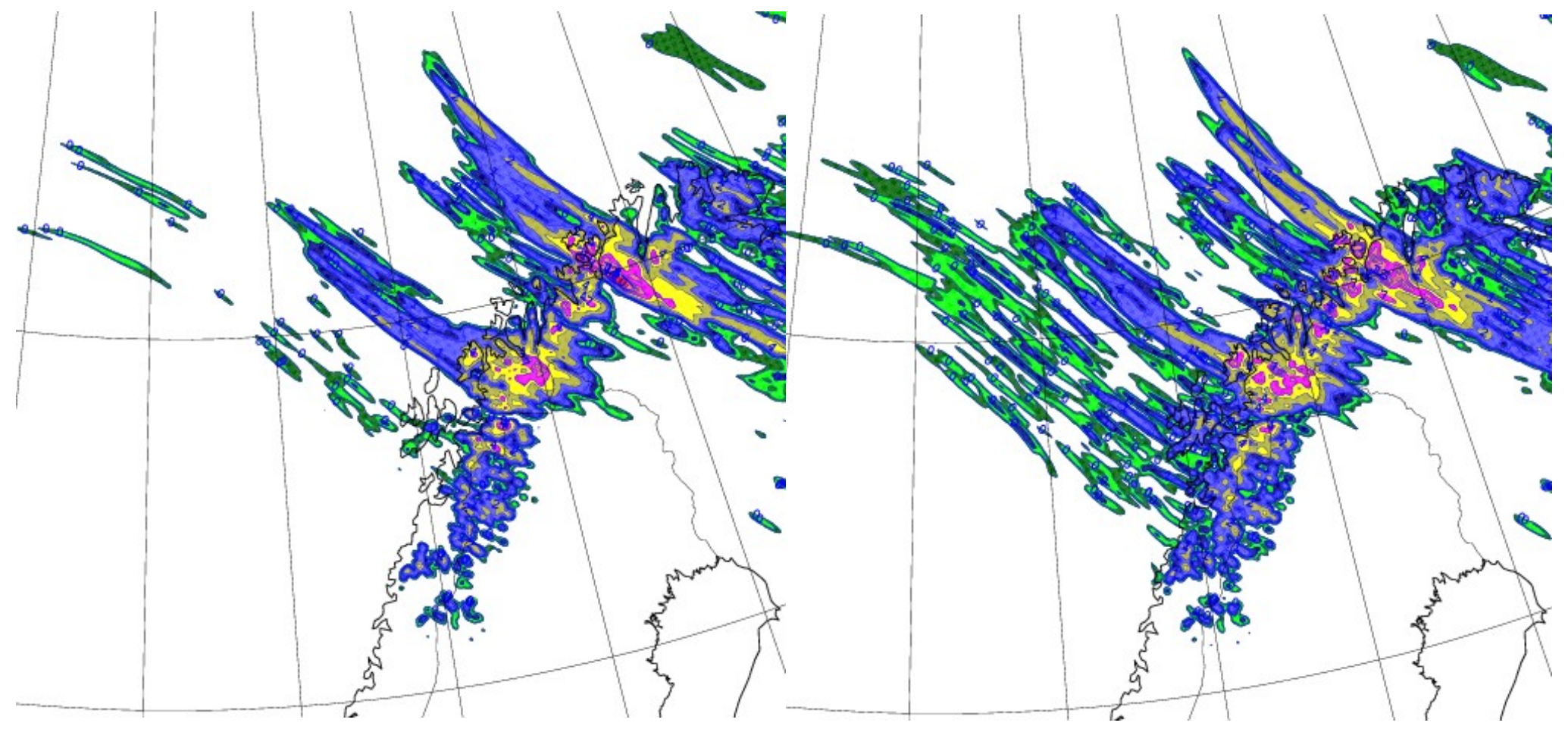

Figure 3: *6 h acc precip.Harmonie-AROME-MetCoop, Left reference 38h1.2, right, new exp.*

2. Microphysics evaluation

Cloud liquid and ice (+snow and graupel) was evaluated against ACTRIS observations, using cloud-net algorithms (Hogan et al. 2004) against five ground-based remote sensors in central Europe for November, 2011.

Figure 4: *Domain used for experiments, stations Chilbolton, Cabauw, Lindenberg, Leipzig and Juelich.*

A comparison was made between Harmonie 38h.2 with AROME physics, and the option of switching off new cloud ice-microphysics (OCND2=FALSE, Ivarsson, 2014).

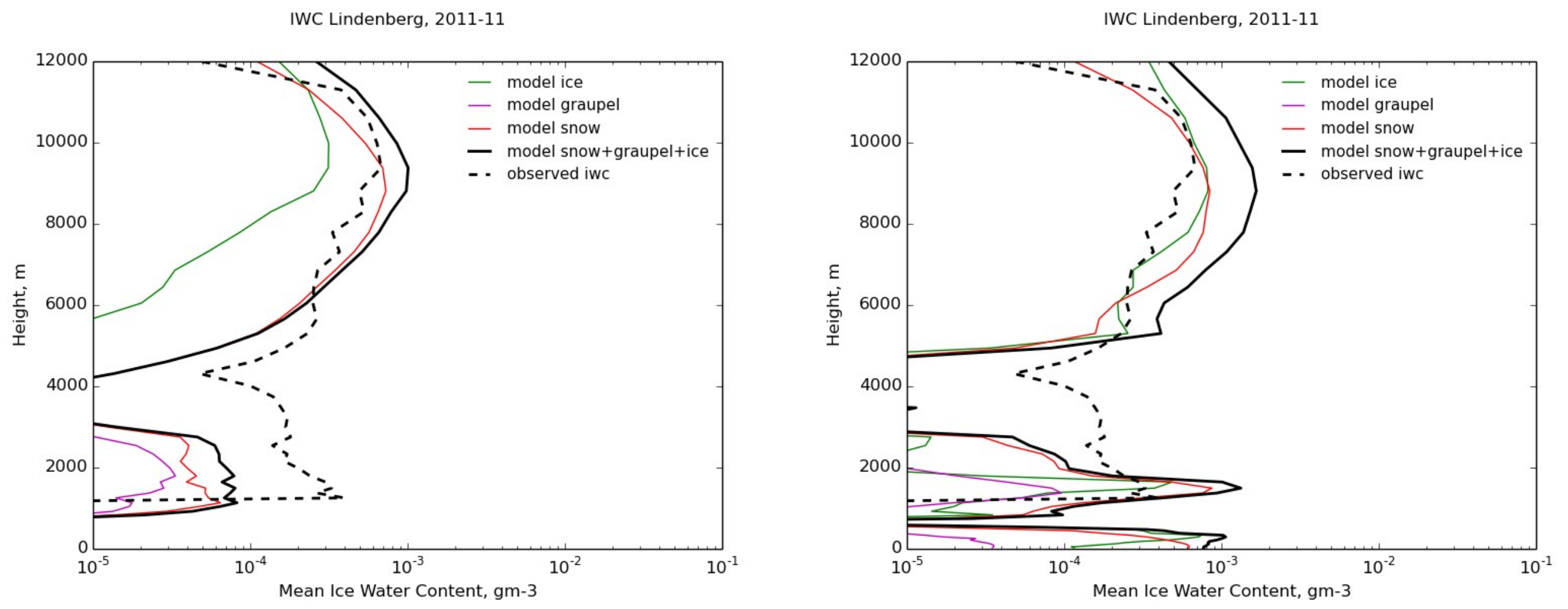

Figure 5: *IWC for Lindenberg, November 2011. Left OCND2 =TRUE, Right OCND2 = FALSE.*

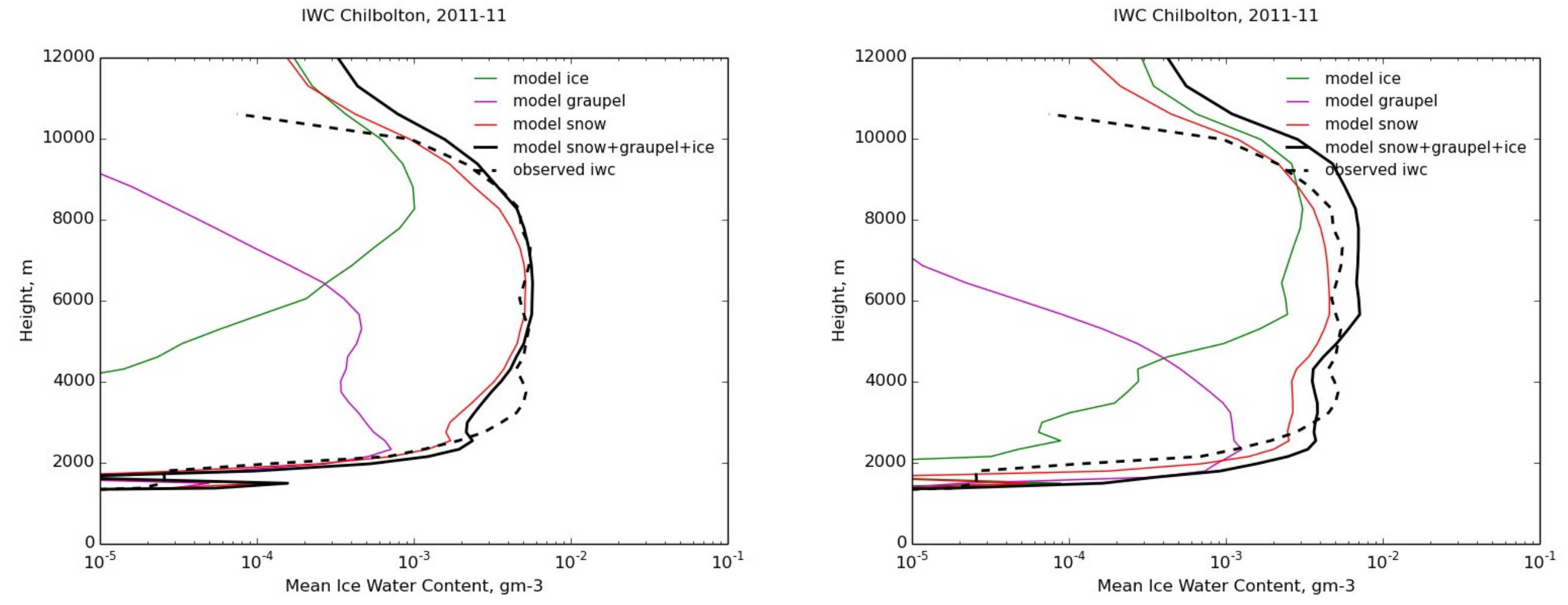

Figure 6: *IWC for Chilbolton, November 2011. Left OCND2 =TRUE, Right OCND2 = FALSE.*

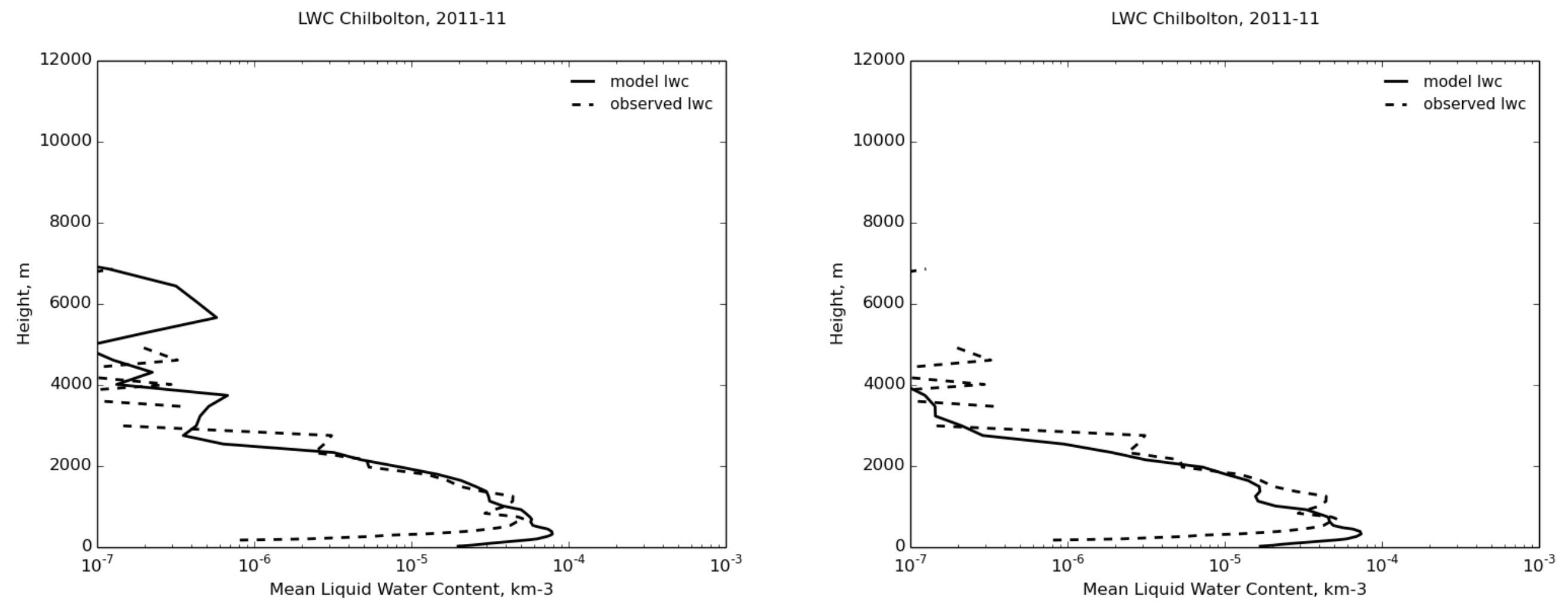

Figure 7: *LWC for Chilbolton, November 2011. Left OCND2 =TRUE, Right OCND2 = FALSE.*

For all stations, the new cloud microphysics option OCND2 gave a better comparison between the modelled and observed IWC for high clouds. In all cases, modelled cloud ice was reduced and modelled snow was increased with OCND2 = TRUE. For low level clouds there is too large of a reduction of ice+snow+graupel in case of OCND2 = TRUE.

The fit of liquid water is very good, although perhaps too much liquid around 6 km with option OCND2 = TRUE.

3. RACMO scheme in MetCoop

Results with the RACMO turbulence scheme in Harmonie-AROME-MetCoop are encouraging. In winter, the scheme gives an improvement in mean sea level pressure, lower troposphere temperature, and frequency bias of 12 h precipitation. In summer, an improved diurnal cycle of the 10 m wind is seen.

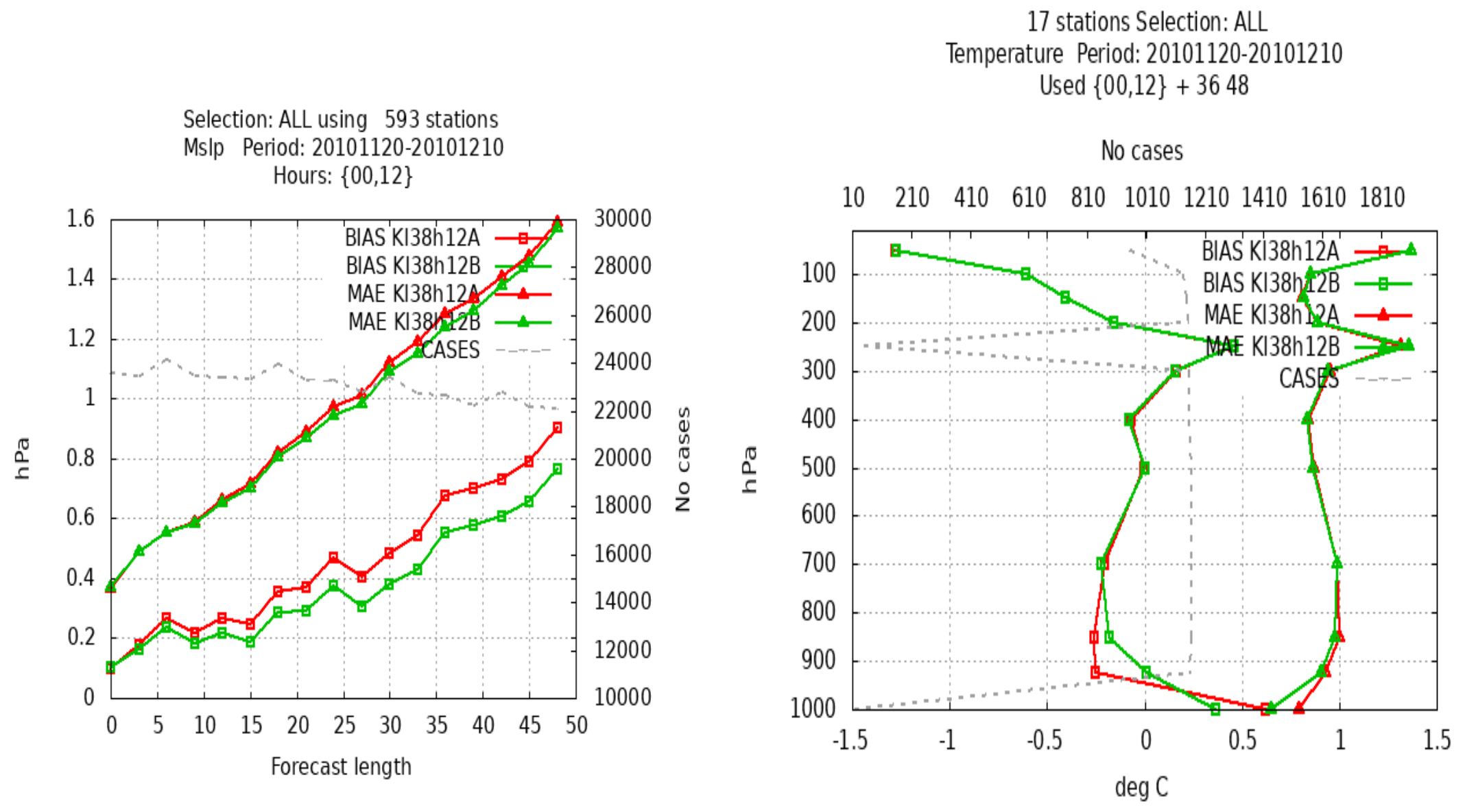

Figure 8 *Left: Bias and MAE for mslp . Right: Bias and MAE temperature profiles. Reference (red), RACMO experiment (green).*

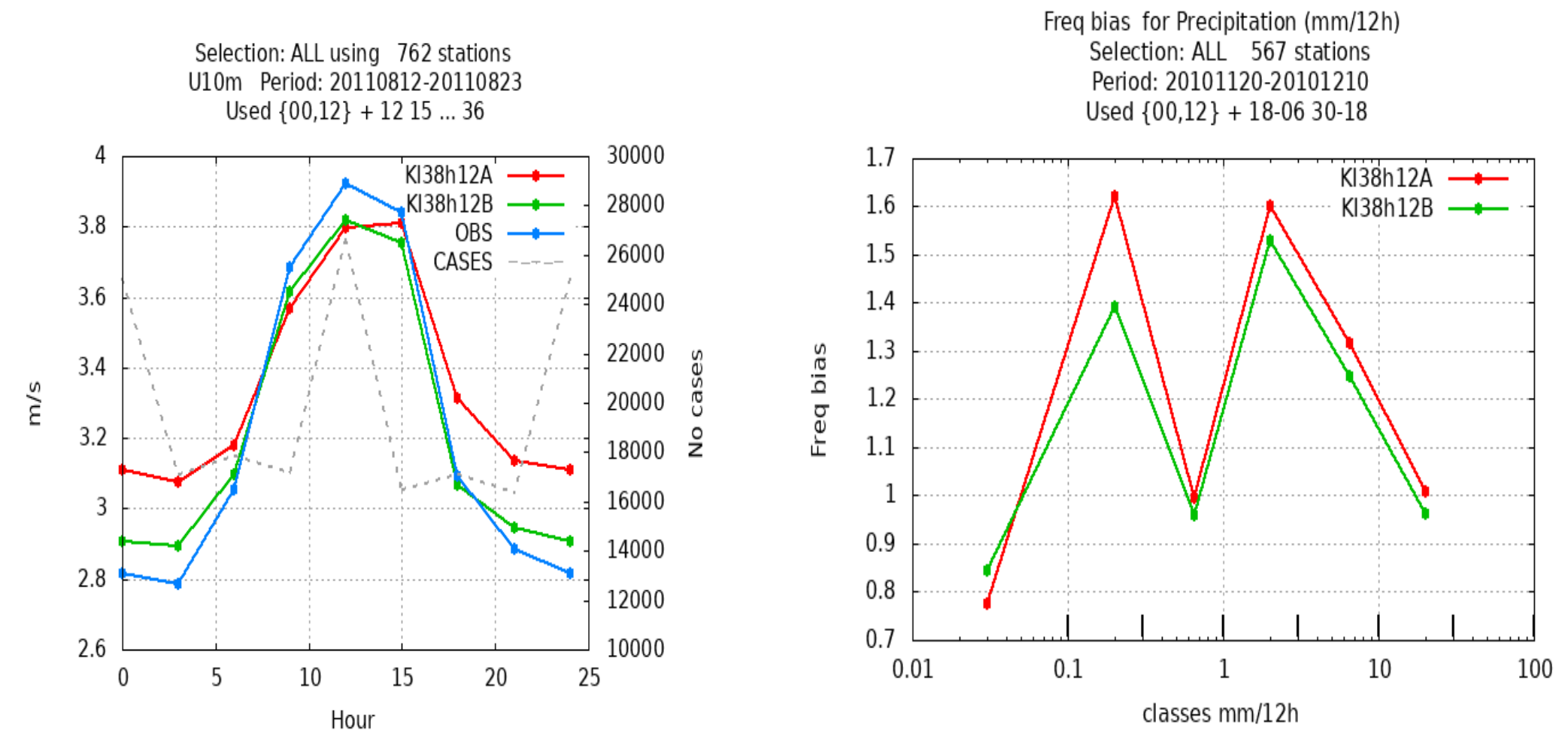

Figure 9: *Left: diurnal cycle of 10 m wind, Right: frequency bias of 12 h acc precip. Red: reference, green RACMO exp and blue observations.*

4. References

Ivarsson, 2014: Documentation of the OCND2 option in the ICE3 cloud- and stratiform condensation scheme in AROME.

Hogan, R. J., M. P. Mittermaier and A. J. Illingworth, 2004: The retrieval of ice water content from radar reflectivity factor and temperature and its use in the evaluation of a mesoscale model. J. Appl. Meteorol.

Kain, 2004: The Kain–Fritsch Convective Parameterization: An Update. J. Appl. Meteor., 43, 170–181.