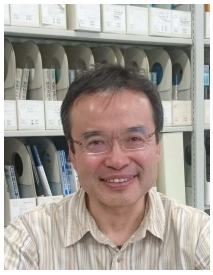
【Grant-in-Aid for Scientific Research (S)】

Broad Section B



Title of Project： Comprehensive picture of atmospheric circulation of Venus revealed by AKATSUKI data assimilation

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Research Project Number：19H05605　Researcher Number：20180979
Keyword：atmospheric general circulation model, Venus, AKATSUKI, super-rotation, data assimilation

【Purpose and Background of the Research】

The structures of atmospheric circulation of Venus still remains to be revealed. The thick cloud layer around 45-70km hides the lower part of the atmosphere. The most impressive characteristic of the Venus atmosphere is “super-rotation” (four-day circulation), which is the intense zonal wind with around 100m/s at the cloud top level. The rotation rate is tens of times higher than that of the solid Venus, 243 days. To understand the structures that produce and sustain the super-rotation is one of the fundamental problems in the fields of meteorology.

Japanese Venus explorer AKATSUKI has been launched to perform intensive meteorological observations for the first time in the world, carrying four types of cameras to gather information at various altitudes. Before AKATSUKI, observations of the Venus atmosphere were fragmentary, while numerical simulation models, which should have been compared to observations, were primitive because of the insufficiency of understandings on the circulation structures.

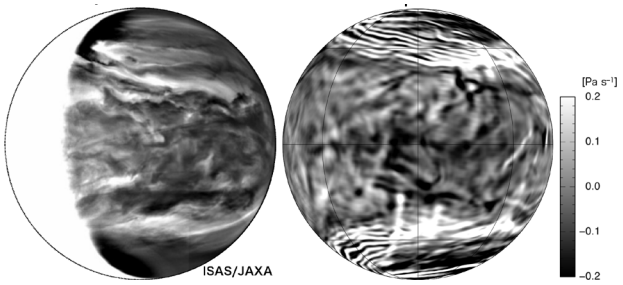

Figure 1 AKATSUKI IR2 image (left), AFES-Venus vertical wind (right).（Kashimura et al., 2019）

Now, we found that the images obtained by AKATSUKI show remarkable resemblance with the results of high resolution simulations by AFES-Venus, which is a general circulation model of the Venus atmosphere being developed by our group optimized for the Earth Simulator (Fig. 1). AKATSUKI and Earth Simulator enables us to compare the observations with the models. The purpose of the present research is to realize the comparisons by introducing leading edge methodology, to promote the development of the atmospheric model, and to try to reveal the circulation structures which sustain the super-rotation.

【Research Methods】

AKATSUKI observations and analyses are combined with AFES-Venus developments and numerical simulations by the use of data assimilation method (e.g. Sugimoto et al., 2017) to produce Venusian circulation fields which are dynamically and also observationally consistent (Fig. 2). AKATSUKI occultation observations, imageries, cloud tracking winds are utilized, and cloud and radiation transfer models are developed to realize AKATSUKI observation simulations.

【Expected Research Achievements and

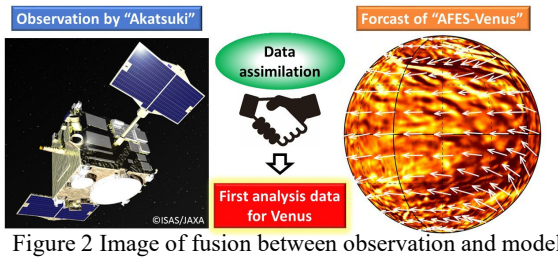

Figure 2 Image of fusion between observation and model development by data assimilation

Scientific Significance】

By the use of assimilated data, we will try to reveal atmospheric disturbances, tracer transport and cloud structure, and meridional circulation and angular momentum transport to understand the structures which realize the super-rotation. “AKATSUKI Venus atmosphere dataset” thus obtained will be a base for further researches on Venusian and planetary atmospheres in general.

【Publications Relevant to the Project】

・Kashimura, H., et al., Planetary-scale streak structure reproduced in high-resolution simulations of the Venus atmosphere with a low-stability layer. *Nature Communications*, **10** (23), 1-11, doi:10.1038/s41467-018-07919-y. (2019).
・Sugimoto, N., et al., Development of an ensemble Kalman filter data assimilation system for the Venusian atmosphere. *Scientific Reports*, **7**, 9321, doi:10.1038/s41598-017-09461-1, (2017).

【Term of Project】

FY2019-2023

【Budget Allocation】

145,200 Thousand Yen

【Homepage Address and Other Contact Information】

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