## Goal8 Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.

Development of an Atmospheric Simulation Model for Estimating the Probability of Local Atmospheric Phenomena

#### R&D item

1. Development of an Atmospheric Simulation Model and Evaluation Methods to Improve the Accuracy of Probability Estimation

# Progress until FY2023

#### 1. Outline of the project

In weather control, selecting the optimal control method requires highly accurate estimates of the probability associated with properties of phenomena, such as location, time, and intensity. In probability estimation, imperfections in the atmospheric simulation model can be an obstacle to accurate estimation. Solving this problem requires qualitatively different approaches rather than an extension of traditional computational methods. Atmospheric simulation models are composed of multiple subcomponents. In this research, we will develop new computational methods for some of the components that are thought to contribute significantly to the decline in the accuracy of probability estimation and build new atmospheric simulation model using these methods.

When developing a new model, it is necessary to confirm the validity and usefulness of the model. Therefore, in addition to developing a new model, this research will also work on developing validation methods to objectively demonstrate that the model improves the accuracy of probability estimation. In this way, we aim to ensure the reliability of the new model and clearly demonstrate its usefulness.

### 2. Outcome so far

The following four new calculation schemes were implemented and validated through numerical experiments.

- A surface layer turbulence scheme using a new calculation formula that eliminates the spatio-temporal uniformity assumption and considers turbulence of the order of 1 m.
- A fluid dynamic scheme that combines high computational efficiency with high accuracy, employing the discontinuous Galerkin method.
- A Lagrangian particle-based cloud microphysics scheme that computes cloud behavior by calculating the motion of water droplets and ice particles that make up clouds.
- A scheme that explicitly calculates the spatio-temporal variability of aerosols and their interaction with clouds We have also developed validation method to objectively

evaluate the accuracy of probability estimations from simulations.



Example of simulation results using the developed cloud microphysics scheme. The behavior of cloud particles is represented as motion of particles which enables more precise calculations.



Here begins our new MIRAI

Examples of simulation results using the developed aerosol and cloud precipitation scheme. The aerosol variation can be represented in the simulation. The simulated PM2.5 variations (blue) are consistent with the observation (red).

### 3. Future plans

We will continue to improve the calculation schemes under development and build a new atmospheric simulation model that incorporates these calculation schemes. We will also try to realize a simulation of the real atmosphere using the model. Furthermore, we aim to objectively demonstrate that the new simulation model improves the accuracy of probability estimation.

