ICMW2020 cumulus congestus: UWLCM simulations

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Lagrangian Cloud Model

- Anelastic LES
- MPDATA for Eulerian advection
- Lagrangian microphysics (super droplet method, Shima et al. 2009)
- Eulerian SGS diffusion: Smagorinsky or ILES
- Lagrangian SGS diffusion: none or GA17 (Grabowski & Abade JAS 2017)
- Details: Dziekan et al. GMD 2019
Simulation setup

- 3D 10km x 10km x 10km
- Absorber above 9km
- 3h simulated time
- Averages from 5 runs
- Time steps:
  - Main 0.5s
  - Condensation 0.1s
  - Coalescence 0.1s
## List of simulations

<table>
<thead>
<tr>
<th>dx=dy=dz</th>
<th>Eulerian SGS</th>
<th>Lagrangian SGS</th>
<th>$N_a$</th>
<th>#SD</th>
<th>coalescence</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 m</td>
<td>ILES</td>
<td>none</td>
<td>2xRICO</td>
<td>100</td>
<td>on</td>
</tr>
<tr>
<td>100 m</td>
<td>ILES</td>
<td>none</td>
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</tr>
<tr>
<td>50 m</td>
<td>ILES</td>
<td>none</td>
<td>4xRICO</td>
<td>100</td>
<td>on</td>
</tr>
<tr>
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</table>

+ SGS model tests for 11xRICO (not shown); SGS model caused only minor differences.
Liquid water mass vs resolution
Resolution tests - NA11 LWM

Higher resolution = more liquid water
Resolution tests - NA4 LWM

dx = 50m

dx = 100m

Higher resolution = more liquid water
Resolution tests - NA2 LWM

dx = 50m

Higher resolution = more liquid water
Liquid water mass vs #SD
#SD tests - NA11 LWM

#SD = 100

#SD = 500

#SD does not affect LWM much
#SD tests - NA4 LWM

#SD = 100

#SD = 500

#SD does not affect LWM much
#SD tests - NA2 LWM

#SD = 100

#SD = 500

#SD does not affect LWM much
Surface precipitation vs #SD
#SD tests - NA2 precipitation

More SD = less precipitation
#SD tests - NA2 droplet number @ first LWM max

#SD = 100

Number Concentration of Cloud and Rain droplets

#SD = 500

Number Concentration of Cloud and Rain droplets

Similar droplet concentration for different #SD
#SD tests - NA2 droplet radius @ first LWM max

Similar effective radius for different #SD
Tentative conclusions

- Higher resolution $\rightarrow$ more liquid water
- More super-droplets $\rightarrow$ more surface precipitation, why?