Numerical simulation of squall line by using detailed microphysics

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Background

The characteristics of cold pool affect both the formation and propagation of squall line.

Preliminary studies shows that the released latent heat of evaporation depends on the size distribution of water drops.

In convective clouds the liquid precipitation form during the melting (or shedding).

Description of the model

Four different hydrometeor species, both number concentartion and mixing ratio are simulated in 36 size bins:

water drops, pristine ice crystals, snow particles and graupel particles.

Furthermore:

mixing ratio of rimed water on the surface snow particles;

melted water on the snow particles and graupel particles.

Moment conserving technique of Tzivion et al. (1987, 1999) implemented to prevent artificial broadening of the hydrometeor distributions by numerical diffusion.

Microphysical processes involved in the model :

Cloud droplets initiated from a CCN spectra as a function of supersaturation
typical of continental and maritime clouds.

Ice initiated via:
Deposition or condensation freezing (Cooper, 1986).
Freezing of drops via Biggs freezing mechanism (Bigg, 1954).

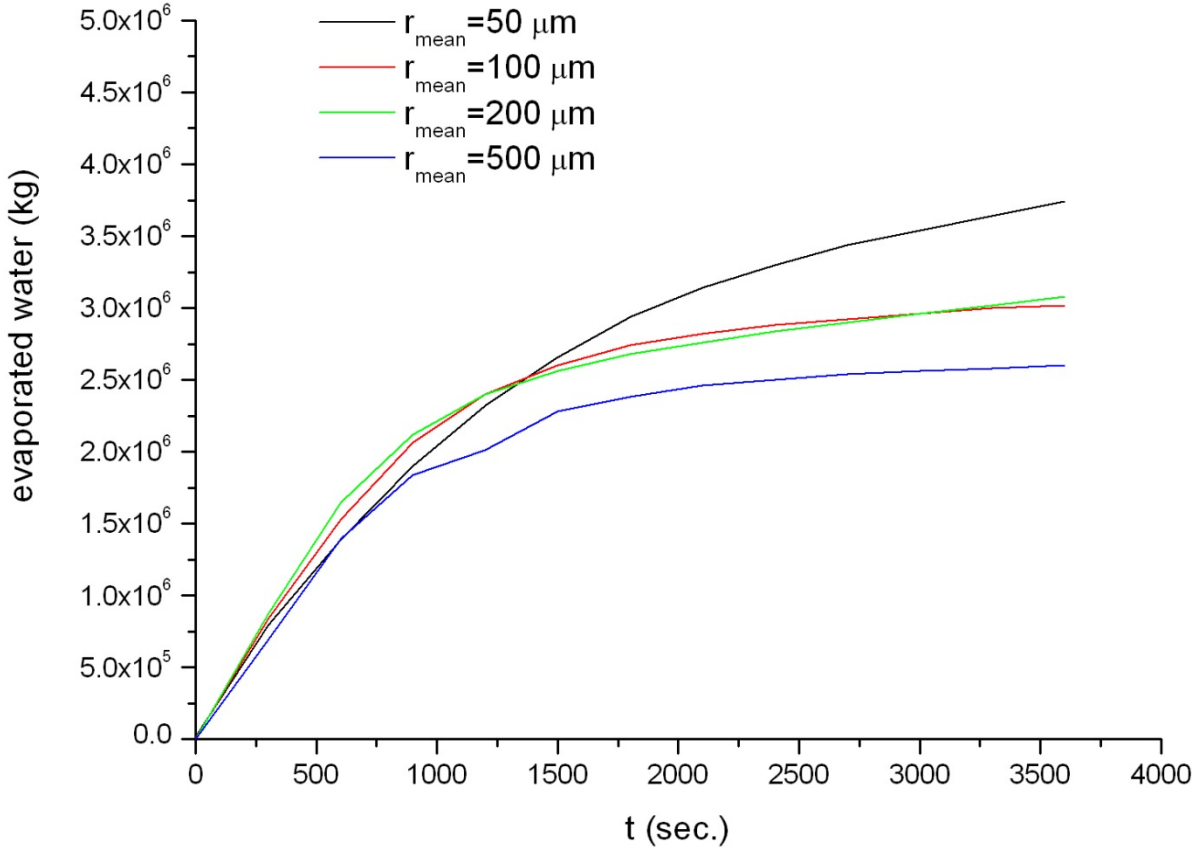
Diffusional growth (water drops, pristine ice, snow and graupel particles).

Melting of the different type of ice particles:
No shedding of water from partially melted snow/graupel particles unless diameter >1 cm.
Water drops form after the complete melting of the ice particles.

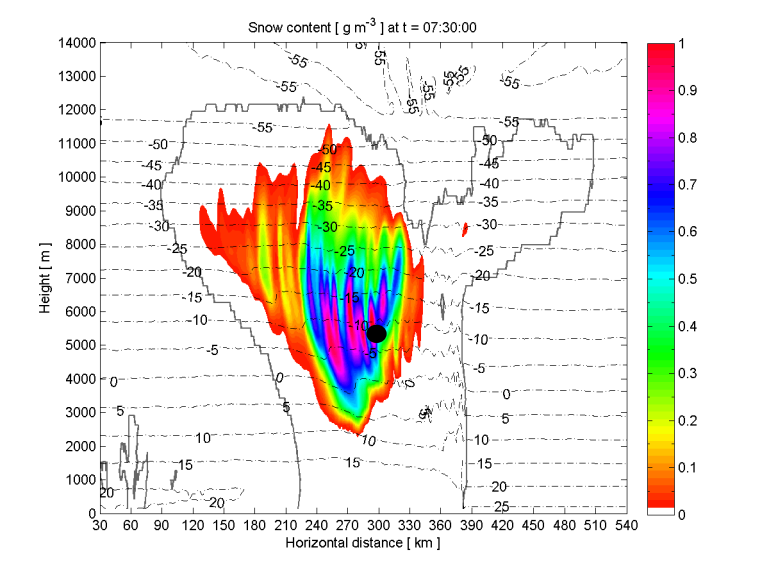
Collision and coalescence between different types of species.

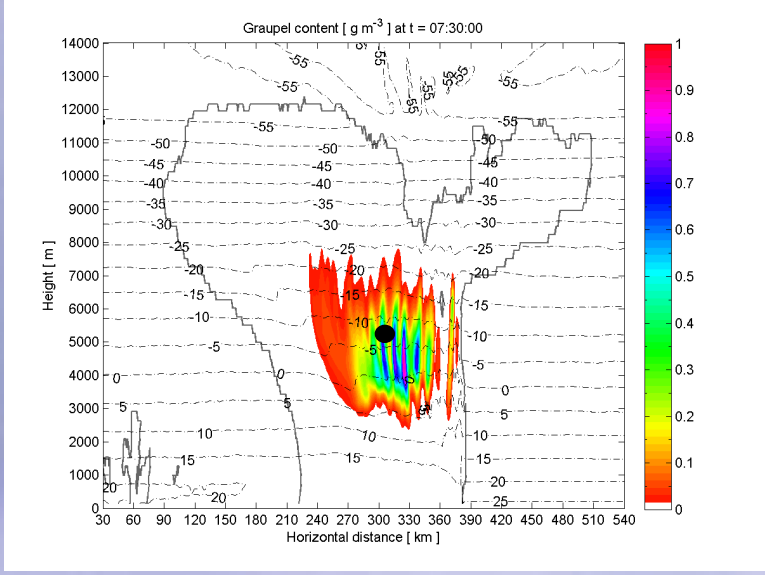
Riming of the snow particles:
Transfer from snow to graupel depends on the fraction of the collected water drops

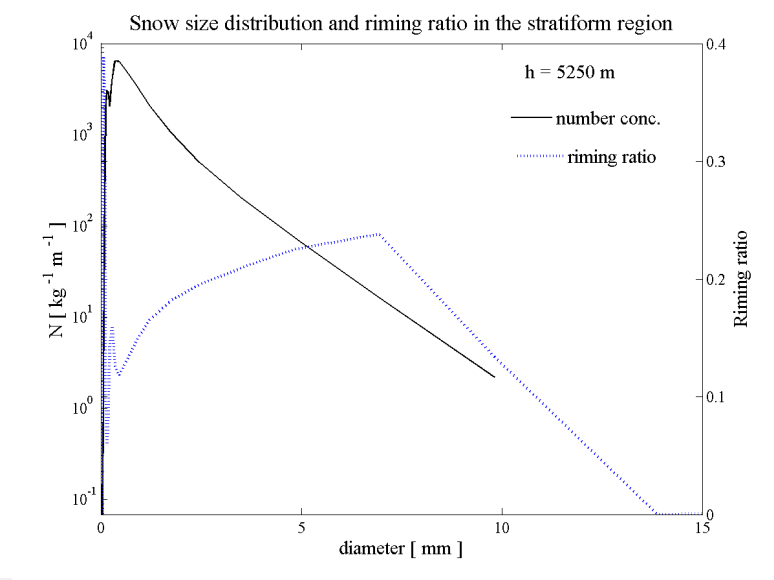
Sensitivity of evaporation on the size distribution of the water drops

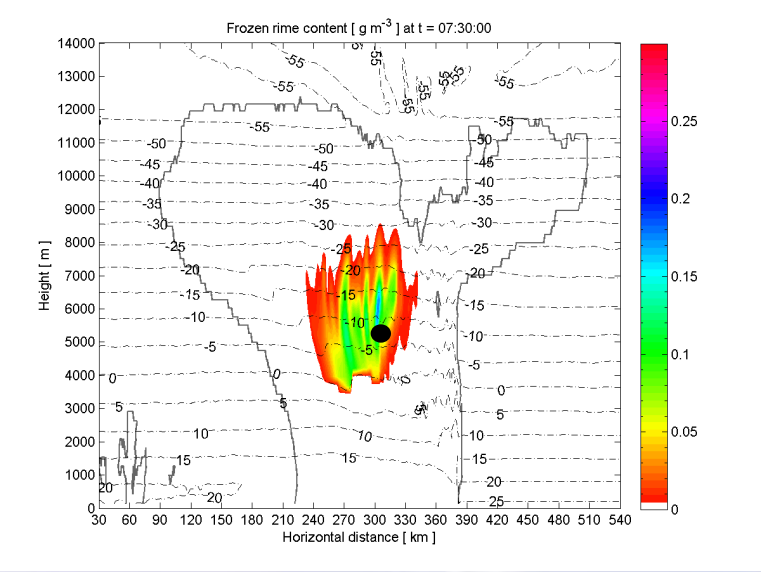


Formation of graupel particles

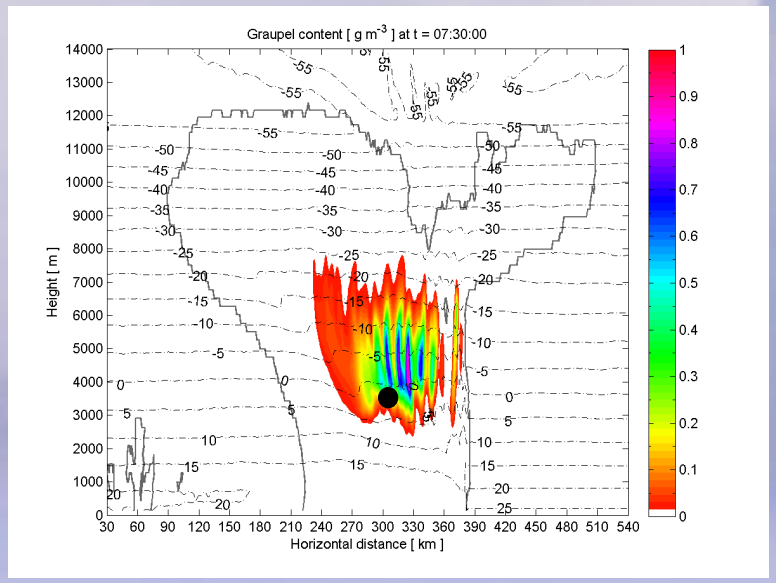


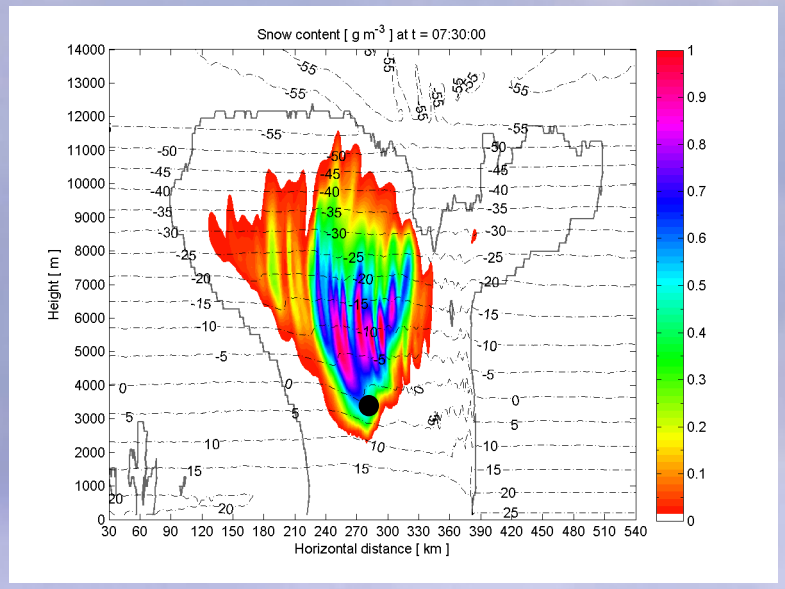


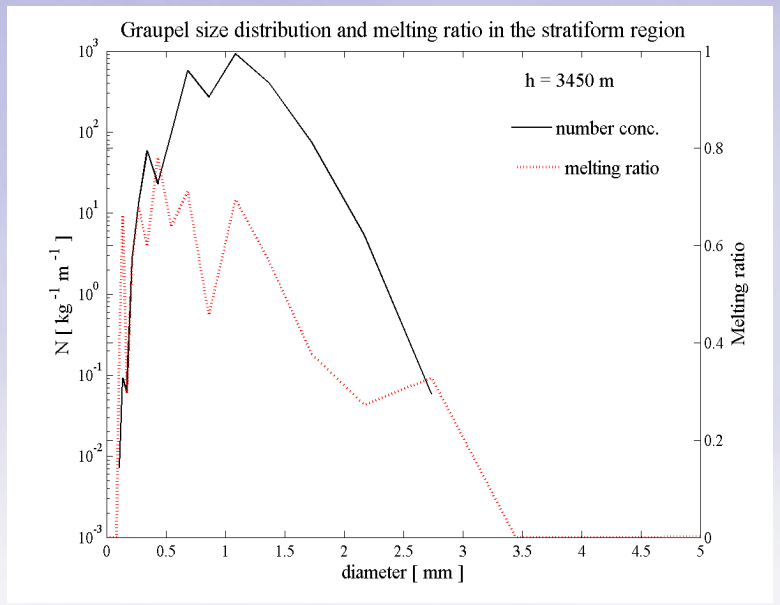


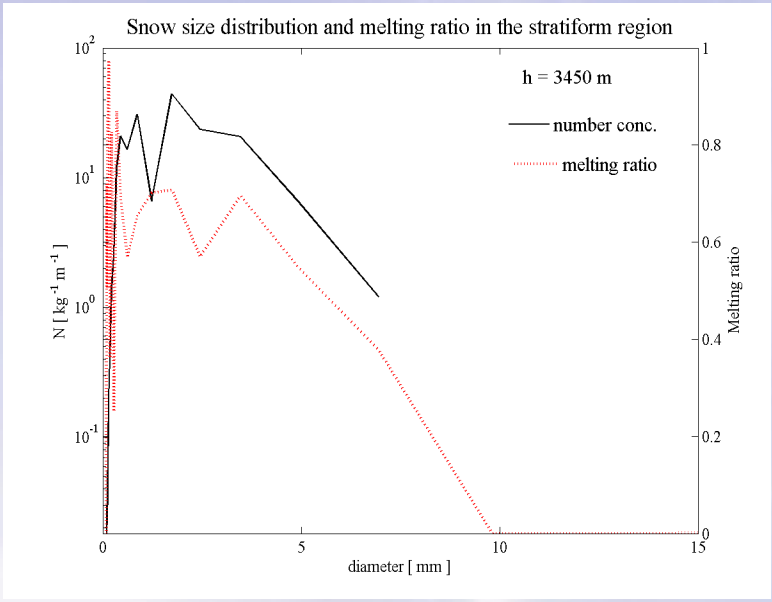


Melting of snow flakes and graupel particles

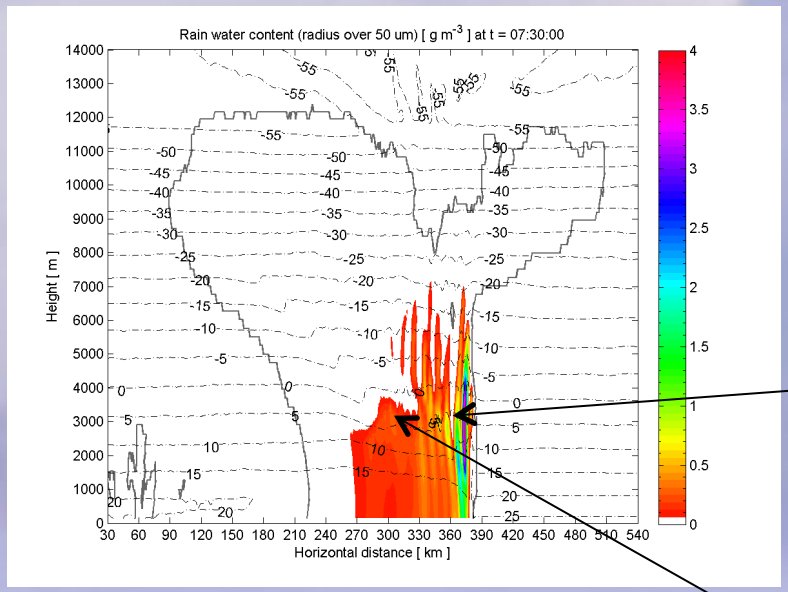


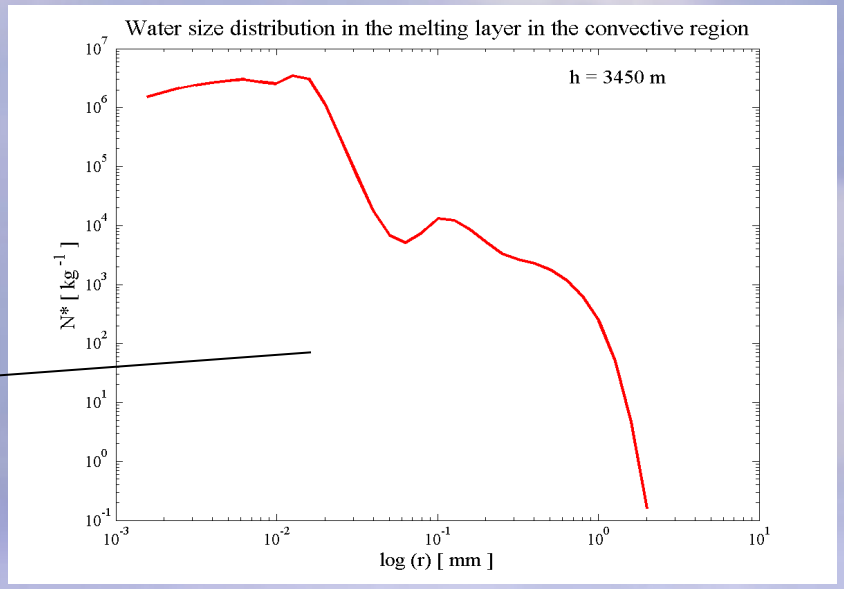


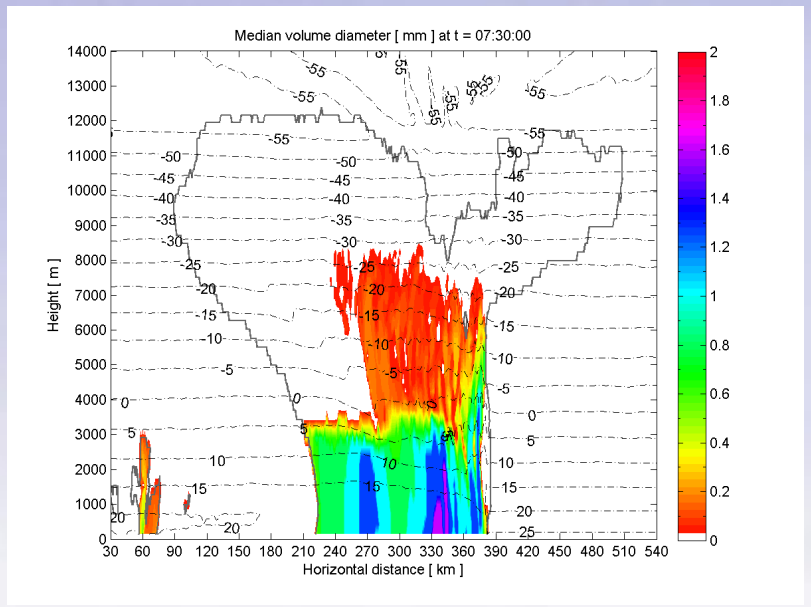


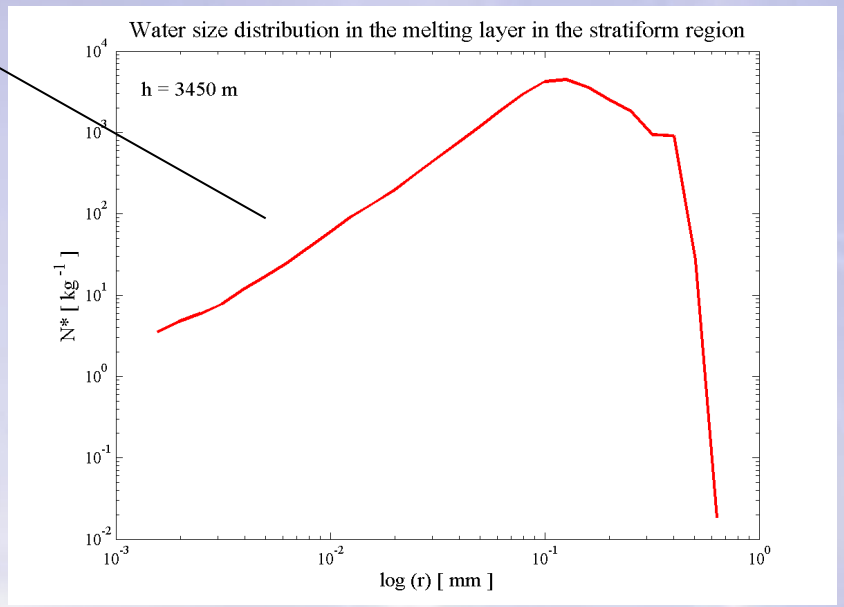


Characteristics of the water drops









Conclusions:

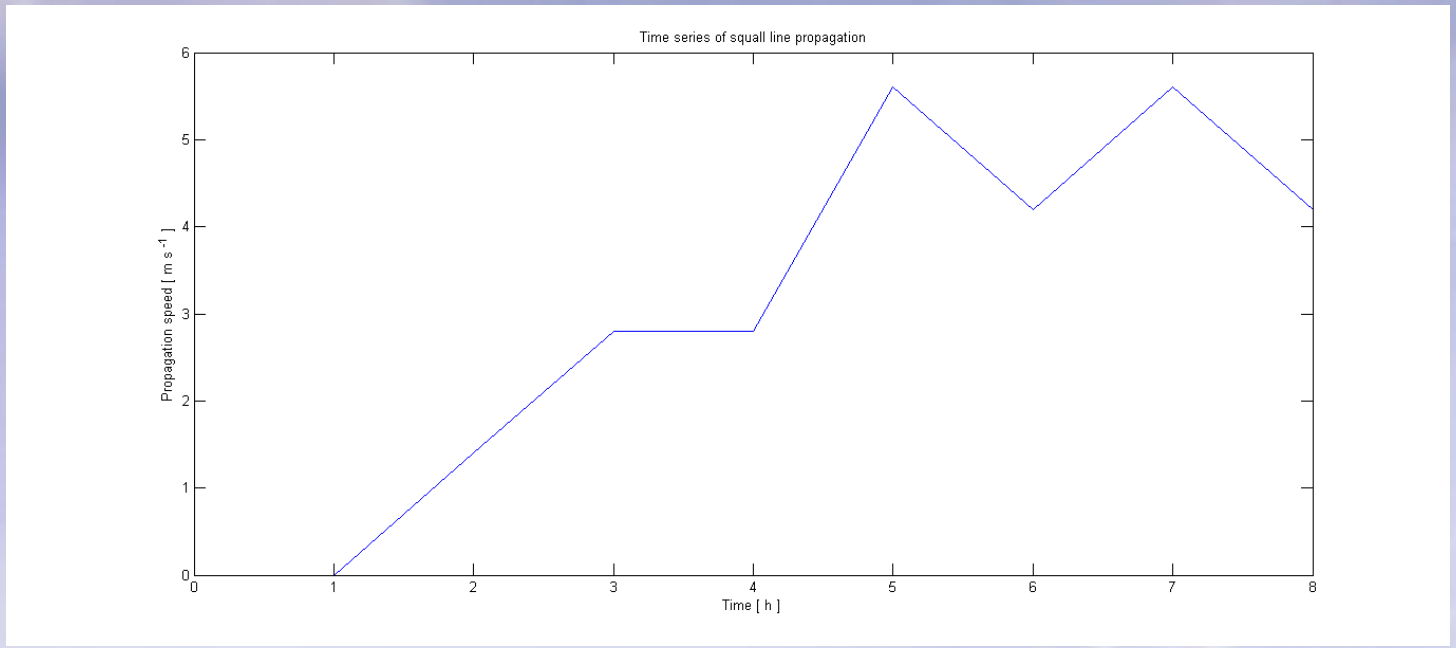
Tracking of rimed water and melted water significantly improves reliability of the model.

Further development of bin scheme (eg. aggregation of the snow flakes, hail category).

Application of the detailed model as a bench mark for development of bulk schemes.

Thank you for your attention!

Propagation of the cold pool relative to the ground



Comparison of the detailed and bulk microphysics