P2.12 INITIATION OF A HIGH RESOLUTION TROPICAL CLOUD CLIMATOLOGY

Mary Bedrick*, Kirk Swanson**, Lynn Rose, Brian Morrison
Aeromet, Inc.

1. INTRODUCTION

Clouds play an important role in the tropics. Globally, high clouds have two effects on the global radiation budget. They reflect solar radiation and absorb and re-radiate terrestrial radiation. Deep convective clouds act to affect the temperature profile of the atmosphere through diabatic processes.

Several global cirrus climatologies have been composed (e.g. Wylie et al., 1994, and Wylie and Menzel, 1999) using National Oceanic and Atmospheric Administration (NOAA) polar-orbiting satellite High Resolution Infrared Radiation Sounder (HIRS) multispectral data. Global cloud cover is detected by a Carbon Dioxide (CO_2) slicing method. The algorithms calculate cloud top pressures and emissivity from radiative transfer principles. For these climatologies, information was sampled only from every third Field of View (FOV) with a zenith angle less than 10º from every third line of data. This represents less than 2% of the total data available.

Since October 1999, NOAA polar-orbiting HIRS multispectral data have been archived from Kwajalein, Republic of the Marshall Islands (RMI) (Table 1). The number of passes greatly decreased when NOAA-12 HIRS data became unavailable. Cloud occurrence, height, and effective emissivity are determined through CO_2 slicing techniques for the area between 5ºS and 30ºN, 155ºE and the international date line. Unlike previous global climatologies, this tropical study uses data from every available FOV for NOAA-12 and -14.

TABLE 1. Number of passes archived from Kwajalein, RMI.

Month	Number of passes
October, 1999	117
November, 1999	127
December, 1999	183
January, 2000	147
February, 2000	146
March, 2000	140
April, 2000	141
May, 2000	187
June, 2000	124
July, 2000	143
August, 2000	144
September, 2000	153
October, 2000	140
November, 2000	138
December, 2000	113
January, 2001	92
February, 2001	73
March, 2001	40
April, 2001	48

2. DATA AND METHODS

Daily passes are collected, processed and archived. Archived data is divided into morning and evening cycles, which is further divided into different layers for the heights of the calculated cloud tops. Low clouds extend from 1000 to 700 hPa (near the surface to 3 km), medium clouds from 700 to 400 hPa (3 to 9.5 km), and high clouds exist above 400 hPa (9.5 km). The choices for the different levels of clouds is rather arbitrary because a very robust cumulonimbus cloud would be placed in the high cloud group, although most of its characteristics are that of low and medium altitude clouds. Morning and evening passes are also grouped together and counted in a total cloud count cycle.

Each cycle also has a grid of data that has been calculated as clear. Each cloud layer is sub-divided into thickness categories: Thin, Thick and Opaque. Calculated emissivity values range between 0.0 (fully clear) and 1.0 (fully opaque). Thin clouds are defined as those with emissivity values less than 0.5, while Thick clouds have emissivity values between 0.5 and 0.95. Opaque clouds are defined as those with emissivity values greater than 0.95. These data are stored in ¼º latitude-longitude grid squares. Total counts of clouds are stored at each grid point. Since the CO_2 algorithms detect clouds from the top layer towards the surface of the earth, only the first encountered layer of cloud top heights are processed. The data set is, in this sense, biased toward the higher clouds.

In this paper, only daily total results of all high, medium, low and all clouds will be evaluated. Time of day and cloud opacity are not taken into consideration in this portion of the study. Since the traditional climatological four seasons does not apply to Kwajalein's tropical location, the data for each level is divided into two seasons. The high wind (low precipitation) season extends from December through May. The low wind (high precipitation) season runs from June through November.

3. PRELIMINARY RESULTS

Initial results of the climatology show interesting features for the high wind season (Figure 1a) and low wind season (Figure 2a). The maximum in total observed clouds is found between the equator and 10ºN for both season, but the maximum is located more

*Corresponding author: Mary Bedrick, Aeromet, Inc., P.O. Box 701767, Tulsa OK 74170-1767; e-mail: maryb@aeromet.com
**Current affiliation: Architecture Technology Corp.

poleward and over a broader region during the low wind season. A second maxima in clouds looks to start near 5ºS with a relative minima near the equator in all seasons. In the high wind season, another maxima in total clouds is seen in the northern portion of the domain. The relative lack of clouds found between 10º and 25º N in the high wind season hints at the position and intensity of the subtropical high.

A majority of the total observed clouds are in the high cloud group. This is not surprising because of the CO_2 slicing algorithm's top down cloud finding approach. There does appear to be a "sloshing" of the concentration of high clouds from the western portion of the domain to the center of the domain from the high wind season (Figure 1b) to the low wind season (Figure 2b).

Part of this "sloshing" effect may be a residual of our choice for groupings of high clouds. In the high wind season just to the east of the cloud maxima along 5ºN, there is a maxima in the medium cloud group (Figure 1c). A similar but less pronounced pattern can be seen in the low wind season middle cloud group (Figure 2c). It appears that a majority of the total cloud maxima found at the northern part of the domain during the fast wind months is due to medium layer clouds.

The highest concentration of low clouds is found outside of the regions of high concentrations of medium, and high level clouds. In the high wind season (Figure 1d) low level clouds are concentrated between 10º and 25ºN. In the low wind season (Figure 2d), most low levels clouds are found between 15ºN and the northern portion of the domain. Interestingly, more low cloud tops are detected in both seasons (and every individual month) than medium cloud tops.

4. DISCUSSION

Many of the features presented in this study can be correlated with known meteorological features. The broad band of clouds and its movement between the equator and 15ºN can be associated with the intertropical convergence zone and its movements. There are hints of a second cloud band in the southern hemisphere from this climatology. The maxima in clouds located in the northern portion of the domain during the high wind season can be correlated to the movement of mid-latitude cold fronts into sub-tropical regions during the cold months. This is supported by the presence of more medium and low-level clouds in these maxima, which would correspond to the stratus type clouds often associated with cold fronts.

The preliminary results of this 19-month study compare well to the Wisconsin HIRS 6.5 Year Global Cloud Climatology prepared by Don Wylie (http://www.ssec.wisc.edu/~donw/PAGE/CLIMATE.HTM). The 6.5 year climatology also has the movement of total cloud concentrations poleward in our domain area in the low wind season and broadening of the maximum region. It also shows the encroachment from mid-latitude systems in winter months into the northern part of our domain. The 6.5 year climatology does not show the bi-model equatorial cloud band seen in this study. This difference could be due to either our small number of months or to the higher resolution of our data set

This paper presents the preliminary data gathered in an ongoing climatology. As more data is gathered, it is hoped that annual and seasonal trends will become more apparent. Finer scale features will be available from this data set as compared to the current global cloud climatologies. Soon, cloud height data from NOAA-16 will be added to the study. The paucity of data in the medium cloud layer will be investigated. Since the problem may come from the definitions of cloud heights, the separation of clouds into different layers will also be examined. The problem may actually be that too many cloud free grid points are being classified as containing low-level clouds. This could be caused by poorly initiating low level temperature profiles (sea surface temperatures).

Acknowledgements: The authors would like to thank Don Wylie for his CO_2 slicing code and for his helpful discussions on the procedures used for the analyses.

5. REFERENCES

Wylie, D. P., and W. P. Menzel, 1999: Eight years of high cloud statistics using HIRS, *J. Climate*, **12**, 170-184.

____, _____, H. M. Woolf, and K. I. Strabala, 1994: Four years of global cirrus cloud statistics using HIRS, *J. Climate*, **7**, 1972-1986.

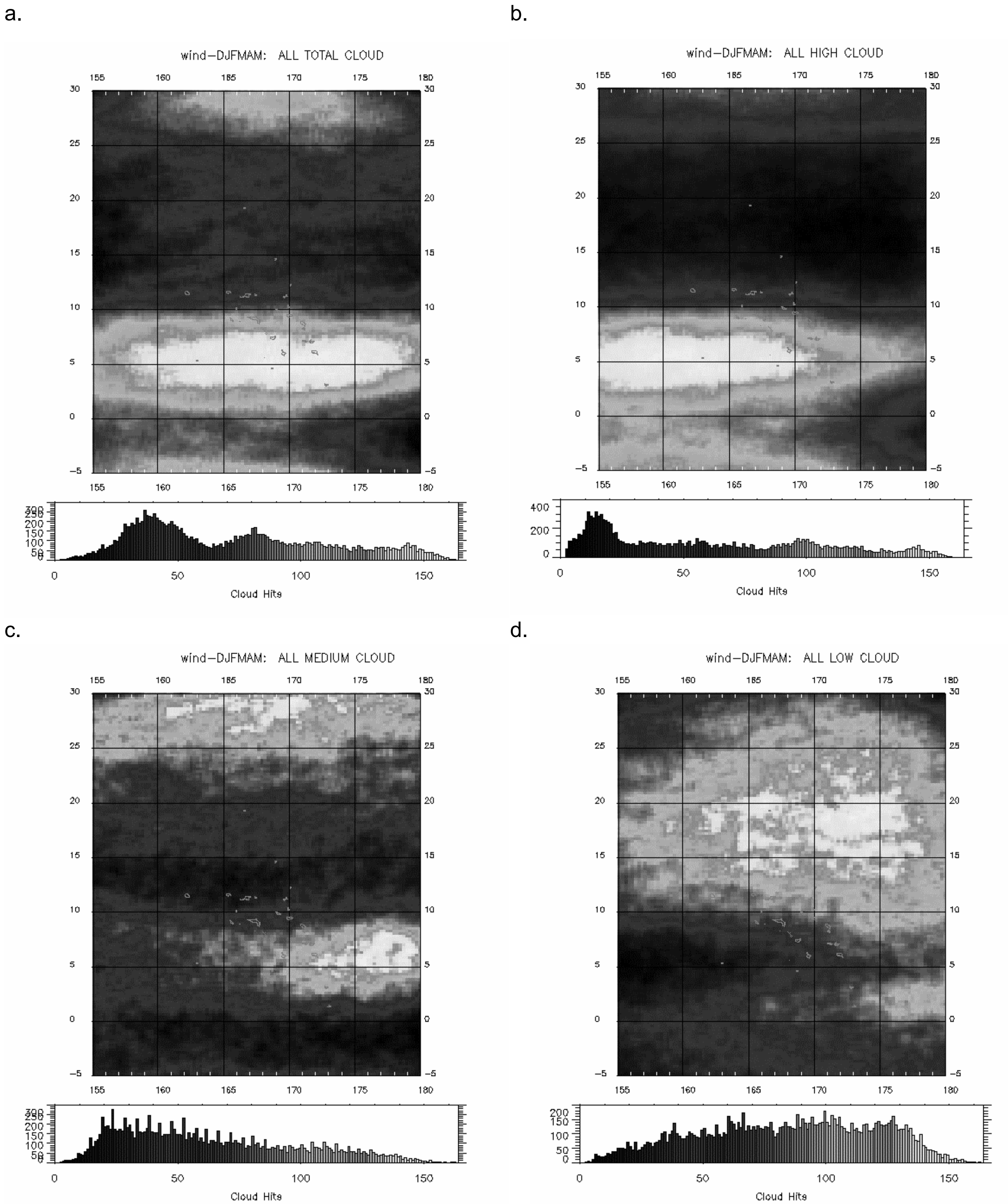

FIGURE 1: Plots of cloud counts for the high wind (DJFMAM) season with histograms of the number of ¼º by ¼º latitude-longitude bins with a particular number of cloud counts for a. all clouds, b. all high clouds (>400 hPa), c. all medium clouds (400 – 700 hPa), and d. all low clouds (<700 hPa).

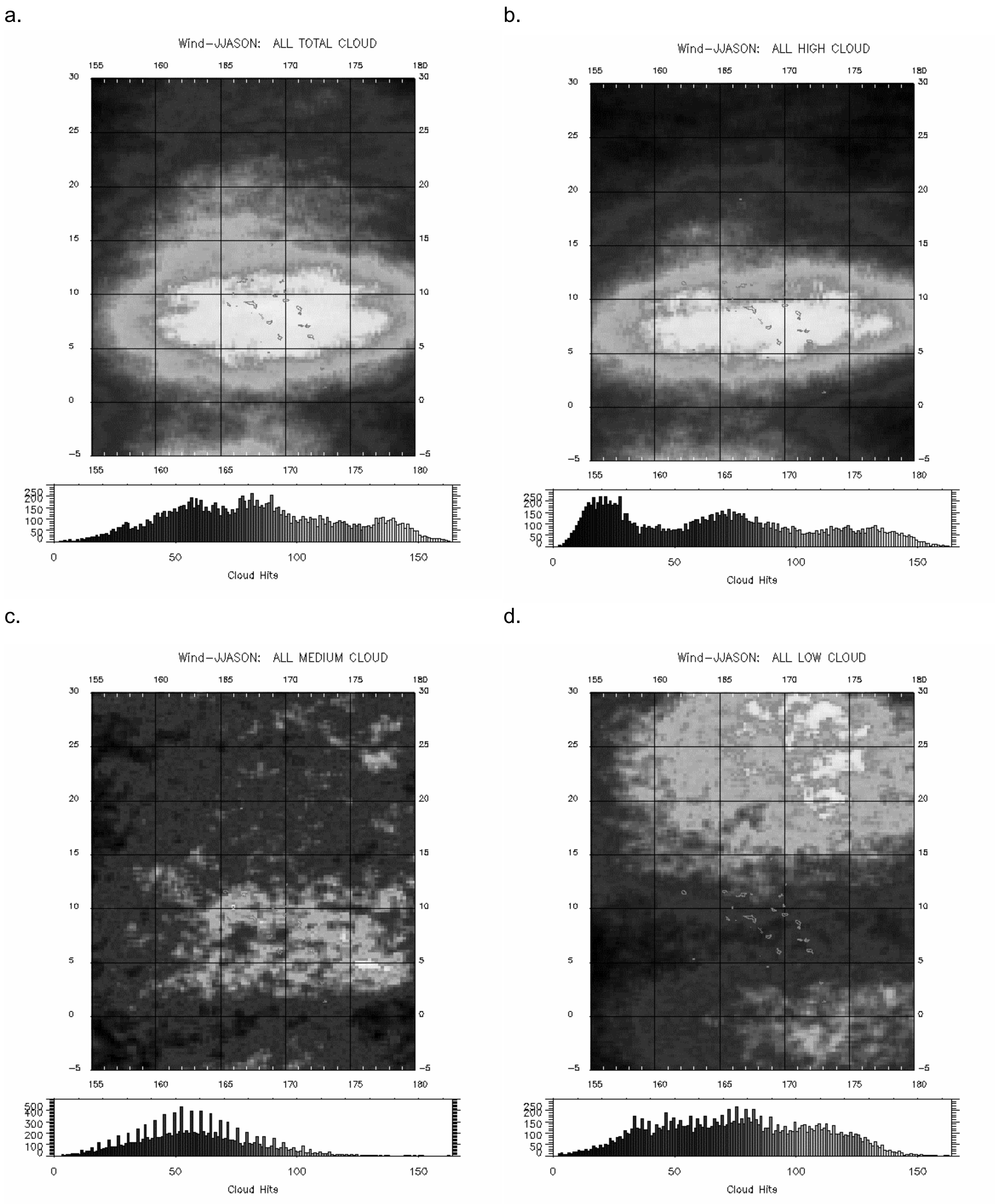

FIGURE 2: Same as Figure 1 except for the low wind (JJASON) season.