

Multi-wavelength Analysis of Venusian Cloud by Correlation Coefficient Mapping

*Minori Narita¹, Takeshi Imamura¹

1. Graduate School of Frontier Sciences, The University of Tokyo

We investigated the correlation between Venusian images which were taken in different wavelengths by Venus orbiter Akatsuki using the correlation coefficient mapping, and successfully caught the characteristics of the relationship between the ultraviolet channels 283 nm and 365 nm, and that between the dayside near-infrared 2.02 μm (IR2) and thermal infrared 10 μm (LIR). As a result, a strong positive correlation was shown to be dominant between 283 nm and 365 nm. As for IR2 dayside and LIR, negative correlation prevails in most of the cases. This is the first to examine quantitatively the relationship between different wavelengths for Venusian cloud image over a geographically broad range.

Three different spatial scales, which are less than 4°, 6°, and 8° both in latitude and longitude, are examined in this study. As a result, the correlation between ultraviolet 283 nm and 365 nm shows strong positive values in most of the regions for all spatial scales. Since 283 nm corresponds to the absorption by SO_2 and 365 nm is supposed to reflect that by the unknown UV absorber, it is concluded that the distributions of SO_2 and the unknown UV absorber are basically similar. Also, the tendency of negative correlation between IR2 and LIR indicates an inverse relationship between the cloud height and the cloud top temperature because IR2 shows the cloud height and LIR reflects the temperature at the cloud top.

As the analysis method, we used the correlation coefficient mapping. Firstly, a pair of Venus images taken almost simultaneously at different wavelengths are chosen and then projected onto the latitude/longitude coordinate. Next, the effect of the change of the incidence and emission angles over the Venus disk is corrected by using Minnaert Law, except for LIR images. Then these images are processed by high pass filtering by subtracting a Gaussian-smoothed image from the original image. This filtering enables us to compare cloud features at various scales. The correlation coefficient mapping is done using these preprocessed images.

The procedure is as follows. Firstly, a certain size of a square region is selected from each of the pair of images in the same geographical location, and the correlation coefficient between them is calculated. The area in which incidence or emission angle is less than 75° is used. Then the value is plotted onto the point which geographically corresponds to the center of the square region. This procedure is repeated while sequentially shifting the square region pixel by pixel over the whole image area, and the correlation coefficient map is created. The size of the square region is set to twice the size of the half width of the Gaussian filter used in high pass filtering.

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