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A mesoscale model intercomparison study of a mid-latitude event observed during the HYMEX campaign: Influence of initiation data, dynamics and microphysics on precipitation

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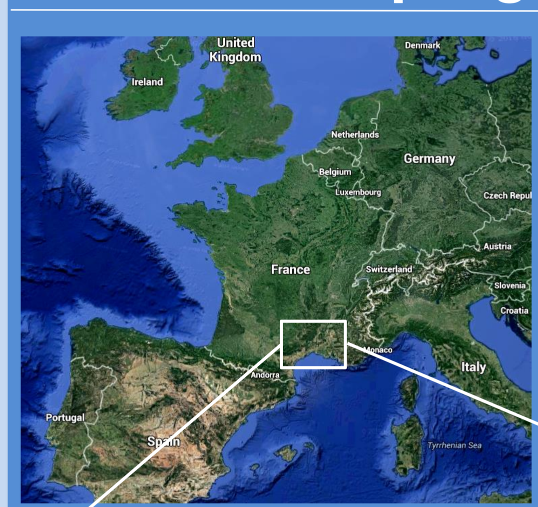
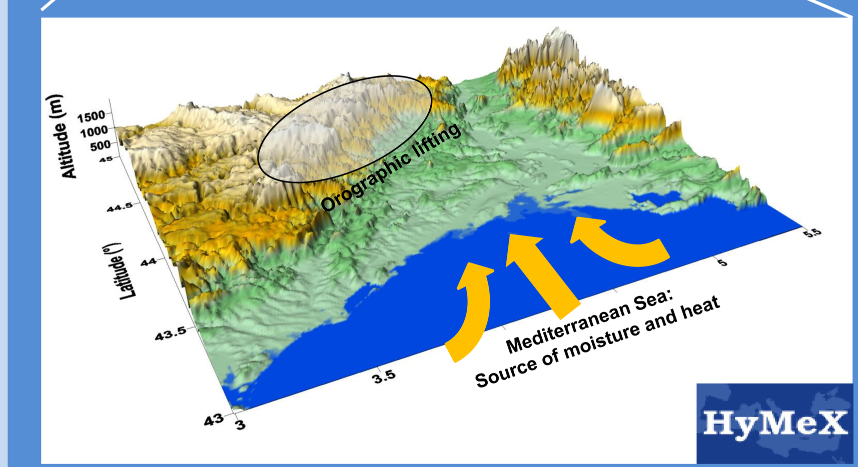
Objectives

A main objective of HYMEX is to provide a better understanding and modelling of intense convective precipitation events in Mediterranean region in order to improve their forecast by state-of-art kilometric and sub-kilometric scale Numerical Weather Prediction (NWP) models.

The HYMEX programme: Description



Mesoscale convective systems that stay over the same area during several hours are the main responsible for high rainfall totals that produce flash-flooding.
These meteorological phenomena result from complex multiscale interactions between the ambient flow, topography and deep atmospheric convection that makes the forecast of the precise timing and location of the intense convective precipitation quite difficult



Hydrological cycle in the Mediterranean eXperiment

- 10-years international program
- Observation Period (SOP1) in autumn 2012
- Large set of instruments (radars, rain gauges, aerosol & microphysical on-board probes,...) was deployed on multiple sites over the western Mediterranean basin.

Participating models

- Two different 3D dynamical models: Clark et al. (1996) & WRF v3.6
- Four microphysics modules:
  - 3 bulk schemes: Kessler (1969), Morrison et al., (2009, MWR) & Thompson et al., (2008, MWR)
  - 1 detailed scheme: Detailed SCAvenging Model (DESCAM)

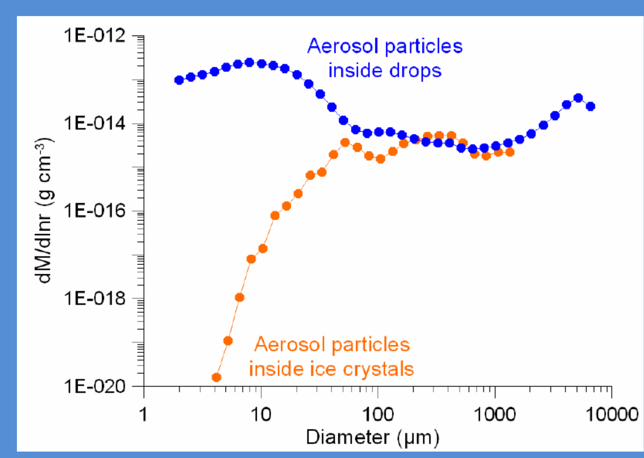
DESCAM (Flossmann and Wobrock, 2010, Atm. Res.)

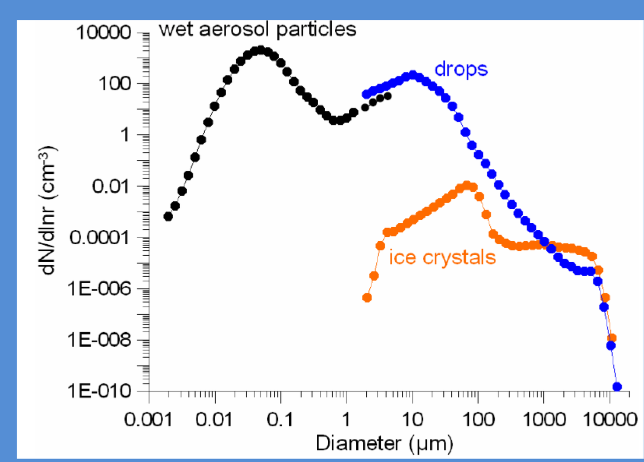
***Warm microphysical processes*:** aerosol particle growth and activation, droplet de-activation, growth of drops by condensation and collision-coalescence, break up.

***Cold microphysical processes*:** homogeneous and heterogeneous nucleation, growth by vapor deposition, riming.

5 distribution functions: see Figs.➪

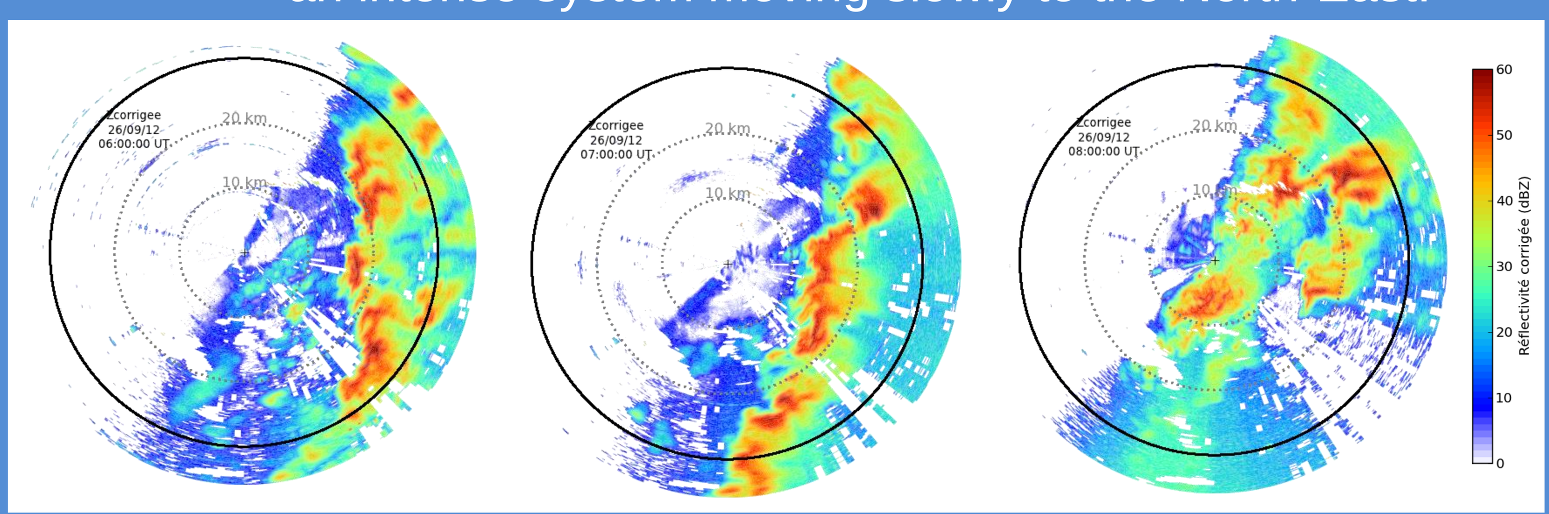
- f_{AP}: number of wet aerosol particles
- f_{drop}: number of droplets
- f_{ice}: number of ice crystals
- $g_{AP,drop}$: aerosol mass inside droplets
- $g_{AP,ice}$: aerosol mass inside ice crystals





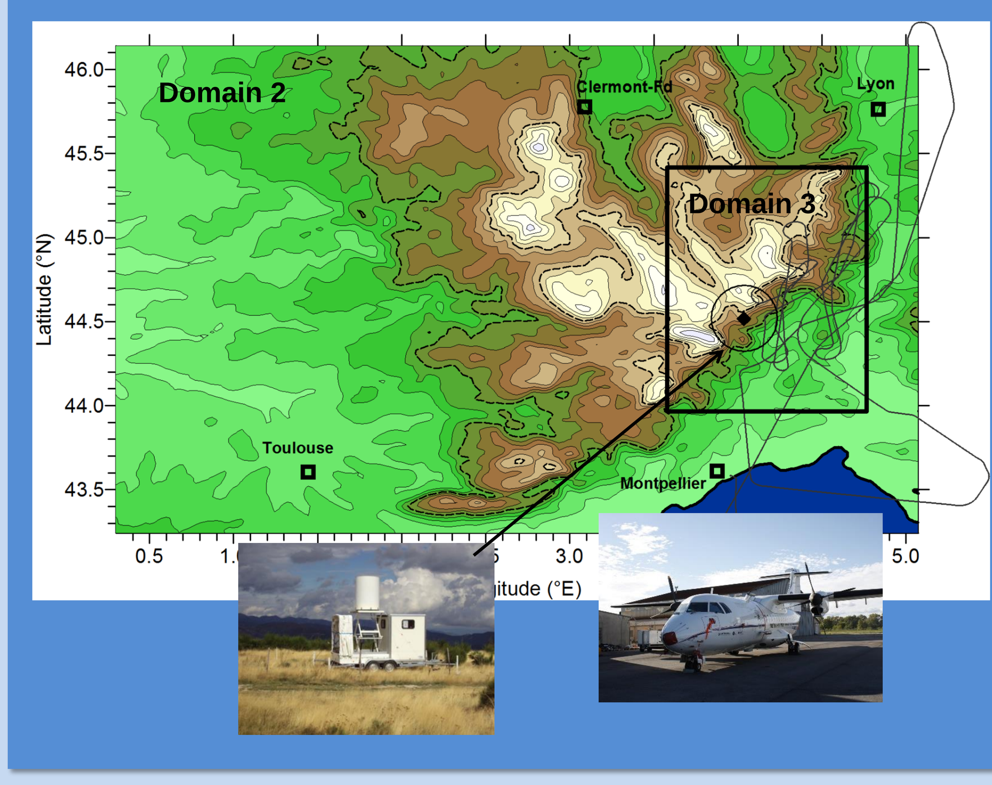
Case study: Convective system observed on 26/09/2012

- Observations of the X-band radar situated on the mountains slopes: an intense system moving slowly to the North-East.



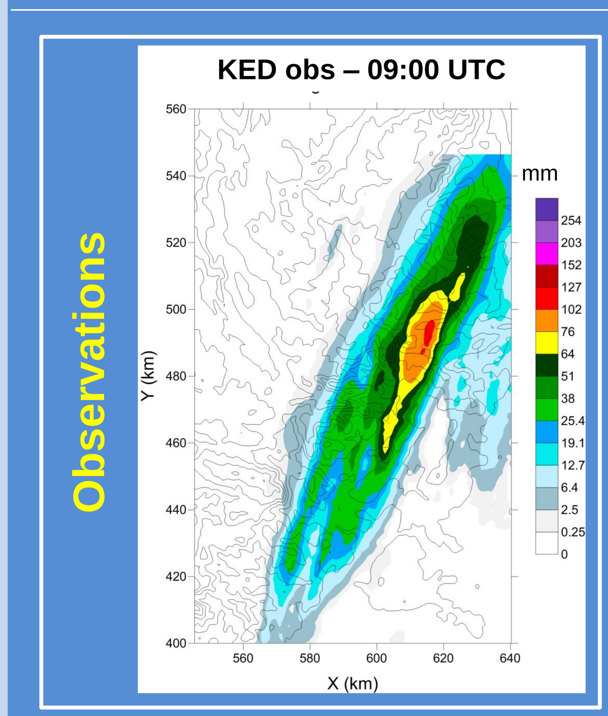
- Radar–raingauge QPE using kriging method with external drift (KED) (Delrieu et al., 2014) provides observed rainfall which is compared to simulated results over the domain 3.

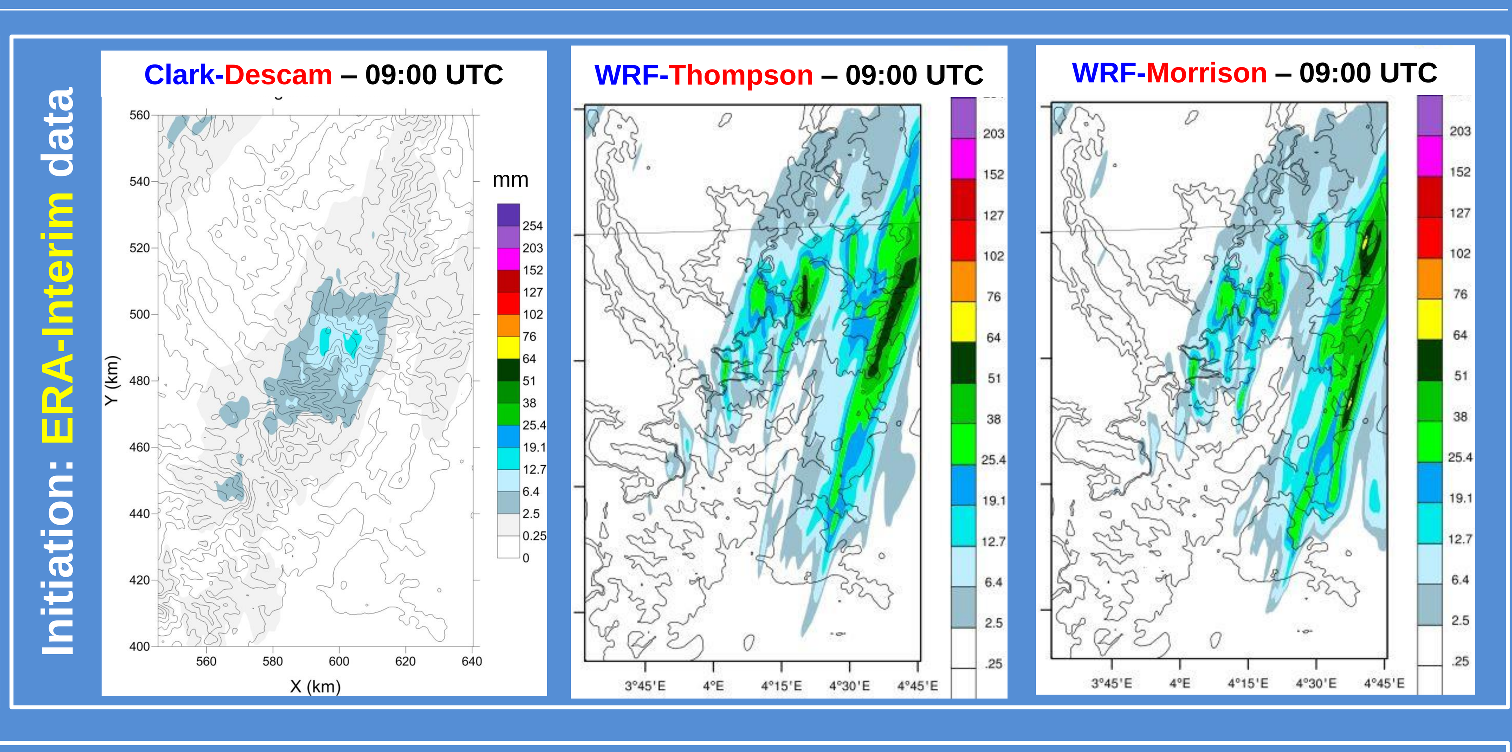
Model settings

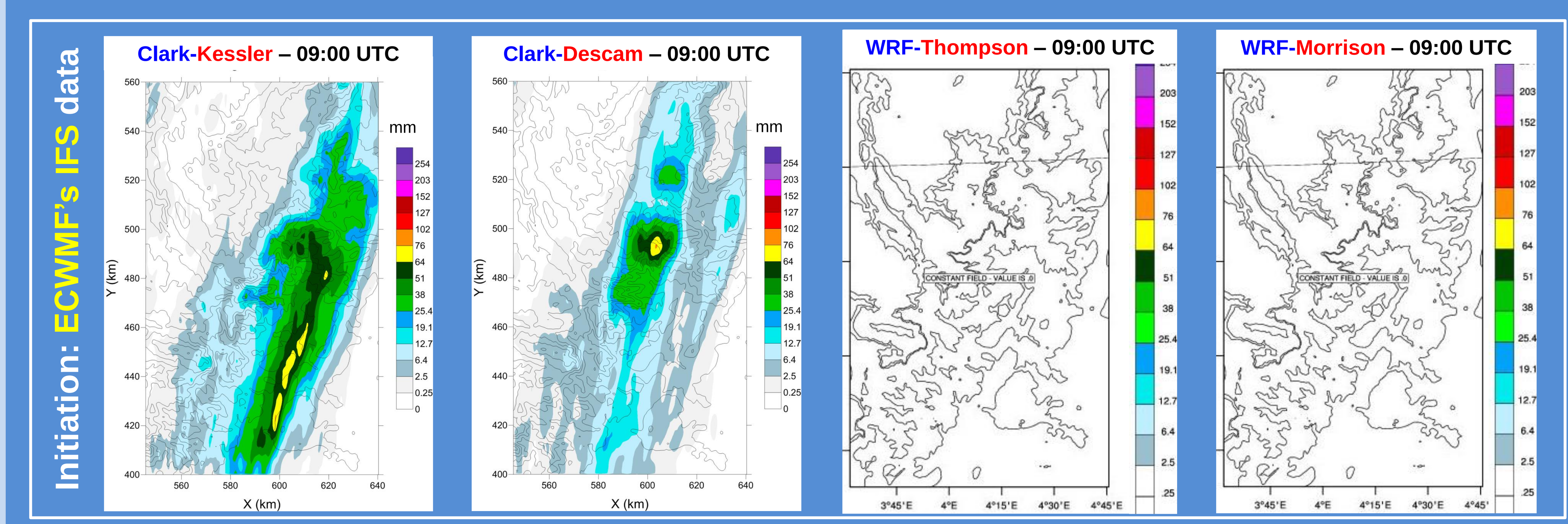


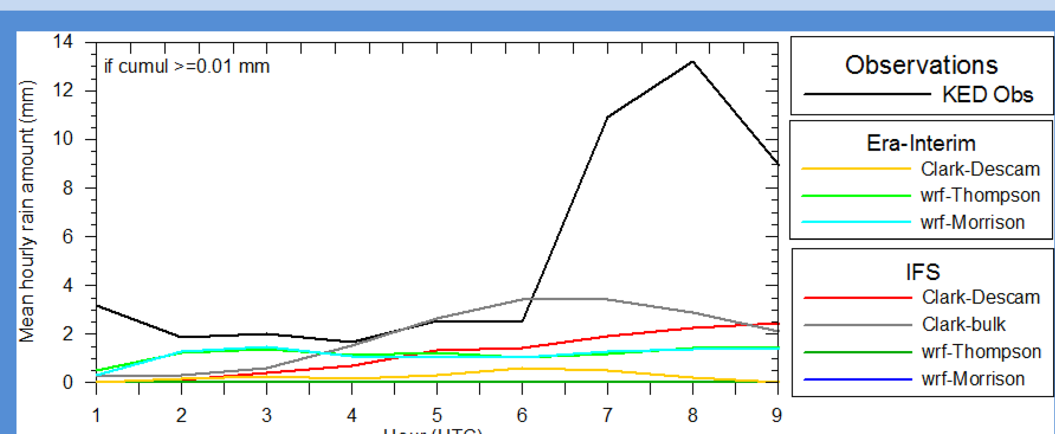
- 3 nested domains with increasing resolution (8, 2, 0.5km)
- Non-equidistant vertical grid
- Aerosol properties (needed in DESCAM) idealized according to SOP1 measurement made onboard the French ATR-42 flight
- Initialization with 2 different types of the large scale data:
  - ECMWF's IFS of the 26th Sept. 2012 at 00:00 UTC,
  - ECMWF ERA-Interim data of the 26th Sept. 2012 at 00:00 UTC

Results: Cumulative rain amount at the ground









Temporal evolution of the mean hourly rain amount. Average made using only points where the hourly rain amount is ≥ 0.

- No simulation can reproduce the intense rainfall observed on 7-9h period

- The location of the maximum orographic precipitation was found by most simulations.
- The simulations show the important role of the initiation data, but also of the microphysics scheme.
- It is most surprising that the WRF simulations with IFS data do not produce precipitation.
- It seems that the simulations that produce more precipitation amount are simulations using the couple (IFS + Clark) or (ERA_Interim + WRF).

Conclusions and Perspectives

The first step of this study shows the important role of the initial data on the simulated precipitation as well as the characteristics of the model used. As a next step, we will compare the different simulated cloud properties and the corresponding observations to estimate where the discrepancies come from and understand how the NWP models could be improved.

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