



ICMW2020 cumulus congestus: UWLCM simulations

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University of Warsaw 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

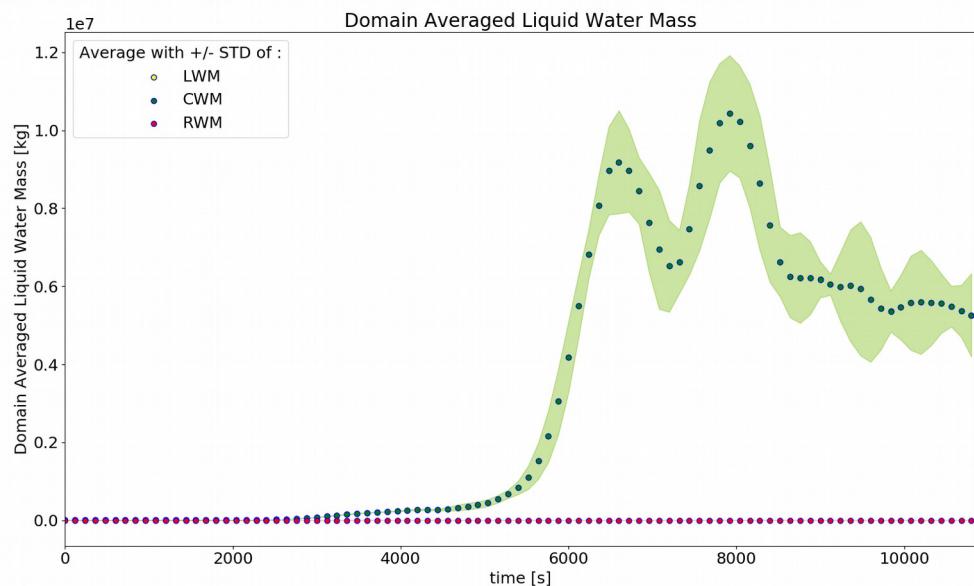
dx=dy=dz	Eulerian SGS	Lagrangian SGS	N _a	#SD	coalescence
50 m	ILES	none	2xRICO	100	on
100 m	ILES	none	2xRICO	100	on
100 m	ILES	none	2xRICO	500	on
50 m	ILES	none	4xRICO	100	on
100 m	ILES	none	4xRICO	100	on
100 m	ILES	none	4xRICO	500	on
50 m	ILES	none	11xRICO	100	on
100 m	ILES	none	11xRICO	100	on
100 m	ILES	none	11xRICO	500	on

+ SGS model tests for 11xRICO (not shown); SGS model caused only minor differences.

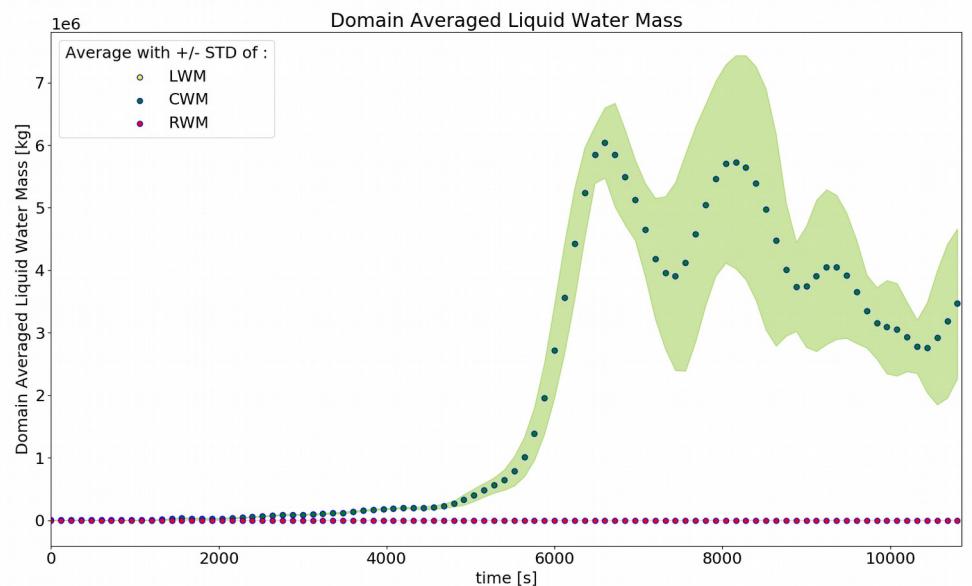
Liquid water mass vs resolution

Resolution tests - NA11 LWM

$dx = 50m$



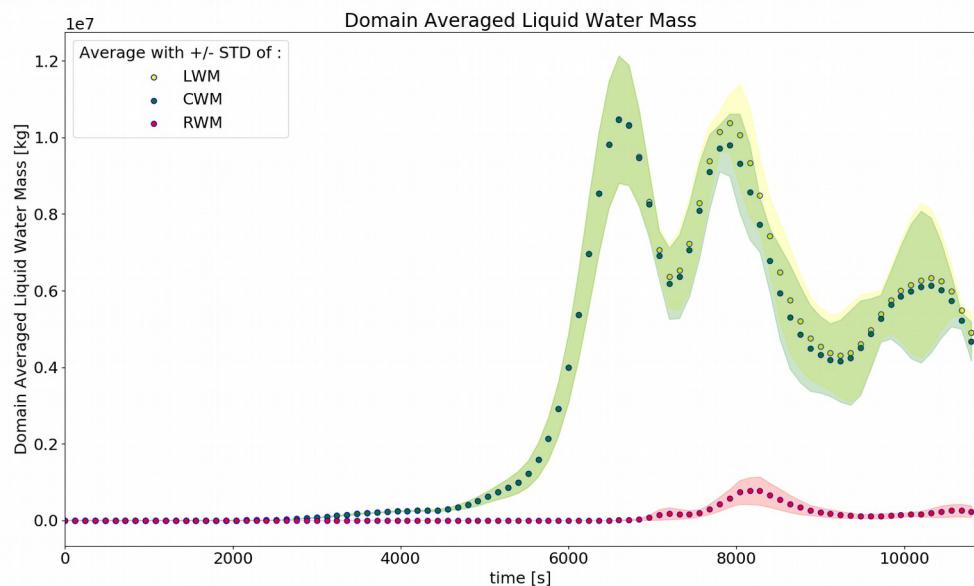
$dx = 100m$



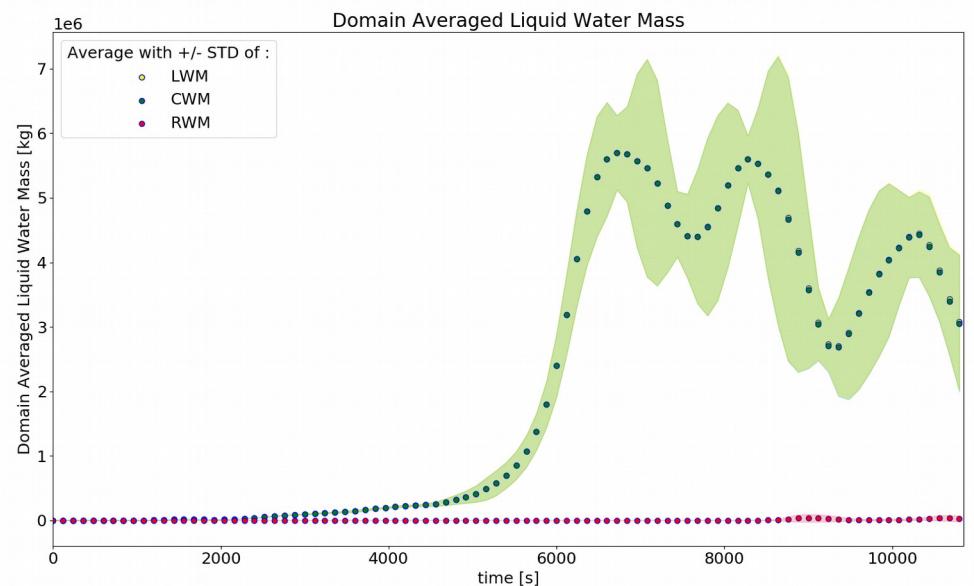
Higher resolution = more liquid water

Resolution tests - NA4 LWM

$dx = 50m$



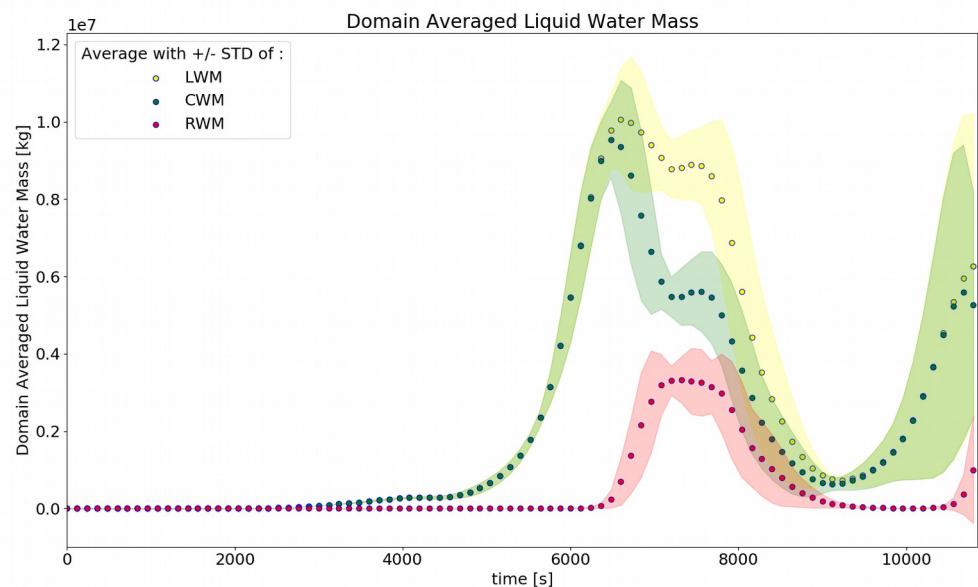
$dx = 100m$



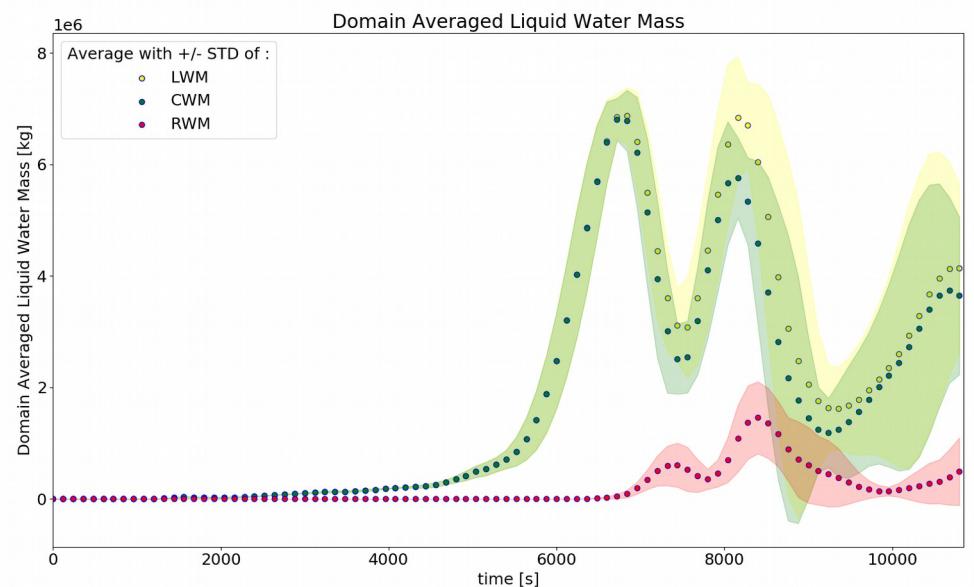
Higher resolution = more liquid water

Resolution tests - NA2 LWM

$dx = 50m$



$dx = 100m$

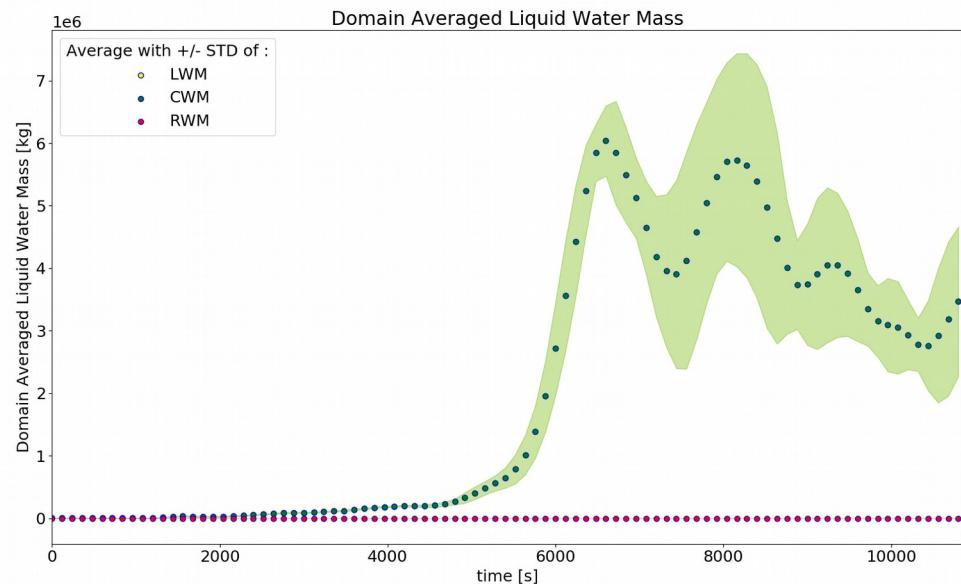


Higher resolution = more liquid water

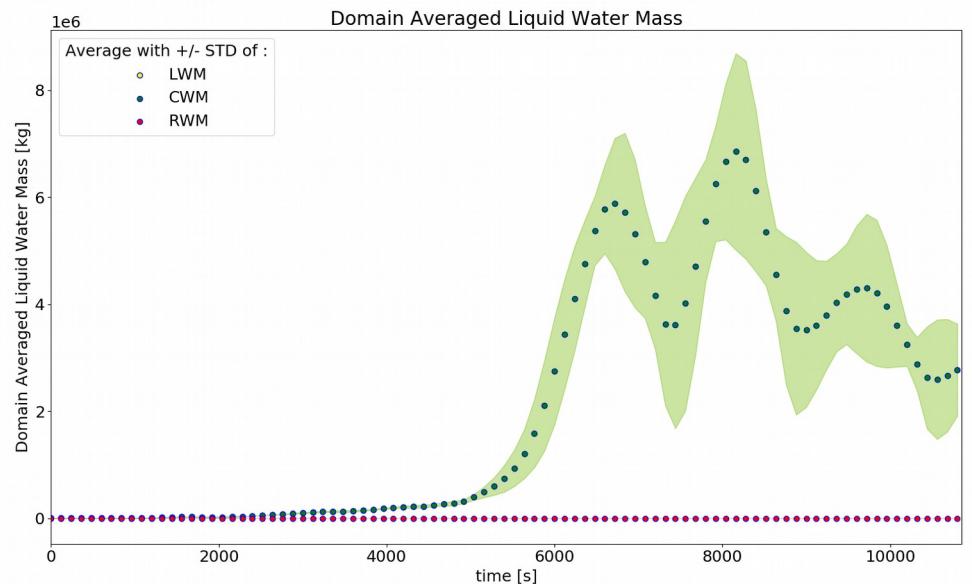
Liquid water mass vs #SD

#SD tests - NA11 LWM

#SD = 100



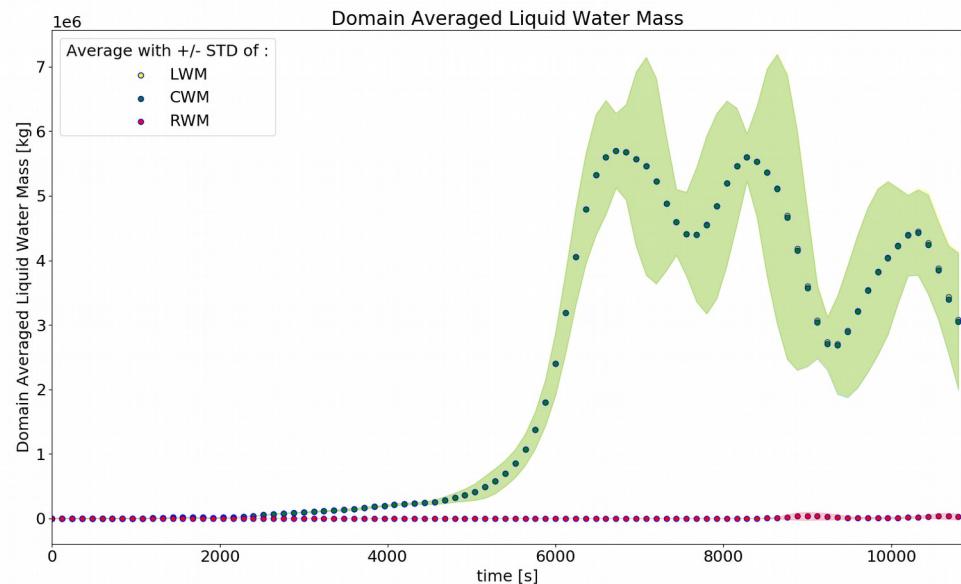
#SD = 500



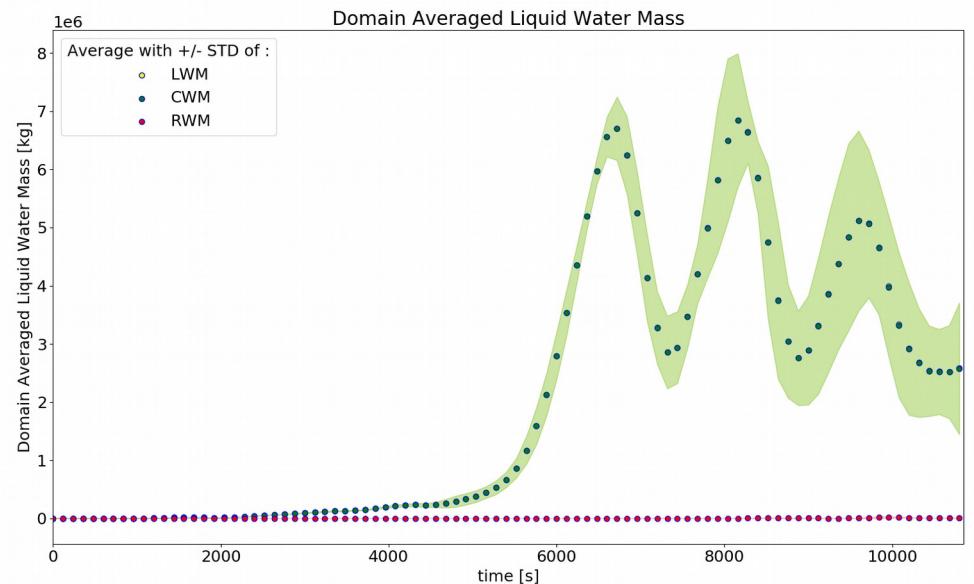
#SD does not affect LWM much

#SD tests - NA4 LWM

#SD = 100



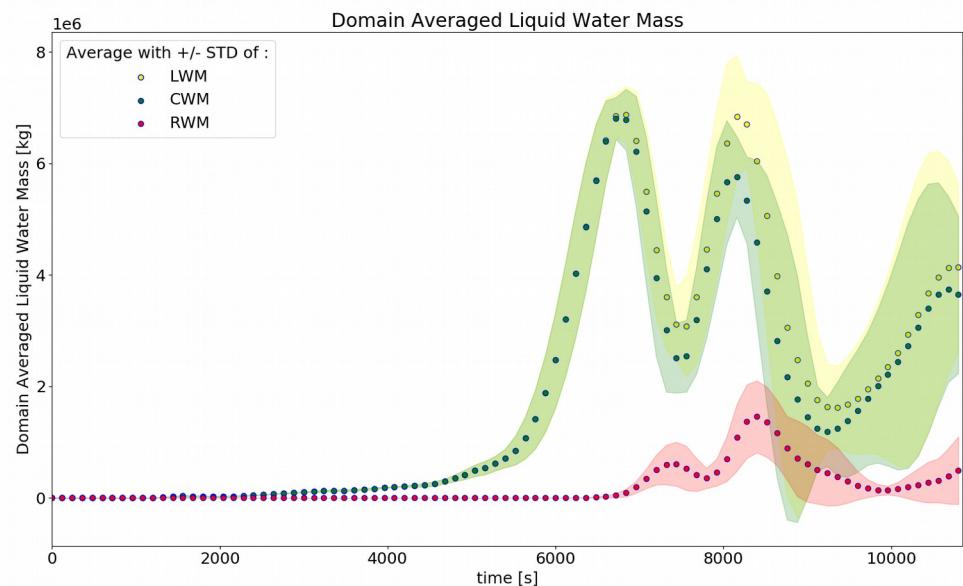
#SD = 500



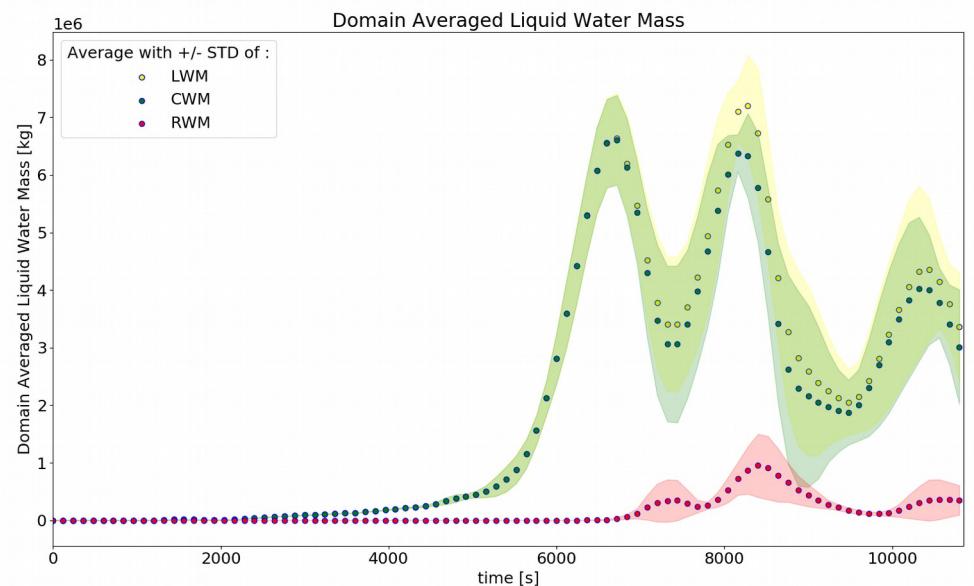
#SD does not affect LWM much

#SD tests - NA2 LWM

#SD = 100



#SD = 500

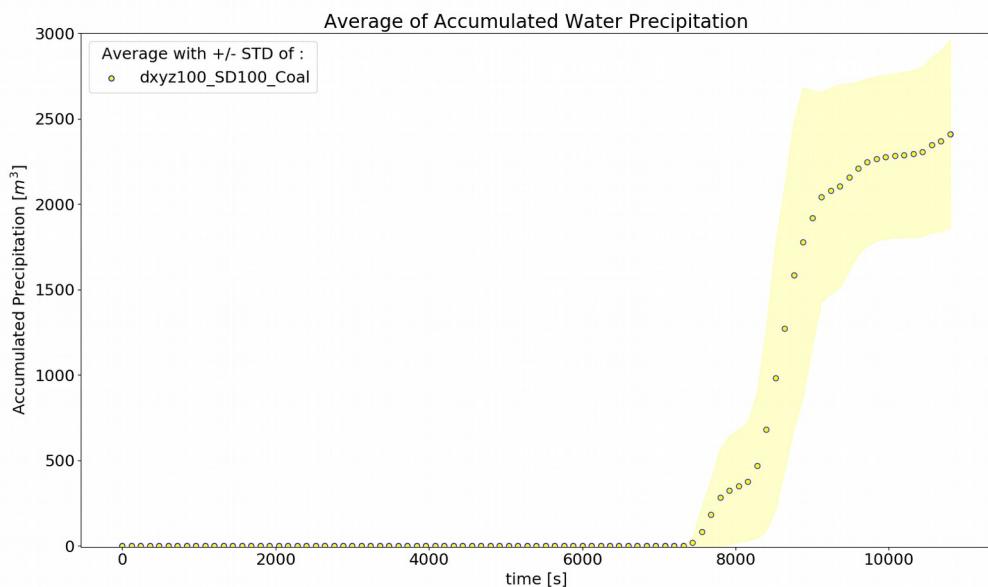


#SD does not affect LWM much

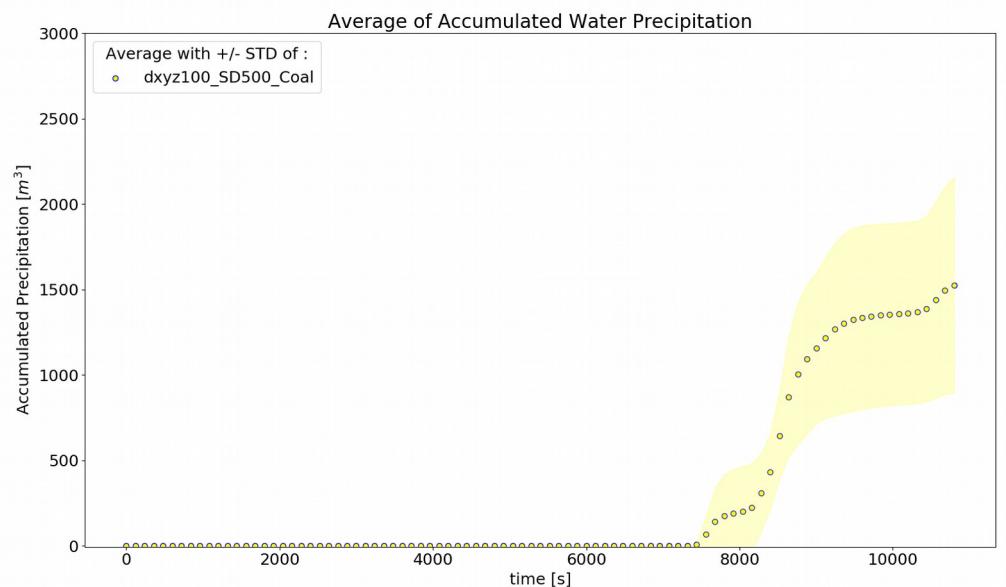
Surface precipitation vs #SD

#SD tests - NA2 precipitation

#SD = 100



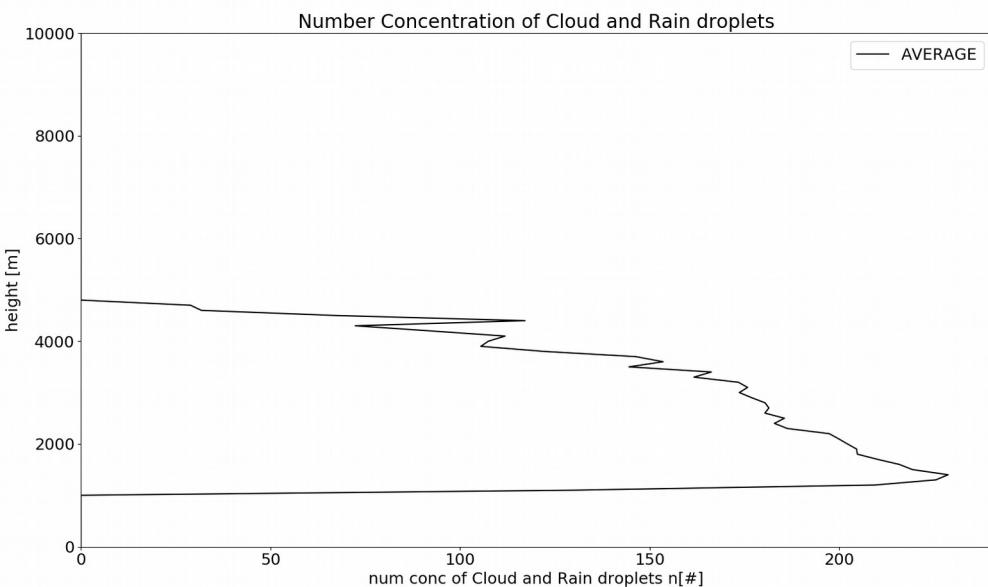
#SD = 500



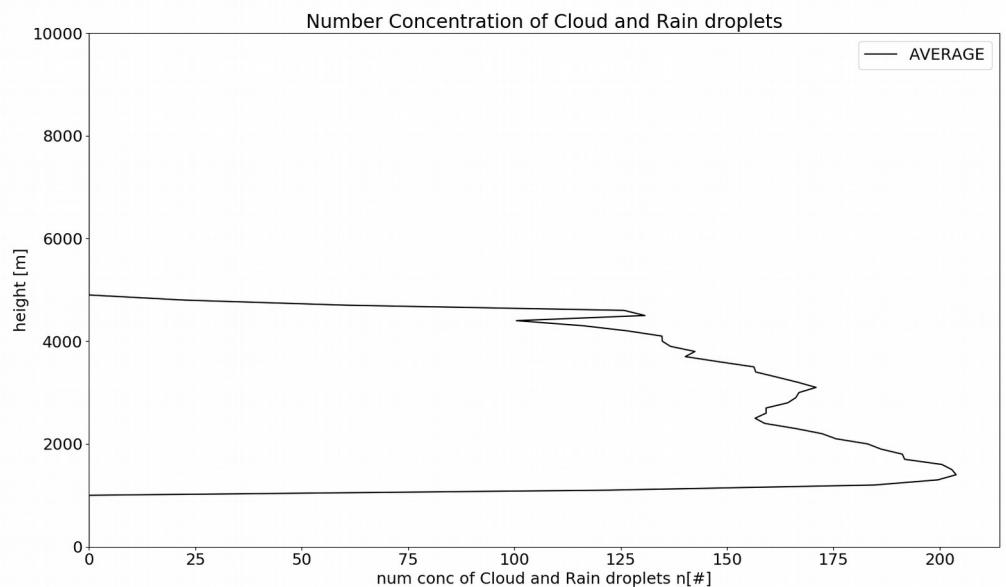
More SD = less precipitation

#SD tests - NA2 droplet number @ first LWM max

#SD = 100



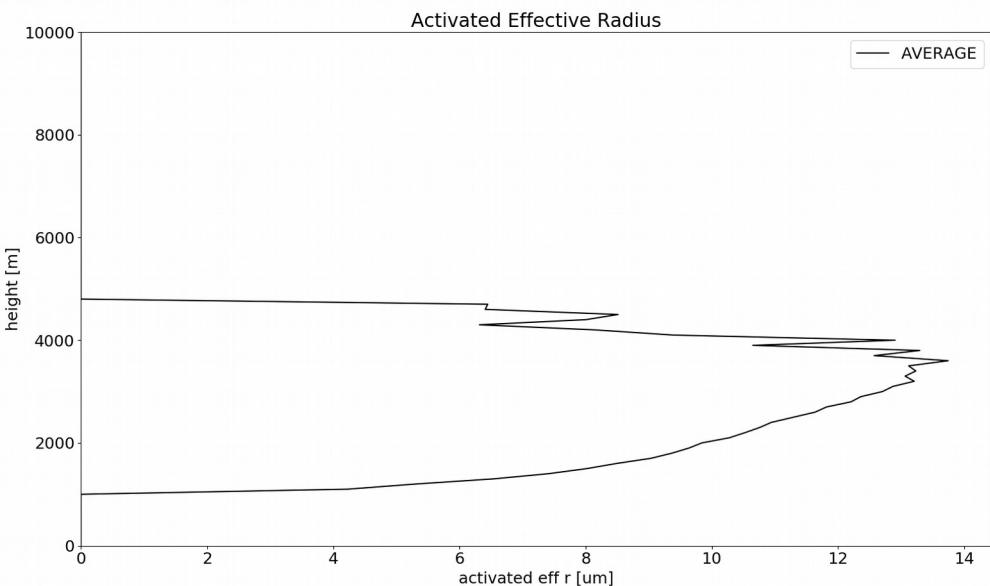
#SD = 500



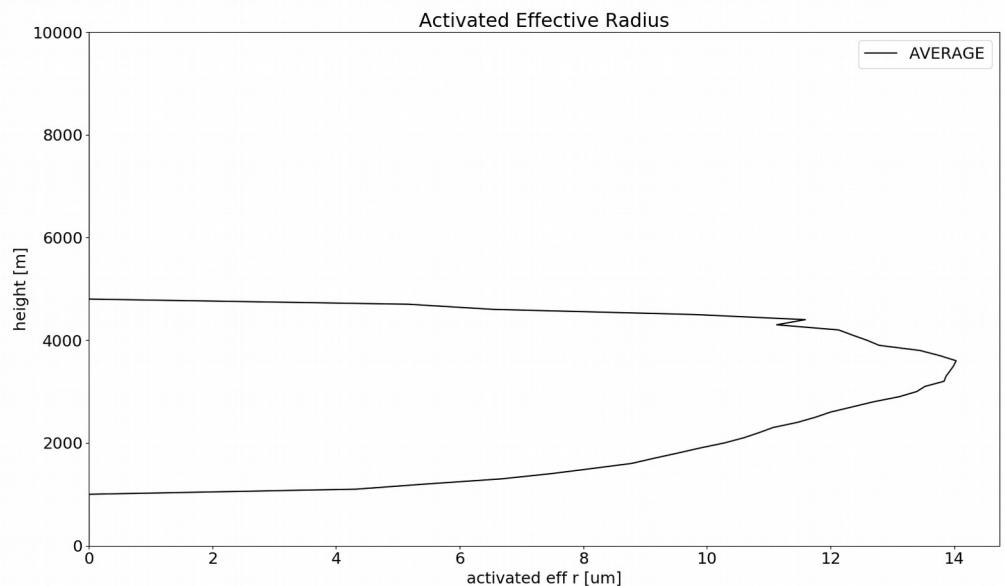
Similar droplet concentration for different #SD

#SD tests - NA2 droplet radius @ first LWM max

#SD = 100



#SD = 500



Similar effective radius for different #SD

Tentative conclusions

- Higher resolution → more liquid water
- More super-droplets → more surface precipitation, why?