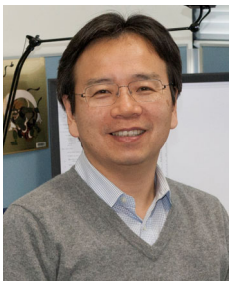
【Grant-in-Aid for Scientific Research (S)】

Broad Section B



Title of Project : Study of dynamic-thermodynamic structure and intensification process of super-typhoon by aircraft observation

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Research Project Number : 21H04992 Researcher Number : 90222140

Term of Project : FY2021-2025 Budget Allocation : 145,500 Thousand Yen

Keyword : super-typhoon, aircraft observation, rapid intensification process, concentric eyewall structure, dropsonde

【Purpose and Background of the Research】

Typhoons are the biggest cause of natural disasters in East Asia, including Japan. Super-typhoons, which are the strongest category of typhoons, are particularly dangerous and can cause huge damage. In association with global warming, there are concerns that they may make landfall on the Japanese islands. However, a major problem is that there are large uncertainties in both estimation data and predictions of typhoon intensity. The biggest reason for this is the rapid intensification of typhoons and the concentric eyewall structure that often accompanies the rapid intensification. The dynamic and thermodynamic structures involved in the process and structure are still unknown. How super-typhoons form and the role of rapid intensification and concentric eyewall structures in their formation are major unanswered questions about typhoons. For the first time in Japan, our research team conducted observations of a super-typhoon at a high altitude of about 14 km using an aircraft. In this research, we aim to extend the results of the research and clarify the above issues.

【Research Methods】

In a developed typhoon, an "eye" is formed in the center and an "eyewall" surrounds it. Inside the eye, a region with higher temperature than the surrounding area is formed. This is called the "warm core," and it is the thermodynamic structure that determines the intensity of the typhoon. As shown in Fig. 1, an aircraft flies around the typhoon and inside the eye, and launches an observation equipment called a dropsonde. Dropsondes will observe all layers from the top of the typhoon to the sea surface. Ground-based observations using radar and weather balloons will be also conducted on Yonaguni Island and Minamidaito Island.

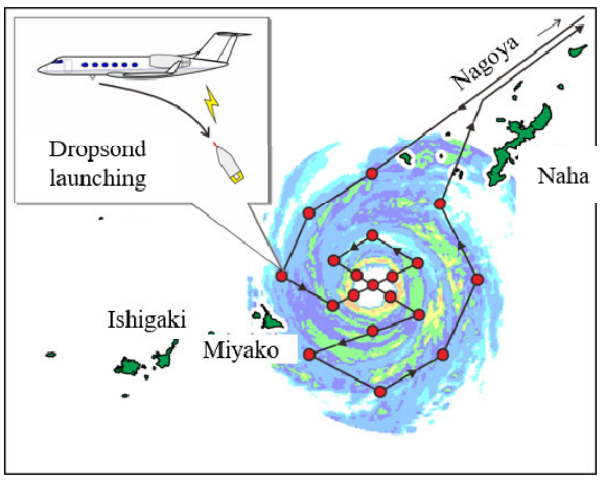

Figure 1: Schematic diagram of an aircraft observation of a typhoon. The solid line indicates the flight path and red closed dots indicate the dropsonde launching

Dropsonde data are transmitted in real time to the Japan Meteorological Agency (JMA) via Nagoya University, and are used for operational forecast of typhoons. The detailed data is later used for numerical simulations with data assimilation. Numerical models of Nagoya University, JMA, and the United States are used to perform high-resolution numerical simulations to clarify the roles of rapid intensification and concentric eyewall structures in the formation of super-typhoons.

【Expected Research Achievements and Scientific Significance】

The observation of super-typhoons from high altitude by aircraft enables us to observe the structure of the warm core and to obtain the accurate data of typhoon intensity. This will lead to the elucidation of the dynamic and thermodynamic structure of typhoons and the rapid intensification process, and contribute to improve typhoon forecasts. This will contribute to the mitigation of typhoon disasters and improve the evacuation from typhoons.

The highly accurate measurements obtained from the aircraft observations will contribute to typhoon research and climatology of typhoon change due to global warming.

The aircraft observations will be conducted as an international collaboration with the United States, Taiwan, and South Korea. This will contribute to the development of an international community for aircraft observations.

【Publications Relevant to the Project】

· Tsuboki, K., M. K. Yoshioka, T. Shinoda, M. Kato, S. Kanada, and A. Kitoh (2015), Future increase of supertyphoon intensity associated with climate change, *Geophys. Res. Lett.*, **42**, 646–652.

· Yamada, H., K. Ito, K. Tsuboki, T. Shinoda, T. Ohigashi, M. Yamaguchi, T. Nakazawa, N. Nagahama, and K. Shimizu, (2021): The Double warm-core structure of Typhoon Lan (2017) as observed through the first Japanese eyewall-penetrating aircraft reconnaissance. *J. Meteor. Soc. Japan*, **99**, (accepted).

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