LIMA: Evaluation and recent developments

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Motivations

- Complex aerosols – clouds – precipitations interactions
LIMA: Liquid Ice Multiple Aerosols

2-moment, mixed-phase microphysical scheme

<table>
<thead>
<tr>
<th>Droplets</th>
<th>Drops</th>
<th>Ice</th>
<th>Snow</th>
<th>Graupel</th>
<th>Hail</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_c )</td>
<td>( r_r )</td>
<td>( r_i )</td>
<td>( r_s )</td>
<td>( r_g )</td>
<td>( r_h )</td>
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<tr>
<td>( N_c )</td>
<td>( N_r )</td>
<td>( N_i )</td>
<td></td>
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</tbody>
</table>

\( r \): mass mixing ratio (kg.kg\(^{-1}\))  \( N \): number conc. (\#.kg\(^{-1}\))

Prognostic aerosol population

- Interaction with clouds (nucleation ...)
- Resolved and subgrid transport

Current implementation of LIMA

- LIMA was integrated in AROME (cycle 42 and 45+)

- Recent developments
  - Revised CCN activation properties, using the “κ-Köhler theory”
  - Internal time-splitting technique
  - Optimization of the splitted sedimentation scheme
  - Improvements and bug fixes

- Aerosol initialization from MACC or MOCAGE data
  - In test for various situations
Evaluation for HyMeX deep convection

- LIMA represents the cloud composition better than ICE3, but produces too large raindrops

Taufour et al., 2018: Evaluation of the two-moment scheme LIMA based on microphysical observations from the HyMeX campaign, QJRMS, DOI: 10.1002/qj.3283

Observed (disdrometers) and simulated rain characteristics, HyMeX IOP 16, 2012/10/26

Observed (disdrometers) rain μ-Dm relationship during HyMeX SOP 1

- Improvements (under evaluation)

Rain diameter (mm) at level 1, HyMeX IOP 6, 03UTC 2012/09/24
LIMA: Evaluation for deep convection

- Snow diagnostic number concentration
  \[ N_s = C \cdot \lambda^x \]
LIMA: Evaluation for deep convection

HyMeX IOP 6: 12-h accumulated precipitation, 2012/09/24, 12UTC

Two-moment microphysics for AROME
LIMA: Evaluation for deep convection

HyMeX IOP 16: 24-h accumulated precipitation, 2012/10/27, 00UTC
LIMA: Evaluation for fog situations

- LES of fog at SIRTA
  - Droplets sedimentation
  - Droplets deposition
  - Account for cooling in the diagnostic supersaturation

- LES of fog for Lanfex cases →

Lanfex IOP 12: 2-m cloud water mixing ratio at 01UTC, 2015/10/02
Aerosol initialization: Bure, 2015/11/01

ICE3

LIMA

LIMA + MACC

LIMA + MOCAGE

$\rho_c (\text{g.kg}^{-1})$

24h precipitation (mm)

300m
LIMA (old version): 1-month scores

20160316-20160417, 6-h accumulated precipitation, 10mm threshold

ICE3
Conclusion & prospects

- Thorough evaluation of LIMA (convection, fog, cyclones...)
  - Input from Karl-Ivar and Daniel will be interesting

- Be careful when changing parameters!

- Scheme efficiency
  - Currently, 8 new prognostic variables result in +30% computing time

- Subgrid cloud fraction

- Aerosol initialization from MACC and MOCAGE
To be continued...