Performance of ALARO0 baseline in pre-operational testing

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Outline

- What is new in ALARO0?
- What is (prognostic) convection and how to interpret it?
- Resolved or not resolved (precipitation) that is the question
  - Several cases shown in different resolutions
- Conclusions

Introduction – what is new?

The scheme is Modular Multi-scale Micro-physics and Transport (3MT) scheme.

Both moisture convergence and CAPE closure are available as well as a combination of them, the first one performs better for most cases of severe convection, while using the other is better for cases with light sub-grid showers.

The combined closure is the one used operationally since it allows optimal forecast in both weather patterns and tuning of the schemes performance.

The operational turbulence scheme uses prognostic TKE and interacts with deep convection in multiple ways through closure and fluxes.

The TKE scheme also parametrizes contribution of shallow convection.

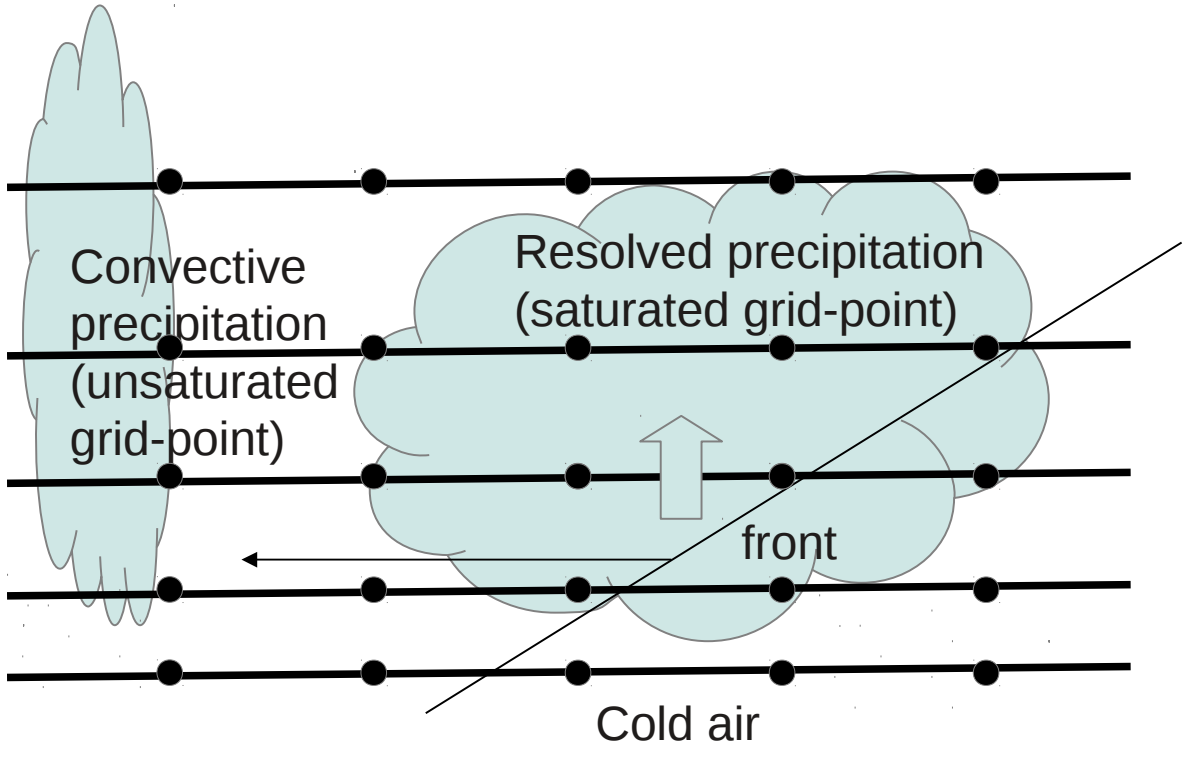
Sub-grid precipitation or convection?

Convective clouds are a source of heat and remove moisture from the atmosphere.

Convective mass flux redistributes momentum, temperature and moisture along the vertical.

Only sub-grid precipitating clouds are parametrized by the deep convection scheme.

The extent of the grey zone is dependent on the weather.



Prognostic convection

Computes the contribution of the unresolved condensation and feeds it to the same micro-physics scheme that is used for the resolved condensation. Prognostic equations for:

cloud liquid water and ice,

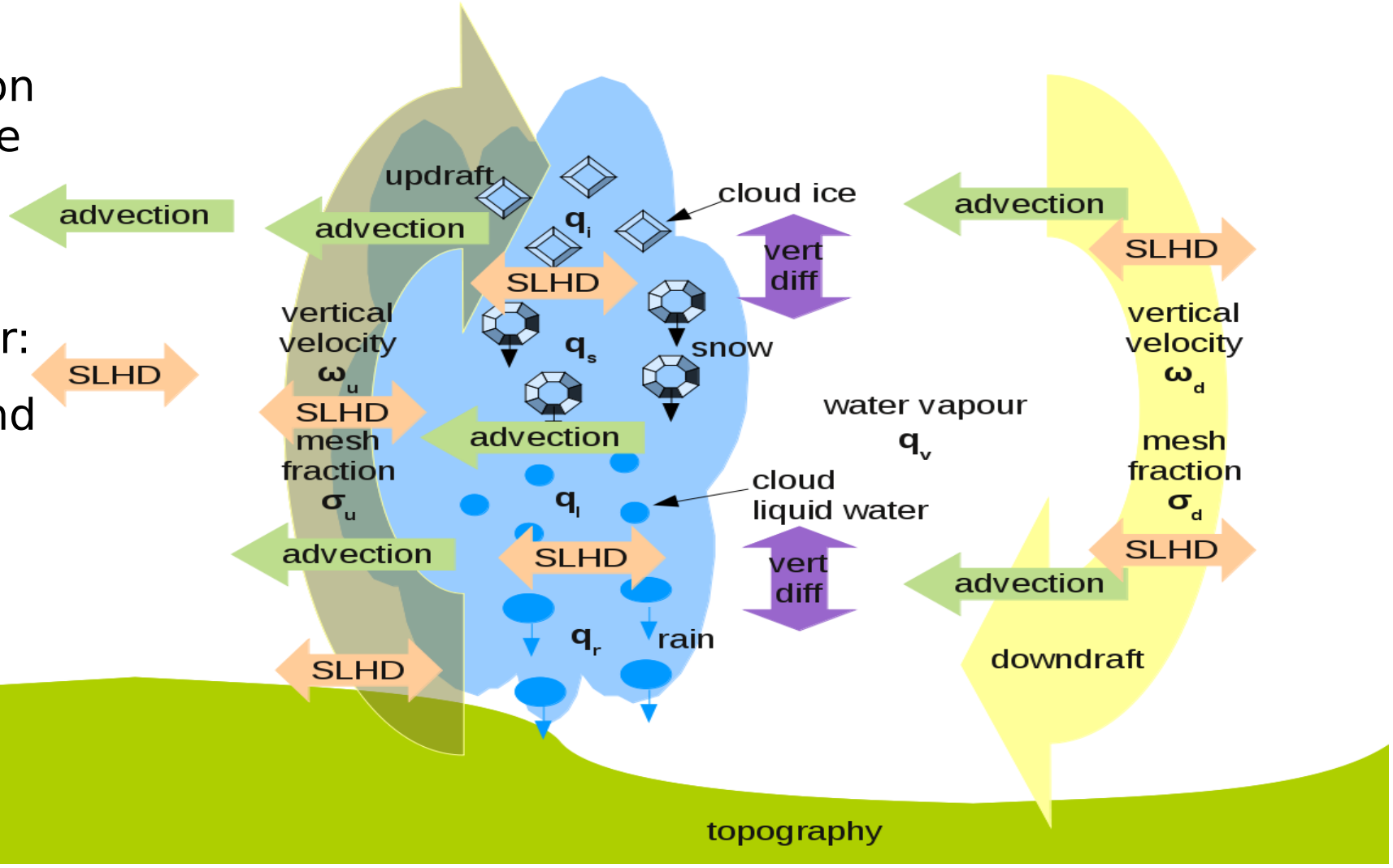
rain, snow,

updraft and downdraft

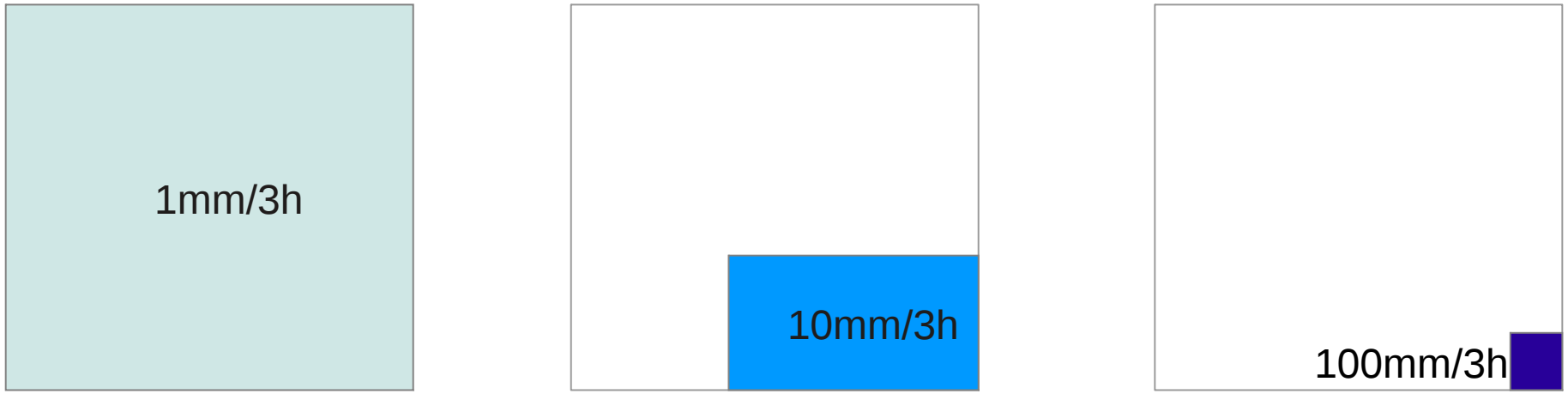
vertical velocities

mesh fractions

and entrainment rate.



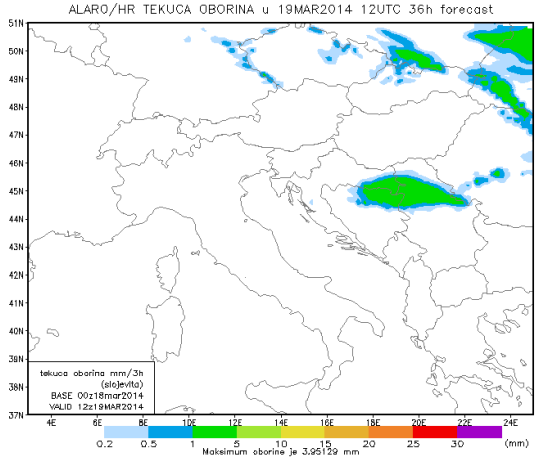
Interpretation issues

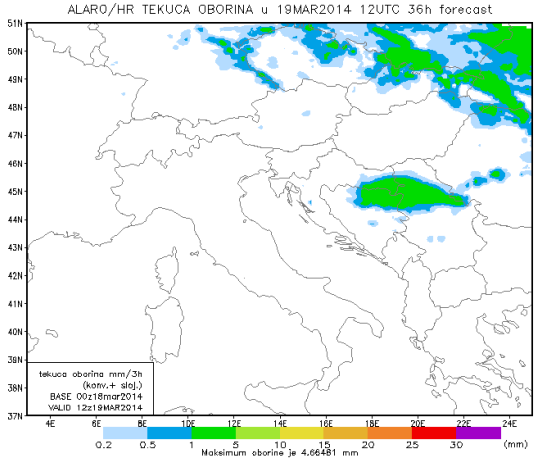


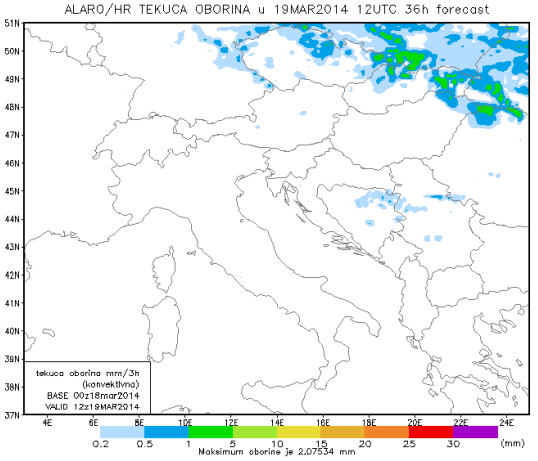
- The absence of convective precipitation (and clouds) from the model forecast is often interpreted as the absence of convection. This issue gets worse with increasing resolution.
- Convective precipitation is subgrid!

Resolved precipitation associated to a cold front

Deep convection that develops due to a cold front can be resolved in the 8km horizontal resolution so the resulting precipitation is stratiform as a result of resolved precipitation scheme although the nature of the event is convective.

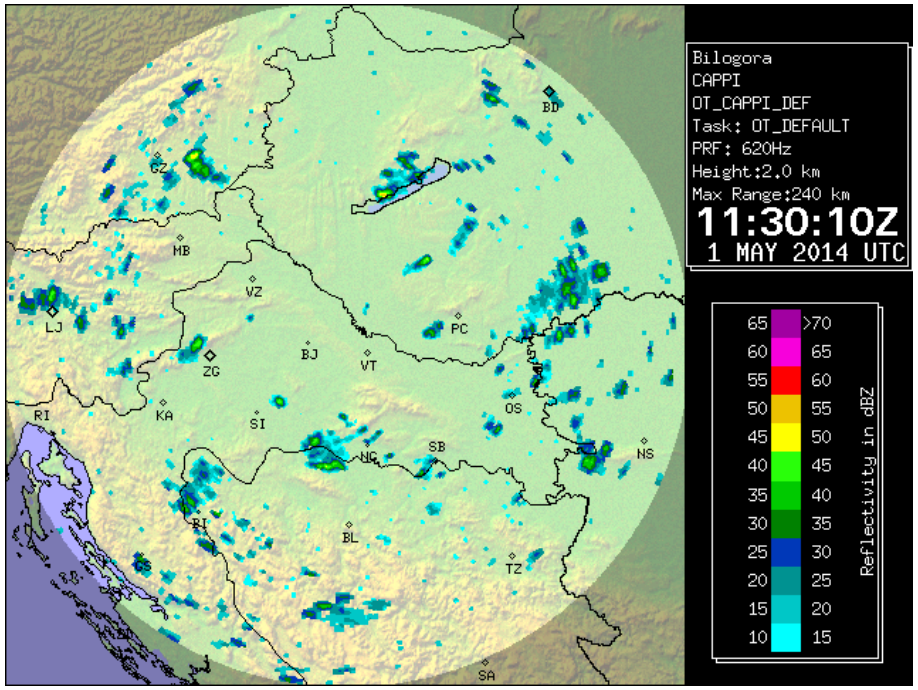


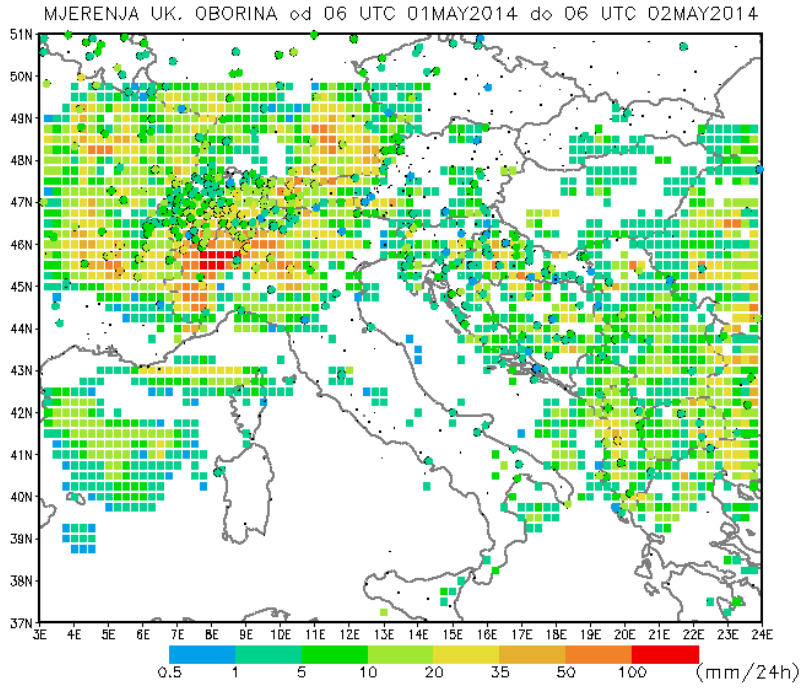




Forecast in 8 km resolution of the accumulated precipitation during 3h associated to passage of a cold front: total (left), resolved (centre) and unresolved convective (right).

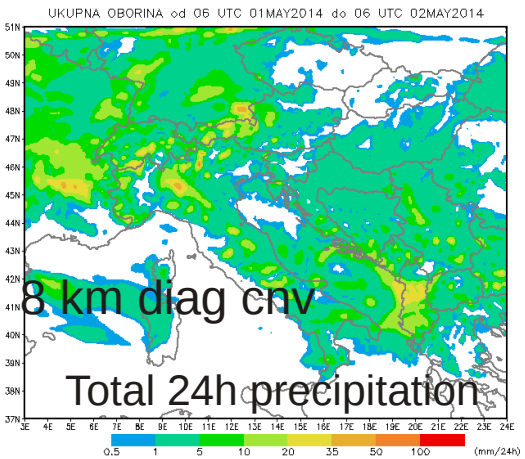
Intensive local showers - subgrid

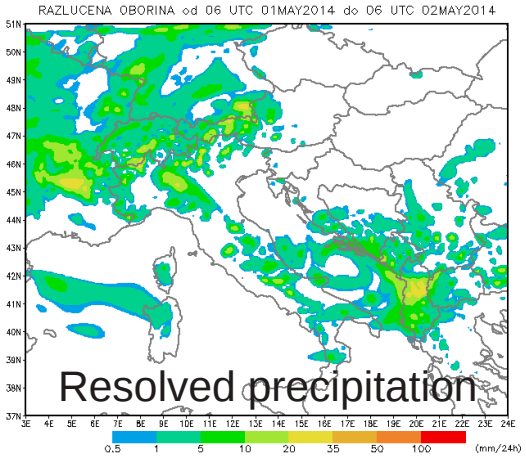


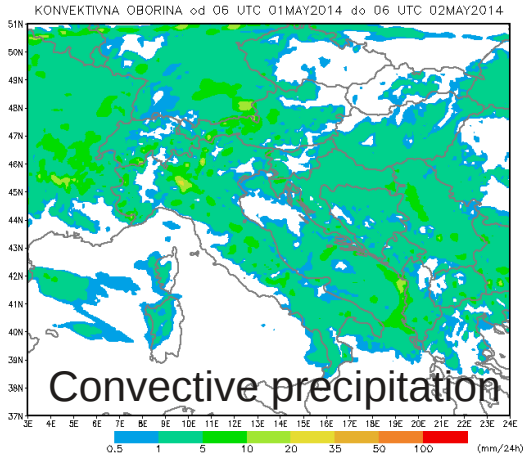


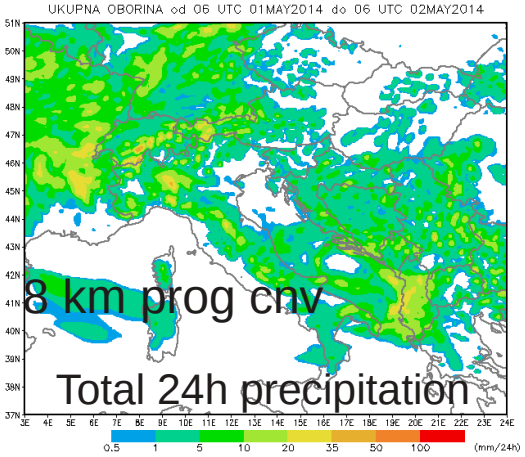
Local showers of small horizontal extent (left), while accumulated 24 hourly rainfall shows large spatial variability (right).

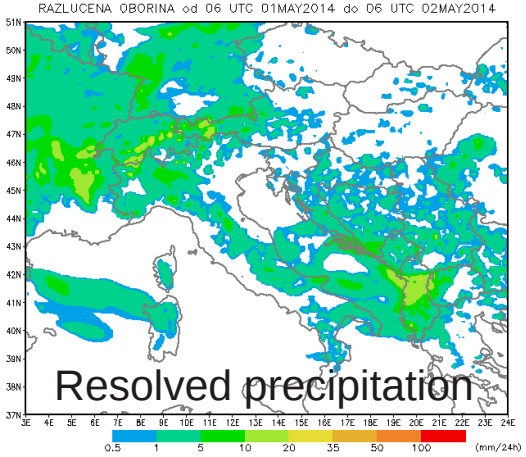
Intensive local showers – subgrid in 8 km

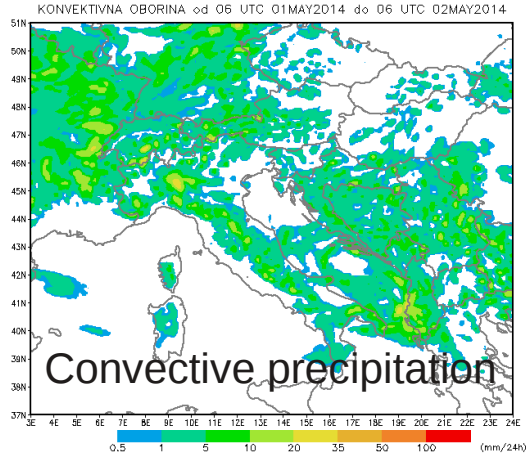






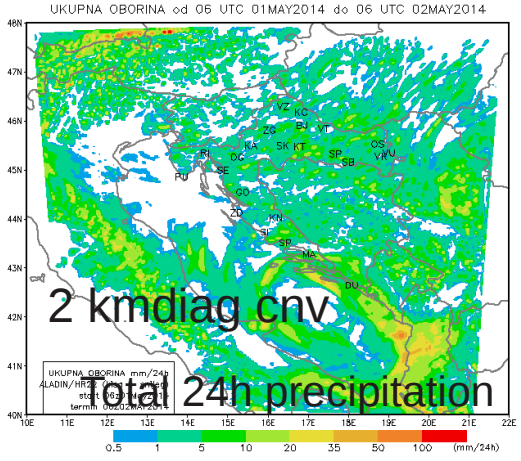


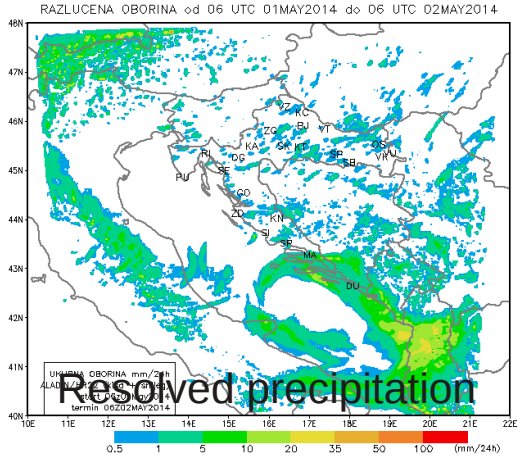


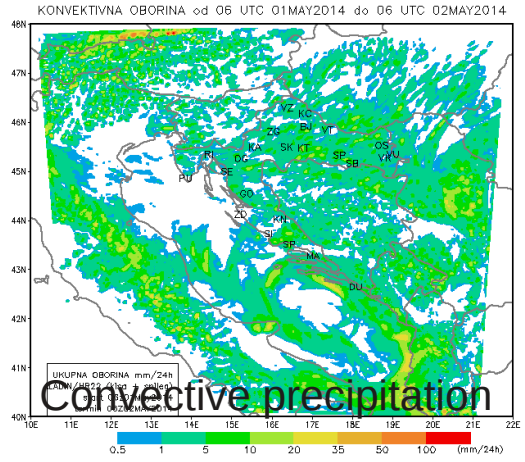


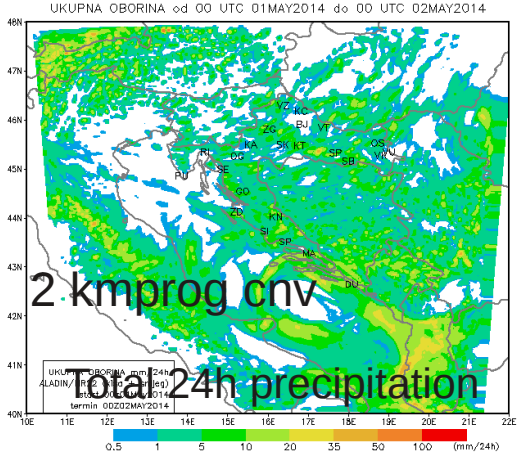
Forecast using diagnostic convection is smooth and precipitation in the model forecast is purely convective over the flat terrain

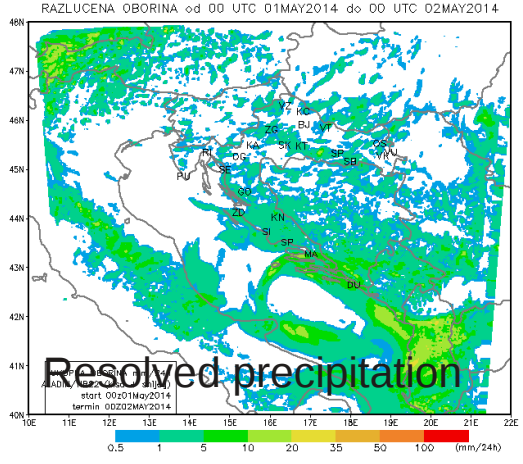
Intensive local showers – in 2 km

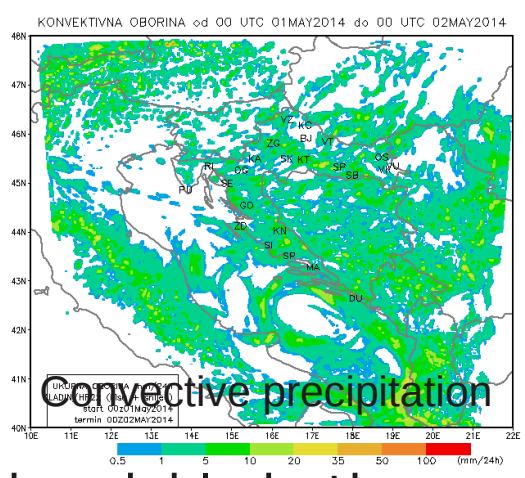








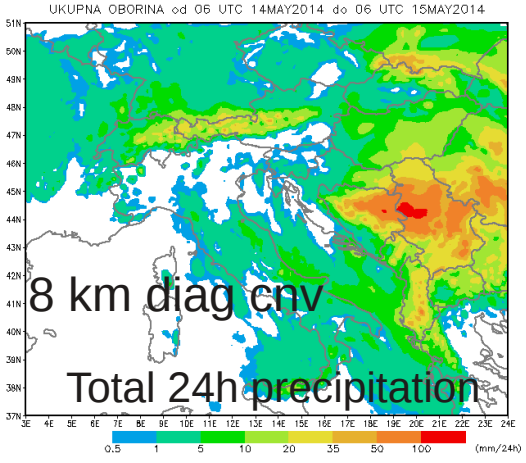


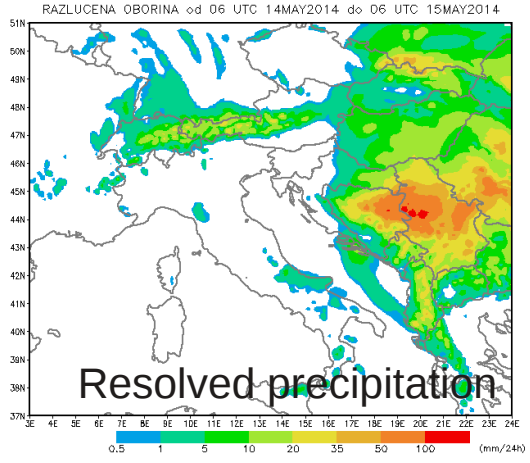


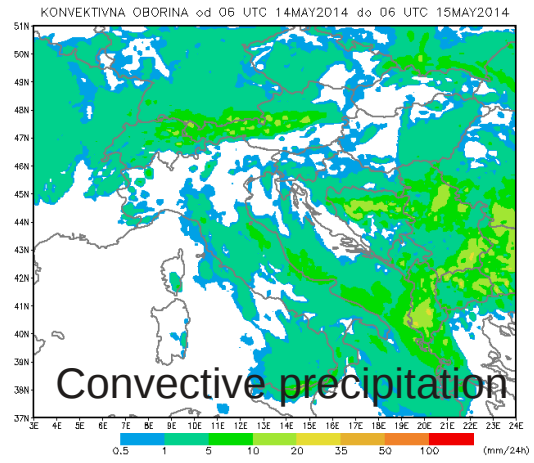
Small scale convection, stationary in space, but evolved quickly in time.

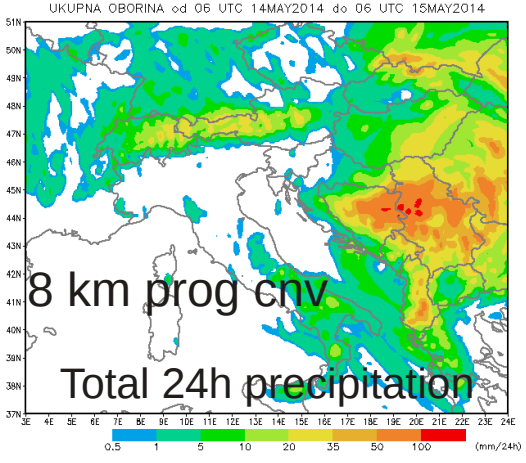
More precipitation is resolved when prognostic convection is used.

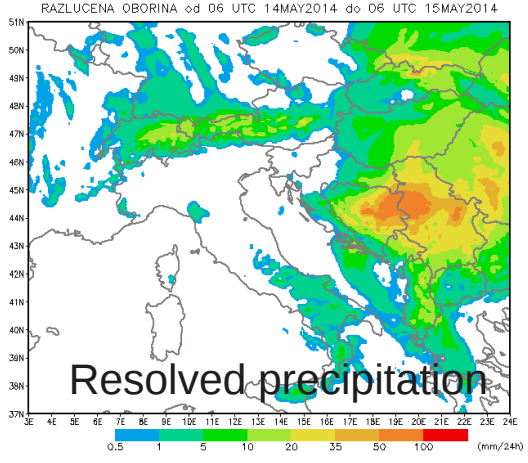
Severe torrential rain

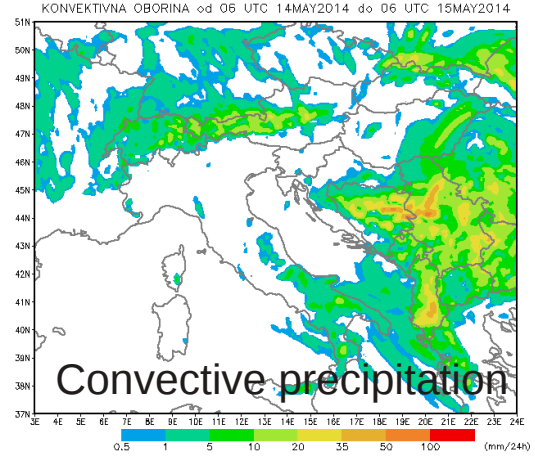








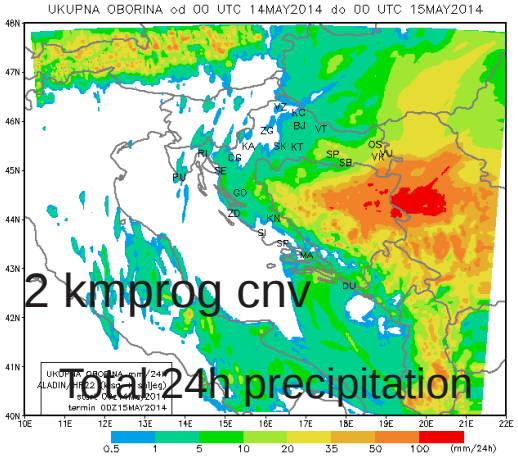


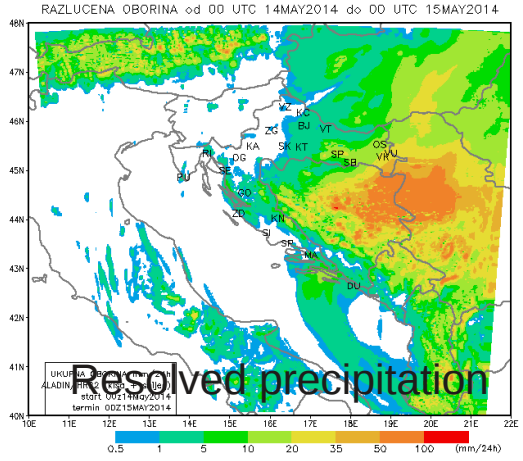


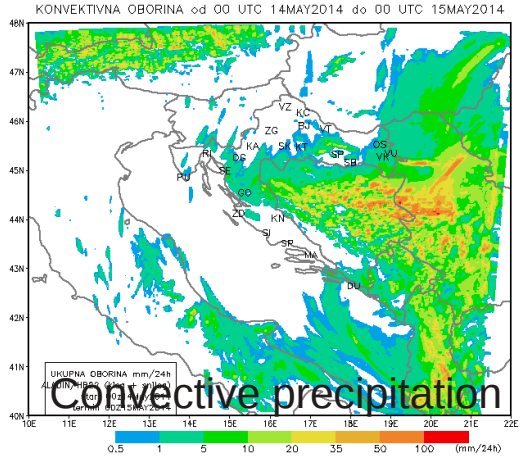
The prognostic convection scheme yields less precipitation than the diagnostic one in 8 km

Severe torrential rain in 2 km

d)







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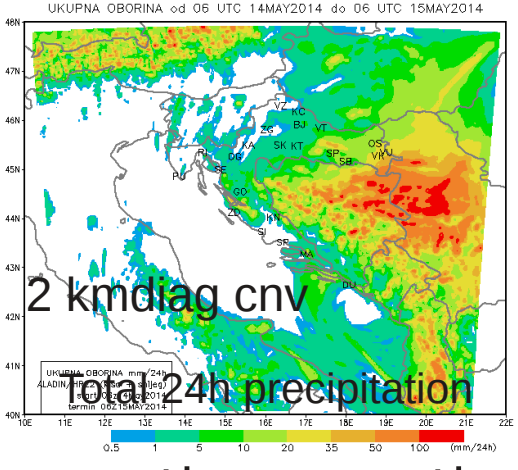
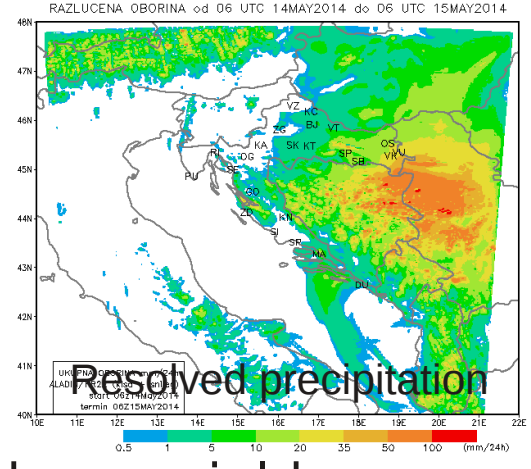
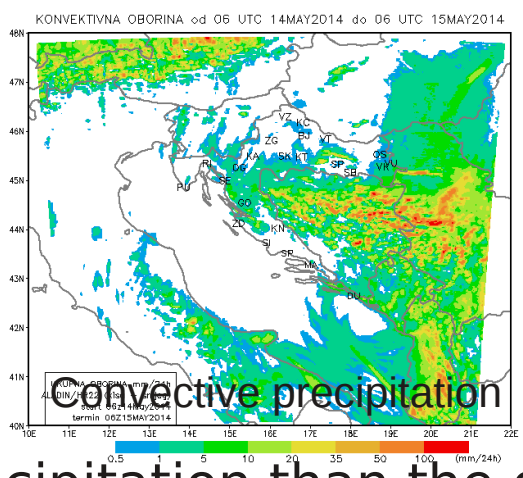






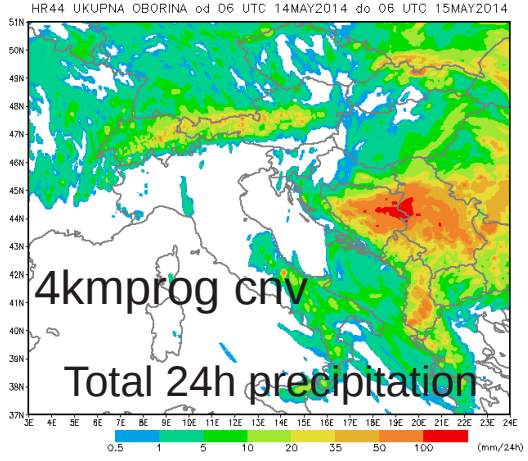
The prognostic convection scheme yields **more** precipitation than the diagnostic one in 2 km, more spatial variability!

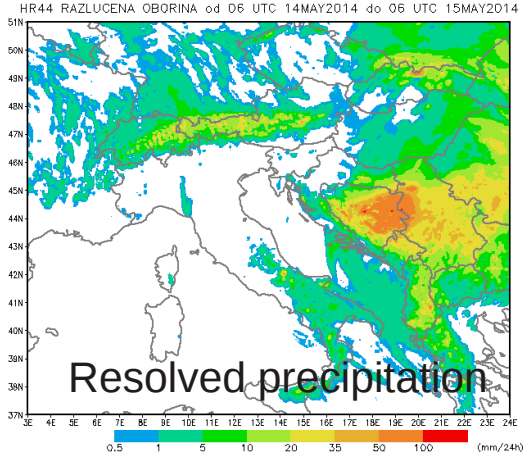
Summary

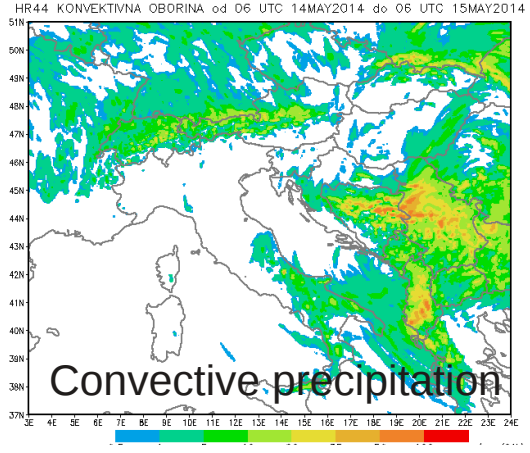
- Stratiform and convective precipitation are resolved and subgrid
- Convective rainfall should be interpreted as subgrid variability added to the resolved precipitation
- Convective precipitation can be fully resolved in low resolution
- Prognostic convection can be used in high resolution and still useful

What happens in 4 km?

c)







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