Cloud classification based on histogram analysis of pixel values of night time cloud images over Manila Observatory (14.64N, 121.07E)

*GlennFranco Barroso Gacal[1,2], Nofel Lagrosas[1,2]

1.Manila Observatory, 2.Ateneo de Manila University

Satellites and ground based instruments are utilized to achieve cloud detection. At night time, detection of clouds is accomplished by satellites, whole-sky imagers, lidars, and sky cameras. In practice, ground-based detection is executed by sky cameras and whole-sky imagers and incorporating a threshold value into the analysis of cloud detection. This will classify pixels as clouds or non-clouds. In this work, we use a ground-based sky imager using a digital camera to take pictures of the sky. The digital camera (Canon Powershot A2300) is continuously operated to take images of night time clouds at 5 minute intervals. The camera is configured to have an exposure time of 1s and 5s and is situated on the roof top of the Manila Observatory building (14.64N, 121.07E). This is to ensure that there is a minimal presence of obstructions for the camera. A threshold value is applied to distinguish a pixel to be a cloud or non-cloud by analyzing the histogram of pixel values of clear sky. Other works use the similar procedure of applying a threshold value to detect clouds at daytime (Heinle et al., 2010). In this study, the RGB formatted images are converted to greyscale format. Lastly, an algorithm is applied to compute cloud occurrence (Gacal et al., *submitted*). Cloud occurrence is determined but not its corresponding cloud types: thin, thick, and cloud-free. The objective of this study is to determine these cloud types in terms of their range of pixel values. Figs. 1a -1c show the images of a clear night sky, thin clouds, and thick clouds, respectively. These images were taken on 16 January 2016, 21 October 2015, and 25 May 2014, respectively. From visual inspection, thick clouds (Fig. 1c) are perceived to have no distinguishable dark background as compared to the thin clouds (Fig. 1b). Figs. 1a –1c are taken at 1s exposure time except Fig. 1a with an exposure time of 5s. Figs. 1d –1f show the histogram of each corresponding cloud type. The histogram of a cloud free sky (Fig. 1d) presents the pixel values that range from 0 –16. This implies that a minimal pixel value of 17 can be used to discriminate the presence and absence of clouds of a night sky (Gacal et al., *submitted*). Comparing this to Fig 1e, this histogram shows a superposition of a clear sky and thin clouds. Since the range of pixel values for a clear night sky is from 0 –16, it follows that the remaining range of pixel values has to be from thin clouds. In this study, we observe that the range of pixel values for thin clouds is from 19 –40. Fig. 1f is a histogram of an extreme example of a thick cloud where pixel values range from 47 –111. Visual inspection of Fig 1c shows that there is no thin cloud or clear sky component. This pixel range can represent of thick clouds at night time. This work has shown the possibility of discriminating cloud types in terms of the range of pixel values. In the future, these results will be used to calculate cloud cover from thin and thick clouds as the calculation of cloud occurrence is simultaneously done.

References:

Heinle, A., Macke, A., Srivastav, A. (2010). Automatic cloud classification of whole sky images. *Atmos. Meas. Teach*, 3: 557-567.

Gacal, G.F.B., Antioquia, C., Lagrosas, N. (2016). Ground-based cloud detection of night time clouds above Manila Observatory (14.64N, 121.07E) using a digital camera. *Aerosol and Air Quality Research. (submitted).*

Keywords: Digital image, Pixel values, Histogram, Nighttime clouds