

# **Azimuthal LW Flux Dependence from CERES/Terra Along-Track Data**

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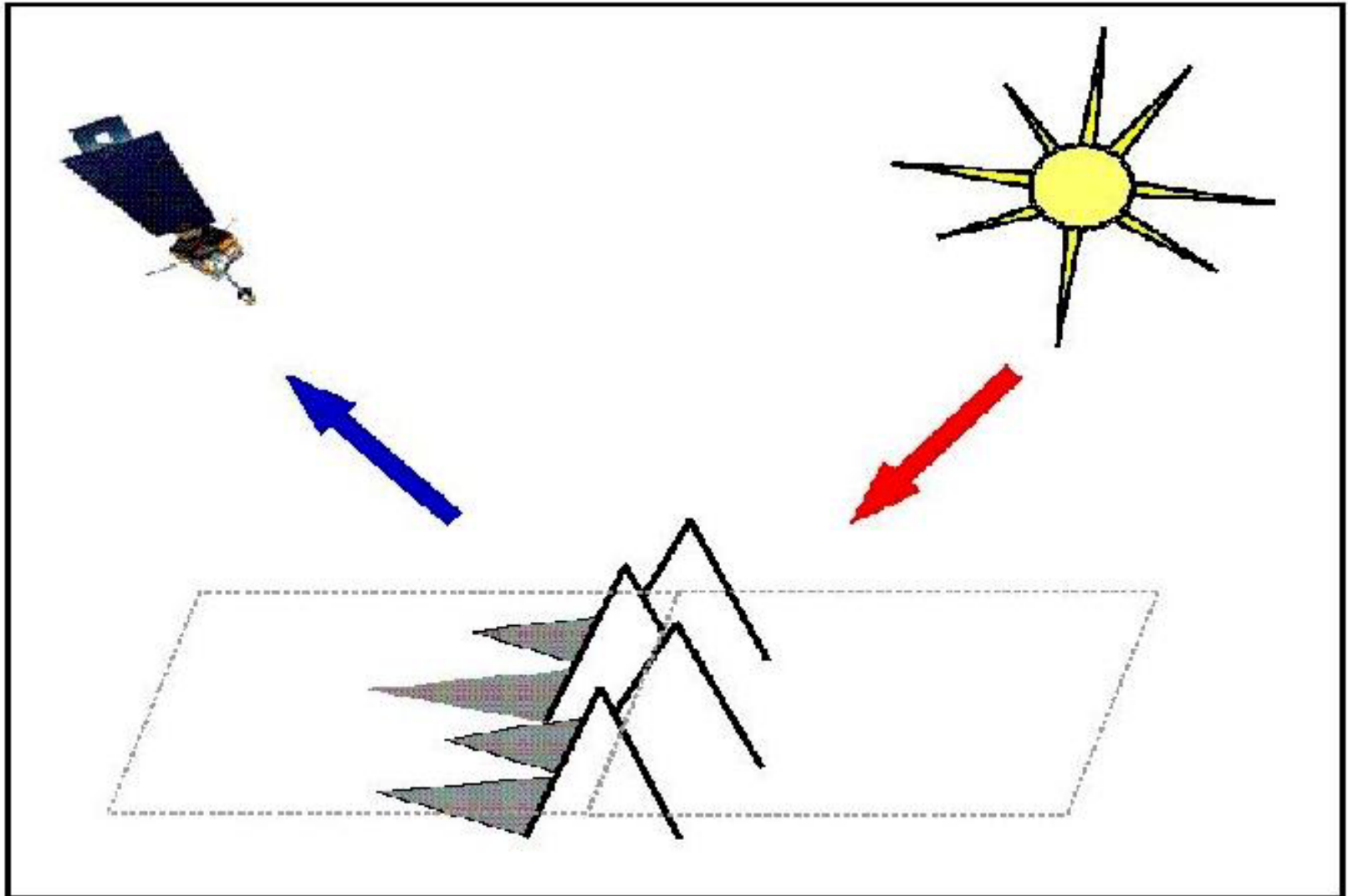
SAIC, Hampton, VA

**N.G. Loeb**

Hampton University, Hampton, VA

CERES-II Science Team Meeting, March 2004

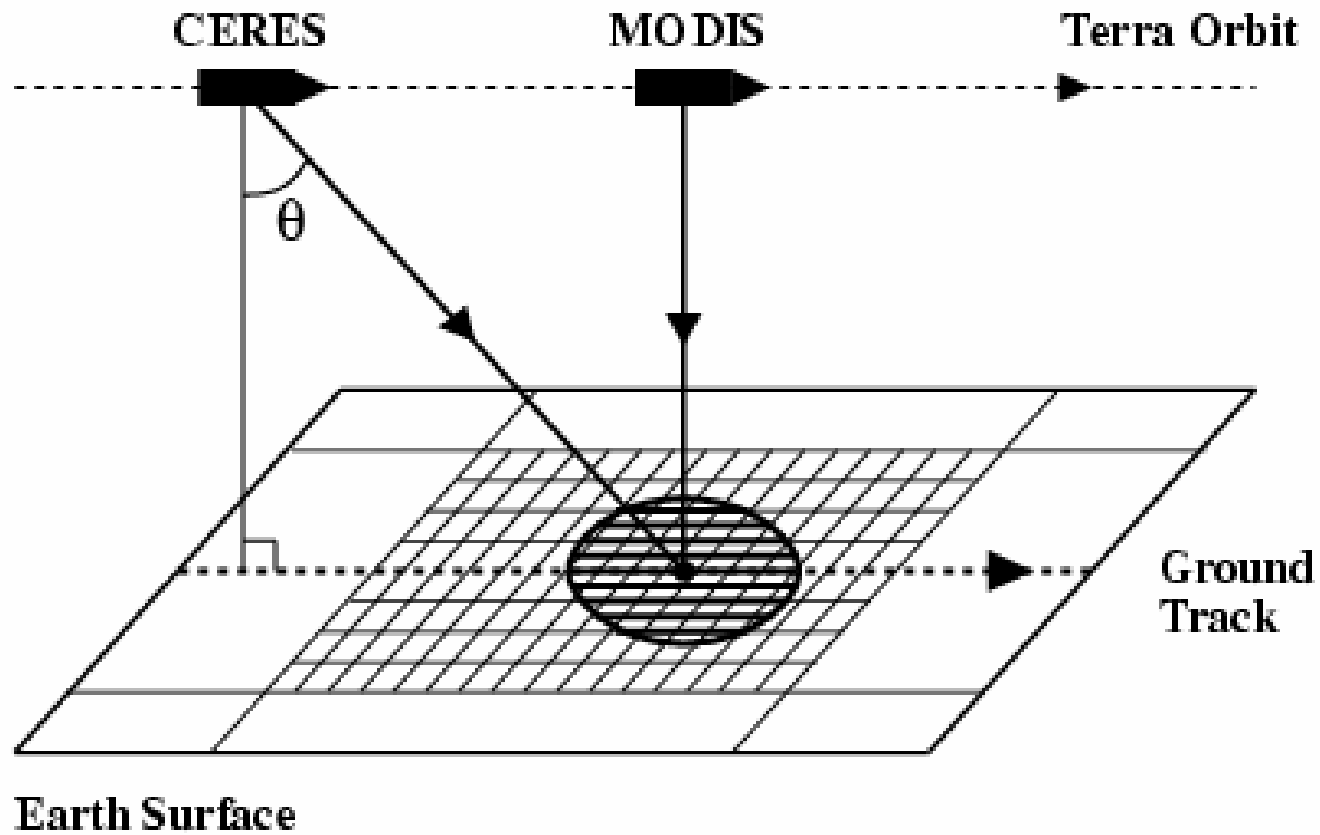
# THEME OF STUDY



Forward scatter  
Colder temperature measured

Back scatter  
Warmer temperature measured

# Along-Track Data Analysis: CERES and MODIS Geometry

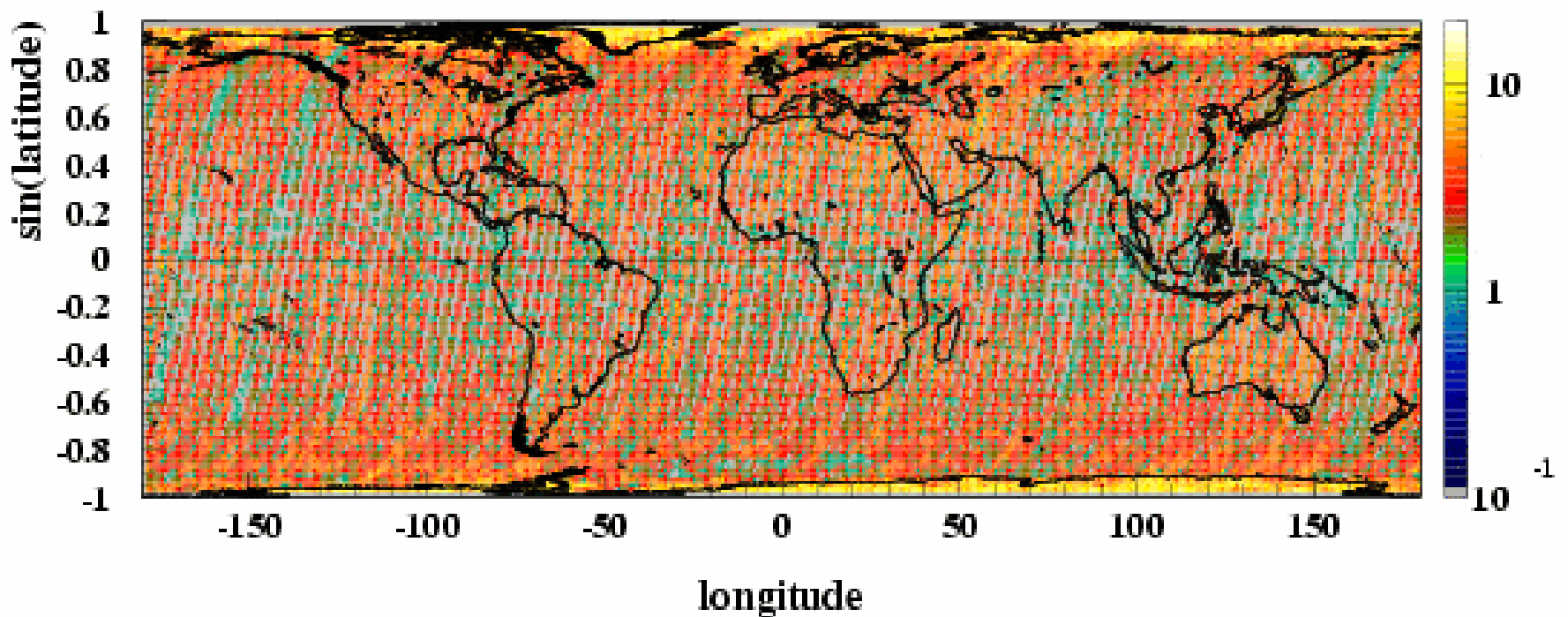


# Method Outline

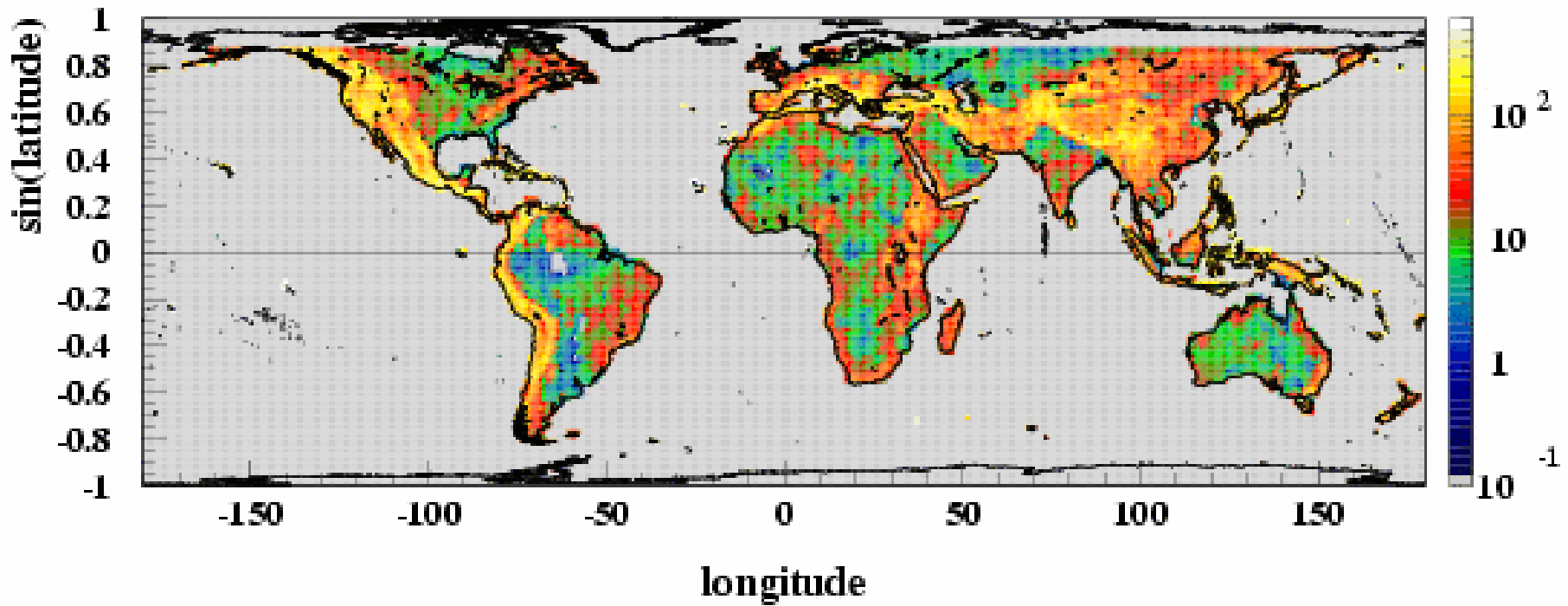
- ➡ **Narrow-to-broadband conversion for regions using FAPS data,  $VZA < 10^\circ$ . Geo-resolution:  $1^\circ$  in longitude and 0.02 in  $\sin(\text{latitude})$ .**
- ➡ **Application of the narrow-to-broadband conversion to MODIS radiance w/  $STD(\text{fit}) < 1\%$ , along-track data, FOV-level analysis: selecting FOVs w/  $VZA$  difference from  $50^\circ$  to  $60^\circ$ .**
- ➡ **Scene type: IGBP from 1 to 16, except IGBP 11 (permanent wetlands), 13 (urban areas) and 15 (permanent snow and ice). Snow cover = 0%, Latitude:  $60^\circ$  North to  $60^\circ$  South.**

# Region Sampling: Total

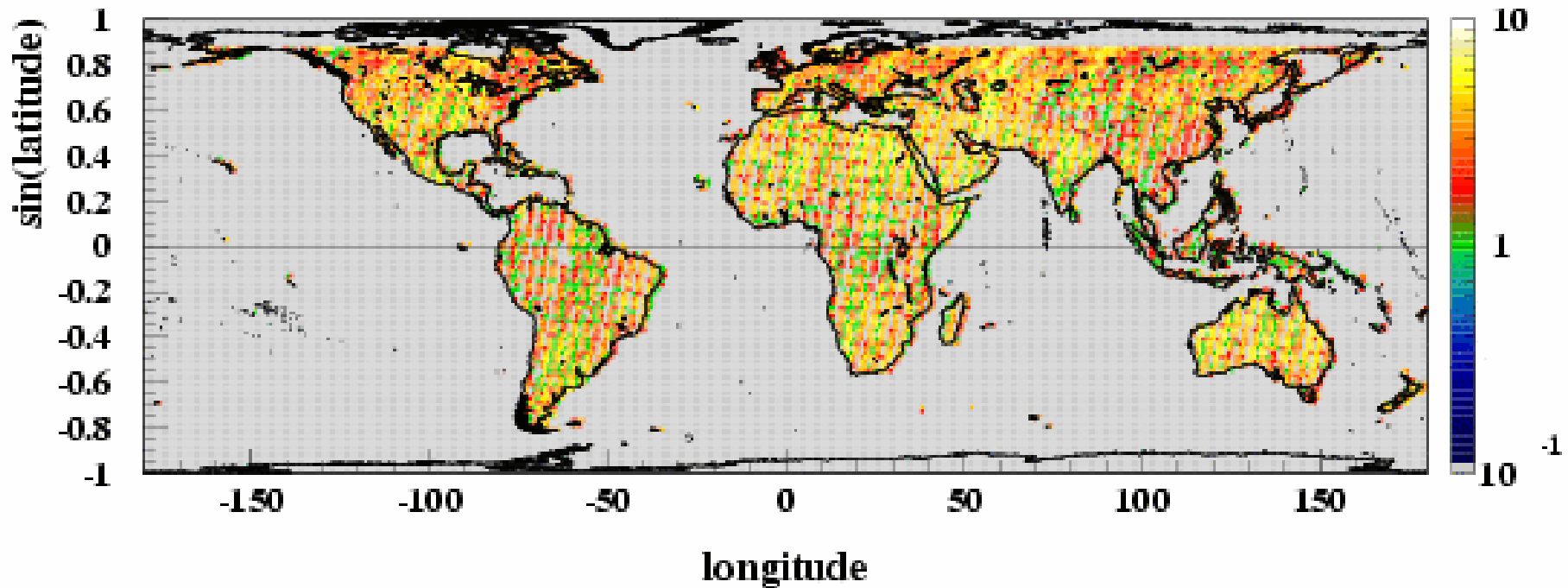
(48 days of along-track data, SSF Edition-2A)



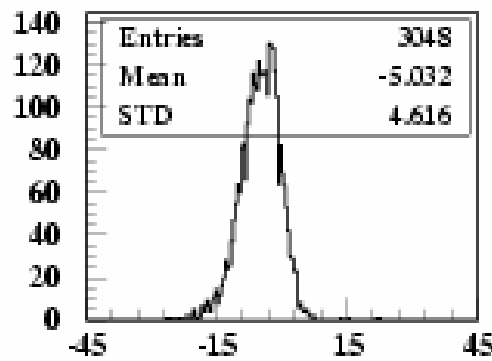
# Relative Surface Variability: STD(alt) (%) (consistent with *Minnis et al.*)



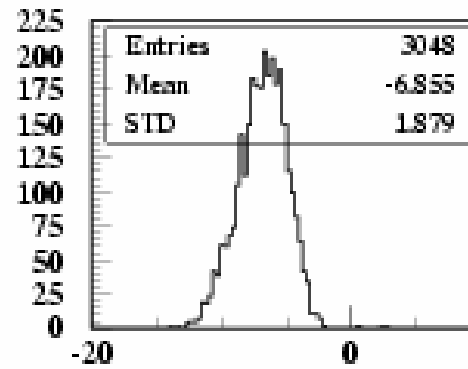
**Region Sampling: STD(alt) > 0%**  
(48 days of along-track data, SSF Edition-2A)



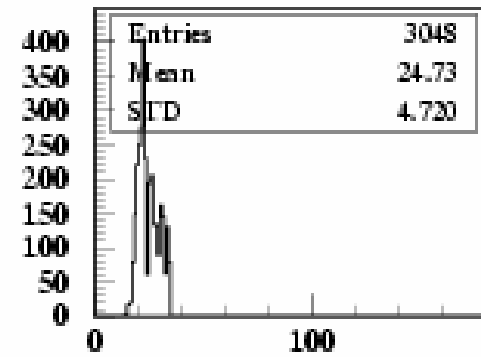
**Clr. Land 1a:**  $15\% < \text{STD}(\text{alt}) < 30\%$ ;  
 $VZA = 60^\circ$ ;  $SZA > 50^\circ$ .



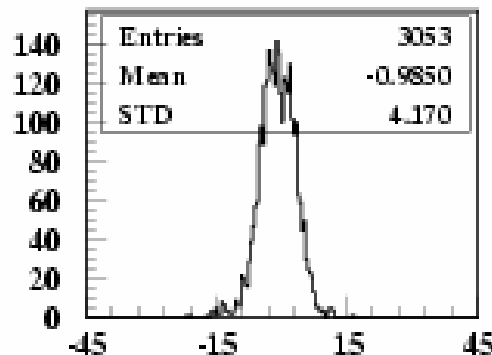
**F: Fc - Fm**



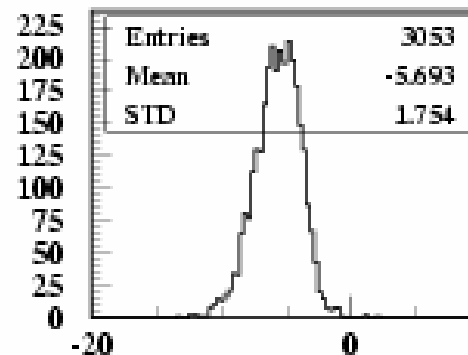
**F: Rc - Rm**



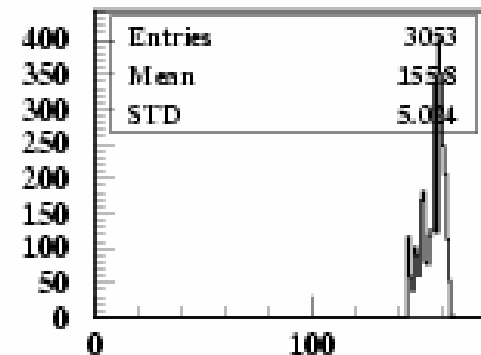
**F: raz**



**B: Fc - Fm**



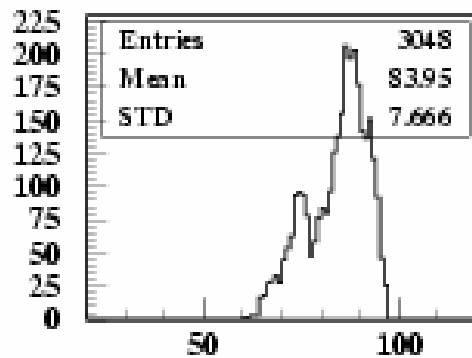
**B: Rc - Rm**



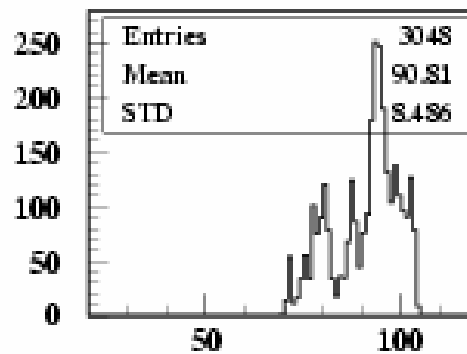
**B: raz**



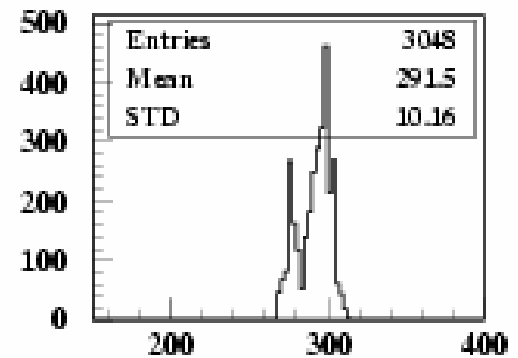
**Clr. Land 1b:  $15\% < \text{STD}(\text{alt}) < 30\%$ ;  
 $VZA = 60^\circ$ ;  $SZA > 50^\circ$ .**



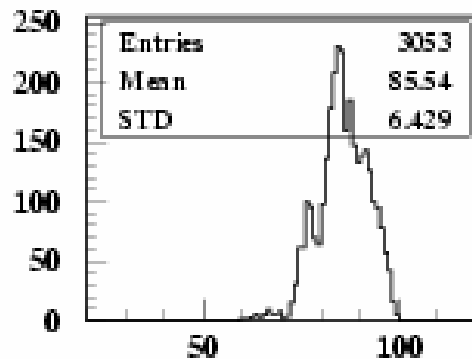
**F: Rc**



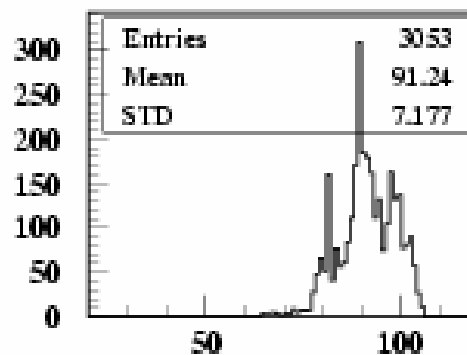
**F: Rm**



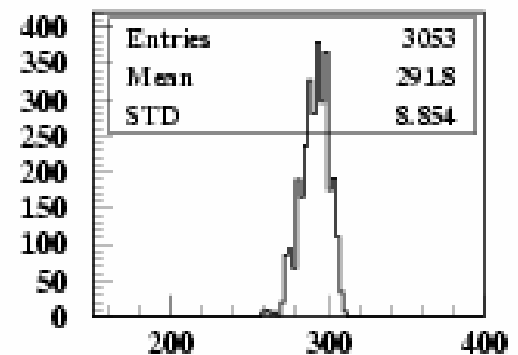
**F: Ts**



**B: Rc**

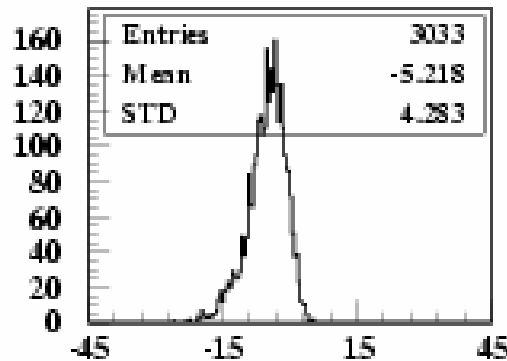


**B: Rm**

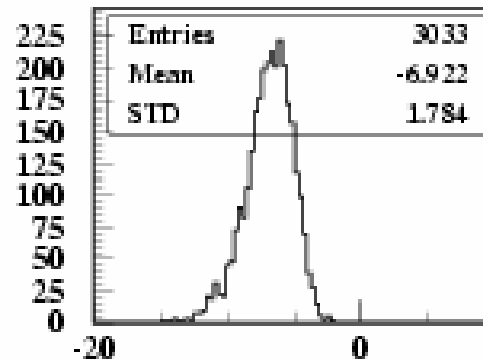


**B: Ts**

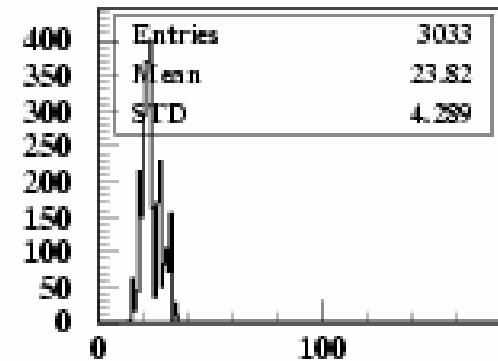
**Clr. Land 2a:  $30\% < \text{STD}(\text{alt}) < 50\%$ ;  
 $VZA = 60^\circ$ ;  $SZA > 50^\circ$ .**



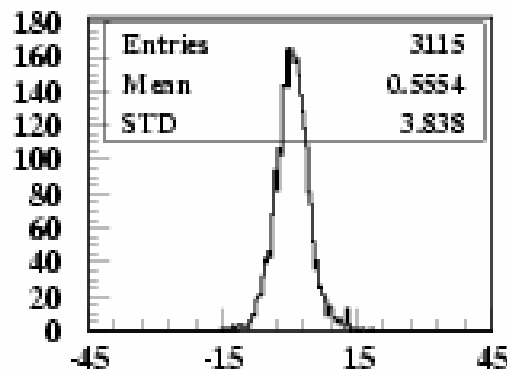
**F: Fc - Fm**



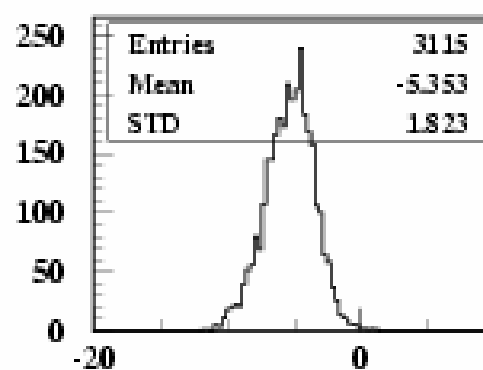
**F: Rc - Rm**



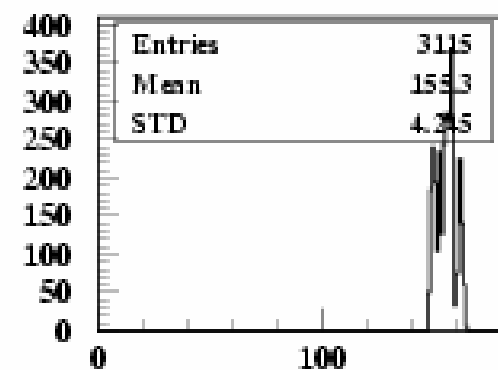
**F: raz**



**B: Fc - Fm**

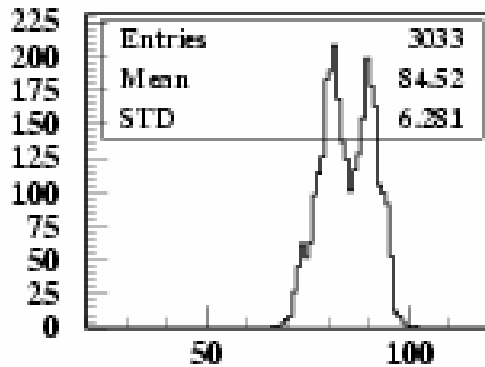


**B: Rc - Rm**

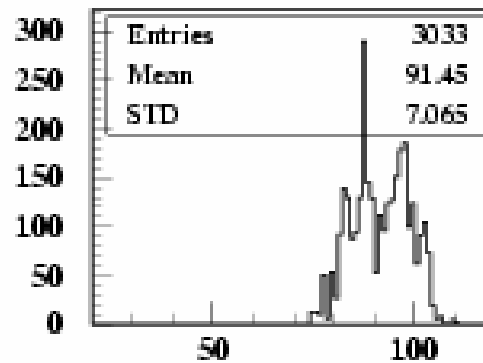


**B: raz**

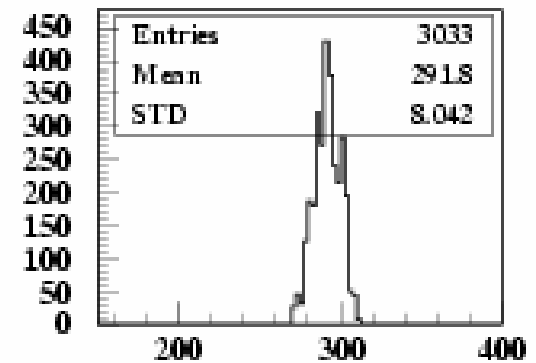
**Clr. Land 2b:  $30\% < \text{STD}(\text{alt}) < 50\%$ ;  
 $VZA = 60^\circ$ ;  $SZA > 50^\circ$ .**



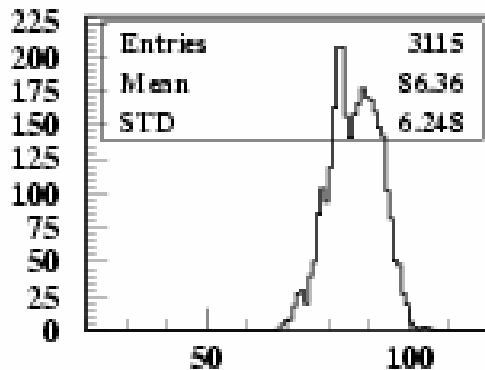
F: Rc



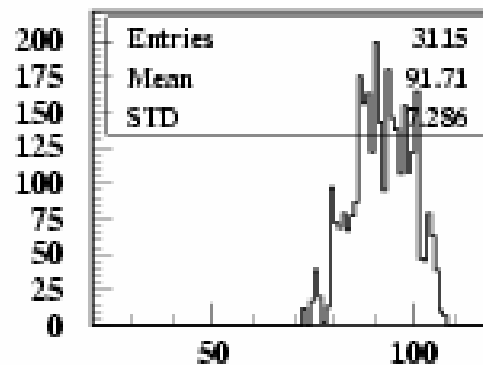
F: Rm



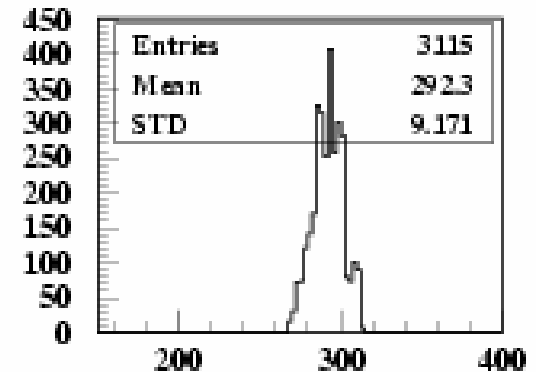
F: Ts



B: Rc

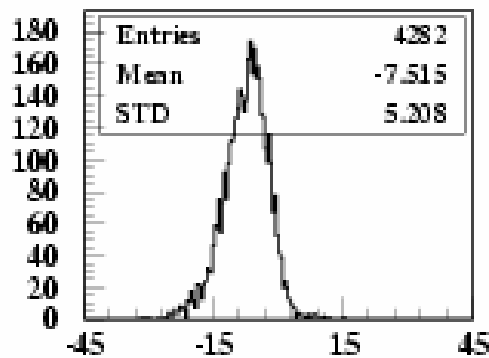


B: Rm

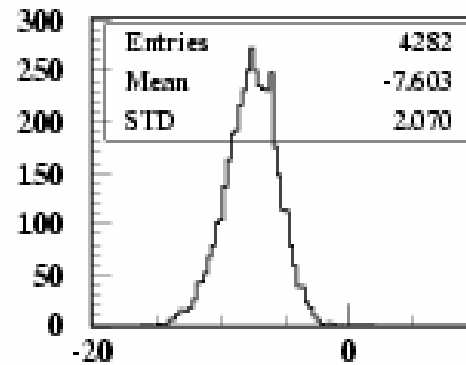


B: Ts

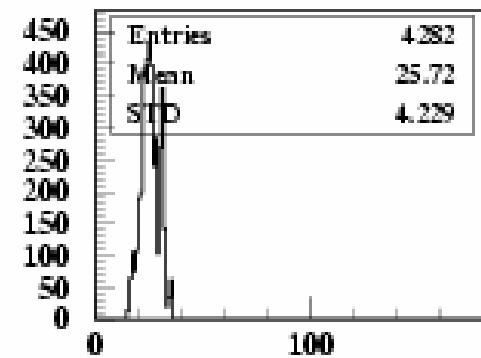
**Clr. Land 3a: STD(alt) > 50%,  
VZA = 60°; SZA > 50°.**



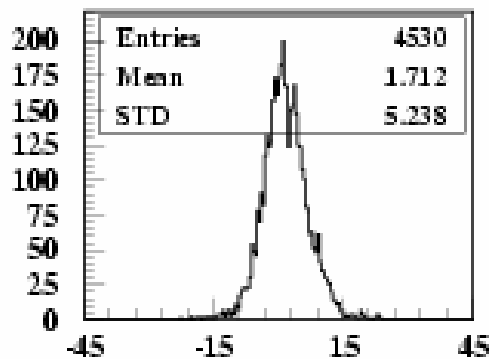
**F: Fc - Fm**



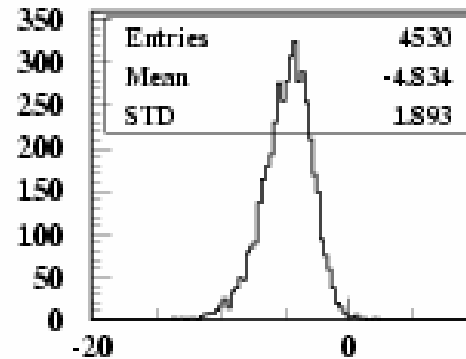
**F: Rc - Rm**



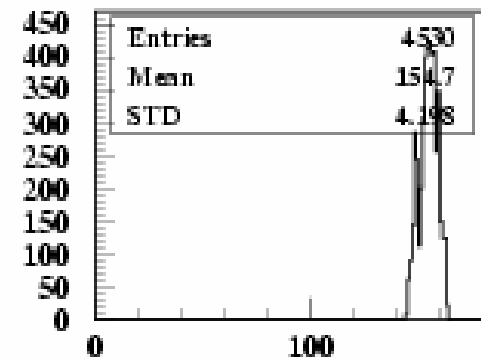
**F: raz**



**B: Fc - Fm**

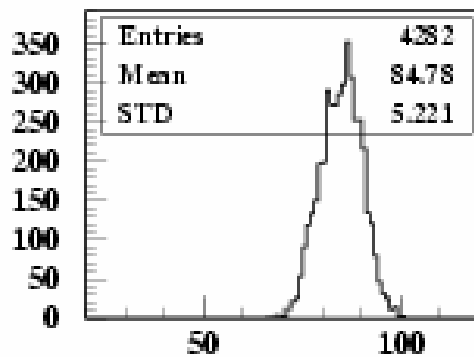


**B: Rc - Rm**

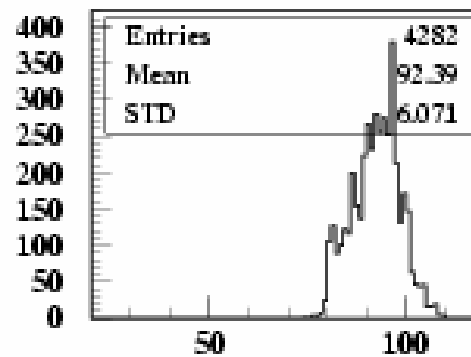


**B: raz**

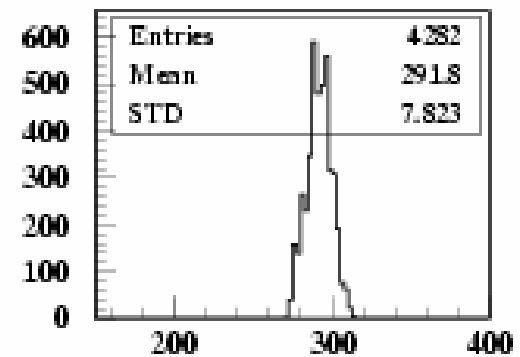
**Clr. Land 3b:  $STD(alt) > 50\%$ ,  
 $VZA = 60^\circ$ ;  $SZA > 50^\circ$ .**



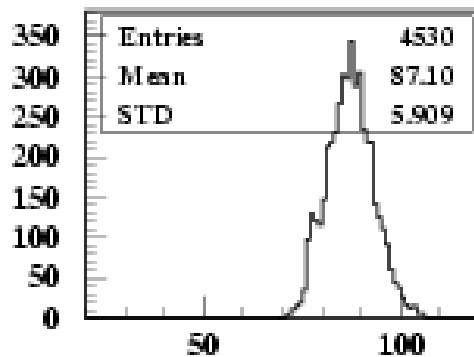
**F: Rc**



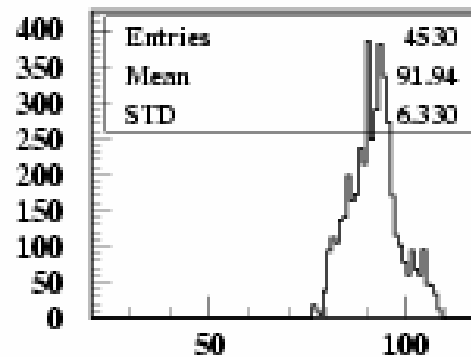
**F: Rm**



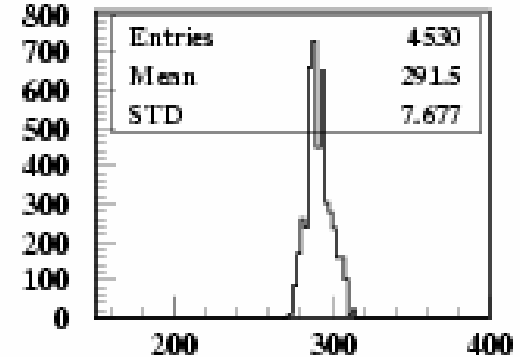
**F: Ts**



**B: Rc**

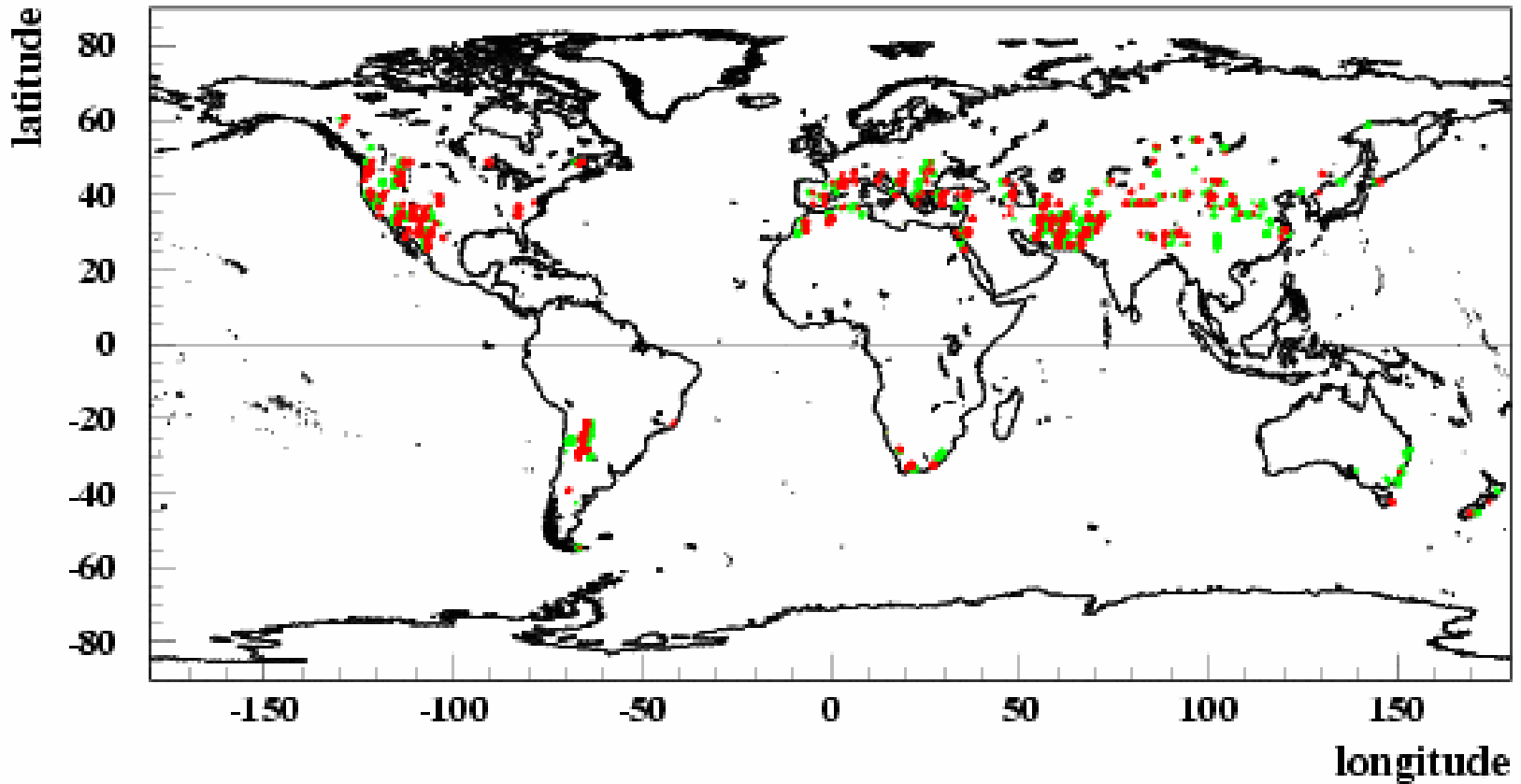


**B: Rm**



**B: Ts**

**STD(alt) > 50%: Location of Selected FOVs**  
(red - forward, green - backscattering)



**Difference in Radiance,  
RAZ effect on LW Flux  
Cloud Cover < 1%**

<b>STD(alt) Range (%)</b>	<b>Rc(F) – Rc(B) (Wm<sup>-2</sup>sr<sup>-1</sup>)</b>	<b>Rm(F) – Rm(B) (Wm<sup>-2</sup>sr<sup>-1</sup>)</b>	<b>LW FLUX (Wm<sup>-2</sup>)</b>
<b>15 - 30</b>	<b>-1.59</b>	<b>-0.43</b>	<b>-4.05</b>
<b>30 - 50</b>	<b>-1.84</b>	<b>-0.26</b>	<b>-5.77</b>
<b>&gt; 50</b>	<b>-2.32</b>	<b>0.45</b>	<b>-9.23</b>
<b>0.0 (CLR.OCEAN)</b>	<b>0.04</b>	<b>0.05</b>	<b>-0.13</b>

**Difference in Radiance,  
RAZ effect on LW Flux  
1% < Cld. Cover < 50%**

<b>STD(alt) Range (%)</b>	<b>Rc(F) – Rc(B) (Wm<sup>-2</sup>sr<sup>-1</sup>)</b>	<b>Rm(F) – Rm(B) (Wm<sup>-2</sup>sr<sup>-1</sup>)</b>	<b>LW FLUX (Wm<sup>-2</sup>)</b>
<b>15 - 30</b>	<b>No consistent effect</b>		
<b>30 - 50</b>	<b>-0.83</b>	<b>0.26</b>	<b>-3.53</b>
<b>&gt; 50</b>	<b>-2.43</b>	<b>-0.11</b>	<b>-7.37</b>
<b>0.0 (PC. OCEAN)</b>	<b>0.62</b>	<b>0.83</b>	<b>-0.48</b>



# Corrections

- ➡ **Land: All IGBP types together.**
- ➡ **Simultaneous sampling of a region with both forward and backscattering viewing geometry.**
- ➡ **For given angular bin:**

$$\text{Delta} = F(\text{vza}) - F(\text{nadir})$$

**F(vza), F(nadir) & Delta are mean values  
(48 days of along-track data).**

- ➡ **Application (instantaneous):**

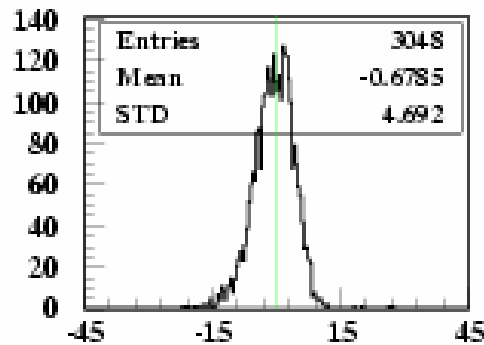
$$F(\text{new}) = F(\text{original}) - \text{Delta}$$

# RAZ Correction Bins

Index	Variable	N Bins	Bin Width
1	IGBP	2 (stat ?)	7, 10 1-5, 6, 8, 9, 12, 16
2	Cld. Cover (%)	2	0 - 1 1 - 50
3	VZA (°)	2	40 - 50 50 - 70
4	RAZ (°)	2	F: 0 - 40 B: 140 - 180
5	SZA (°)	2	30 - 50 50 - 70
6	STD(ALT) (%)	3	15 - 30 30 - 50 > 50

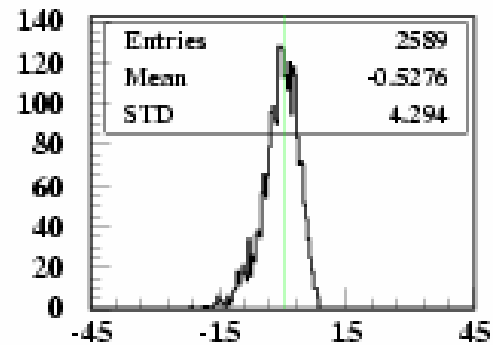
# Correction Test: $VZA = 60^\circ$ ; $SZA > 50^\circ$ ; Cloud Cover $< 1\%$

15% < STD(alt) < 30%



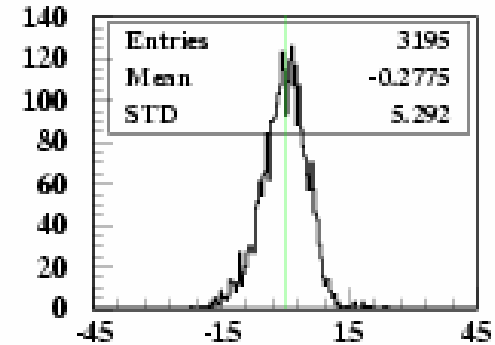
F:  $F_c - F_m$

30% < STD(alt) < 50%

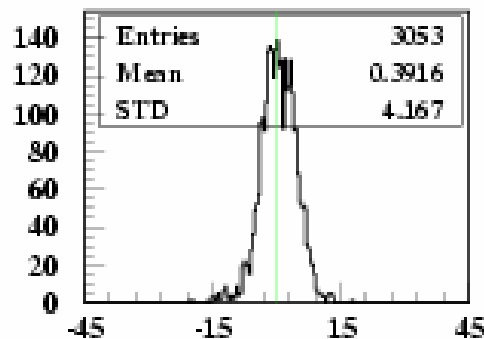


F:  $F_c - F_m$

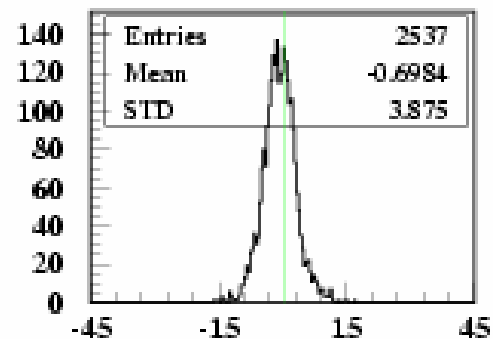
STD(alt) > 50%



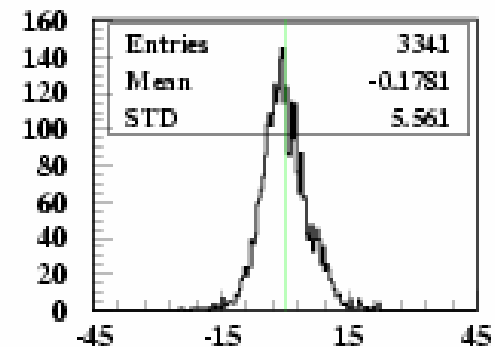
F:  $F_c - F_m$



B:  $F_c - F_m$

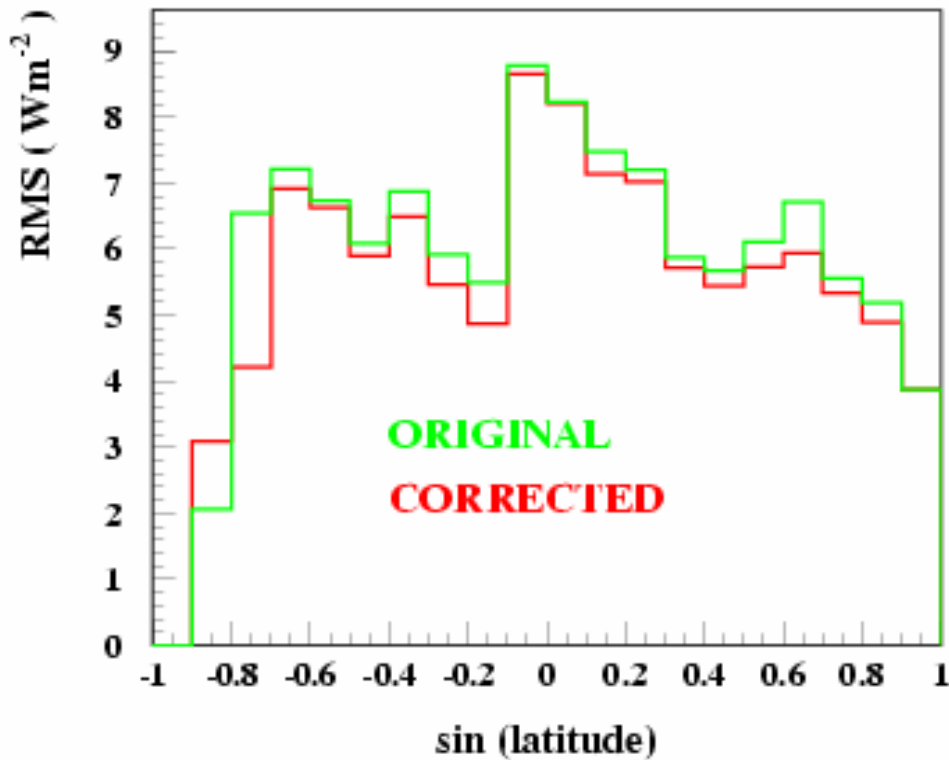


B:  $F_c - F_m$



B:  $F_c - F_m$

# Correction Test: Clear Land, Instantaneous LW Flux Consistency



## Global RMS

Original (SSF):  
**6.26  $\text{Wm}^{-2}$  (2.01%)**

Corrected:  
**5.97  $\text{Wm}^{-2}$  (1.92%)**

# Summary

- ➡ **Observed dependency of clear-sky land LW flux on RAZ is consistent with that in *Minnis et al.* paper draft.**
- ➡ **Statistics can be increased factor of two by using all Terra/CERES along-track data (May, 2004).**
- ➡ **Correction to CERES LW radiance can be derived from along-track data for the configurations: large VZA, SZA, and surface variability.**
- ➡ **Percentile of corrected data (Terra) = 2.93%.**
- ➡ **Major issue is SAMPLING.**