

Towards the improvement of icing forecasts using the HARMONIE-AROME model



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WISLINE – Wind, Ice, and Snow Loads Impact on Infrastructure and the Natural Environment

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Photo: Ole Gustav Berg, statnett

Later that year.....

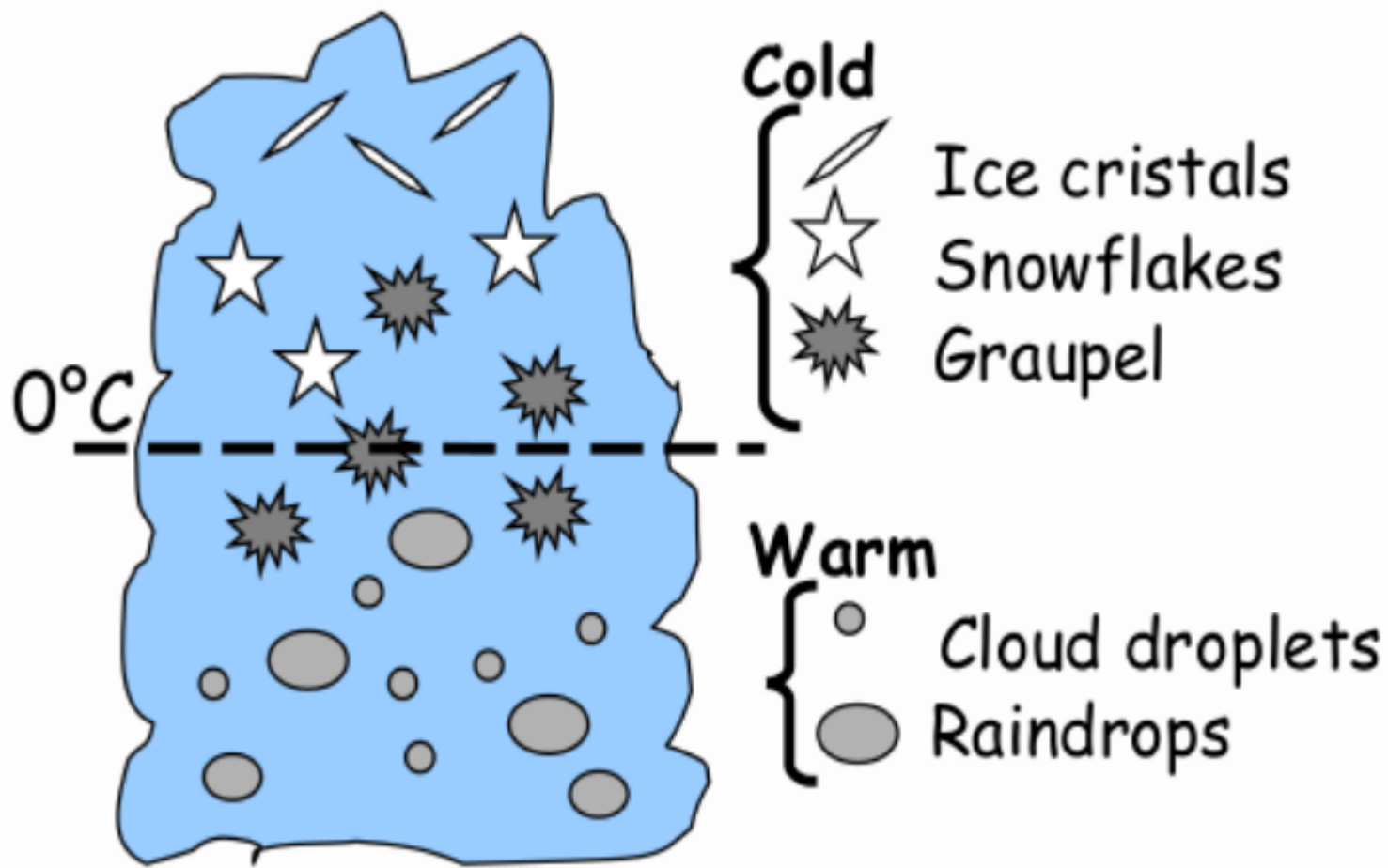


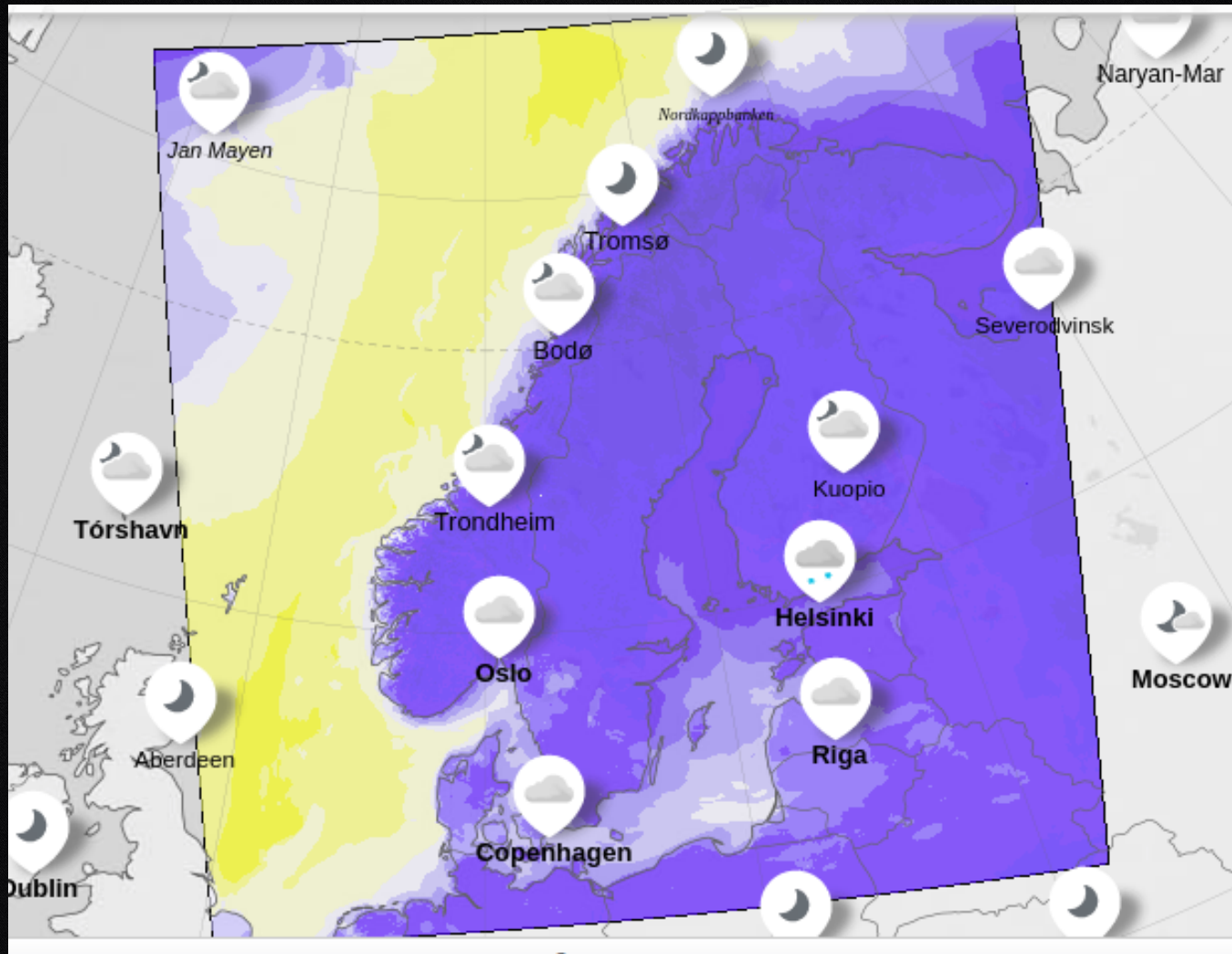




How to represent supercooled liquid in a weather model?







The HARMONIE-AROME model

2.5km grid distance

Operational model at MET-Norway and SMHI

Developed at Meteo-France and within the Hirlam-aladin consortia

1D column version of HARMONIE-AROME,
called MUSC

Quick testing

Idealized experiments

Isolate the processes

Feed the model with an initial vertical profile

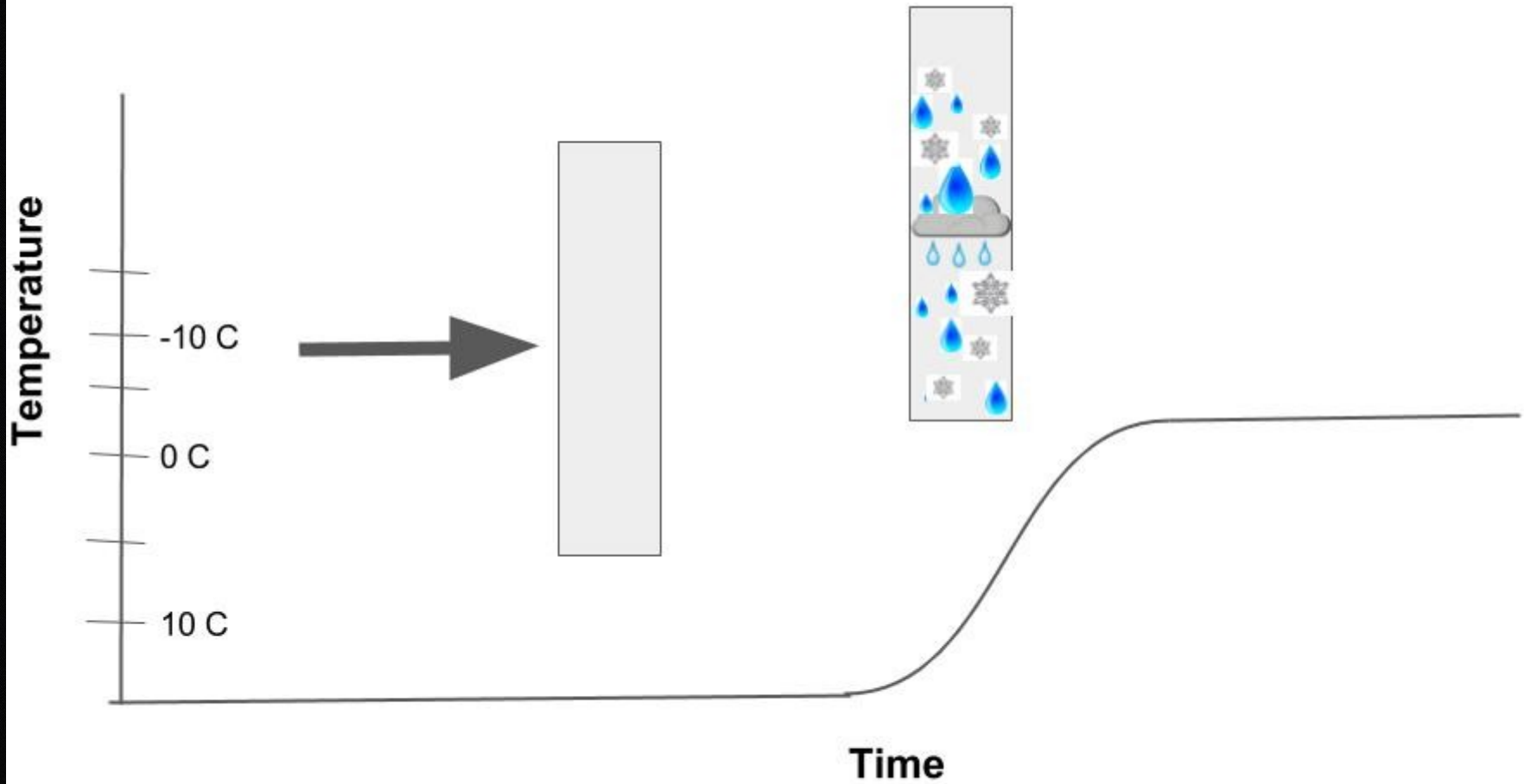
Vary the vertical velocity forcing

Turn on and off processes

Make your own cloud!

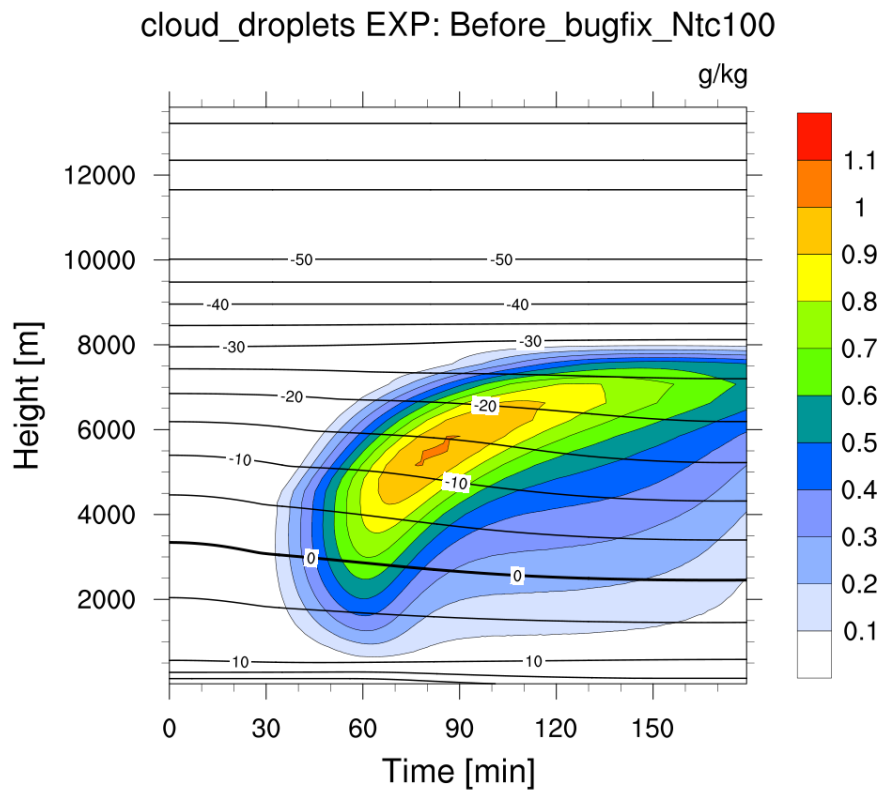


Idealized experiment

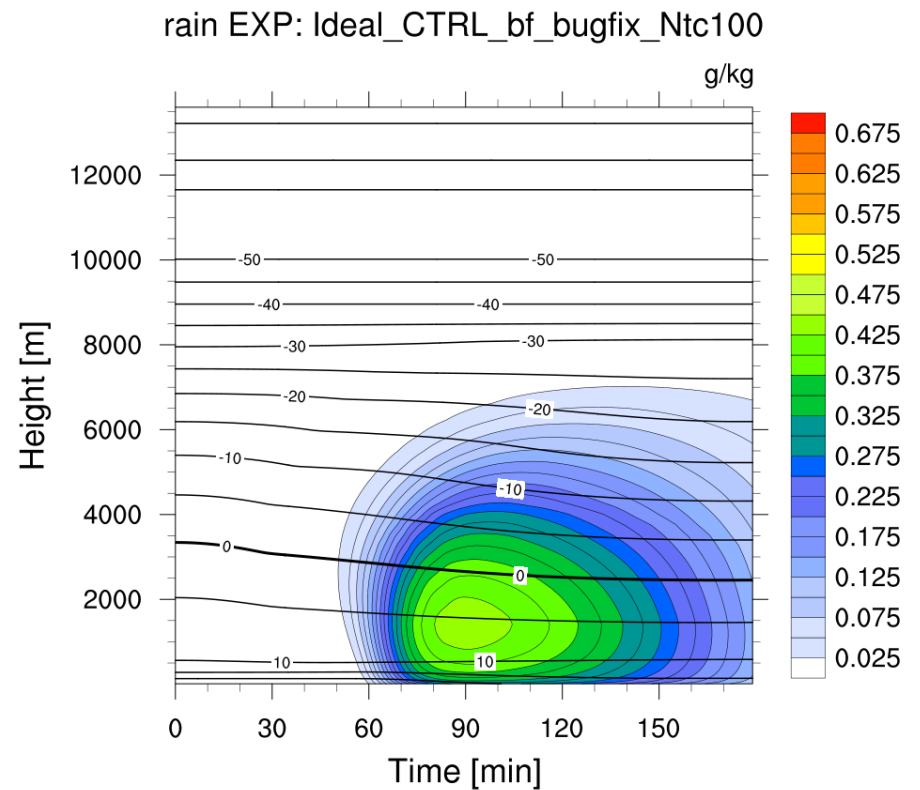


First results: liquid water

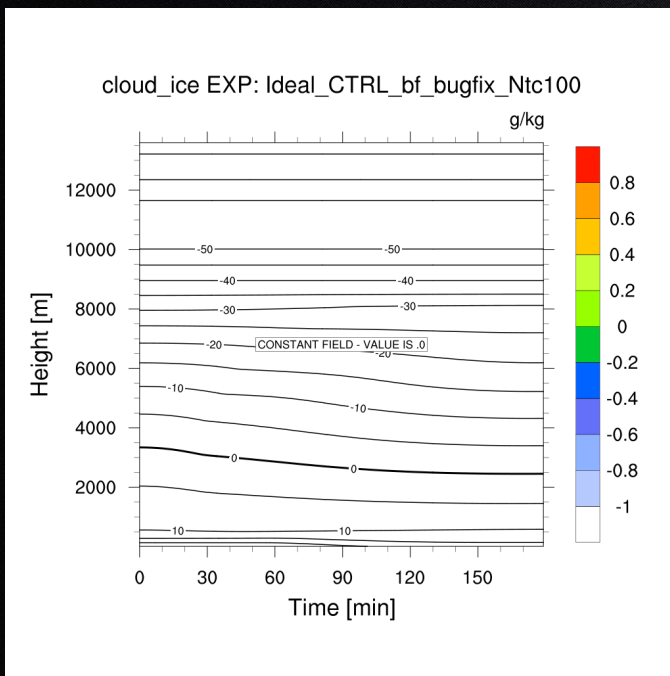
Cloud droplets



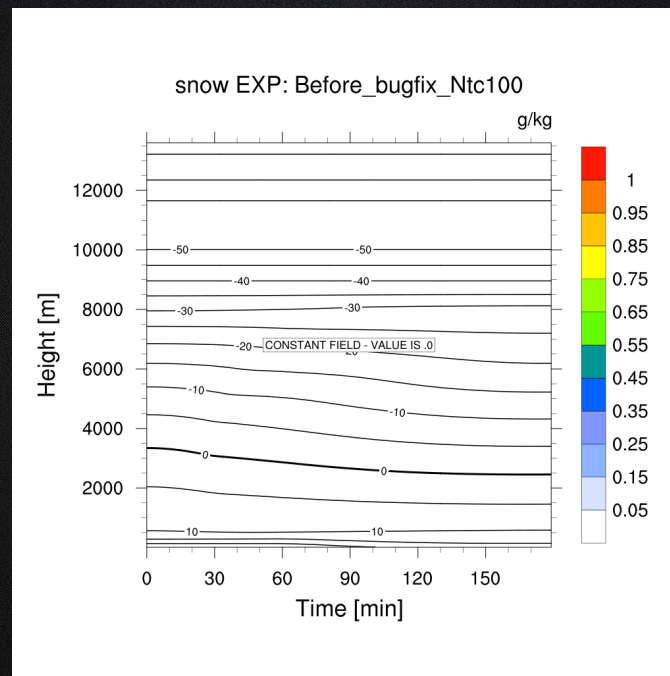
Rain



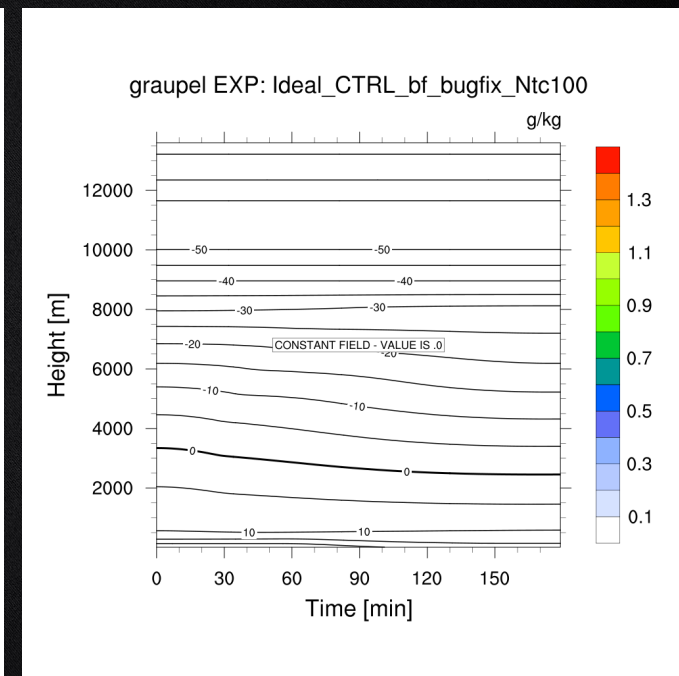
First results: ice



Cloud ice



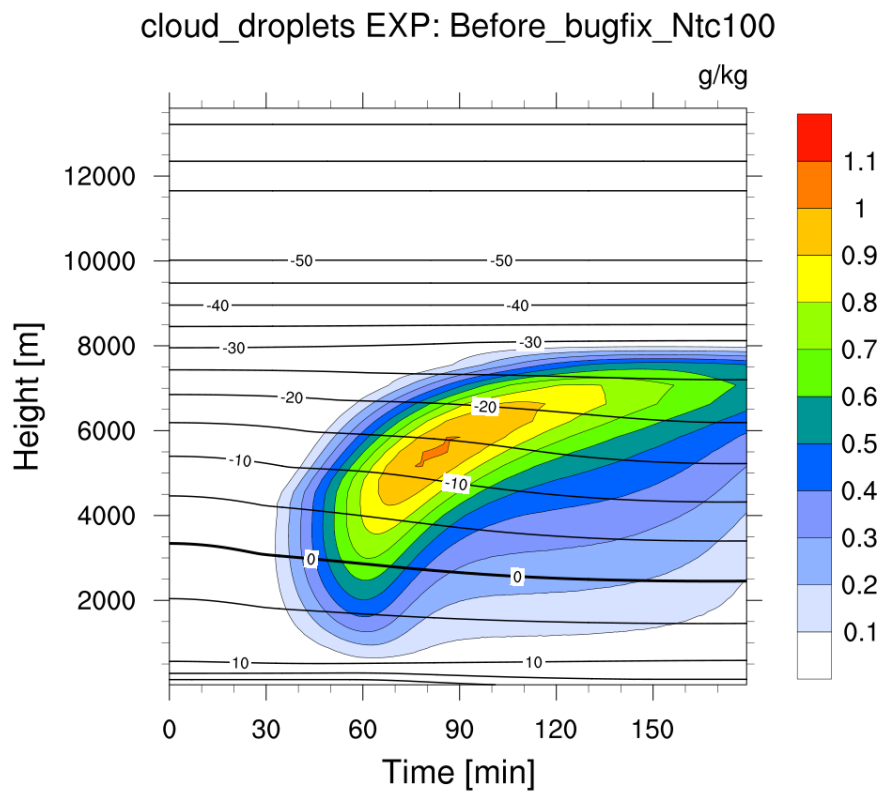
Snow



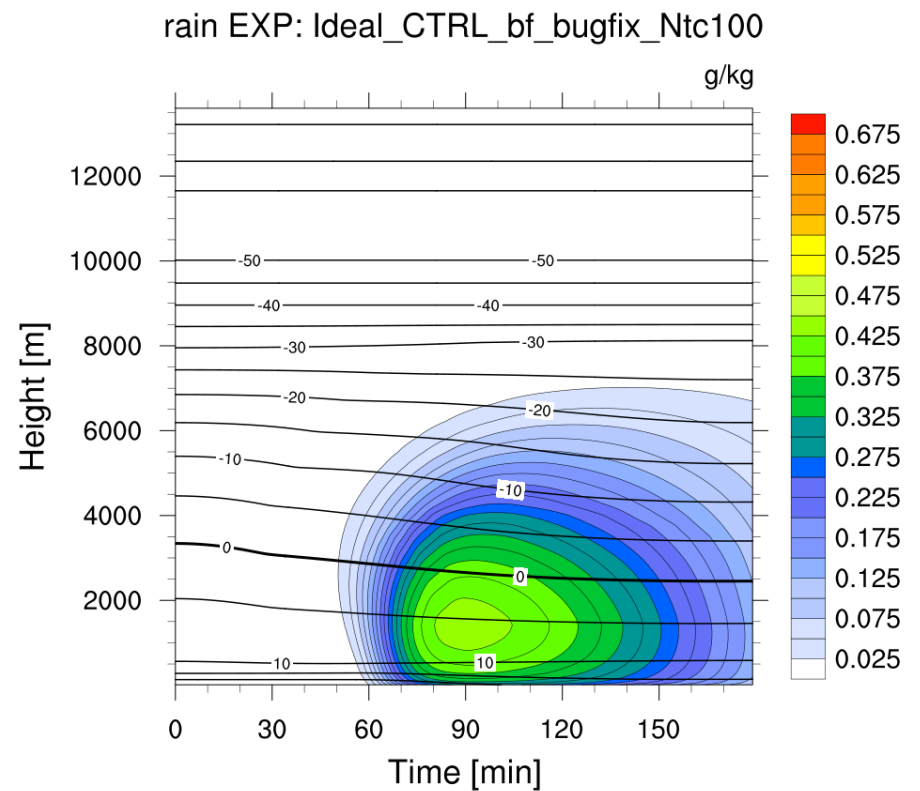
Graupel

First results: liquid water

Cloud droplets

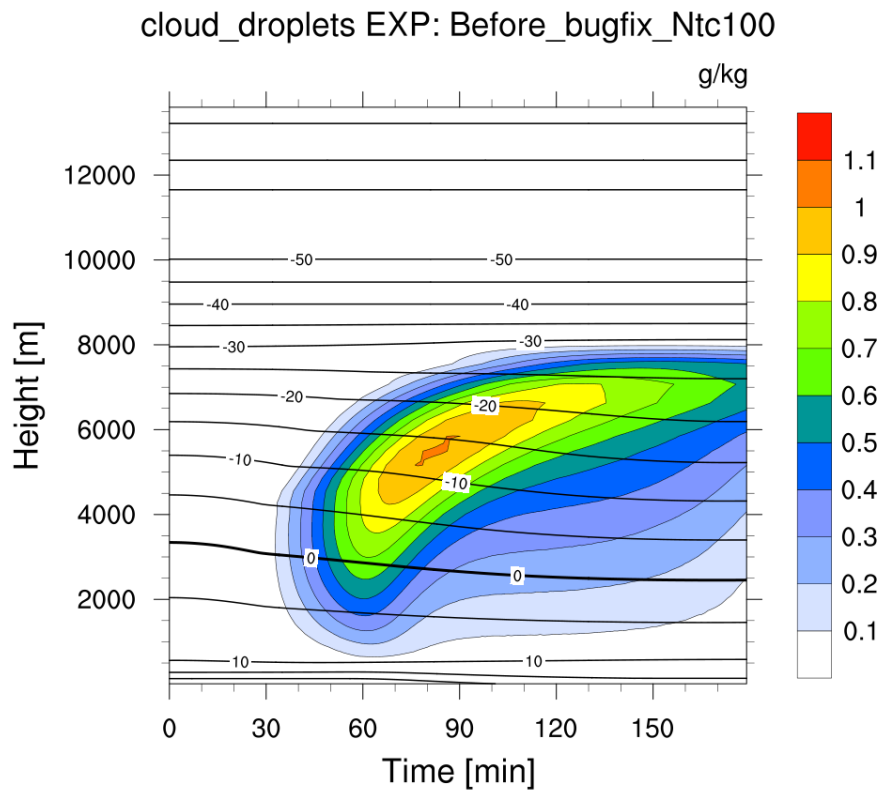


Rain

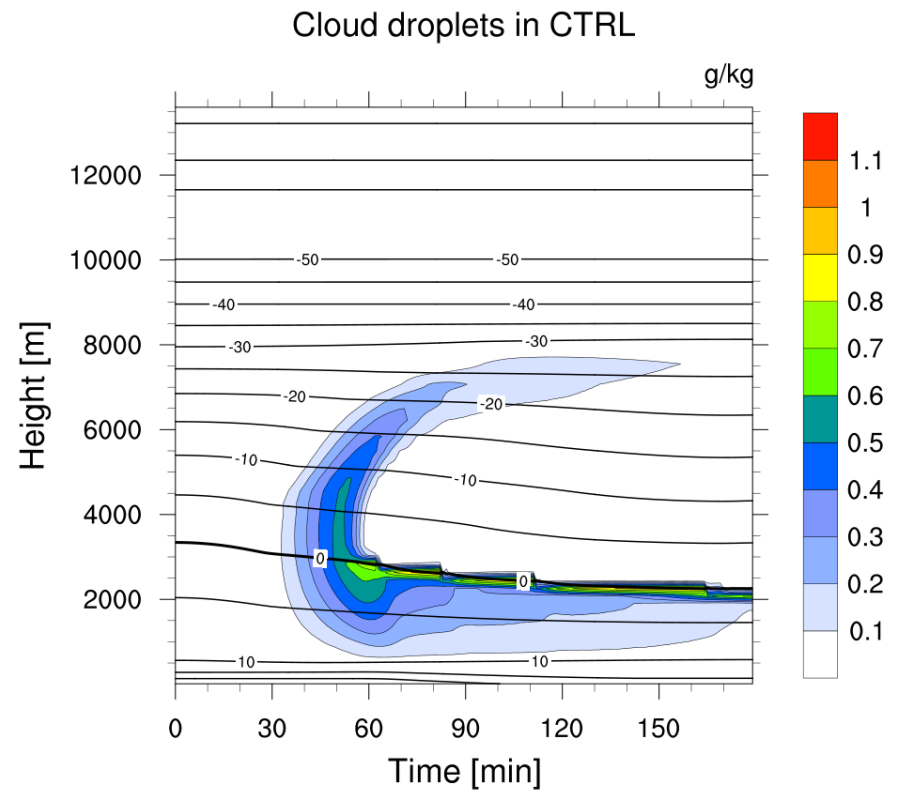


Cloud droplets

Before bugfix

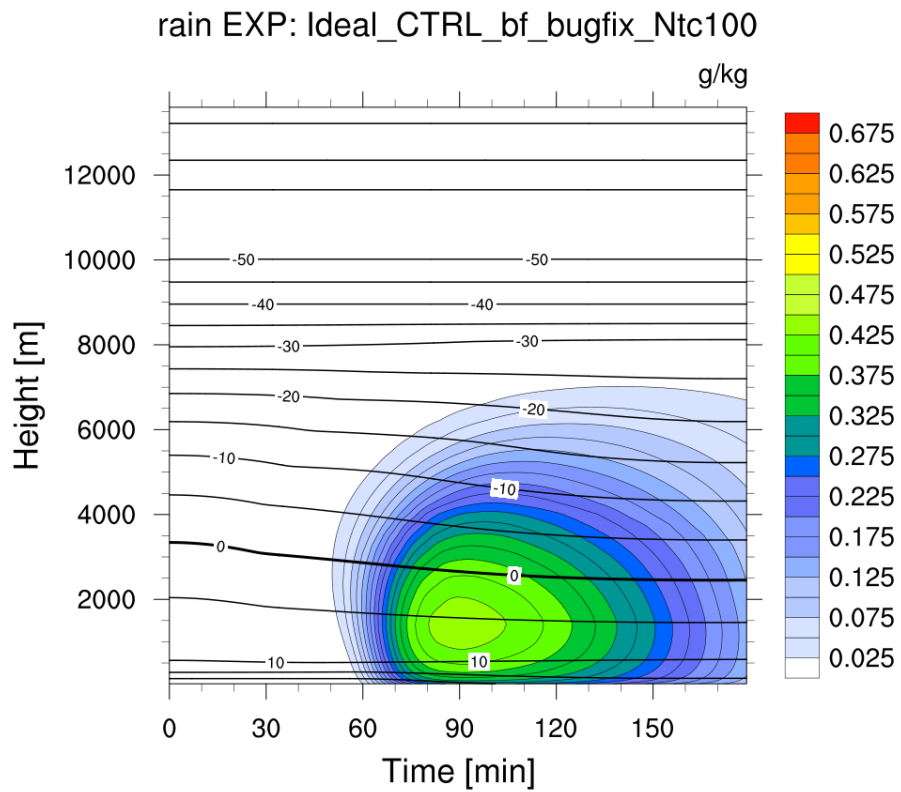


After bugfix

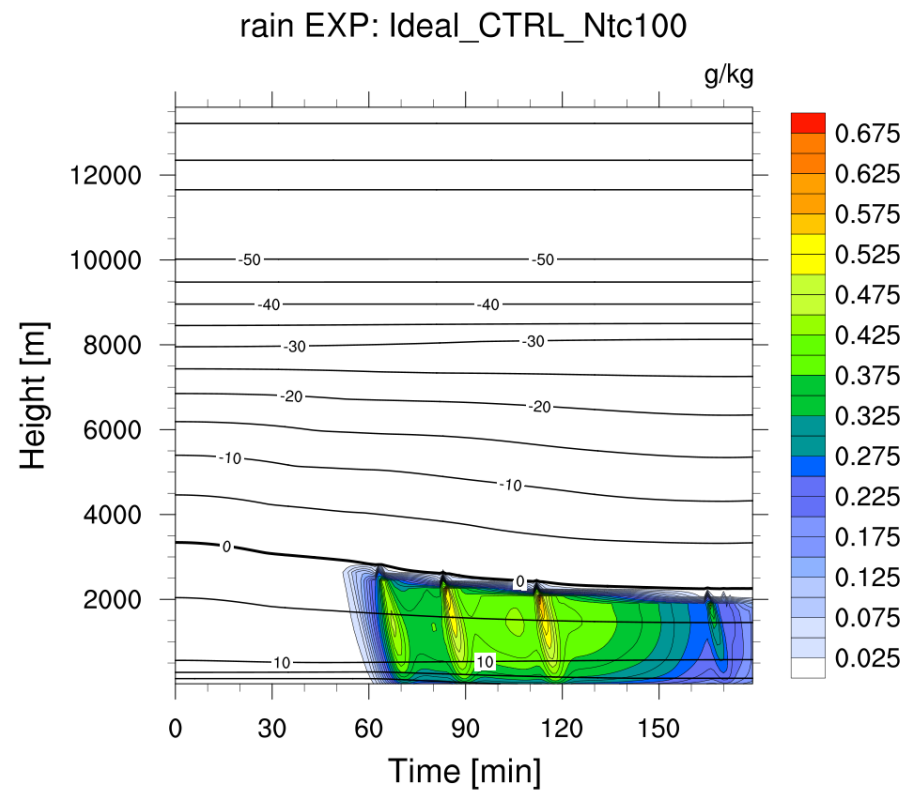


Rain

Before bugfix

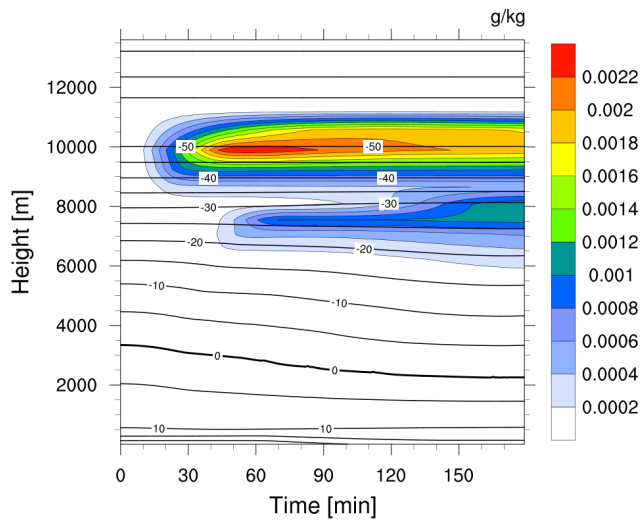


After bugfix



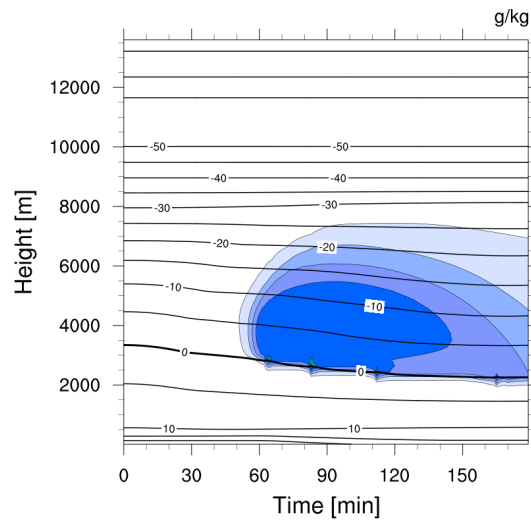
After bugfix: Ice

cloud_ice EXP: Ideal_CTRL_Ntc100



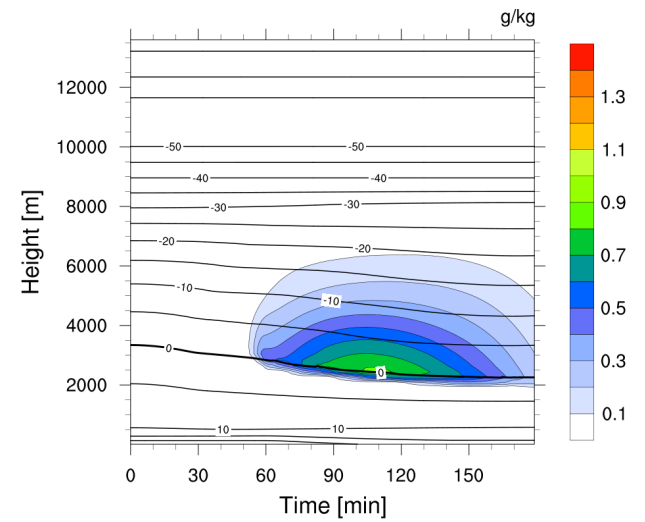
Cloud ice

snow EXP: Ideal_CTRL_Ntc100



Snow

graupel EXP: Ideal_CTRL_Ntc100



Graupel

Changes

Process:

Effect:

Autoconversion

Rain initiation

Ice nucleation

Triggers the cold processes

Snow/Graupel collecting
cloud droplets

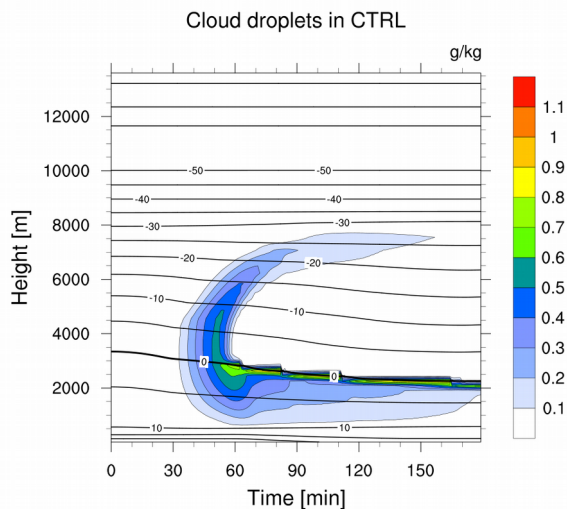
Depletes cloud water

Rain and Snow collision

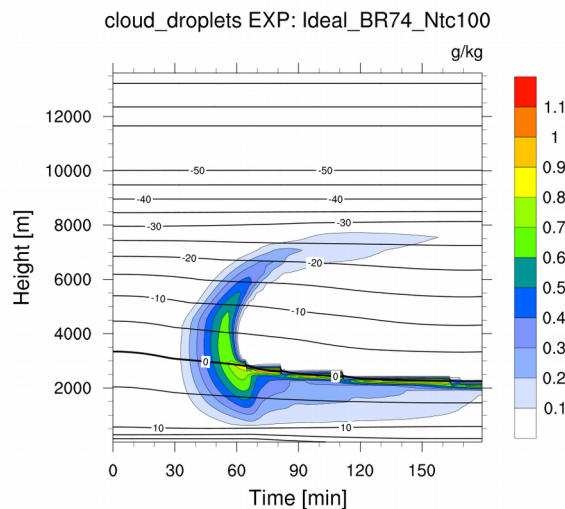
Favors graupel

Cloud droplets

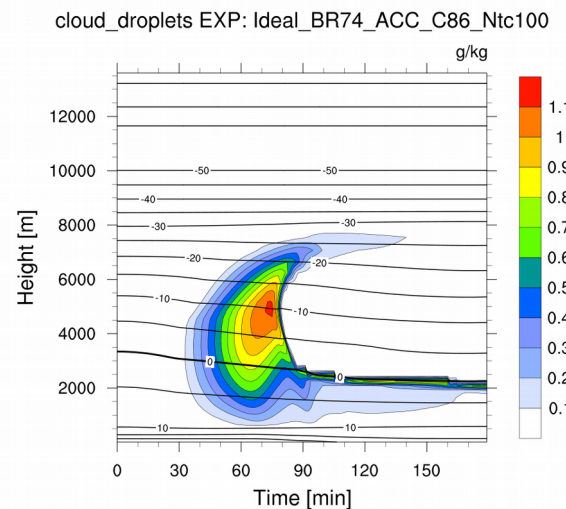
CTRL



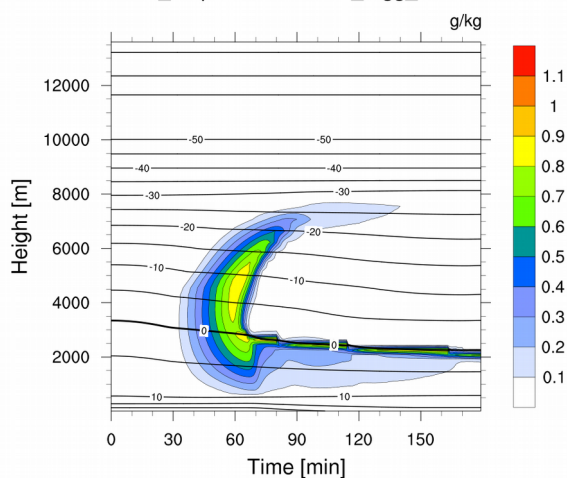
Autoconversion



Ice initiation

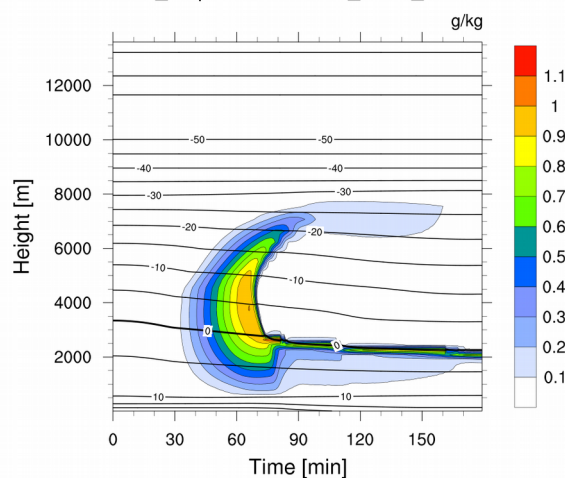


cloud_droplets EXP: Ideal_Bigg_Ntc100



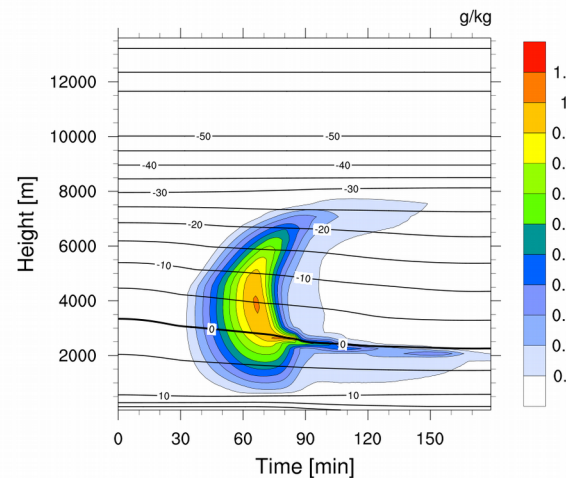
Immersion freezing

cloud_droplets EXP: Ideal_GCW_Ntc100



Graupel col. cloud water

cloud_droplets EXP: Ideal_RCS_Ntc100



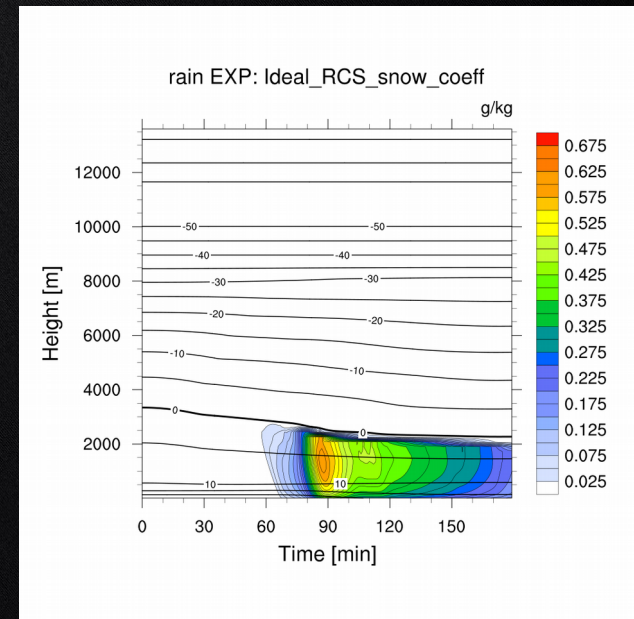
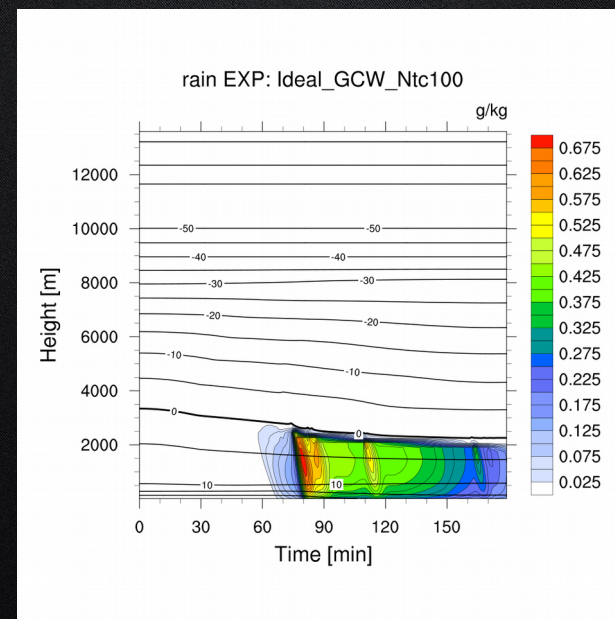
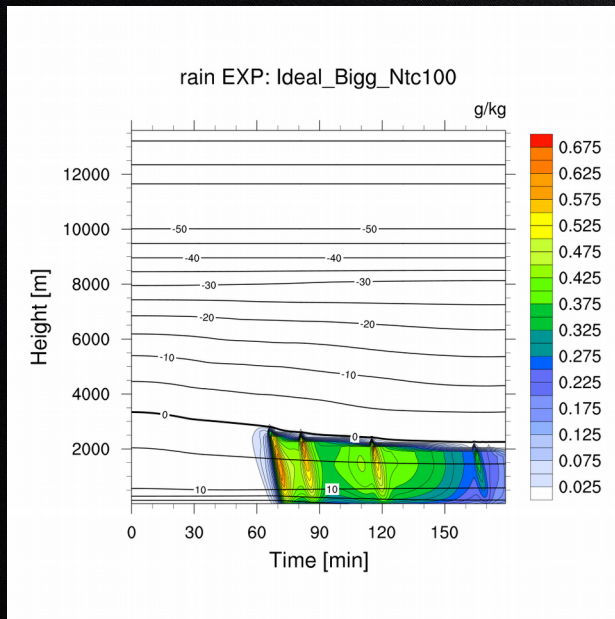
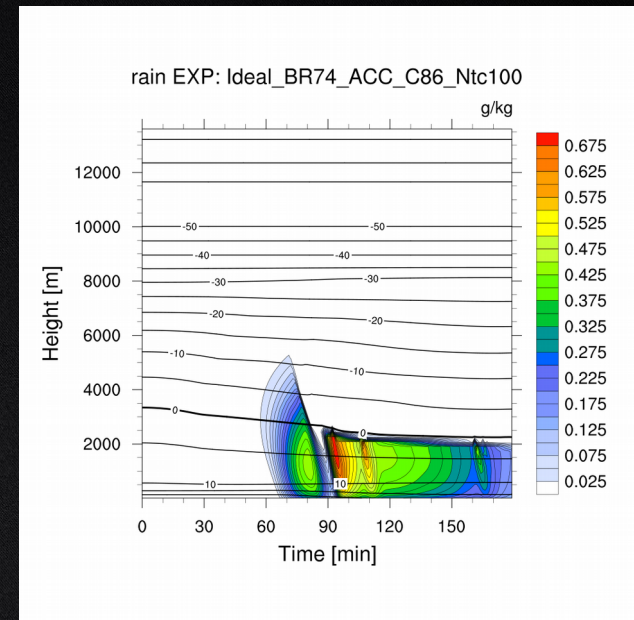
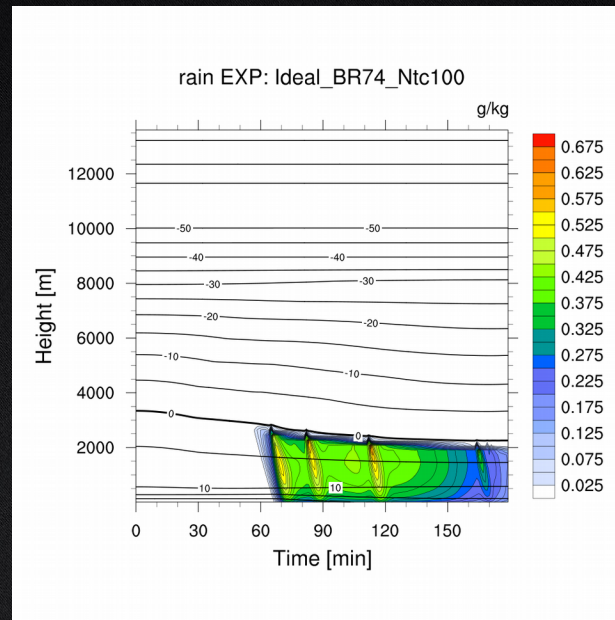
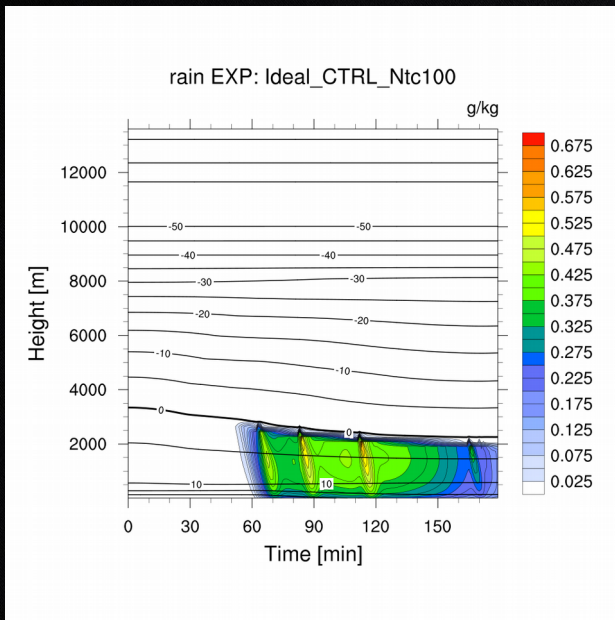
Rain and snow collision

Rain

CTRL

Autoconversion

Ice initiation



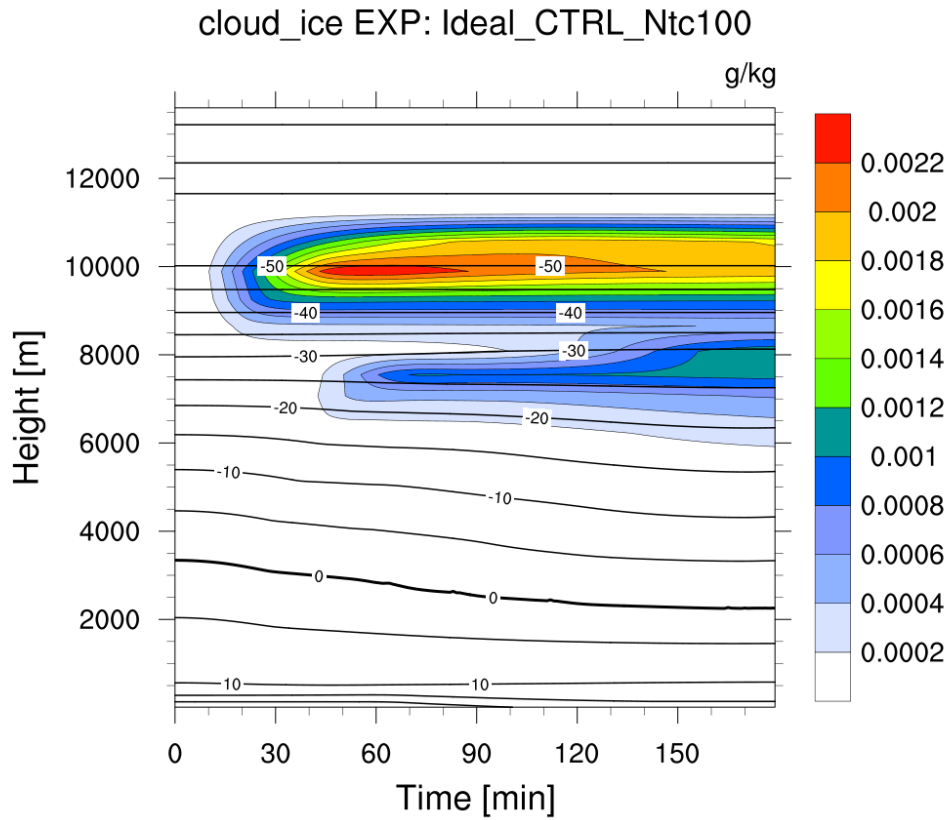
Immersion freezing

Graupel col. cloud water

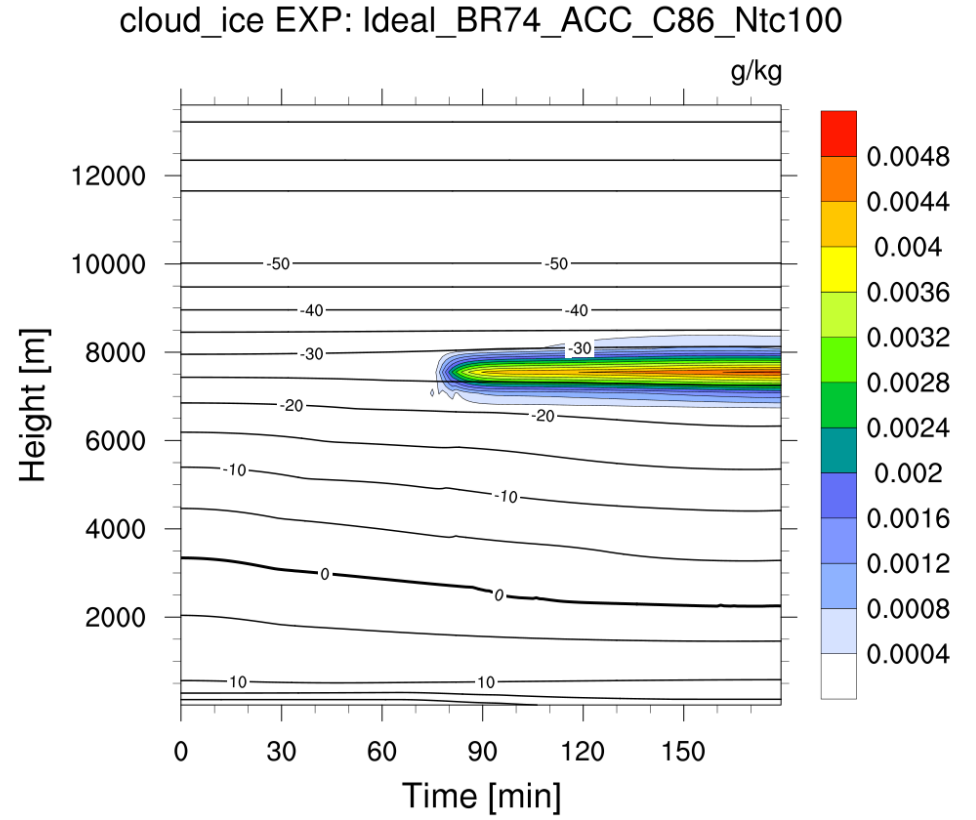
Rain and snow collision

Cloud ice

CTRL

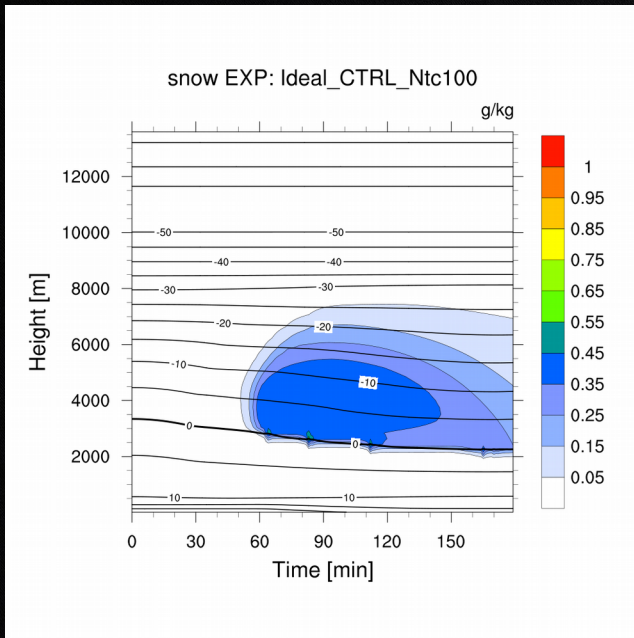


Ice initiation

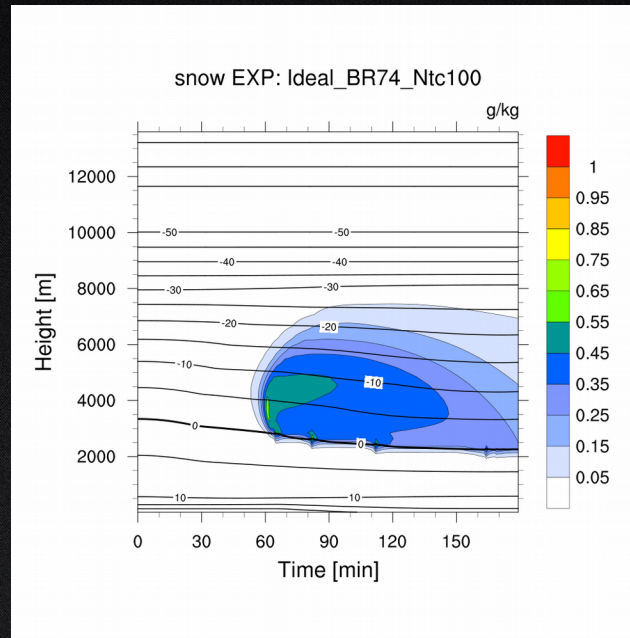


Snow

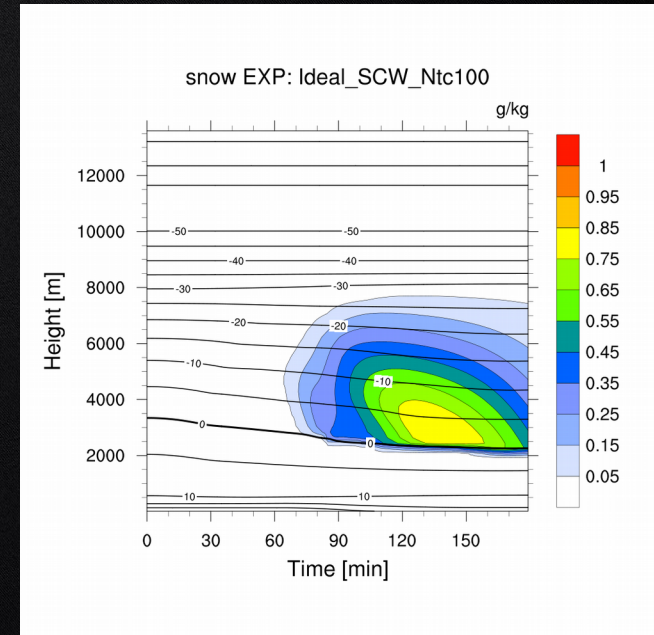
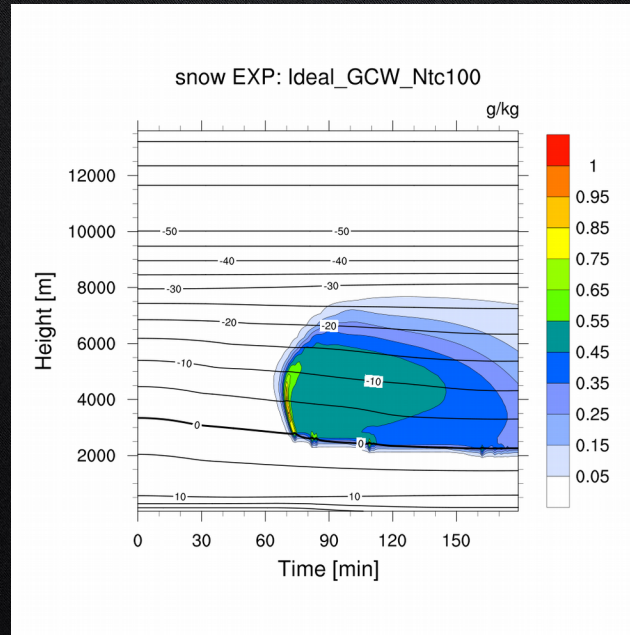
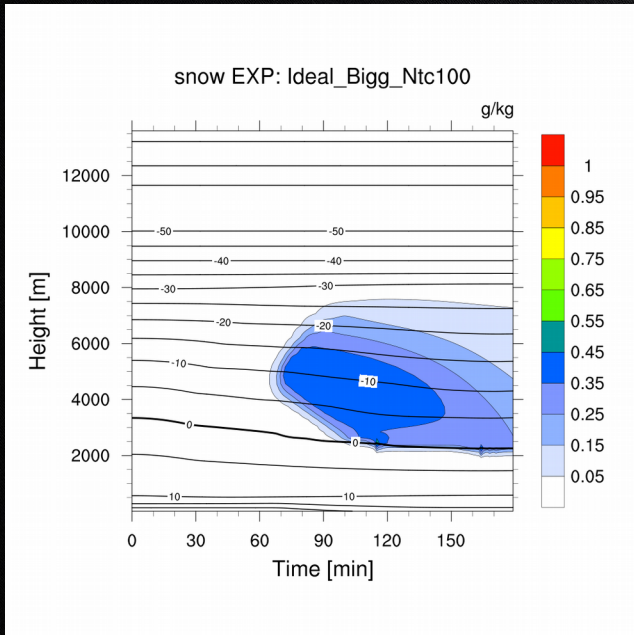
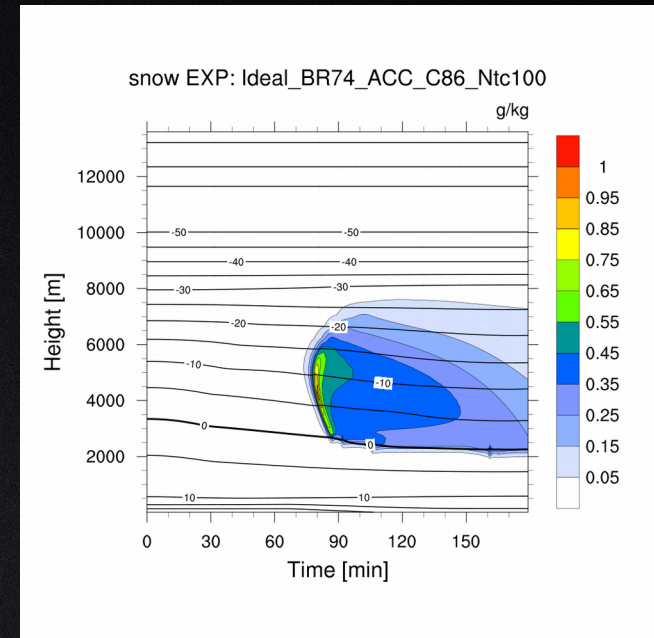
CTRL



Autoconversion



Ice initiation



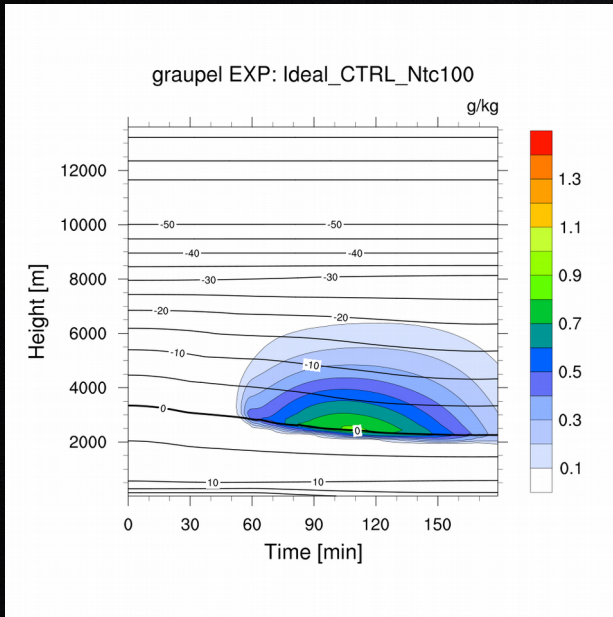
Immersion freezing

Graupel col. cloud water

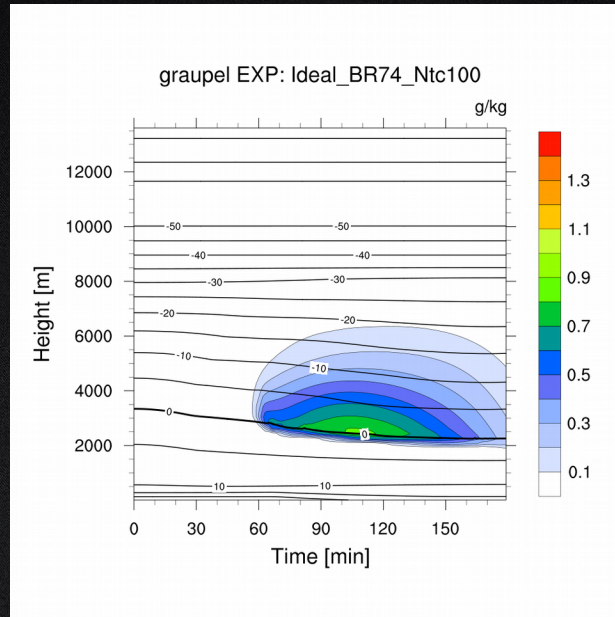
Rain and snow collision

Graupel

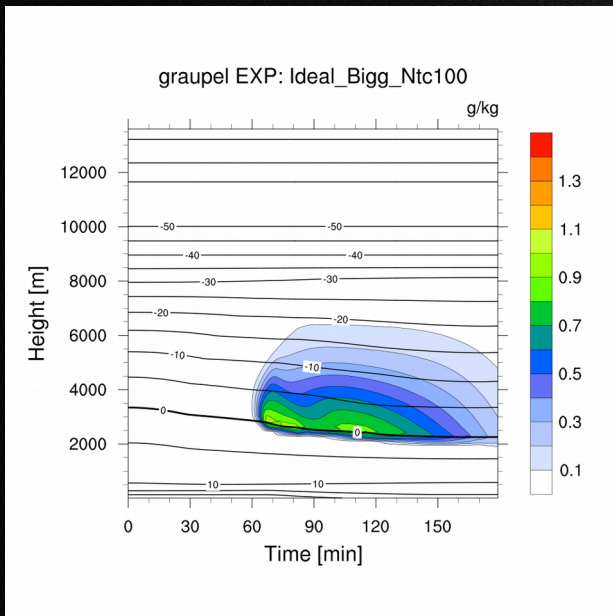
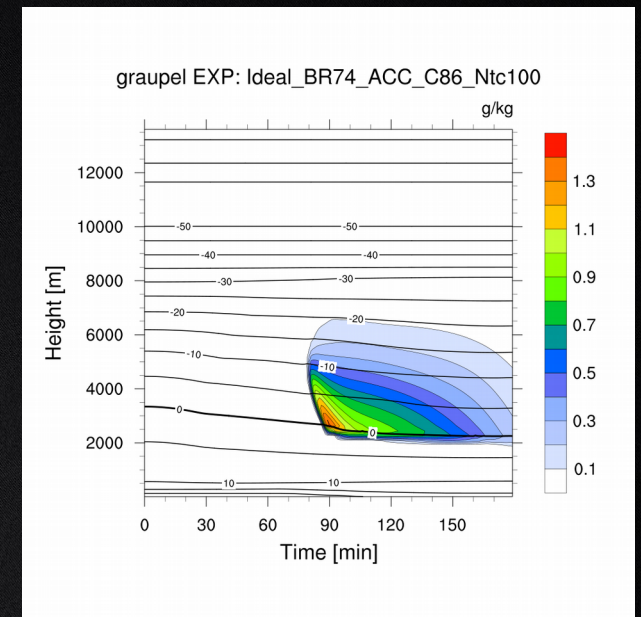
CTRL



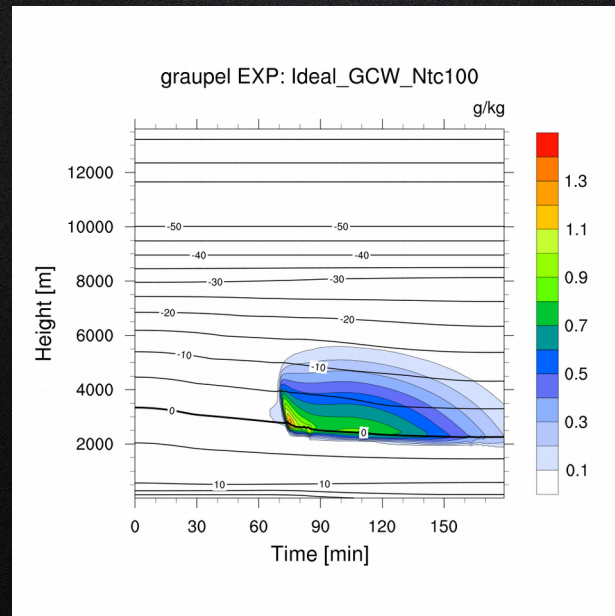
Autoconversion



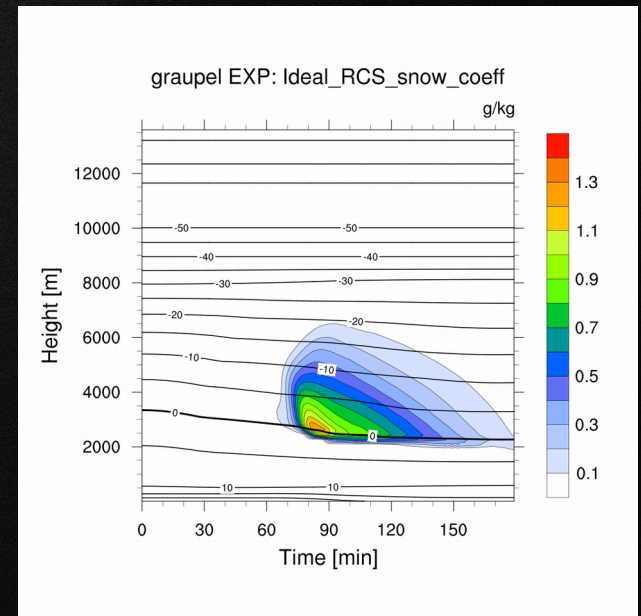
Ice initiation



Immersion freezing



Graupel col. cloud water



Rain and snow collision

Summary

Supercooled liquid drops are important for icing

Difficult for the weather models

Initiation of cloud ice acts like a trigger

Collision-collection processes determine the rate of loss for supercooled liquid water

Future work

More idealized cases

- Freezing drizzle/rain case (Jan 15 Oslo)
- Summer case (convection)

Real 3D cases

- Validate against both specialized and conventional observations

Get it into operation

Thank you for your attention!

