Improved representation of supercooled liquid water in HARMONIE-AROME

Bjørg Jenny K. Engdahl
MET-Norway

Norwegian Meteorological Institute

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

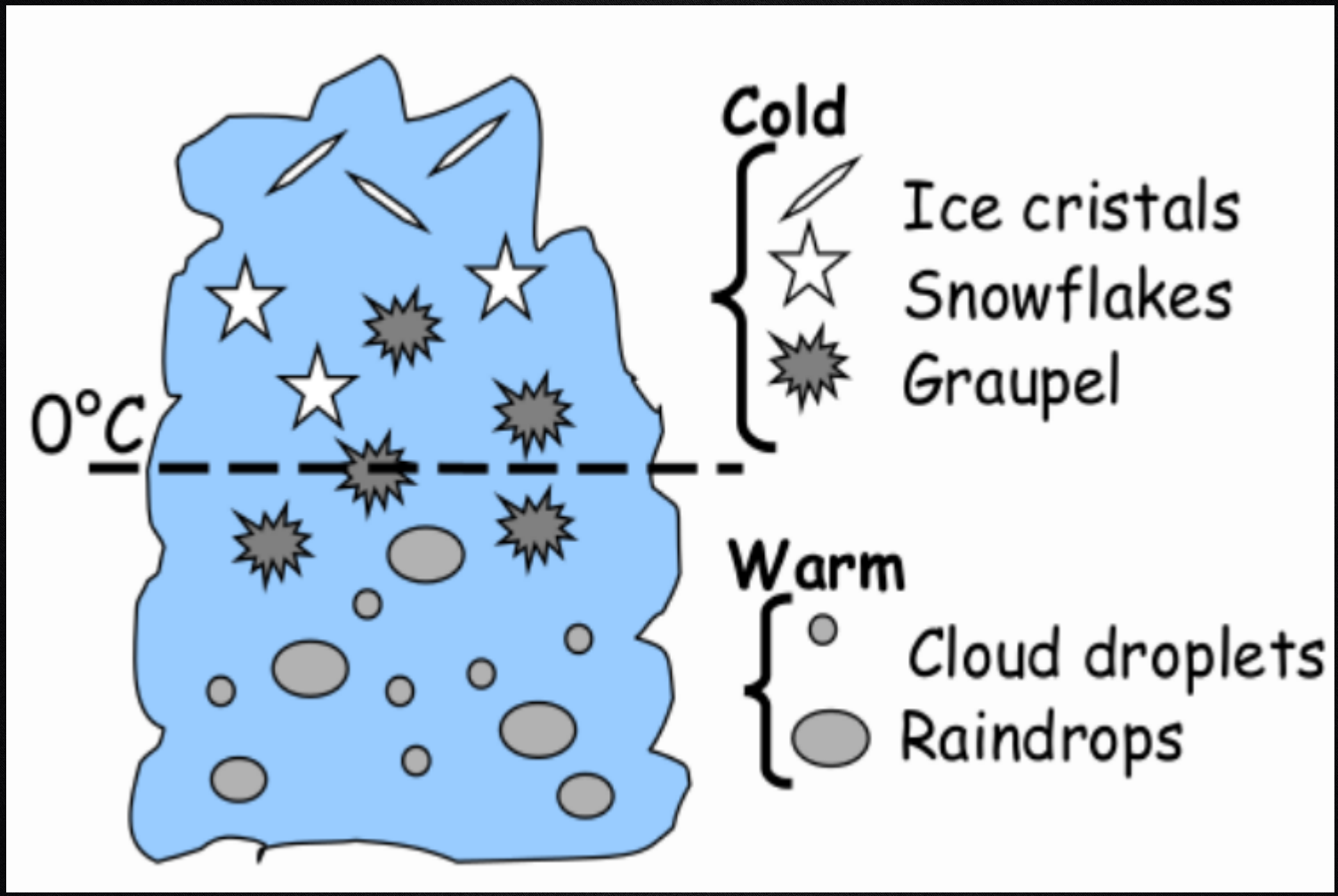
Lead by MET-Norway and funded by the Norwegian Research Council

Supervisors:

- Bjørn Egil Nygaard (Kjeller Vindteknikk)
- Greg Thompson (NCAR)
- Lisa Bengtsson (SMHI/NOAA)
- Jón Egill Kristjánsson (University of Oslo)
- Terje Berntsen (University of Oslo)
- Trude Storelvmo (University of Oslo)

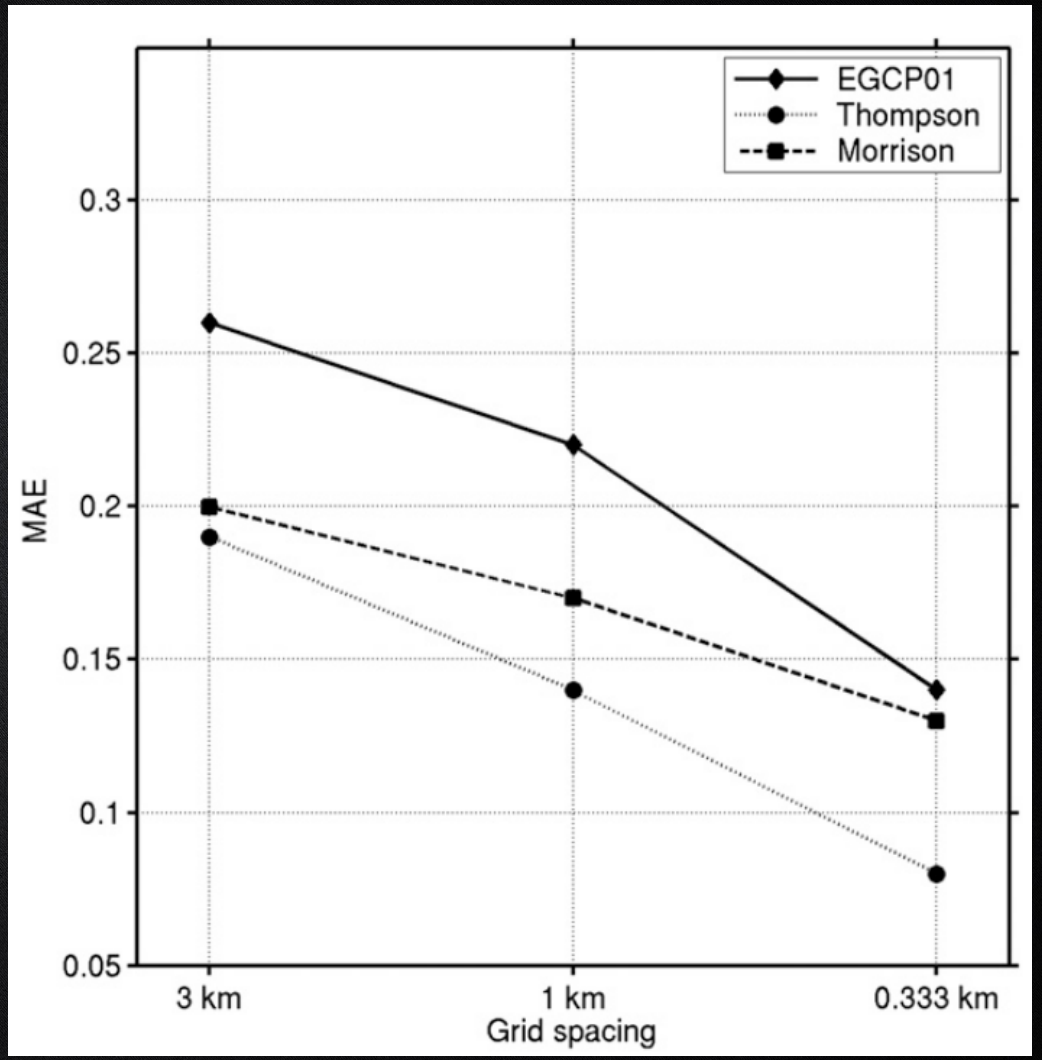
Photo: Ole Gustav Berg, statnett

How to represent supercooled liquid in a weather model?


Cold
Ice cristals
Snowflakes
Graupel
0°C
Warm
Cloud droplets
Raindrops

Thompson scheme is designed to be less “ice friendly”

We want to put parts of the Thompson scheme into HARMONIE-AROME



Nygaard et al. 2011

MUSC

1D column version of HARMONIE-AROME

Quick testing

Idealized experiments

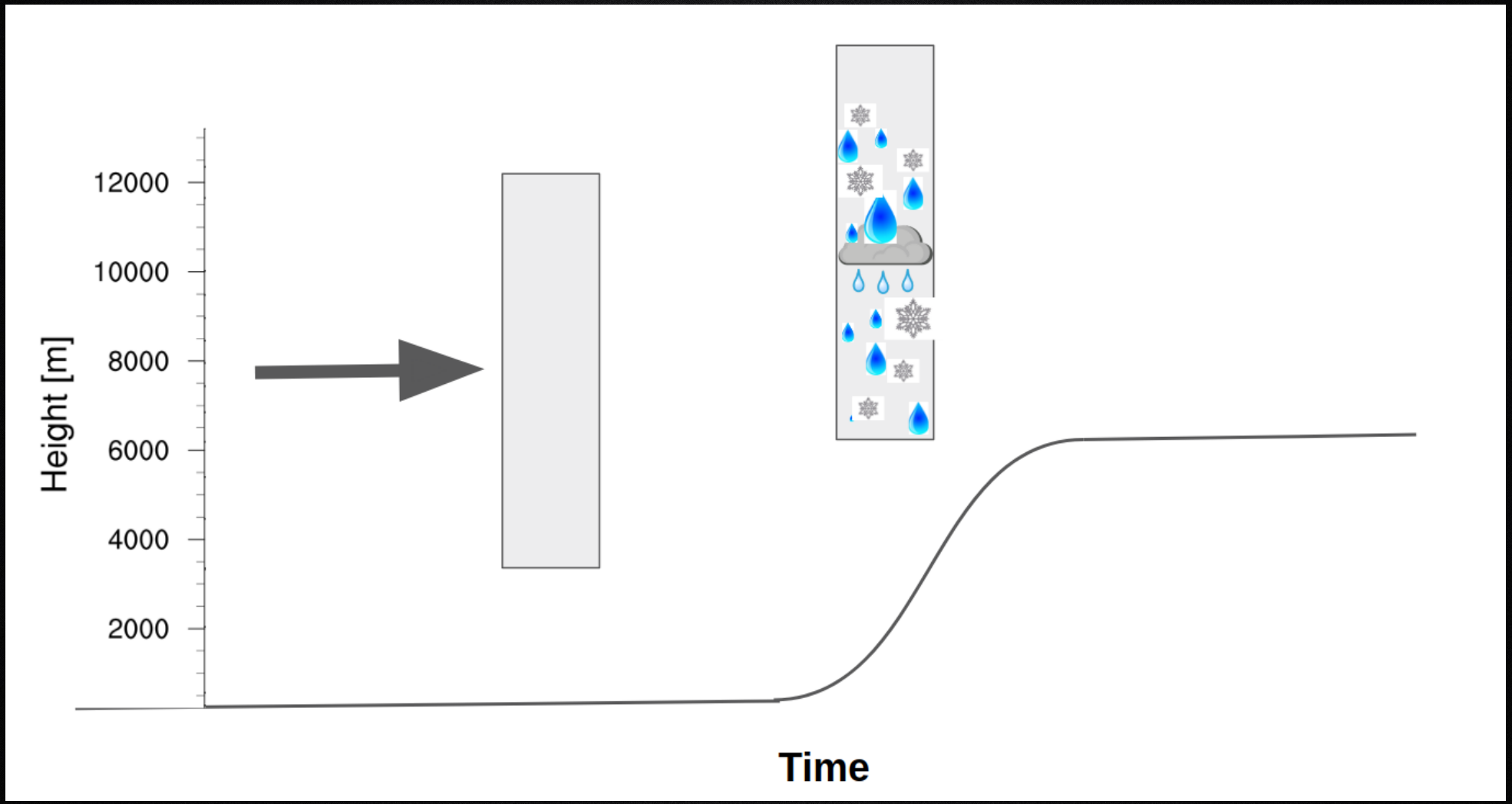
Isolate the processes

Turn on and off processes

Initial vertical profile + vertical velocity forcing

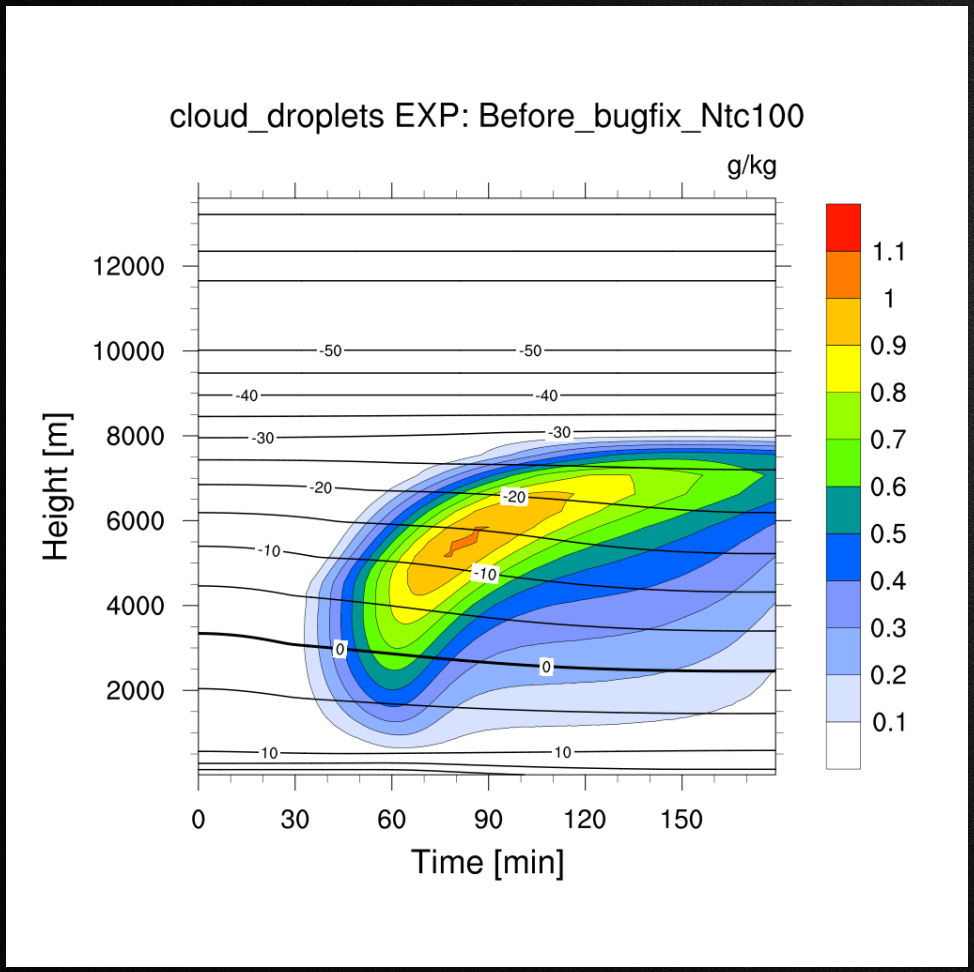
Make your own cloud!

Idealized experiment: orographic lifting

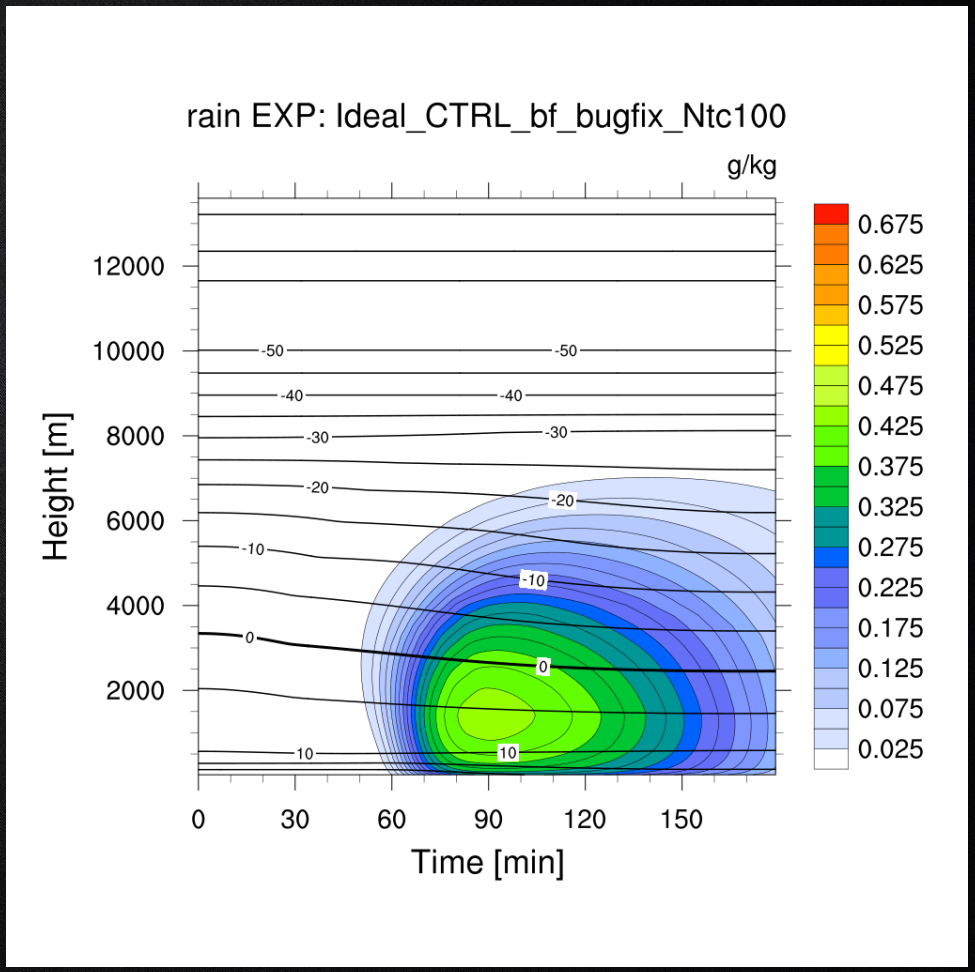


First results: liquid water

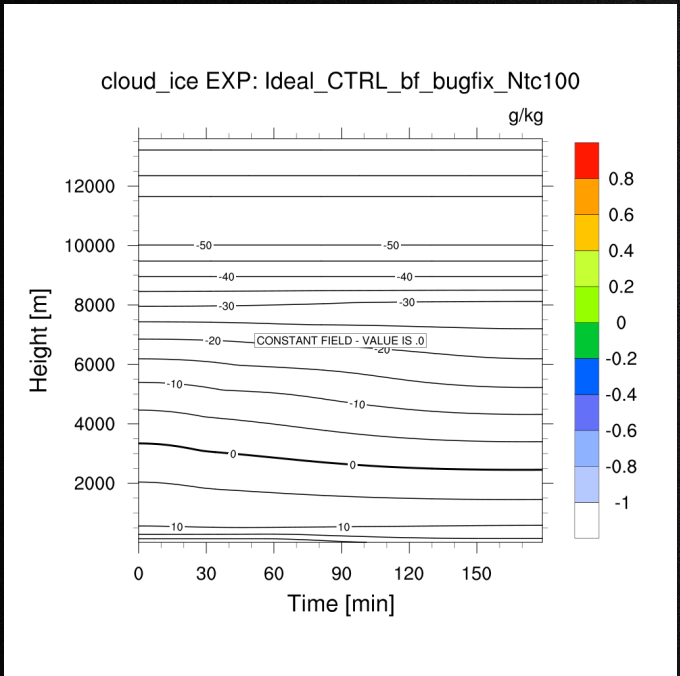
Cloud droplets



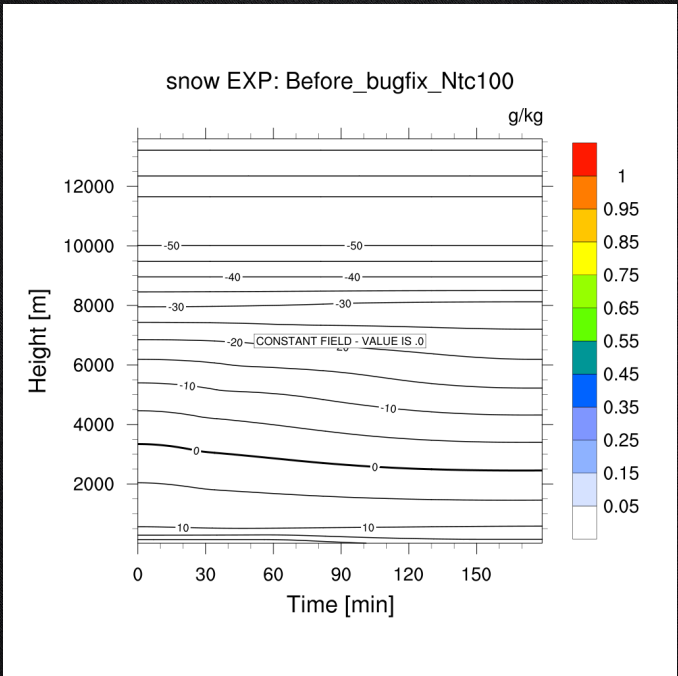
Rain



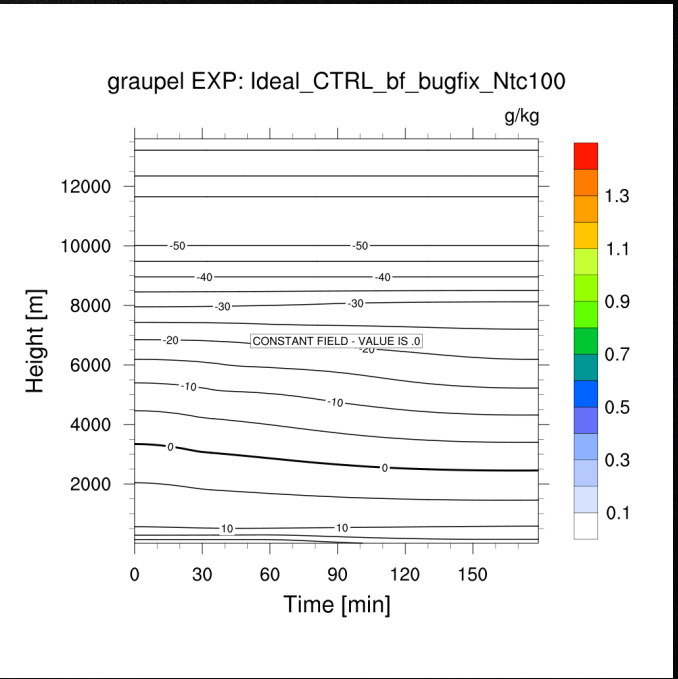
First results: ice



Cloud ice



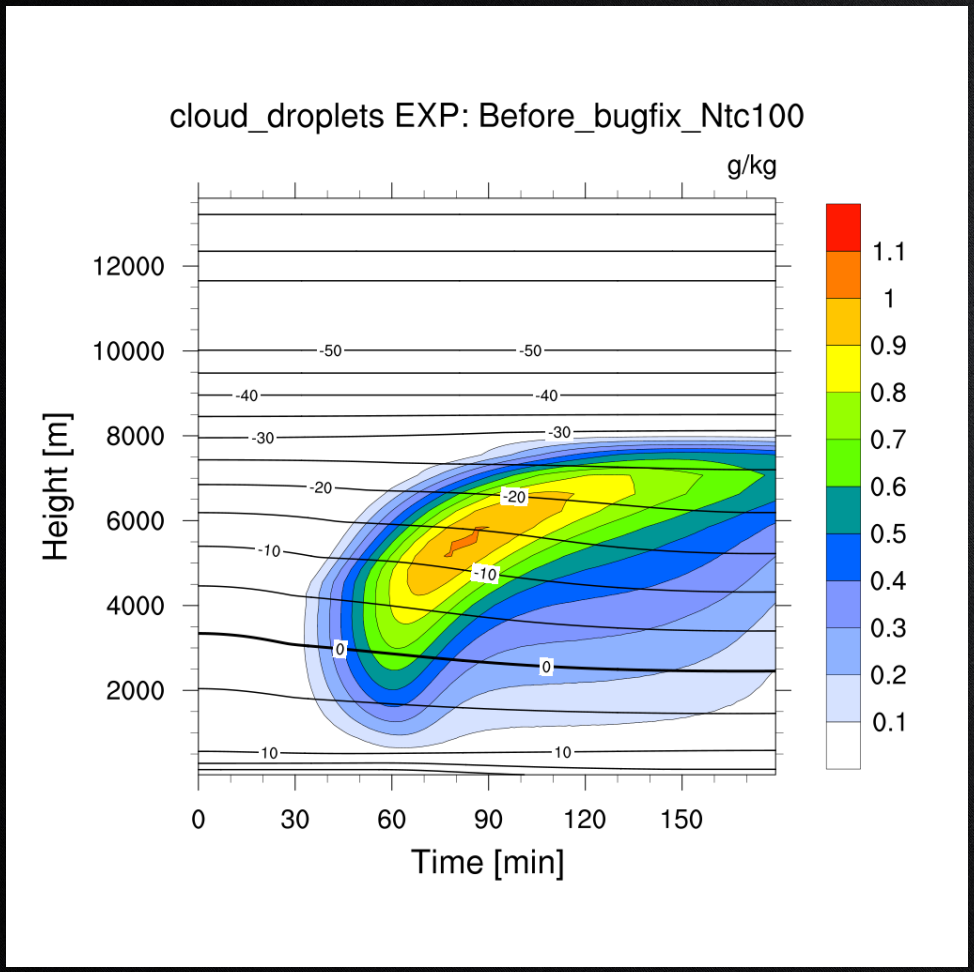
Snow



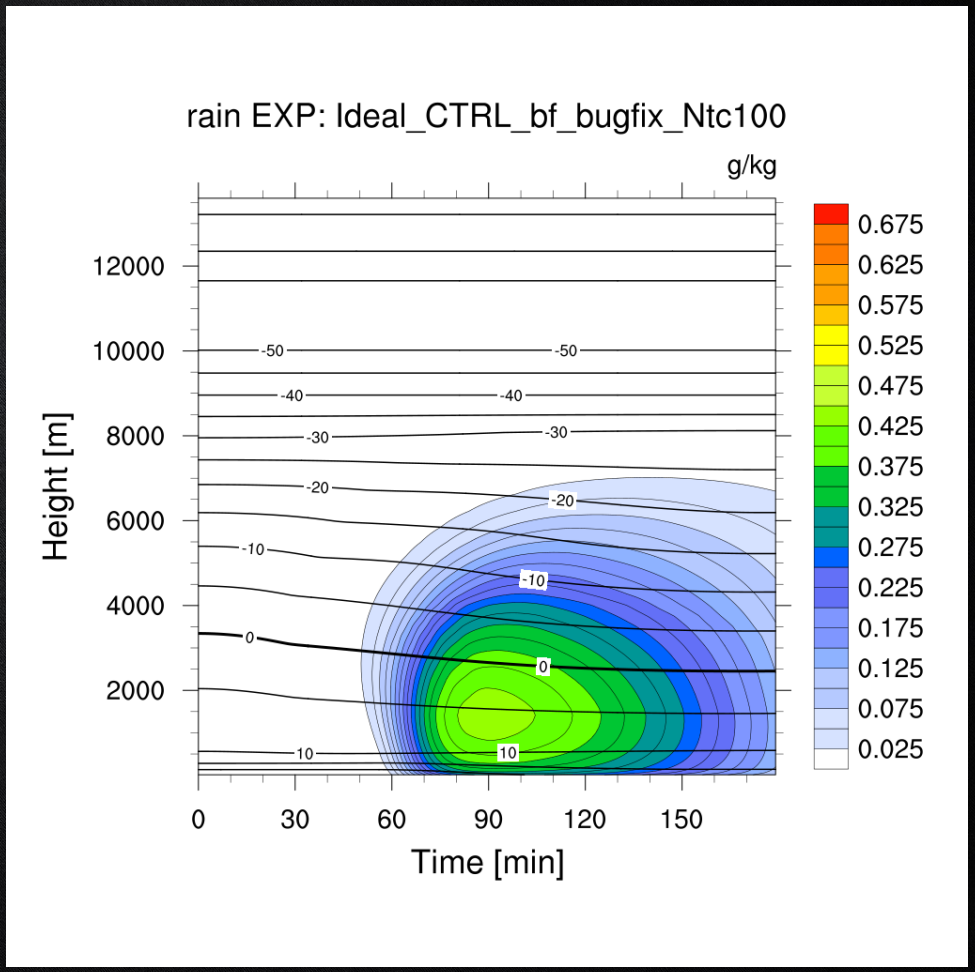
Graupel

First results: liquid water

Cloud droplets

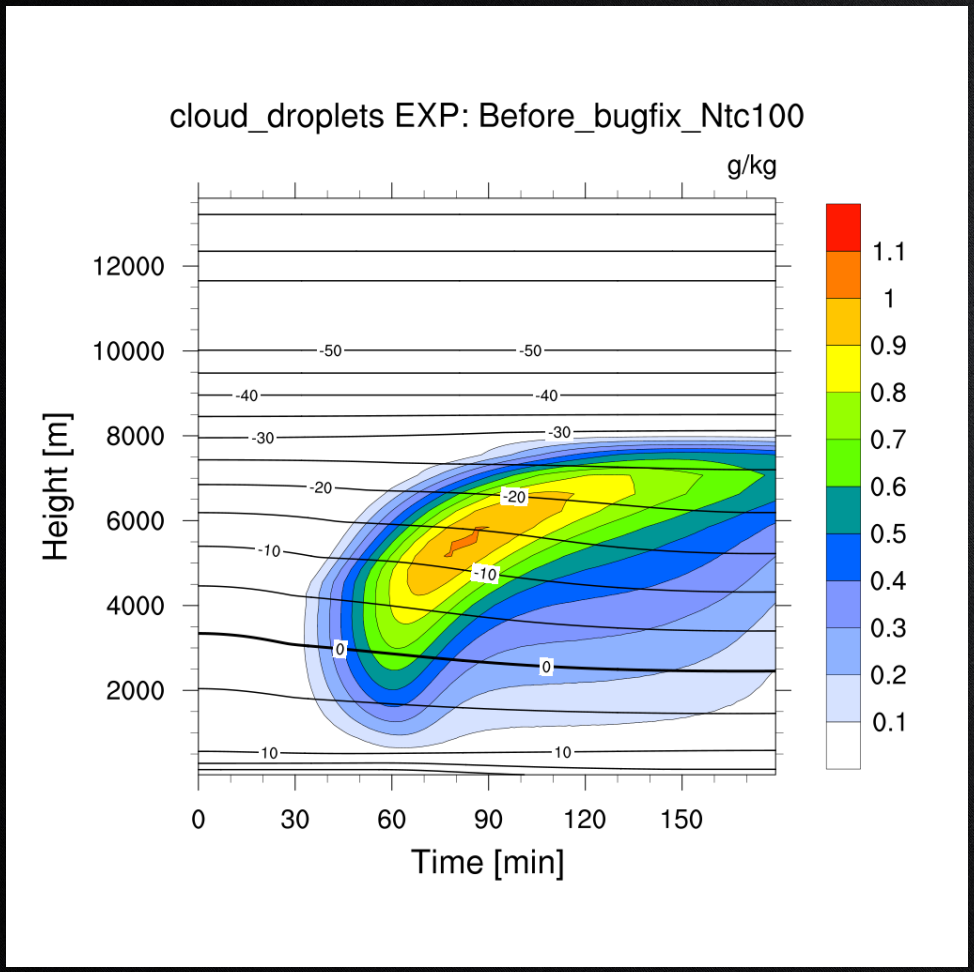


Rain

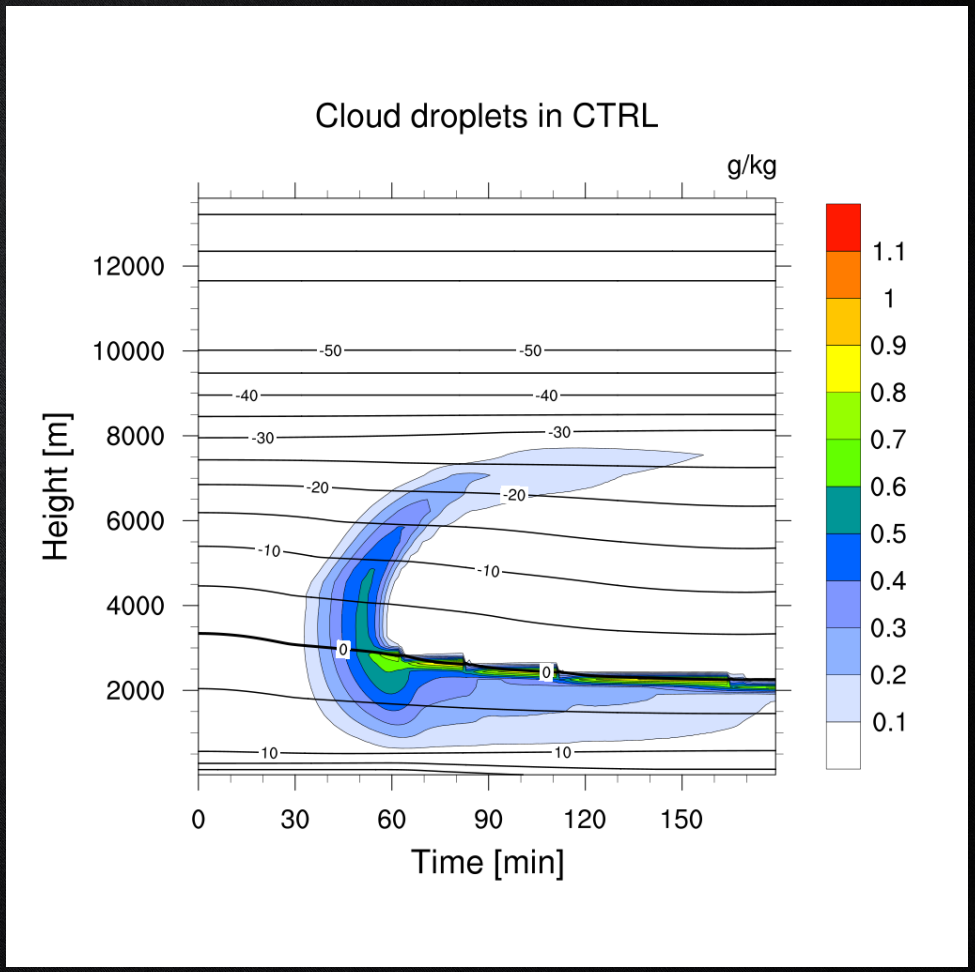


Cloud droplets

Before bugfix

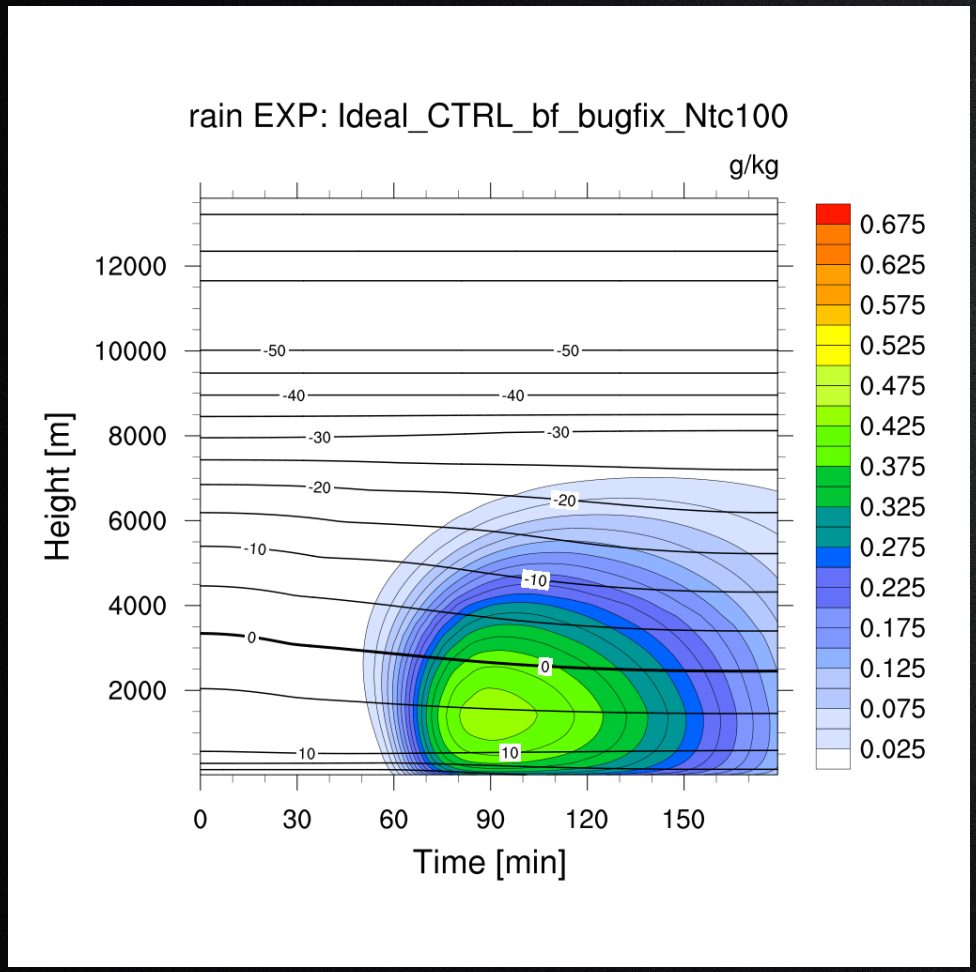


After bugfix

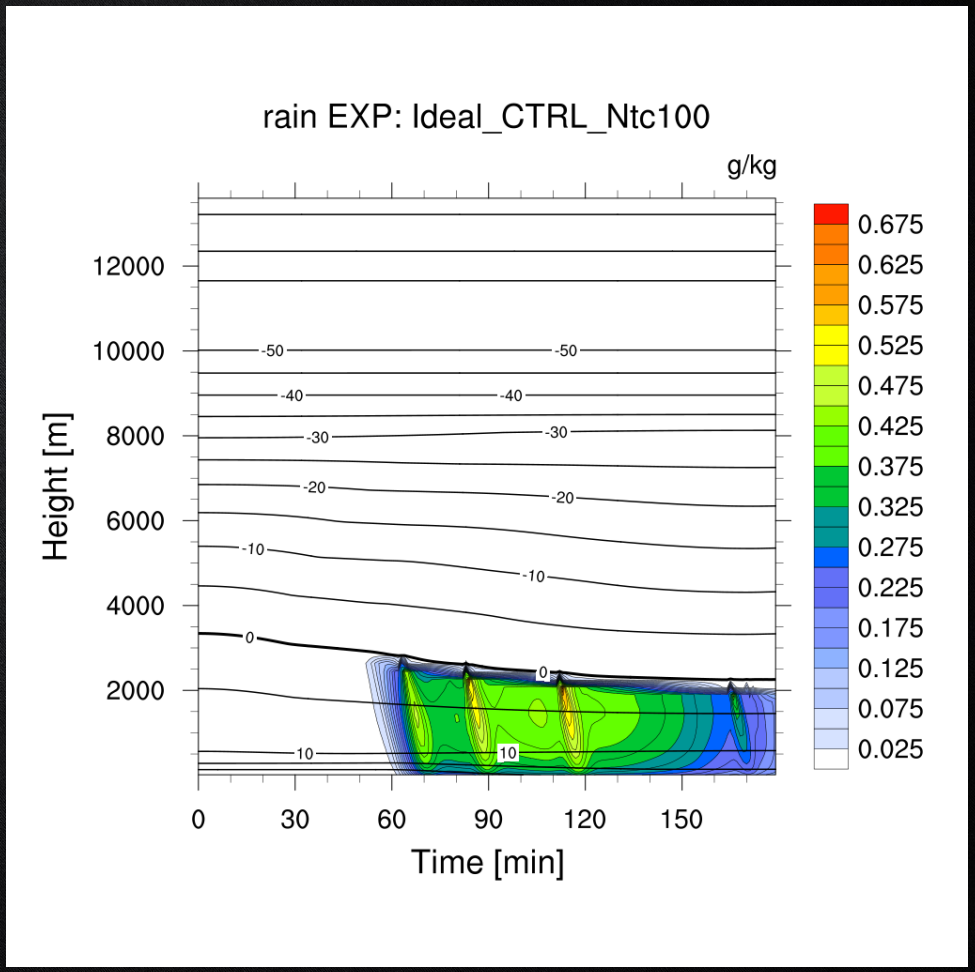


Rain

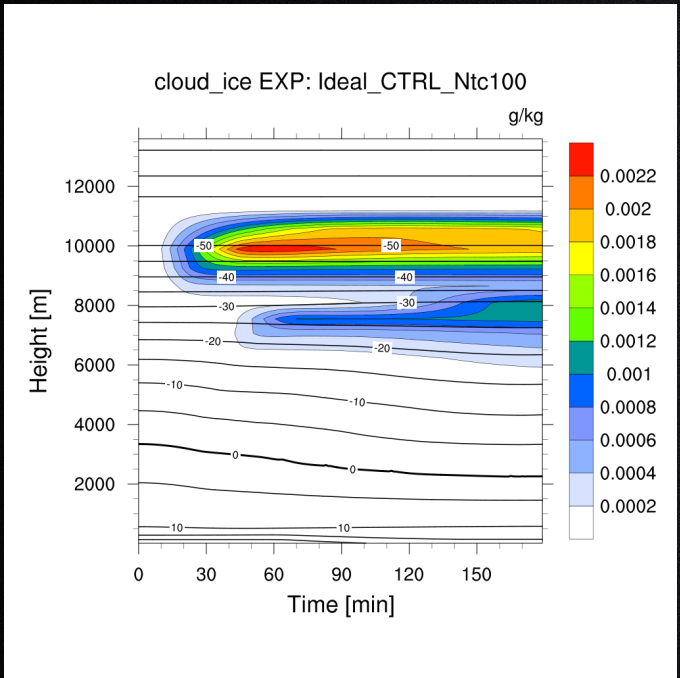
Before bugfix



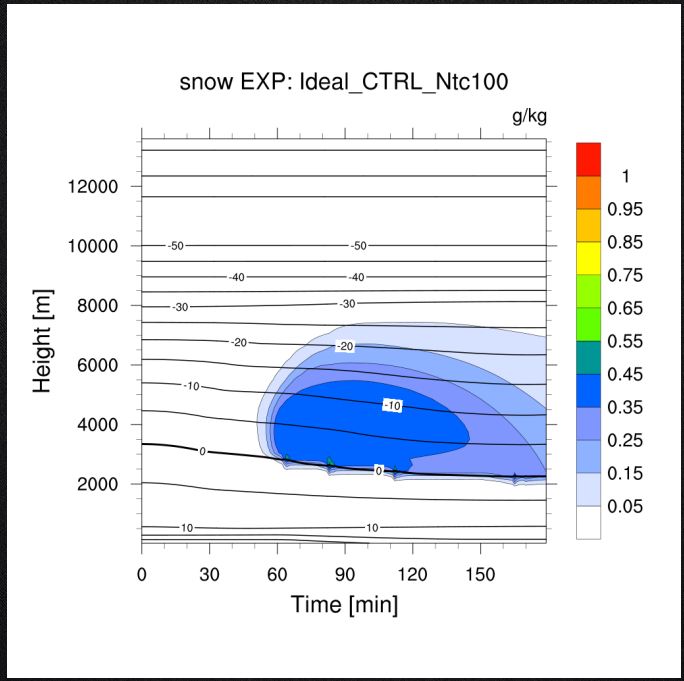
After bugfix



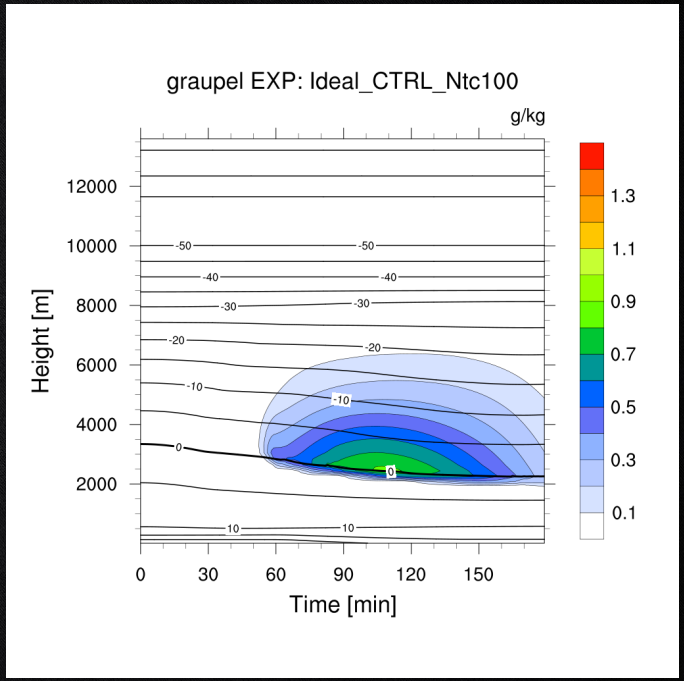
After bugfix: Ice



Cloud ice



Snow



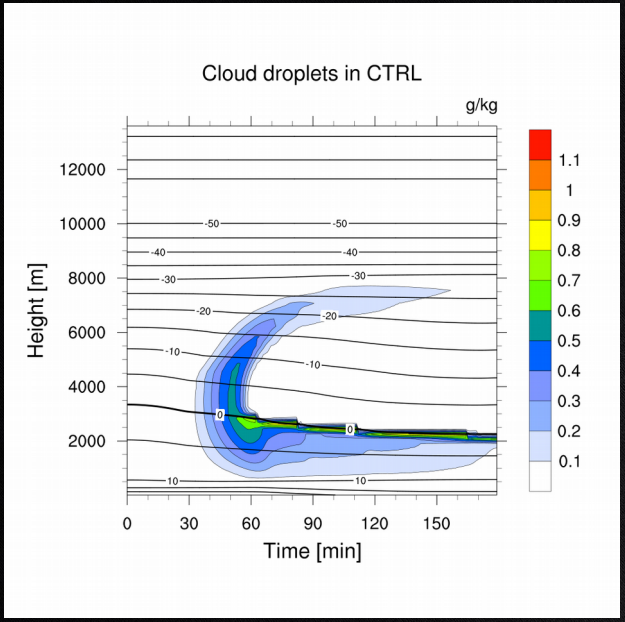
Graupel

Changes

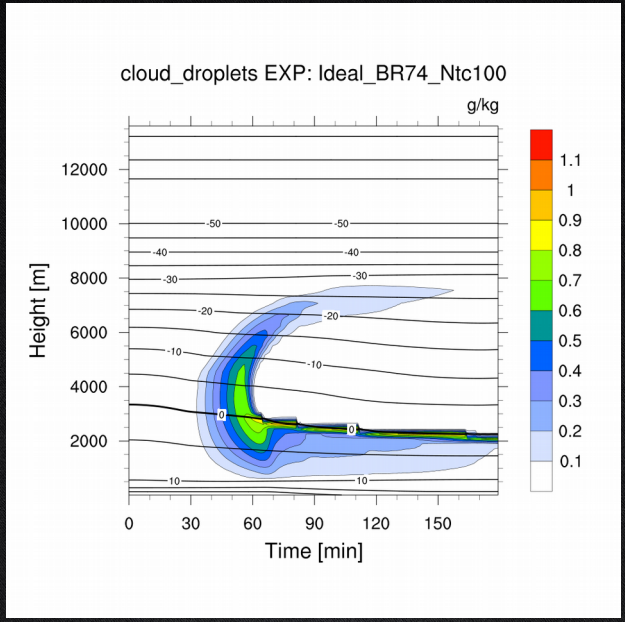
Process:	Effect:
Autoconversion	Rain initiation
Ice nucleation	Triggers the cold processes
Snow/Graupel collecting cloud droplets	Depletes cloud water
Rain and Snow collision	Favors graupel

Cloud droplets

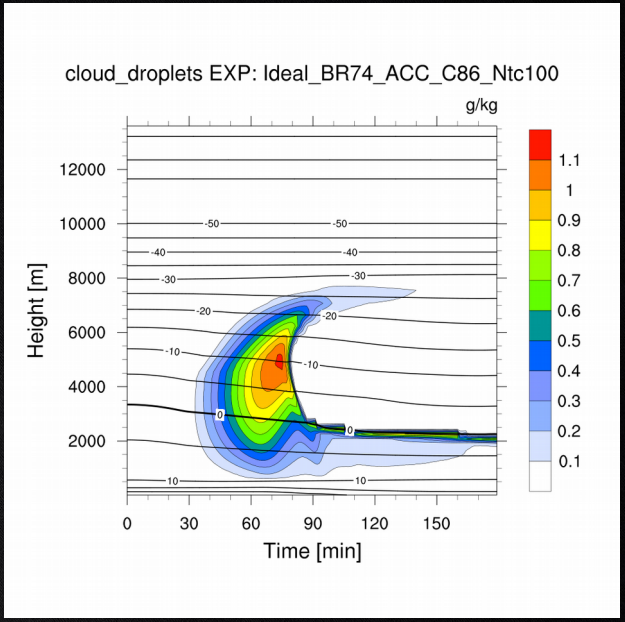
CTRL



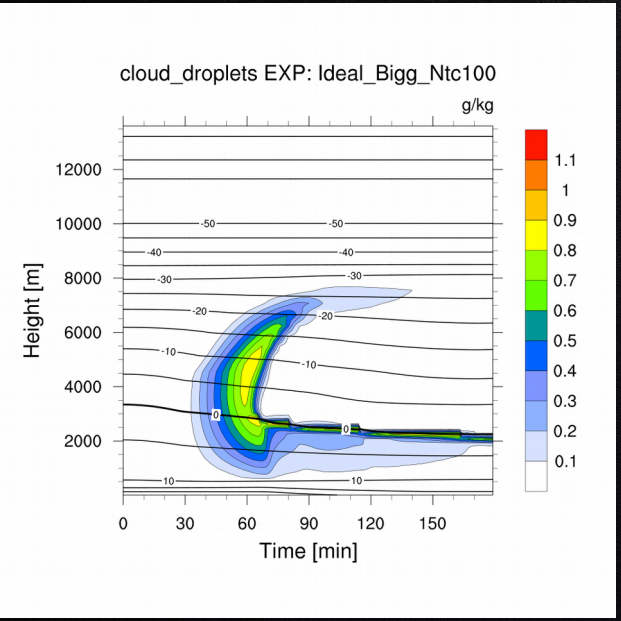
Autoconversion



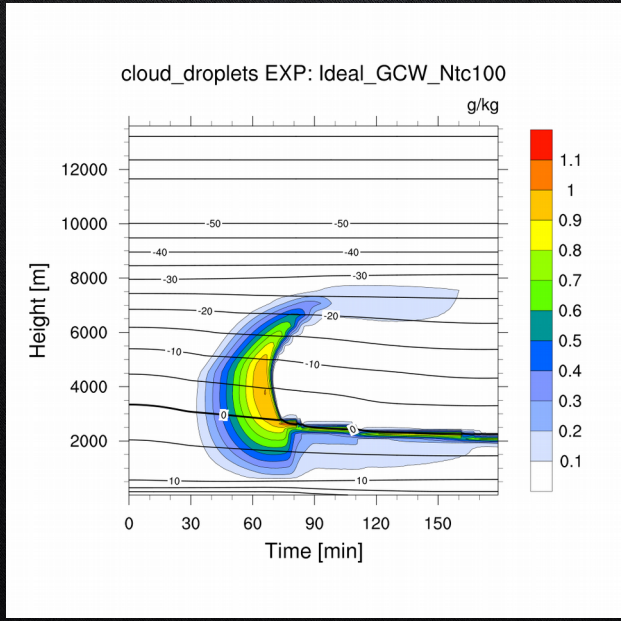
Ice initiation



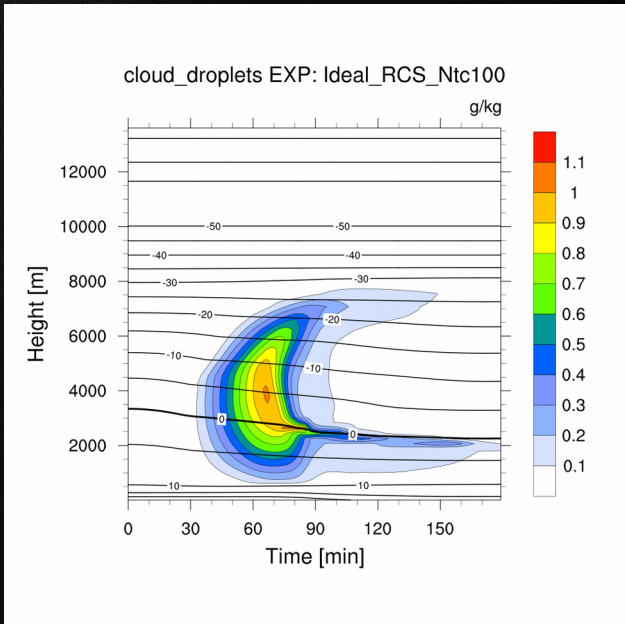
Immersion freezing



Graupel col. cloud water

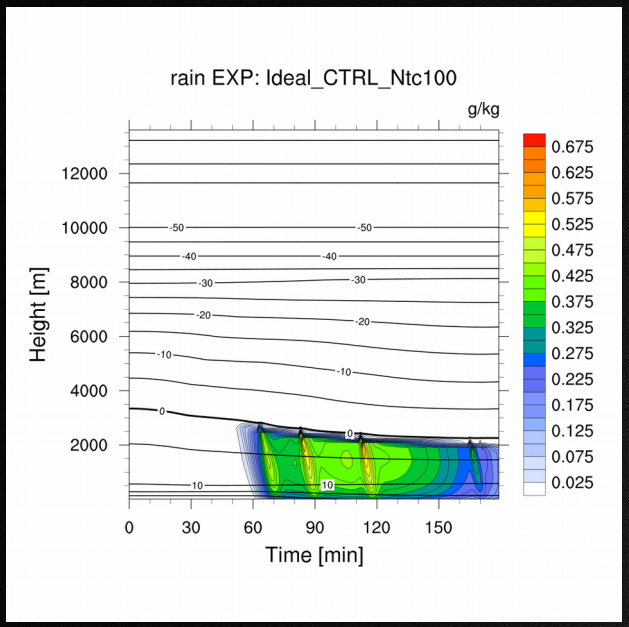


Rain and snow collision

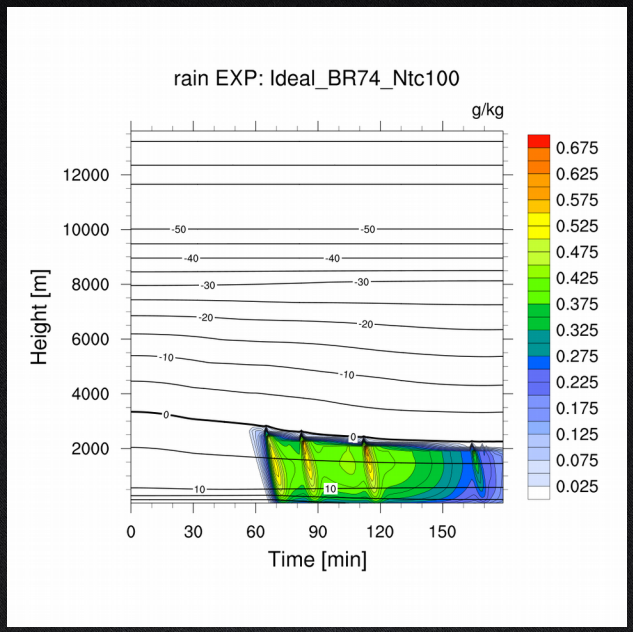


Rain

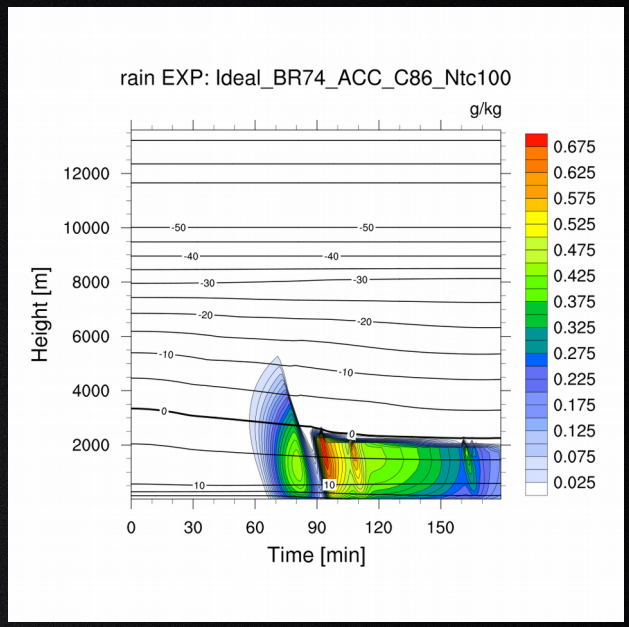
CTRL

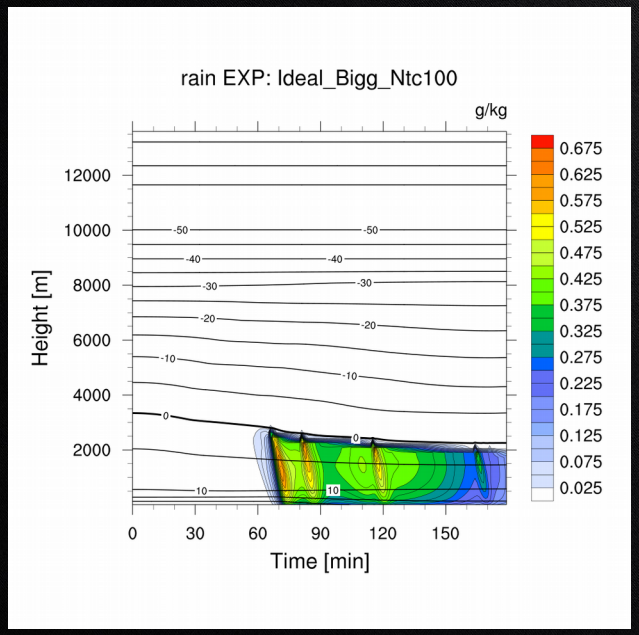


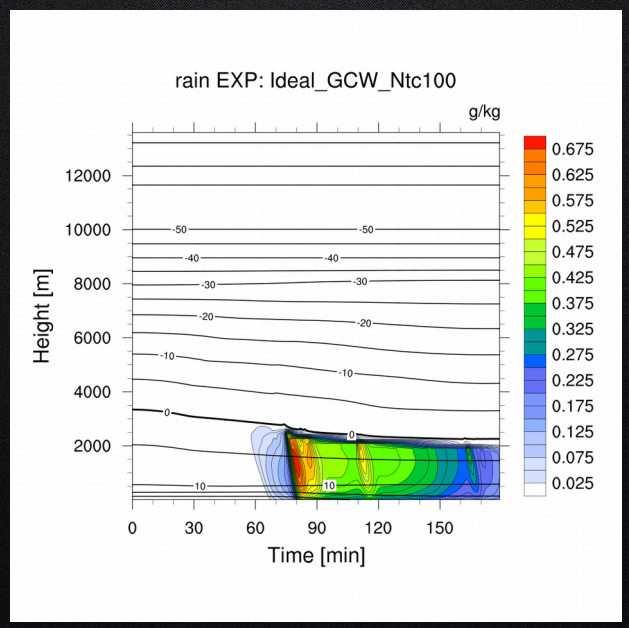
Autoconversion

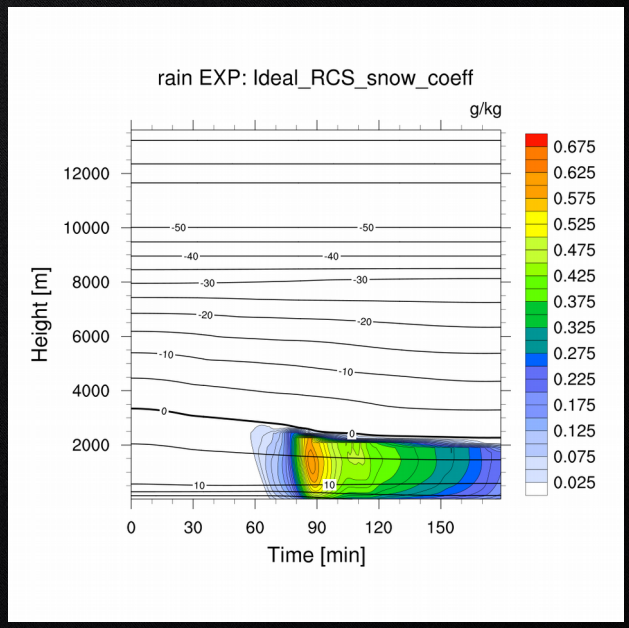


Ice initiation









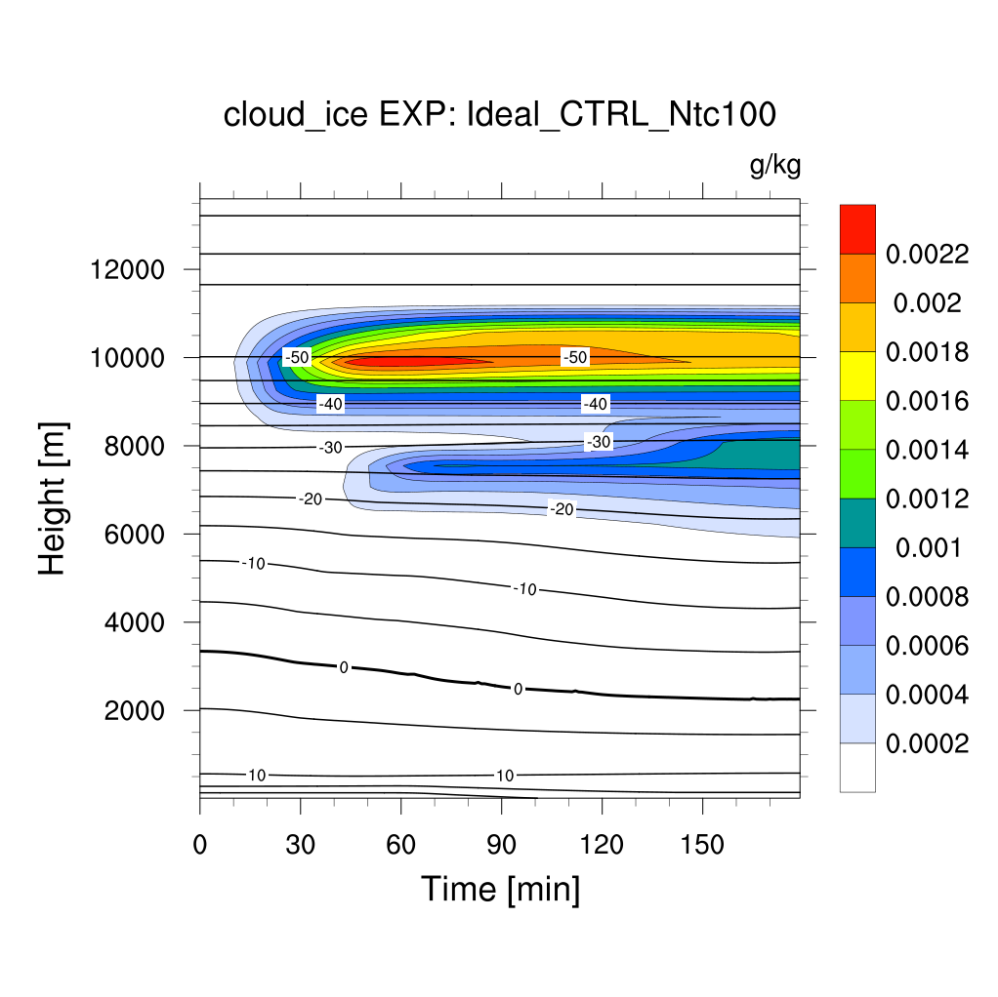
Immersion freezing

Graupel col. cloud water

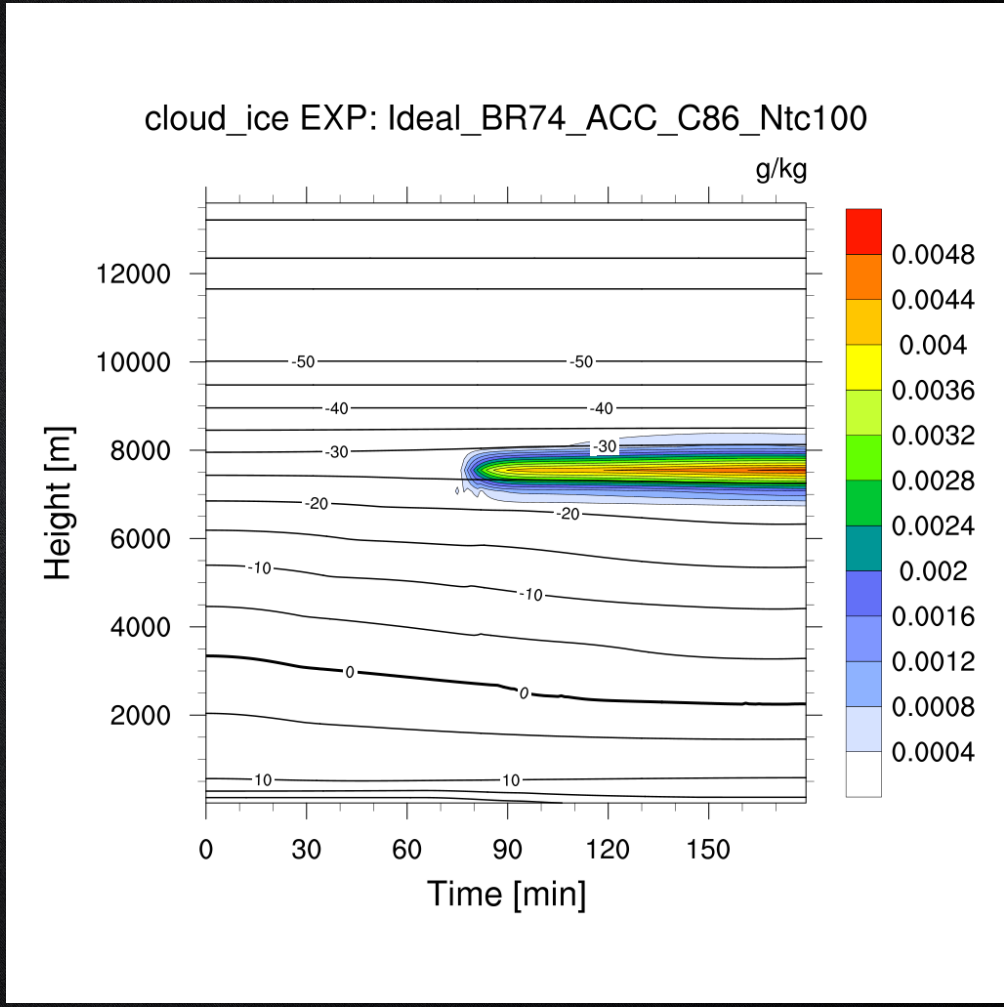
Rain and snow collision

Cloud ice

CTRL

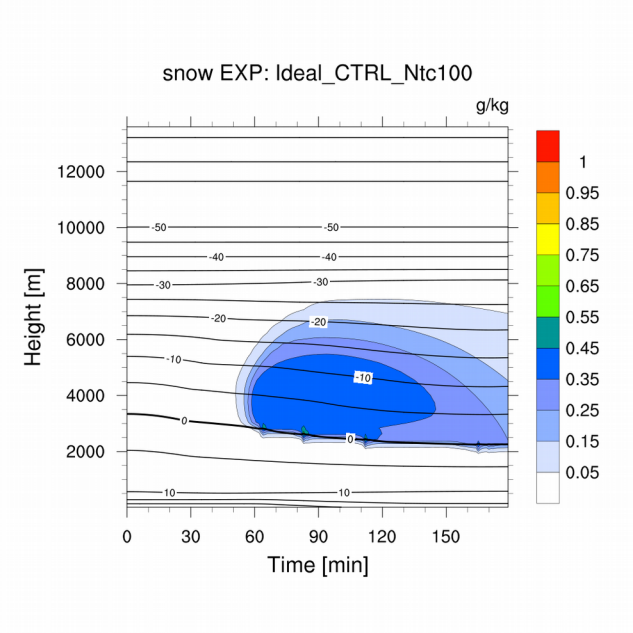


Ice initiation

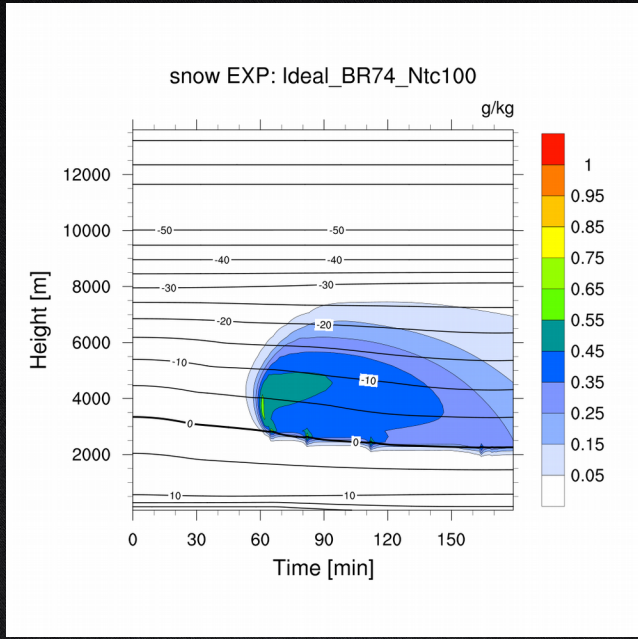


Snow

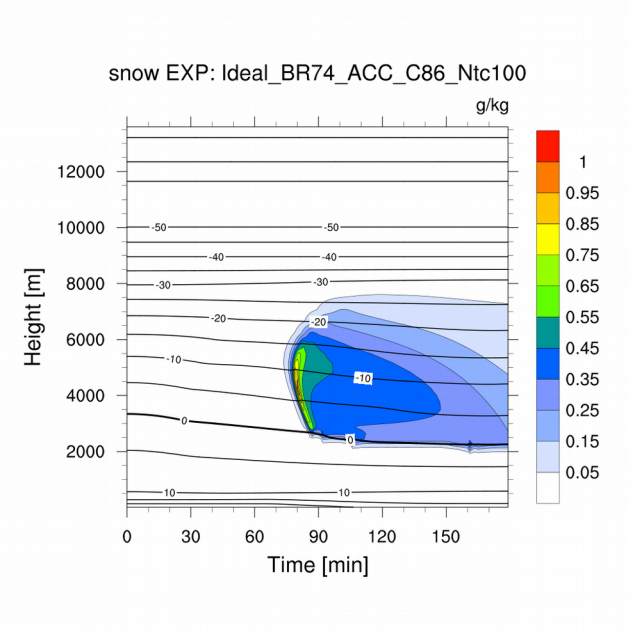
CTRL



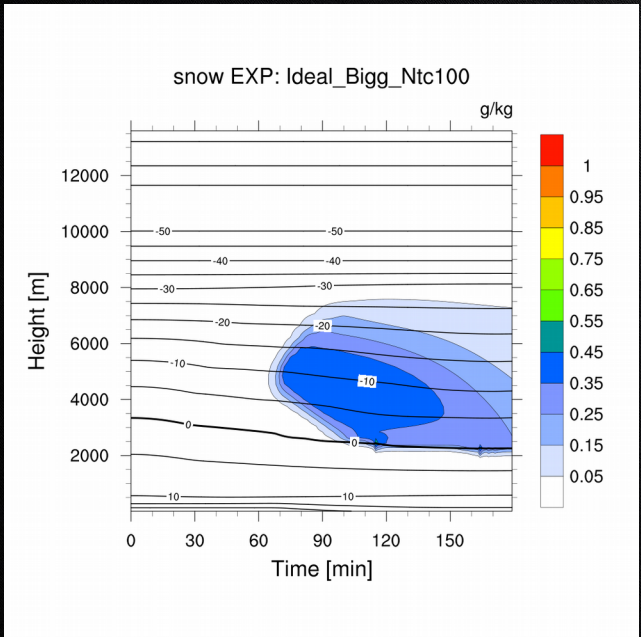
Autoconversion



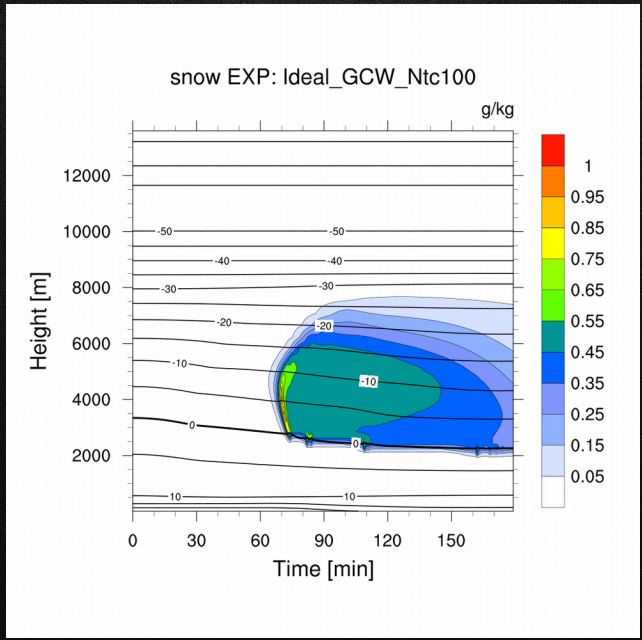
Ice initiation



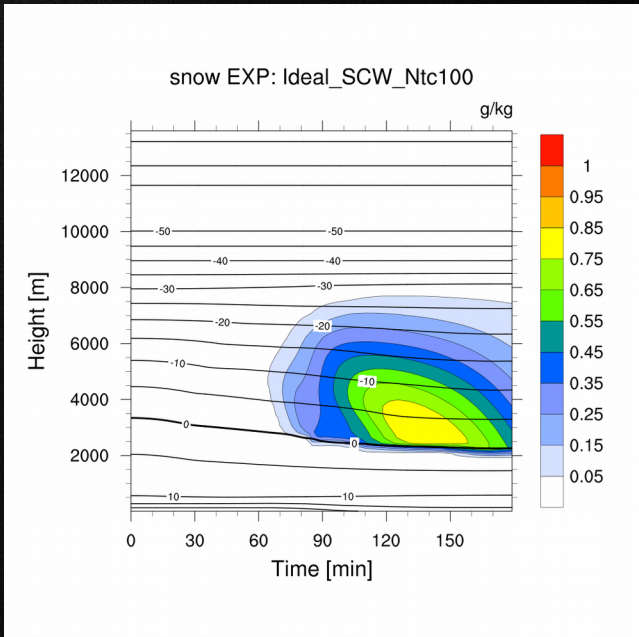
Immersion freezing



Graupel col. cloud water

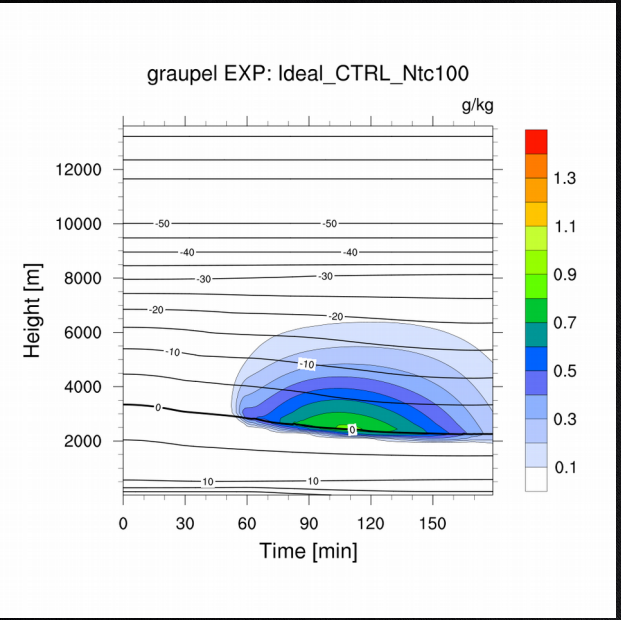


Rain and snow collision

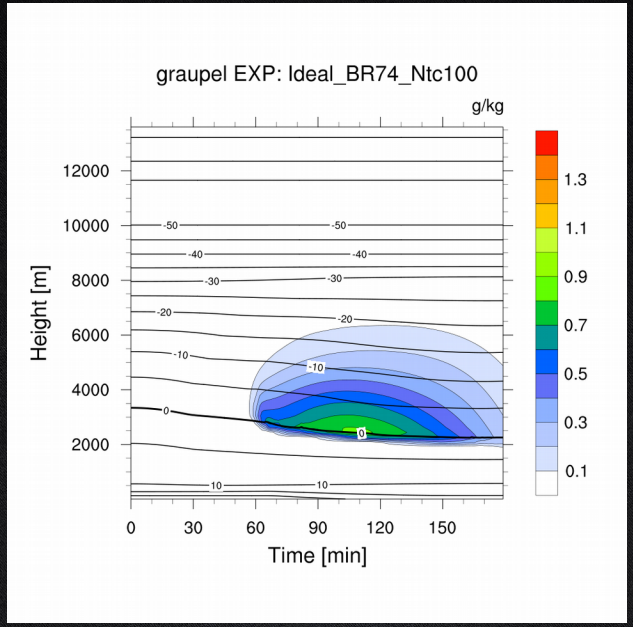


Graupel

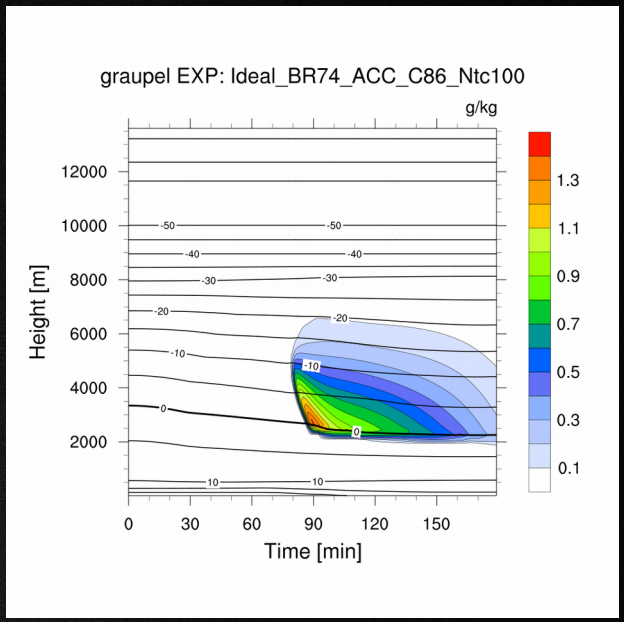
CTRL

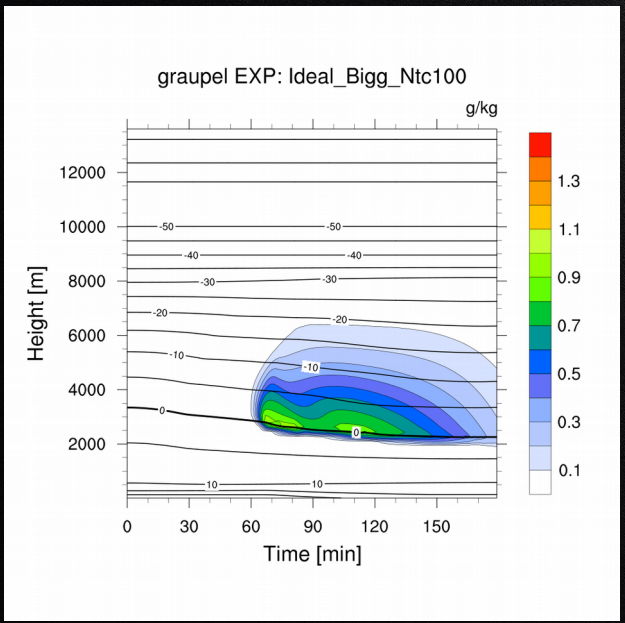


Autoconversion

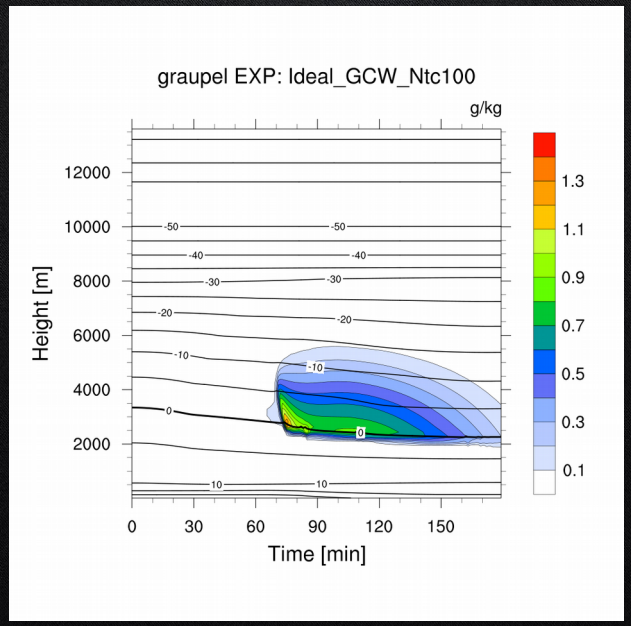


Ice initiation

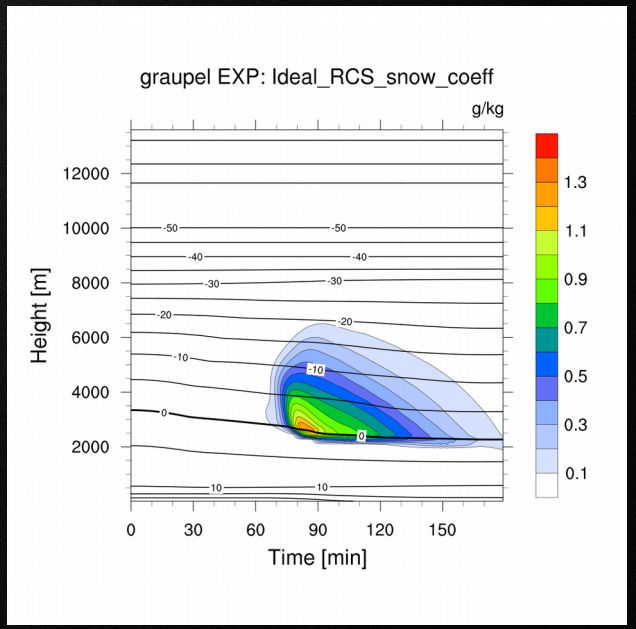




Immersion freezing



Graupel col. cloud water



Rain and snow collision

Summary

Supercooled liquid water is essential when forecasting icing

Autoconversion important for rain triggering

Cloud ice triggers cold processes

Variable collision-collection efficiencies important to allow mixed-phase clouds

Future work

More idealized cases

- Freezing drizzle/rain case (Jan 15 Oslo)
- Convection case
- Sensitivity tests

Real 3D cases

- Validate against both specialized and conventional observations

Thank you for your attention!

Norwegian Meteorological Institute