1. Cloud physics seminar

Noémi Sarkadi

Pécs, 06. Oct. 2017.

EXPERIENCES OF ECSS 2017

Scope

The scope of the conference covers all aspects of severe convective storms. Researchers, operational forecasters, and risk and emergency managers are invited to submit contributions. In light of the global relevance of the conference themes, participants from all over the world are encouraged to attend. These are the conference topics (and tentative session titles):

- Convective storm and tornado dynamics
- Numerical modelling of storms, storm-scale data assimilation
- Impact of storms on society, impact mitigation and early warning systems
- Convective storms within extratropical, Mediterranean and tropical cyclones
- Floods and flash floods
- Forecasting and nowcasting of severe weather
- Severe weather forecast training
- Satellite studies of storms and their environment
- Radar studies of storms
- **Storm electrification, lightning, microphysics and hail**
- Storm climatologies, risk assessments and climate change
- Collection of storm data, historical events and damage assessment

Next: 10th European Conf. on Severe Storms, ECSS 2017, Kraków, Poland, 4 – 8 November 2019.

- **9th European Conf. on Severe Storms, ECSS 2017, Pula, Croatia, 17-22 September 2017.**
- 8th European Conf. on Severe Storms, ECSS 2015, Wiener Neustadt, Austria, 14-18 September 2015.
- 7th European Conf. on Severe Storms, ECSS 2013, Helsinki, Finland, 3-7 June 2013.
- 6th European Conf. on Severe Storms, ECSS 2011, Palma de Mallorca, Balearic Islands, Spain, 3-7 October 2011.Proceedings: Atmos. Res., 123, pp. 1-412.
- 5th European Conf. on Severe Storms, ECSS 2009, Landshut, Germany, 12-16 October 2009. Proceedings: Atmos. Res., 100 (4), 305-782.
- 4th European Conf. on Severe Storms, ECSS 2007, Trieste, Italy, 10-14 September 2007. Proceedings: Atmos. Res.,93(1-3) 672 pp.
- 3rd European Conf. on Severe Storms, ECSS 2004, León, Spain, 9-12 November 2004. Proceedings: Atmos. Res.,83(2-4), 442 pp.
- 2nd European Conf. on Severe Storms, ECSS 2002, Prague, Czech Republic, 26-30 August 2002. Proceedings: Atmos. Res., 67-68, 703 pp.
- European Conf. on Tornadoes and Severe Storms, ETSS 2000, Toulouse, France, 1-4 February 2000. Proceedings:Atmos. Res., 56(1-4), 409 pp.

Some interresting problems – Dynamics and others

- **Ensemble-based storm-scale analysis and prediction of severe convection: Assimilation of radar reflectivity.** (de Lozar, Alberto; Blahak, Ulrich; Seifert, Axel)
- **Ensemble-based storm-scale analysis and prediction of severe convection: Single- vs double-moment microphysics.** (Seifert, Axel; de Lozar, Alberto; Blahak, Ulrich)
- **Development of a new seamless prediction system for very short range convective-scale forecasting at DWD.** (Blahak, Ulrich; Potthast, Roland; Wapler, Kathrin; Seifert, Axel; De Lozar, Alberto; Bauernschubert, Elisabeth; Welzbacher, Christian; Osinski, Robert; Rempel, Martin; Hoff, Michael; Junk, Markus; Bach, Liselotte)
- **What have we learned about high-shear low-CAPE severe weather? A review.** (solicited: Parker, Matthew)
- **Performance of waterspout forecasting method using high resolution numerical weather model**. (Ivusic, Sarah; Renko, Tanja; Telisman Prtenjak, Maja; Horvat, Igor; Soljan, Vinko; Szilagyi, Wade)
- **The regulation of tornado intensity by updraft width.** (solicited:Trapp, Robert; Marion, Geoffrey; Nesbitt, Stephen)
- *Poster:* **Use of new radar products for nowcasting of severe storms.** (Böhme, Tim; Herold, Christian; Schappert, Sebastian)

Some interresting problems – Microphysics, lightning and hail

- **The Impact of Vertical Wind Shear on Hail Growth in Simulated Supercell Storms.** (Kumjian, Matthew; Dennis, Eli)
- **The life-cycle of hail storms: lightning, radar reflectivity and rotation characteristics.** (Wapler, Kathrin)
- **Mapping of thunderstorm charge structures by automated lightning leader speed analysis of Lightning Mapping Array data: applications and statistics.** (van der Velde, Oscar; Montanyà, Joan; López, Jesús Alberto; Pineda, Nicolau)
- **Analysis and simulations of the 4 July 2007 large hailstorm in NE Italy.** (Manzato, Agostino (Tino); Riva, Valentino; Miglietta, Mario Marcello; Laviola, Sante)

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NUMERICAL SIMULATION OF CONVECTIVE SQUALL LINES OVER SOUTHWEST ENGLAND WITH DETAILED MICROPHYSICAL SCHEME

Outline

- Detailed microphysics – short overview
- Meteorological background of case
- Model setup
- Results
  - CTRL case: all microphysics
  - HM case: all microphysics without Hallett-Mossop effect

Detailed microphysics

- Four different hydrometeor types
- Each type of the different particles were divided into 36 bins:

	Ice crystal	Water drop		Snowflake	Graupel particle
		Cloud water	Raindrop		
Min. size (m)	$2.06 \cdot 10^{-6}$	$1.56 \cdot 10^{-6}$	$2.50 \cdot 10^{-5}$	$2.06 \cdot 10^{-6}$	$3.37 \cdot 10^{-6}$
Max. size (m)	0.38	$2.50 \cdot 10^{-5}$	$1.02 \cdot 10^{-2}$	$7.85 \cdot 10^{-2}$	$5.08 \cdot 10^{-3}$

- Calculated variables: ~400, mixing ratio, number concentration, melted water on snow and graupel (mixing ratio), rimed water on snow (number and mixing ratio)

  →melting fraction calculated (0.8)

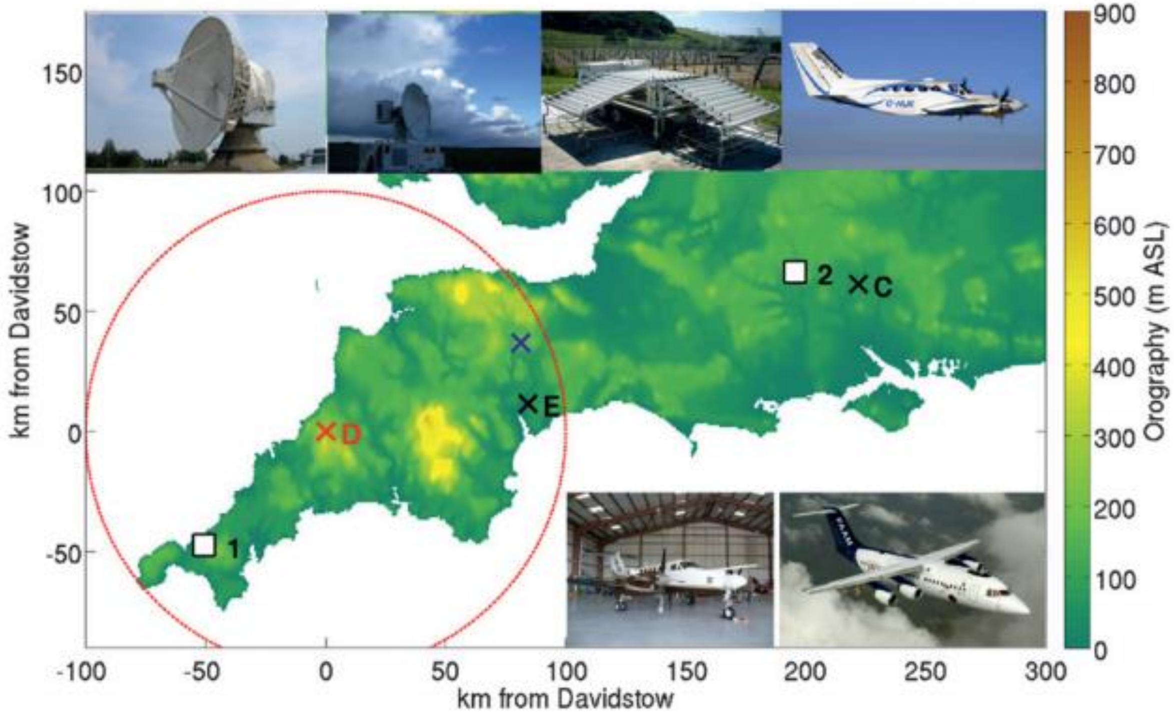
  →riming fraction calculated (0.5)

Detailed microphysics

- The following microphysical processes were taken into consideration:
  1) Diffusional growth of different type of hydrometeors;
  2) Melting of solid hydrometeors;
  3) Freezing of supercooled water drops;
  4) Collision and coalescence of water drops;
  5) Self-coagulation of pristine ice crystals results in snowflakes;
  6) Self-coagulation of snowflakes increases the mass of snowflakes;
  7) Riming;
  8) Breakup of water drops;
  9) Formation of pristine ice crystals by deposition nucleation or condensational freezing;
  10) Sedimentation;
  11) Collision-induced shedding
- Microphysics with dynamical time-step for collision and coalescence processes

Meteorological background

- Convective Precipitation Experiment (COPE)
- IOP: 3rd August 2013
- Ice processes – ice multiplication

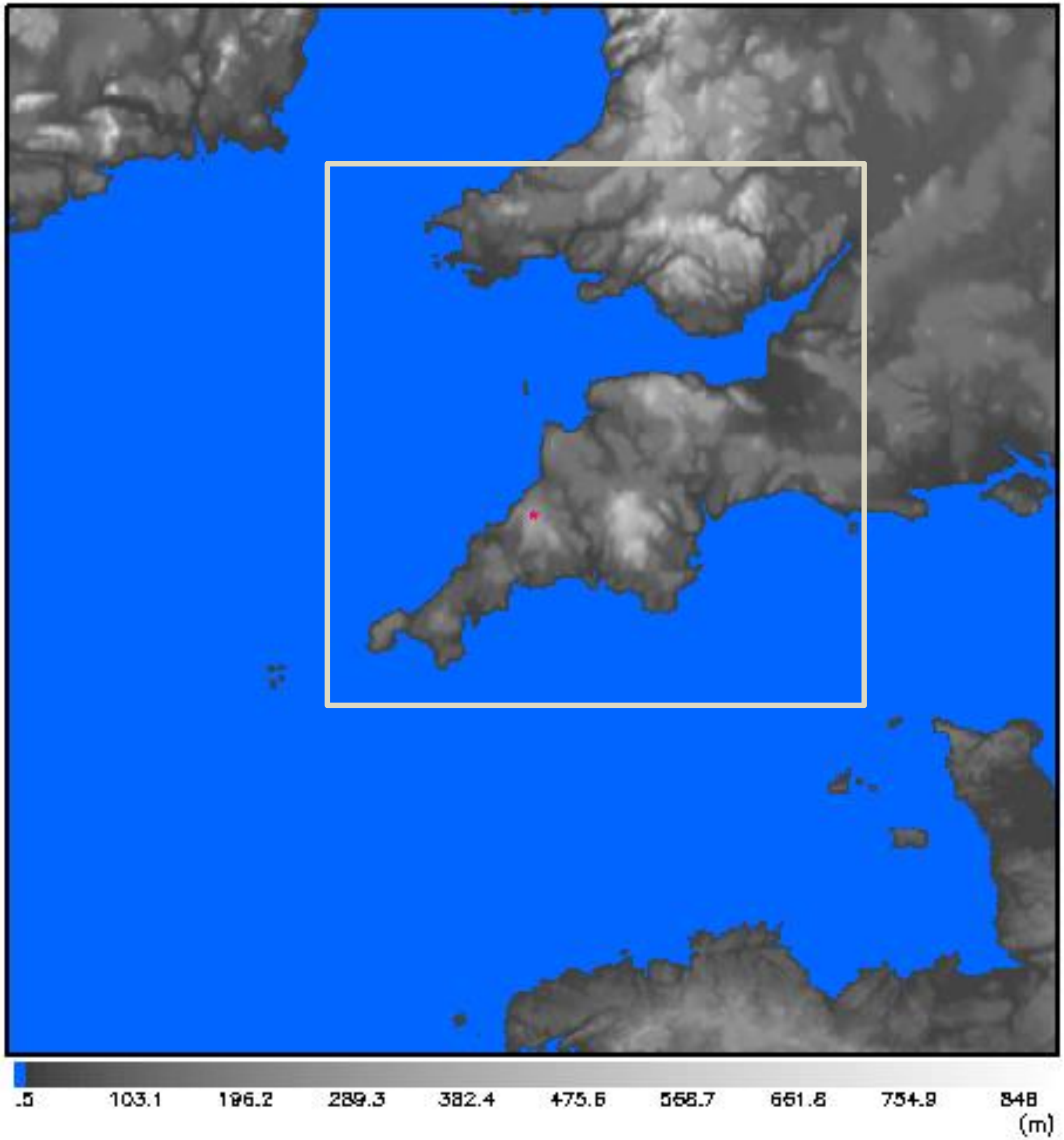


Leon et al., 2015, BAMS

Model setup

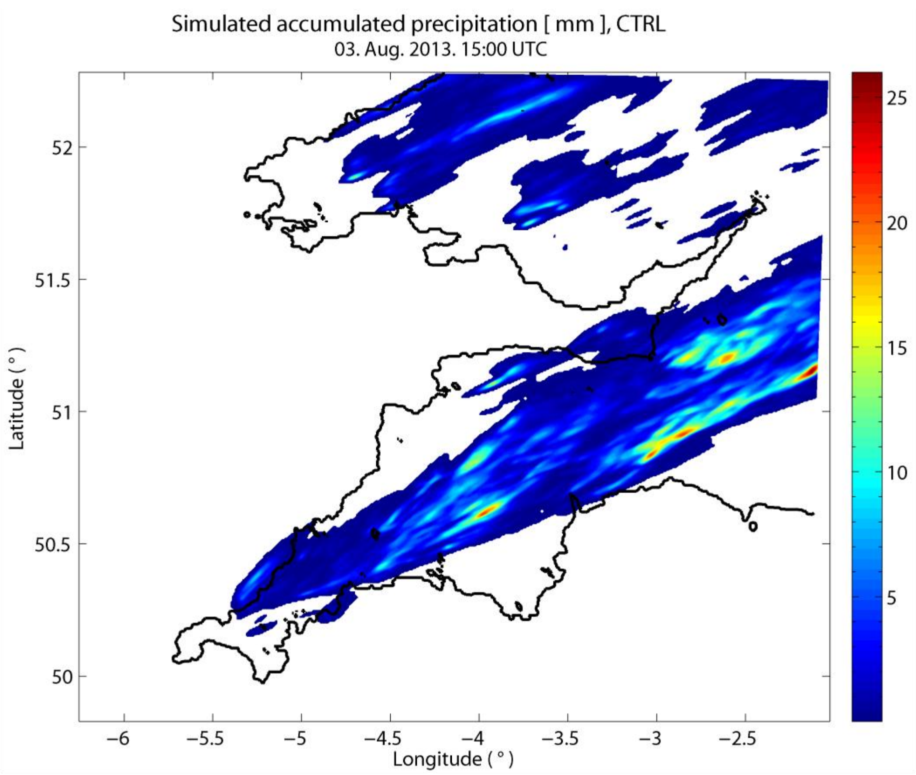
- WRF (**W**eather **R**esearch and **F**orecasting) v3.7.1
- Initialization from GFS data (coarse grid: 3 km → 600 m)
- CCN ~ 200 cm^{-3}

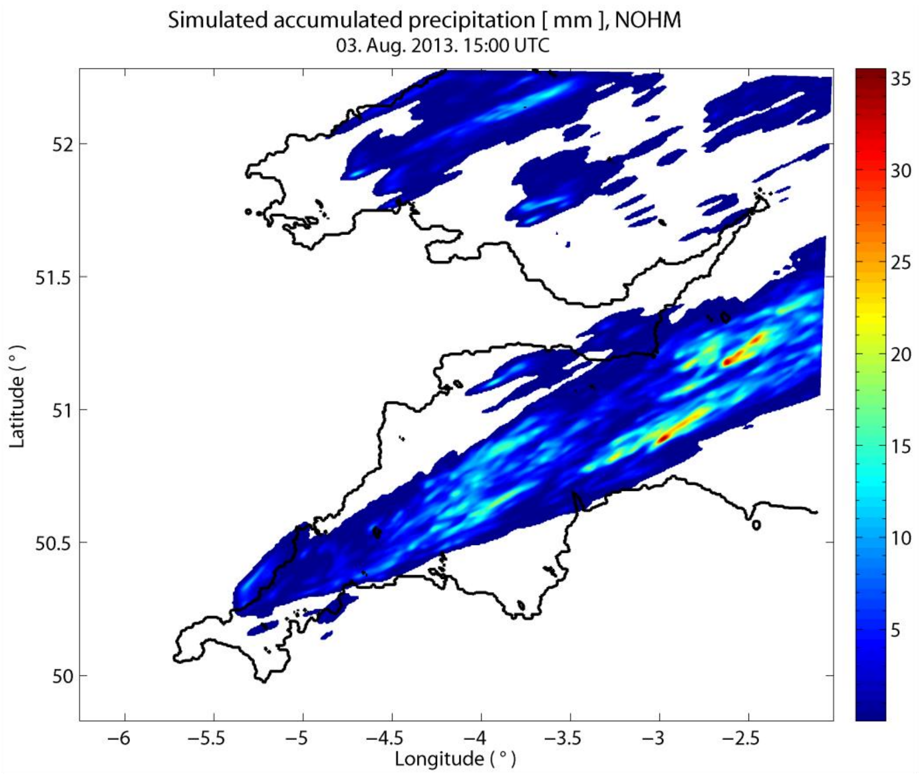
	CTRL	NOHM
Domain size in horizontal	830x700	830x700
Horizontal resolution	600 m	600 m
Domain size in vertical	71 (~ 20 km)	71 (~ 20 km)
Vertical resolution	streched grid (~45-700 m)	streched grid (~45-700 m)
Simulation time	12 h	12 h
Time step	3 s	3 s
Microphysical processes	**ALL** microphysics	Without **Hallett-Mossop** effect

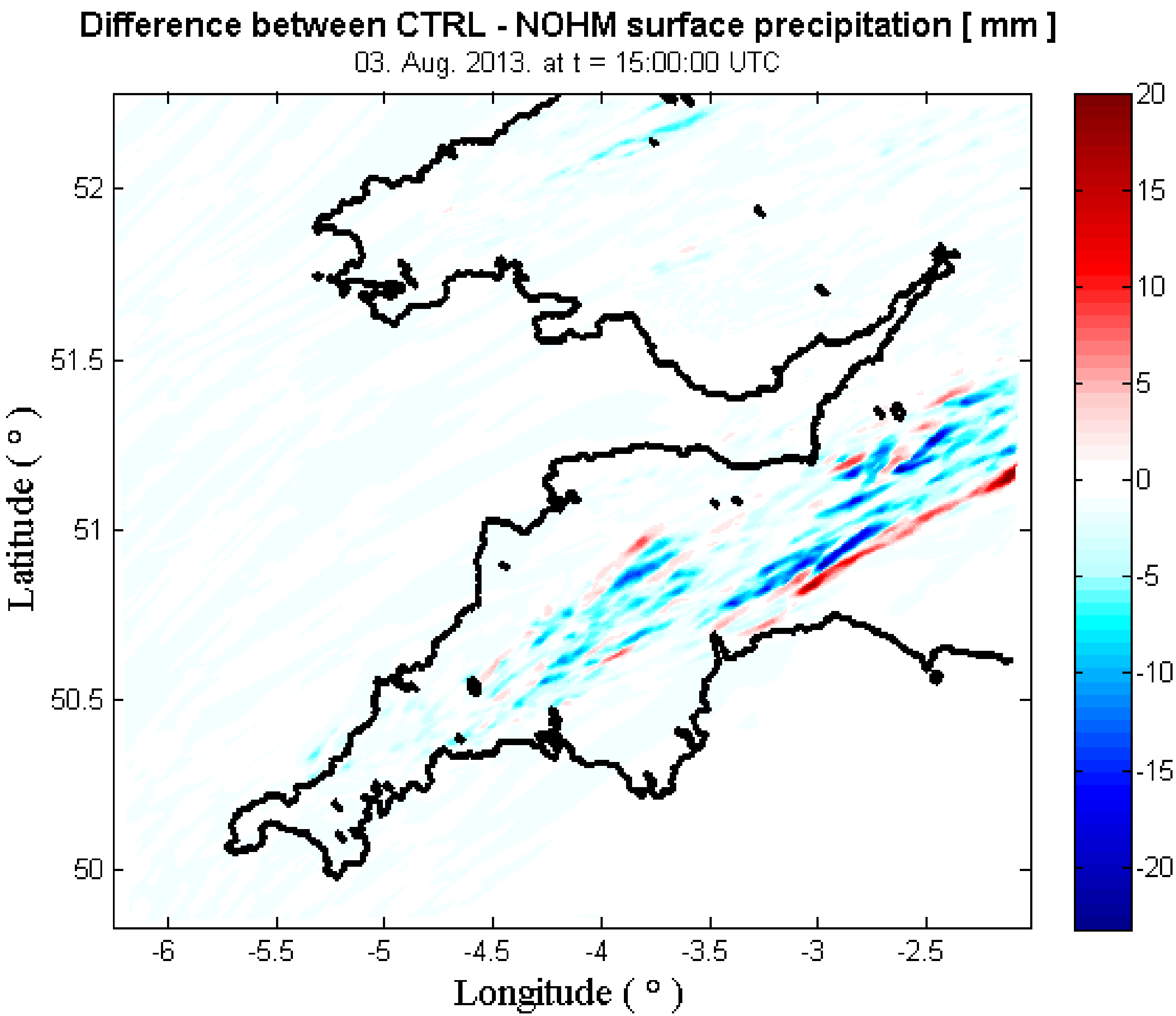

.5
103.1
196.2
289.3
382.4
475.5
568.7
661.8
754.9
848
(m)

RESULTS – Precipitation

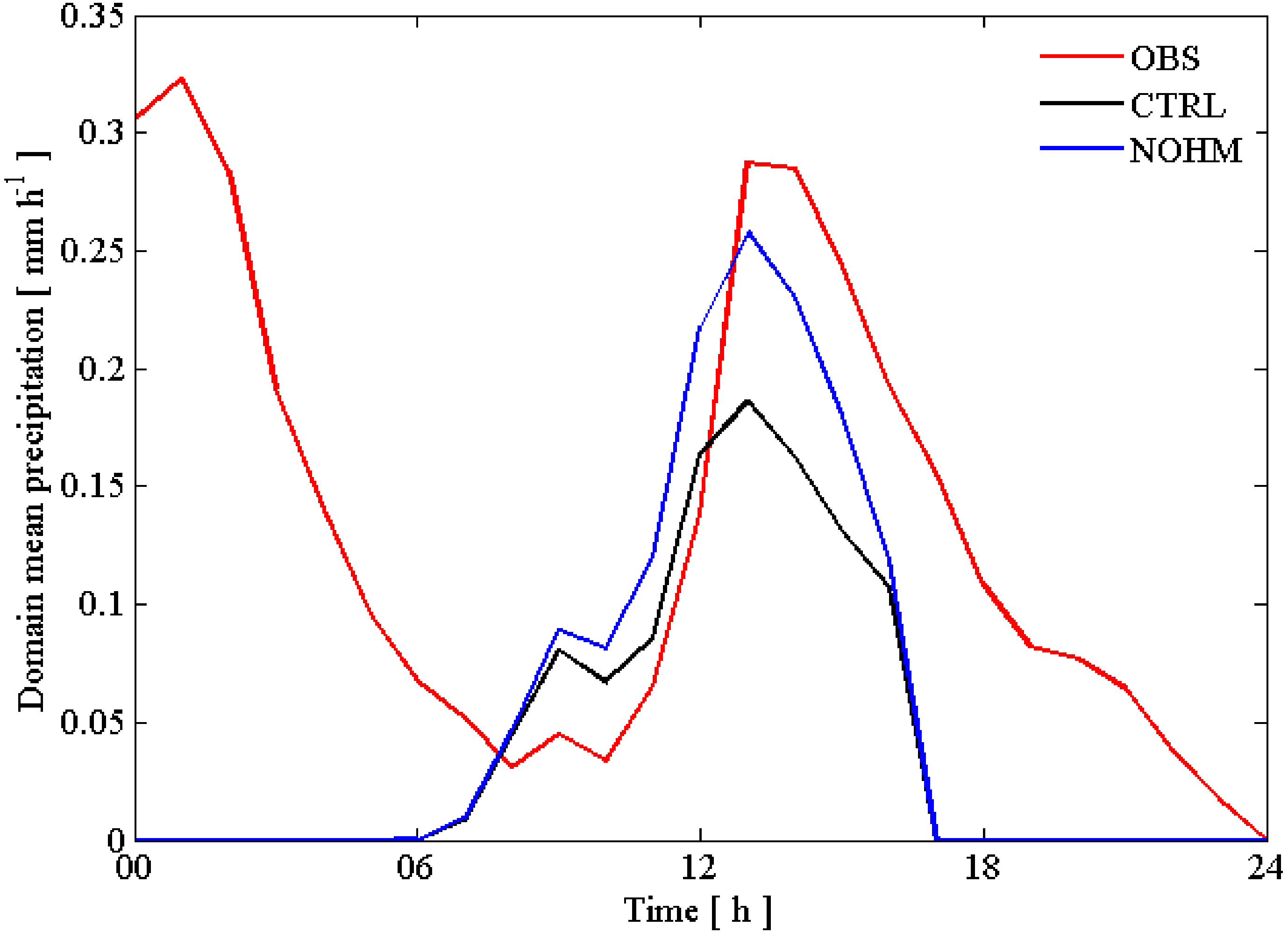
Domain integrated precip., CTRL = 298920 mm
Domain integrated precip., NOHM = 384900 mm

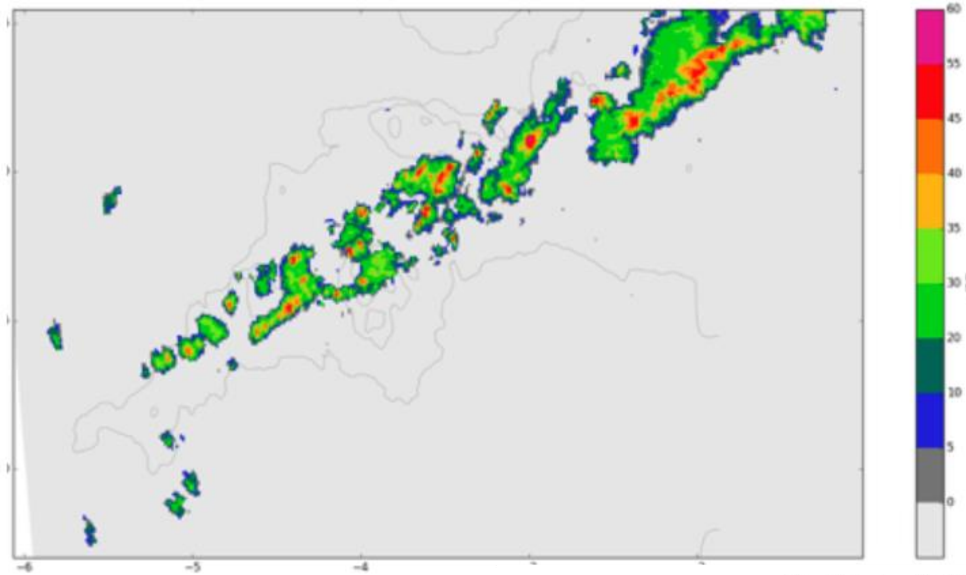




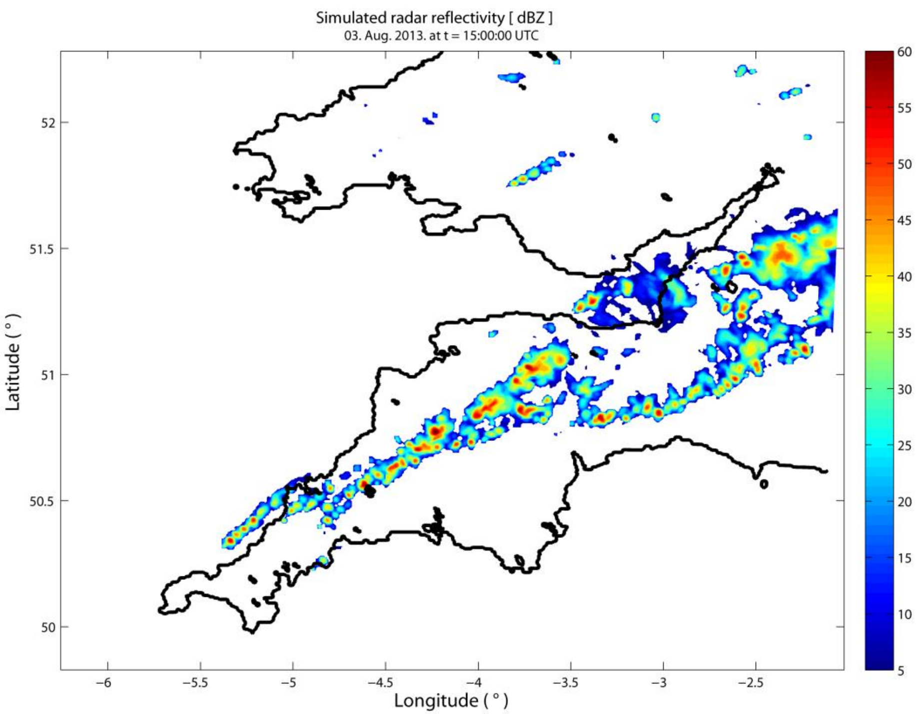

Difference between CTRL - NOHM surface precipitation [mm]
03. Aug. 2013. at t = 15:00:00 UTC
Latitude (°)
Longitude (°)
52
51.5
51
50.5
50
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
20
15
10
5
0
-5
-10
-15
-20

RESULTS – Precipitation

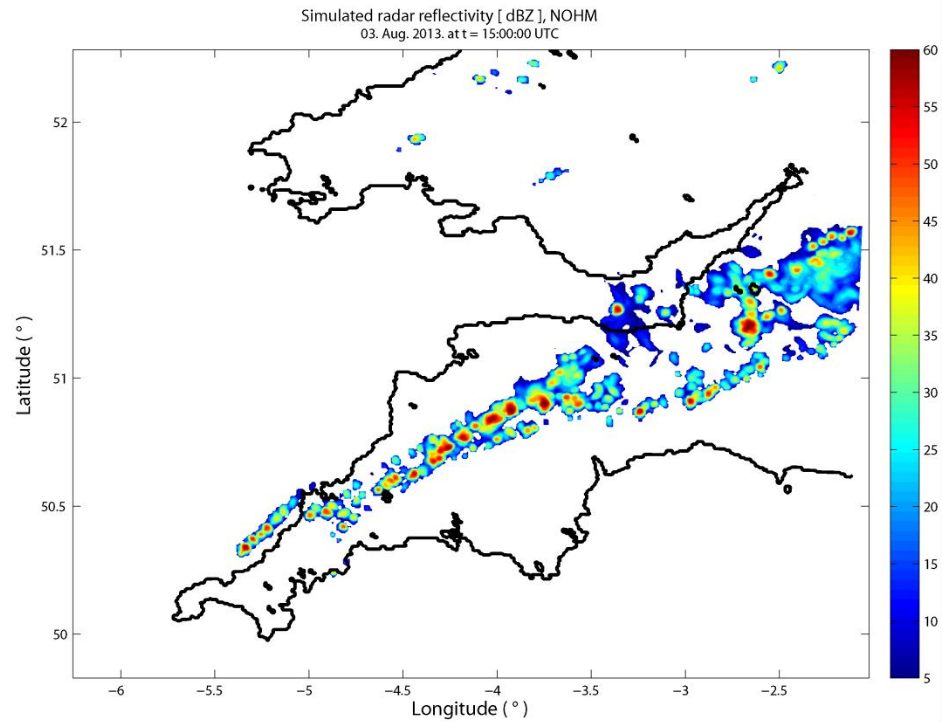




60
55
45
40
35
30
20
10
5
0
dBZ
-6
-5
-4

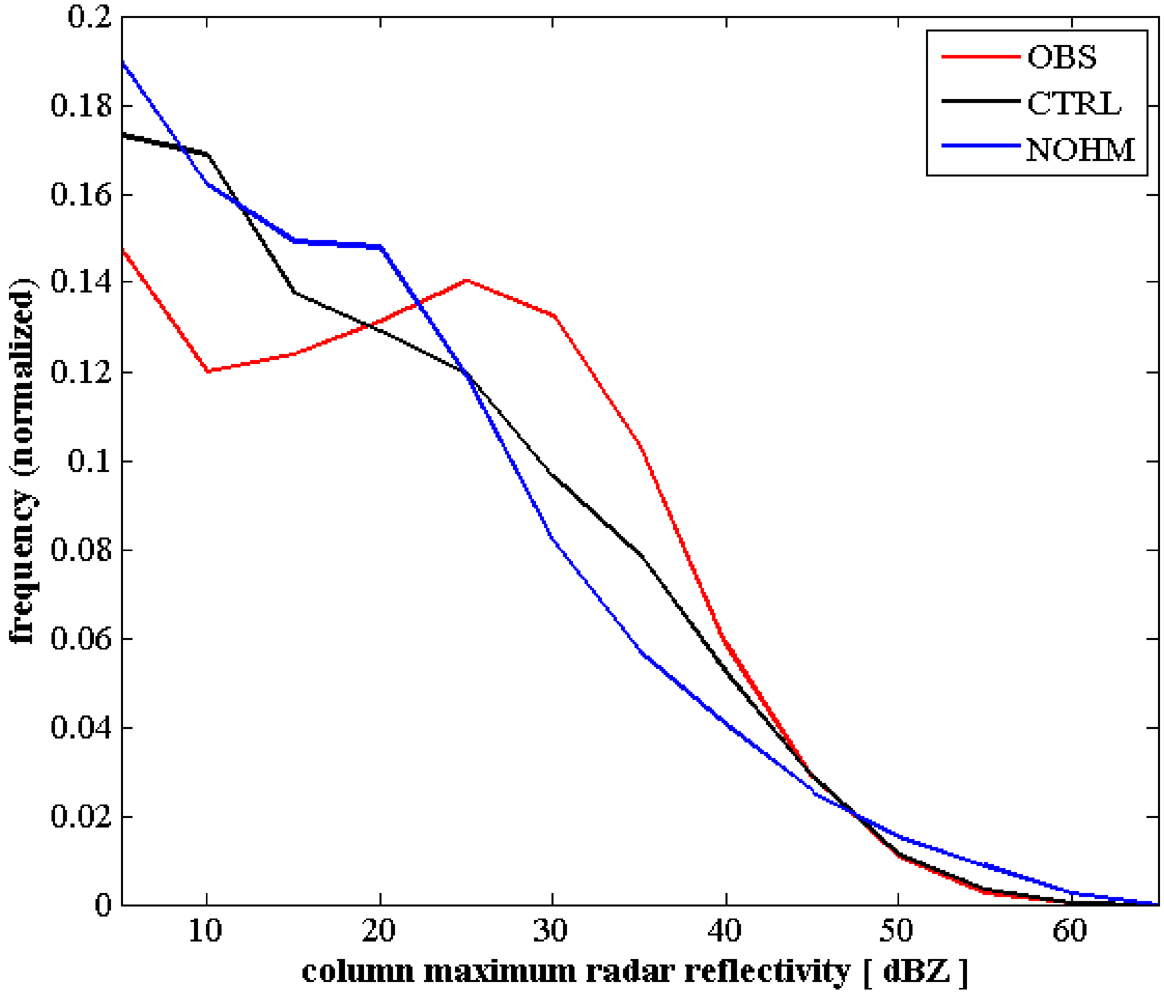


Simulated radar reflectivity [dBZ]
03. Aug. 2013. at t = 15:00:00 UTC
Latitude (°)
Longitude (°)
52
51.5
51
50.5
50
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
60
55
50
45
40
35
30
25
20
15
10
5

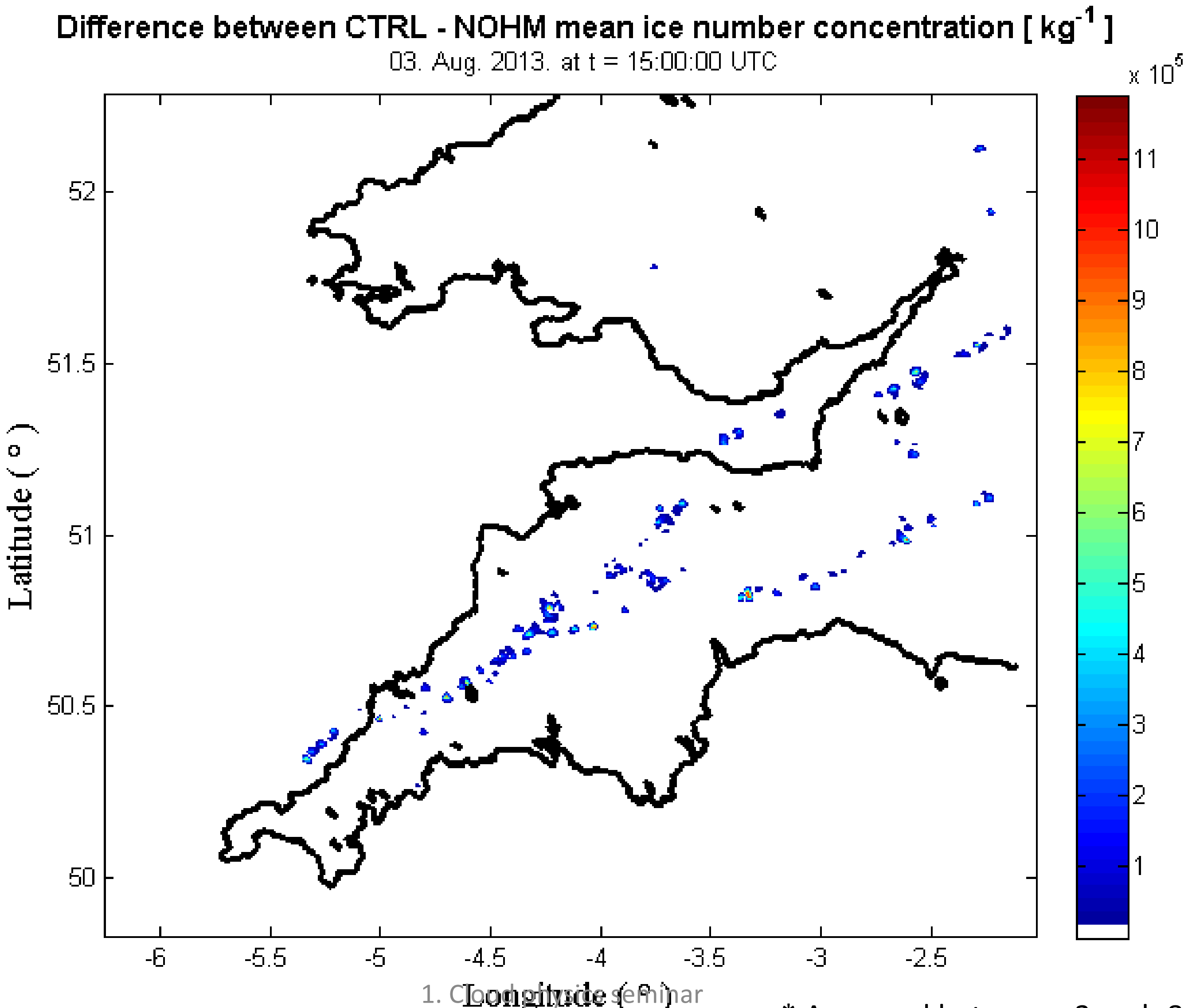


Simulated radar reflectivity [dBZ], NOHM
03. Aug. 2013. at t = 15:00:00 UTC
Latitude (°)
Longitude (°)
52
51.5
51
50.5
50
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
60
55
50
45
40
35
30
25
20
15
10
5

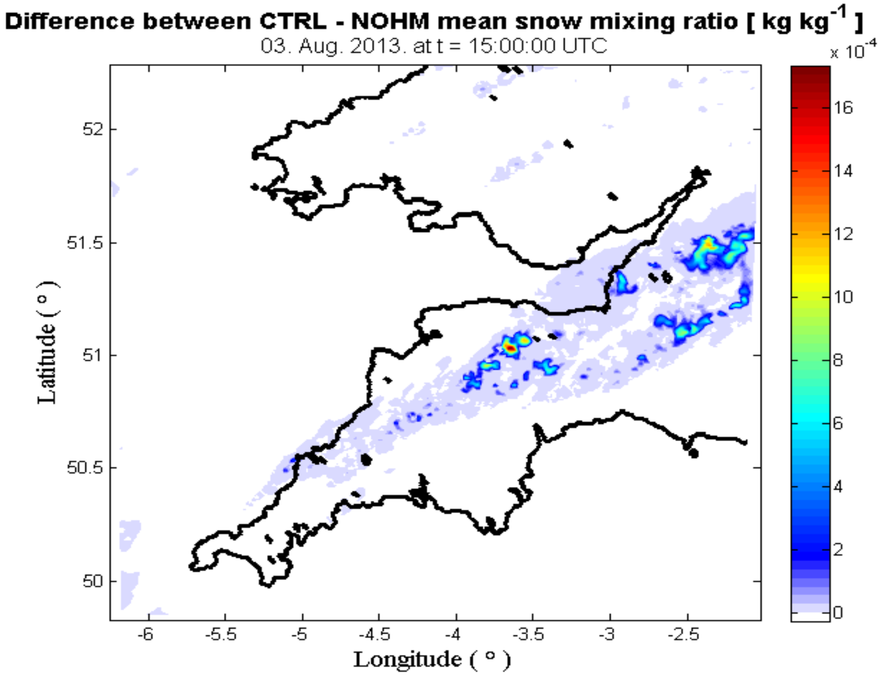
RESULTS – Radar reflectivity



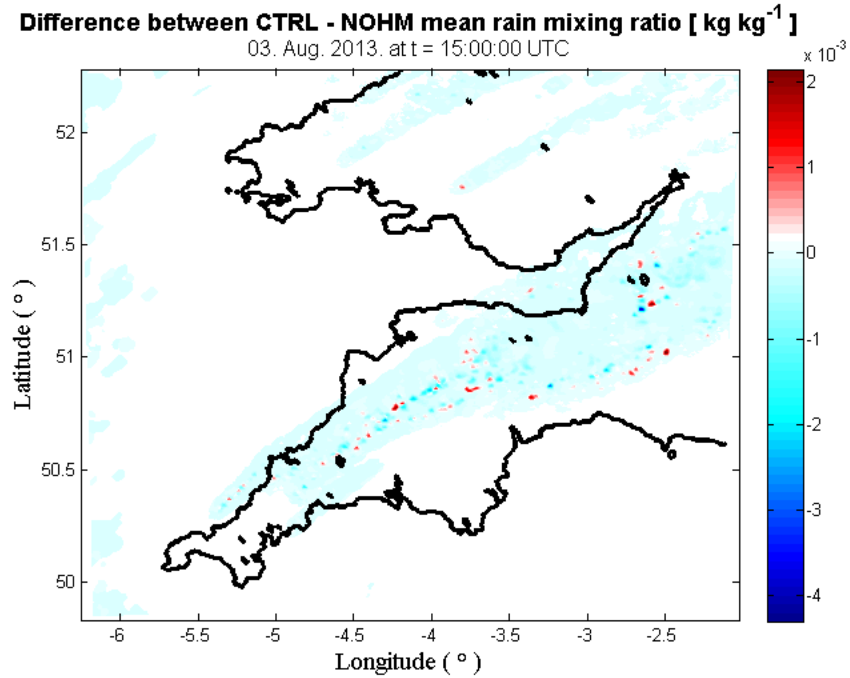
RESULTS – Mean ice number concentration*



* Averaged between -3 and -8 °C

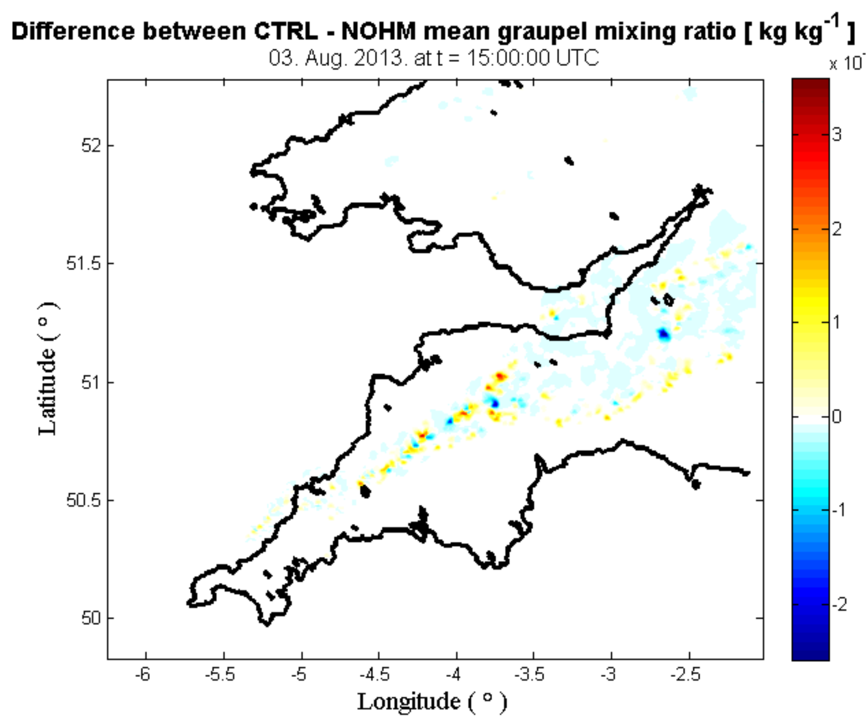


Difference between CTRL - NOHM mean snow mixing ratio [kg kg-1]
03. Aug. 2013. at t = 15:00:00 UTC
x 10-4
Latitude (°)
Longitude (°)



Difference between CTRL - NOHM mean rain mixing ratio [kg kg-1]
03. Aug. 2013. at t = 15:00:00 UTC
x 10-3
Latitude (°)
Longitude (°)

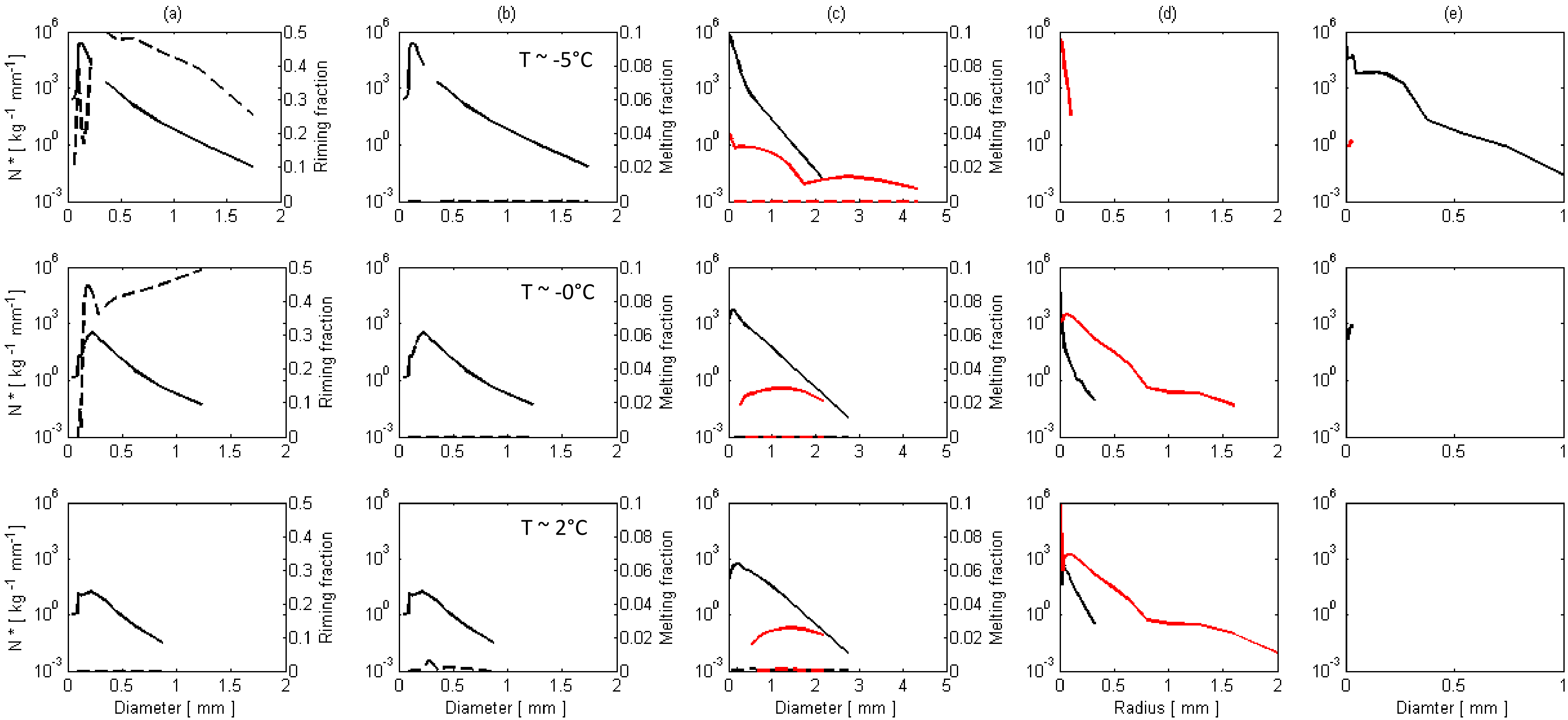
Near to 0°C



Difference between CTRL - NOHM mean graupel mixing ratio [kg kg-1]
03. Aug. 2013. at t = 15:00:00 UTC
x 10-3
Latitude (°)
Longitude (°)

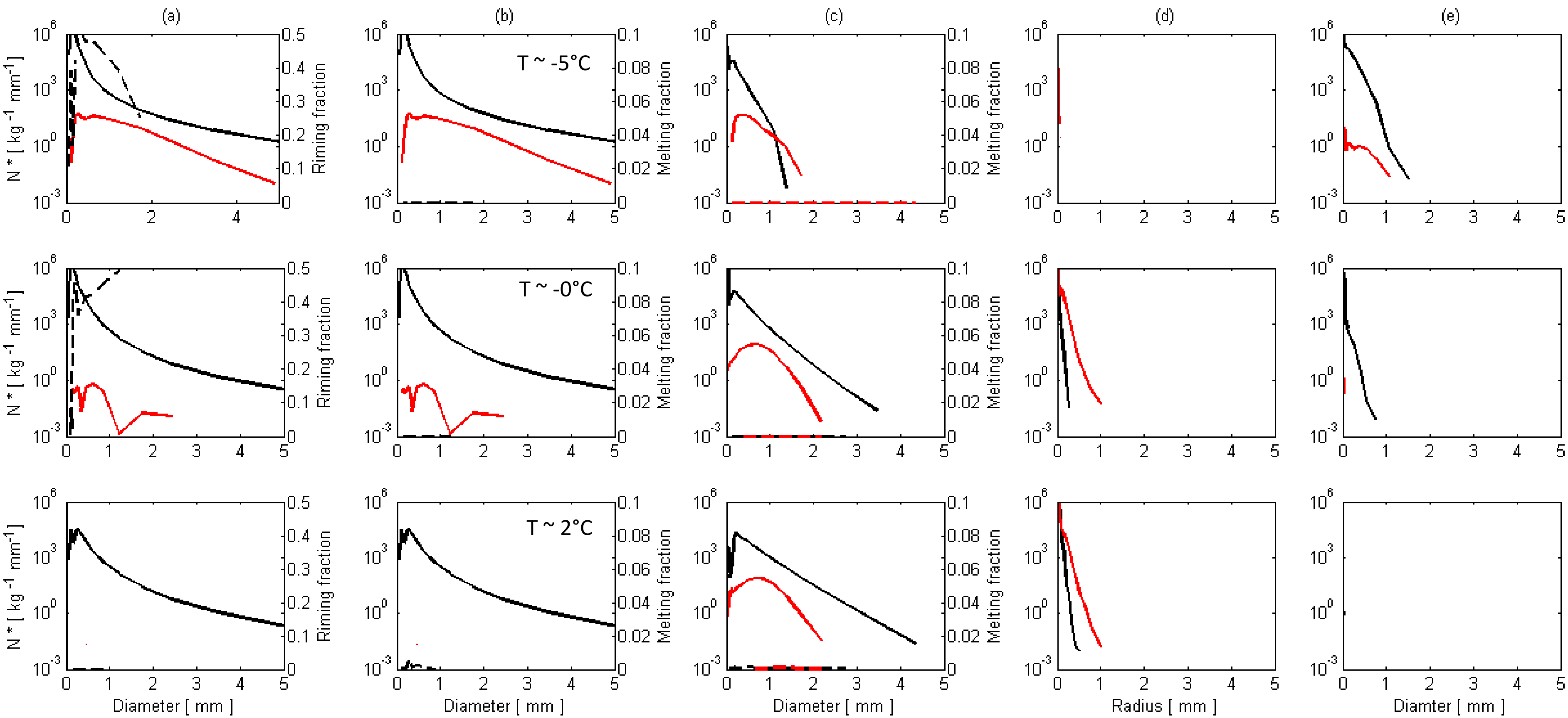
RESULTS – Size distribution

Size distribution at the point where the surface precipitation has its maximum in NOHM case.



RESULTS – Size distribution

Size distribution at the point where the difference in snow number concentration has its maximum.



SUMMARY and FURTHER PLANS

- Case without HM effect agreed better with measurements (mean precipitation)
- Good agreement with radar measurements frequency.
- Future plans:
  - Compare the simulated and observed PSDs
  - Aerosol – cloud interactions (available aerosol measurements, and initialization)
  - Sensitivity to ice initiation: Cooper vs Meyers?

Special thank to the coauthors!

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THANK YOU FOR YOUR ATTENTION!