ARM Atmospheric Radiation Measurement

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Relating the TWP-ICE Period to Darwin Climatology

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Introduction

TWP-ICE ran from about mid-January through mid-February of 2006, during the monsoon season at Darwin. The TWP-ICE period can be divided into three general regimes encompassing an active "wet" monsoon, a "suppressed" monsoon, and a "break" period, based on factors such as winds aloft and synoptic situation. Note that traditionally the Darwin monsoon is divided into “active” and “break” periods only, e.g. Drosdowsky, 1996; Hendon and Liebmann, 1990, etc. The “suppressed monsoon” classification has been proposed by May et al. (2007) for the middle of the TWP-ICE period.

TWP-ICE Radiation/Cloud Characteristics

- Break phase exhibited clear-sky periods, Suppressed and Wet phases did not (Fig. 1)
- Wet phase was nearly continuously overcast (Fig.2)
- Suppressed phase relative shortwave cloud effect was < 0.5, Break phase < 0.3 (Fig.3)
- Wet phase RH > 80% (Fig.4)

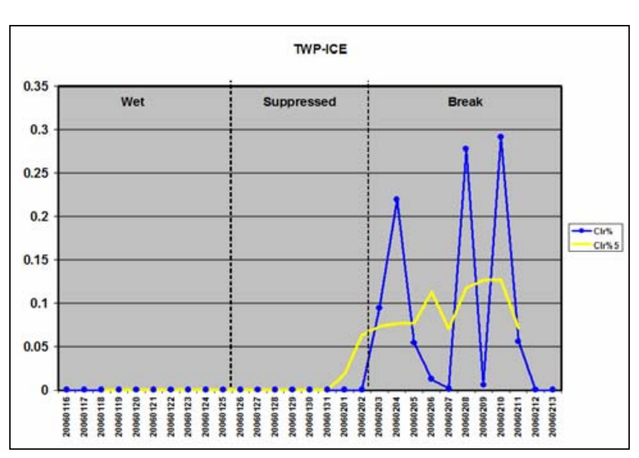

Figure 1: The ratio of detected clear-sky data over the corresponding total possible daylight data for each day of TWP-ICE (blue) and the corresponding running 5-day average (yellow).

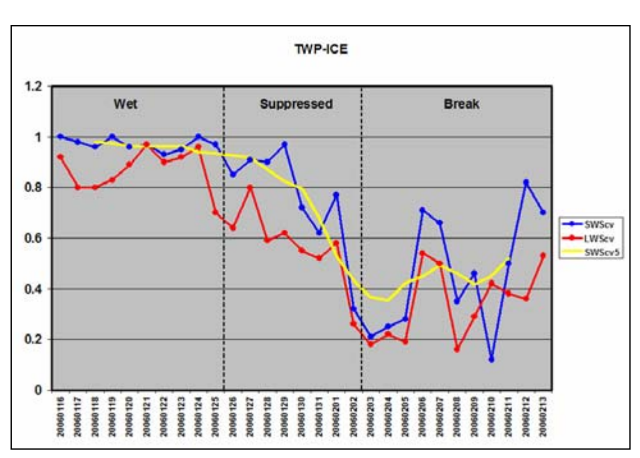

Figure 2: Daylight average total fractional sky cover (blue) and effective LW fractional sky cover (red) for TWP-ICE. Yellow represents a running 5-day average of the total sky cover.

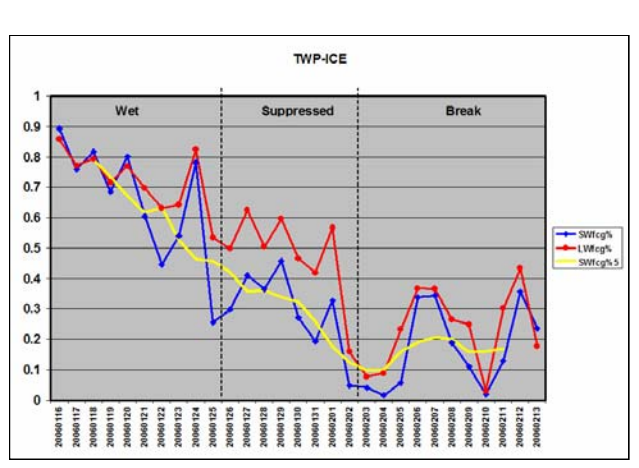

Figure 3: Daylight average SW (blue) and LW (red) net radiative cloud effect expressed as the absolute value of the difference between clear- and all-sky values divided by the net clear-sky irradiances for TWP-ICE. Yellow represents a running 5-day average of the SW cloud effect.

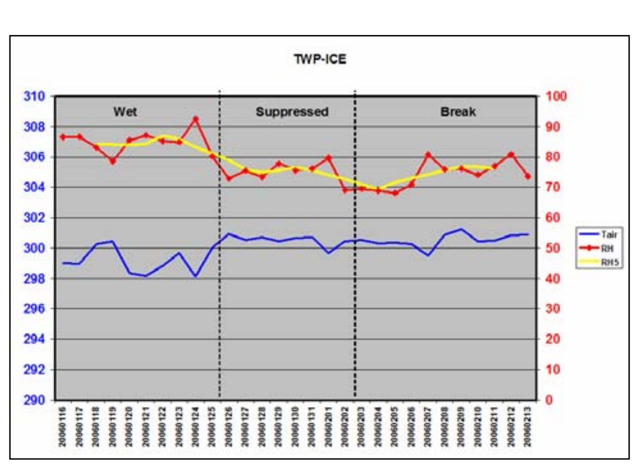

Figure 4: Daylight average 2-meter level air temperature (blue) and relative humidity (red) for TWP-ICE. Yellow represents a running 5-day average of the relative humidity.

For more details, see handout.

Classification of Darwin Record

Using the clear-sky detection of Long and Ackerman (2000), we define the “cloudy season” as those months where clear skies occur too infrequently for daily fitting and interpolation. The “cloudy periods” used in this study are 20021027 – 20030312 (P2), 20031101 – 20040323 (P3), 20041003 – 20050419 (P4), and 20050902 – 20060525 (P5). We then classify these periods by using a 5-day running analysis searching for the three sets of radiative/cloud characteristics derived from TWP-ICE (Table 1). While there is some correspondence between the three radiative/cloud classifications and zonal winds aloft (Fig. 5 shows the 2005-6 cloudy period), the exact relationship to more traditional monsoon classifications is the subject of further study.

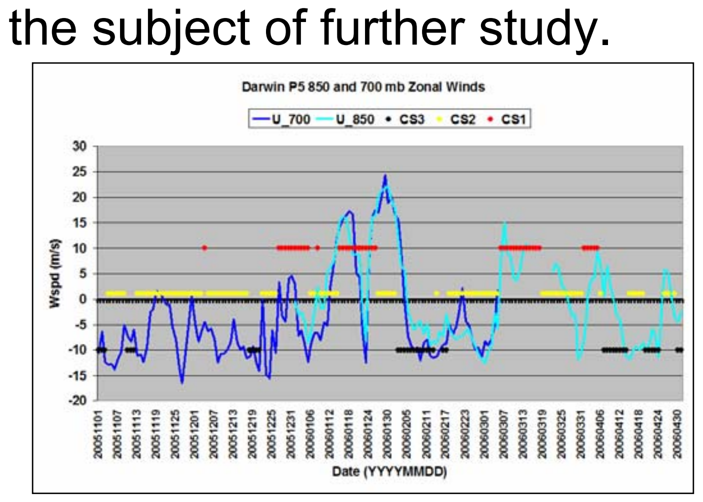

Figure 5: Daily average zonal winds aloft at Darwin and classification results from analysis of Flux Analysis data.

Table 1: Sets of 5-day running mean daylight average radiative/cloud characteristics used for classification of the long-term record.

Char.Set	Characteristics
CS1	Clear-sky % < 5% Total Sky Cover > 85% RH> 78%
CS2	Clear-sky % < 5% SW Cloud Effect < 50%
CS3	Clear-sky % > 5% SW Cloud Effect < 30%

Summary

Results show that the three sets of radiative/cloud characteristics that occurred during TWP-ICE do occur in the longer record, with similar diurnal characteristics. Some observed exceptions for TWP-ICE compared to the over-arching periods include:

- TWP-ICE daylight total sky cover is about 10-15% greater for CS2 data.
- TWP-ICE overcast sky cloud optical depths are greater in the mornings for CS1 data, and the all-sky cloud transmissivities are smaller.
- TWP-ICE exhibited anomalous frequent occurrence of positive SW cloud effect, and lack of occurrence of negative SW cloud effect, for the 1100-1130 LST time periods for the 11 days of the Break data resulting in a slightly positive total net cloud effect for these times.
- TWP-ICE Suppressed phase exhibits about twice the magnitude of 10 meter wind speeds as CS2 data, due to the influence of “Landphoon John.”

References:

Drosdowsky, W. (1996): Variability of the Australian Summer Monsoon at Darwin: 1957-1992, JOC, 9, 85-96.

Hendon H.H. and B. Liebmann (1990): The Intraseasonal (30-50 day) Oscillation of the Australian Summer Monsoon, JAS, 47,2909-2923.

Long, C. N. and T. P. Ackerman, (2000): Identification of Clear Skies from Broadband Pyranometer Measurements and Calculation of Downwelling Shortwave Cloud Effects, JGR, 105, No. D12, 15609-15626.

May, P., J. H. Mather, G. Vaughan, C. Jakob, G. M. McFarquhar, K. N. Bower, and G. G. Mace (2007): The Tropical Warm Pool International Cloud Experiment (TWP ICE), BAMS, submitted.

Selected Analysis Results

To compare the TWP-ICE data to the longer-term climatological data, we calculate mean diurnal cycles for the four “cloudy seasons” and the TWP-ICE period, composited by the three radiative/cloud classifications. Our study shows that the TWP-ICE data fall within typical values for many of the surface-derived variables. Details of the complete analyses are given in the handout. Some selected results where there are differences in the TWP-ICE data include:

CS2 Sky Cover

- P4 shows lowest values, esp. afternoon
- P2&3 and TWP-ICE sky cover about constant across the day
- TWP-ICE about 10-15% higher

CS1 Cloud Optical Depth

- TWP-ICE and P4 greater in morning than afternoon
- P2 and P3 greater in afternoon
- P5 roughly same all day

CS3 Net SW Cloud Effect

- TWP-ICE anomaly from 1100-1130 LST
- Caused by Frequent positive cloud effect, little negative cloud effect for these 11 days.

CS2 10 m Wind Speed

- Periods 2-5 show max wind in afternoon, min near sunrise
- TWP-ICE Wspd about double
- Associated with “Landphoon John”

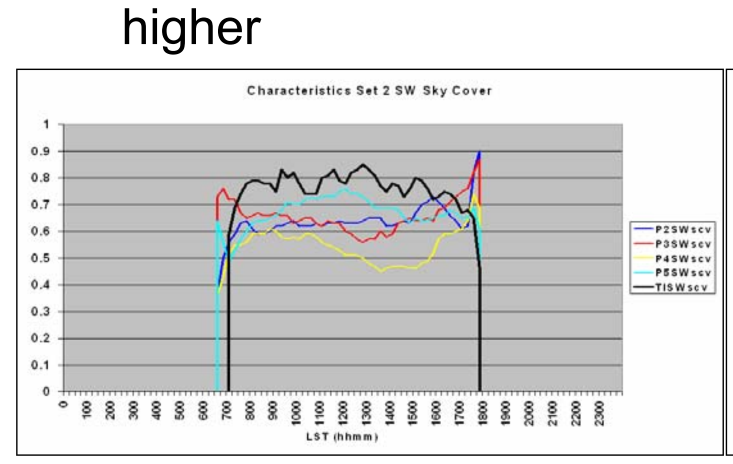

Figure 6: Daylight total sky cover for CS2 data for Periods 2 (blue), 3 (red), 4 (yellow), 5 (light blue) and TWP-ICE (black).

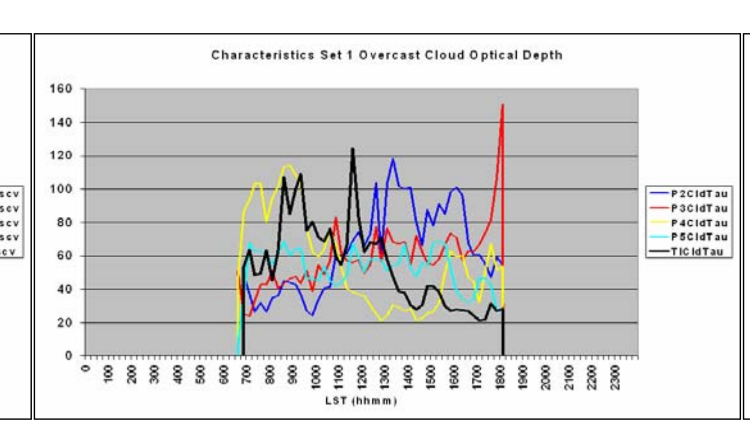

Figure 7: Similar to Figure 6, but for daylight overcast cloud optical depths for CS1 data.

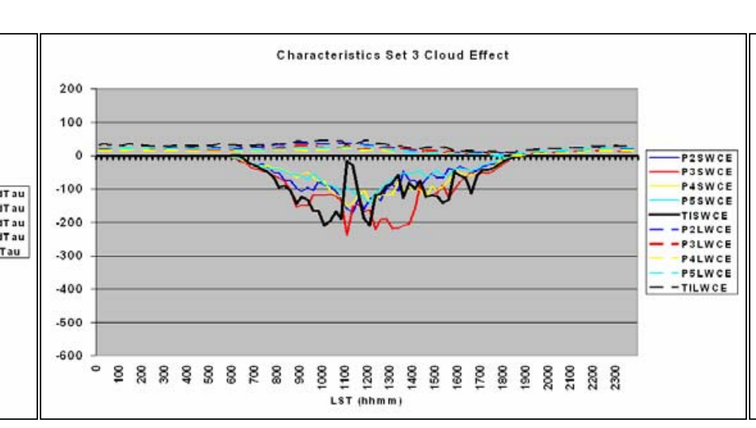

Figure 8: Similar to Figure 6, but for net SW (solid) and net LW (dashed) cloud effect for CS3 data.

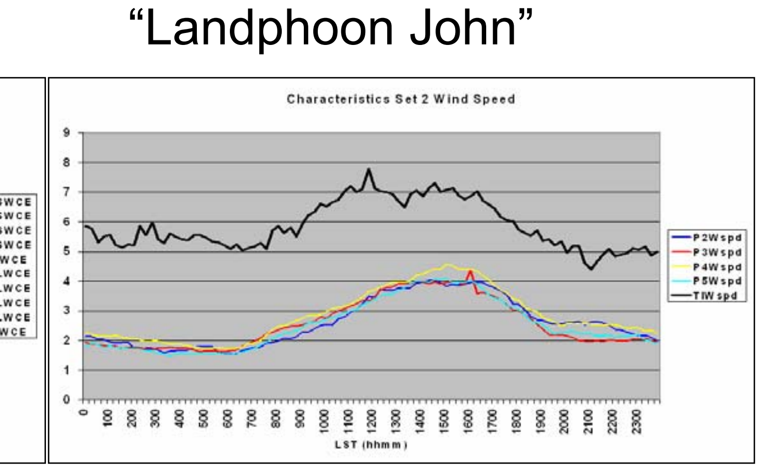

Figure 9: Similar to Figure 6, but for 10 meter wind speeds for CS2 data.