

# Venus Observation by Akatsuki : 2015 - 2019

Masato Nakamura and Akatsuki project team  
Institute of Space and Astronautical Science (mnakamur@stp.isas.jaxa.jp)

## Abstract

Akatsuki is the first Japanese Venus orbiter. It started observation in December 2015. It is equipped with 5 cameras observing different altitudes of Venusian atmosphere. 2 cameras worked over 1 earth year and other cameras continue observing Venus. New findings are made by the observations from Akatsuki.

## 1. Introduction

Akatsuki was launched in 2010 from Tanegashima Space Center. It was failed to be inserted into the orbit around Venus in December 2010, but after 5 years of wondering around the sun, it arrived at Venus in December 2015. The spacecraft was designed to observe the Venusian atmosphere, especially its motion, to reveal the meteorological structure of Venus which is very much different from that of the earth [1]. The spacecraft was equipped with 5 cameras, which are IR1 camera observing 1- $\mu\text{m}$  infrared light, IR2 camera observing 2- $\mu\text{m}$  infrared light, LIR camera observing 8-12- $\mu\text{m}$  infrared light, UV imager observing 283-nm and 365-nm UV lights, and LAC camera observing Venus lightning. These cameras take motion pictures of clouds and minor components at different altitudes to reveal the 3D structure of the Venusian atmospheric motion. Furthermore, the ultrastable oscillator, which is identical to the one onboard the Venus Express, was equipped for the radio occultation measurement to understand the vertical structure of the Venusian atmosphere. IR1 and IR2 cameras worked for more than 1 earth year and other cameras are still observing Venus.

## 2. Observation

### 2.1 IR1 and UVI observation

An example of the IR1 and UVI observation is shown in Figure 1. This is Venus dayside synthesized false color image by IR1 and UVI (2016 Nov 20). In the 283 nm band observed by UVI, there is an absorption band

of sulfur dioxide ( $\text{SO}_2$ ). Also, there is an absorption band of an unidentified chemical substance in the 365 nm band. We may argue that the amount of  $\text{SO}_2$  is relatively low in the bluish areas in this image.

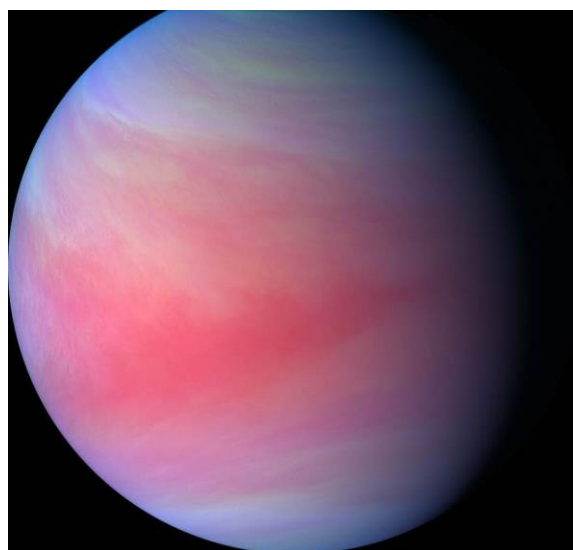


Figure 1: A synthesized false color image of Venus using 283-nm and 365-nm images taken by UVI plus 0.90- $\mu\text{m}$  image taken by IR1. (283 nm : blue; 365 nm : green; 0.90  $\mu\text{m}$  : red. ) ©Akatsuki project team

### 2.2 IR2 observation

Figure 2 shows the zonal wind velocity in the lower and middle cloud regions below about 57 km in altitude in 11–12 July 2016 seen by the IR2 camera [2]. This fast flow, exceeding  $80 \text{ m s}^{-1}$  is called an equatorial jet, the feature that has not been observed previously in the Venusian atmosphere.

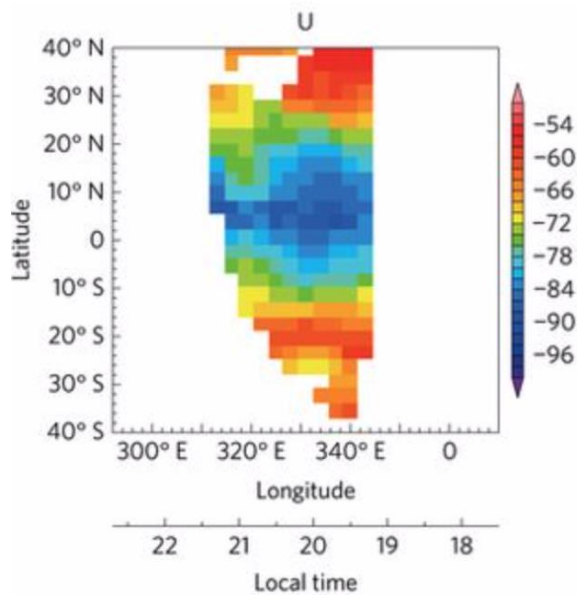


Figure 2: Longitudinally averaged zonal wind (Figure 2(a) of [2])

### 2.3 LIR observation

Figure 3 shows the new findings by the LIR camera which is the large-scale stationary structure at 65 km altitude [3]. This structure is found to be fixed at the geological future at the Venusian surface, i.e., Aphrodite Terra. As the structure is fixed to the surface measure, this structure was continuously detected over 5 day, not affected by the super-rotation.

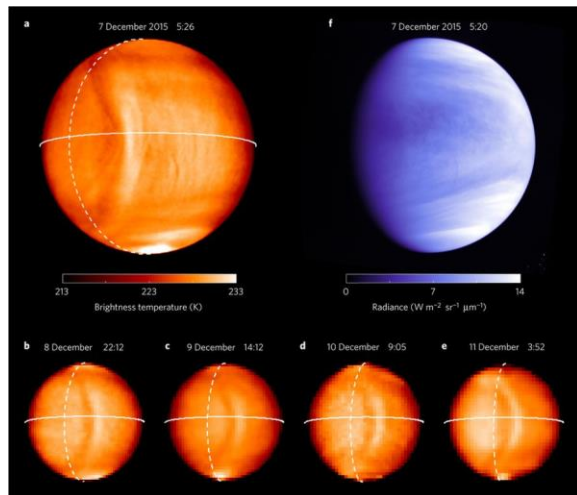


Figure 3: a–e, Sequence of brightness temperature distributions obtained by LIR from 7 to 11 December

2015. The equator and evening terminator are shown by solid and dashed lines, respectively. f, UV 283-nm image obtained by UVI. (Figure 1 of [3])

### 3. Summary and Conclusions

Akatsuki is the Venus orbiter studying the Venusian meteorological structure since 2015. It made over 3 earth years observation and still UVI, LIR, and LAC imagers are working for future observation. A lot of clues to understand the angular momentum transfer in three dimensional have been found by these and future observation by Akatsuki.

### Acknowledgements

We gratefully thank NEC Corporation, Fujitsu Limited, Sumitomo Heavy Industries, Ltd., Nikon Corporation, Mitsubishi Heavy Industries, Ltd., IHI AEROSPACE Co., Ltd., Meisei Electric Co., Ltd., Mitsubishi Electric Corporation, Hamamatsu Photonics K.K., NEC Space Technologies, Ltd., Space Engineering Development Co., Ltd., FUJITOK Corporation, K. K. MAGOSHI, and TimeTech GmbH for their contribution to the design, manufacturing, and operation of AKATSUKI since 2001.

### References

- [1] Nakamura, M. *et al.*: AKATSUKI returns to Venus. *Earth Planets Space* 68:75. doi:10.1186/s40623-016-0457-6, 2016
- [2] Horinouchi, T. *et al.*: Equatorial jet in the lower to middle cloud layer of Venus revealed by Akatsuki, *Nature Geoscience*, doi:10.1038/NGEO3016, 2017
- [3] Fukuhara, T. *et al.*: Large stationary gravity wave in the atmosphere of Venus, *Nature Geoscience*, doi:10.1038/NGEO2873, 2017