Shallow cumulus cloud cover estimation by a stereo camera ring

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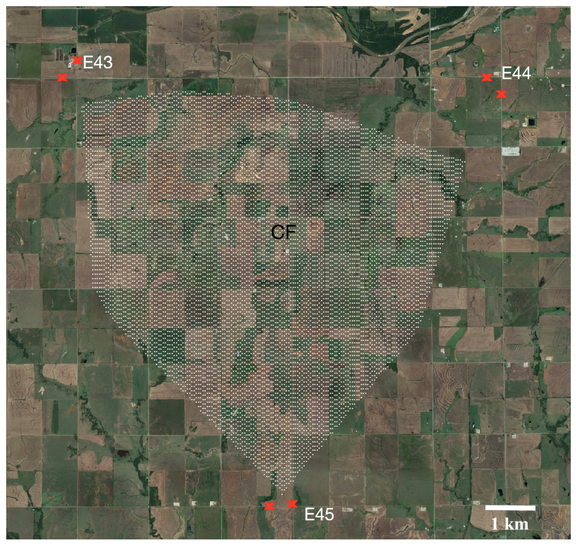
ARM Stereo Ring

The ARM Stereo Ring is a multi-view stereo system recently deployed at the SGP site to collect exclusive set of data on shallow cumulus clouds overhead the central facility (CF). The stereo ring is formed by three ARM Cloud Digital Camera (ACDC) pairs standing at approximately 6 km radius from the CF and with a tilted view of 19° from the ground. The cameras continuously capture synchronized images of the region around the CF, which are stored at the ARM archive. The shaded area on the below map illustrates the common field of view of all cameras that is the intersection of field of views of ACDCs running at the extended facilities E43, E44 and E45. Each ACDC pair provides a stereo reconstructed Point Cloud of Cloud Points (PCCP) that correspond to the x,y,z coordinates of cloud features detected from stereo image pairs. These PCCPs from the three pairs are later combined together and are processed to generate a gridded cloud field.

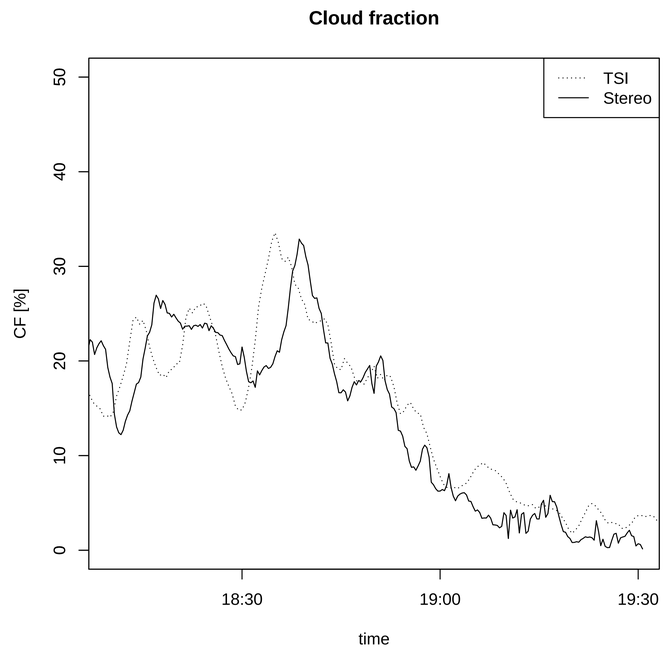


Gridded Cloud Field

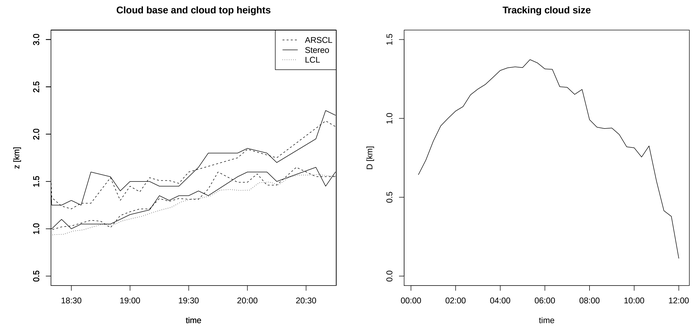
The gridded cloud field product is basically a 4D mask representing clouds in a volume enclosed by a 6 km $\times$ 6 km $\times$ 6 km cube centered at the CF. The spatial resolution of the cloud field is 50 m, and the time resolution is 20 seconds. Each grid takes a value 0, 1, or NA to denote "cloud", "no cloud", or "not available". NA refers to points that are either out of field of view of the cameras, or cannot be detected because of occlusion of all views. The mask is generated by a computer vision algorithm developed to project PCCPs to a common reference frame and then to eliminate false detections and estimate missing grid points in the field of view of the cameras.

The figure above shows the 18:20 UTC snapshot of the gridded cloud field generated from the stereo ring data of August 31, 2017. The representation of shallow cumulus clouds overhead CF is clearly seen. The gridded cloud field provides a data set from which several physical properties of shallow cumulus clouds such as cloud cover, cloud size and cloud heights can be extracted.

Cloud Cover Estimated from Gridded Cloud Field



Cloud cover extracted from the gridded cloud field of August 31, 2017 is plotted in the figure above. Cloud fraction is estimated by scaling the total number of "cloud" grid points projected onto the base layer by the total number of available grid points in the base layer. The estimate of cloud fraction by the total sky imager that captures a zenith view of the sky (dashed line) is also plotted for comparison. The two lines show good agreement in the presence of shallow cumulus clouds.



The two panels above show cloud base/top heights and cloud size tracking that can also be extracted from the gridded cloud field.

Acknowledgments

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References

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