Norwegian
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Model studies – atmospheric icing
Mapping of ice and snow loads

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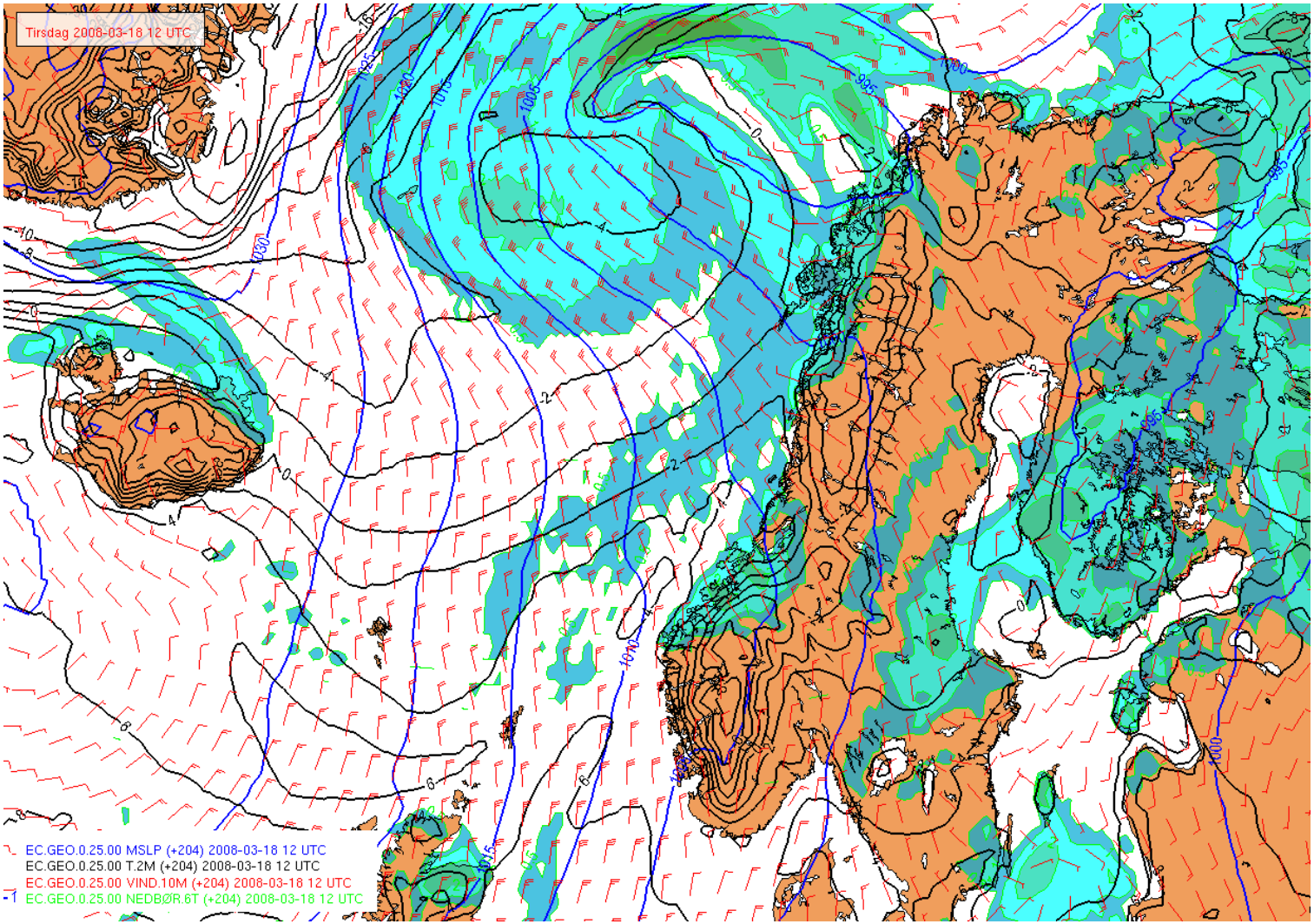
Forecast for today



Atmospheric icing of power lines

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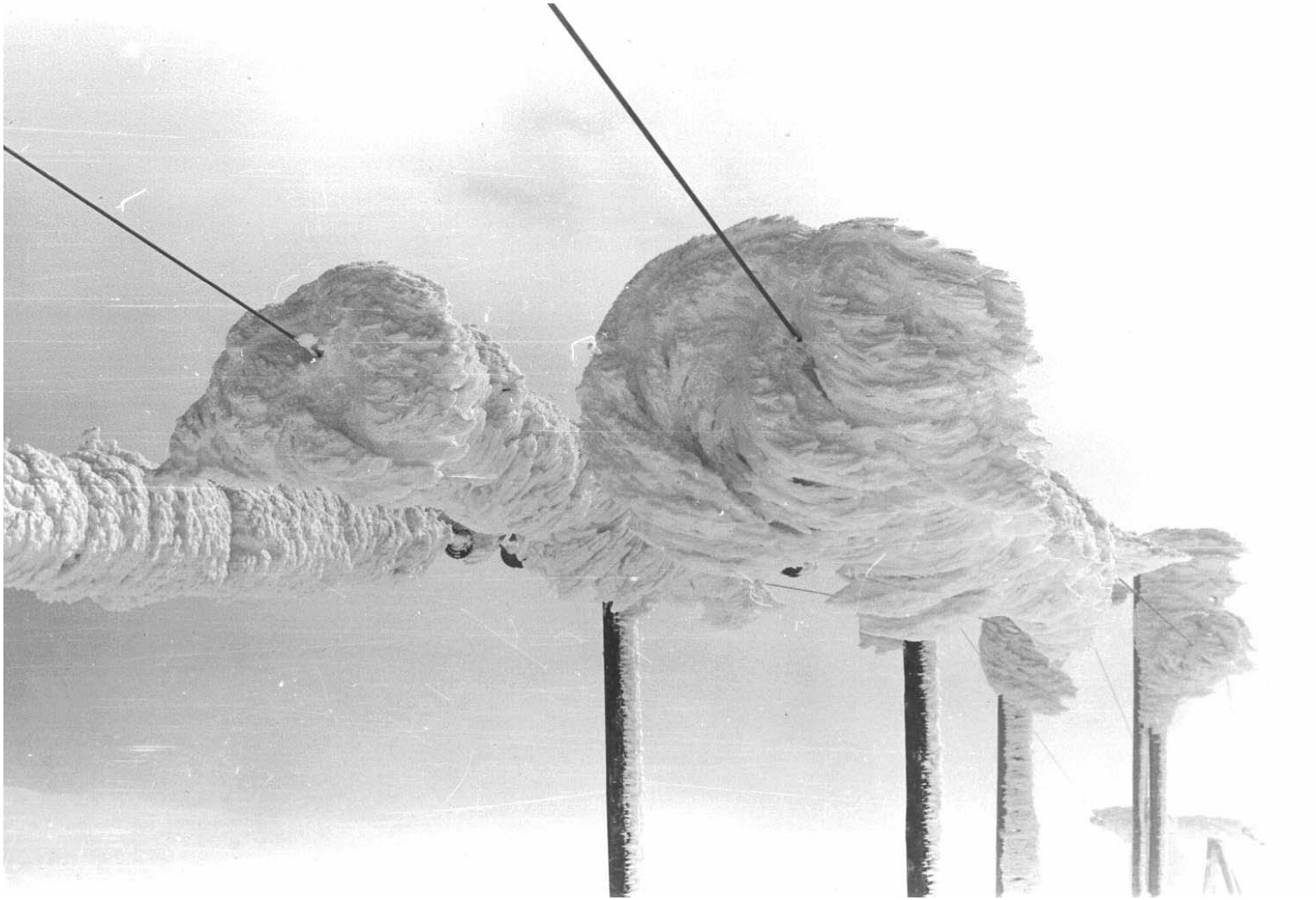


Atmospheric icing of transmission lines

Wet snow accretion from Iceland

In-cloud icing Gütsch, Switzerland.

Atmospheric icing

- In-cloud icing (rime icing)
  - Supercooled cloud droplets
- Wet snow accretion
  - Sticky, wet snowflakes
- Freezing rain
  - Supercooled rain
- Soft rime
  - Direct deposition of water vapour

Numerical modeling of ice accretion

- Following the ISO12494 standard (Atmospheric icing of structures)

$$\frac{Dm}{dt} = \alpha_1 \alpha_2 \alpha_3 \cdot w \cdot A \cdot V$$

- α1 = collision efficiency.
- α2 = sticking efficiency.
- α3 = run off/melt water.
- W*A*V = Flux of water/snow/rain

Needed input information

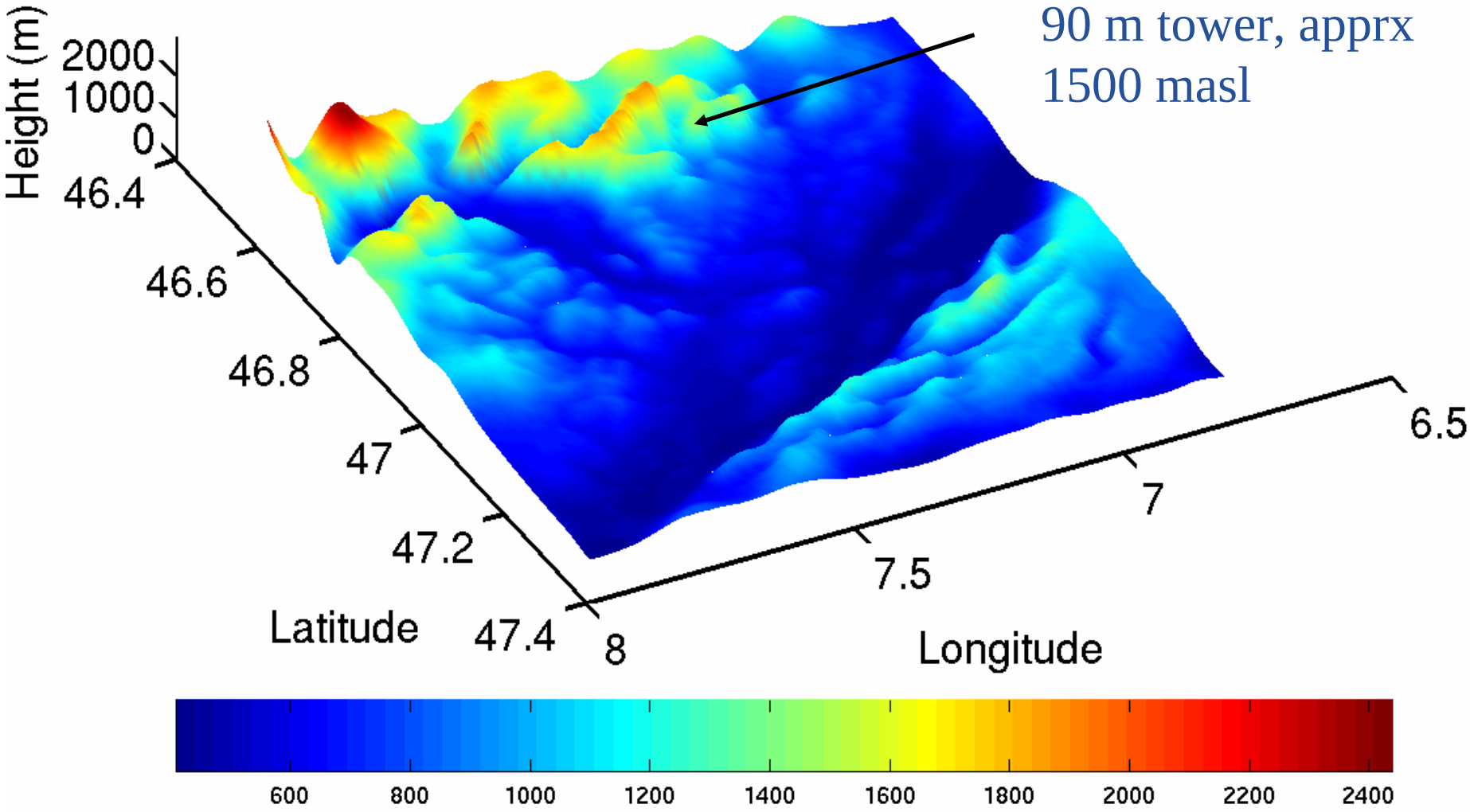
- Rime icing
  - Temperature, Wind speed, water content of clouds
- Wet snow
  - Precipitation intensity, liquid fraction of snow particles, wind speed, temperature, humidity.

- From where??

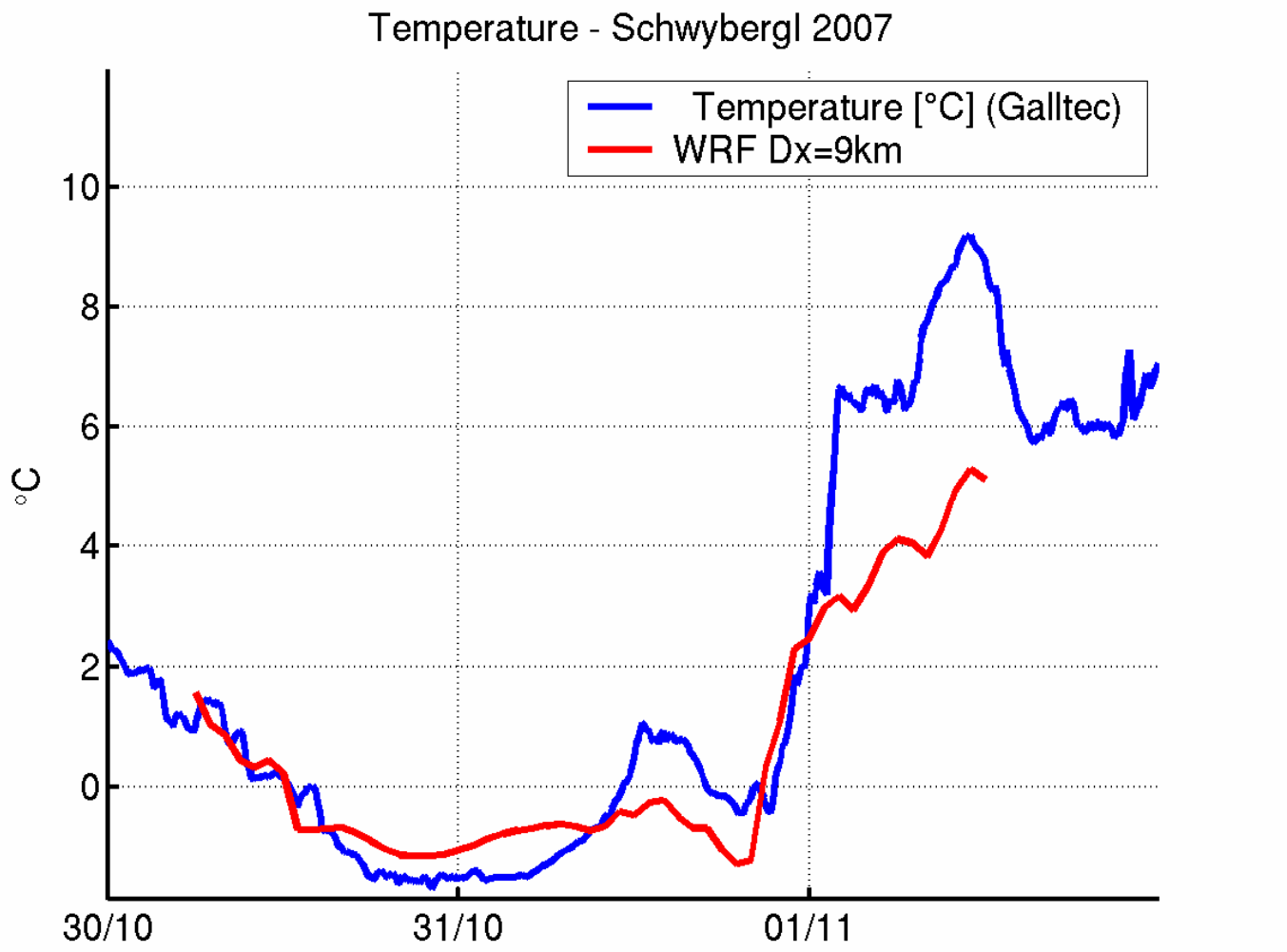
Let's try the WRF model..

- Weather research and forecasting model V2.2.1
- Regional, non-hydrostatic numerical weather prediction model
- http://www.wrf-model.org/
- Represent "today's" NWP models
- The "new" mm5 model
- Use global model background data
- High horizontal resolution ($\Delta x \sim 1km$)
- Mixed phase microphysics

Scwyberg, Switzerland



Scwyberg, Switzerland



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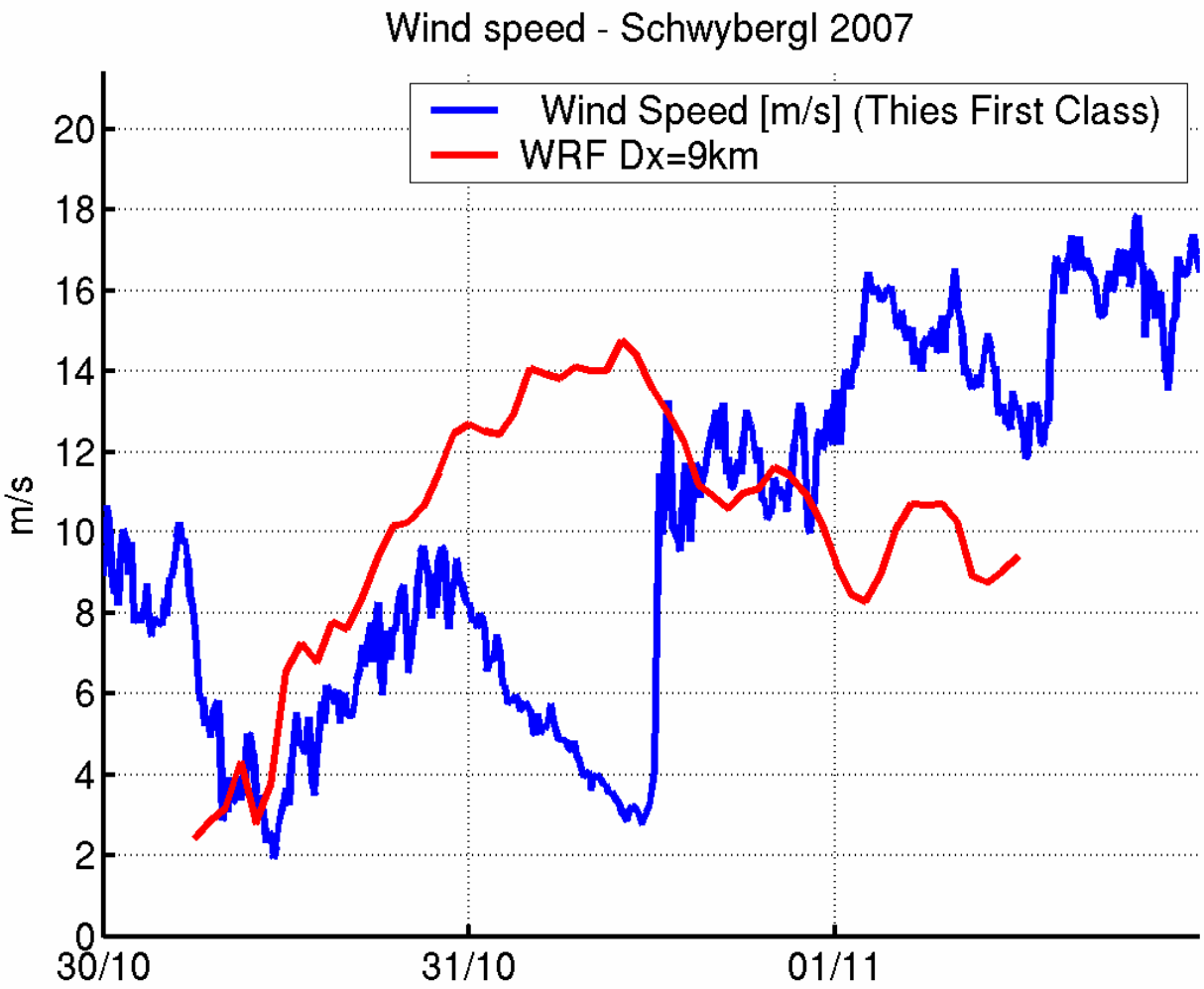
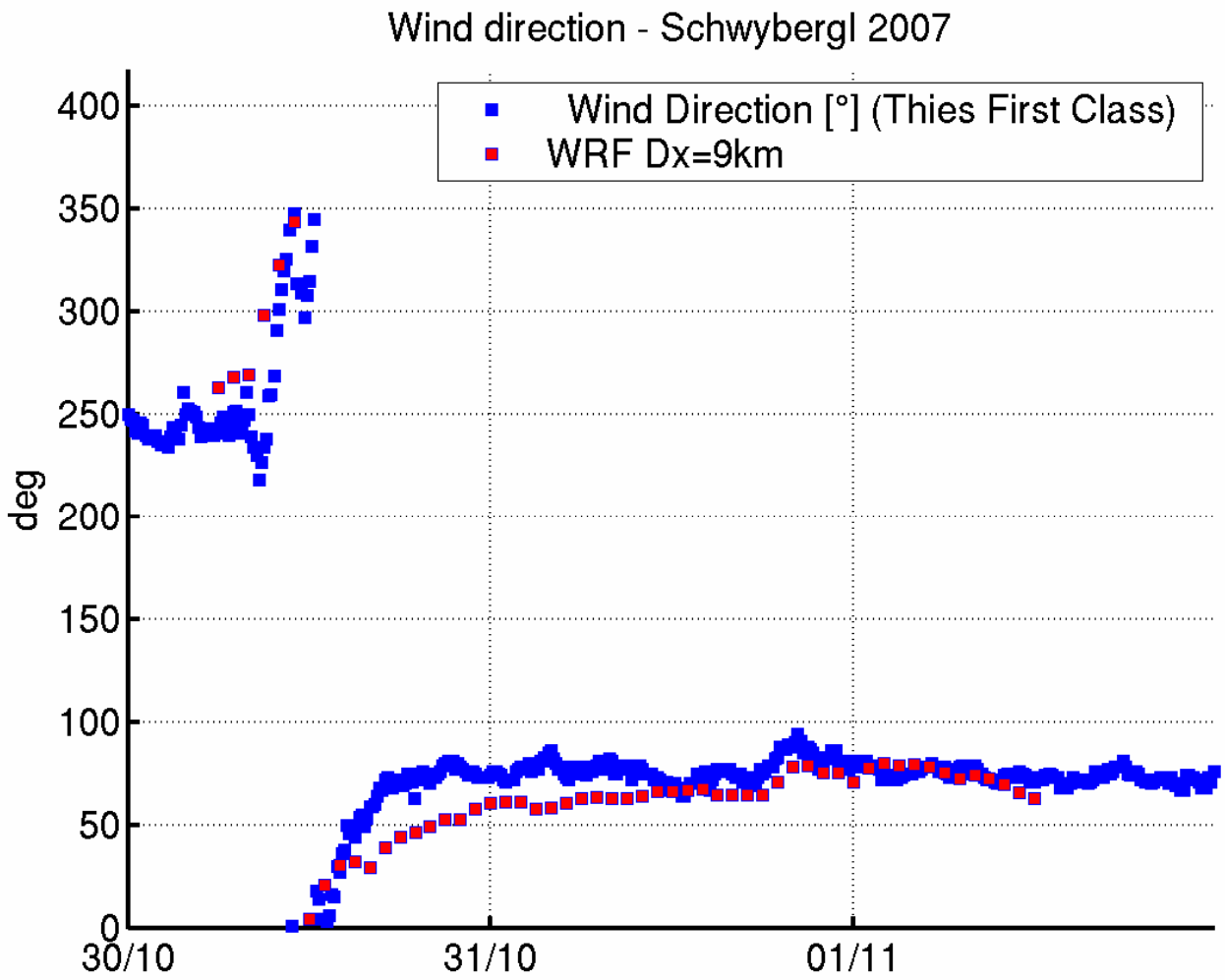


Scwyberg, Switzerland



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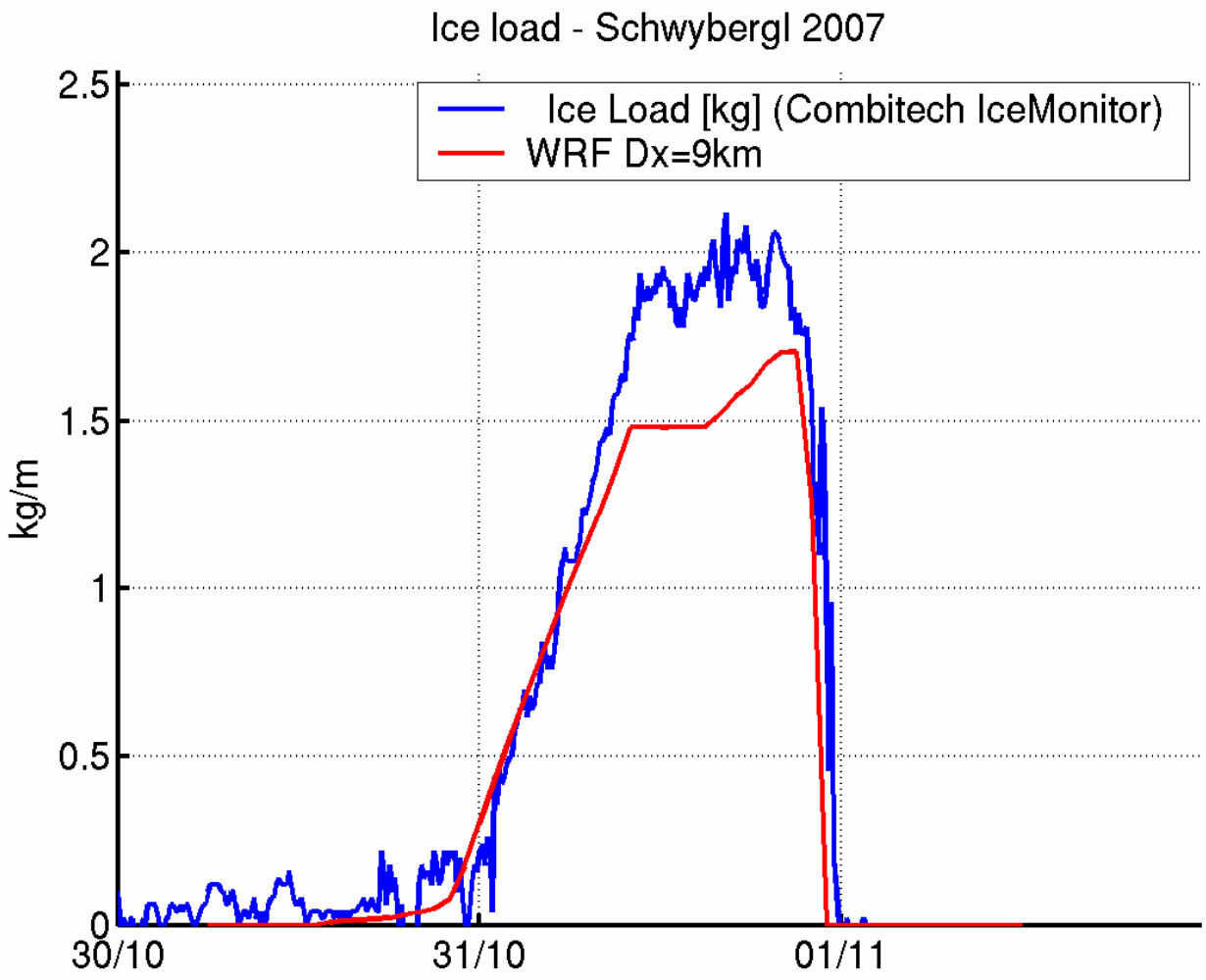
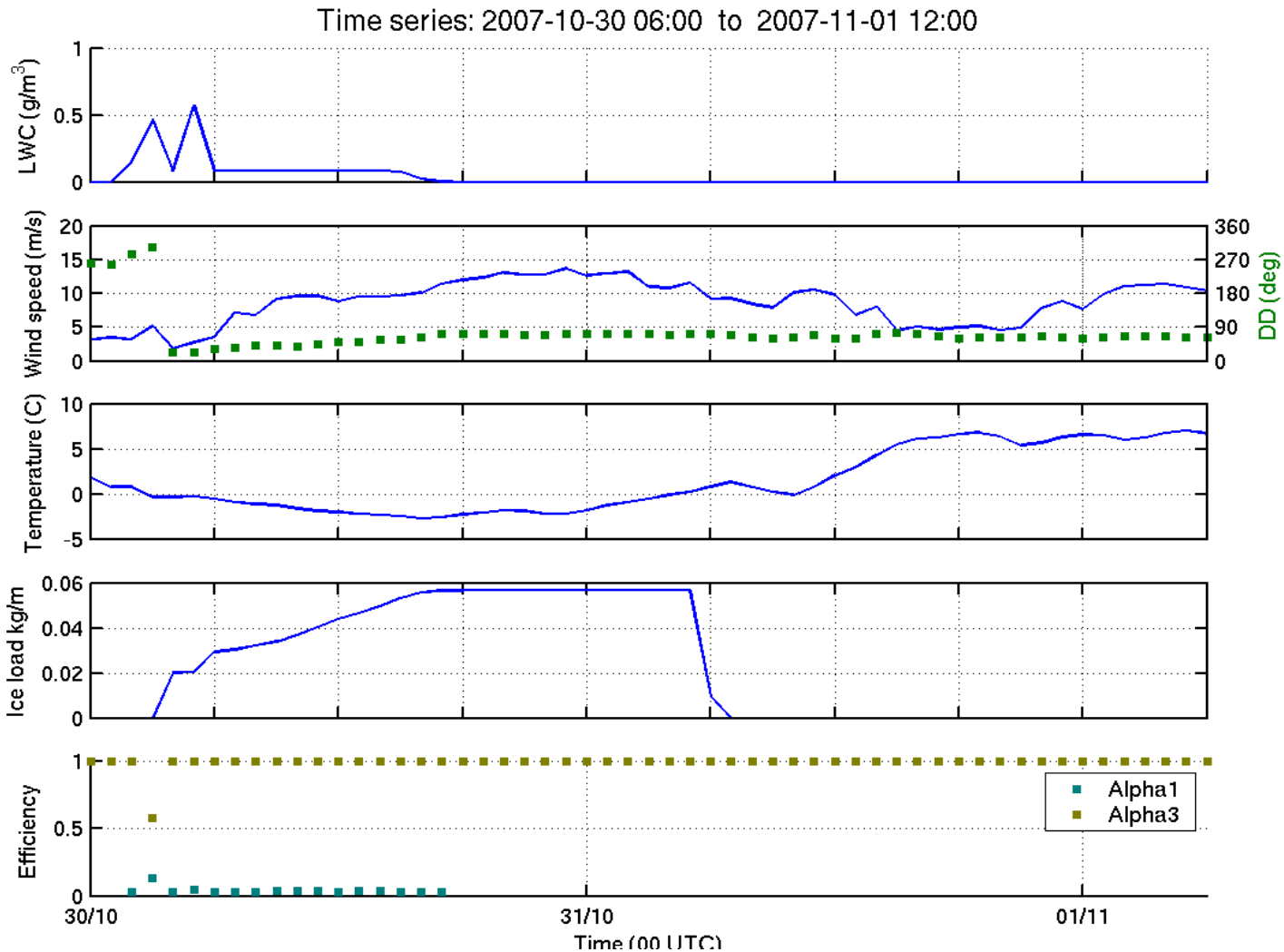


Testing different microphysics

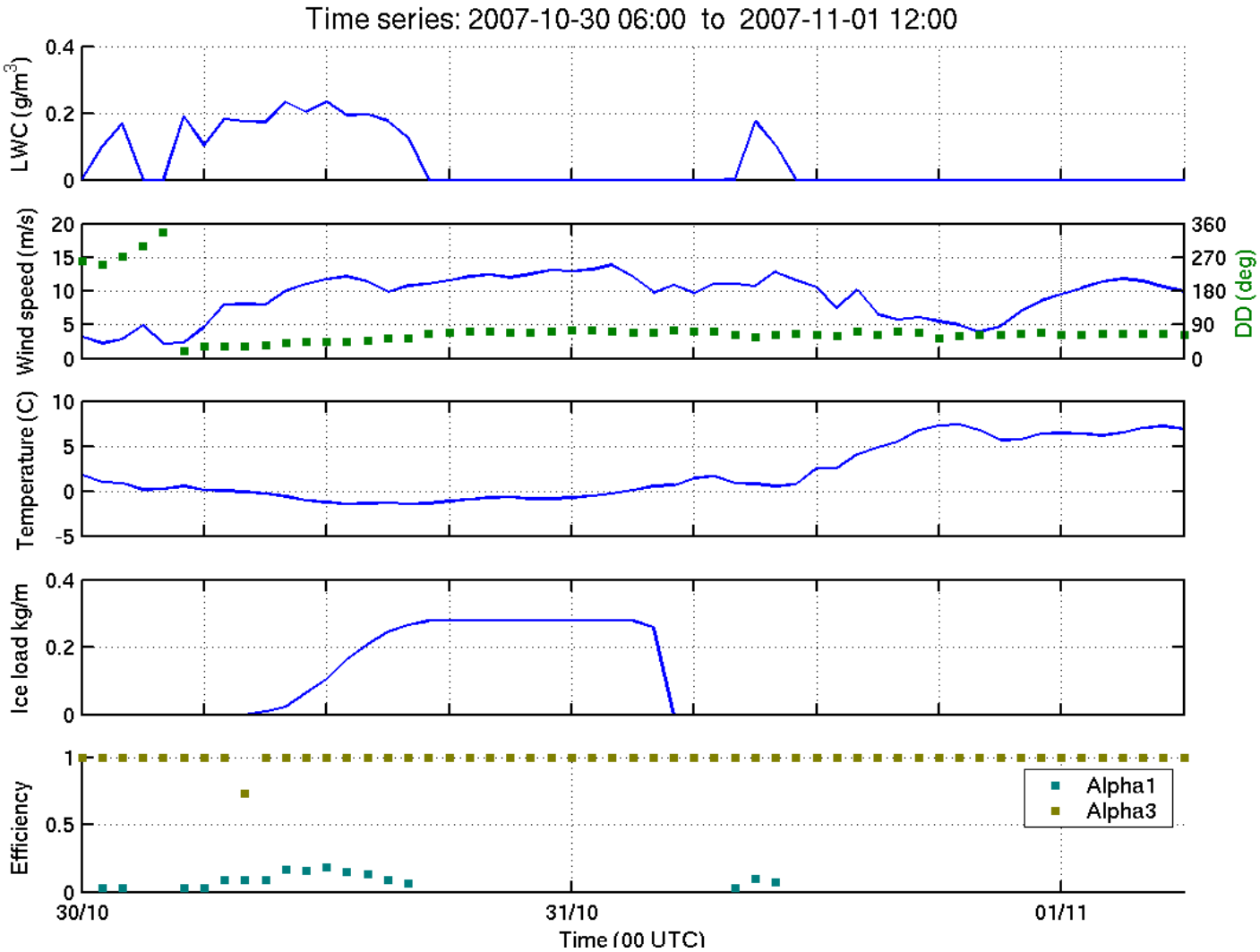
1. WSM3
   - Simple parameterization of clouds and precipitation. 3 classes of hydrometeors
2. ETA-Ferrier
   - Used in the North American operational model. 6 different hydrometeors
3. Thompson-Microphysics
   - Sophisticated cloud parameterization, designed to forecast aviation icing. 7 hydrometeors.

- Triple nested domains 1 km horizontal resolution. 36 hr simulation.

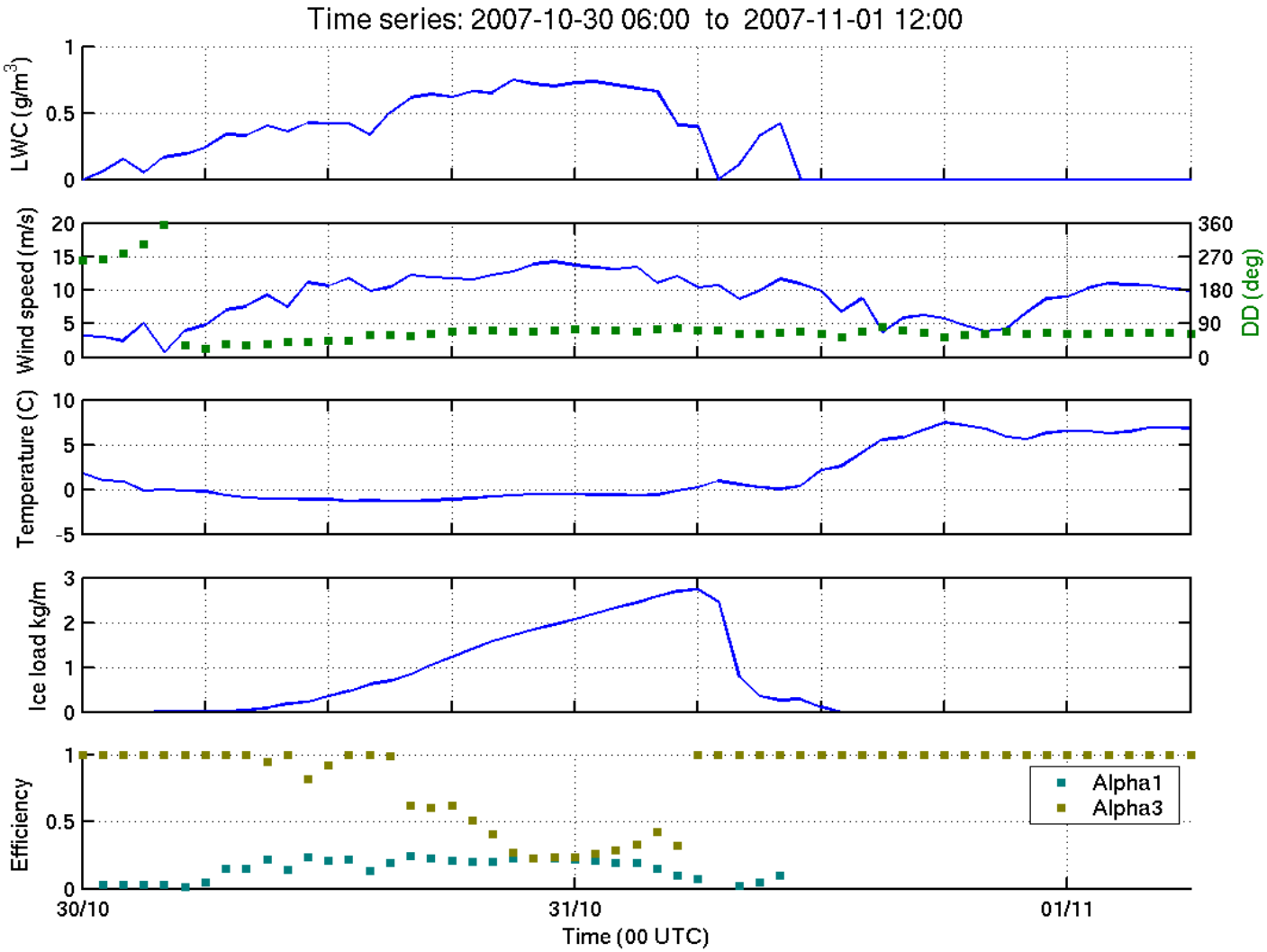
WSM3 – Simple scheme



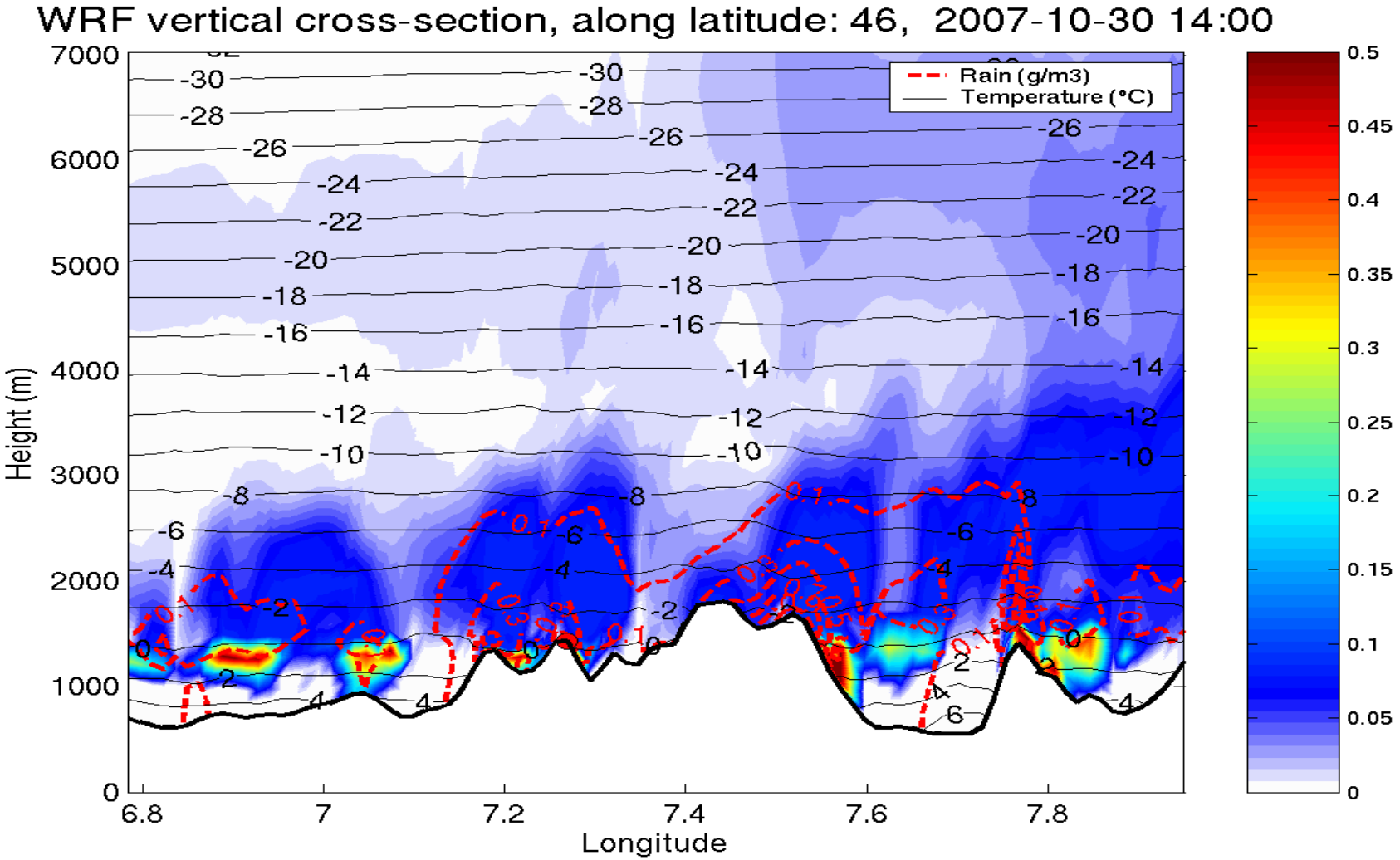
ETA- Ferrier – 6 class



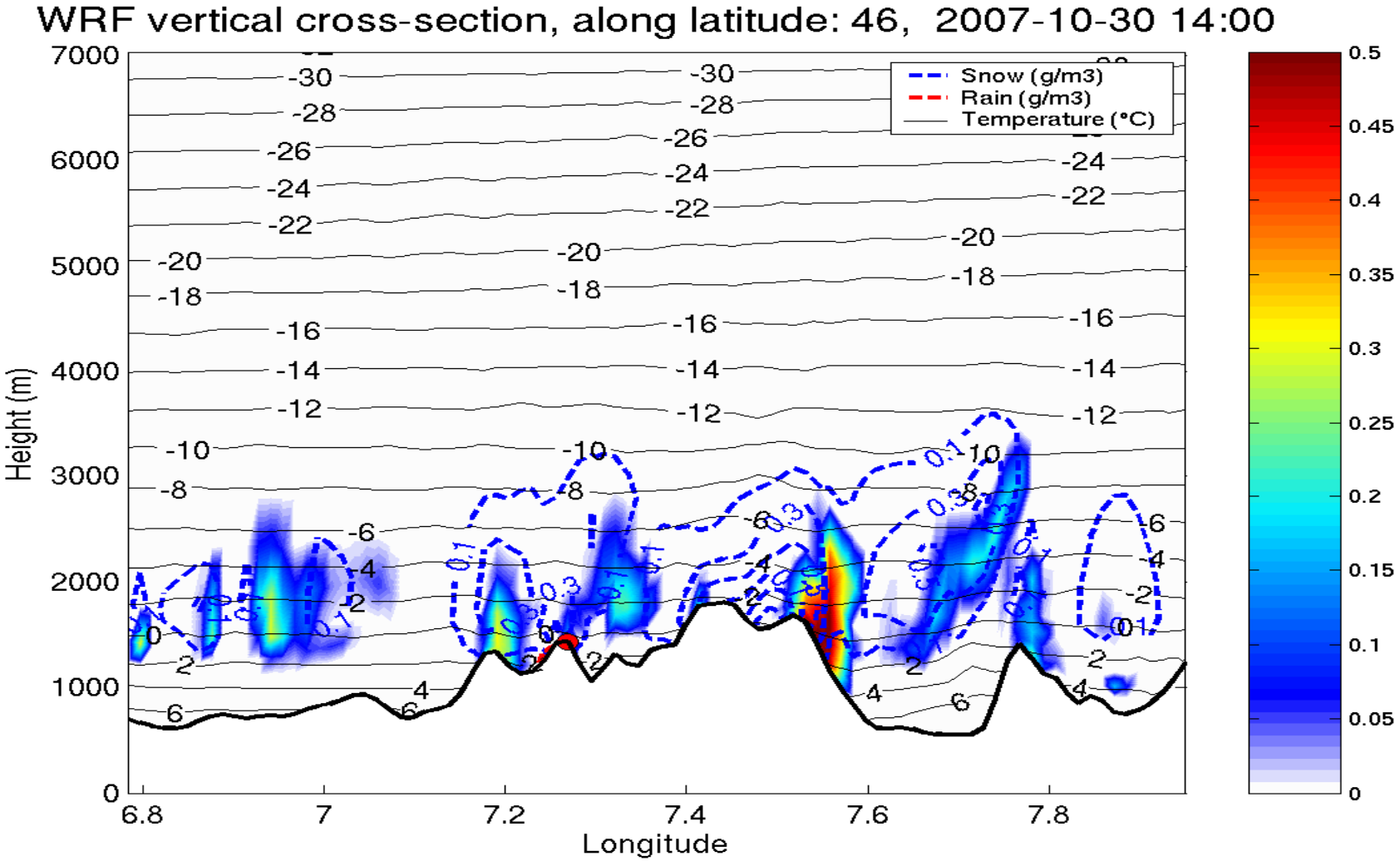
Thompson – advanced cloud scheme



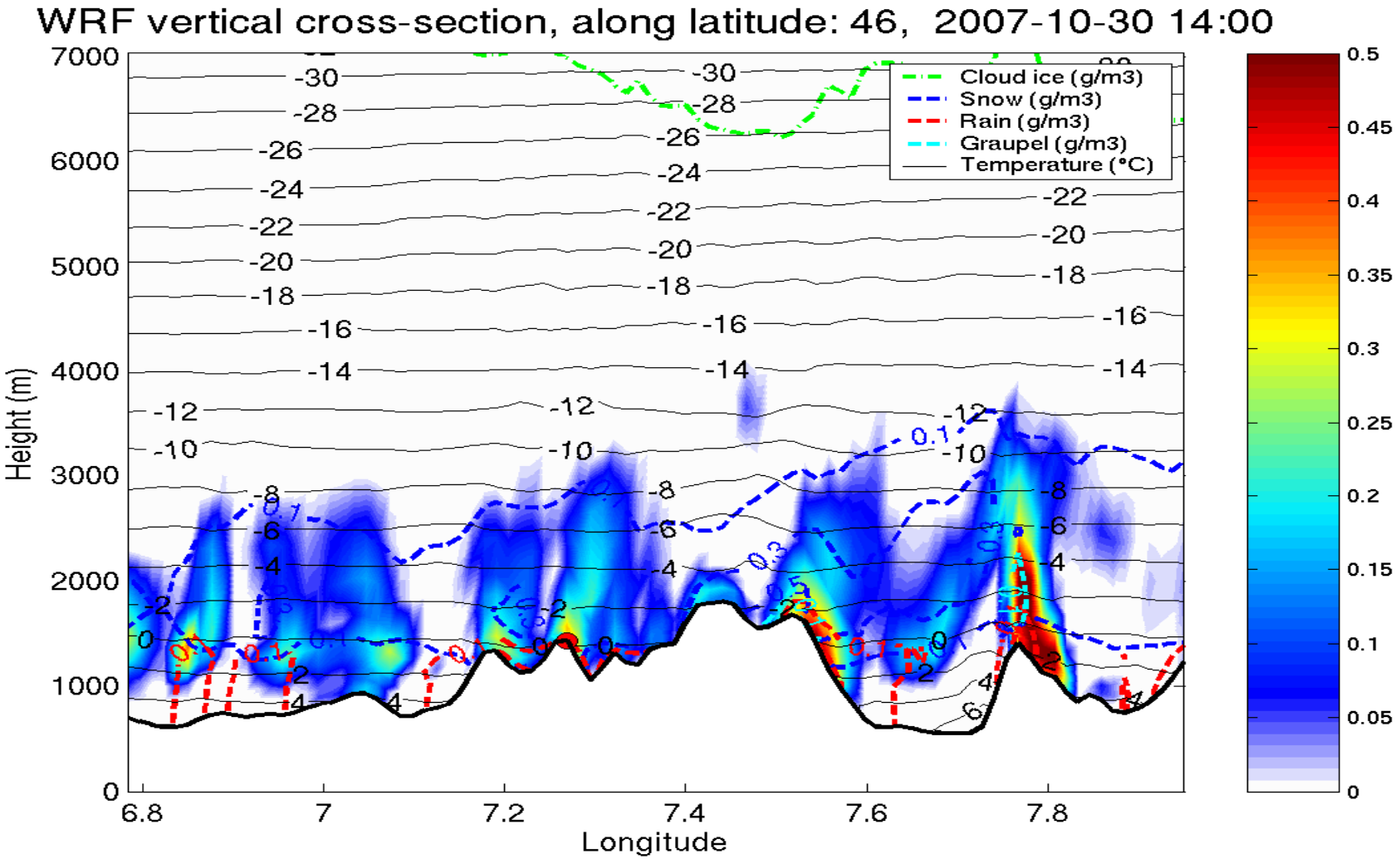
WSM3 – Simple scheme



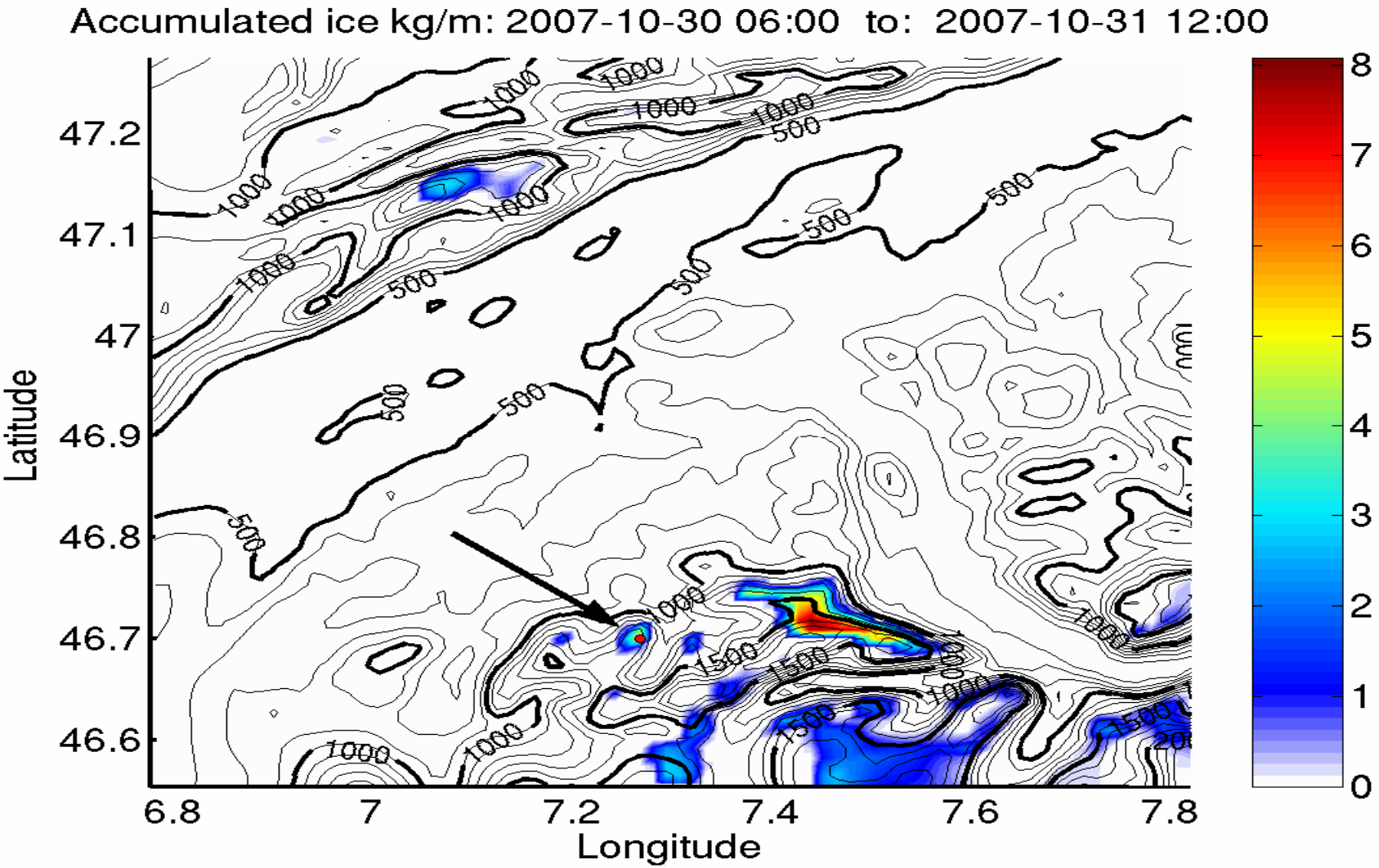
ETA- Ferrier – 6 class



Thompson – advanced cloud scheme



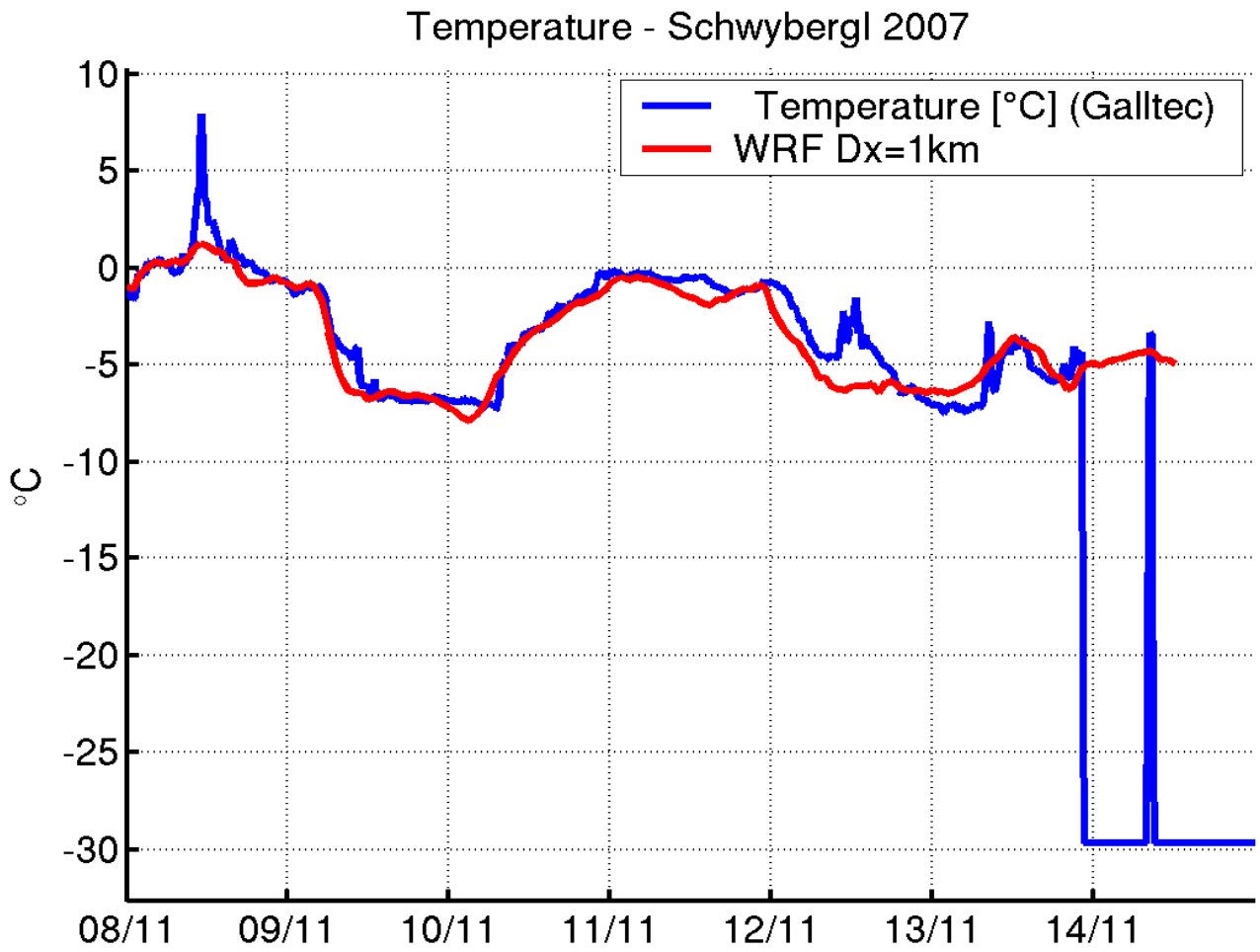
Thompson – advanced cloud scheme



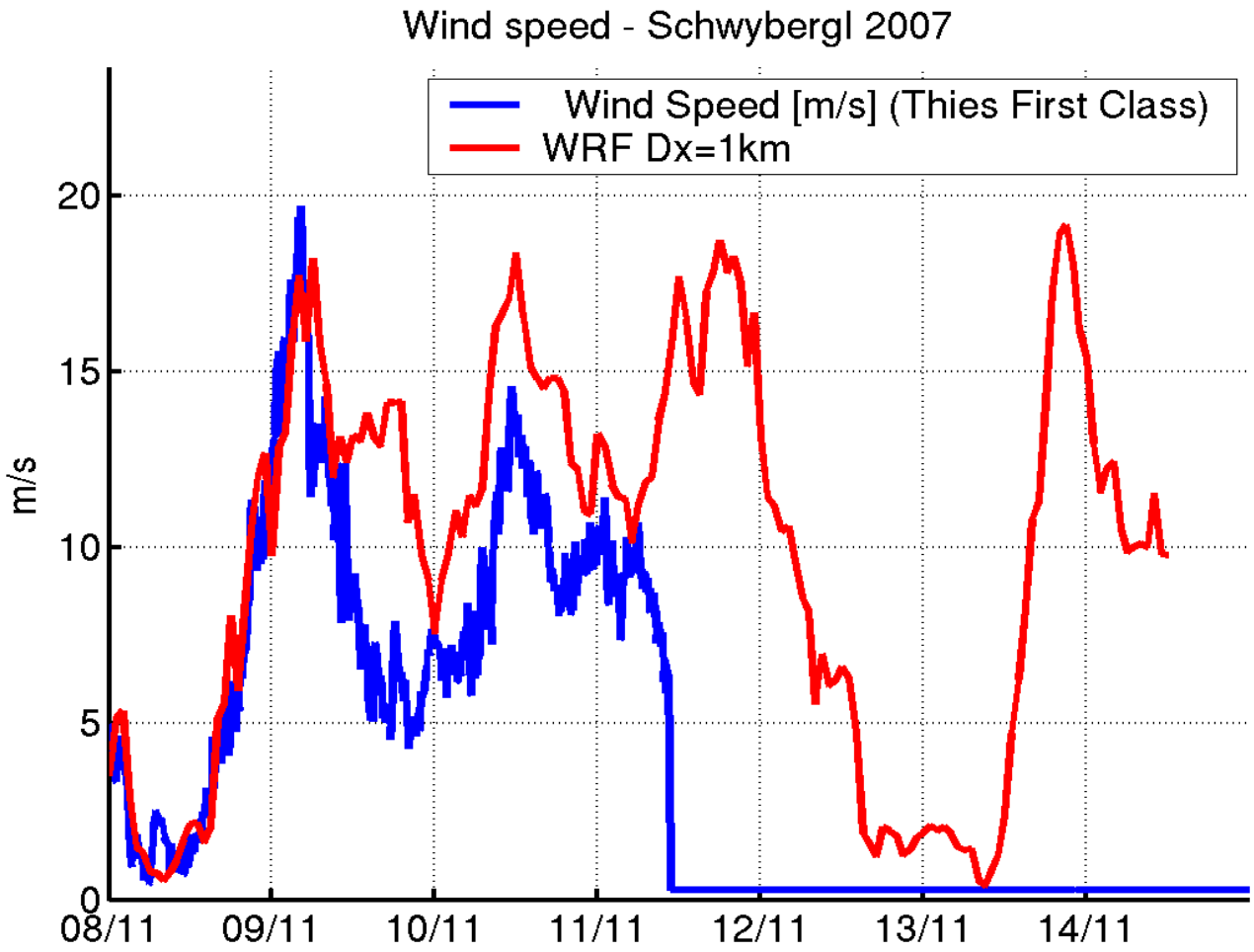
Two weeks later..

- Tower collapses due to icing and strong wind.

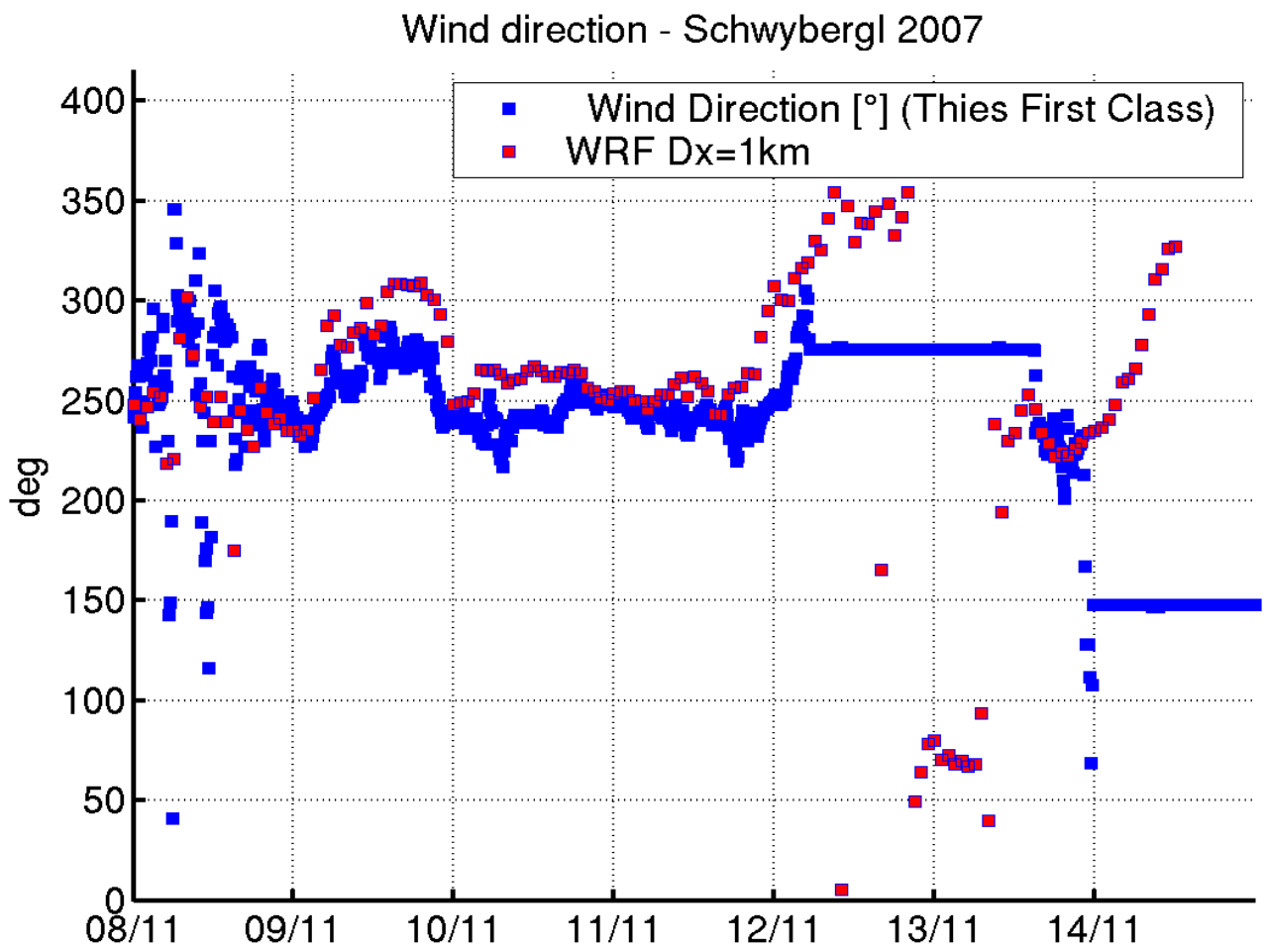
Schwyberg nov 07



Schwyberg nov 07



Schwyberg nov 07



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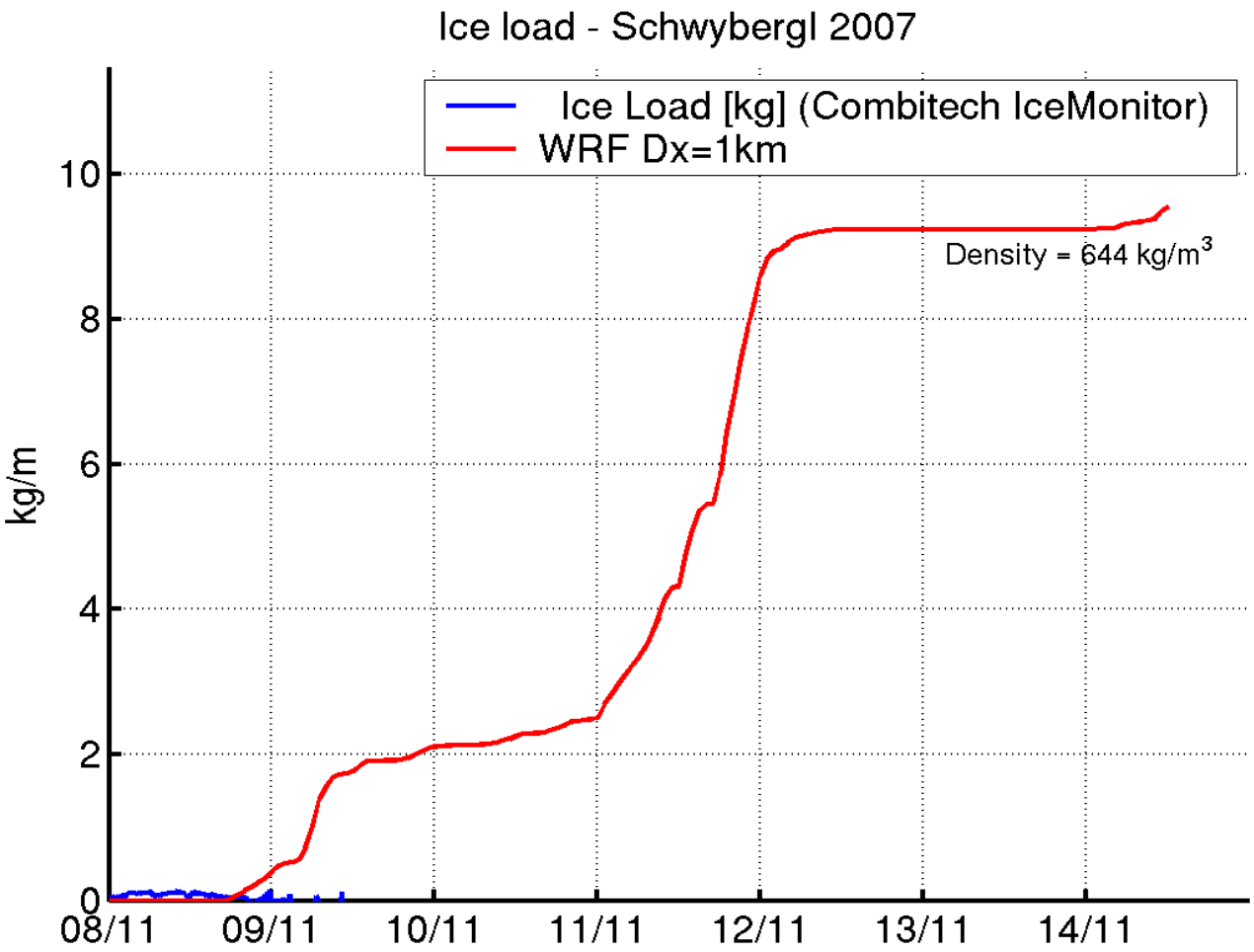
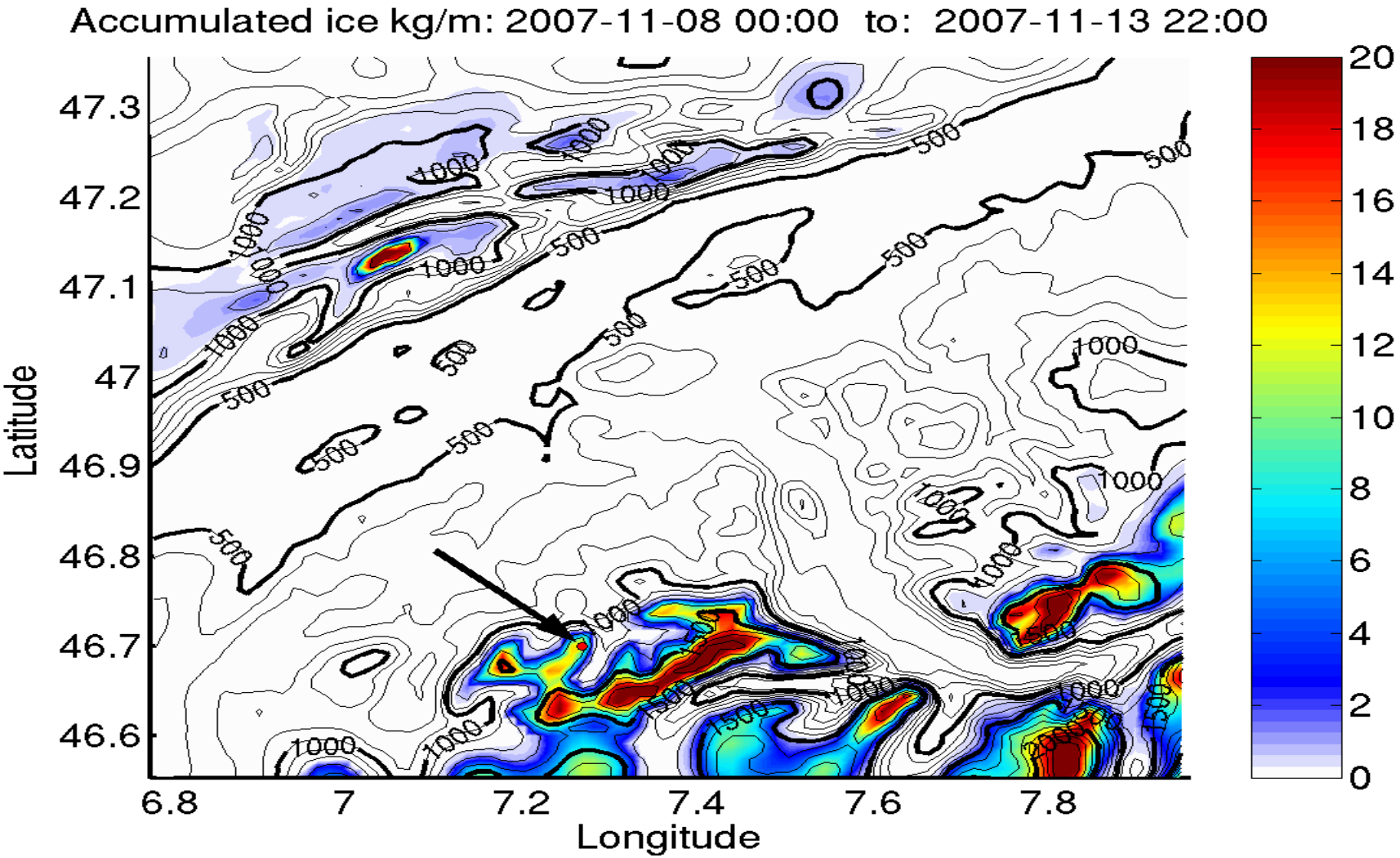


Ice load 100 magl.

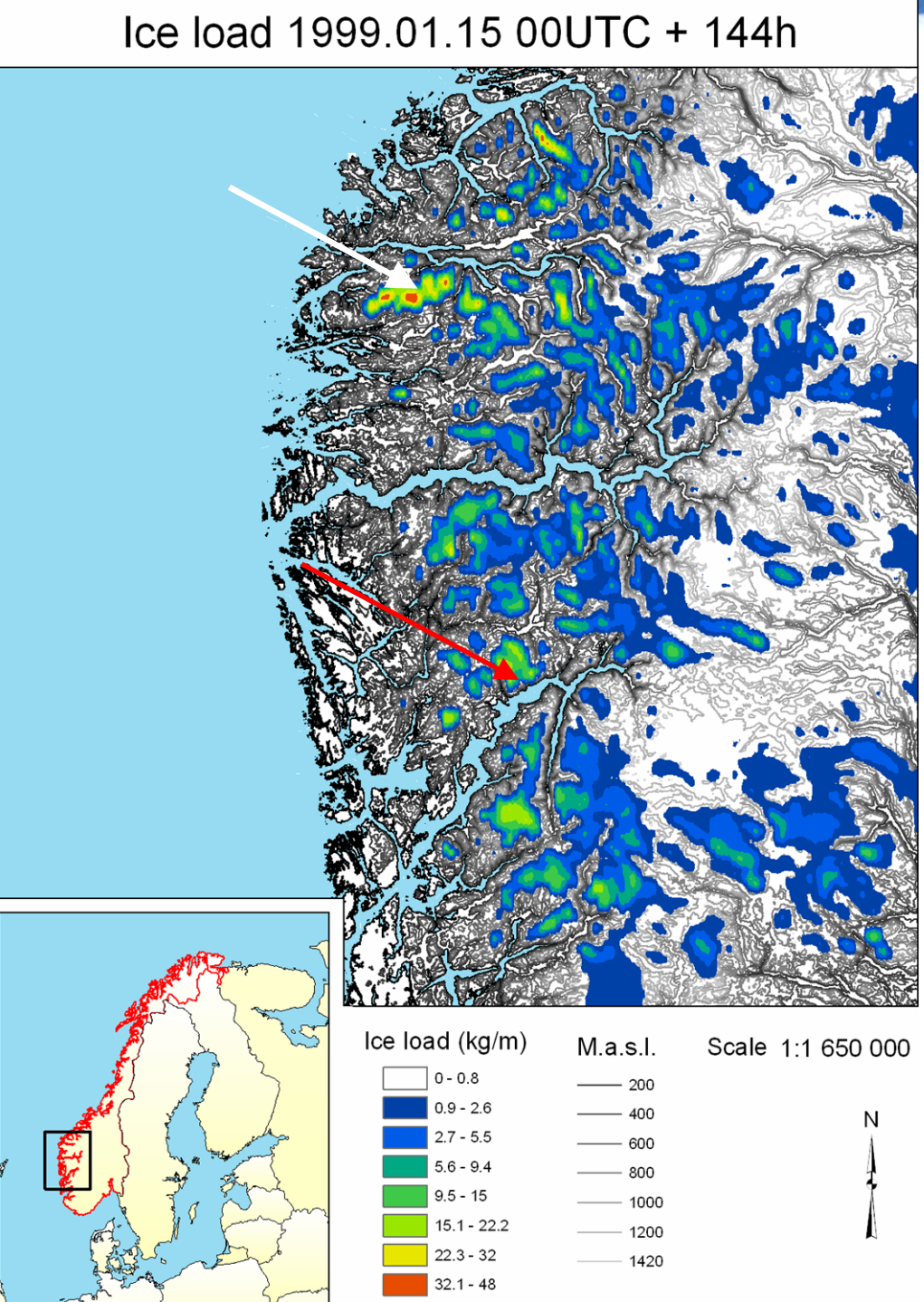


New transmission line in Norway

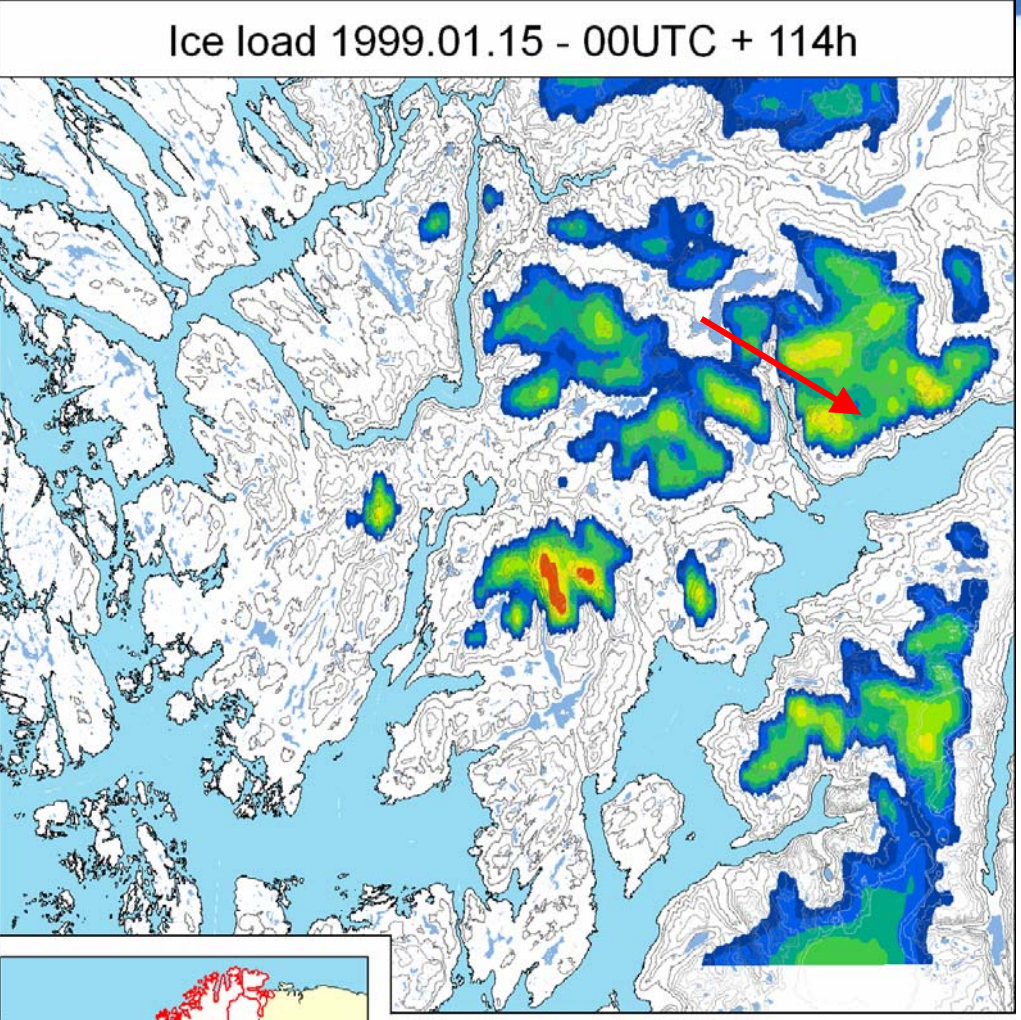
Norwegian ice-rack (1996-2005)

Experimental design

- Use ice-rack data to identify severe icing episodes
- Select 3 extreme icing events
- WRF simulations with Δx=2km and Δx=0.8km
- Compare modelled ice loads to measurements
- Compare modelled ice loads at the two sites



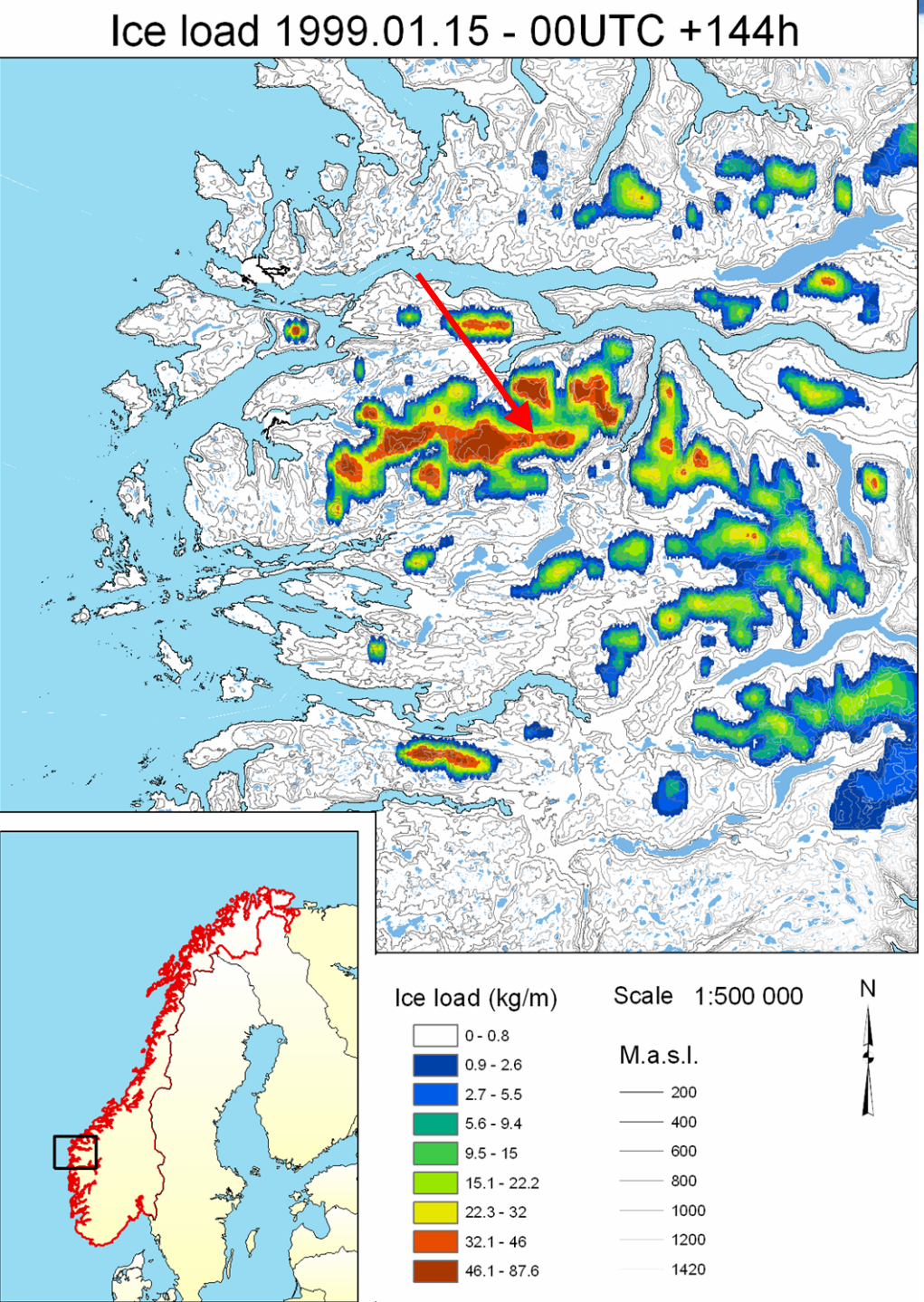
5 days with winds from S and SW



5 days with winds from S and SW

Measured: 9 kg/m

Simulated: 11.5 kg/m



Simulated: 50 kg/m !!!

Conclusions

- Large potential for quantitative forecasts and hindcasts of atmospheric icing
- In general good agreement between measured and modelled ice loads
- Choice of microphysics is crucial
- Need for more verification studies
- Very soon ready to produce icing maps

Activities within COST 727 (measuring and forecasting atmospheric icing of structures)

- Collect icing measurements from 6 different test stations in Europe
- Carry out wrf-icing simulations for 2-3 cases from each station
- Results ready autumn 2008

Takk for oppmerksomheten!