EMS Annual Meeting Abstracts
Vol. 14, EMS2017-660, 2017

Measurements of Clouds Using 3D models Generated from Images Captured with Uncalibrated Cameras

Maya Shimono (1), Ken Hirata (1), Kuriki Murahashi (2), Ade Purwanto (2), Hiroshi Kawamata (1,3), Nobuyasu Naruse (3,4), Yukihiro Takahashi (1,2)

(1) Global Science Campus, Hokkaido University, Japan, (2) Graduate School of Science, Hokkaido University, Japan (spriteselves@gmail.com), (3) Institute for the Advancement of Higher Education, Hokkaido University, Japan (kawamata@high.hokudai.ac.jp), (4) Shiga University of Medical Science, Japan (naruse@belle.shiga-med.ac.jp)

The photogrammetric approaches on ground-based observation of clouds have enabled measurements of location, height and other characteristics of clouds. For accurate measurements, fixed camera pairs with precise calibration and geo-information (location and orientation) are required. This constraint prevents us from fully tracking clouds with rapid growth at arbitrary locations and requires us to increase the number of the camera in order to monitor the cloud growth of a wider coverage. To overcome this issue, we applied a Structure from Motion (SfM) technology. Numerous feature points common in multiple cloud images are detected and matched to map out camera locations and orientations to have the 3D model reconstruction with an adequate accuracy.

As a feasibility test, we captured images of cotton wool and white clay in the laboratory, replicating the actual image-capturing setting. Plentiful sets of images were captured with different camera positions and lighting conditions and then their 3D models were reconstructed with SfM software; PhotoScanPro. Close inspection on the outcomes revealed that the angle between cloud-camera planes should be less than about 5° to be able to construct 3D models that can offer high accuracy measurements. The images of the front-illuminated clouds, compared to those of back-illuminated clouds, would result in more accurate 3D models.

Subsequent to the laboratory works, we utilized four digital cameras located apart from one another and simultaneously captured images of the clouds several times, applying the optimal conditions discovered in the laboratory. With the SfM software, 3D models were successfully generated from the cloud images. The cloud height off the ground was calculated with the information of the GPS position of the cameras. In order to validate the results of our new method, we are planning to capture further sets of cloud images and make measurements of clouds using conventional photogrammetry with some calibrated cameras.

As a whole, this study demonstrates a new simple method for 3D cloud modeling without precise calibration of camera positioning and optimal image-capturing conditions for the task. These outcomes will contribute to the improved observations of rapidly growing clouds and short-term precipitation forecast.