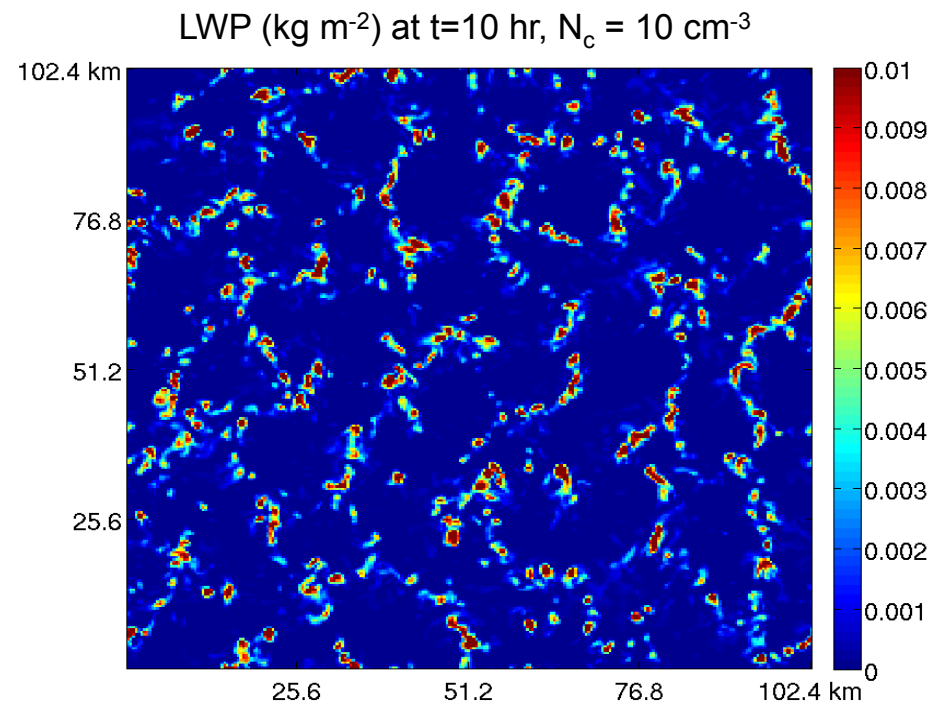


CONSTRAIN cold air outbreak DALES results



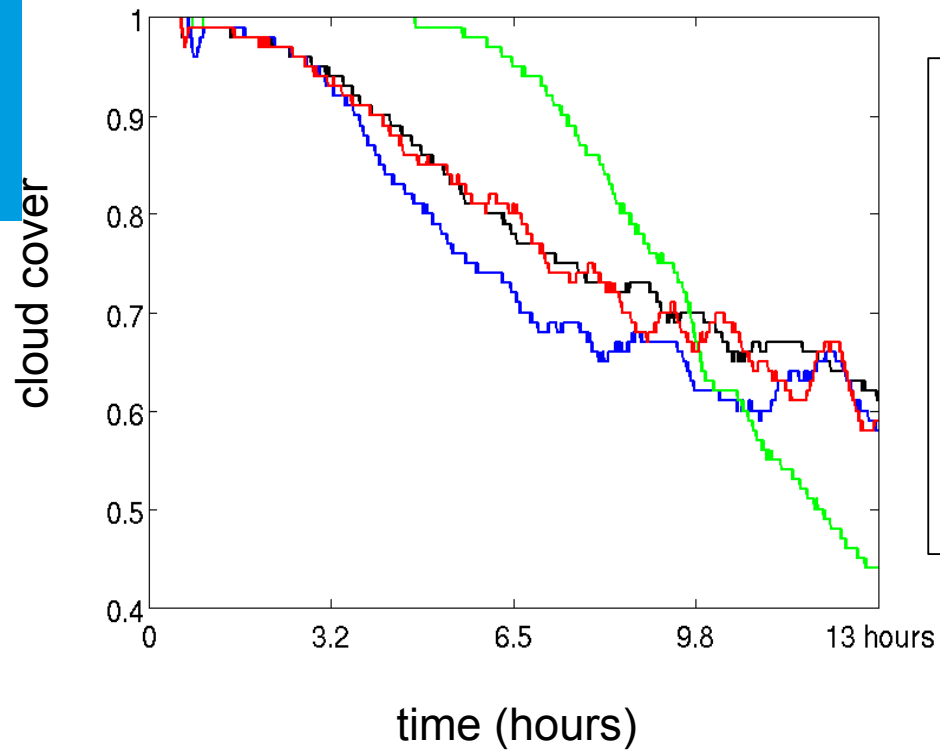
Thomas Frederikse, Stephan de Roode, and Pier Siebesma

Set up of the simulations

L (km)	Δx (m)	N_c (cm ⁻³)	Purpose
102.4	200	10	Reference
102.4	400	10	Lower horizontal resolution
102.4	400	50	Larger droplet concentration
51.2	200	10	Smaller domain size
12.8	50	10	Fine-scale velocity structures

- No ice microphysics

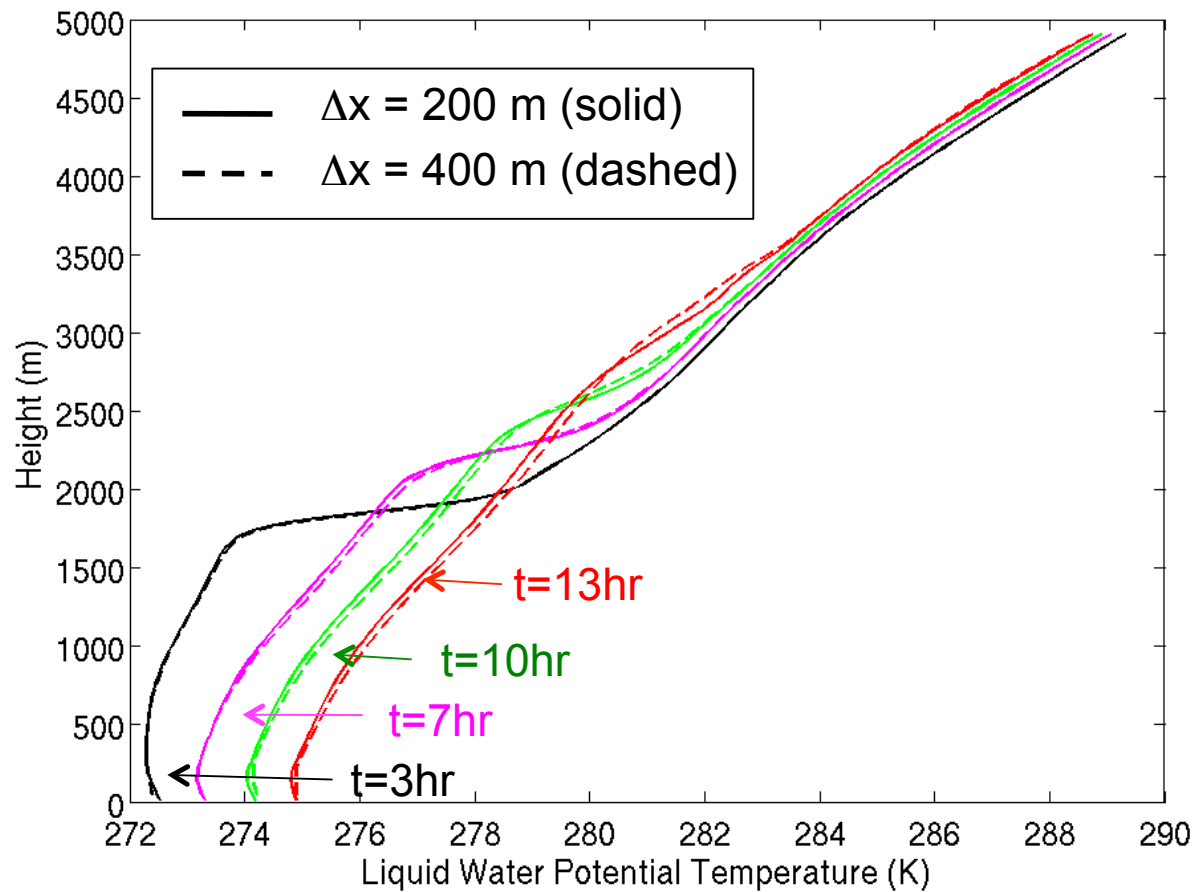
Time series: cloud cover



	L (km)	Δx (m)	N _c (cm ⁻³)
<div></div>	102.4	200	10
<div></div>	102.4	400	10
<div></div>	102.4	400	50
<div></div>	51.2	200	10

Droplet concentration affects cloud cover evolution

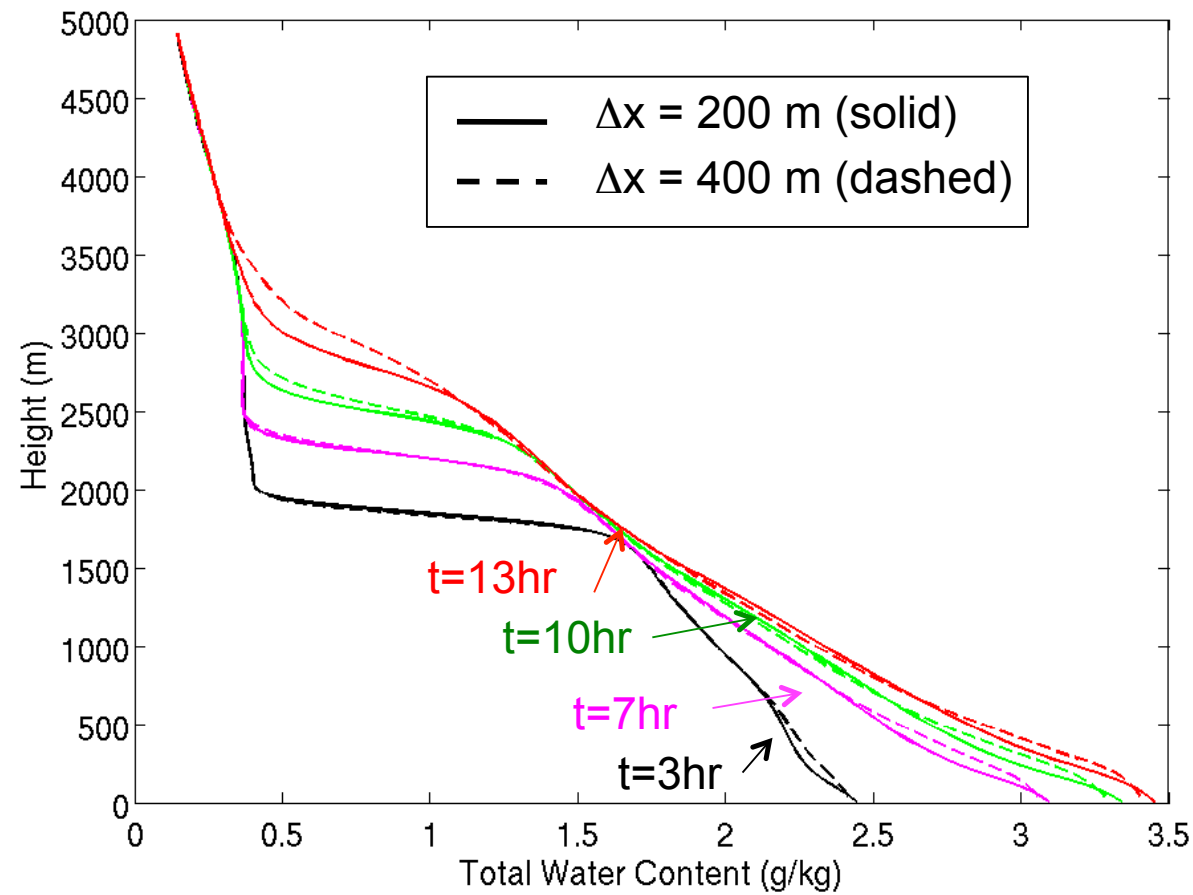
Liquid water potential temperature $L = 102.4 \text{ km}$, $N_c = 10 \text{ cm}^{-3}$



Coarser resolution hardly has an effect on the mean state evolution

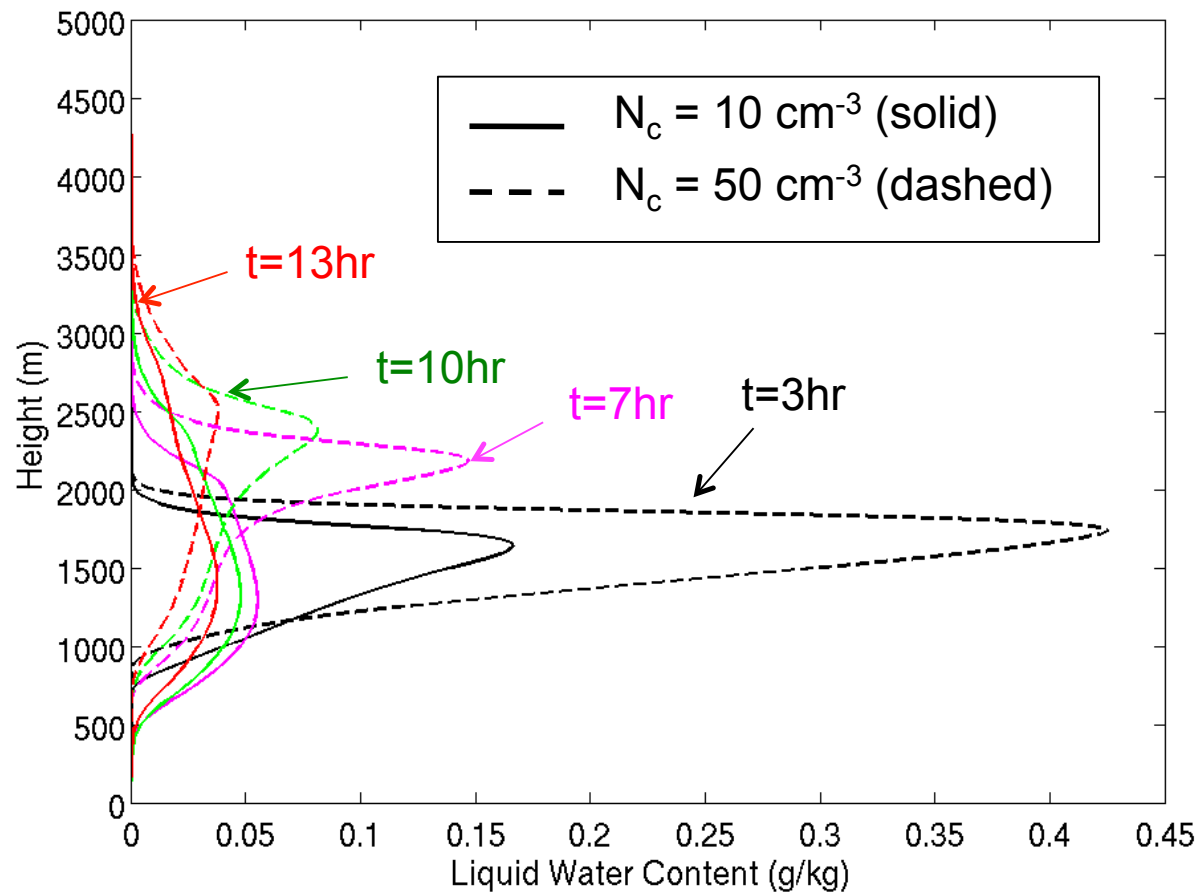
Total water content

$L = 102.4 \text{ km}$, $N_c = 10 \text{ cm}^{-3}$



Coarser resolution hardly has an effect on the mean state evolution

Liquid water content $L = 102.4 \text{ km}$

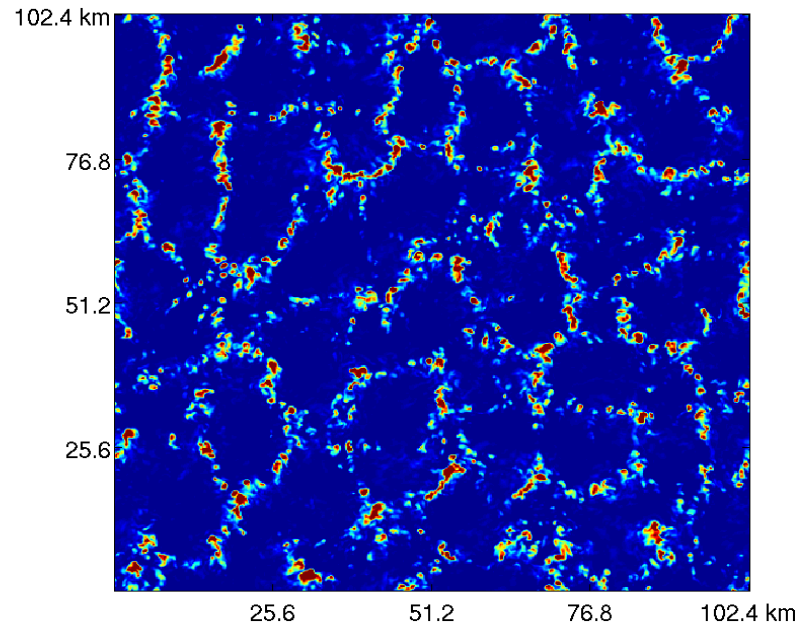


Cloud droplet concentration has a large influence on the liquid water content

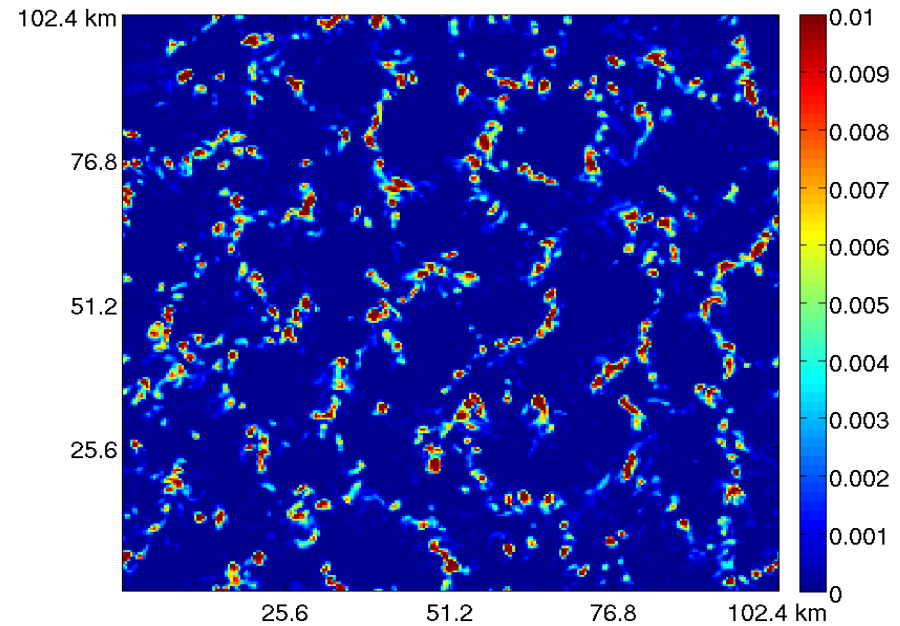
Open-cell cloud structure

$t=7 \text{ hr}$, $N_c = 10 \text{ cm}^{-3}$

LWP (kg m^{-2})



$\Delta x = 200 \text{ m}$

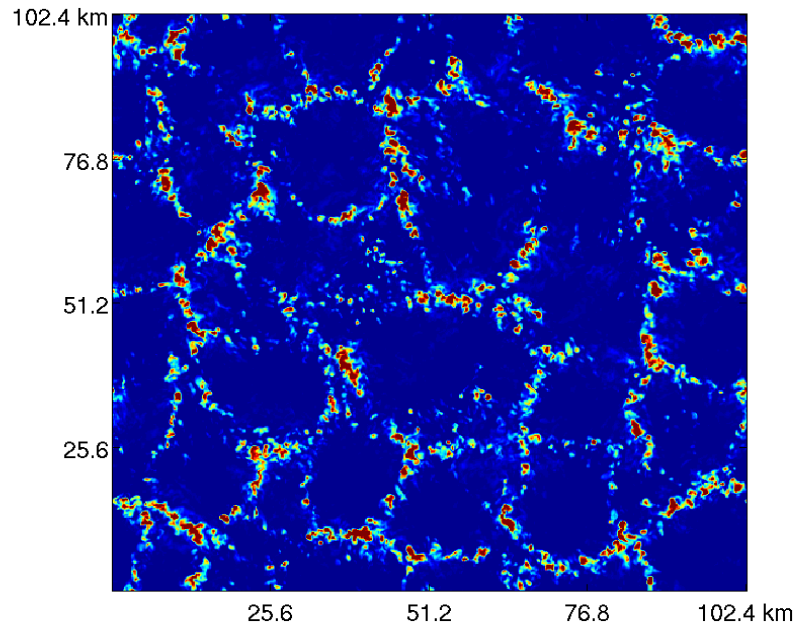


$\Delta x = 400 \text{ m}$

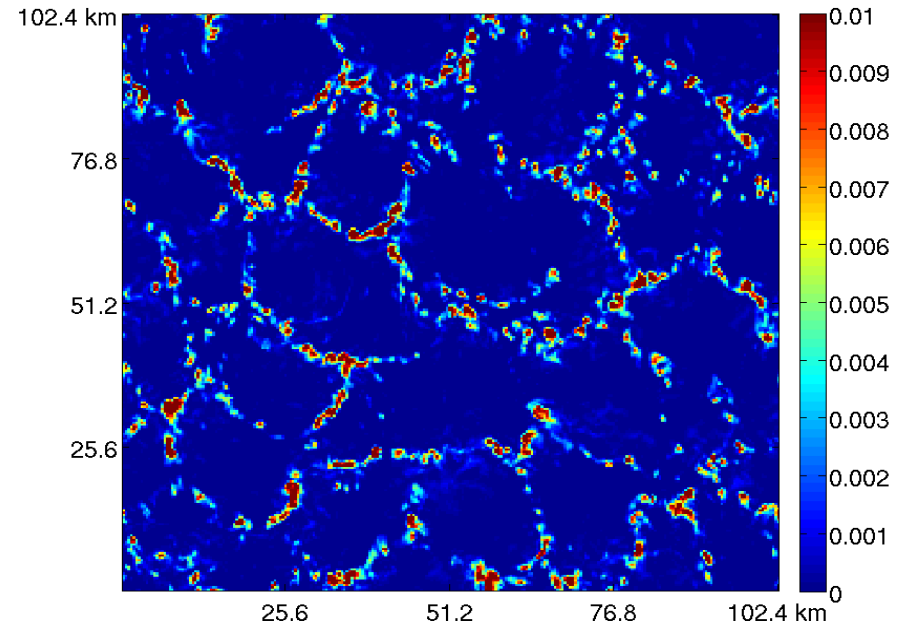
Cell sizes grow with time

$t=10 \text{ hr}$, $N_c = 10 \text{ cm}^{-3}$

LWP (kg m^{-2})



$\Delta x = 200 \text{ m}$

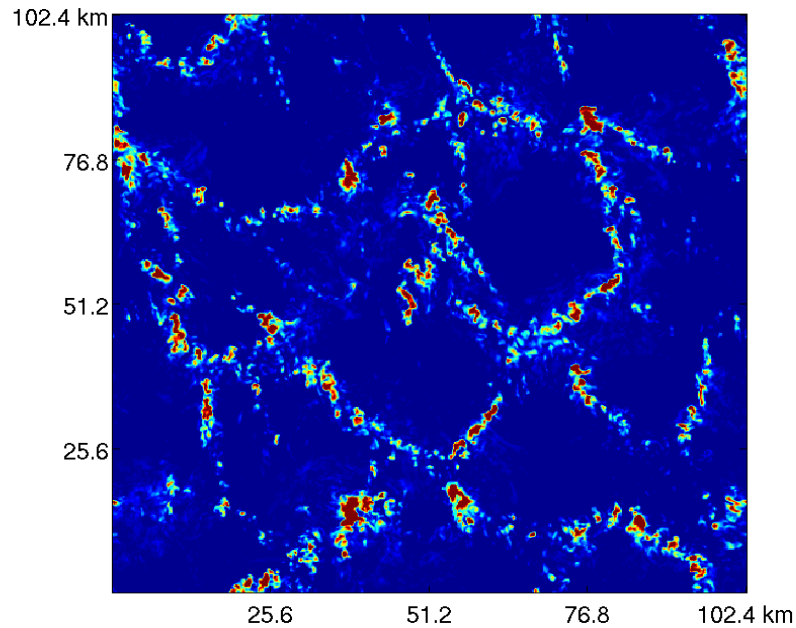


$\Delta x = 400 \text{ m}$

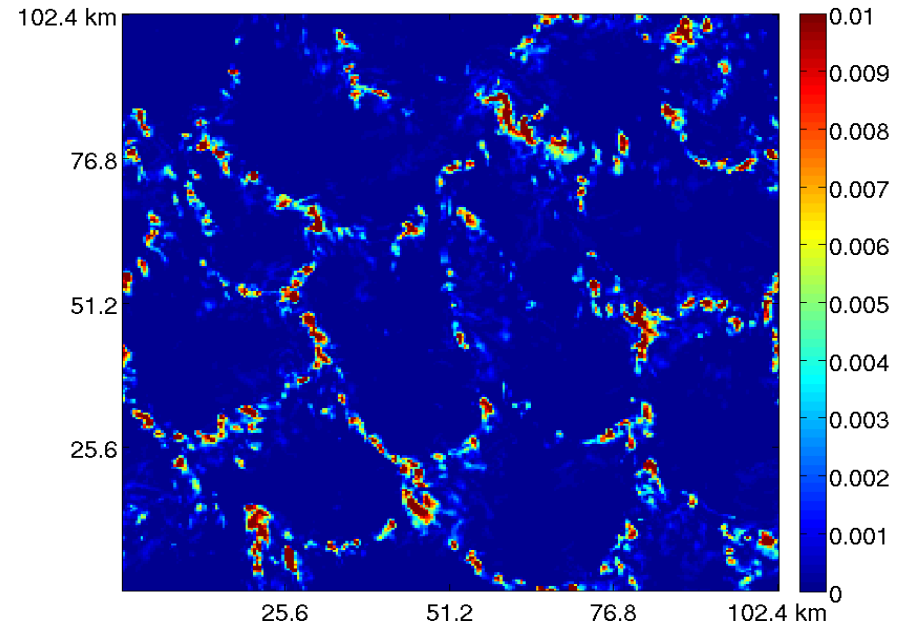
Cell sizes grow with time

$t=13 \text{ hr}$, $N_c = 10 \text{ cm}^{-3}$

LWP (kg m^{-2})



$\Delta x = 200 \text{ m}$

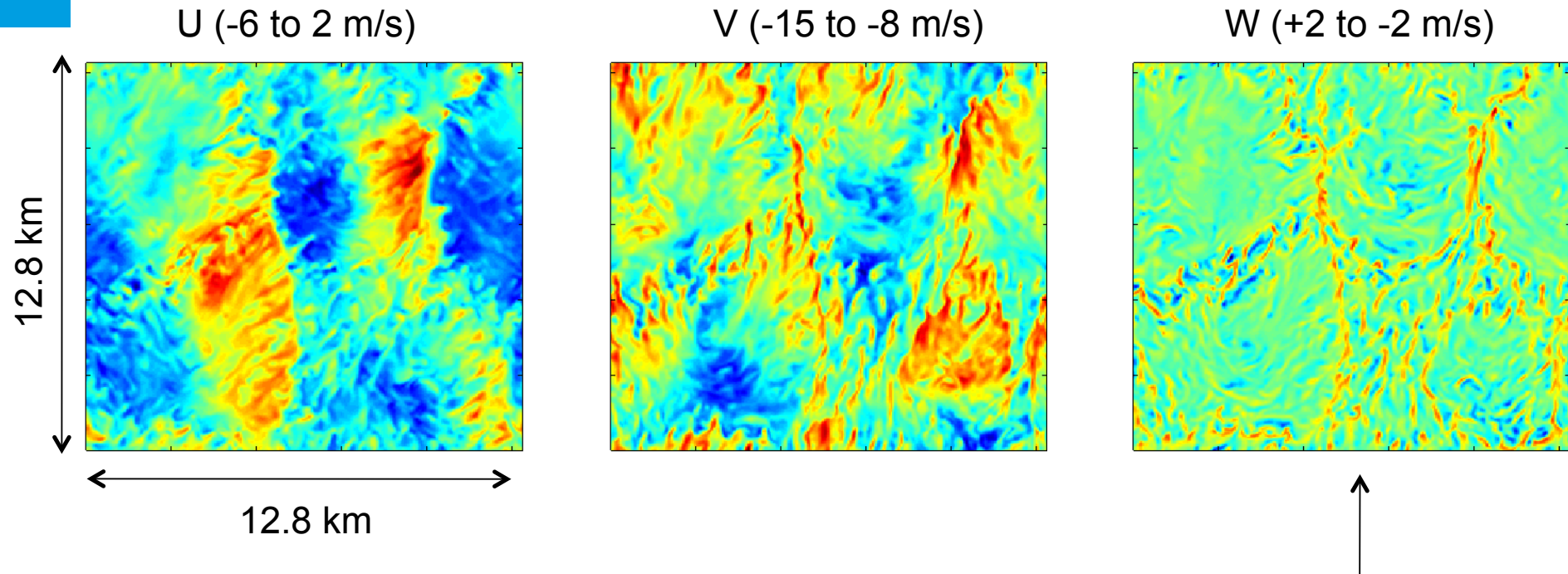


$\Delta x = 400 \text{ m}$

Wind velocity structure

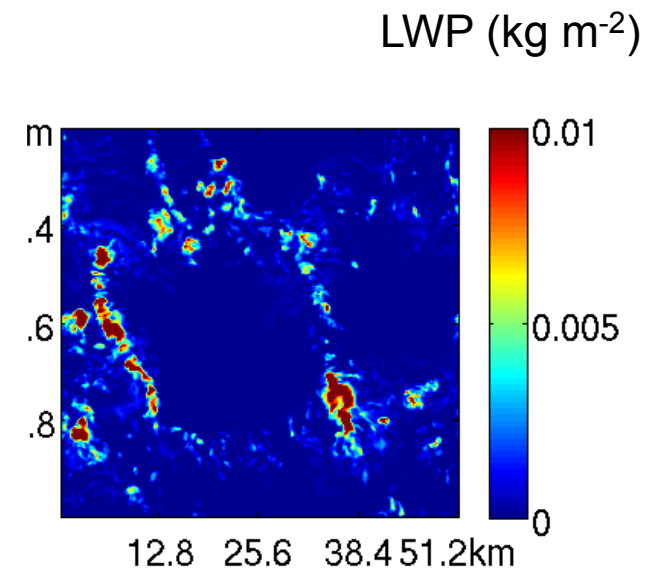
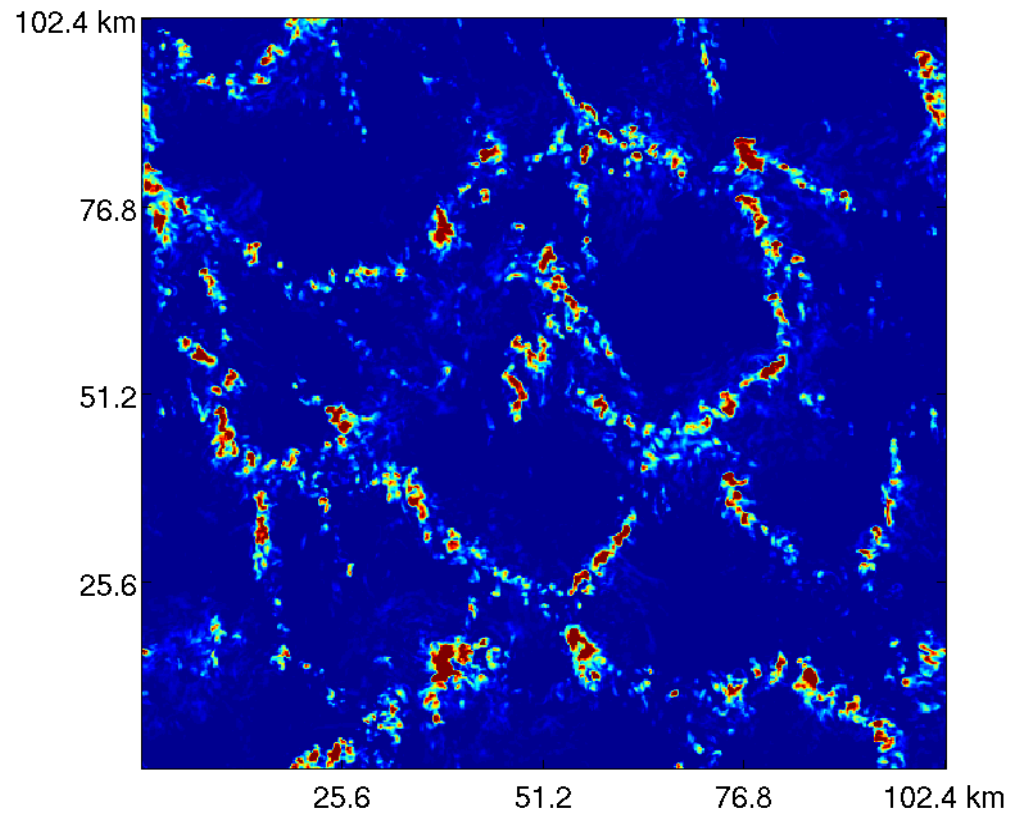
$t = 3\text{ hr}$, $N_c = 10\text{ cm}^{-3}$ at $z = 362.5\text{ m}$

Results from small domain size $L = 12.8\text{ km}$, high horizontal resolution



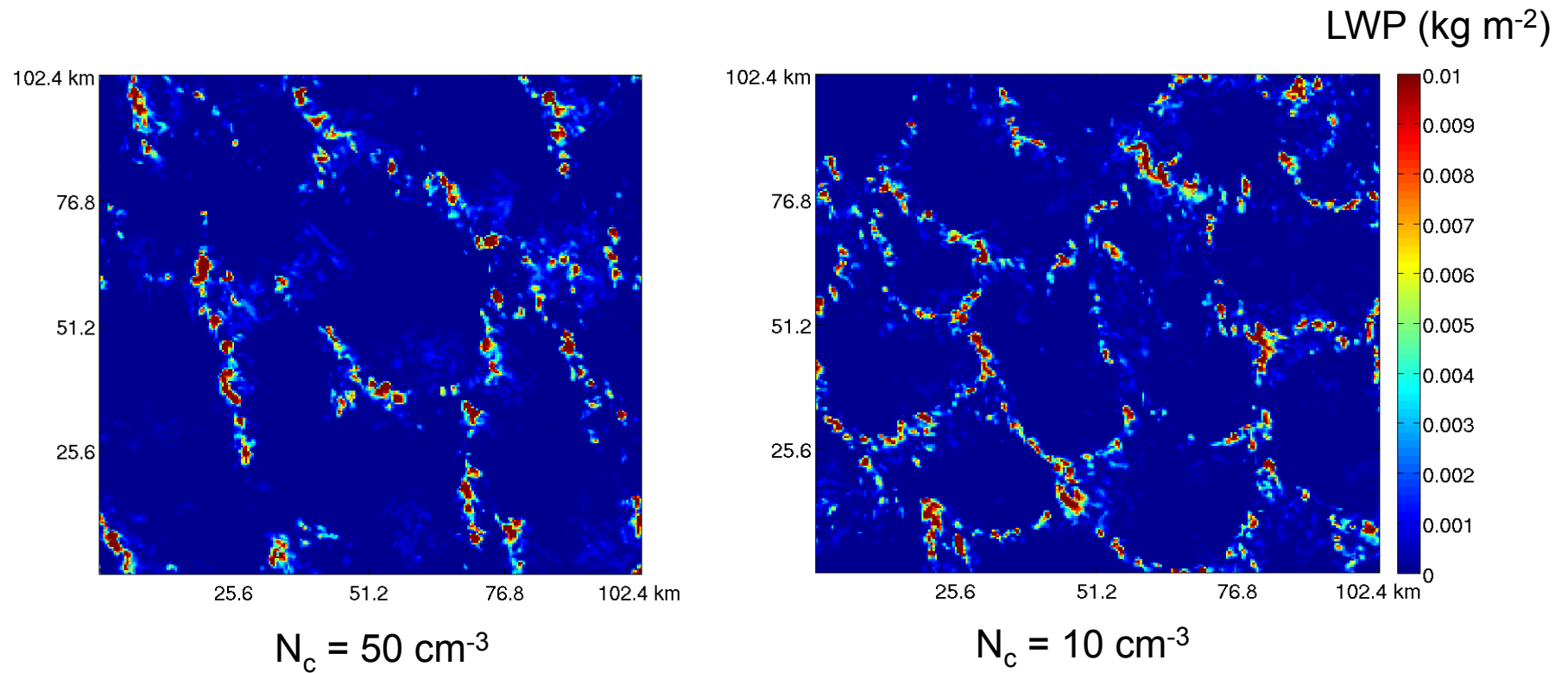
Notice delicate vertical velocity (w) structure

Effects of domain size ($\Delta x = 200\text{m}$) $t = 13\text{ hr}$, $N_c = 10\text{ cm}^{-3}$



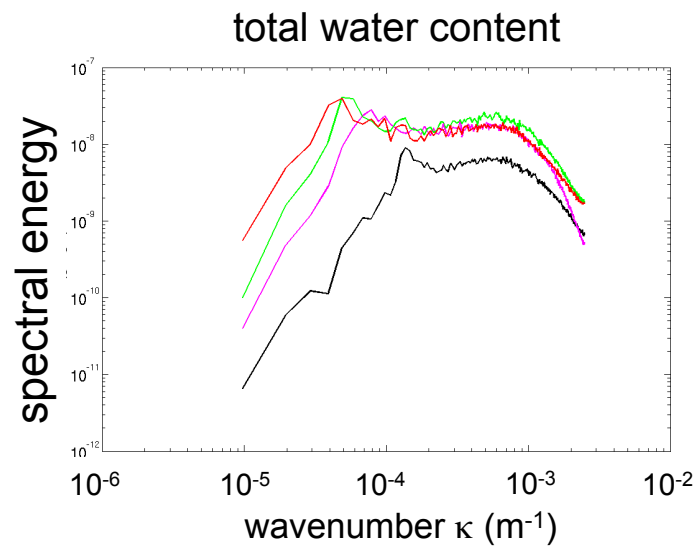
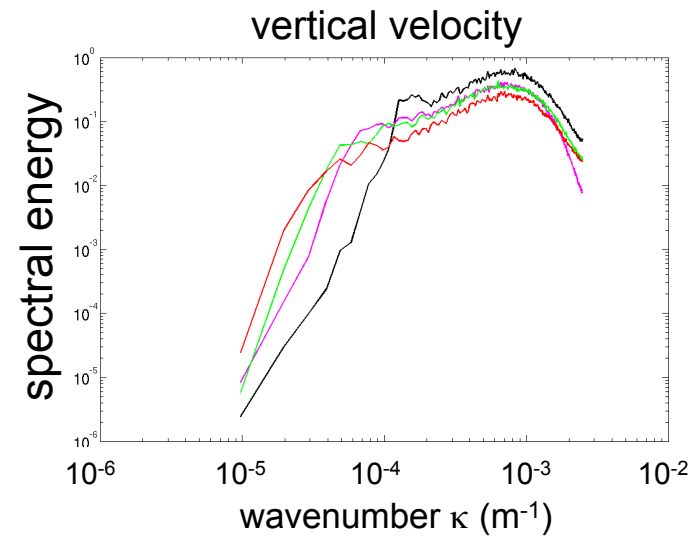
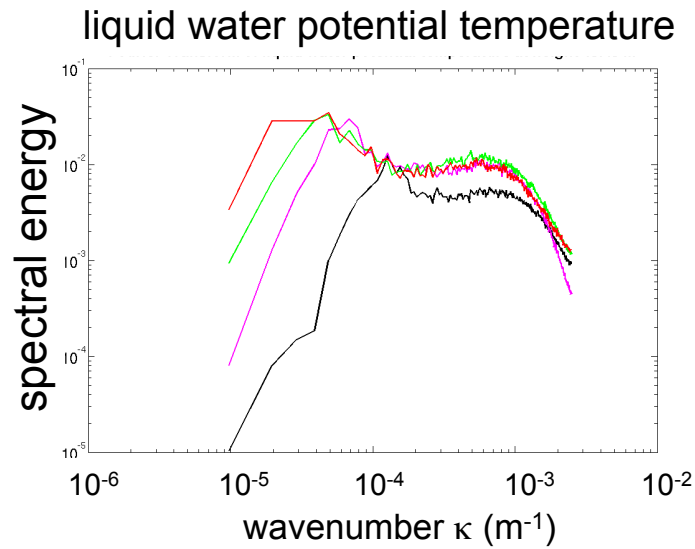
L=50 km seems just sufficiently large

Effects of cloud droplet concentration



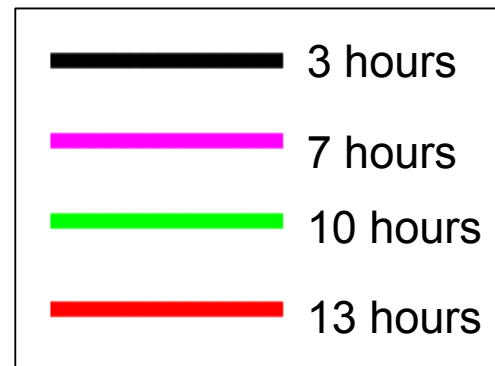
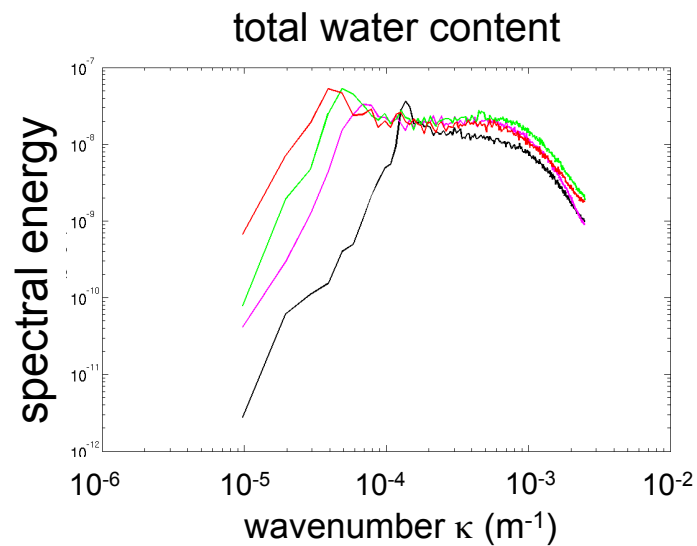
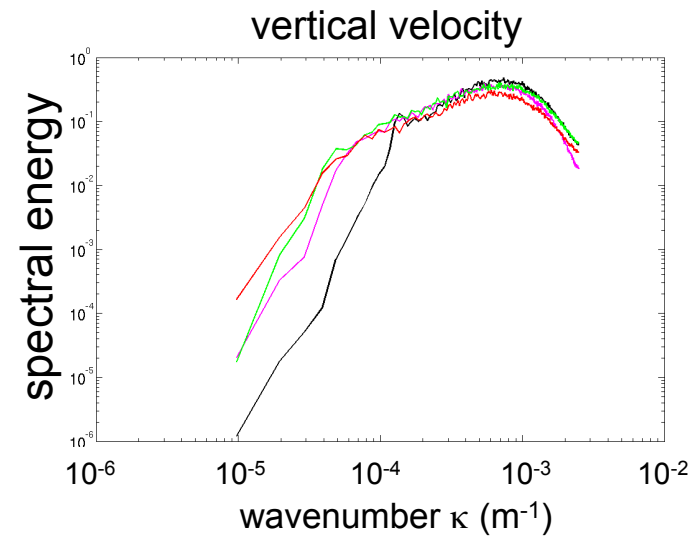
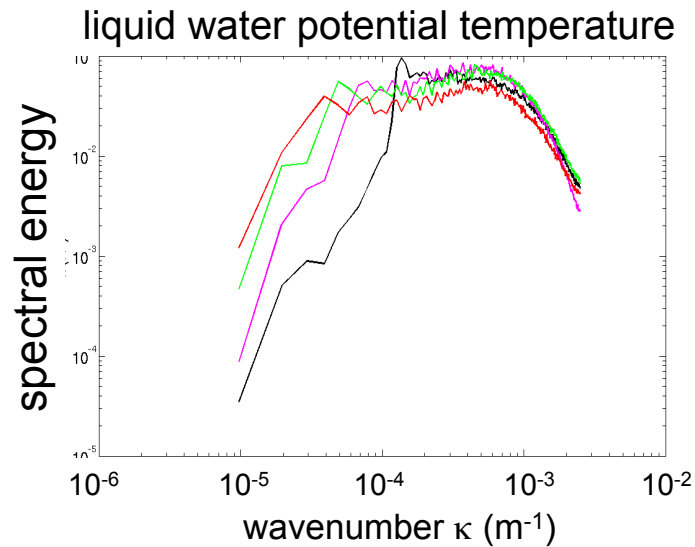
Open cells develop both for $N_c = 10$ and 50 cm^{-3}

Energy spectra (reference simulation, $z = 487.5$ m)



gradual shift of spectral energy
towards larger scales

Energy spectra (reference simulation, $z = 1487.5$ m)



gradual shift of spectral energy
towards larger scales