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PREFACE

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Special issue "Akatsuki at Venus: The First Year of Scientific Operation"

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The JAXA Venus explorer, which had been developed in Japan since 2001, was launched in 2010. The spacecraft was named "Akatsuki" after the Japanese word meaning dawn. Akatsuki was inserted into the Venus orbit and began its observation program in 2015, after 5 years wandering around the sun due to the failure of orbit insertion in 2010. Nakamura et al. (2016) described the orbit insertion as well as some initial results from the IR1, UVI, and LIR cameras.

In the twentieth century, well before the start of Akatsuki mission, the former Soviet Union and the USA had explored Venus and elucidated basic characteristics such as atmospheric temperature, pressure, composition, wind speed, surface topography and the plasma environment. However, the physical processes leading to the present state were still unclear. Among them, the Akatsuki mission focused on the study of atmospheric dynamics as a major goal of Venus exploration in the early twenty-first century. The Venusian atmosphere encircles the planet from east to west at all latitudes at a speed much faster than the solid planet. This wind system, called the super-rotation, is one of the biggest mysteries of planetary meteorology and should have a major effect on Venus' environment. Akatsuki is aimed at a comprehensive survey of the meteorological processes and a quantitative evaluation of the momentum transport sustaining the super-rotation. For this purpose, five cameras imaging the planet at different wavelengths are installed on the spacecraft to visualize atmospheric motions at different altitudes. Combined with a radio occultation instrument that probes the vertical structure, this suite of instruments can monitor the dynamics of the whole atmosphere in three dimensions.

The second attempt of the orbit insertion using attitude control thrusters in 2015 was perfectly successful. The first scientific discovery was made just 3 h after the arrival: the longwave infrared camera captured a planetary-scale atmospheric gravity wave that was stationary with respect to the surface topography. Starting with this discovery, many other scientific results have been accomplished.

This issue presents initial results of the Akatsuki mission. Iwagami et al. (2018) reported the initial results from Akatsuki/1-μm camera (IR1). More than 600 day-side and 150 night-side images have been obtained since the beginning of regular operation on April 2016. The night-side images are less numerous due to limitations related to the light scattered from the bright day-side. Satoh et al. (2017) reported the performance of Akatsuki/2-μm camera (IR2), and the results obtained with IR2 camera from December 2015 through November 2016. A total of 3091 images of Venus (1420 dayside images at 2.02 μm and 1671 night-side images at 1.735, 2.26, and 2.32 μm) were acquired in this period. Additionally, 159 images, including those of stars for calibration and dark images for the evaluation of dark levels, were obtained. Yamazaki et al. (2018) described the initial results from Akatsuki/Ultraviolet Imager (UVI) at 283 nm and 365 nm. The UV images provide the spatial distribution of SO_2 and the unknown absorber at the cloud tops and characterize the cloud-top morphologies and haze properties. Nominal sequential images with 2-h intervals are used to understand the dynamics of the Venusian atmosphere by deriving the wind velocity field from measured motion vectors at the cloud tops, as well as the mass transportation of UV absorbers. Fukuhara et al. (2017) described the calibration of the Akatsuki/longwave infrared camera (LIR). The brightness

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temperature derived from LIR images contained an unexpected bias related not to natural phenomena but to a thermal condition of the instrument. Deep-space images were acquired at different baffle temperatures, and a reference table for eliminating the bias from images was prepared. Takahashi et al. (2018) described the lightning search using the Akatsuki/lightning and airglow camera (LAC). LAC was designed to observe the light curve of possible flashes at a sufficiently high sampling rate to discriminate lightning from other sources and thereby perform a more definitive search for optical emissions. It was confirmed that the operational high voltage was achieved and that the triggering system functions correctly. LAC lightning search observations are planned to continue for several years.

Imamura et al. (2017) reported the initial results of the radio occultation experiments revealing the Venus atmosphere structure. The physical quantities retrieved include the pressure, the temperature, the H_2SO_4 vapor density, and the ionospheric electron density and their variations.

Archiving of the results of these observations is important. Ogohara et al. (2017) gave an overview of the data products. The level-2 images include calibrated radiances and geometry information. The level-3 data are global-grid data in a regular longitude–latitude coordinate system. The method of correcting the boresight pointing of each camera by fitting an ellipse to the observed Venusian limb is also described.

Three numerical modelling and theoretical works are included in this special issue. Horinouchi et al. (2018) studied the cloud-top wind field using images taken by the Ultraviolet Imager (UVI) at the wavelengths of 365 nm (unidentified absorber) and 283 nm (SO_2). These two wavelengths yield slightly different wind velocities, suggesting a difference in the altitude of the cloud features. The local-time dependence and an asymmetry with respect to the equator were observed. The geographic distribution of the zonal wind reported previously (Bertaux et al. 2016) was not seen in the data. McGouldrick (2017) studied the effects of variation in the coalescence efficiency of the Venus cloud particles on the structure of cloud using a one-dimensional cloud model. Specifically, they explored the consequence of allowing the coalescence efficiency of supercooled sulfuric acid in the upper clouds to tend to zero. The most significant result is the appearance of thick clouds of small particles near the transition between upper and middle clouds. Limaye et al. (2018) summarized the characteristics of Venus clouds seen in the multi-wavelength images taken by Akatsuki. The images reveal new and puzzling morphology of the complex cloud cover. The cloud morphologies provide some clues to the processes occurring in the atmosphere and are thus a key diagnostic tool when quantitative dynamical analysis is not feasible due to insufficient information.

In this special issue, you will find the history of the spacecraft development, the design of the observation instruments, the data processing procedure and the initial scientific results. We hope this special issue will familiarize readers with the outline of the JAXA Akatsuki mission that opened up a new era of Venus exploration. Akatsuki follow-up Venus missions are planned by some space agencies and are discussed by Glaze et al. (2018).

Authors' contributions
All authors read and approved the final manuscript.

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Competing interests
The authors declare they don't have any competing interests.

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