# Development of the microphysical trajectory model to simulate the aerosol/cloud particle evolution in upper tropospheric ice cloud

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## 1. Introduction

The microphysical trajectory model developed on the basis of JMANHM is applied to simulate the behaviors of the aerosol and cloud particles in upper-tropospheric cloud which were detected by the balloon-borne observation carried out over Tsukuba, Japan. This model is able to simulate the temporal evolution of each of aerosol/cloud particles including the ice nucleation and depositional growth. The possible history of physical transformations of the particles which finally reached in the detectable area of balloon-borne measurement is figured out. Several sensitivity tests are performed, changing the conditions for ice nucleation, to discuss the influence of the ice forming ability of the aerosol particles on their long-range transportation.

## 2. Microphysical trajectory model

The microphysical trajectory model composes of Eulerian and Lagrangean schemes. The Eulerian part of the model corresponds to the framework of the JMANHM. The Lagrangean part is newly implemented in order to monitor the time evolution of each aerosol particle and ice crystal associated with development of the upper tropospheric ice cloud from the view point of microphysics. The dynamical, thermodynamical and other physical processes in the atmosphere are calculated using the usual framework of the JMANHM. The aerosol particles are released from the prescribed points in the model domain. The advection of each particle is calculated using the wind vector at the particle position and the terminal fall velocity.

In this study, the aerosol particles are assumed to activate as ice nuclei. The particles transform into ice crystals when they encounter the atmospheric condition satisfying the requirement for activation; the humidity in the grid including the particles exceeds the given level of supersaturation with respect to ice: $Sc$. The ice crystals increase their masses through depositional growth.

## 3. Design of numerical experiment

The model domain has the area of 2000 km × 1500 km covering Tohoku to Kyushu districts of Japan and Korean peninsula. The horizontal resolution is 5 km. The time integration up to 13 hours is conducted from the initial time of 03UTC (12JST) 9 May, 2007.

The aerosol particles are released one hour after the initiation from the 176 grid points distributed from 8,488 to 14,981 m in the vertical over the East China Sea (Fig. 1). The numerical simulations are performed changing the ice-super-saturation ratio required for the ice nucleation *Sc* from 0.0 to 0.3. Only the particles that reach the detecting volume over Tsukuba, Japan (Fig. 1) are focused in analysis.

## 4. Results

Fig. 2 shows the spatial distribution of the appearance frequency of the particle trajectories horizontally projected to the west-east cross section. For the particles with the threshold value of *Sc*=0.0 (Fig. 2a), the trajectories tend to distribute lower level than for those with the threshold value of Sc=0.3 (Fig. 2b). This feature comes from that the former particles activate to form ice crystals earlier than the latter ones and increase their masses through depositional growth so as to start gravitational sedimentation. It is indicated that the ice forming ability of aerosol particle influences their long-range transportation.

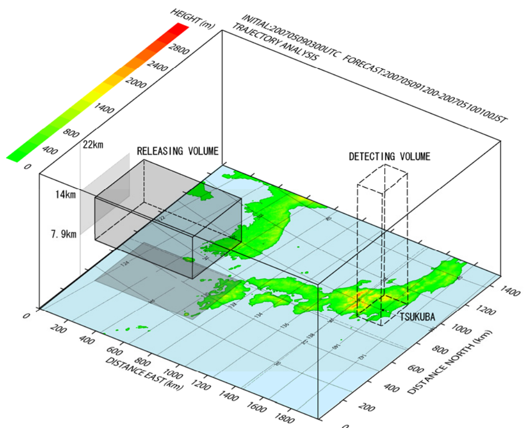


Fig. 1. Calculation domain. The shaded volume indicates where the particles are released. The box drawn with broken lines indicates where to detect the particles.

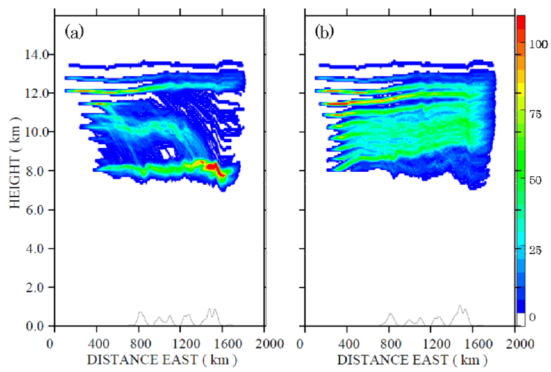


Fig. 2. The spatial distribution of the appearance frequency of the aerosol trajectory for the particles with ice-forming threshold of (a) *Sc*=0.0 and (b) *Sc*=0.3.