# A simulation of vertical structure of frontal cloud using a bin cloud microphysical model

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## Introduction:

**An active remote-sensing using radar and/or lidar can provide the vertical structure of cloud properties. *Okamoto et al*. [2007] showed the vertical cloud structure over the Pacific Ocean near Japan using radar and lidar on the Research Vessel Mirai during MR01/K02 cruise (May 2001). This study reports the substitute result by a nest-grid simulation using a three dimensional non-hydrostatic model with a spectral bin microphysics for clouds.**

## Model Description:

**A numerical model for atmospheric dynamics used in this study is based on a multi-purpose non-hydrostatic atmospheric model developed by the Japan Meteorological Agency (JMA-NHM) [*Saito et al*., 2006]. We replaced the original bulk-type cloud microphysical scheme with a bin-type scheme based on the Hebrew University Cloud Model [e.g., *Khain et al*., 2000] [*Iguchi et al*., 2007]. The cloud microphysical tracers are size distributions of hydrometeors categorized into 7 forms (water droplets, ice plate crystals, ice dendrite crystals, ice column crystals, snow flakes, graupels and hails). This scheme treats nucleation from condensation nuclei, condensation growth, evaporation, sublimation, freezing, melting and collision coagulation growth processes.**

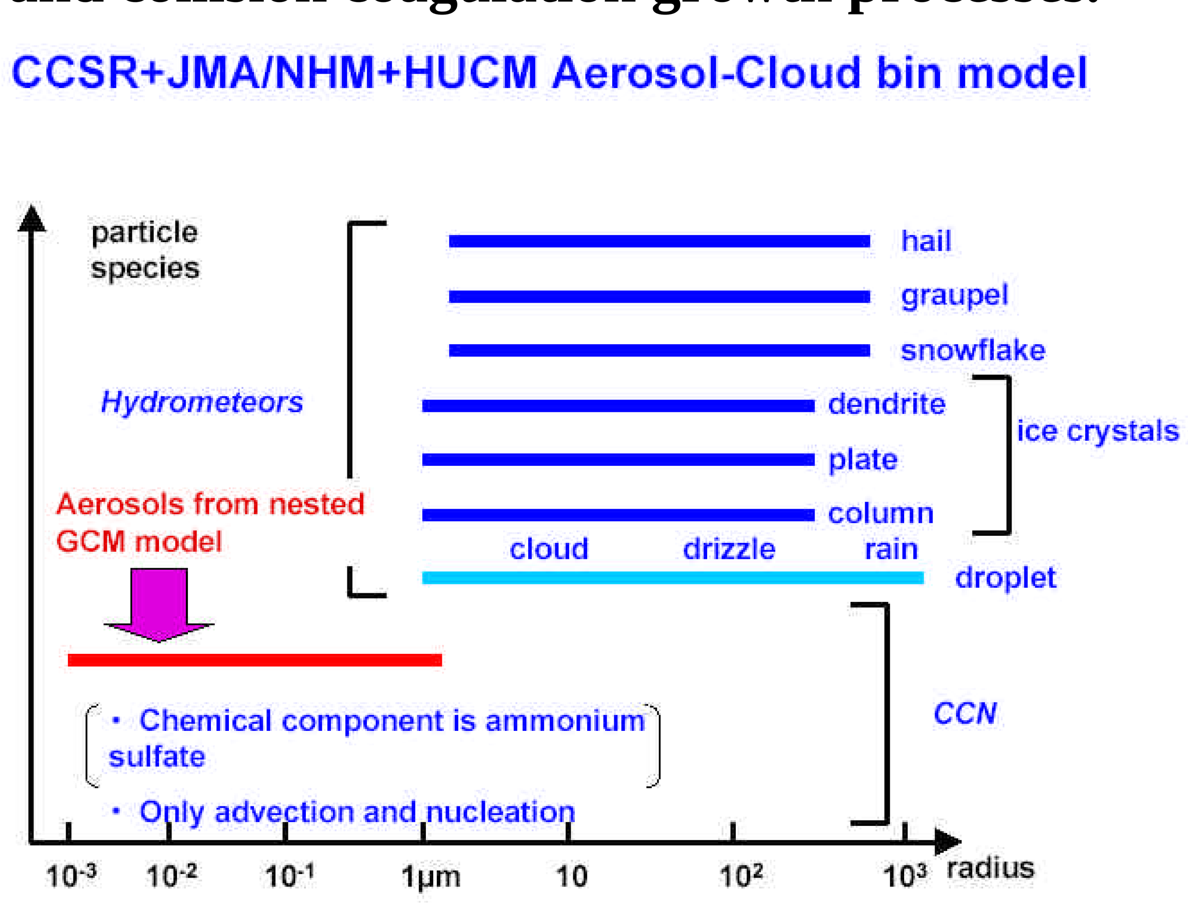


**Figure 1. Schema of the bin microphysics for clouds.**

## Results and Discussion:

**Numerical simulation was conducted for a region around the track of the research vessel on 22-23 May 2001. The horizontal grid intervals of 3 km is set (for 202 grid points) and the atmosphere up to 20 km is divided by 40 vertical layers with intervals increasing with altitude (40 m for the bottom layer to 1,120 m for the top layer). The values on the nearest grid to the ship track at the time is used to the comparison.**

**Figure 2 shows the time-height cross sections of radar reflectivity factors and lidar backscattering coefficients obtained using 95 GHz radar and lidar at 532 nm on the vessel, MIRAI during 22-23 May 2001. The corresponding observables are calculated using the size distribution of hydrometeors in the JMA-NHM simulation.**

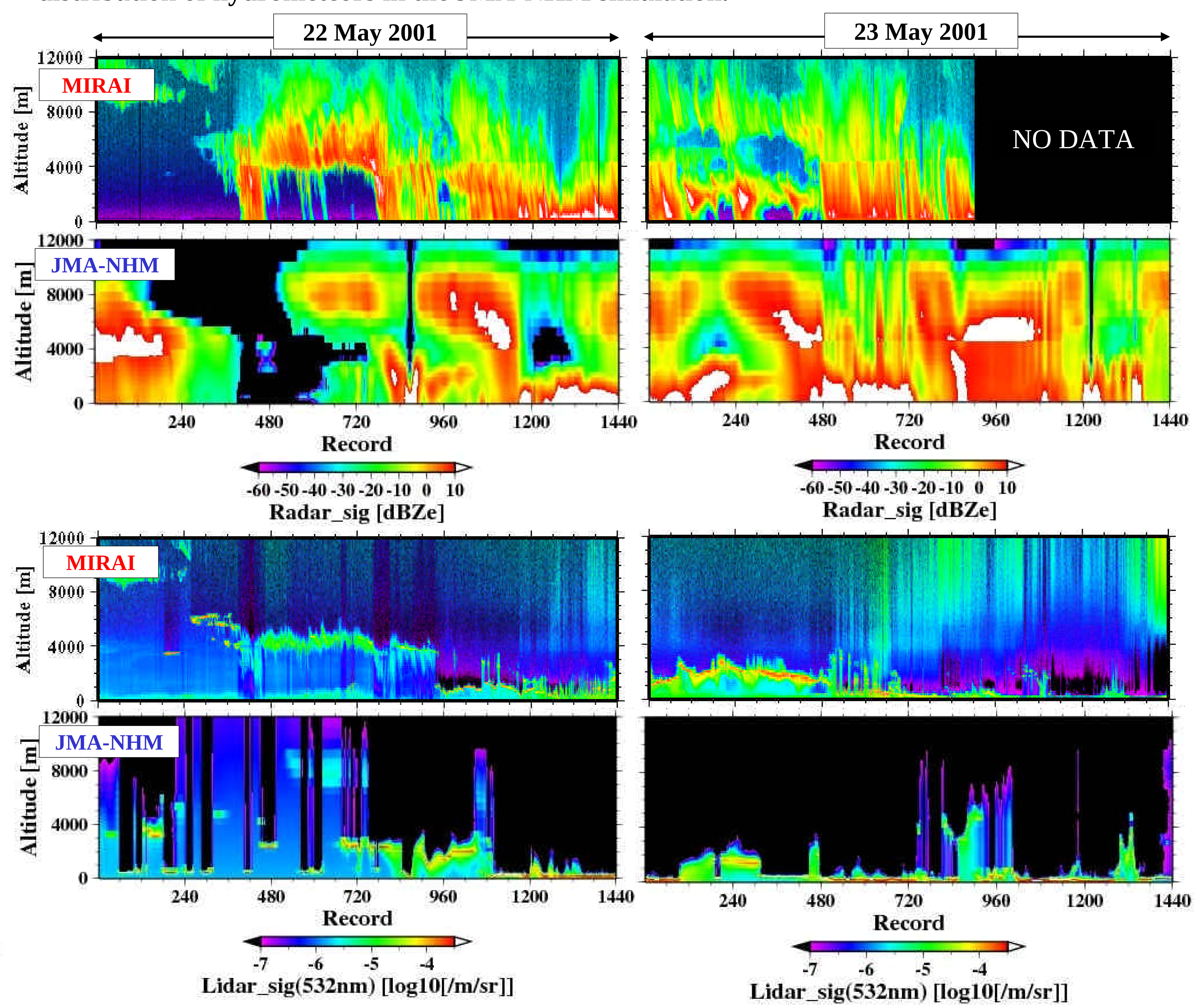


**Figure 2. Time-height cross sections of radar reflectivity factors and lidar backscattering coefficients.**

## Conclusion and Future Work:

**The model simulation can well represent the RRF and LBC (altitude of cloud base) of water cloud layer under the freezing level. RRF of ice cloud are overestimated, especially in the middle layer of ice cloud around the altitude of 8 km in our current simulation. The overestimation is caused by the error in prediction of vertical IWC structure and overestimation of the ice particle radius.**

**We will compared with the vertical structures of IWC and effective ice radius using the retrieval algorithm for the radar observation data. A future work is to conduct the similar study using the data of CloudSat and CALIPSO, and EarthCARE.**

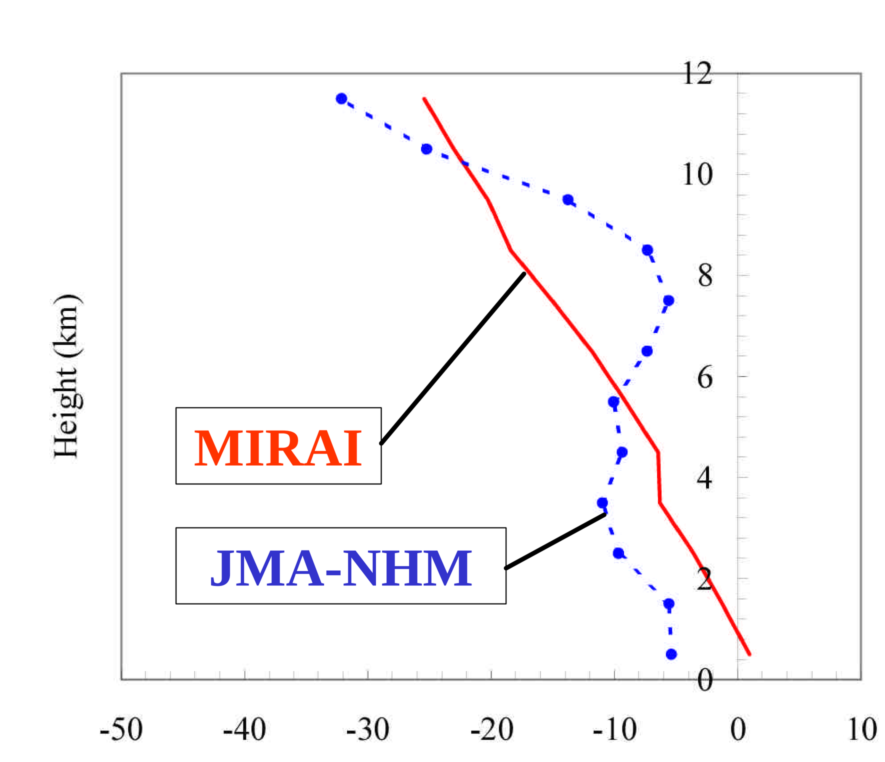


**Figure 3. Vertical profiles of time-averaged radar reflectivity factor during 22 May 2001.**

Reference list:

Iguchi et al. (2007), A study of the cloud microphysical properties influenced by aerosols in an East Asia region using by a meso-scale model coupled with a bin cloud microphysics for clouds, *J. Geophys. Res*., submitted.

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Okamoto et al. (2007), Vertical cloud structure observed from shipborne radar and lidar: Midlatitude case study during the MR01/K02 cruise of the research vessel Mirai, *J. Geophys. Res*., 112, D08216, doi:10.1029/2006JD007628.

Saito et al. (2006), The operational JMA nonhydrostatic mesoscale model, *Mon. Wea. Rev*. 134(4), 1266, DOI: 10.1175/MWR3120.1