WRF-SBM simulation of radar signatures containing melting layers observed in LPVEx

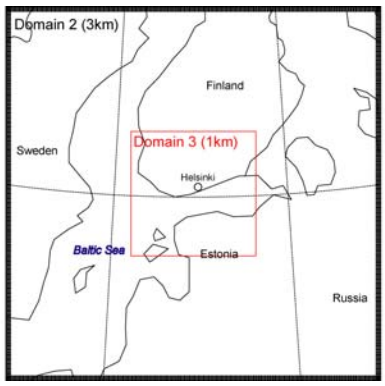
Takamichi Iguchi*[1,2], Toshihisa Matsui[1,2], and Wei-Kuo Tao[2]

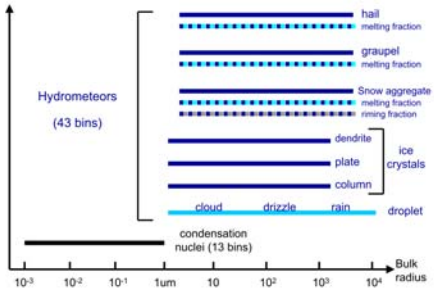
(1:Earth System Science Interdisciplinary Center, University of Maryland College Park 2: Code 612, NASA Goddard Space Flight Center)

Collaborators: A. Khain, V. Phillips, C. Kidd, D. Moisseev and T. L'Ecuyer

The next-generation Global Precipitation Measurement (GPM) mission will offer a global view of precipitation systems including over middle and high latitudes and enable accurate measurement of frozen precipitation and light rainfall. The project of a synthetic GPM simulator was proposed to offer cloud-resolving-model (CRM) database to support development of the GPM retrieval algorithm (Matsui et al. 2013).

This presentation addresses meso-scale model simulations upon the Light Precipitation Validation Experiment (LPVEx) field campaign. This campaign was took place in the vicinity of Helsinki, Finland during the autumn of 2010. Mixed-phase stratiform clouds with low-level melting layer were dominant over the area in the season. Two light rainfall events on Sep. 21 and Oct. 20, 2010 were simulated by the Weather Research and Forecasting model coupled with spectral bin microphysics for cloud (WRF-SBM). We focused on the structures of observed and simulated radar signatures containing melting layers to attempt evaluating melting process in the WRF-SBM model.

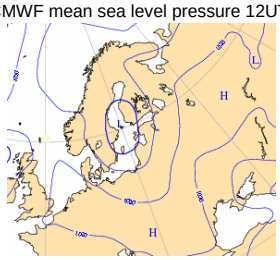




We implemented spectral bin microphysics (SBM) for cloud based on the Hebrew University Cloud Model (HUCM) (Khain et al., 2011) into the Weather Research and Forecasting model (WRF) ver. 3.4. The SBM explicitly prognosticates mass liquid fraction of each bin of melting snow aggregates, graupel and hail (Phillips et al., 2007). The WRF-SBM was employed in 36-hours real-time simulations using online 2-way grid nesting configuration for the domains 2 and 3.

Sep 21, 2010

ECMWF mean sea level pressure 12UTC



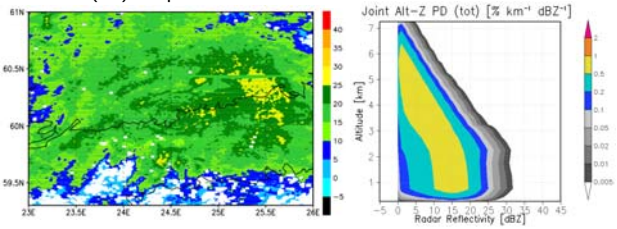
Wide spread warm sector stratiform rain covered the full operations area making for some ideal sampling conditions. Nearly four full hours of research flights were carried out in continuous stratiform rainfall. The freezing level today was quite high at 2000-2400 m.

Against C-band radar 3D scanning

Radar measurements

Max Z (dB) snapshot at 09GMT

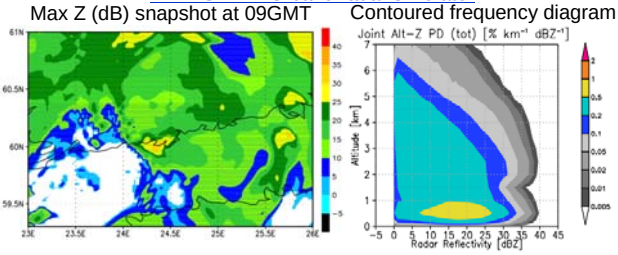
Contoured frequency diagram



WRF-SBM + C-band radar simulator

Max Z (dB) snapshot at 09GMT

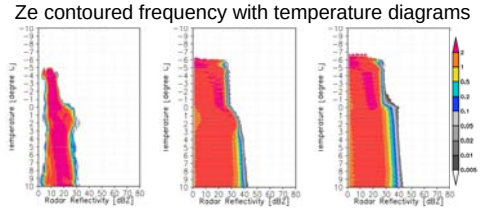
Contoured frequency diagram



Against vertically pointing micro rain radar (24.15GHz(K-band), FM-CW Doppler)

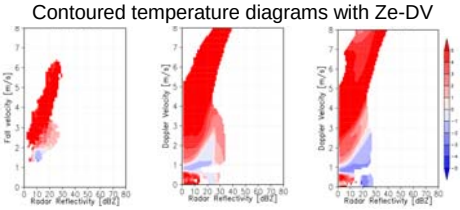
MRR WRF-SBM WRF-SBM instantaneous melting

Ze contoured frequency with temperature diagrams



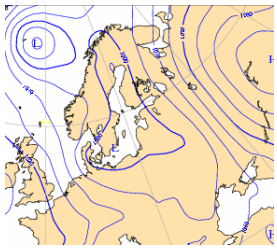
MRR WRF-SBM WRF-SBM instantaneous melting

Contoured temperature diagrams with Ze-DV



Oct 20, 2010

ECMWF mean sea level pressure 12UTC



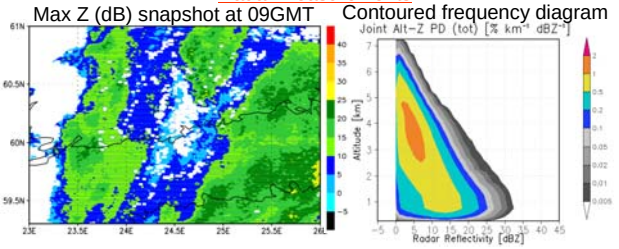
Widespread light and moderate precipitation in Helsinki and points east. Extensive microphysics measurements were collected above, below, and in the melting level at 1000 m.

Against C-band radar 3D scanning

Radar measurements

Max Z (dB) snapshot at 09GMT

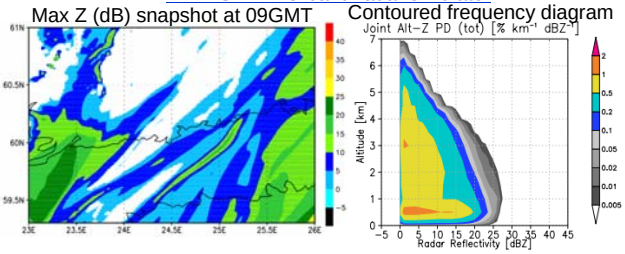
Contoured frequency diagram



WRF-SBM + C-band radar simulator

Max Z (dB) snapshot at 09GMT

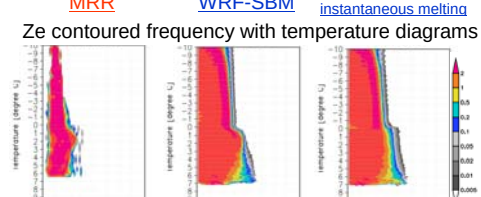
Contoured frequency diagram



Against vertically pointing micro rain radar (24.15GHz(K-band), FM-CW Doppler)

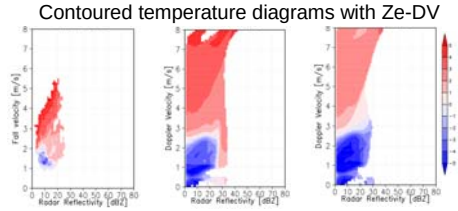
MRR WRF-SBM WRF-SBM instantaneous melting

Ze contoured frequency with temperature diagrams



MRR WRF-SBM WRF-SBM instantaneous melting

Contoured temperature diagrams with Ze-DV



Summary

•.Bright bands were observed and simulated in the layers with temperature roughly from 0 to +3 ºC.

• Gradual melting model is necessary to reproduce the characteristics.

• Radar reflectivity simulated by WRF-SBM generally is overestimated.

Upcoming

• Investigate sensitivity to assumption of melting particle structures in the radar simulator in G-SDSU.

• Comparison with in-situ measurements focusing on melting particles