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ALADIN Numerical Weather Prediction Project

# Low cloud experiments with AROME over Hungary

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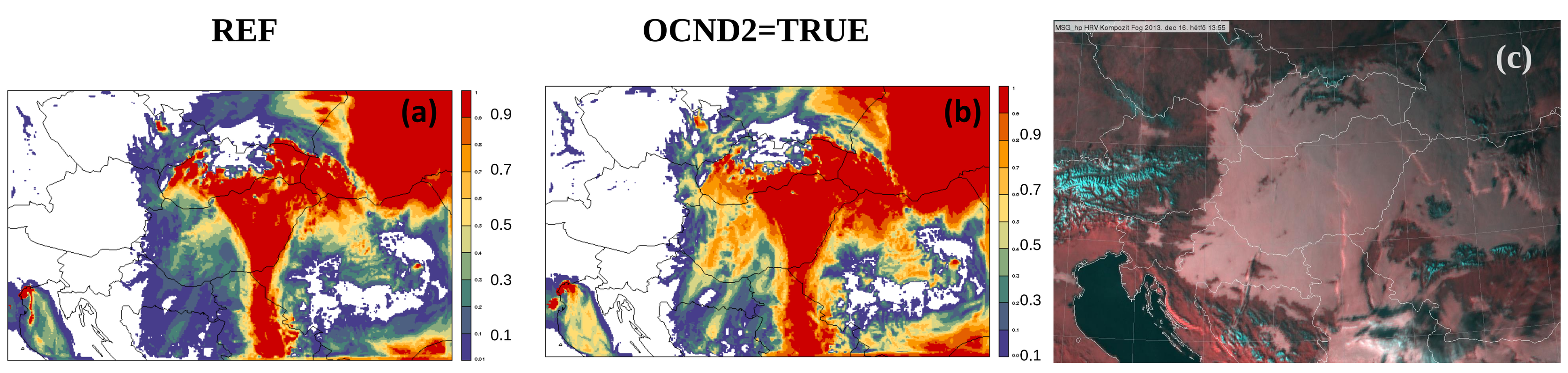
## Introduction

In wintertime thermal inversion with fog and stratus cloud is a common phenomenon over the Carpathian Basin. It sometimes happens that it becomes permanent, lasted 7-10 days and it breaks up after changes in synoptic scale weather systems (e.g. cold front). During this period the scenario of each day is very similar: at night stratus sinks down to the surface forming fog then after sunrise fog begins to elevate because cloud top becomes an emissive surface where condensation starts. NWP models usually predict well the nighttime fog but they tend to dissolve the stratus layer in daytime. This winter favored this phenomenon that often led to poor air quality in the larger cities.

## Experiments with OCND2 option

Sensitivity experiments by Szintai et al. (2014) indicated that the cause of the underestimation of low cloud cover can be searched in the microphysics parameterization. Increase of the critical value of the autoconversion is not able to solve the problem in all of the cases, so developments continued and the modification of cloud physics (ICE3) suggested by Karl-Ivar Ivarsson (2014) was implemented our AROME configuration (cy38) which can be switched with LOCND2 logical variable from namelist. This modification pack mainly concerns the ice processes. It separates more rigorously the fast liquid water processes and the slower ice processes, so it has big impact on the mixed-phase clouds also.

In the case study 16th December 2013 the modified autoconversion function (*Szintai et al.*,2014) did not change significantly the low cloud cover forecast while in the run with the OCND2 version the stratus layer increased, but it still less than seen on the satellite image. Moreover the structure is also different: with OCND2 the cloud tends to become thinner and more homogenous on the area contrary to the reference run where only in a small area remained from the stratus but there the cloud fraction was 100%.



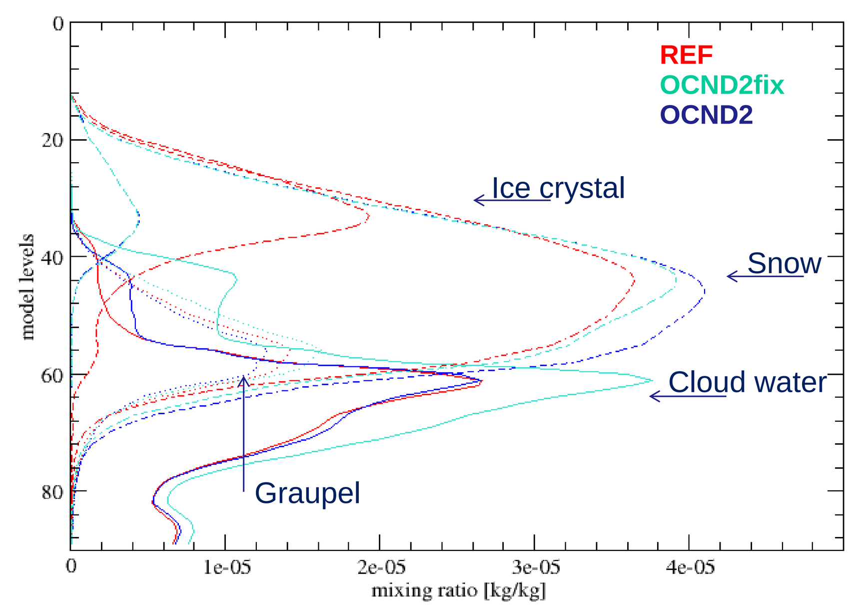

*Low cloud cover forecast fields on 16th December 2013 at 14 UTC a) in the reference run, b) with OCND2 modification c) MSG satellite image.*

## Experiments with OCND2

During a one-month stay in Toulouse the properties of the OCND2 modification were studied. Some missing parts were realized in the OCND2 code implemented in cy41t1:

- ZCOLF (collision factor cloud liquid to snow/graupel) and ZACRF (collision factor cloud liquid to rain) arrays were not used anywhere;
- the modified autoconversion function of cloud droplet to rain was not implemented.

After adding these modifications to the code we can experienced the below changes in the vertical profiles of hydrometeors: liquid water content was increased, snow was decreased but still produced more than in REF, while graupel was increased. The modified autoconversion function causes the presence of more liquid water.
(See more details in the report: http://www.rclace.eu/File/Physics/2015/homonnaiv_LACEreport_Nov2015_Toulouse.pdf)



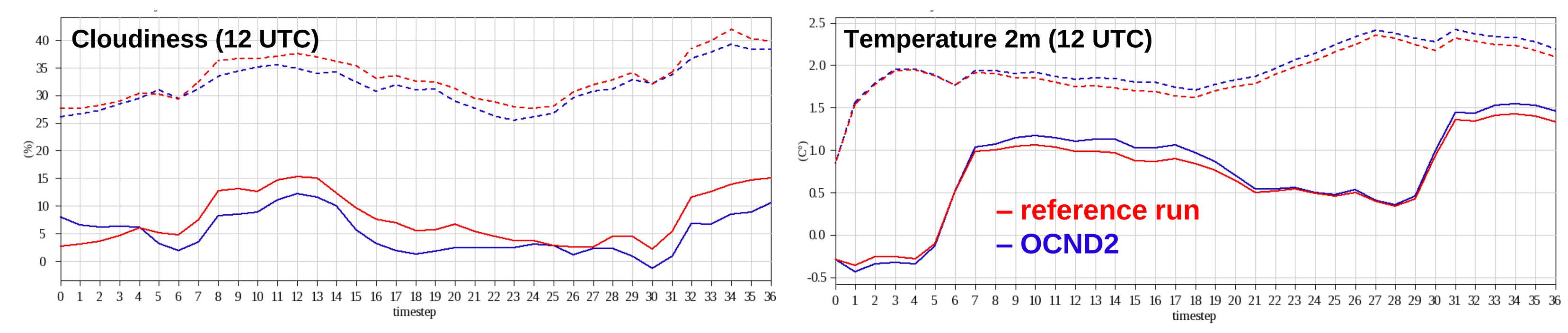

*Vertical profiles of hydrometeors in case of OCND2 (blue), fixed OCND2 (turquoise) and REF (red) on 15/01/2015 at 06UTC over France.*

## Summary

This poster presents our experiences with the OCND2 modifications in the microphysical scheme, especially in winter thermal inversion cases. In these situations the experiment with OCND2 predicts clouds on larger area than the operational version but the cloud fraction usually remains low.

## Experiments over longer period

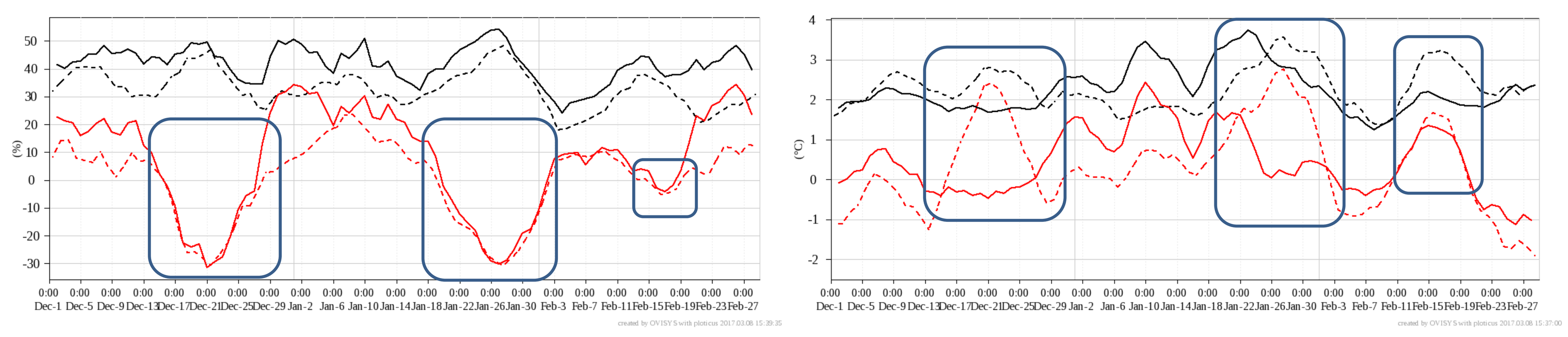
The OCND2 modification was tested for a two-weeks period from 18th November to 2nd December 2011 when the situations were under the previously mentioned meteorological conditions during the whole period (24-hours forecasts from 00 UTC) and for a three-weeks long summer period from 1st to 23th August 2014 (36-hours forecasts from 00 and 12 UTC). Results in both cases show smaller bias and root mean square error in cloud forecasts. But the scores for the temperature are not too convincing with the new experiment: the bias increased, especially in the summer period. Frequency bias of 24h-precipitation does not show any positive impact either, unlike the experiences from Sweden.




*BIAS (solid) and RMSE (dashed) verification scores as a function of lead time for the three-weeks summer period (12 UTC runs). SYNOP stations below 400 m were used for the calculations. Red lines indicate the operational run and blue lines are the experiment with OCND2 option.*

## 2016/2017 winter

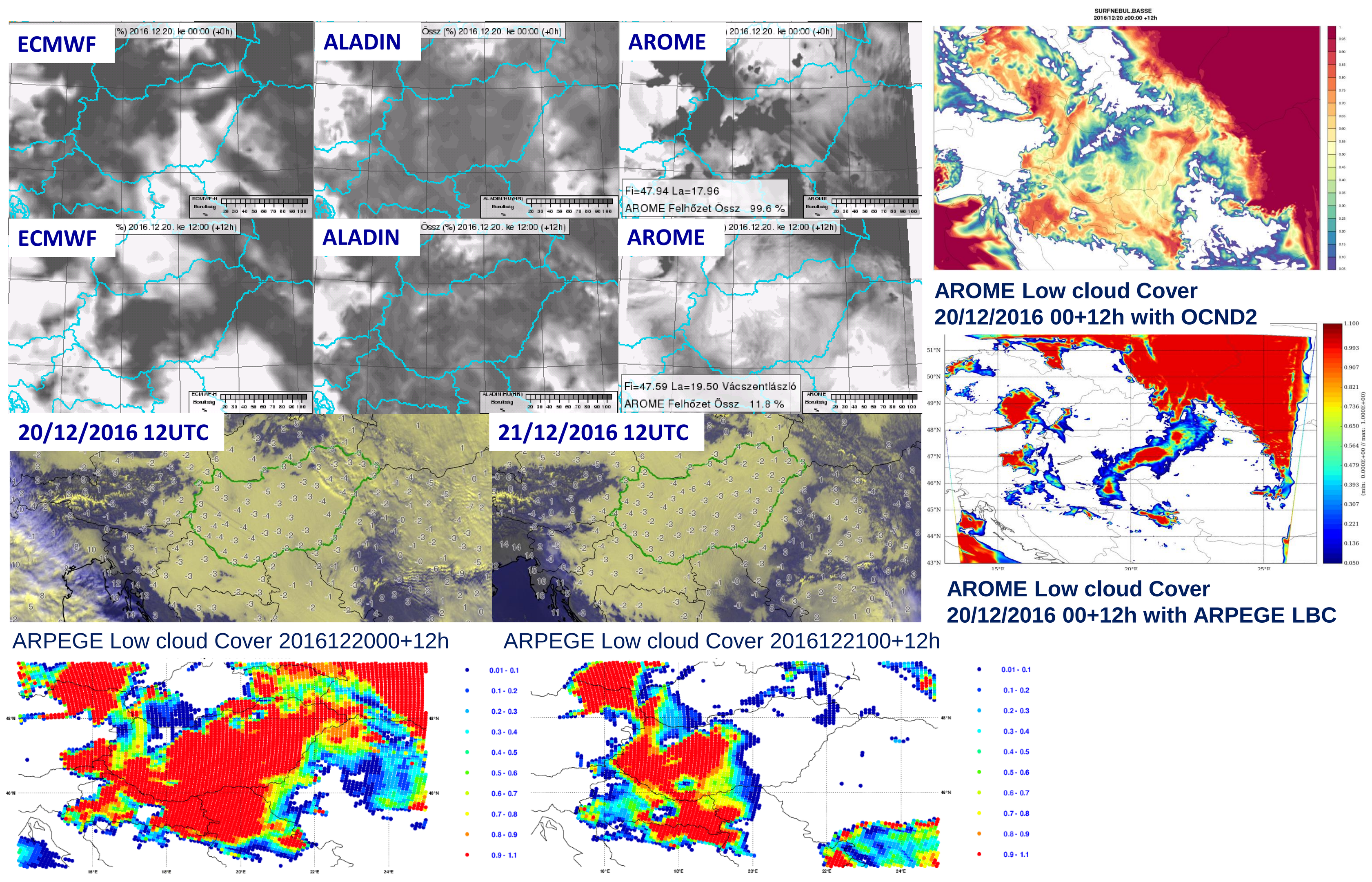
On the last winter there were three longer periods with strong thermal inversion: before Christmas (19/12/2016-24/12/2016), at the end of January (25/01/2017-30/01/2017) and in the middle of February (12/02/2017-16/02/2017). These periods can be seen well on the cloudiness and temperature bias time series as well. Usually the cloud-bias is positive but during these periods were negative because models tend to give no cloud in these situations, so temperature usually has a large positive bias.



*BIAS (red) and RMSE (black) verification scores as a function of days for the 2016/2017 winter period (00 UTC runs). SYNOP stations below 400 m were used for the calculations. Solid lines indicate the +12h forecast and dashed lines are the +24h forecasts.*

## Case study: 20/12/2016

Before Christmas in 2016 the weather was overcast, foggy and the temperature dropped below zero, the inversion remained over more days and the characteristics of the weather did not change. In these days the forecasts of all models were very unreliable, only the forecasters could predict well this persistent weather. For 20/12/2016 ARPEGE forecast was quite good, but the next day the cloud cover was much lower in contrast with the observations. Using ARPEGE LBCs in AROME does not help either. Experiment with OCND2 option gives a little more cloud, but the thickness is not adequate.




*Total (grey shaded) and low cloud cover forecast fields and satellite images on 20th-21th December 2016 at 12 UTC.*

## References

1. Szintai, B., Bazile, E., Seity,Y. (2014): Improving wintertime low cloud forecasts in AROME: sensitivity experiments and microphysics tuning. ALADIN-HIRLAM Newsletters, No. 3., 45-58.
2. Ivarsson, K.-I. (2014): Modification of AROME ICE3 cloud physics, a status report. METCOOP MEMO, No. 2, 32 pp.
3. Viktória Homonnai: Validation and testing of newest modifications in the ICE3/ICE4 microphysics scheme, RC LACE stay report, Toulouse, 2 - 21 November 2015 http://www.rclace.eu/File/Physics/2015/homonnaiv_LACEreport_Nov2015_Toulouse.pdf

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