Regional Cooperation for Limited Area Modeling in Central Europe

LACE

nwp central europe

ALARO status overview

Contributions by Jan Mašek and Luc Gerard

Neva Pristov

Talk outline

- ALARO status
- Developments
  - *TOUCANS (shallow convection)*
  - Radiation scheme ACRANEB2
  - Complementary subgrid drafts scheme
- Outlook

Presentation
Radmila Brožkova

ALARO status

- One of the physical parameterization package inside ALADIN-HIRLAM system

- In the operational use in ALADIN countries
  - ALARO-0: at, be, hr, hu, ro, sk, si, tr
  - ALARO-1vA: cz, po *(e-suite be,tr)*

  model resolution between 8 km – 4 km, 2km

National posters

- In EPS systems
  - ALADIN-LAEF, GLAMEPS, EPS at HMS
  - HarmonEPS convection-permitting ensemble system

Presentation Martin Belluš

- In climatological simulations
  - be, cz, se

Presentation Lesley De Cruz

ACRANEB2

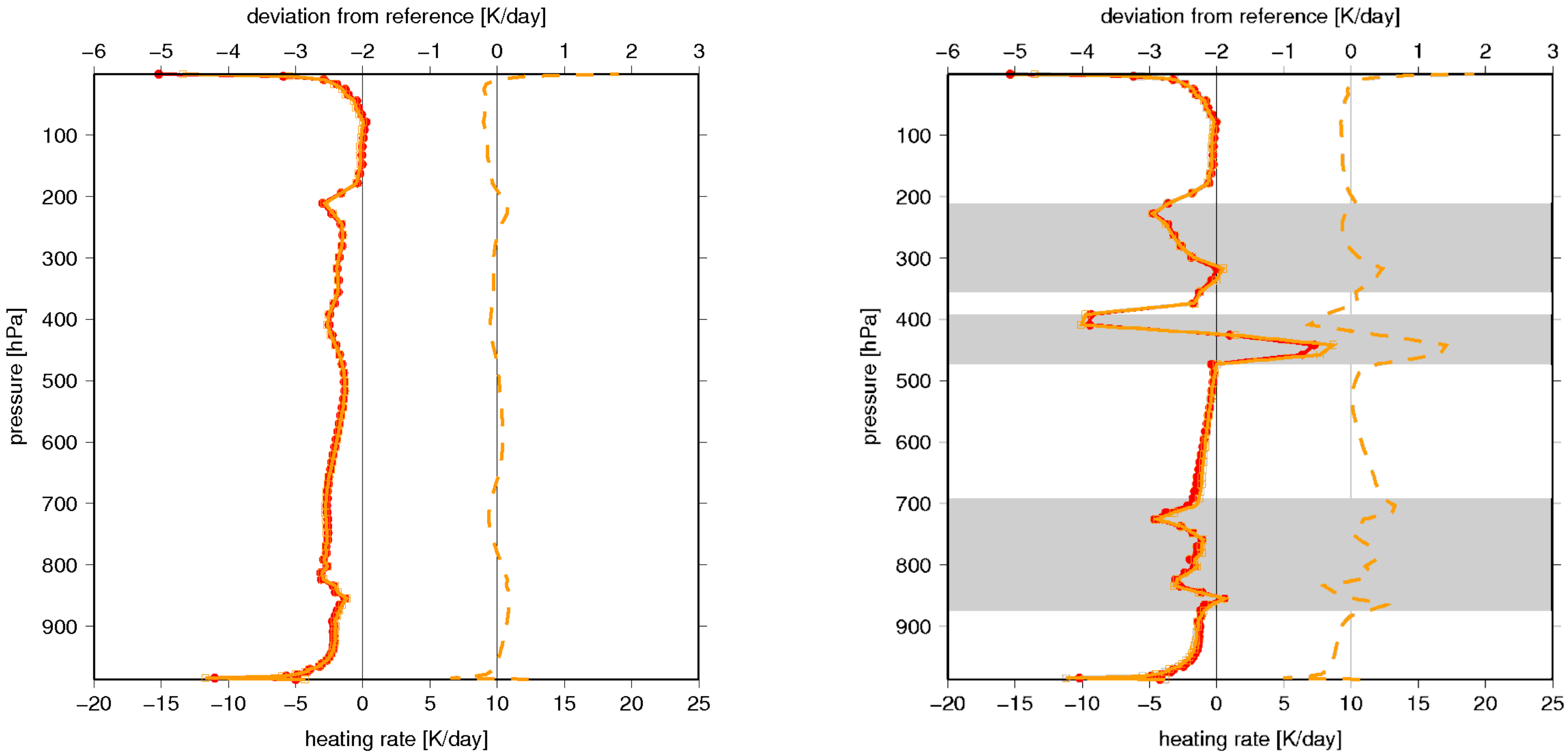
Ongoing work

- scientific paper describing long wave (LW) part
  - an independent LW narrowband reference was constructed for validation of Net Exchange Rate concept with bracketing
- verification in NWP model
- implementation of generalized cloud overlap in radiation
- new products: unscaled direct solar flux, sunshine duration

ACRANEB2

ACRANEB2 is compared against narrowband reference (NBM)

clear sky case | cloudy case



Longwave heating rates: red - NBM reference, yellow - ACRANEB2

Dashed line: difference (upper scale); grey shading – cloud layers

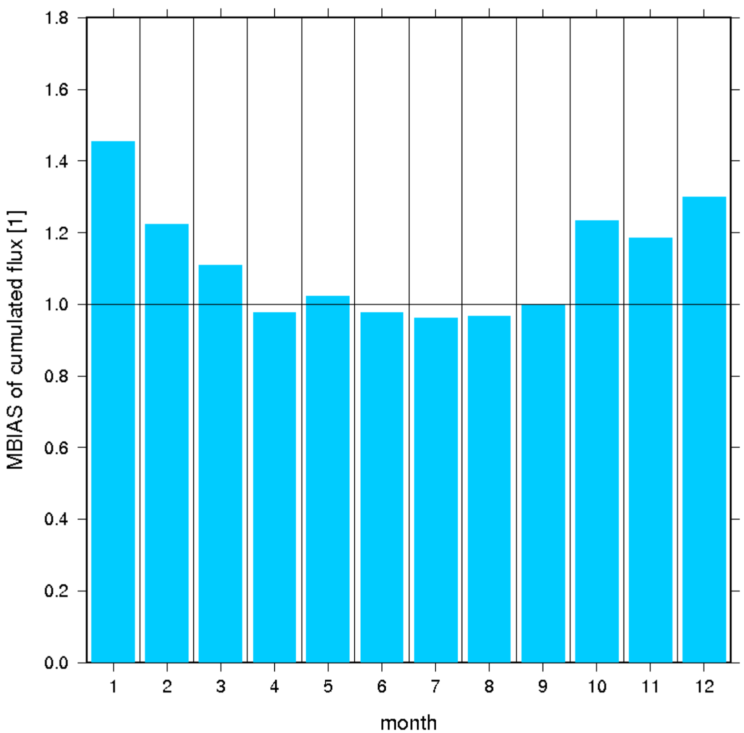
ACRANEB2 – verification in NWP model

- systematic verification of operational ALADIN/CHMI
  - ALARO-1 configuration with ACRANEB2 in 2015
  - daily means of forecasted SW global radiation and LW downward radiation at surface were compared to ground measurements (CHMI network):
    - 19 stations with SW global radiation
    - 1 station with LW downward radiation

ACRANEB2 – verification in NWP model

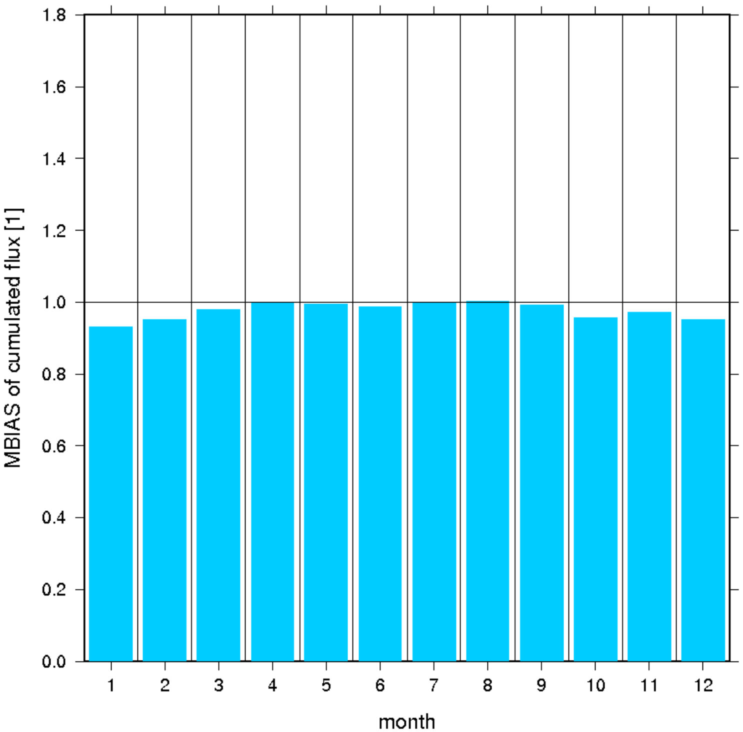
MBIAS of 24-h accumulated downward

short wave flux



Strong yearly variation of SW bias related to underestimated cloud cover in cold season

long wave flux



Partial compensation of overestimated SW during cold season

Clouds and cloud overlaps

2 independent treatments of cloudiness in ALARO-1

- microphysics (APLMPHYS)

  cloud fractions and condensates are computed in thermodynamic adjustment having an implicit PDF, based on Xu-Randall type of computation;

  assumes **exponential-random overlap** between cloud layers when handling geometry of clouds and falling precipitation

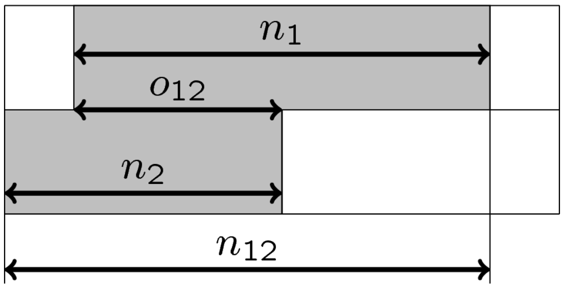
- radiation and diagnostics share the cloud condensates and layer cloud fractions diagnosed by Xu-Randall scheme (ACNEBN)

  radiation (ACRANEB2) assumes **maximum-random overlap** between cloud layers

  diagnostics (ACNPART) assumes (optionally) **nearly maximum-random overlap** between cloud layers

Two basic cloud overlap modes

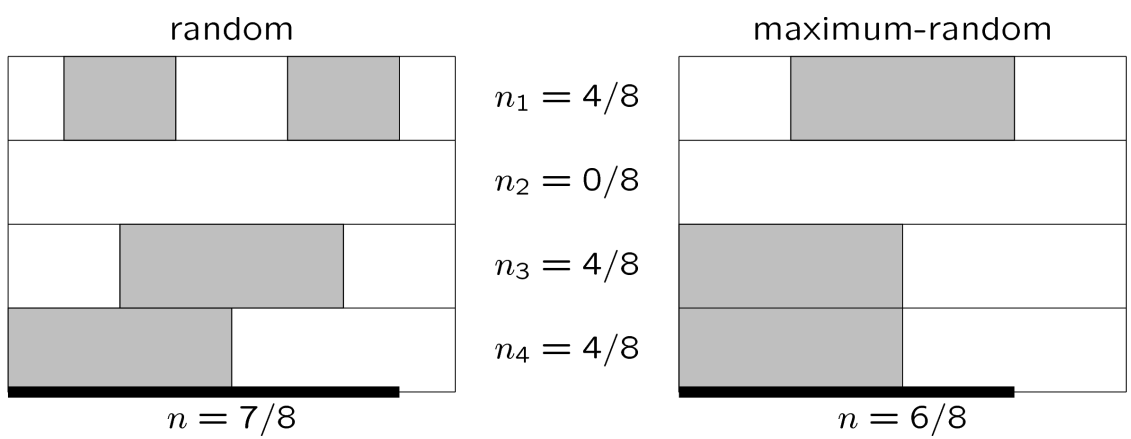
- adjacent cloud layers: random or maximum overlap



$$n_{12} = n_1 + n_2 - o_{12}$$

$$o_{12} = \begin{cases} n_1 n_2 & - \text{ random} \\ \min(n_1, n_2) & - \text{ maximum} \end{cases}$$

- distant cloud layers overlap randomly to the extent allowed by overlaps between adjacent layers → random or maximum-random cloud overlap



Generalized cloud overlap

- *random cloud overlap gives too high total cloud cover (especially in fine vertical resolution)*
- *maximum-random cloud overlap gives too low total cloud cover (especially for deep clouds)*

- solution is to introduce generalized cloud overlap with weight $\alpha<1$

$$o_{12} = (1-\alpha) n_1 n_2 + \alpha \min(n_1, n_2)$$

- **exponential-random cloud overlap** is obtained when α is chosen to decay exponentially with layer separation Δp

$$\alpha = \exp\left[-\Delta p / (\Delta p)_{\mathrm{decorr}}\right]$$

- decorrelation depth is higher in situations with deep convection, it should be at least latitude and season dependent

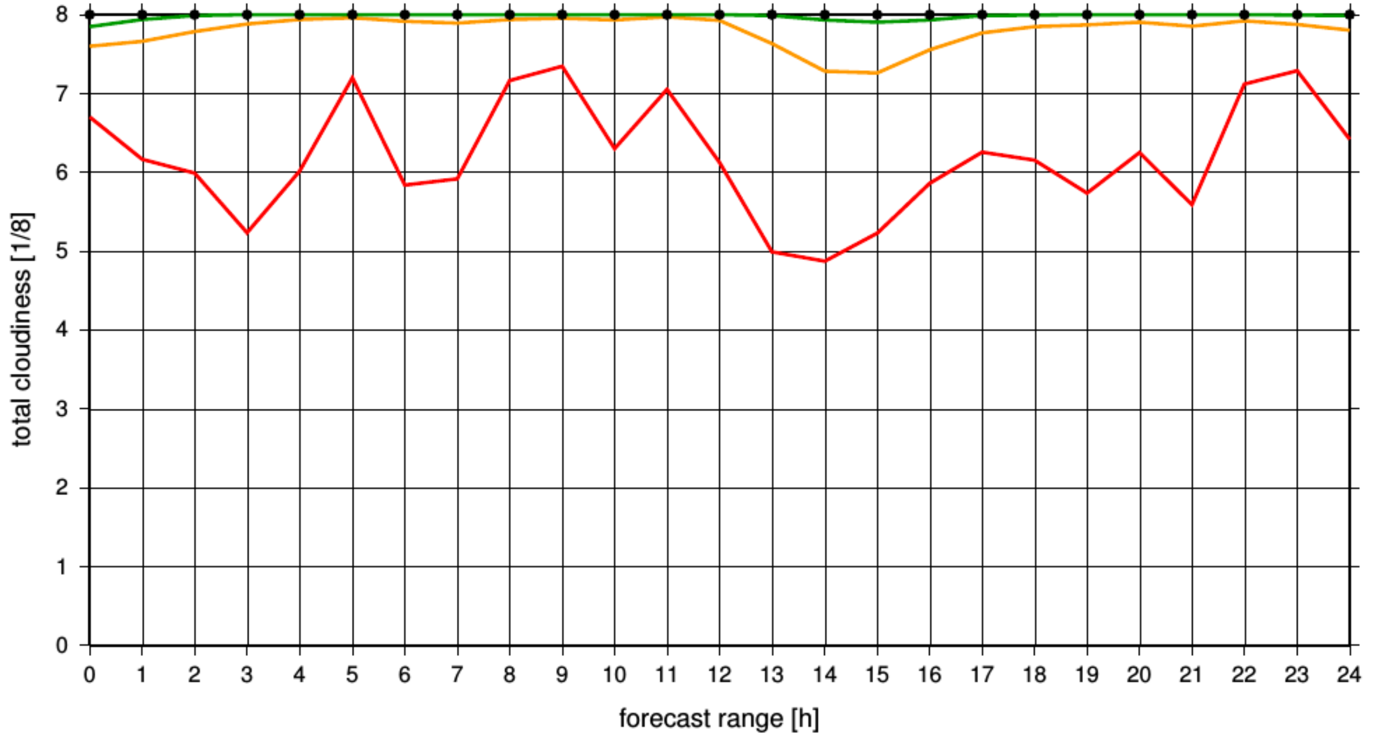
Unifying cloud overlaps in ALARO-1

- first step is unification of cloud overlap hypotheses, which has a strong impact in radiation and has the potential to decrease the observed bias
  - exponential-random overlap has been implemented in ACRANEB2 and ACNPART, where it should replace currently used options
  - variation of decorrelation depth across the globe and year has to be parameterized (using the fixed value is not optimal)
- *next step: use of microphysical cloud condensates and layer cloud fractions in radiation/diagnostics (more demanding on tunings)*

Case:14 October 2015 overcast with rain

Station Pardubice

Total cloudiness



diagnostic cloud cover, nearly maximum-random overlap (WMXOV=0.8)

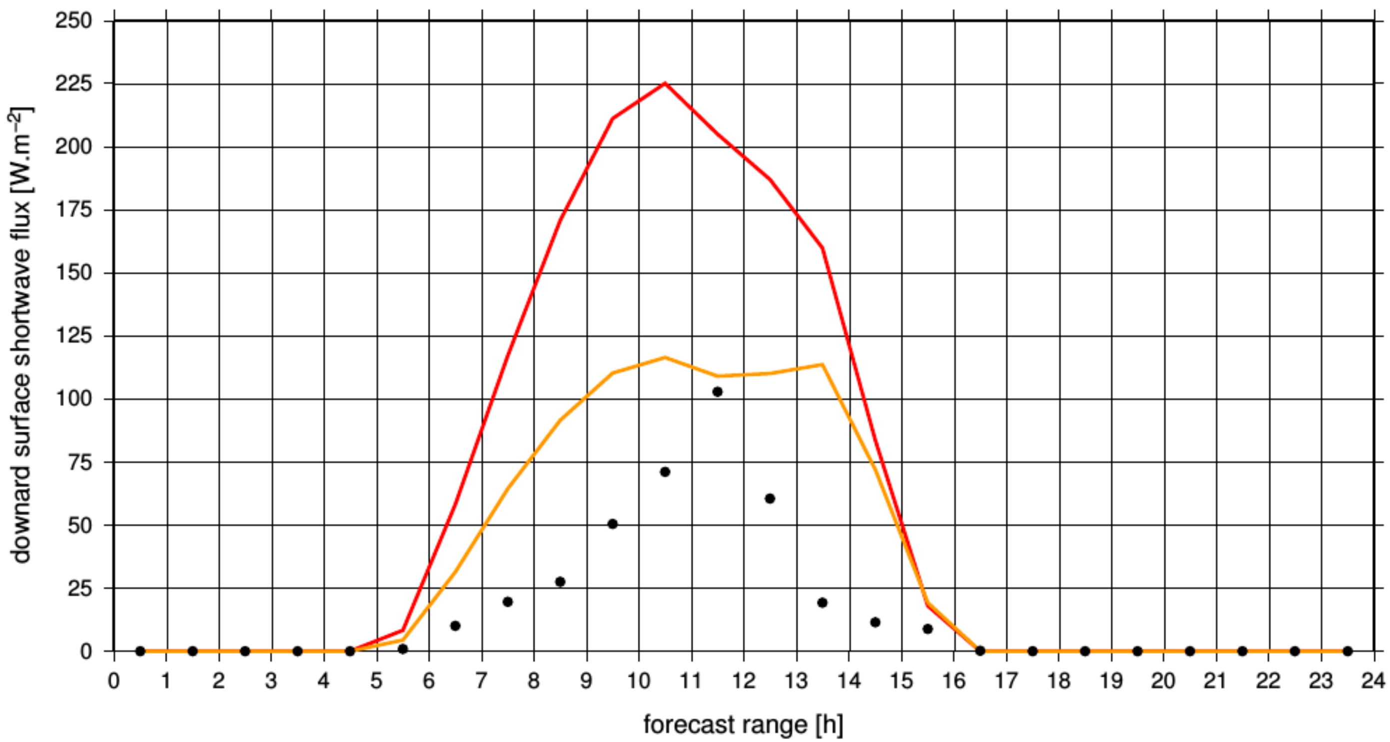
radiative cloud cover, maximum-random overlap

radiative cloud cover, exponential-random overlap (decorrelation depth 100 hPa)

dots - observations

Case:14 October 2015 overcast with rain
Station Hradec Kralove (near Pardubice)

Downward surface SW flux



maximum-random radiative cloud overlap
exponential-random radiative cloud overlap (decorrelation depth 100 hPa)
dots - measurements

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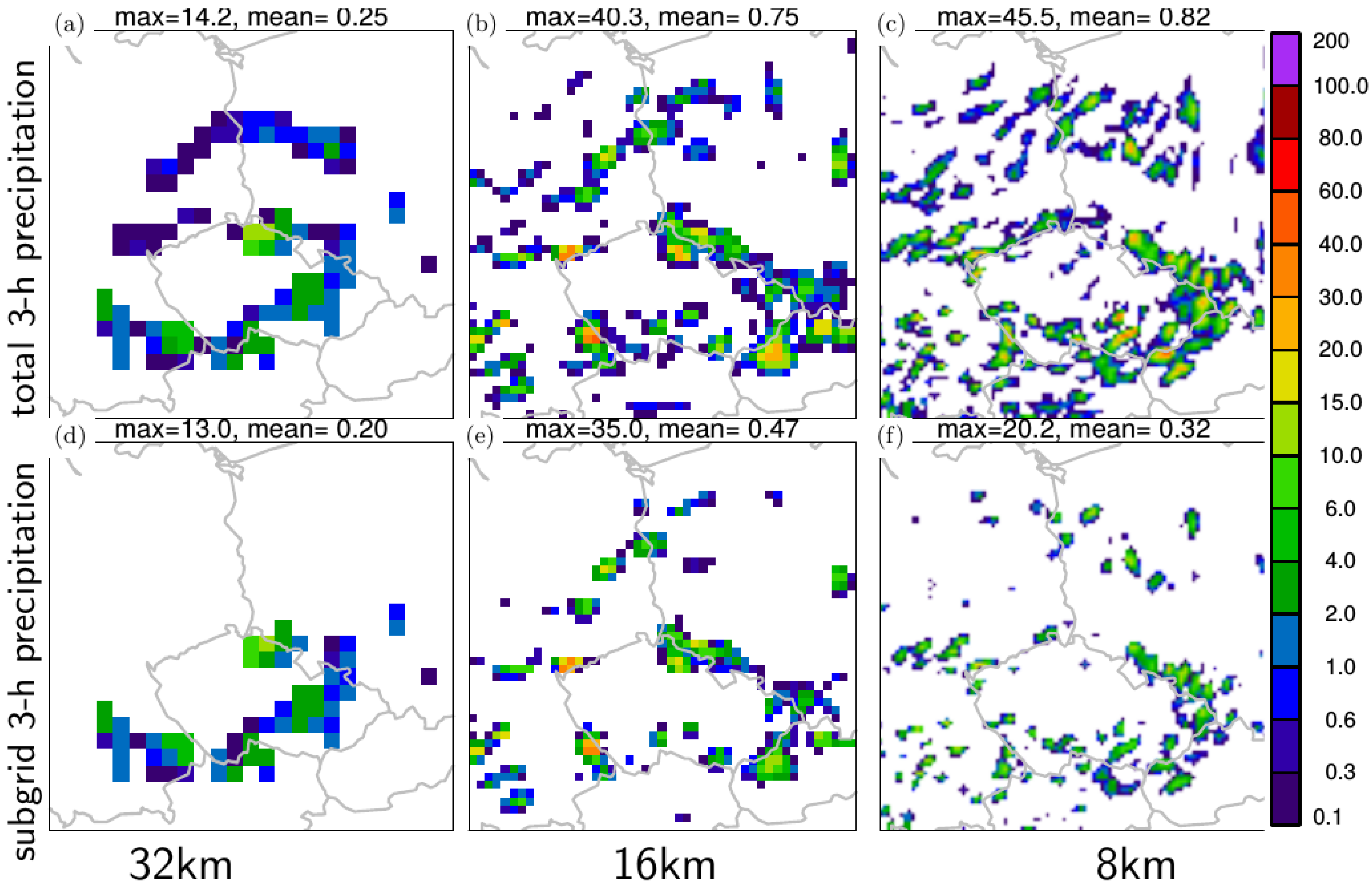
Deep convection

- A new deep convection scheme (Gerard, Mon. Wea. Rev. October 2015) CSD (Complementary Subgrid Draft) in testing
  - showed an improved behaviour at high resolution
  - the execution time of the model with CSD is around 10% longer than with 3MT
  - uses the signal of shallow transport from the turbulence scheme
  - allows a gradual fading out of the parameterized signal at high resolution

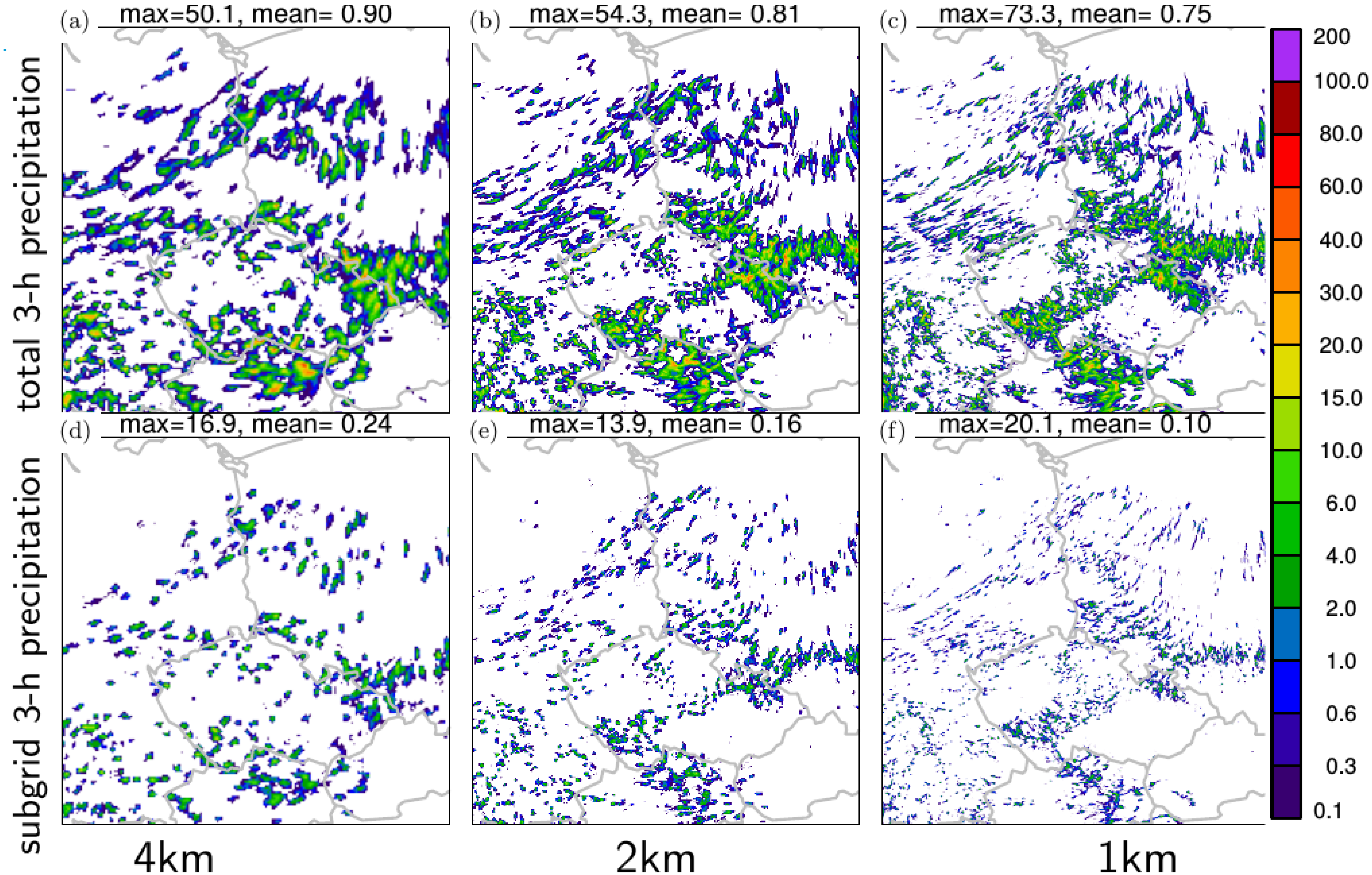
Deep convection

- Expectation
  - improvement of the diurnal cycle
  - further improvement of the multi-scale behavior
  - the potential to produce even more realistic forecasts at fine resolution
- How to keep meso-scale organization below 2 km?
  - when deep convection is represented explicitly it can be too weak
  - with some re-tuning of diffusion
  - with the use of cellular automata

Summer convection 2 July 2009 (3-hour precipitation at 18 UTC)



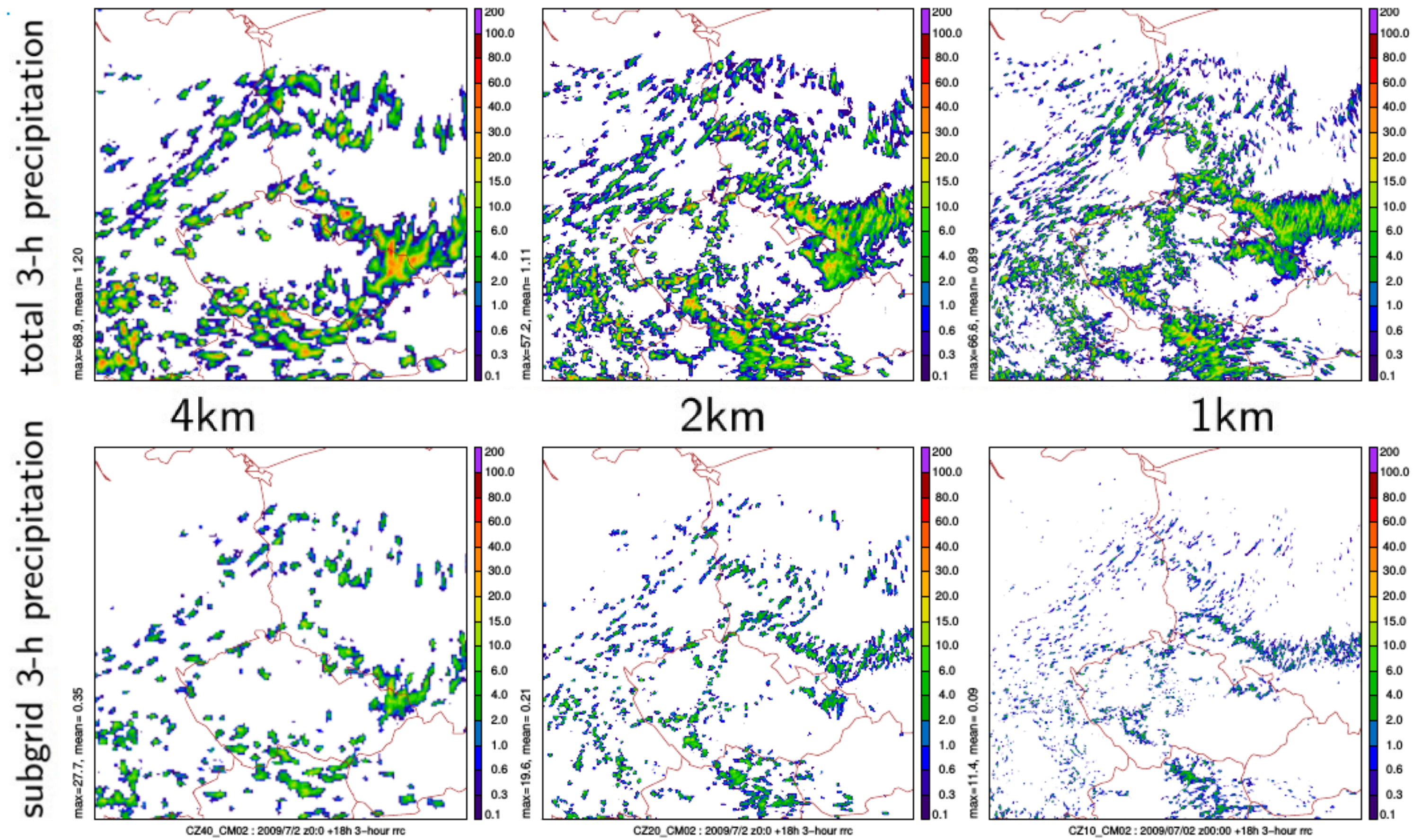
Summer convection 2 July 2009 (3-hour precipitation at 18 UTC)



Sub-grid part of precipitation is decreasing

Lack of meso-scale structure, precipitation areas are more "dotty"

Summer convection 2 July 2009 (3-hour precipitation at 18 UTC)
Using Cellular Automaton and new horizontal momentum handling



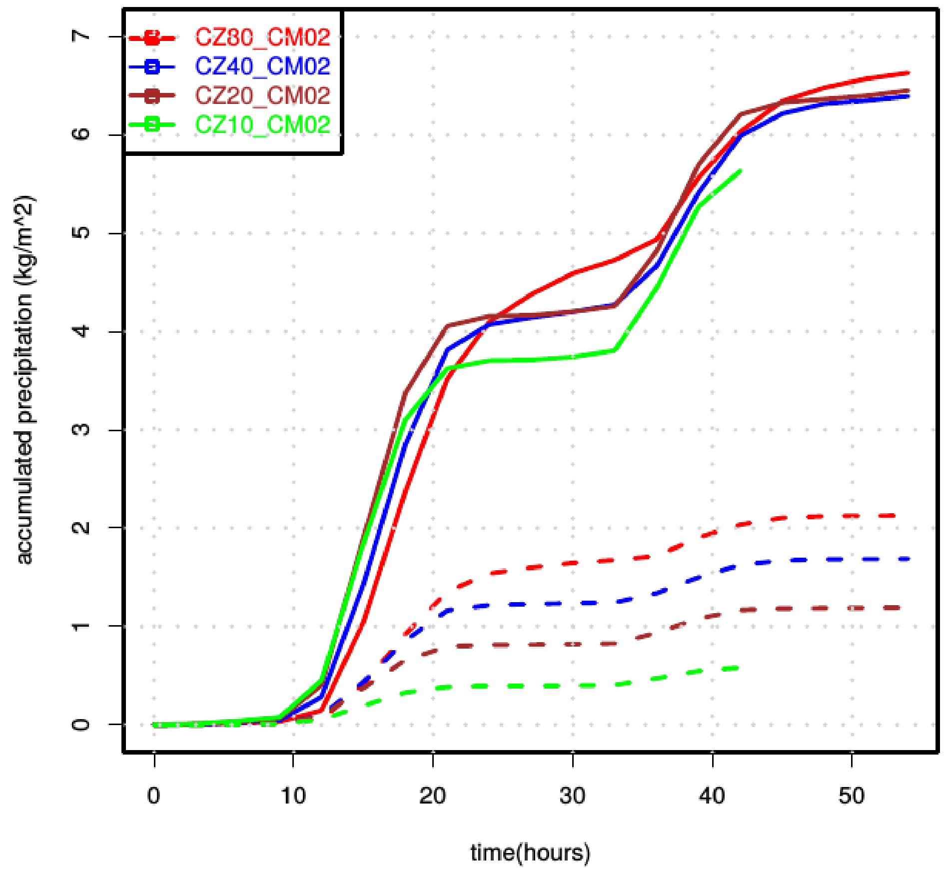
Sub-grid part of precipitation is significantly reduced

Meso-scale structure is kept

Summer convection 2 July 2009
Using Cellular Automaton and new horizontal momentum handling

- **Domain-averaged precipitation accumulation over time (sampled every 3 hours)**

solid – total 3 h precipitation
dashed – subrid 3 h precipitation
red – 8 km
blue – 4 km
brown – 2 km
green – 1 km



Total precipitation is consistent at all resolutions

Outlook

- Enhancement of the 3MT downdraft parameterization towards unsaturated downdraft option
- Adding aspects of Complementary Sub-grid Drafts
- Further enhancements of the shallow convection and mixing length scale parameterization in TOUCANS
- Steps towards the unification of cloud cover representation
- Linking with the SURFEX scheme

Announcement

- ALARO-1 Working days

  12-14 September 2016, Brussels, RMI

  - a status overview, spread knowledge, planning
  - lectures by developers
  - presentations from evaluators/users