Measurements of diffuse radiation during METCRAX

During METCRAX, diffuse radiation was measured with LICOR photodiodes under shadow-bands at the crater rim and the crater floor. The two instruments used were PY10385 and PY7122.

The instruments were sent to the manufacturer for recalibration after the field deployment. This recalibration was performed after the diffusor of PY7122 was replaced, as it had been scratched. We thus have no valid recalibration of the sensor as it was deployed in the field and need to determine this coefficient from data collected during METCRAX.

The calibration coefficients used in the field (programmed in the datalogging system), the post-experimental recalibration values, and coefficients determined from observations and comparisons during the field campaign (field calibration) are shown in Table 1.

Table 1: Calibration coefficients for the two LICOR photodiodes, in units of [W m^{-2} mV^{-1}]

Serial Number	Site	Coefficients from 2/11/97 (used in loggers)	Recalibrations (post experimental)	Field calibration
PY10385	Floor	-103.8776	-104.336213	-165.3
PY7122	Rim	-134.9660	-104.336213 (new diffusor)	-125.0

The calibration history of the two LICORs has been summarized by Steve Semmer. Past calibrations for LICOR PY7122 date back to 1988. The calibrations ranged from -142.914 W m^{-2} mV^{-1} (1/12/90) to -133.912 W m^{-2} mV^{-1} (8/3/94). The last calibration, -134.966 W m^{-2} mV^{-1}, took place on 2/11/97. The average of the 4 calibrations dating from 1988 to 1997 was -137.846 W m^{-2} mV^{-1}.

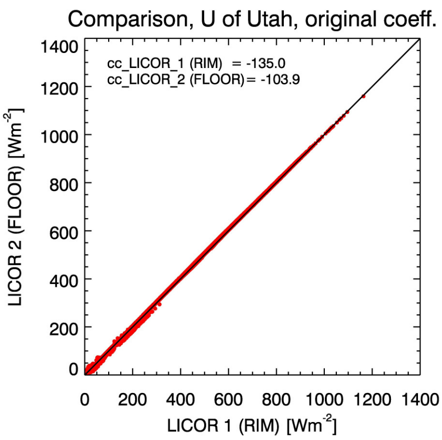

Figure 1: Comparison of LICORs PY7122 and PY10385 at the University of Utah prior to the METCRAX field program.

Prior to the METCRAX field observation, the two LICORs were compared at the University of Utah. A good agreement between the two sensors was found using the most recent calibration coefficient that were later used in the loggers during METCRAX (Figure 1).

Usually, corrections are applied when shadow-bands (instead of shading discs) are used, as they inevitably block a certain amount of the diffuse radiation from the sky. Thus, the use of observational data (collected under the shadow band) may be used to account for the shadow-band effects. Diffuse and global fluxes should be identical when direct radiation is zero, either due to thick clouds or due to a high zenith angle and shading of the observation site by topography.

First we examined observations collected during high zenith angles and shading of the crater floor site. From this data, we obtain a coefficient of for PY10385 of -165.3 W m^{-2} mV^{-1} (Figure 2). This calibration coefficient includes the influence of the shadow-band, and thus differs from previous calibrations when the instrument was used to observe global radiation.

From the comparison measurements of the two LICORs on the roof of the Meteorology Department of the University of Utah, we can infer the coefficient for PY7122. A value of -215.8 W m^{-2} mV^{-1} results (Figure 3). This value includes the effects of a shadow-band.

Plotting all diffuse and global radiation data collected at the rim site during METCRAX, and using this coefficient for PY7122 (Figure 4), we see that this coefficient can not be suitable. Diffuse radiation may not exceed global radiation - the probable cause being the scratching of the LICOR diffusor **prior** to the experiment and **after** the pre-experimental comparisons at the University of Utah.

Thus, we need to estimate a suitable calibration coefficient for PY7122 from the data collected during the METCRAX field campaign. We find such a coefficient by adjusting it to a point where the scatter-plot of global radiation versus diffuse radiation at the rim site looks similar to the same plot using the data collected at the floor site (Figure 5). This is a best guess, thus it is difficult to judge the accuracy of the measurements. Uncertainties are already introduced by the calibration of the LICOR against the pyranometer monitoring global radiation at the floor site: Here the standard deviation of the differences between the instruments amounted to ±4.5 Wm^{-2} (Figure 6).

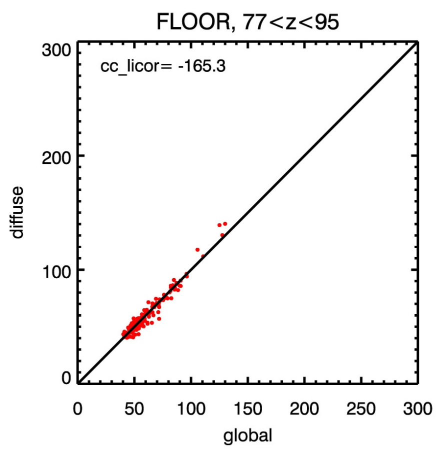

Figure 2: Calibration of LICOR PY10385 against the pyranometer at the floor site, during high solar zenith angles.

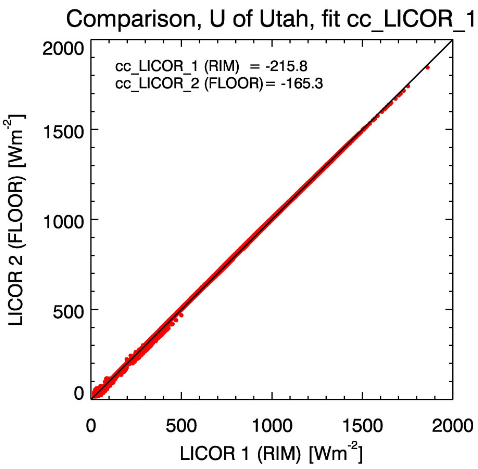

Figure 3: Calibration of LICOR PY7122 against the PY10385 from data collected prior the field program at the University of Utah.

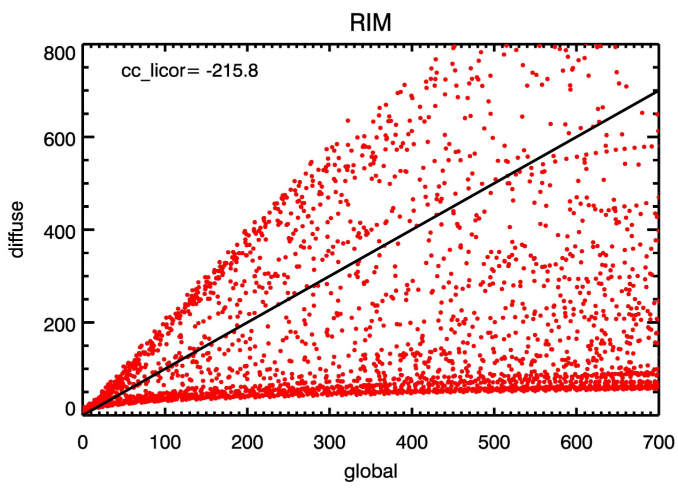

Figure 4: Scatter-plot showing the failure of the calibration coefficient determined with data collected prior the experiment. Diffuse radiation may not exceed global radiation.

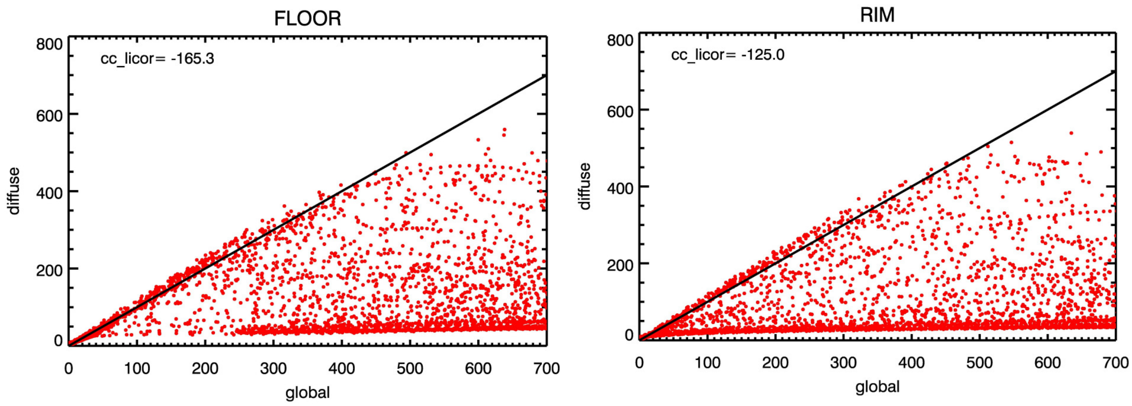

Figure 5: Scatter-plot of diffuse versus global radiation at the crater floor site (left panel) and the corresponding plot for the rim site (right panel). The calibration coefficient for the LICOR used at the rim site was adjusted in order to obtain a comparable plot.

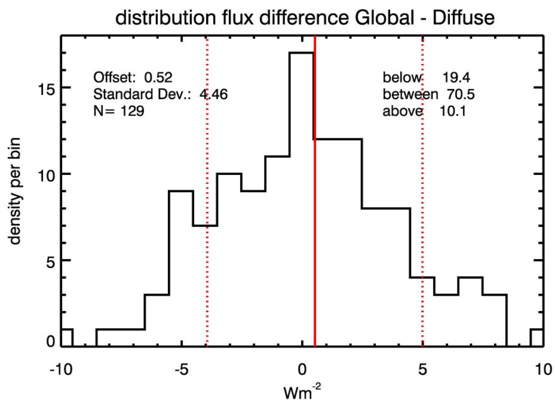

Figure 6: Flux difference distribution after the relative calibration of LICOR PY10385 against the pyranometer at the floor site, during high solar zenith angles. Offset, standard deviation are in units of Wm^{-2}. Vertical lines mark the mean (solid) and ± one standard deviation (dotted).

The resulting values of diffuse radiation must be considered “better” than the ones determined using the old coefficients, as they include the effects of the shadow-bands and the scratched diffusor. Figure 6 shows the diurnal cycle of diffuse radiation at the crater rim and floor for the clear sky day of 21 October 2006, calculated with both sets of coefficients. The differences are fundamental: The old coefficients indicate a higher diffuse radiation at the crater rim throughout the day, while the field coefficients lead to the conclusion that diffuse radiation is enhanced in the crater basin due to reflections from the crater sidewalls – a result that was expected to be seen.

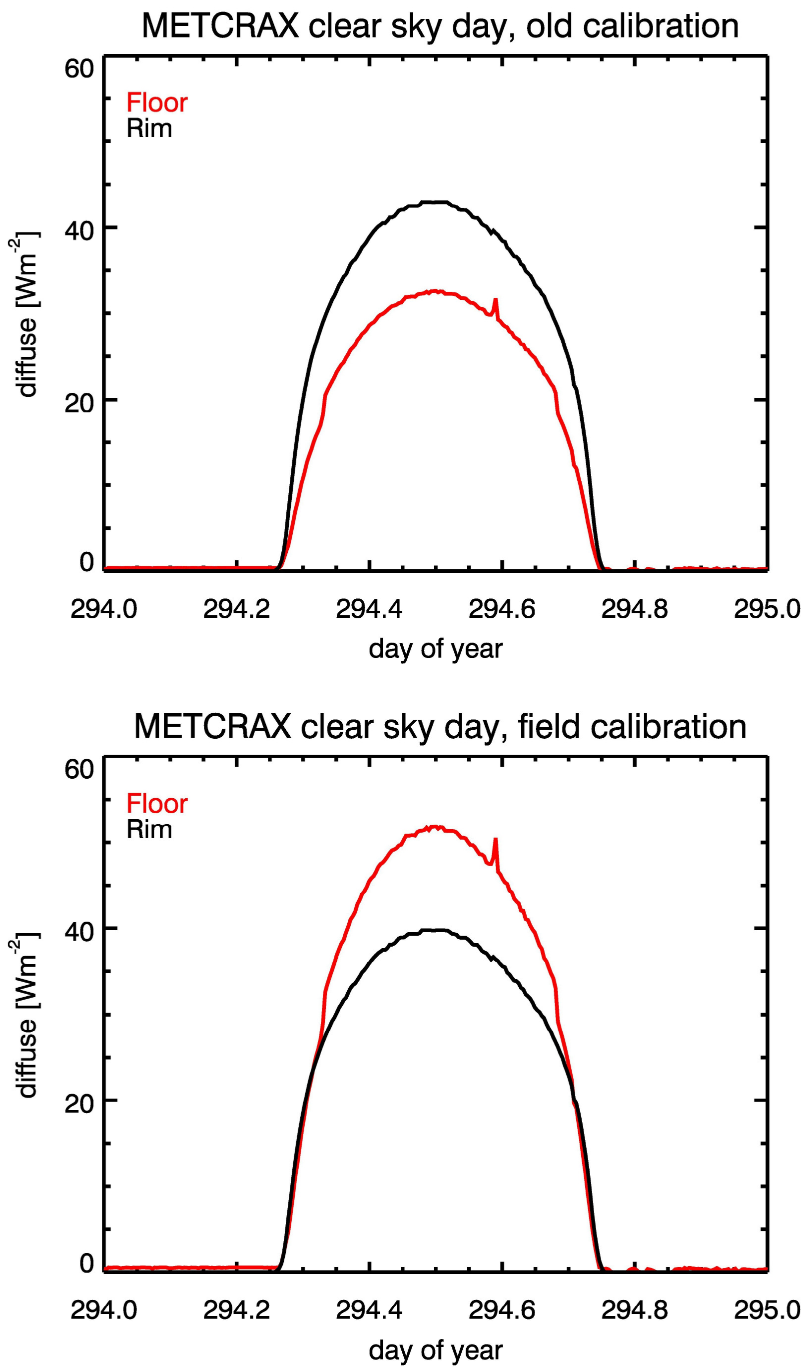

Figure 7: An example diurnal cycle (21 October 2006) of diffuse radiation at the crater rim and crater floor sites during METCRAX, calculated with the original coefficients (top panel) and with the 'field calibration' coefficients (bottom panel).