On the onset of deep moist convection on the southern side of the ALPS

by

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Outline

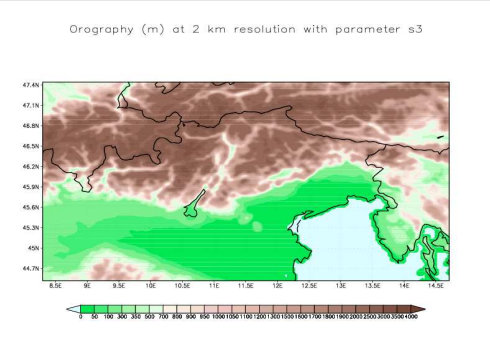
- Deep Moist Convection (DMC) as source of Atmospheric Hazards in complex orographic areas
- Operational numerical model limits in forecasting DMC in complex orographic areas
- A step beyond the operational numerical model outputs by means of non operational numerical model simulations
- Example: DMC on the inner Alpine ridge
- Example: DMC on the foothills
- Concluding remarks

Deep moist convection (DMC) in complex orography: outlook

DMC is one of the major threats for people and property

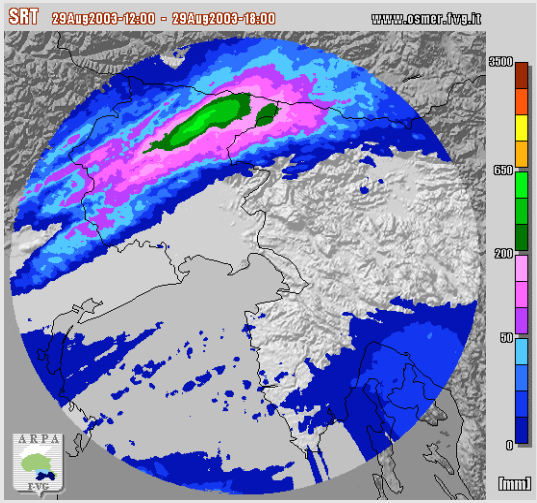
- Large amounts of rain released in a few time (rivers run-offs)?

- Severe ancillary phenomena (gust winds, tornadoes, large hail, ...)



DMC is still an open problem for numerical models

- DMC often occurs at a local scale (few km, usually within the grids of numerical models)?



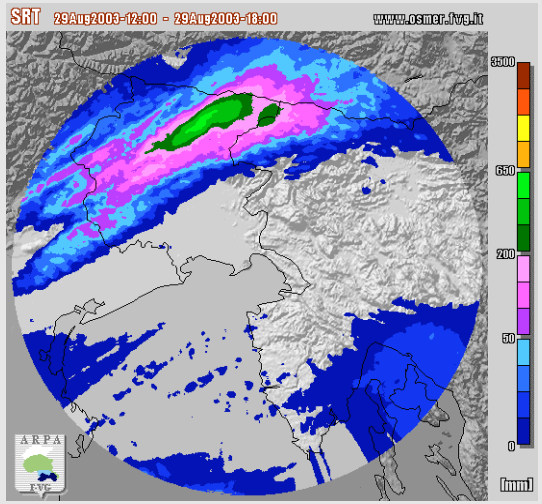
- DMC forcing are rooted in local mechanisms (poorly parametrized by numerical models)

DMC in complex orography: general considerations

Orography as a static forcing for DMC

- Paradoxically, orography can represent an aid for the forecasts and not an additional trouble

- Orography can be considered as a **static forcing** that modules the atmospheric response which is a function of the **air-mass thermodynamic properties**



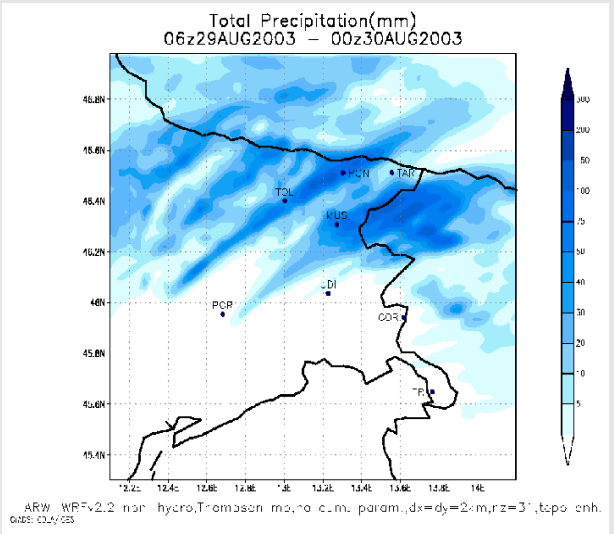
Static forcing and air-mass thermodynamic properties

- High resolution numerical models are nested on global "low" resolution numerical models (smooth initial conditions)?

- Air mass thermodynamic properties quite well foreseen (medium and upper levels)

- Large scale flows quite well foreseen (synoptic forcing)

- Orography represents the local (static) forcing



DMC in complex orography: waiting for High Resolution Numerical Models

"Pull the heart beyond the obstacle" (Joe Klemp, Trieste ECSS 2007)

- 5-10 km horizontal resolution is a "no-men-land" for convection forecasts

(not enough coarse for pure parametrizations, not enough high for explicit resolutions)

- 1-2 km horizontal resolution is still not an operational product: what to do waiting for these next generation HRNM

- Look for **archetypes** – unfortunately often related to specific areas – by means of high resolution simulations for case studies

(conceptual models to be applied to currently available numerical models)

Severe DMC upwind episodes can be clustered according to their onset (FORALPS EU Project INTERREG IIIB – Alpine Space)?

- Onset of DMC on the inner Alpine ridge

(29th August 2003 – Valcanale flood; ...)

- Onset of DMC on the foothill, relatively far from relieves

(9th September 2005 – Pordenone flash flood; ...)?

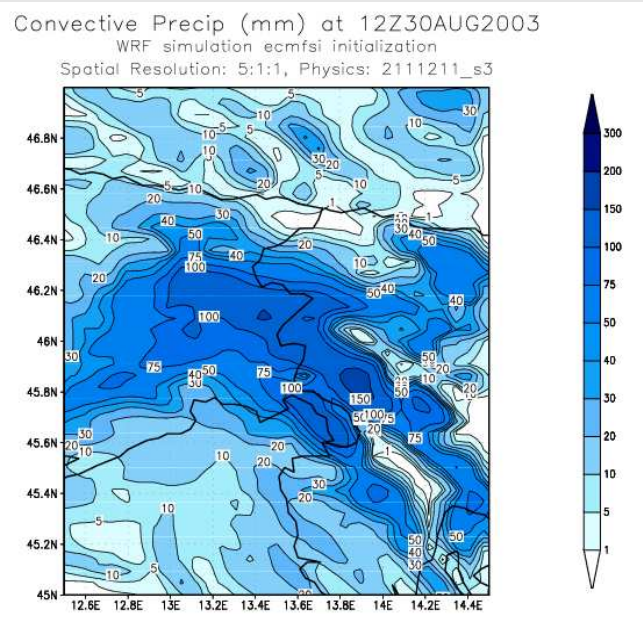
Archetypes – onset of DMC on the inner alpine ridge

Onset of DMC on inner alpine ridge and numerical models

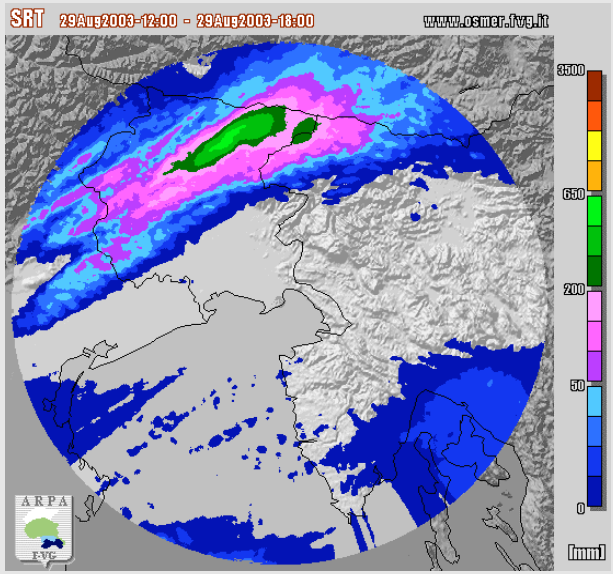
- Often badly foreseen by 5-50 km horizontal resolution numerical models

(DMC parametrizations produce too large amounts of rain on the Prealps and too small amounts of rain on the inner ridge)

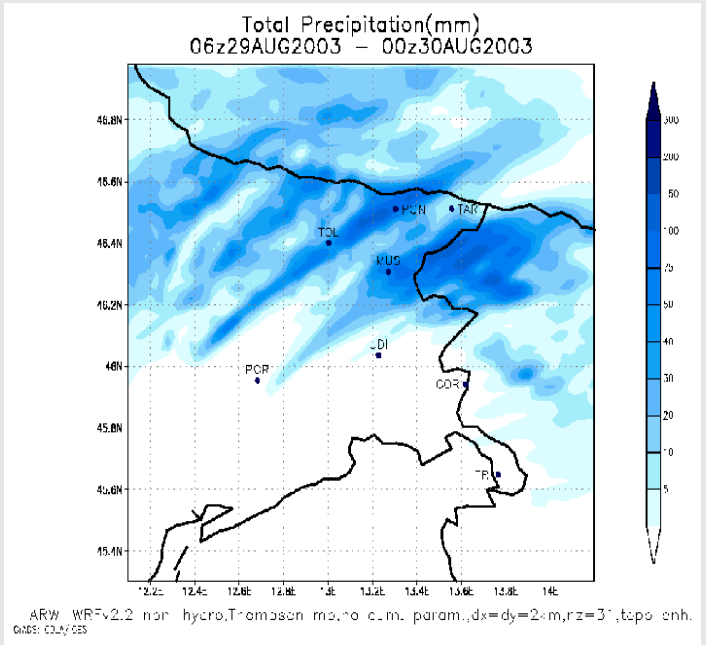
- 2-3 km horizontal resolution numerical models correctly place precipitation maxima but usually underestimating amounts



5 km resolution



RADAR estimate



2 km resolution

Archetypes – onset of DMC on the inner alpine ridge

Conceptual model for the onset of DMC on inner alpine ridge

- Persistent and strong flow impinging the mountains in the obstacle layer

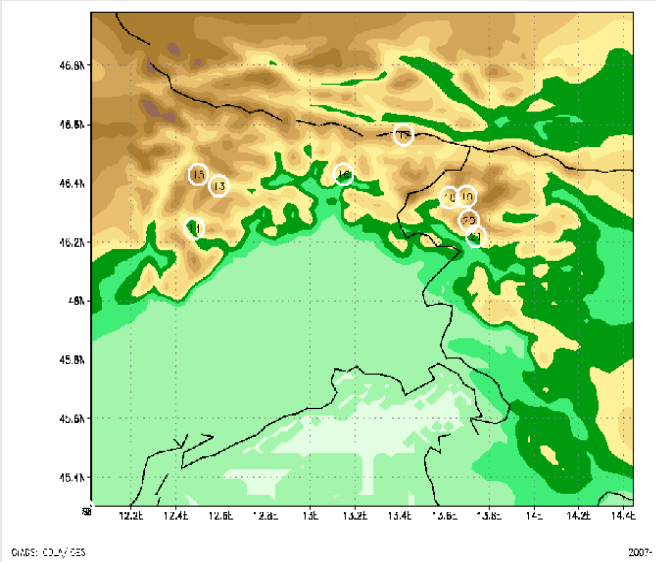
(South-westerly flow stationary front northern Alpine side)

- Potential (convective) instability of the air-mass

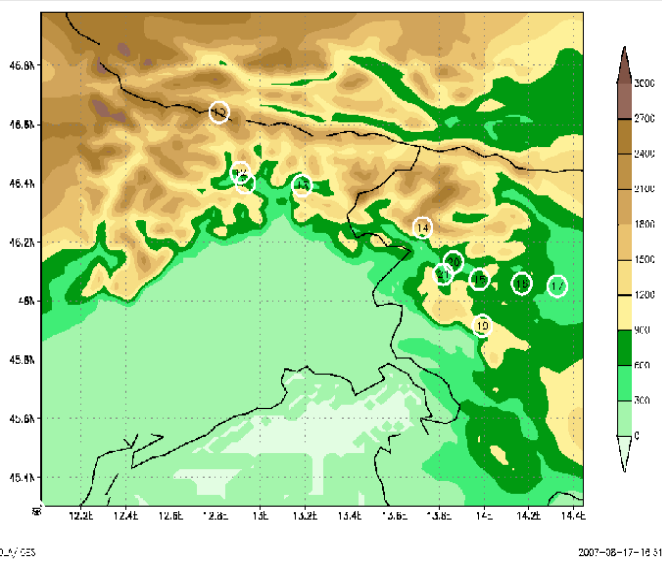
(considering the whole air column)

- Air-mass far from saturation at the lowest levels even if moist – High LCL

(low relative humidity in the lower 50-100 hPa but high mixing ratio)?



Low Relative Hum.



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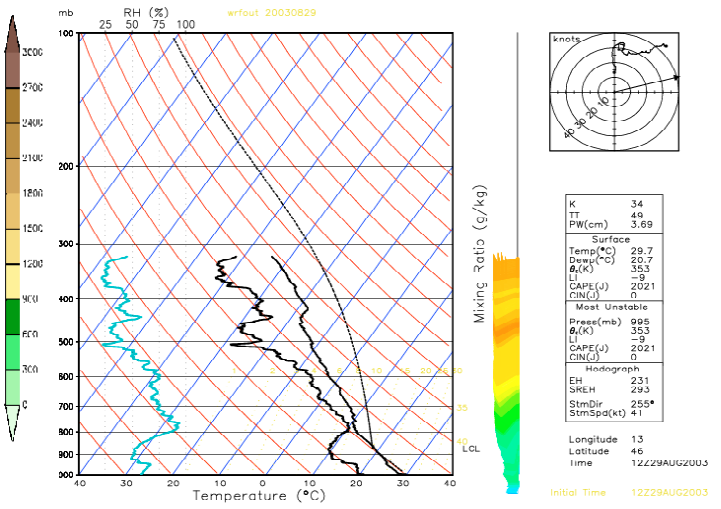


atmospheric sounding

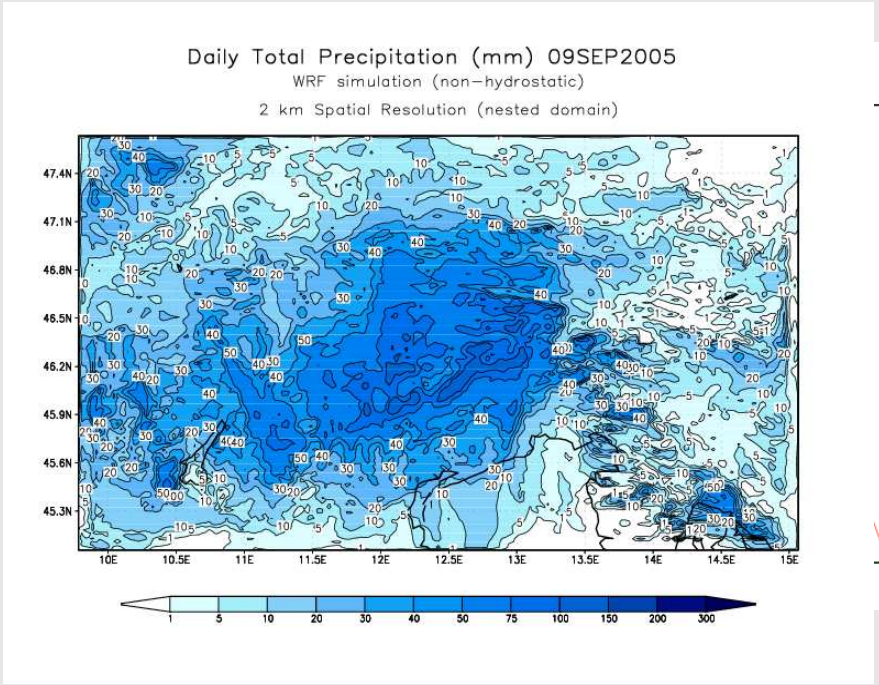
Archetypes – onset of DMC on the foothills (far from relieves)?

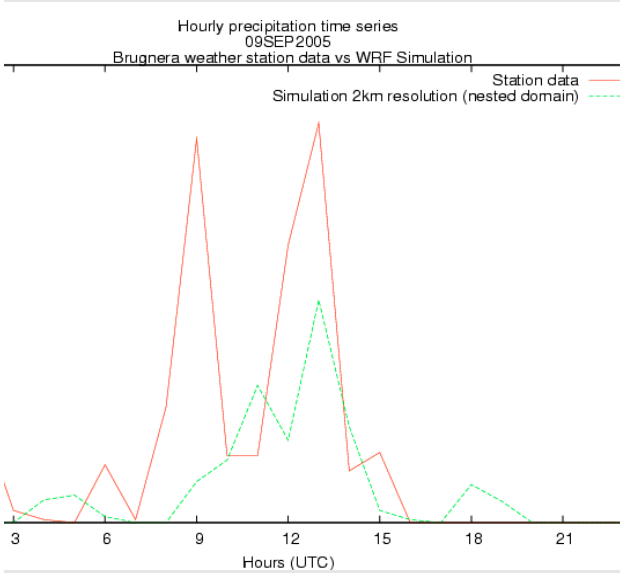
Onset of DMC on the foothill and numerical models

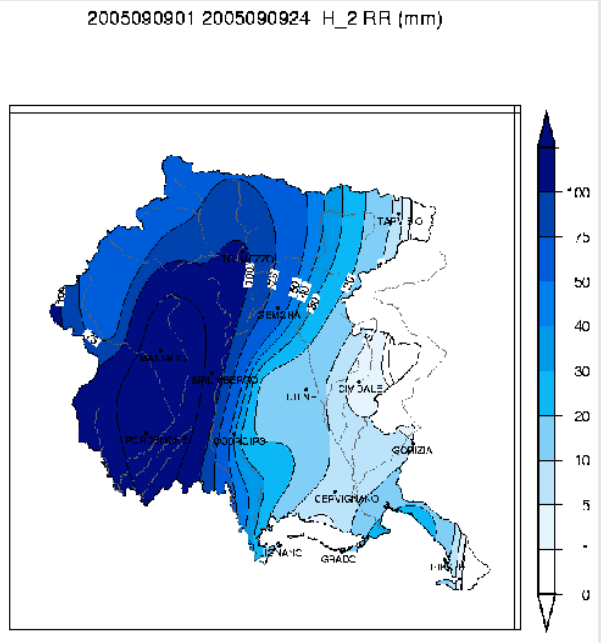
- Almost never foreseen by 5-50 km horizontal resolution numerical models even if they are able to forecast the flow convergence above the ground

(missed onset of DMC on the foothill)

- 2-3 km horizontal resolution numerical models misplace precipitation maxima and usually underestimate their amounts, but they pick up the event







9 September 2005

Archetypes – onset of DMC on the foothills (far from relieves)?

Conceptual model for the onset of DMC on foothills

- Persistent and strong flow impinging the mountains in the obstacle layer

Persistent and strong Southerly or South-westerly flow at mid-low level (mesoscale or synoptic causes)

- Potential (convective) instability of the air-mass

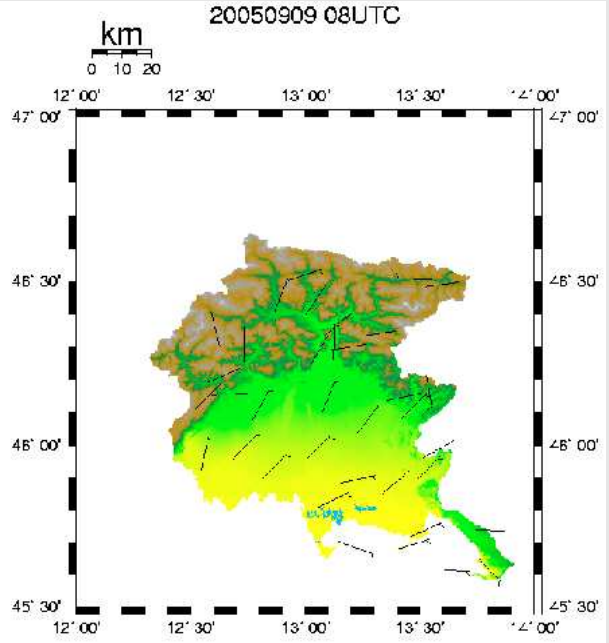
(considering the whole air column)

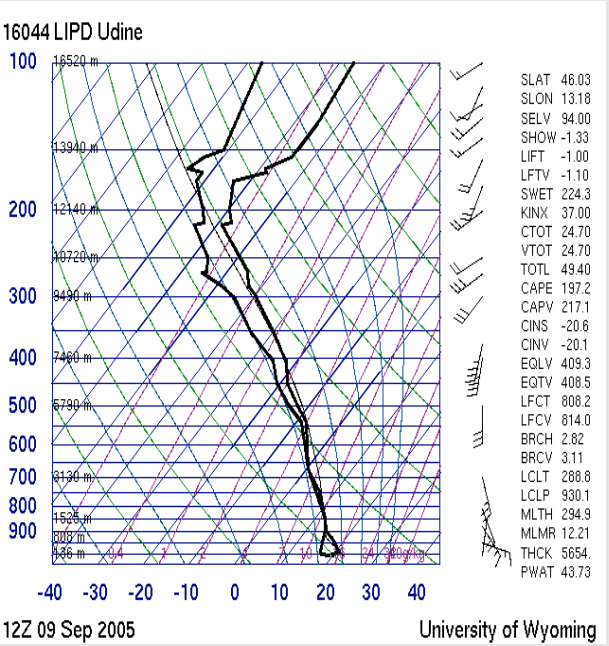
- Moist air-mass at all levels – Low LCL

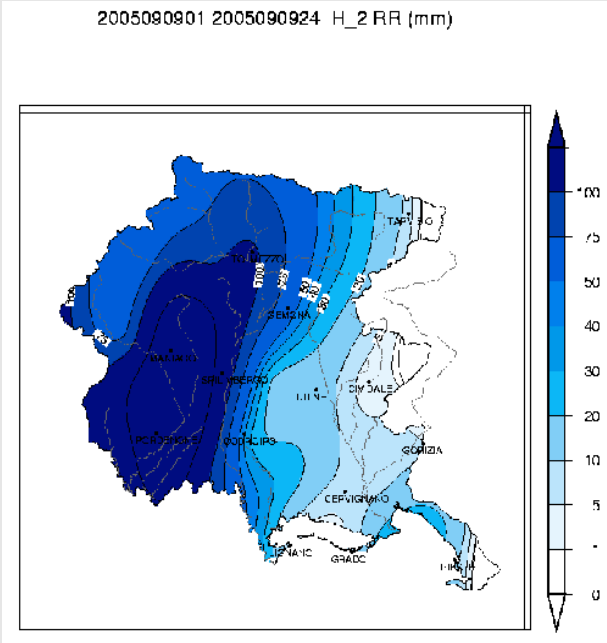
(in particular high relative humidity in the lowest 50-100 hPa)?

- Flow convergence at low levels

(mesoscale orographic effects or already existing convection)?







Concluding remarks

- Deep Moist Convection is an important source of Atmospheric Hazards in complex orographic areas
- Nowadays operational numerical models are affected by significant limits in forecasting DMC in complex orographic areas
- A step beyond the operational numerical model outputs can be done by means of non operational high resolution numerical model simulations
- The use of severe weather archetypes is a useful method to bring the gap while waiting for high resolution operational runs