Improving wintertime low cloud forecasts in AROME: sensitivity experiments and microphysics tuning

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ALADIN/HIRLAM Workshop 2014, Bucharest, Romania

Outline

- Wintertime anticyclonic stratus cases

- Case study, sensitivity experiments

- Tuning of microphysics

- Control cases

- Summary and Outlook

Wintertime stratus cases

- Stratus cases: winter anticyclonic cases; low mixing, fog is formed during the night, which does not dissolve during the day, elevates and forms a stratus layer

- The cloud top radiates out considerably → CTT can decrease even during day → condensation at cloud top → fog elevates

- Complex process: radiation, turbulence, microphysics

- Operational models often give wrong forecasts (too less low clouds)

- Hungary-France bilateral project:
  - „Simulation of the Atmospheric Boundary Layer with the AROME numerical weather prediction model„
  - Goal: Improve AROME forecasts for stratus cases
  - 2 years: autumn 2012 – autumn 2014
 - 8 stays

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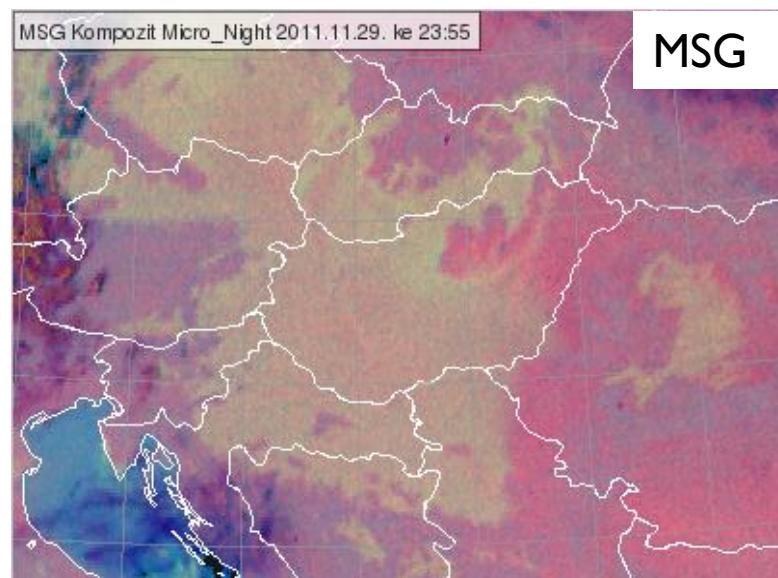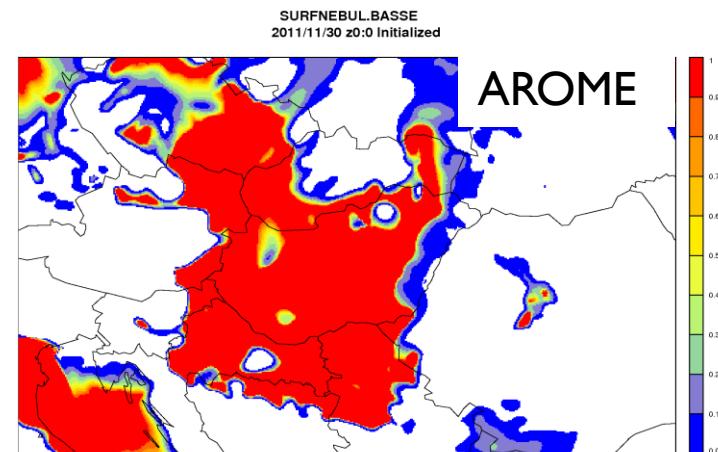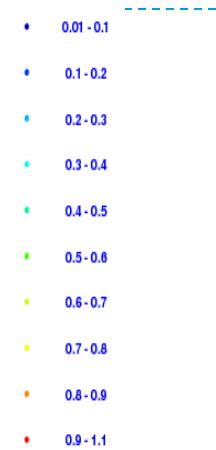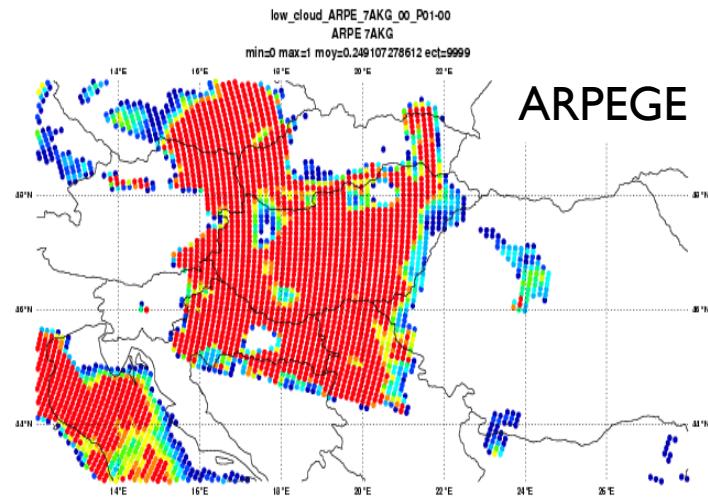
ARPEGE

AROME

MSG

2011-11-30 03 UTC (+3 h)

ARPEGE

AROME

MSG

2011-11-30 06 UTC (+6 h)

ARPEGE

AROME

MSG
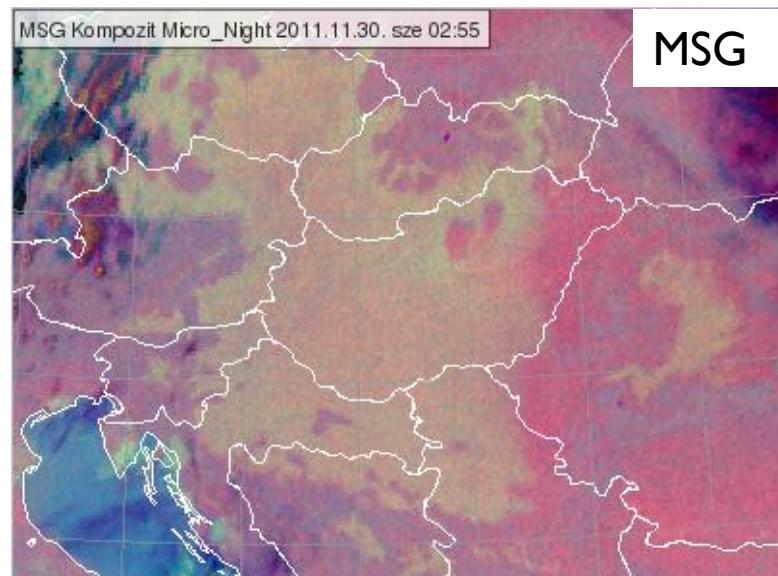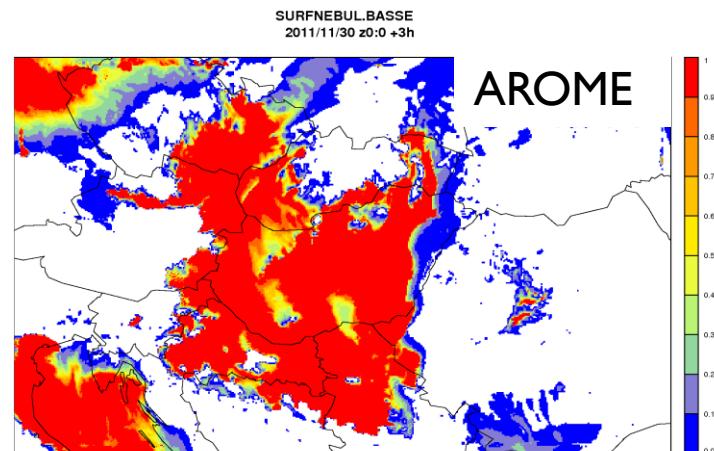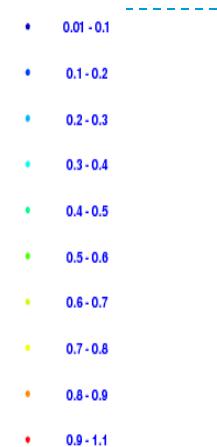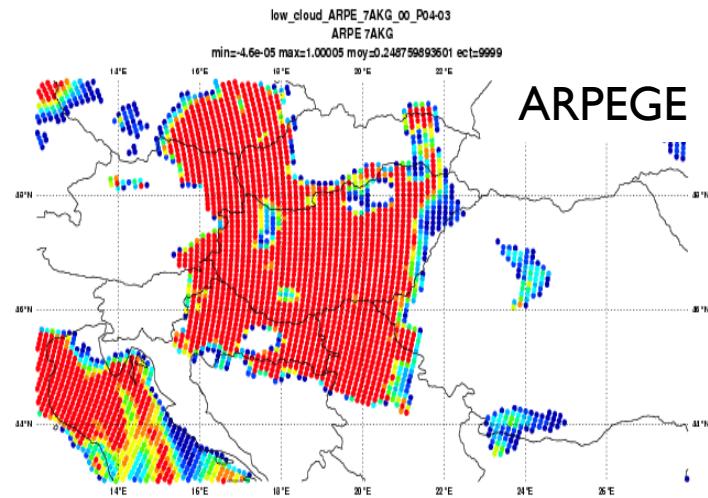
Improving low cloud forecasts in AROME
Balázs Szintai (szintai.b@met.hu)
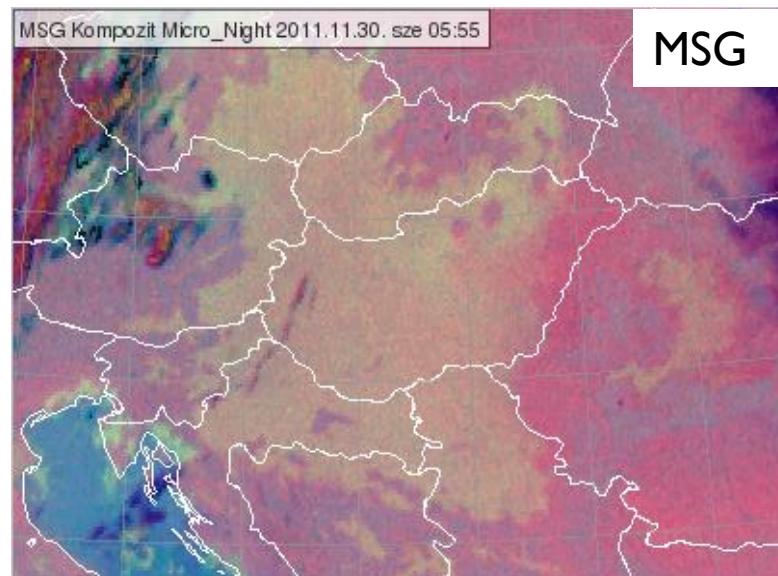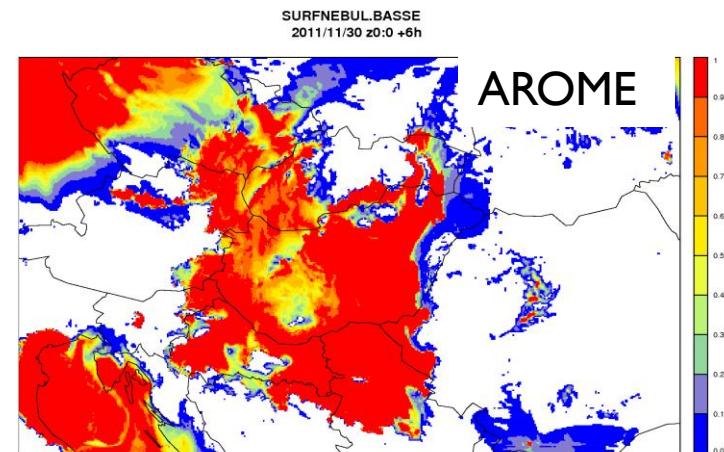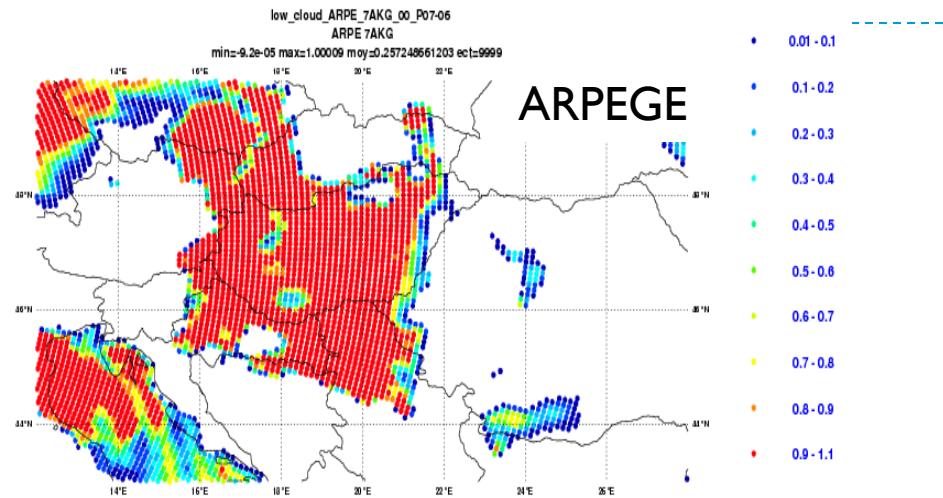
2011-11-30 09 UTC (+9 h)

ARPEGE

AROME

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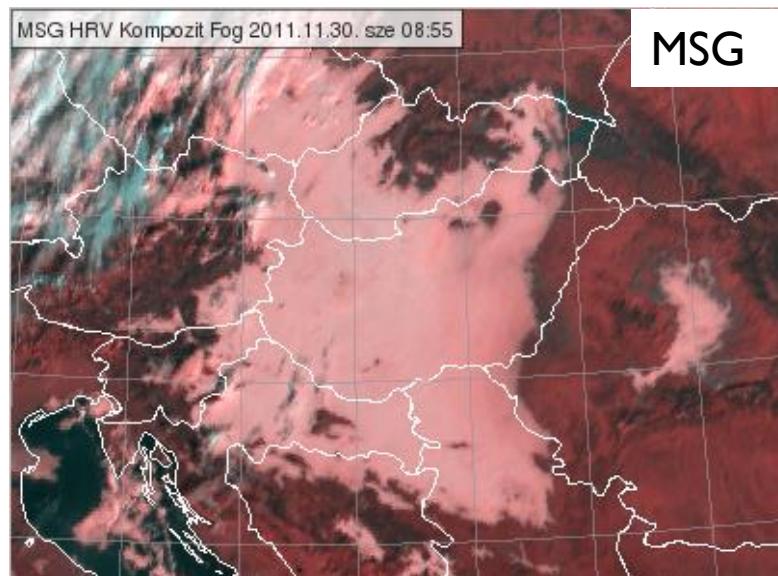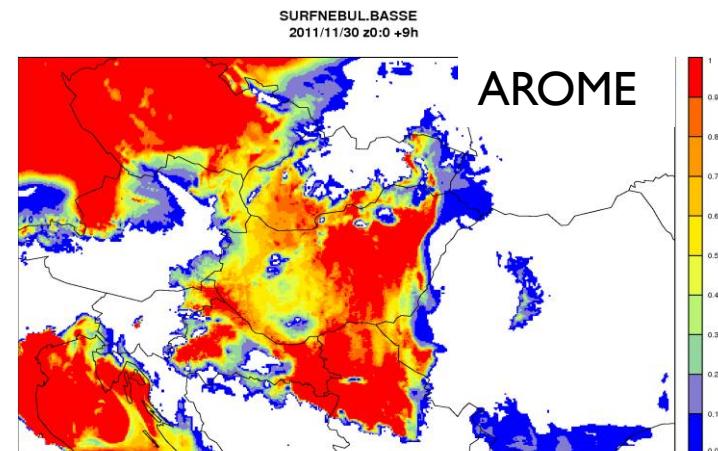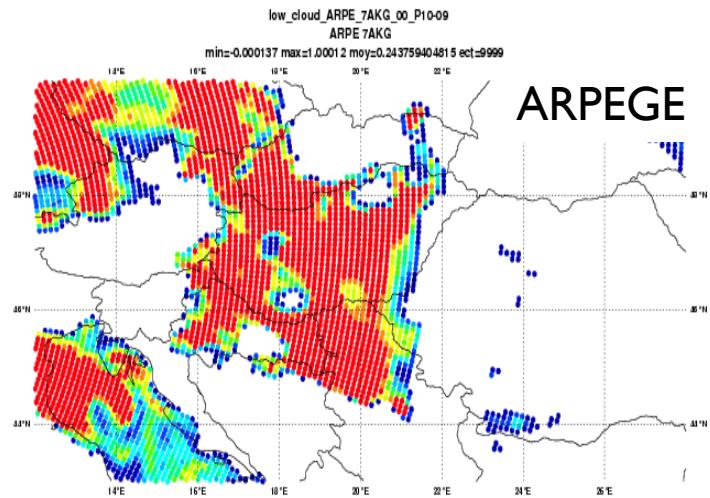
Improving low cloud forecasts in AROME
Balázs Szintai (szintai.b@met.hu)
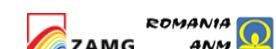
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ARPEGE

AROME

MSG
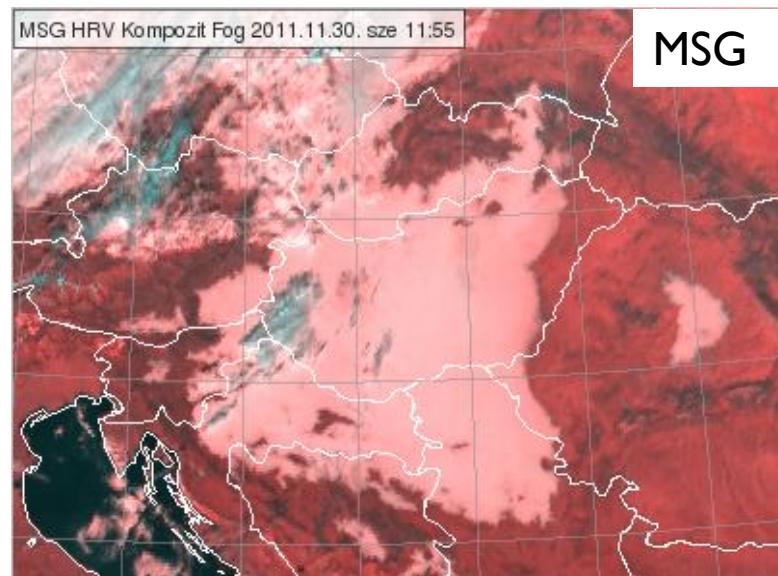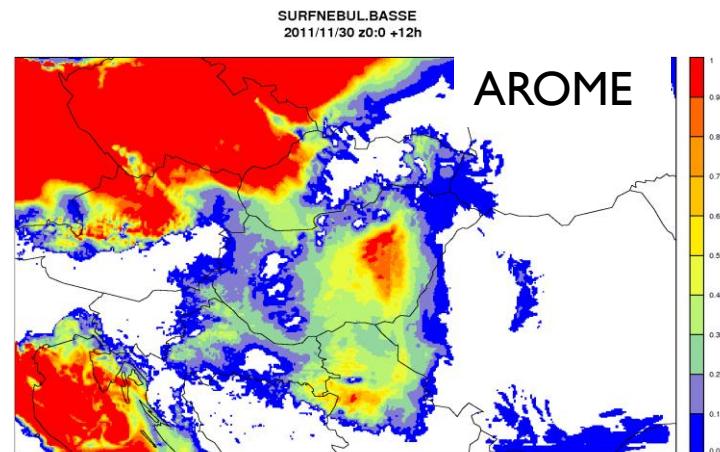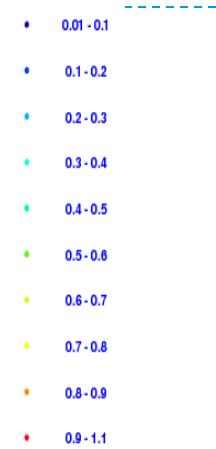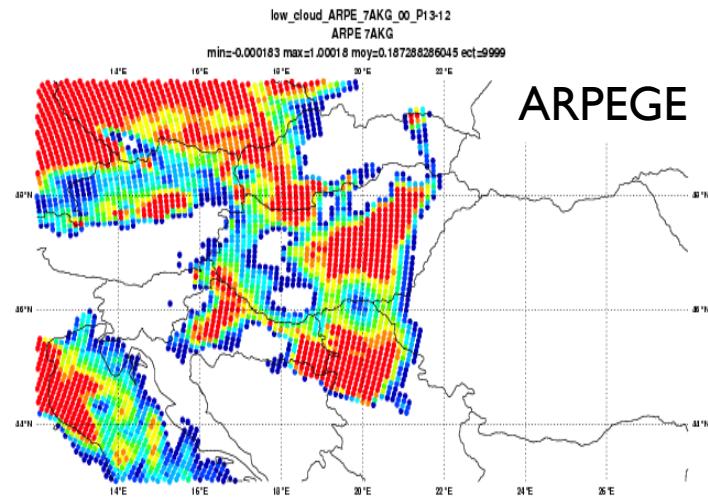
Balázs Szintai (szintai.b@met.hu)

2011-11-30 14 UTC (+14 h)
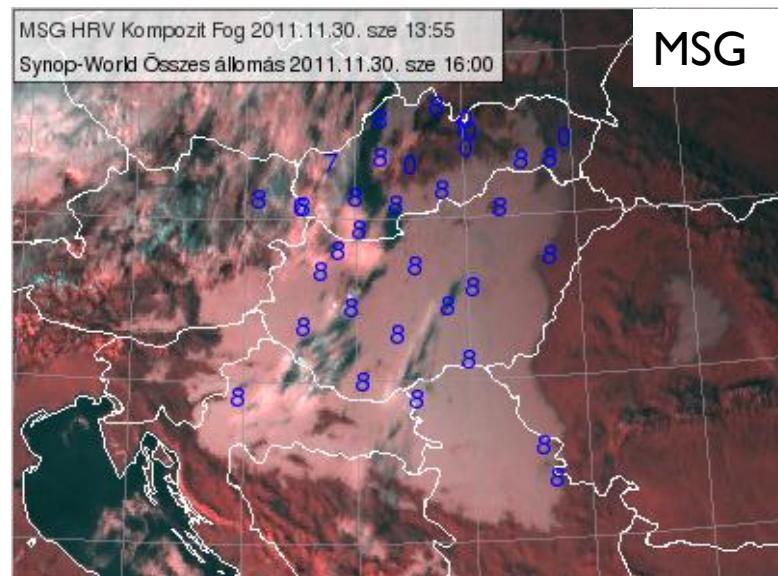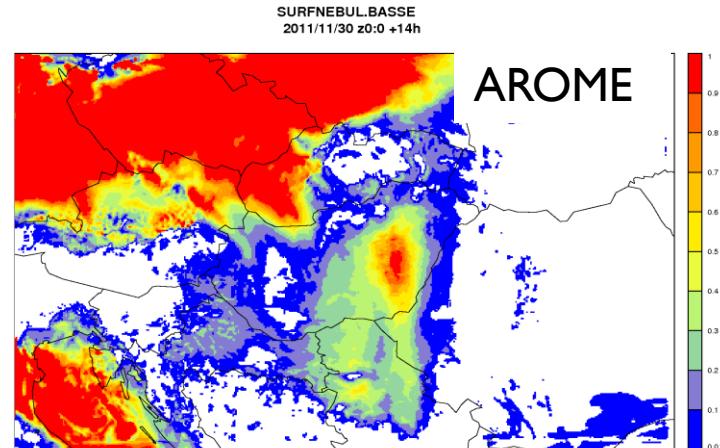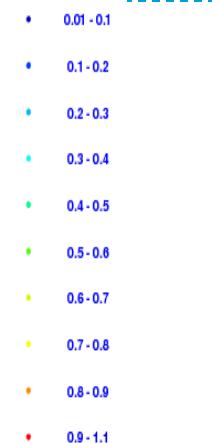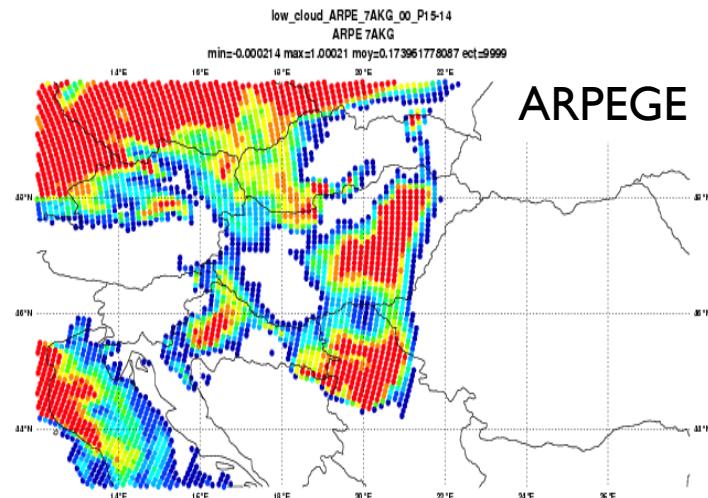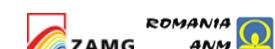
Large scale effects
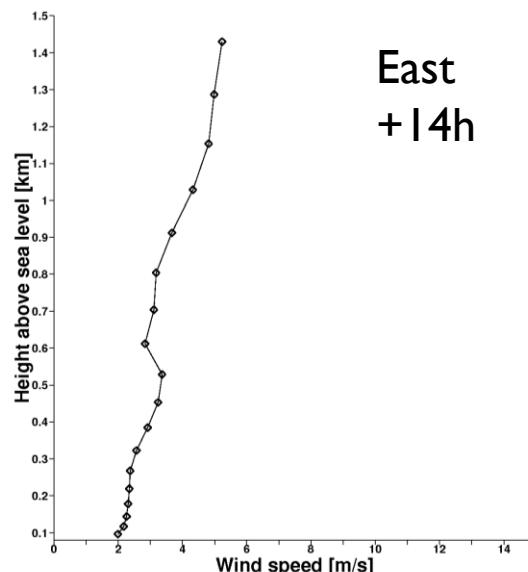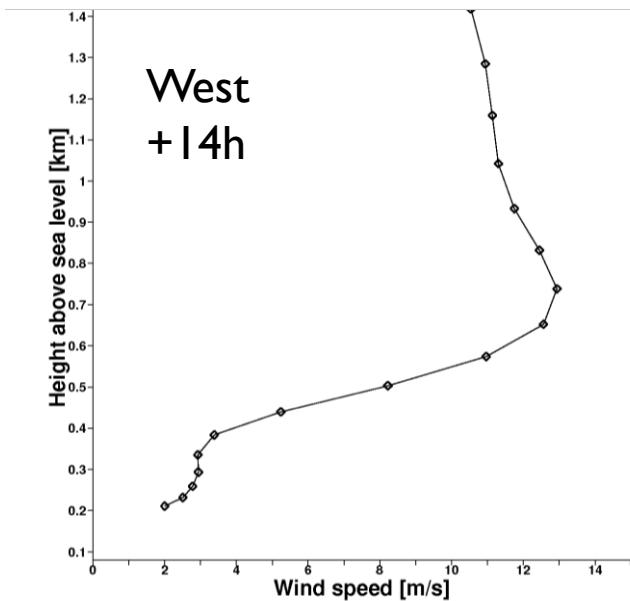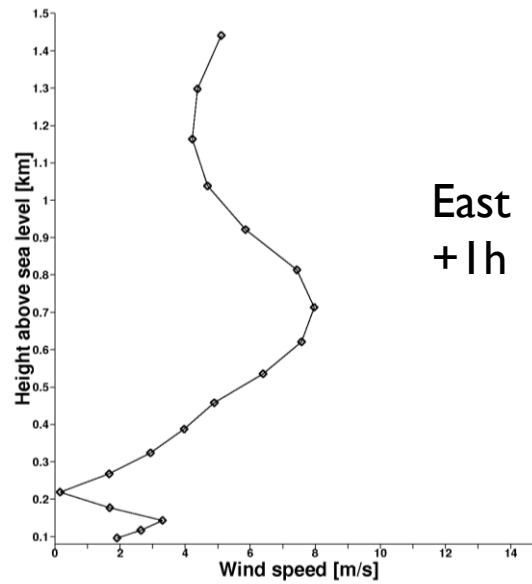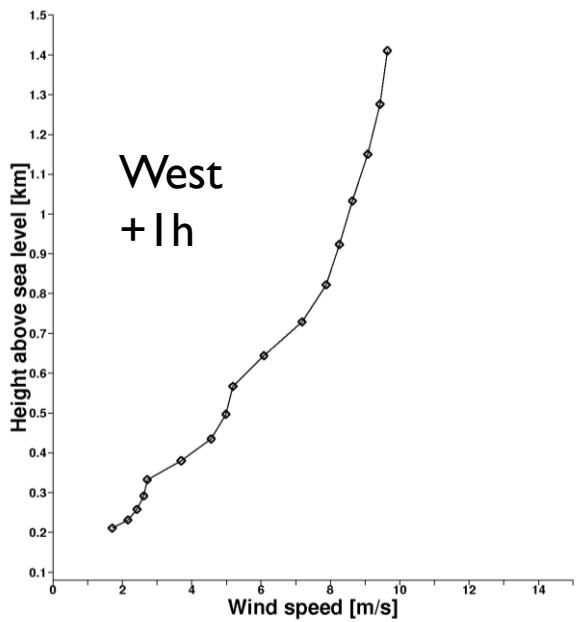
Sensitivity experiment – Data assimilation

- 3DVAR (atmosphere)
- OI (surface)
- 5 day spin-up
- Neutral impact

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REF

SURFNEBUL.BASSE
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TEST-REF

SURFNEBUL.BASSE
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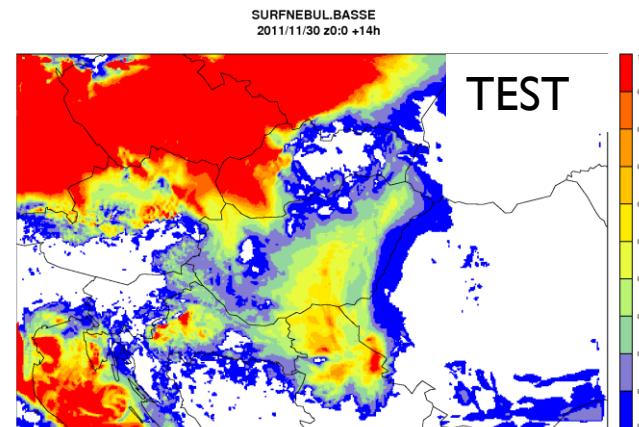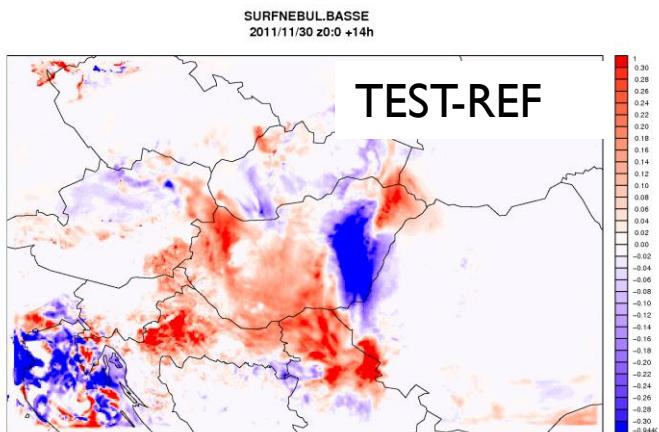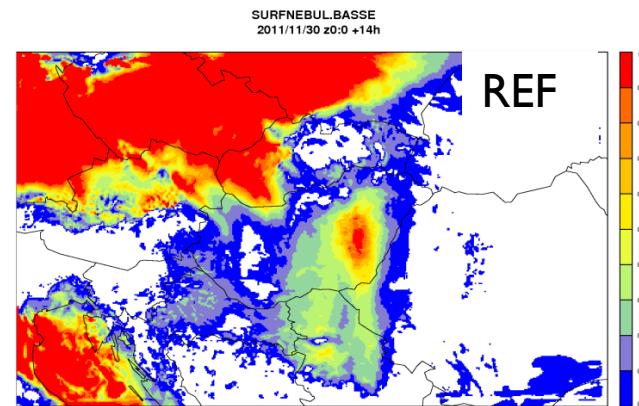
Sensitivity experiment – Lateral boundaries

- ECMWF/IFS LBCs instead of ARPEGE

- Impact on frontal cloud cover

- Stratus is not influenced

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TEST-REF

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TEST

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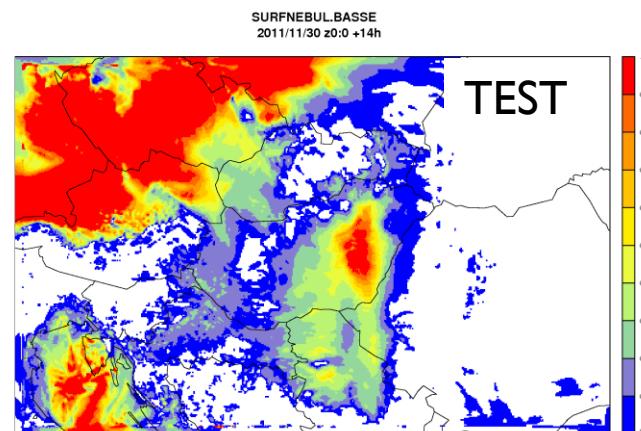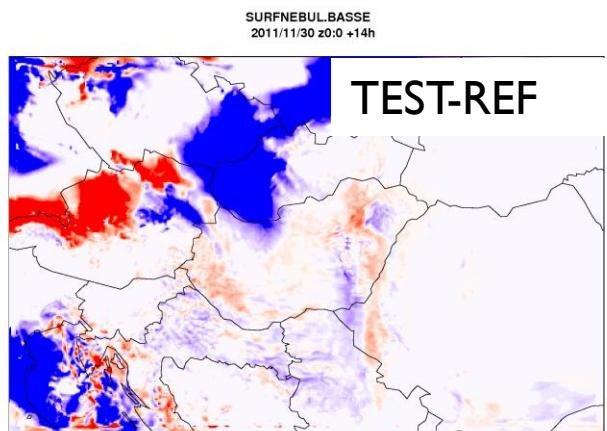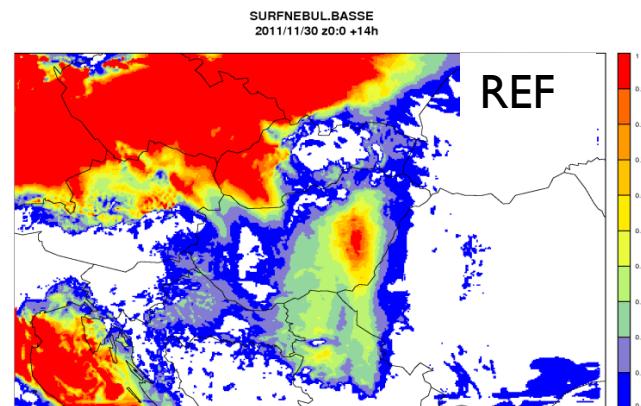
Sensitivity experiment – Statistical cloud scheme

- Two possibilities in code (`LOSIGMAS`)

- OMSZ: diagostic

- Meteo-France: prognostic

- Prognostic scheme gives much less low clouds

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TEST
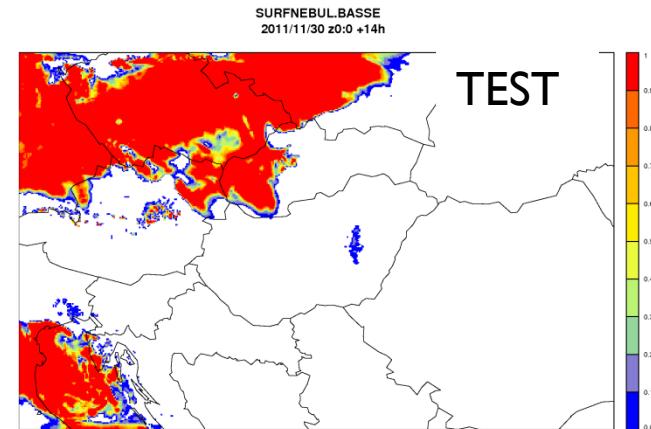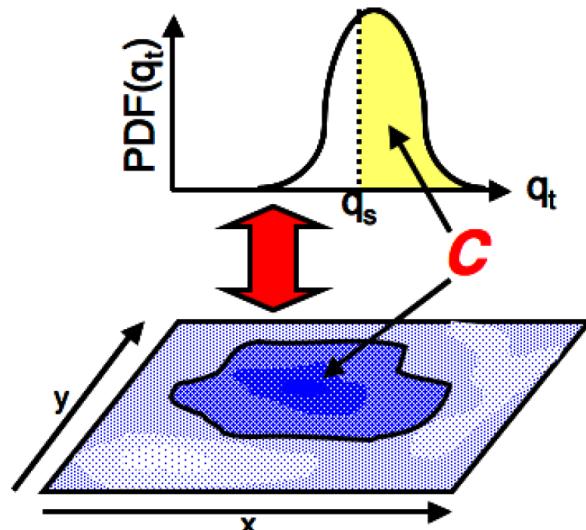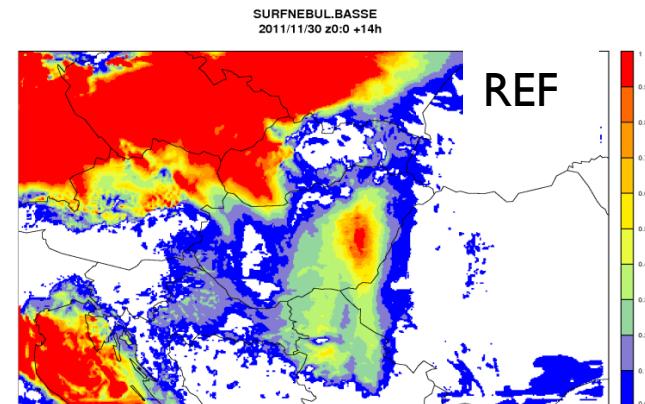
Sensitivity experiment – Radiation (/1)
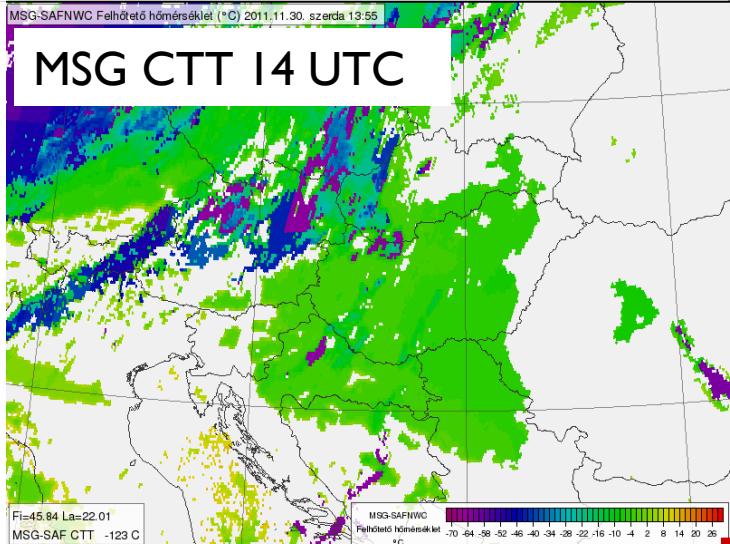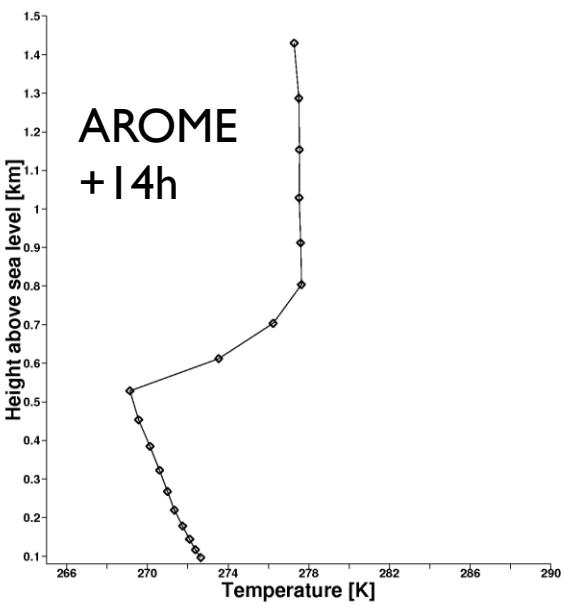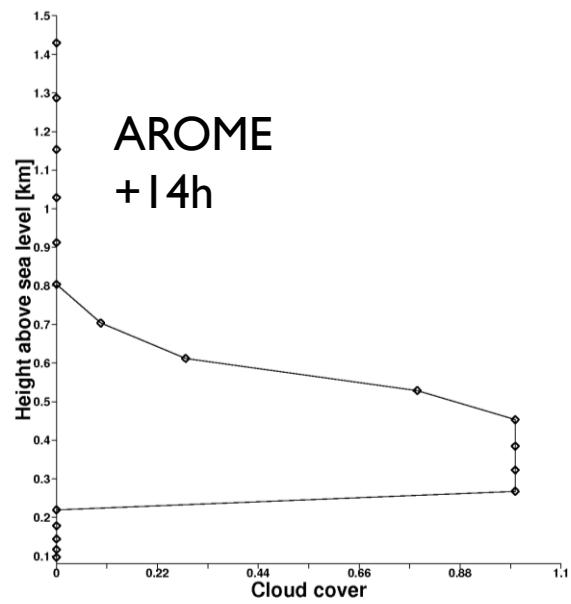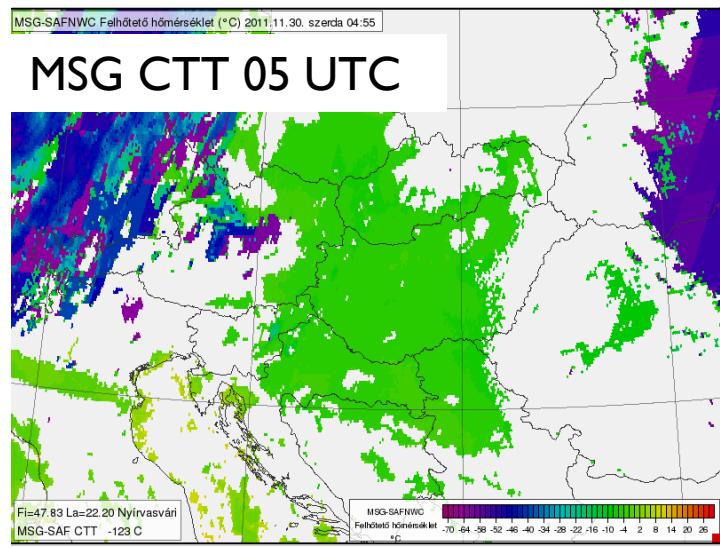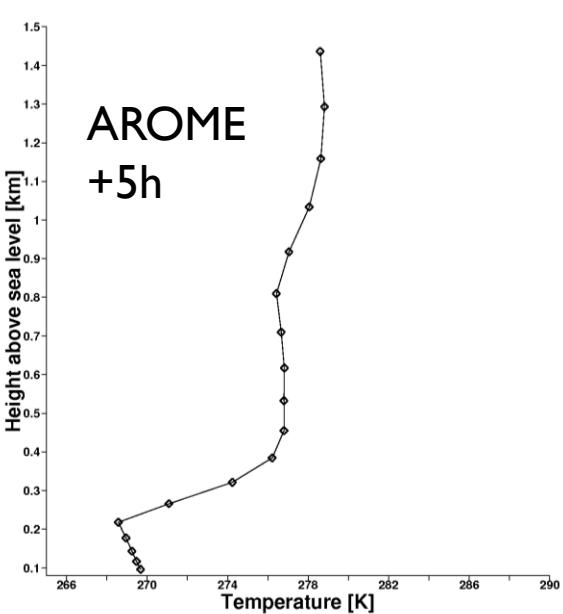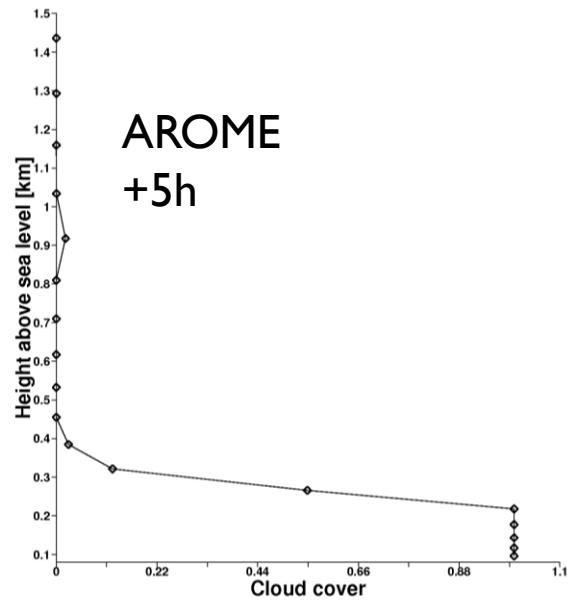
Sensitivity experiment – Radiation (/2)

- Inhomogeneity-factor
- ARPEGE-oper: 0.9
- AROME-oper: 0.7
- AROME experiment: 1.0
- Small improvement

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2011/11/30 z0:0 +14h
REF

SURFNEBUL.BASSE
2011/11/30 z0:0 +14h
TEST-REF

SURFNEBUL.BASSE
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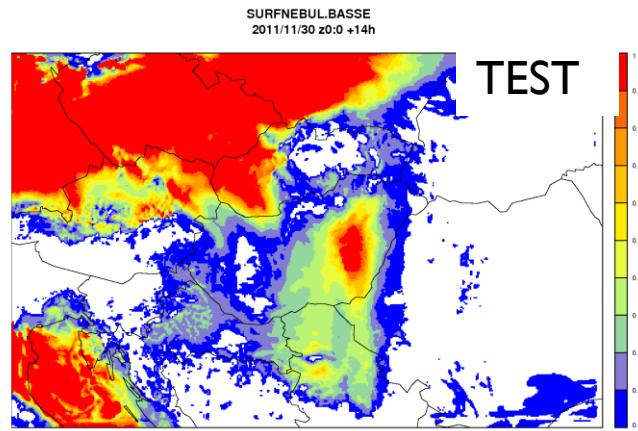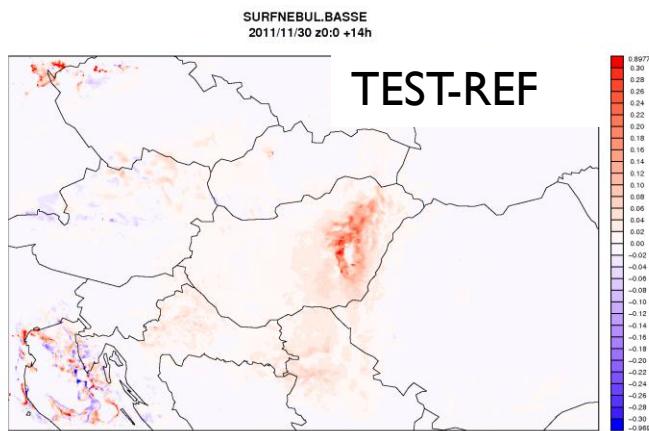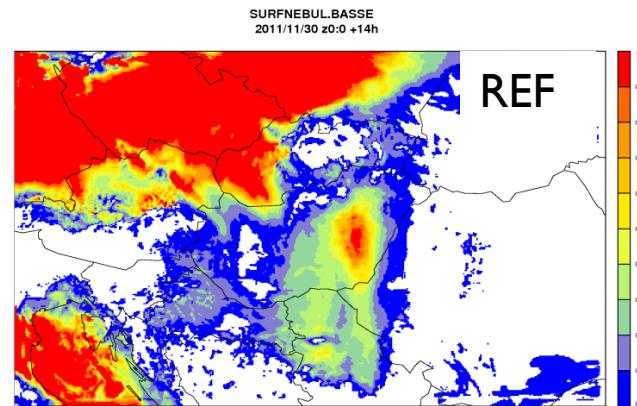
Sensitivity experiment – Radiation (/3)

- Increasing the inhomogeneity factor in AROME → SW_{down} is closer to ARPEGE value → still overestimated as compared to ground measurements

- 1D test: a „real" stratus cloud is put in the profile at 12 UTC → model reproduces the SW_{down} measured values → problem is not in the radiation parameterization

Observations

ARPEGE
AROME-oper
AROME-exp
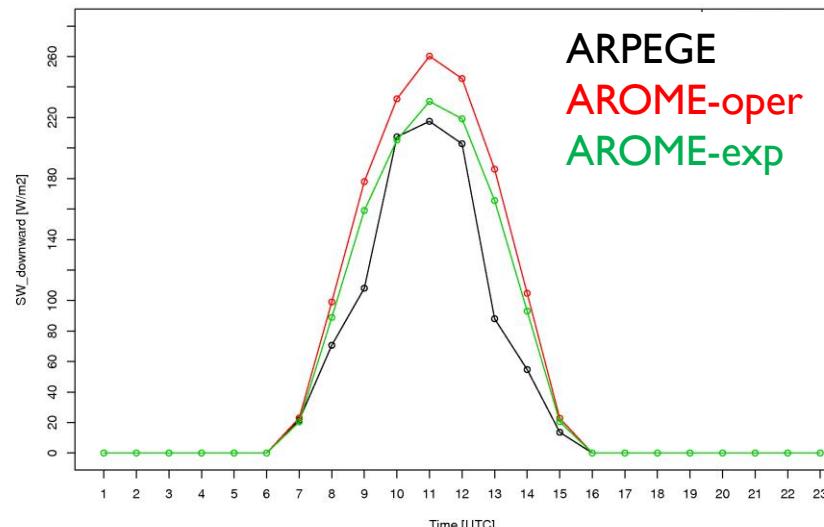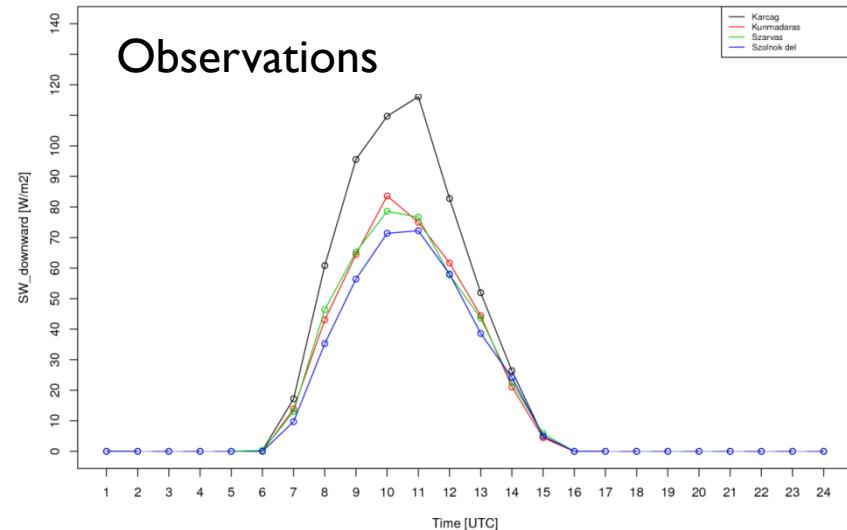
Microphysics tuning (/1)

- Wintertime stratus cases are often associated with light drizzle in AROME
- <u>Above freezing point</u>: liquid drizzle in AROME is close to measurements and other models
- <u>Below freezing point:</u> amount of solid drizzle is higher than in observations or other models → investigation of microphysics (snow processes)

Sedimentation
**D**eposition on snow
Collection of ice on sno'
Autoconversion of ice t
Riming by cloud drople
Collection of raindrops
Melting of aggregates
Wet growth of graupel
Dry growth of graupel
Residual
Total tendency

Deposition

Autoconversion

Riming
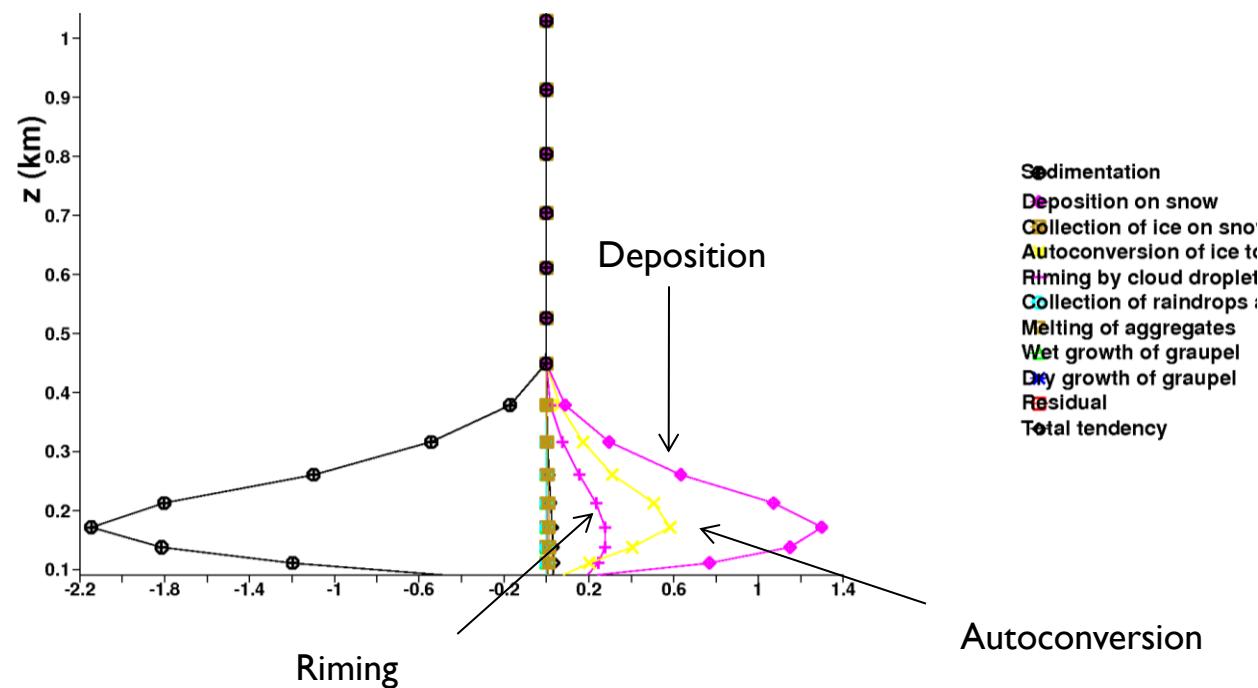
Microphysics tuning (/2)

REF – total prec. x100 [mm]

REF – snow x100 [mm]

SYNOP [mm]
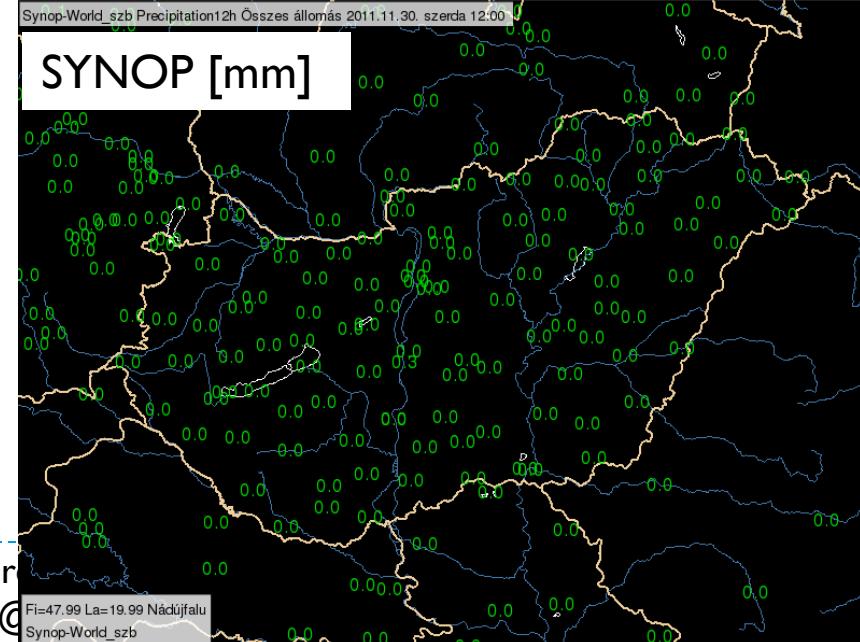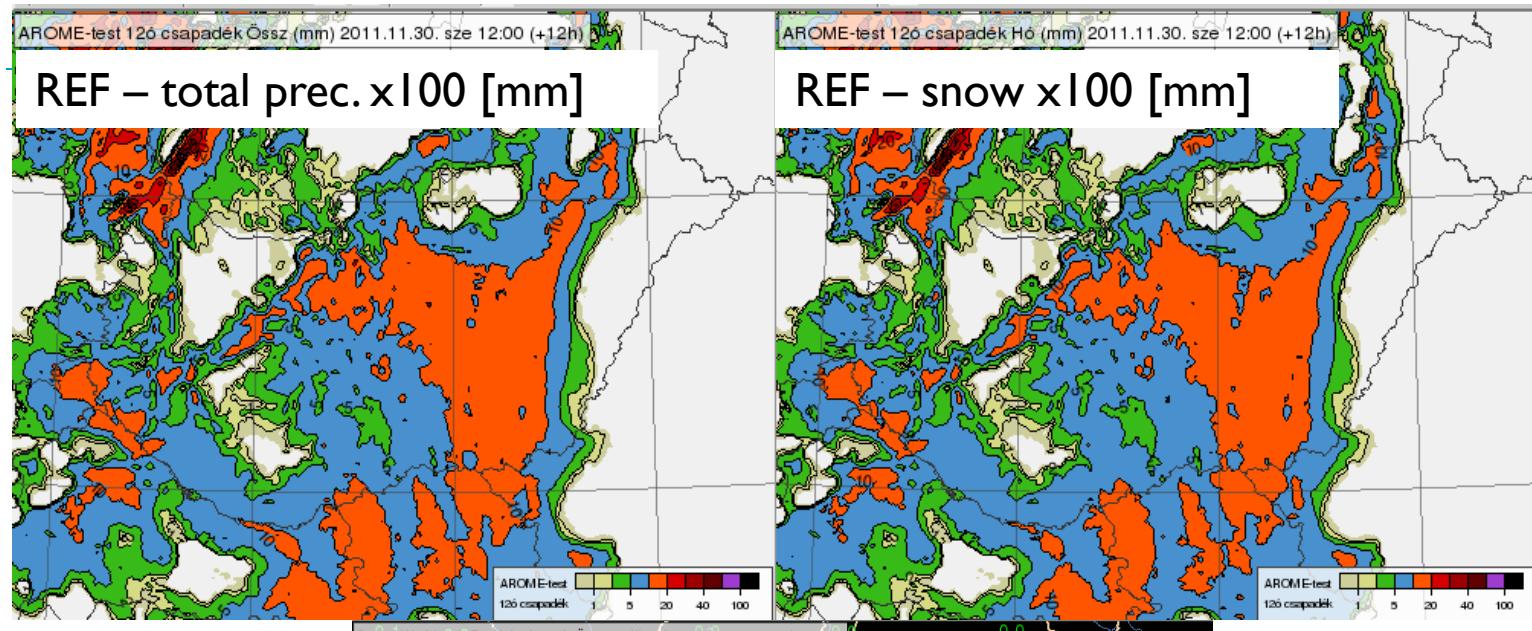
Microphysics tuning (/3)

- Critical value of autoconversion has been increased (0.02 g/m^3 → 1 g/m^3) → less snowfall

Microphysics tuning (/4)

AROME-test 12ó csapadék Össz (mm) 2011.11.30. sze 12:00 (+12h)

REF – total prec. x100 [mm]

AROME-test 12ó csapadék Hó (mm) 2011.11.30. sze 12:00 (+12h)

REF – snow x100 [mm]

AROME-test2 12ó csapadék Össz (mm) 2011.11.30. sze 12:00 (+12h)

TEST – total prec. x100 [mm]

AROME-test2 12ó csapadék Hó (mm) 2011.11.30. sze 12:00 (+12h)

TEST – snow x100 [mm]

Fi=47.28 La=22.13
AROME 12ó csapadék Ös   0 mm
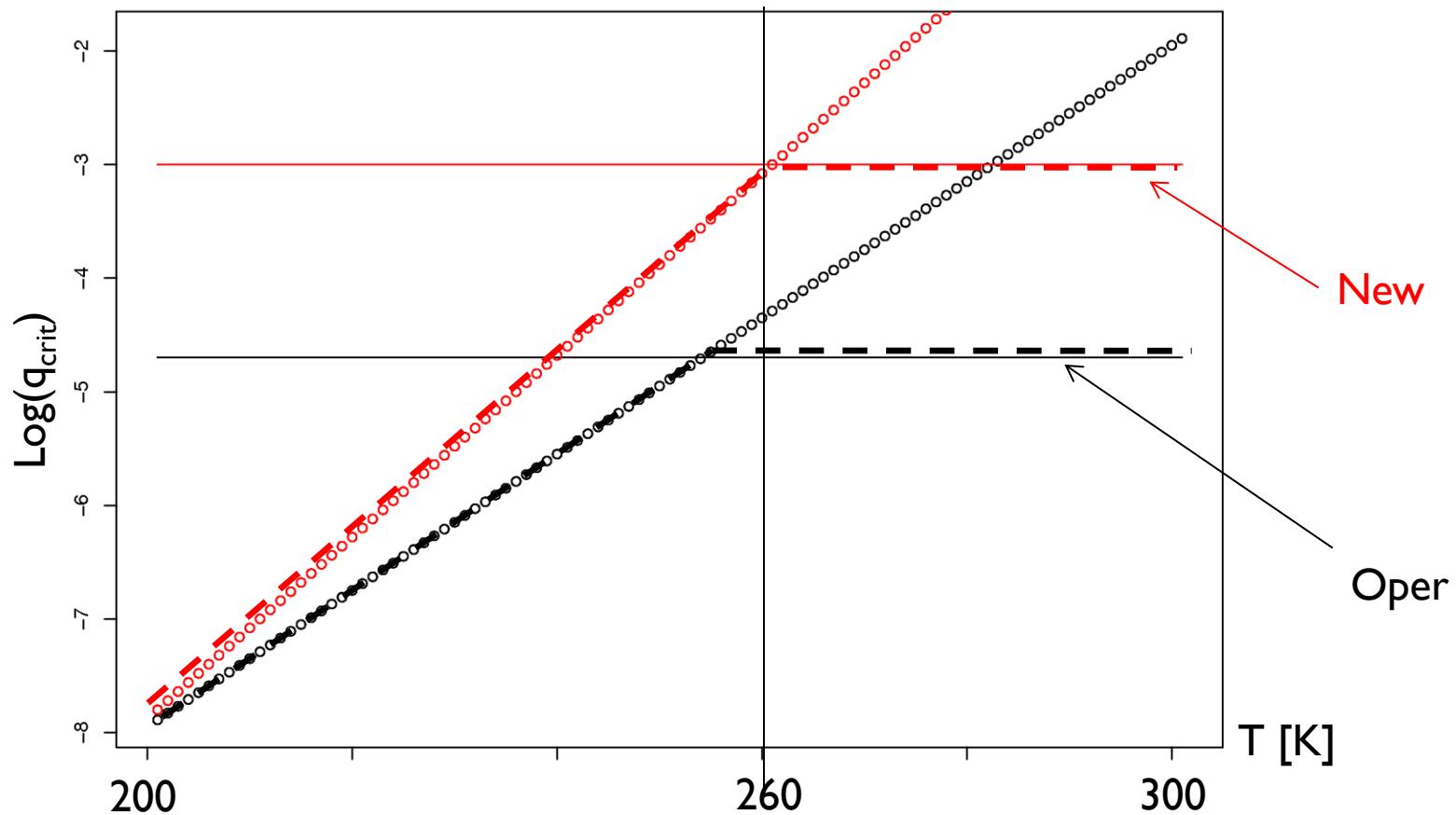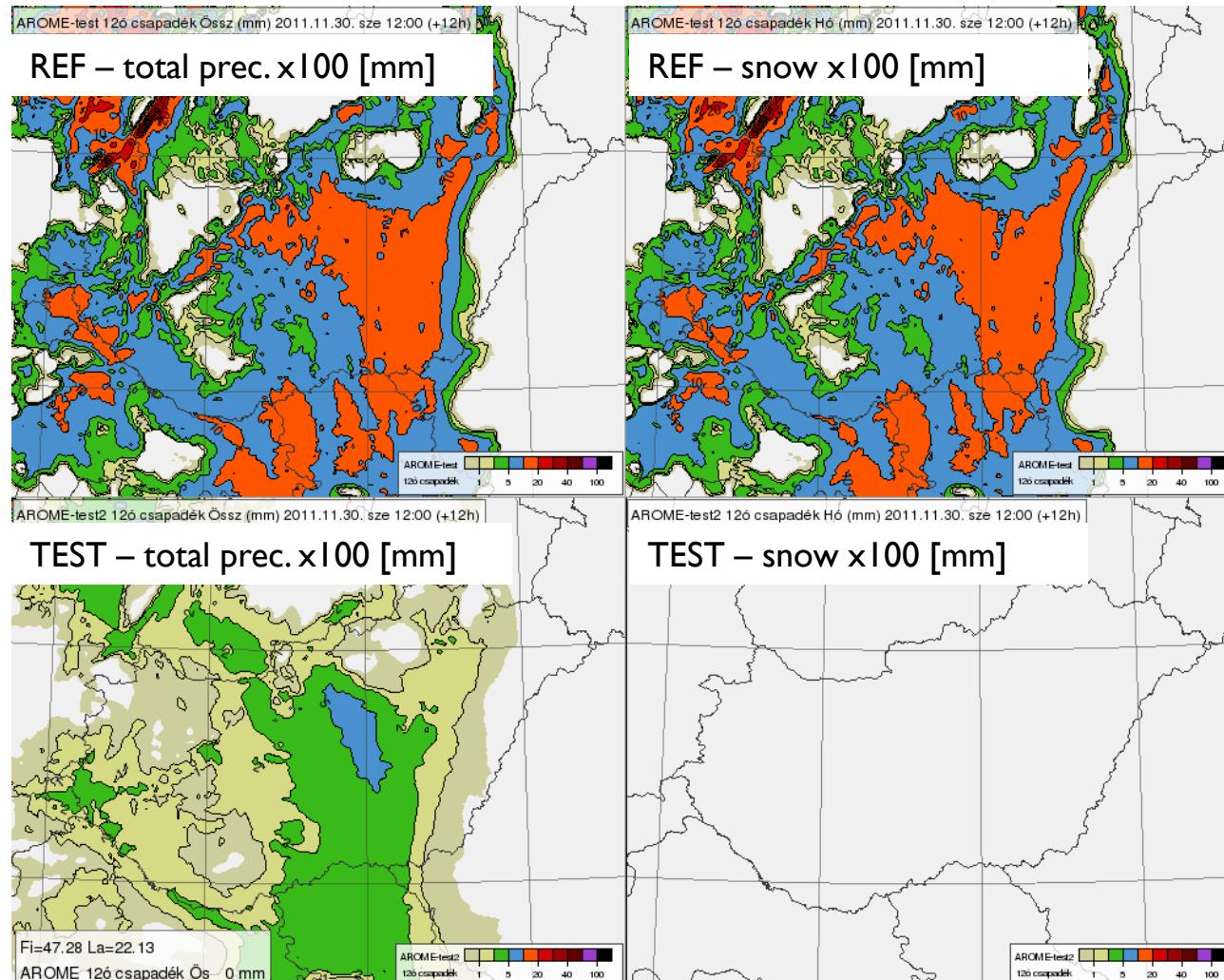
Microphysics tuning (/5)

- By increasing the critical value for autoconversion → snowfall decreases → stratus does not dissolve

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2011/11/30 z0:0 +14h

REF

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2011/11/30 z0:0 +14h

TEST-REF

SURFNEBUL.BASSE
2011/11/30 z0:0 +14h

TEST
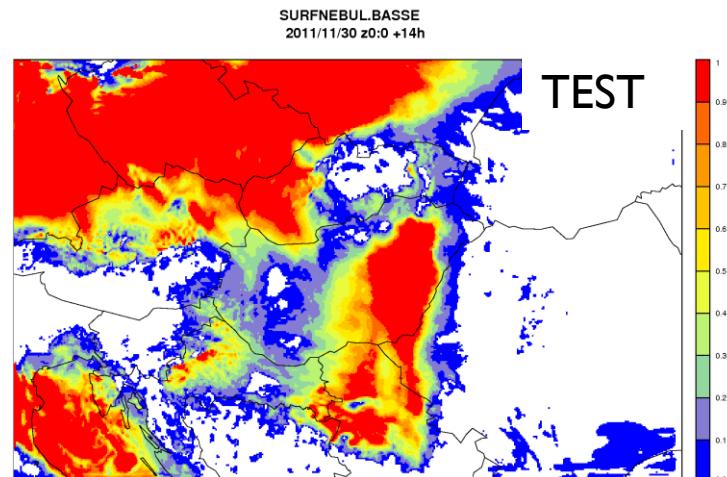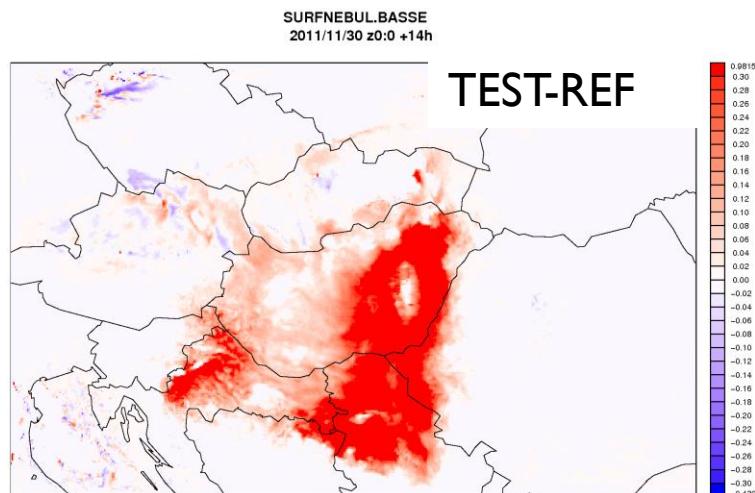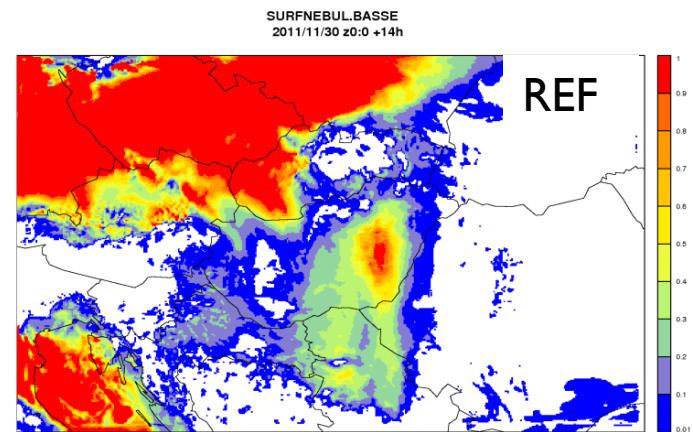
Microphysics tuning (/6) – Scores

- Two weeks period in late autumn 2011

- 24 hour forecasts with DA over Hungary

- Microphysics modification increases low clouds during the whole forecats range

- 2 metre temperature also improves

- No impact on other variables

Period: 11/18/2011 - 12/02/2011
Area: AROME_max400
Variable: N
Runhour: 00

---- AROME_stratus_2011_ref/RMSE
—— AROME_stratus_2011_ref/BIAS
---- AROME_stratus_2011_exp/RMSE
—— AROME_stratus_2011_exp/BIAS

Red: reference
Green: experiment

Cloudiness

T2m
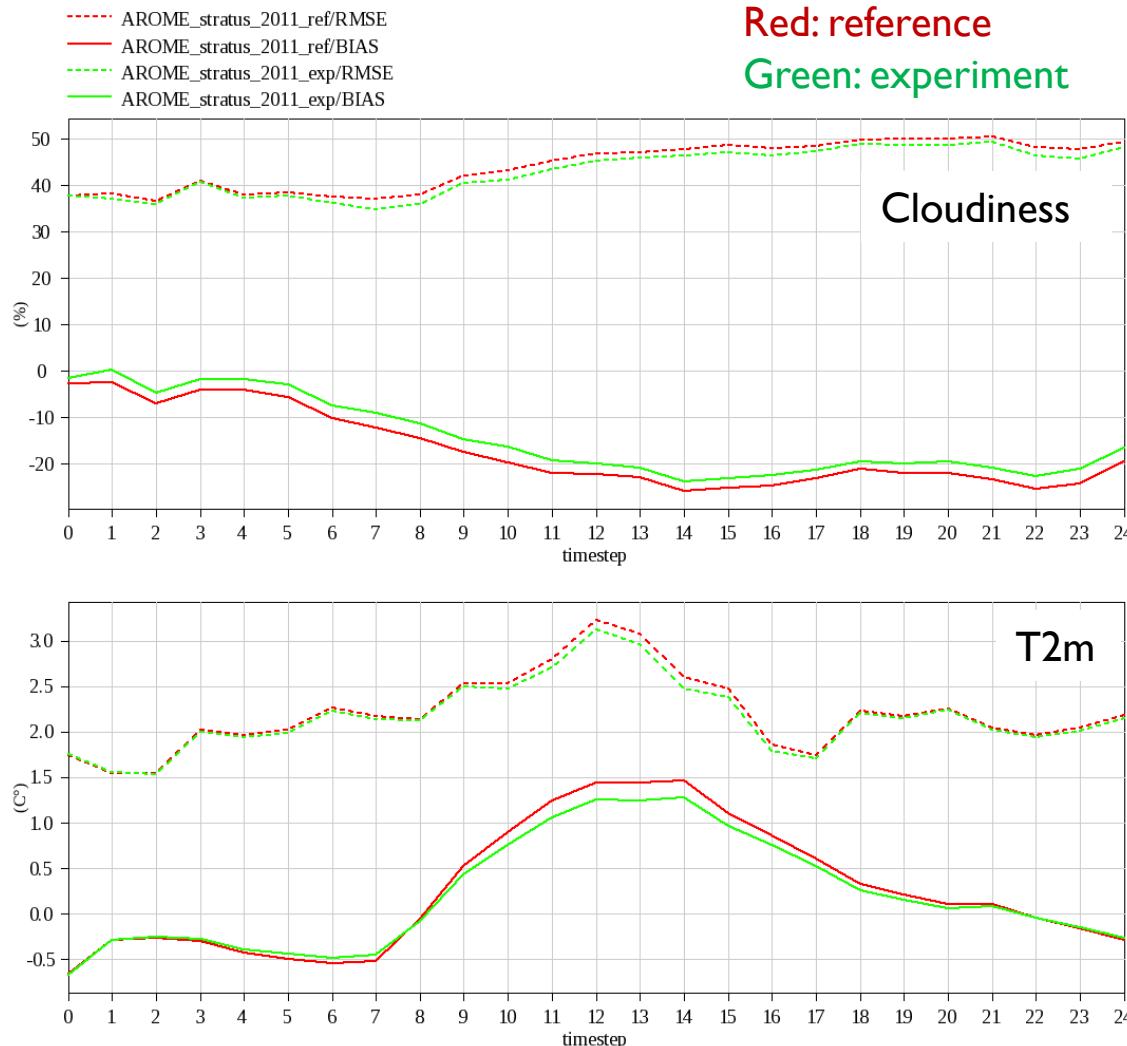
Microphysics tuning (/7) – control case, heavy snowfall

WRF- snow depth [cm]

AROME _REF- snow depth [cm]

AROME _TEST - snow depth [cm]

SYNOP - snow depth [cm]

ALADIN – snow-water eq. [kg/m2]

ECMWF - snow depth [cm]

Fi=47.15 La=18.27 Kiskeszi
AROME SnowD 5.04 cm

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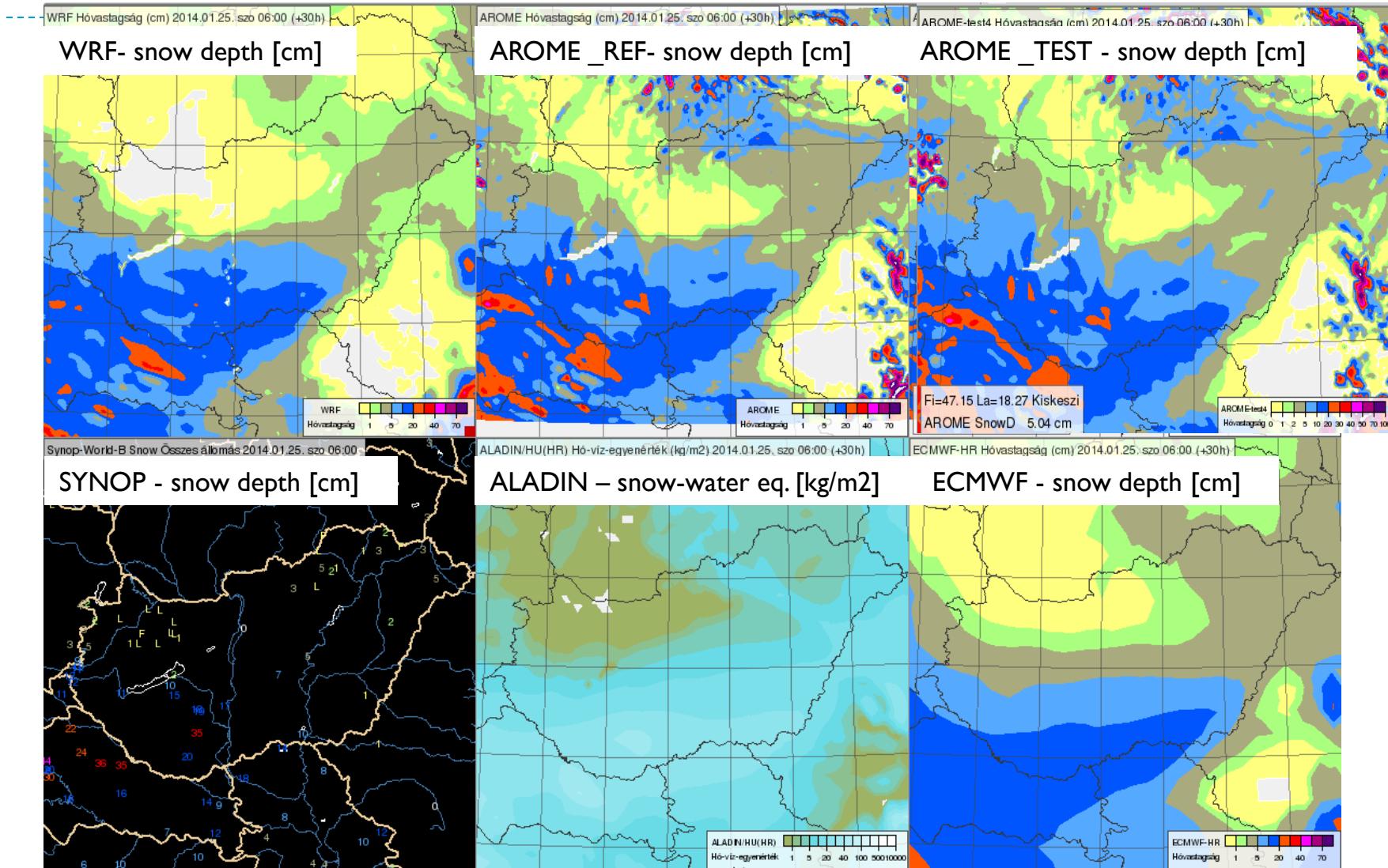
Microphysics tuning (/8) – control case, convection
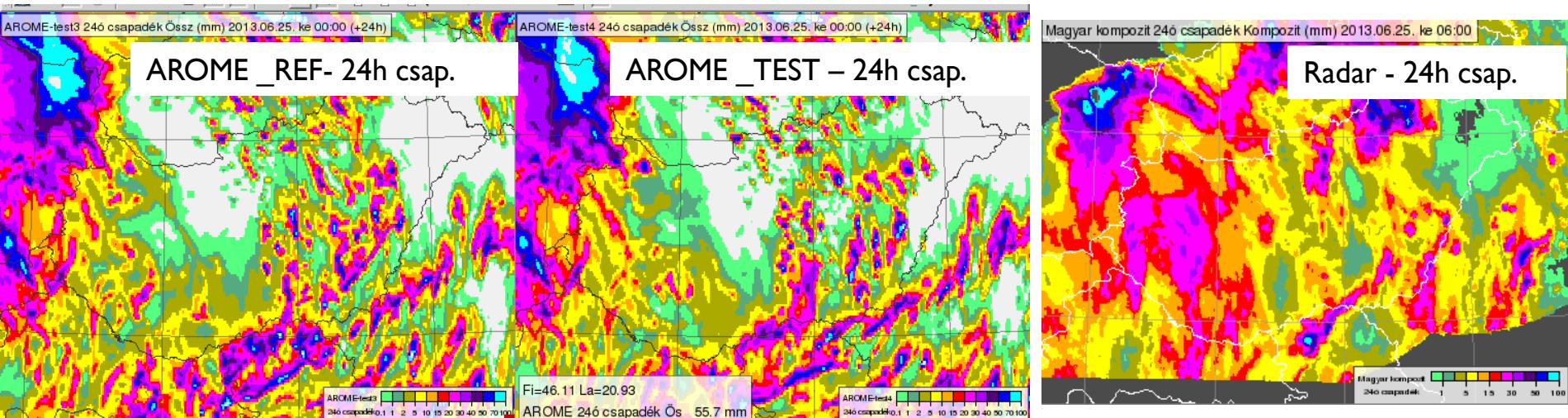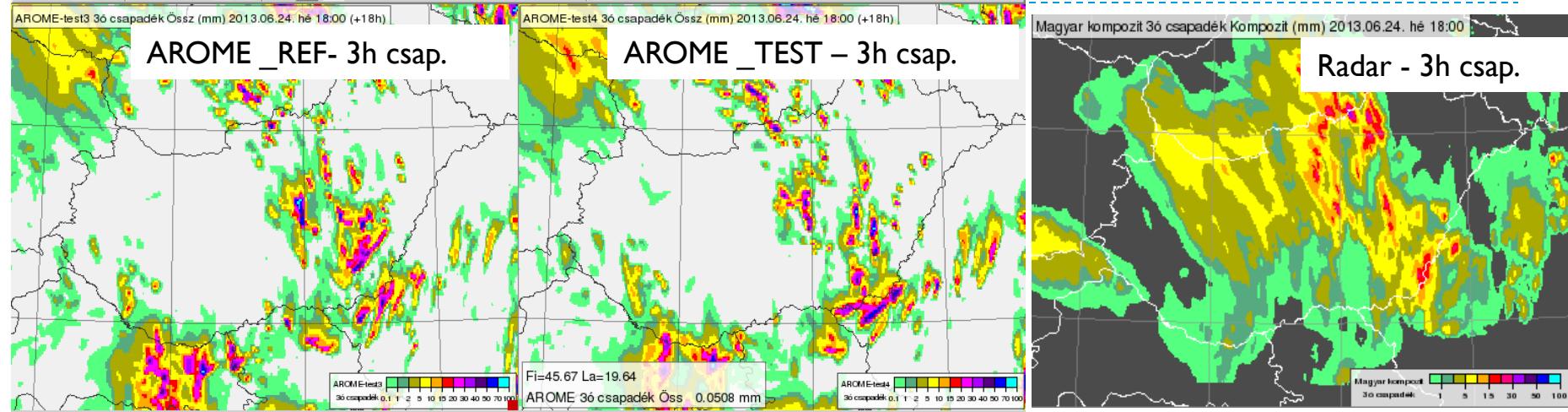
Summary and Outlook

- Wintertime low cloud cases over Hungary are a great challange for operational NWP models

- Two year bilateral project between Meteo-France and the Hungarian Meteorological Service to improve low cloud forecasts

- Sensitivity experiments → tuning of microphysics results in an improvement of simulated low cloud cover

- The proposed change in microphysics does not change significantly the model behaviour in other cases

- Outlook:
  - Verification of longer (summer/winter) periods (MF tests already finished with neutral impact)
  - Operational implementation

Thank you for your attention!

Acknowledgements