Experimental Investigation of CCN and IN Abilities of Various Aerosol Types in the MRI Cloud Simulation Chamber

Takuya Tajiri *, Katsuya Yamashita and Masataka Murakami
Meteorological Research Institute, Tsukuba, Japan

Introduction

A cloud simulation chamber facility run by the Meteorological Research Institute (MRI) has been used to investigate the details of the fundamental processes of cloud formation. An accurate and quantitative description of the relation between physicochemical and biological properties of aerosol particles and their activity and potential role in cloud formation is a crucial subject for improvement of numerical cloud simulation and weather/climate prediction models.

In addition to the well-known aerosol types such as ammonium sulfate, dust and soot, we are currently capable of handling variety of specific aerosol particles and certified reference materials including the biological aerosols, the artificial ice nuclei (AgI), etc. The study herein focuses on the chamber experiments in progress and shows results from the experiments of various types of specific aerosol particles.

MRI Cloud Simulation Chamber

Preconditioning Method

Aerosol free Dry-air Purged

Evacuation

Particle Injection with F control

Setting

Particle conc.

Humid air supply

Tair control

Fixed Conc.

Ascent (Expansion)

Ex. Set injection

P = 1000Pa

T = 15℃

Td = 10℃

Mri Dynamic Cloud Chamber

Experimental procedure is loaded into auto-controlled data acquisition system as form of a detailed, step-by-step list. Both temperature and pressure are automatically controlled to simulate an adiabatic expansion under a wide range of atmospheric conditions.

Aerosol Characterization Measurements

SMPS/CAS/OPC/APS

DMT-CCNC

Diameter (μm)

SSw [%]

CCN activity spectra (0.07-1.0% SSw)

Performance tests demonstrate the chamber’s usefulness as a facility to investigate cloud droplet and ice crystal formation processes through the activation of various types of aerosol particles. For instance, during expansion at an evacuation rate (3m/s), super-micron size particles (cloud droplets) rapidly appeared at water saturation. In mixed-phase conditions above -20degC, ATD was activated as IN. Ice nucleation continued to occur down to below -30degC and produced relatively high activated fraction of ice crystals (more than 1%). ATD could serve as both CCN and IN.

Summary

From comparisons with various types of aerosol particles tested, CCN ability: Hygroscopicity parameter (kappa) ➔ NaCl > (NH4)2SO4 > Bio (bacillus) > Dust > SiO2 ➔ CaCO3 ➔ Soot
IN ability: Onset temperature of freezing ➔ AgI ~ Snomax > bacillus > Dust > Pollen > Soot?
IN ability: Activated Fraction ➔ AgI > K-Feldspar > ATD > Snomax > Illite > bacillus > Soot > Pollen were indicated so far.

ttajiri@mri-jma.go.jp