3D Reconstruction of Typhoon Maysak Using Diwata-2 Microsatellite

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Typhoons and torrential rains are weather phenomena that cause flooding and landslides, especially in the East and South-east Asian countries that are exposed to these extreme weather phenomena. In addition, the frequencies and intensities of typhoons and torrential rains are getting higher due to warming temperature. Because of this, measuring their intensity accurately can help mitigate the hazards that they bring. However, analysis of typhoon (size, shape of clouds and development rate) is difficult to perform because of its chaotic behavior and environmental factors that affect it. According to studies, the essential parameters for estimating typhoon intensity from remote sensing are cloud morphology, cloud-top height, and cloud profiling information across the center of the storm. For stronger typhoons, the typhoon eye and eyewall are also more prominent, making them good indicators of typhoon intensity. Typhoons and cumulonimbus clouds that could cause torrential rains have different spatial and temporal scales. This discrepancy in scaling makes it difficult to analyze clouds using a single imaging source. Thermal infrared from meteorological satellites that measures cloud altitude are unreliable because of inconsistent atmospheric temperatures. Furthermore, radar sensors have insufficient spatial and temporal resolution to measure small cloud particles. These show that the current methods have limitations.
In this research, a method was developed to analyze typhoons using stereo-photogrammetry from Diwata-2 microsatellite. The cloud-top altitude was then estimated from stereo-photogrammetric models and validated using Himawari-8 TIR and dropsonde data.
For the satellite images, Diwata-2 captured multiple images of Typhoon Maysak, a Category 4 typhoon that hit Japan last September 2, 2020. We reconstructed a precise three-dimensional model of a typhoon using the monocular camera setup of the satellite. The area coverage of the model is approximately 33,100 km2 with a ground resolution of 103 m/pix and a 2.64 pix RMS reprojection. It has a latitude range of 31.1˚N to 32.2˚N and longitude range of 126.1˚E to 129.4˚E. A maximum altitude of 16 km was estimated from the model which has an absolute difference of 1.2 km from the estimated cloud-top altitude using TIR. Although there are inconsistencies in the altitude profile between the two methods due to unknown camera rotations, the cloud structures observed are very similar.
The result presented here is preliminary as multiple images of typhoon captured by Diwata-2 is currently under analysis. This research was supported by SATREPS, funded by Japan Science and Technology Agency (JST) / Japan International Cooperation Agency (JICA).

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