【Grant-in-Aid for Scientific Research (S)】

Seamless understanding of nonlinear meteorology-chemistry processes based on multifaceted observations using low-altitude isolated peaks

Principal Investigator	Meteorological Research Institute, Department of Atmosphere, Ocean, and Earth System Modeling Research, Senior Researcher KAJINO Mizuo　　Researcher Number:00447939
Project Information	Project Number : 23H05494　　Project Period (FY) : 2023-2027 Keywords : Meteorology-chemistry model, Micrometeorology model, Physical observation, Chemical observation, Laboratory Experiment

Purpose and Background of the Research

●Outline of the Research

Aerosols and clouds are interacting with each other and causing various meteorological and environmental changes. However, those processes are highly nonlinear with several parameters which are unknown or highly uncertain. In this study, using in-situ measurements of gas, aerosols, and clouds at the top of the mountain which elevation is close to cloud base (approximately 1000 m), laboratory experiments such as a cloud chamber, a chemical reaction chamber, and a rainfall and snowfall generator, and a numerical models coupling atmospheric dynamics, physics, and chemistry, we aim to achieve complete understanding of atmospheric physical and chemical phenomena, that is, meteorological and environmental changes induced by aerosol-cloud interaction processes.

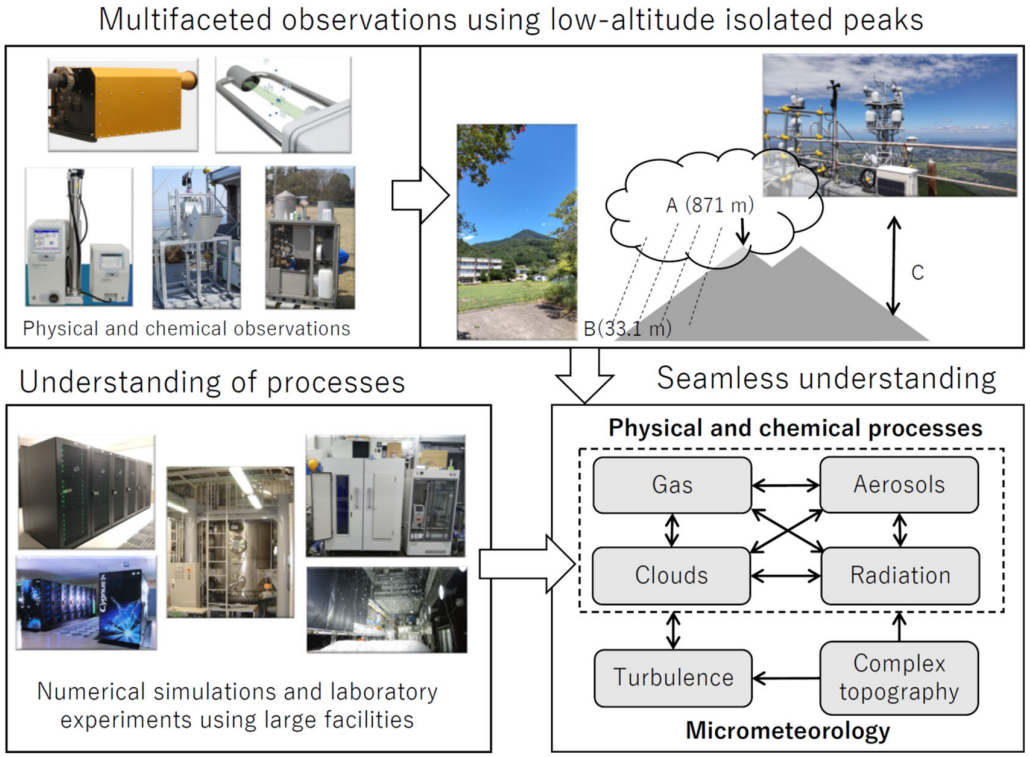
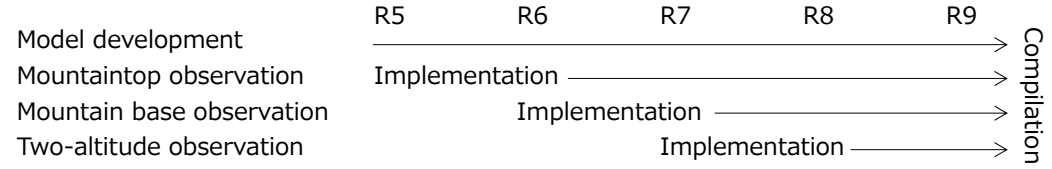


Figure 1. Image of the whole project (A: Mt. Tsukuba observatory, B: Bottom of mountain, C: vertical observation)

●Research method and plan

(1) Micrometeorology, atmospheric physics and chemistry modeling (MRI, Univ. of Tsukuba, Nihon Univ., and NIED)
(2) Meteorological and physical observations of aerosols, clouds, and precipitation (NIED, Nihon Univ., MRI, and Univ. of Tsukuba)
(3) Chemical observation of gases, aerosols, clouds, and precipitation (NIES and MRI)
(4) Laboratory experiments on gases, aerosols, clouds, and precipitation (MRI, NIED, and NIES)



Expected Research Achievements

●Insufficient understanding of aerosol-cloud interactions

(1) When aerosols increase, clouds scatter more solar radiation, extend their lifetime, and cool the earth, but there is a high degree of uncertainty.
(2) Some say heave rain increases as aerosol increases, but the others say it will not change much.
(3) Removal processes by collision and coalescence of aerosols and precipitation are theoretically small, but observed values are two to three orders of magnitude larger.
(4) Trace amounts of precipitation that cannot be detected by normal meteorological measurements can cause serious pollution.

●What this research will reveal (scientific questions)

(1) How significant is meteorological change induced by aerosol-cloud interactions?
(2) How is environmental impact of aerosols mediated by precipitation brought about?

●How to answer this question

To develop a model which can accurately predict the response to changes in the nonlinear and uncertain gas-aerosol-cloud-precipitation system as shown in Fig. 2.

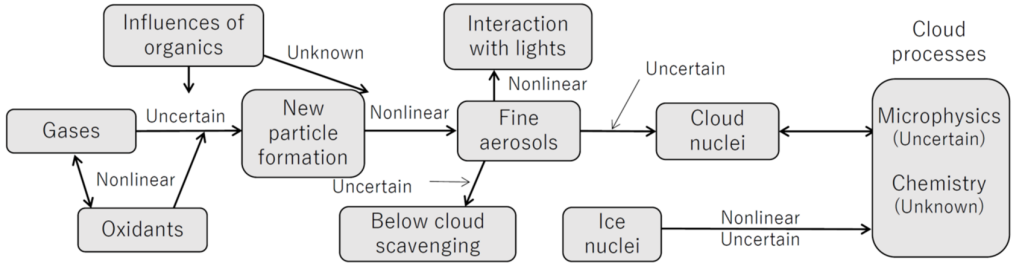


Figure 2. Nonlinear and uncertain elementary processes of gas, aerosols, cloud, and precipitation

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