R&D item

10. Environmental Monitoring

Progress until FY2023

1. Outline of the project

This project will utilize information science to promote social research and dissemination necessary to realize weather control. Using deep learning and visual information processing techniques, we will accelerate weather control research by visualizing the generation process and intervention effects of heavy rains in four dimensions, and by analyzing the effects of weather control operations. Furthermore, this visualization system will be used to contribute to the project's outreach promotion.

In FY2023, we worked on visualization of the generation process of heavy rains and intervention effects with the aim of accelerating weather control research in the future. We worked on how best to visualize what kind of weather phenomena, mainly by promoting mutual understanding with meteorological researchers in Item 5.

2. Outcome so far

(1) We used the Global-merged IR product, which provides global brightness temperature observations, as the meteorological observation data. We used the cloud luminance patterns in the IR images to extract geometric transformations that represent temporal changes in a local area over a range of a few hours. Specifically, the following procedure was used.

1. Extraction of cloud regions based on temperature and completion of missing observations by preprocessing
2. Projection onto a tangent plane to reduce spatial distortion (Fig.1)
3. Correspondence point estimation between projection images at intervals of 30 minutes to 4 hours (Fig.2 Left)
4. Estimation of geometric transformations from the corresponding point cloud (Fig.2 Right)

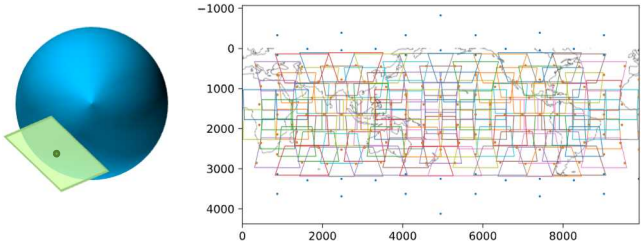

Fig.1: Projection onto tangent planes.

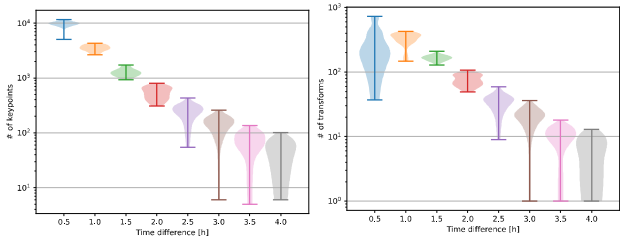

Fig.2: Distribution of time intervals and estimated number of corresponding points and geometric transformations.

(2) We conducted a survey of trends in visual information processing technology and display devices for displaying temporal changes of physical quantities in 3-dimensional space (4-dimensional data) in weather models by means of volume rendering. Specifically, we conducted a survey on display devices and listed four representative categories (non-planar displays, head-mounted displays, spatial reality displays, and ultra-large planar displays). Furthermore, the obtained survey results were shared within the group to deepen discussions on visualization technologies and display devices suitable for this project.

We also exchanged information with meteorological researchers in Item 5, and discussed meteorological data that would contribute to the visualization of the generation process of heavy rains. As a result, we decided to receive the output of The Weather Research and Forecasting (WRF) Model and work on visualization of physical quantities related to rains in it.

3. Future plans

Our goal by FY2024 is to construct a visualization system that will contribute to the analysis of the effects of weather control operations, and toward this end, we will develop a 4D visualization technique for heavy rains generation.