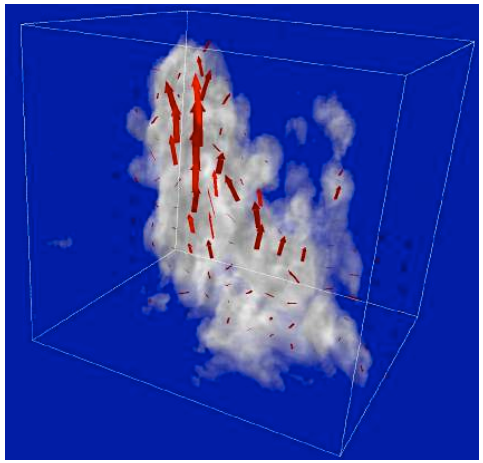
Simulations of deep convection with Harmonie

Emily Jones, Steef Boing, Harm Jonker, Stephan de Roode and Pier Siebesma



Clouds, Climate & Air Quality

Multi-Scale Physics (MSP), Faculty of Applied Sciences, TU Delft

Thanks to our KNMI colleagues Jan Barkmeijer, Emiel van der Plas, Sander Tijm, Ben Wichers Schreur and Gerard Cats (KNMI)

Clouds and Climate group at the TU Delft

Emily Jones, Steef Boing, Harm Jonker, Stephan de Roode and Pier Siebesma



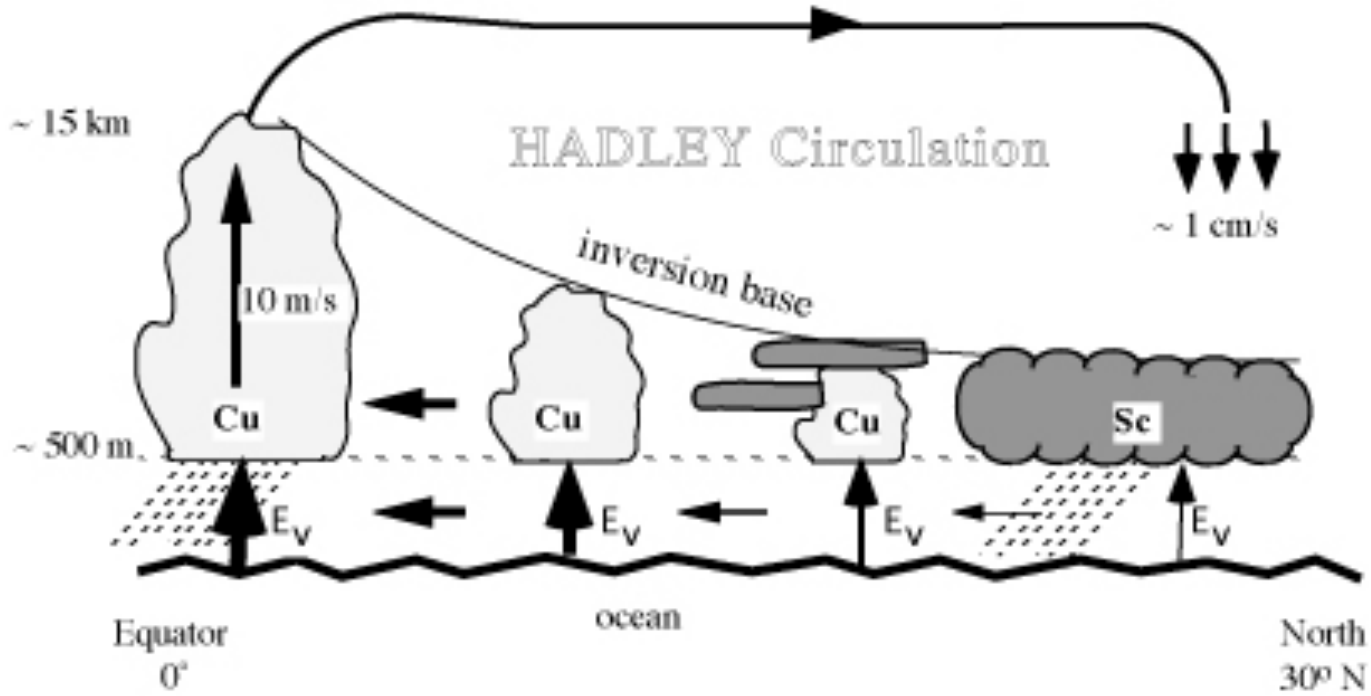


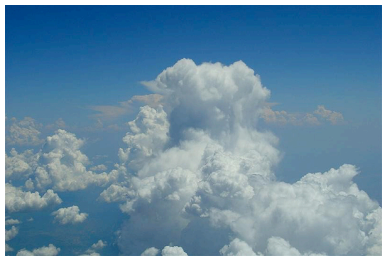
Clouds, Climate & Air Quality

Multi-Scale Physics (MSP), Faculty of Applied Sciences, TU Delft

Thanks to our KNMI colleagues Jan Barkmeijer, Emiel van der Plas, Sander Tijm and Gerard Cats (KNMI)

The playground for cloud physicists: Hadley circulation



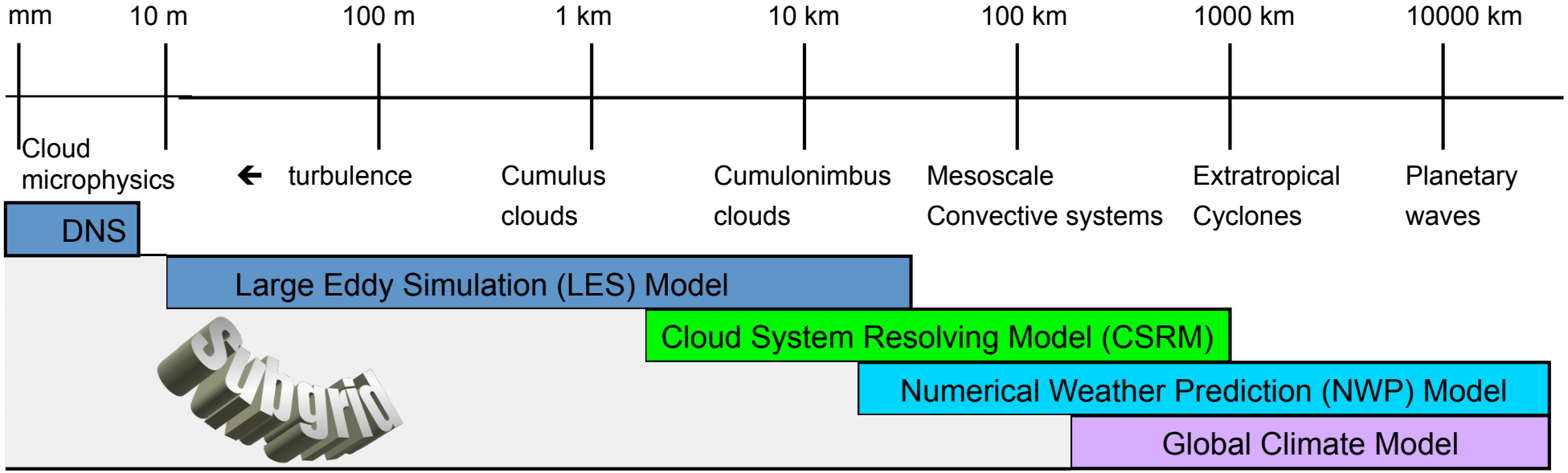


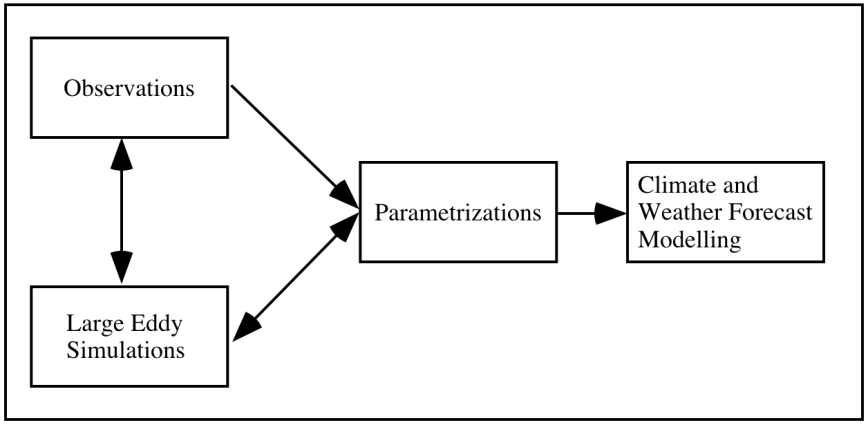
deep convection

shallow cumulus

stratocumulus

The Zoo of Atmospheric Models



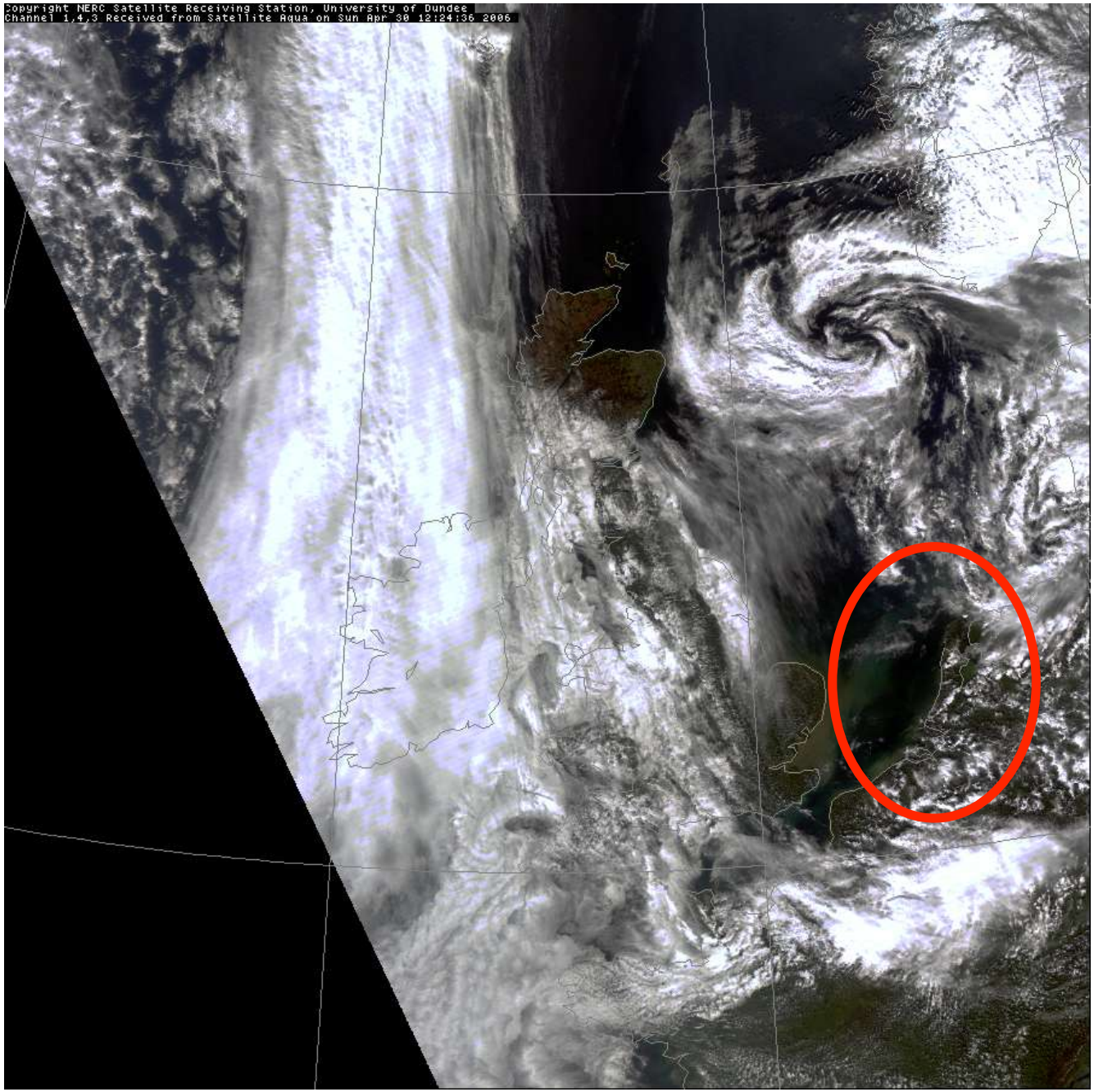


Outline

HARMONIE results

- 30 April 2006, "cold pools" and heavy precipitation
- 25/26 May, bad weather, Schiphol affected

Research strategy

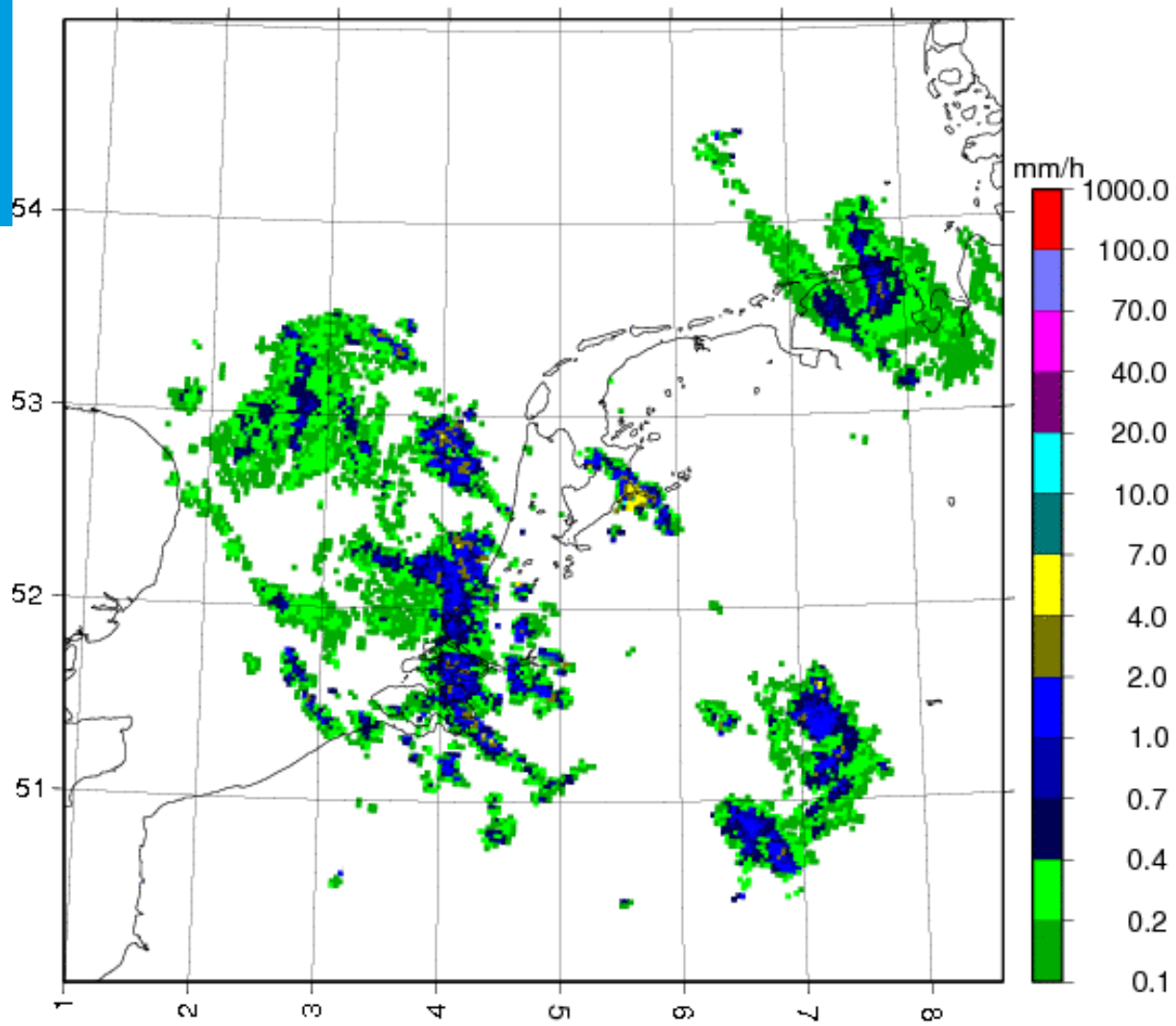


30 April 2006

Relatively small horizontal wind velocities

Deep convection and formation of cold pools

Radar NL 20060430 0000 UTC



Convection driven from the ground surface

Low mean horizontal wind velocity

Convection in HARMONIE

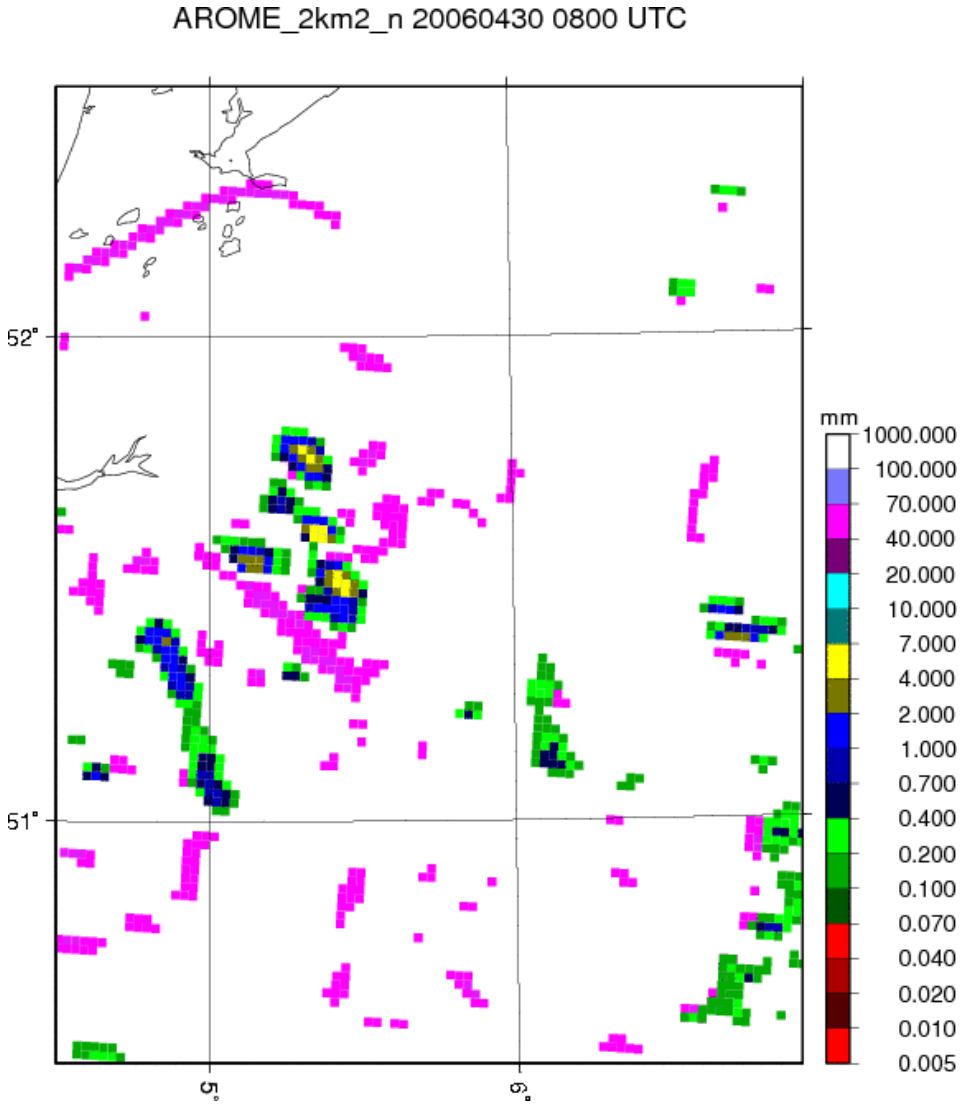
HARMONIE non-hydrostatic model

=> Convective systems can be explicitly represented

Cloud water, ice, rain, graupel (supercooled water droplets that condense on a snow flake) and snow are included

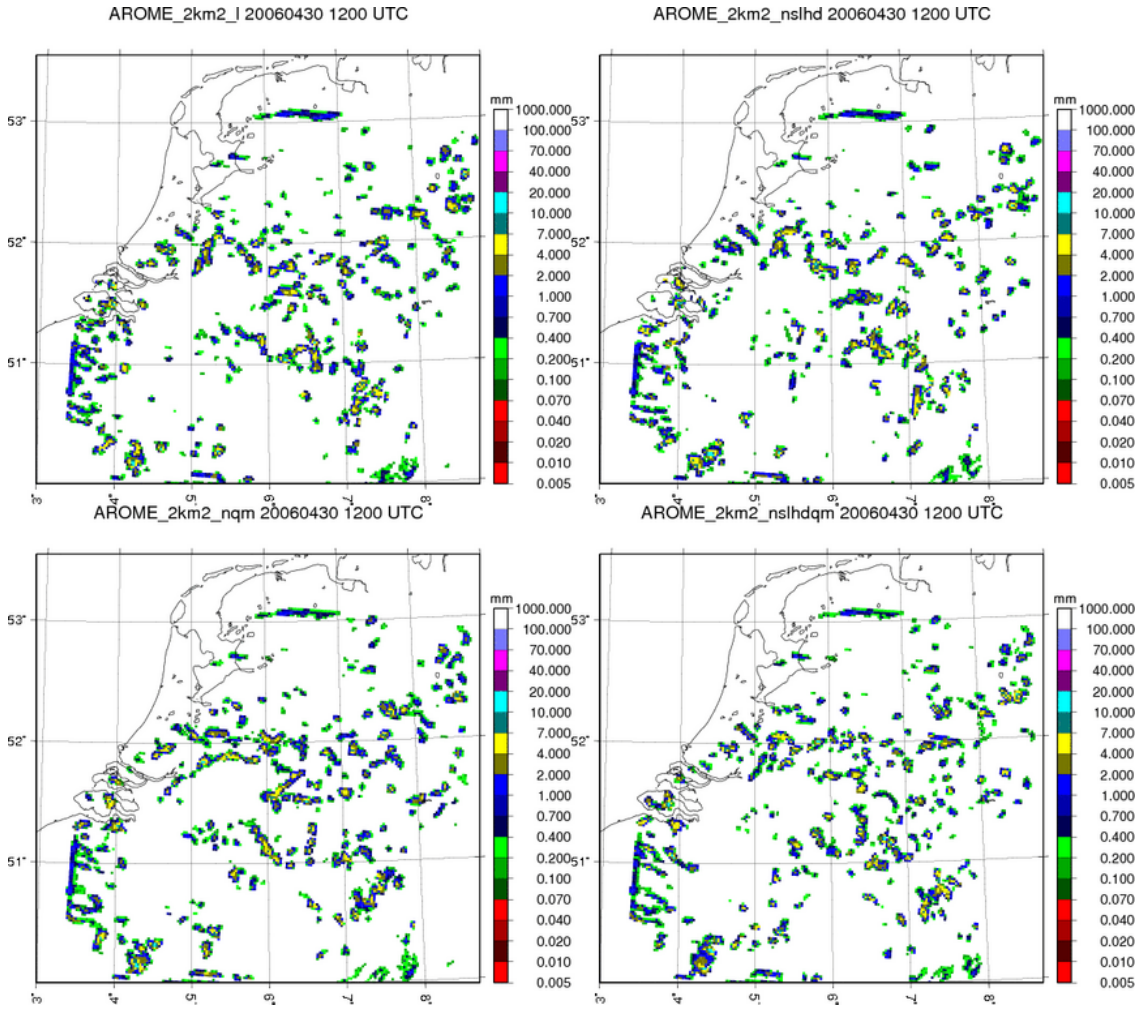
Challenge: understanding the role of evaporation of cloud water on the intensity of downdrafts and outflow strength

Results: outflow & precipitation

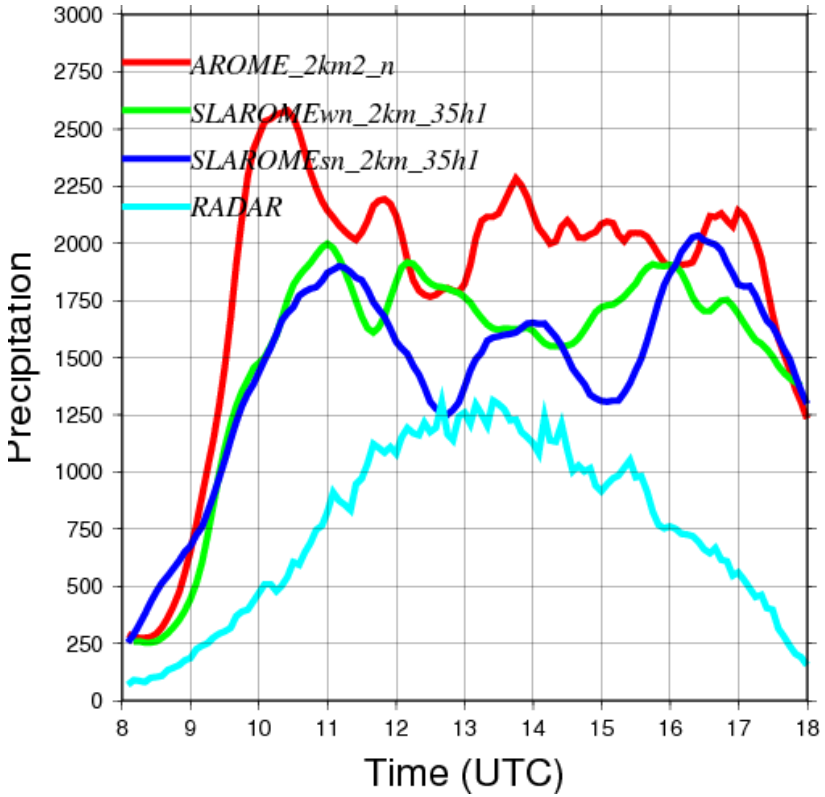


- purple points: strong outflow close to the ground surface
- heavy precipitation very close to these outflow boundaries

Intensity of outflow shows some dependency on numerics and horizontal diffusion

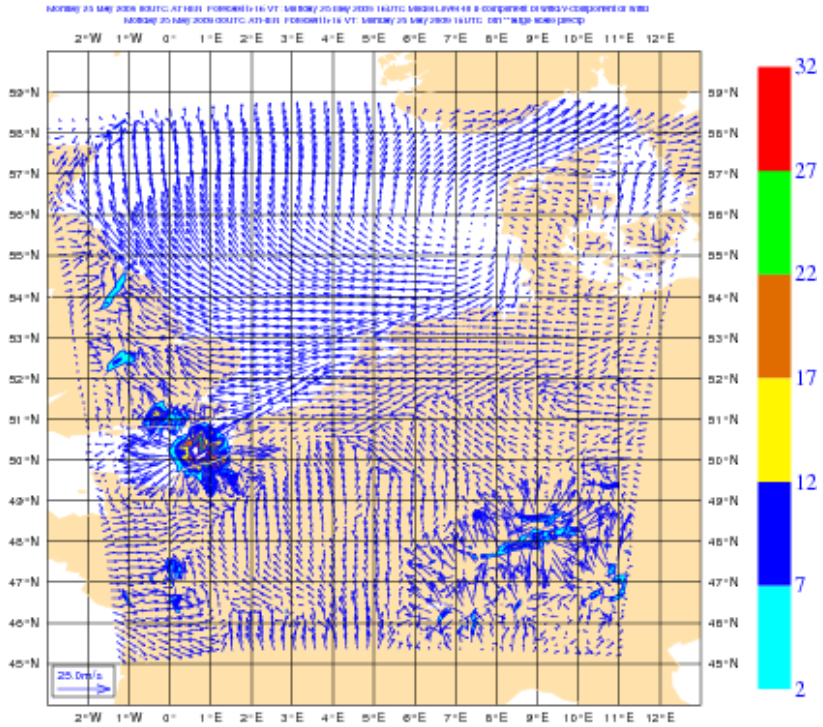


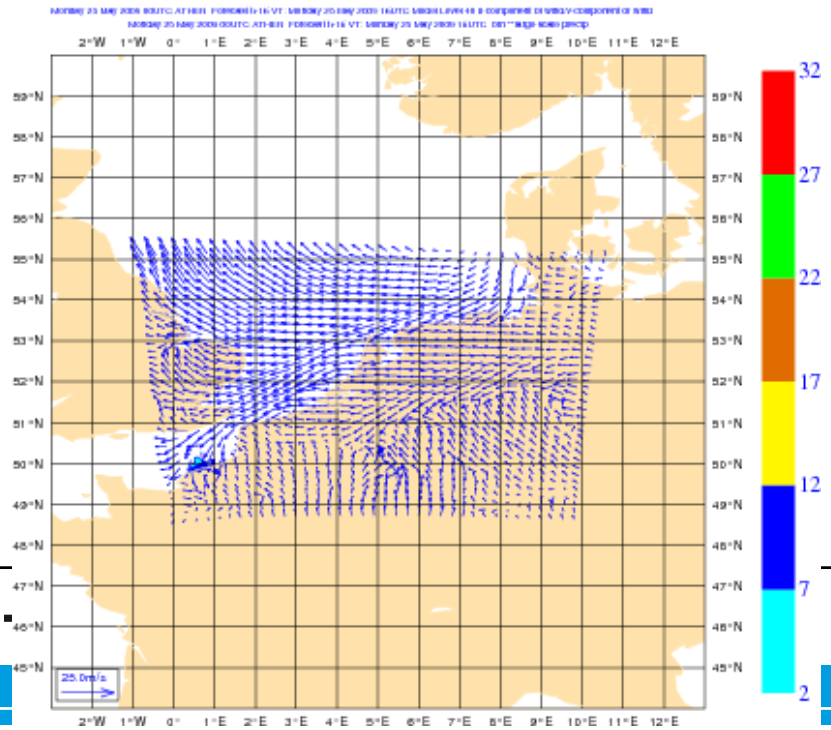
Is the intensity of the precipitation right?



- Precipitation peaks too early and is too large

+ HARMONIE is capable to predict the onset of cold pools





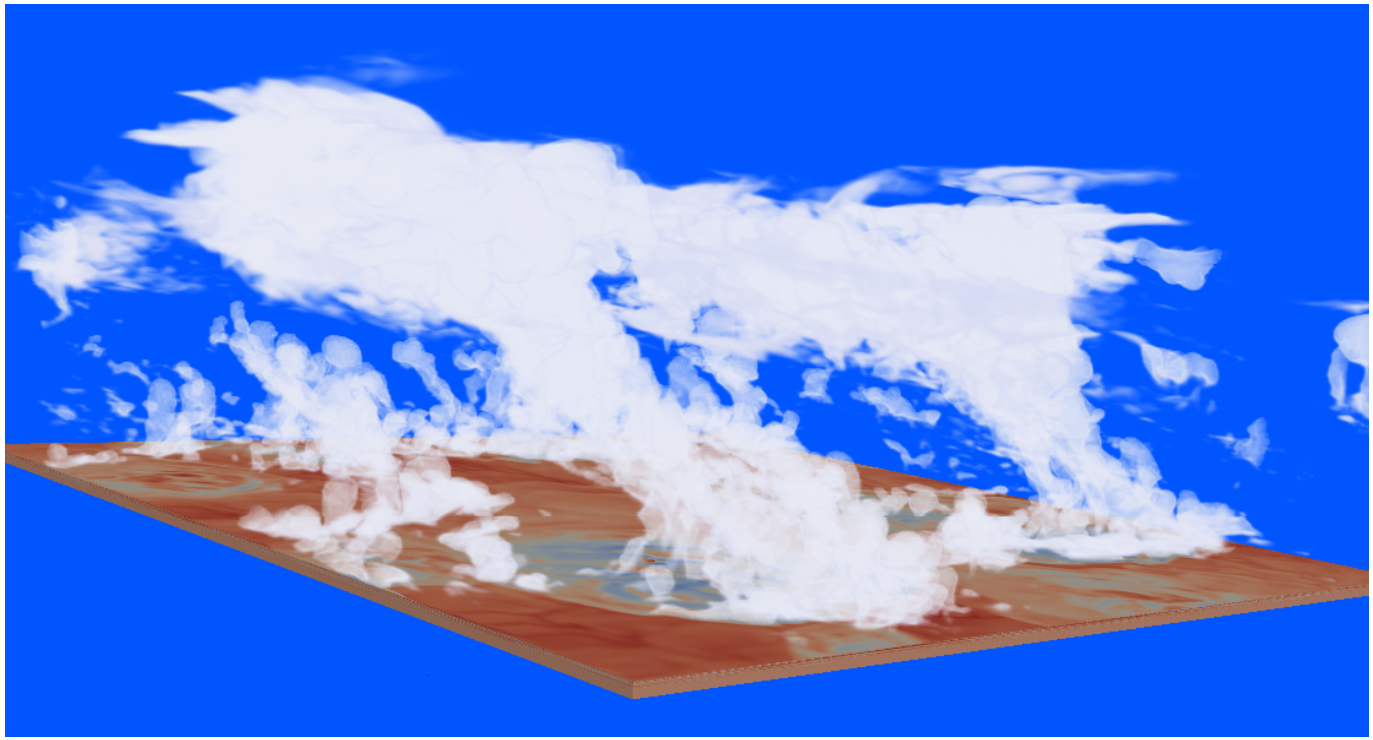
25/26th of May 2009, bad weather (Schiphol affected)

Horizontal domain size too small => bad weather system poorly represented

Convective system does not have sufficient time to develop (it travels rapidly out of the domain)

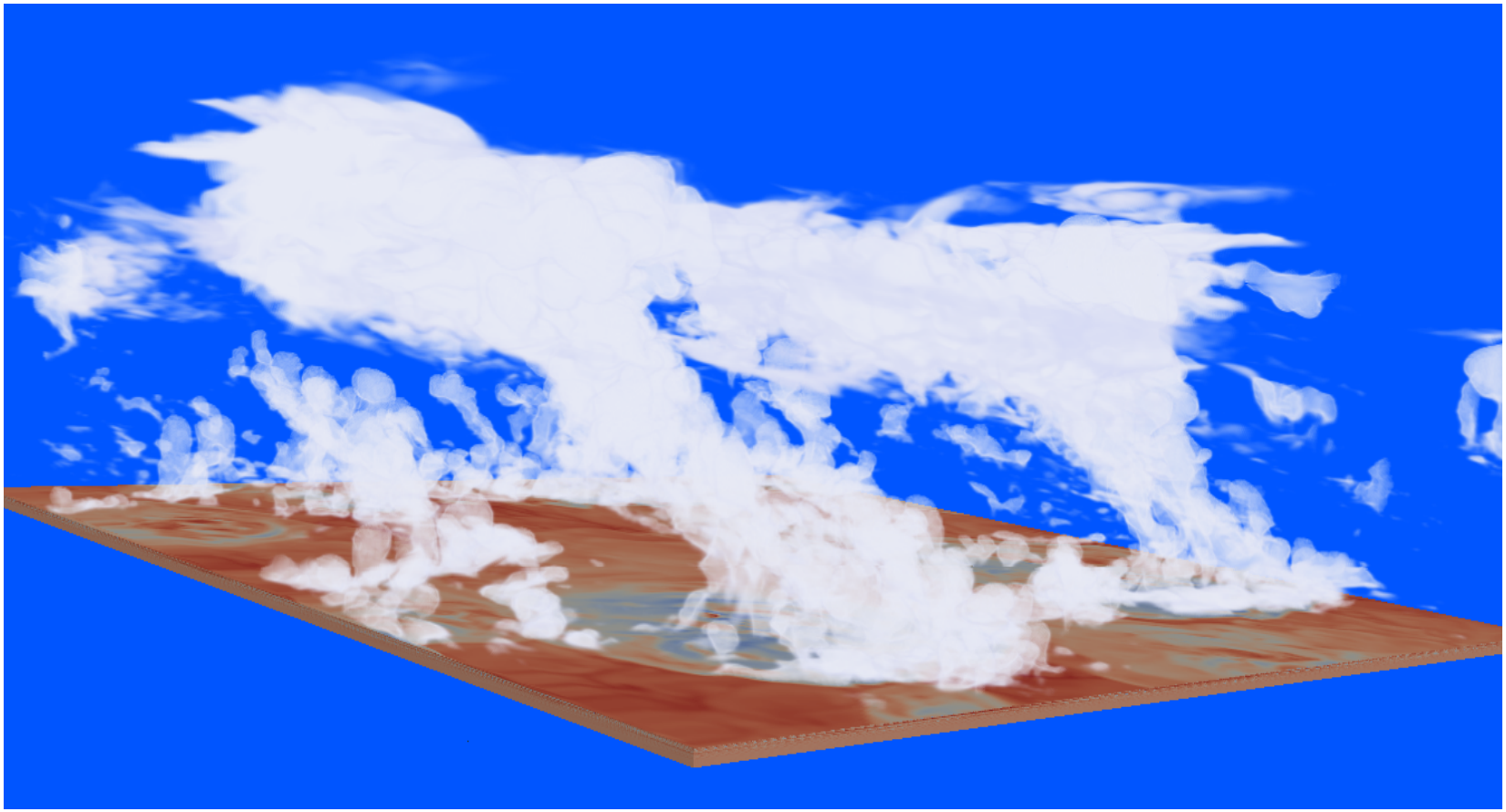
Effect of lateral boundaries

Cold pool dynamics with a fine-scale turbulence model



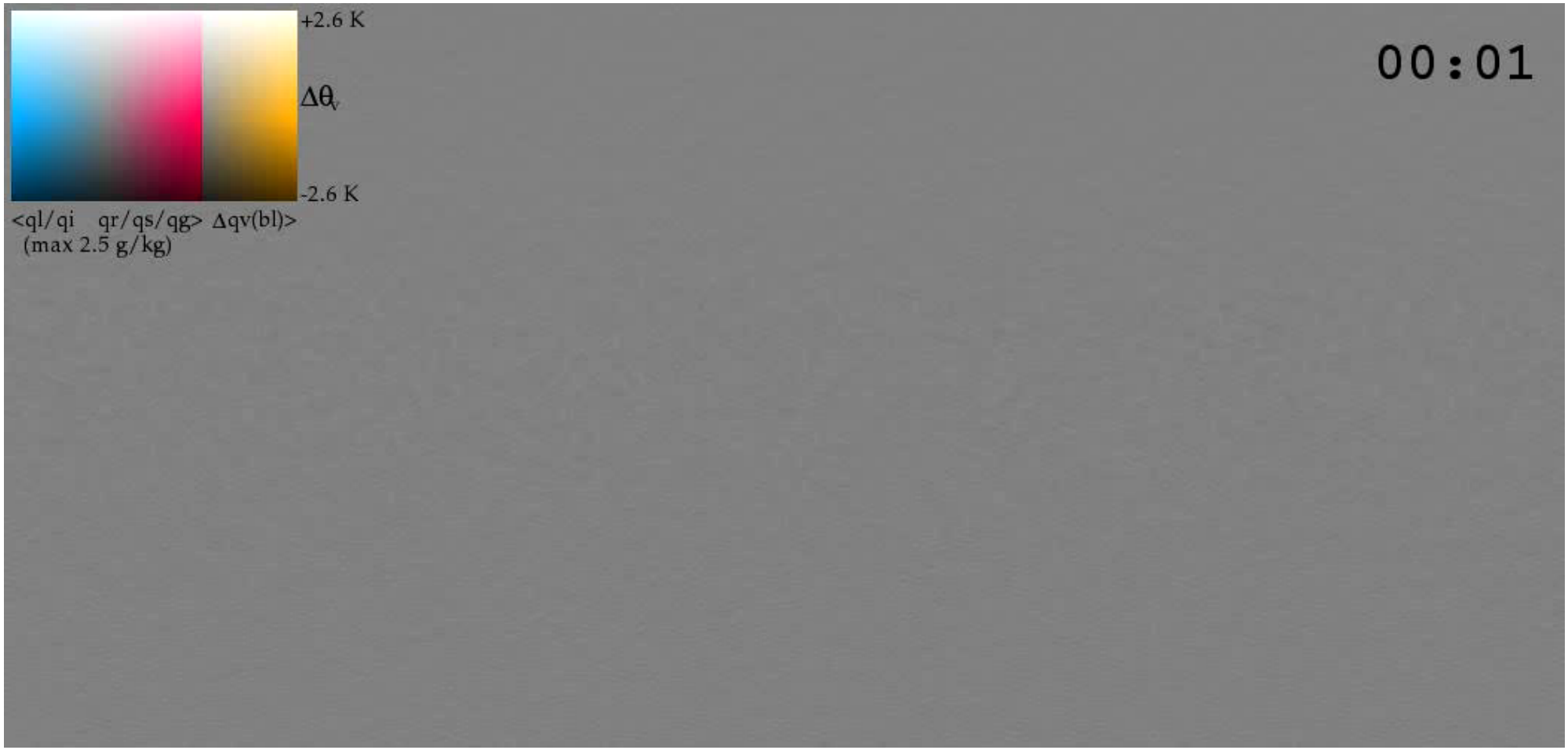
Simulation on a 50x50x25 km^3 domain size
Number of grid points 256^3

Simulation results



Buoyancy ("air density") field at 100 m height (horizontal plane)

Buoyancy ("air density") field at 100 m height (horizontal plane)



Conclusions

- Precipitation peaks too early and is too large

+ HARMONIE is capable to predict the onset of cold pools

+ Convective systems can be well represented, however, take care of horizontal domain size

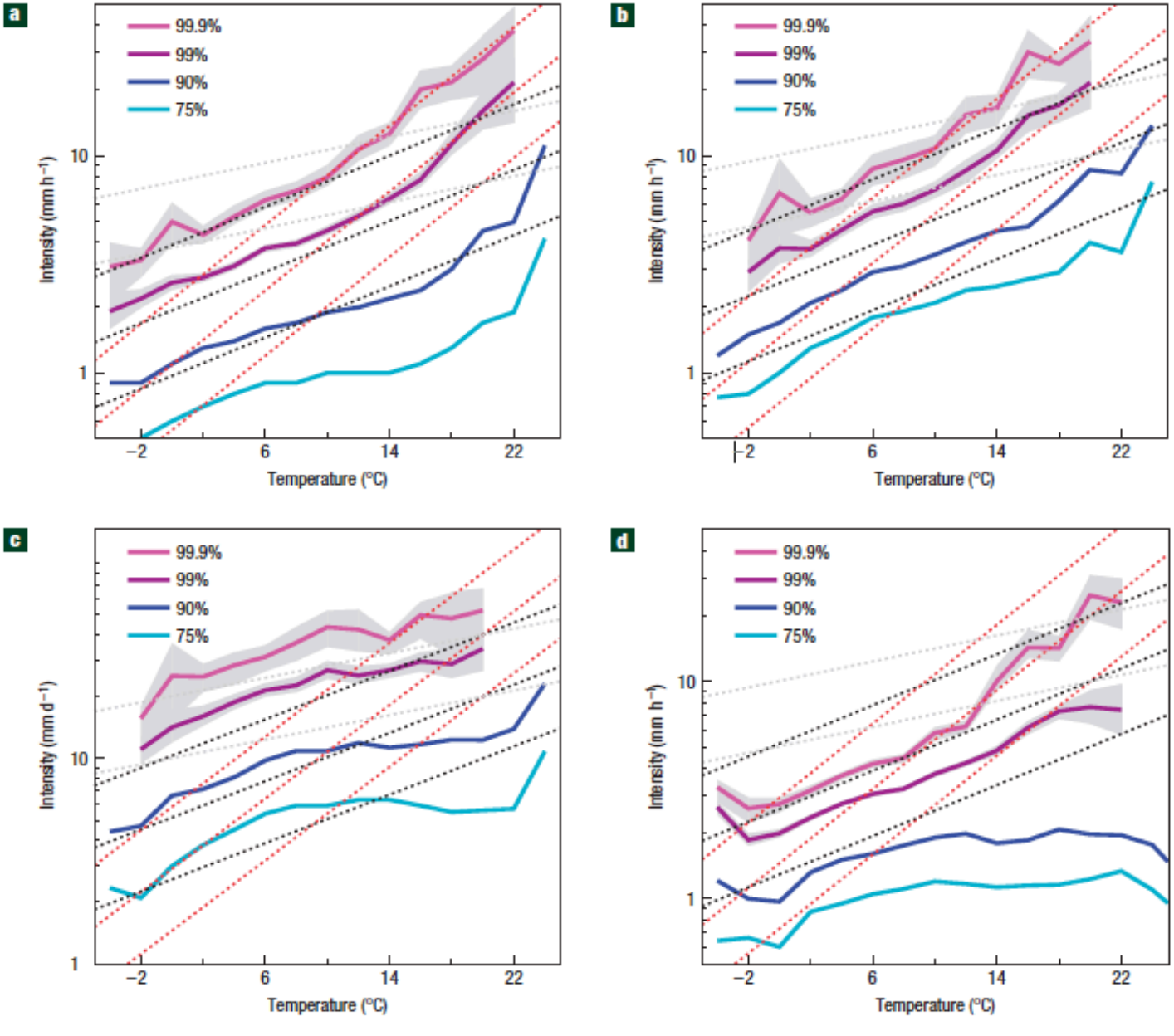
Further research

Ice or liquid water in clouds?

What is the effect on the outflow intensity?

Observed 1 hr

Observed 1 day



Lenderink

Modeled, 1 day

Modeled, Maximum 1 hr