Assessing ARM Clear Sky BBHRP with CERES and AIRS

The RRTM calculations of clear sky OLR agree with CERES observations to ~1 W/m^2 with an uncertainty of ~1 W/m^2.

* True at SGP over 2.5 years, true globally (with some *understood* regional exceptions) for study day.
* True using ARM data as input to RRTM, true using AIRS sounding retrievals as input to RRTM.

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BBRHP summary report

Goal: To assess and improve BBHRP.

Approach: Use CERES fluxes & AIRS radiances and retrievals.

- SSF CERES is currently a better metric for BBHRP assessment than GOES.
- AIRS spectral radiance analysis allows us to evaluate the atmospheric and surface estimates.
- AIRS spectral flux analysis allows us to interpret uncertainties in the flux products, and infer uncertainties in the far IR.
- Using AIRS retrievals allows for *global* RRTM calculations of OLR and heating rate *profiles*.

Old Results from 2007 STM

	OLR differences: Observations minus Calculations	Mean,W/m^2	Stdv,W/m^2	Points
SGP 2000 - 2005 at sonde times	GOES - RRTM using BBHRP method	-0.8	9.6	~3k
SGP 2003 - 2005 at overpass times	GOES - BE* profile and AIRS surface RRTM	+3.1	8.9	~70
SGP 2003 - 2005 at overpass times	ES8 CERES - BE* profile and AIRS surface RRTM	-0.7	6.3	~70

- Results were based on GOES data set received in 2006, visst_olr 20km.
- The GOES - BE RRTM day/night bias was ~10 W/m^2 and had large year to year variability.

* BE = U. Wisconsin Best Estimate atmospheric state product

Summary of Present Results

	NIGHT OLR differences: Observations minus Calculations	Mean, W/m^2	Uncertainty in mean	Stdv , W/m^2	Pnts
SGP 2002 - 2005	SSF CERES - BE profile with Es=1, Ts(Beflux) RRTM	+0.5	~1	2.6	~74
SGP 2002 - 2005	SSF CERES - BE profile with AIRS surface RRTM	+0.8	~1	2.2	~74
SGP 2002 - 2005	SSF CERES - AIRS RRTM	+1.2*	~1	1.8	~74
	NIGHT OLR differences: Observations minus Calculations				
Global 16Nov2002 Lat:[-60:60]	SSF CERES - AIRS RRTM	+0.9*	< 0.5	2.6	~21k

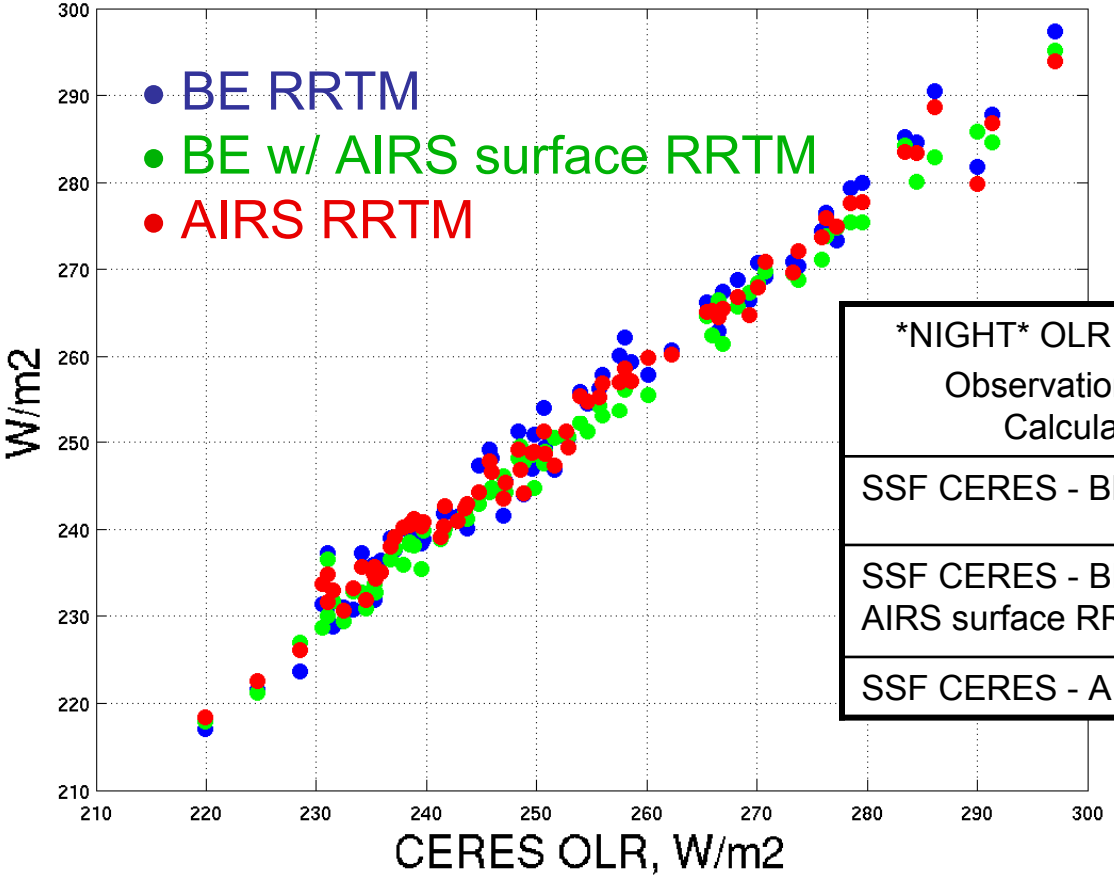
* Adjusted for upper level water error based on AIRS spectral analysis at SGP (~0.8 W/m^2).

- Standard deviations are less than half the STM 2007 results.
- Uncertainty in the mean is estimated to be less than ~1 W/m^2.
- Global results are very similar to results at SGP if we exclude regions where there are known problems (e.g. AIRS surface temperature retrieval have a problem in the daytime deserts).

Results at ARM's SGP

~74 night cases between Sept. 2002 & Feb. 2005

Night time Clear Sky OLR



NIGHT OLR differences: Observations minus Calculations	Mean, W/m^2	Stdev , W/m^2
SSF CERES - BE RRTM	+0.5	2.6
SSF CERES - BE profile & AIRS surface RRTM	+0.8	2.2
SSF CERES - AIRS RRTM	+2.0*	1.8

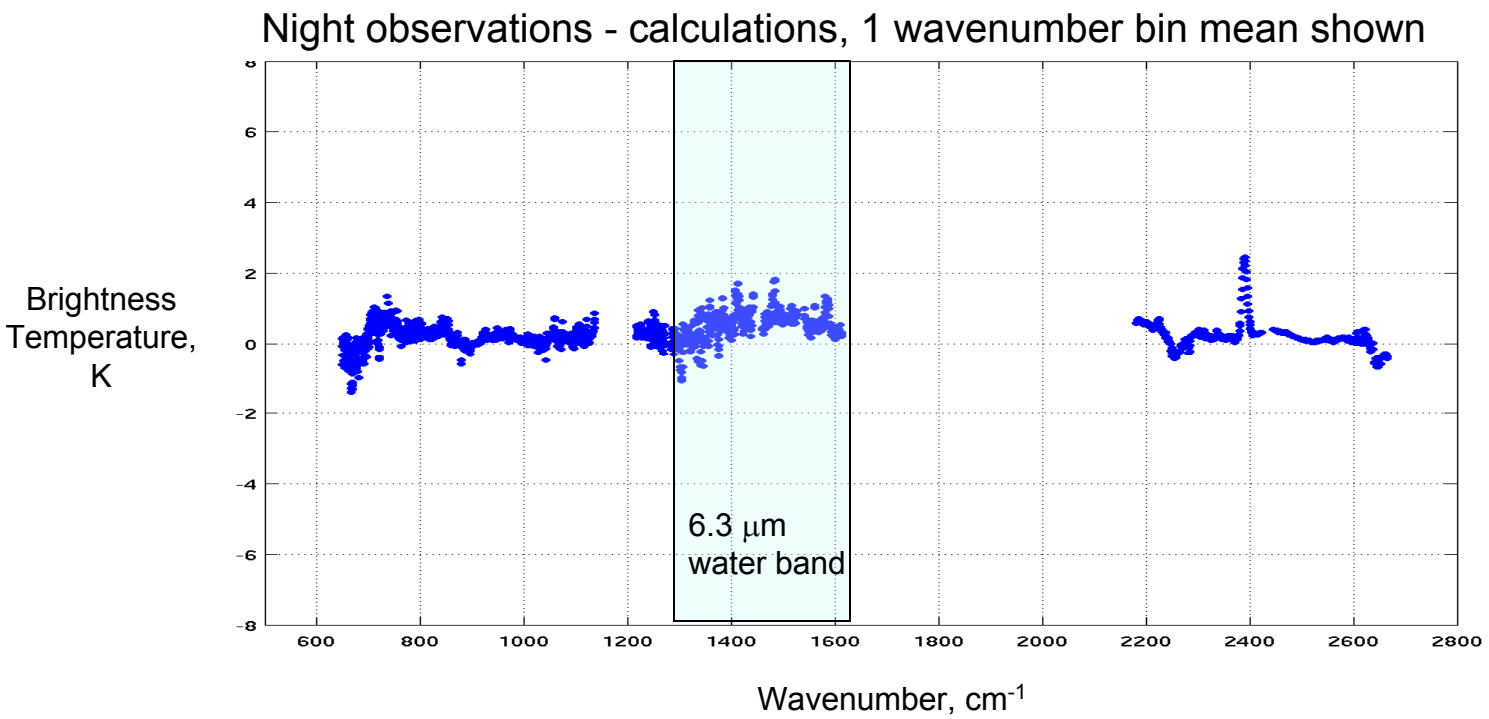
* does not reflect upper level water vapor adjustment

Day/Night Bias at SGP 2002-2005

OLR differences: Observations minus Calculations		Mean, W/m^2	Stdev , W/m^2	npts	Day-Nite Bias	Statistical uncertainty
SSF CERES - BE RRTM	Day	-0.2	4.6	53		
	Night	+0.5	2.6	74	-0.7	0.7
	D&N	+0.3	3.6	127		
SSF CERES - BE profile & AIRS surface RRTM	Day	-0.5	2.4	53		
	Night	+0.8	2.2	74	-1.3	0.4
	D&N	+0.3	2.3	127		
SSF CERES - AIRS RRTM	Day	+0.2	2.2	53		
	Night	+2.0	1.8	74	-1.8	0.4
	D&N	+1.3	2.4	127		

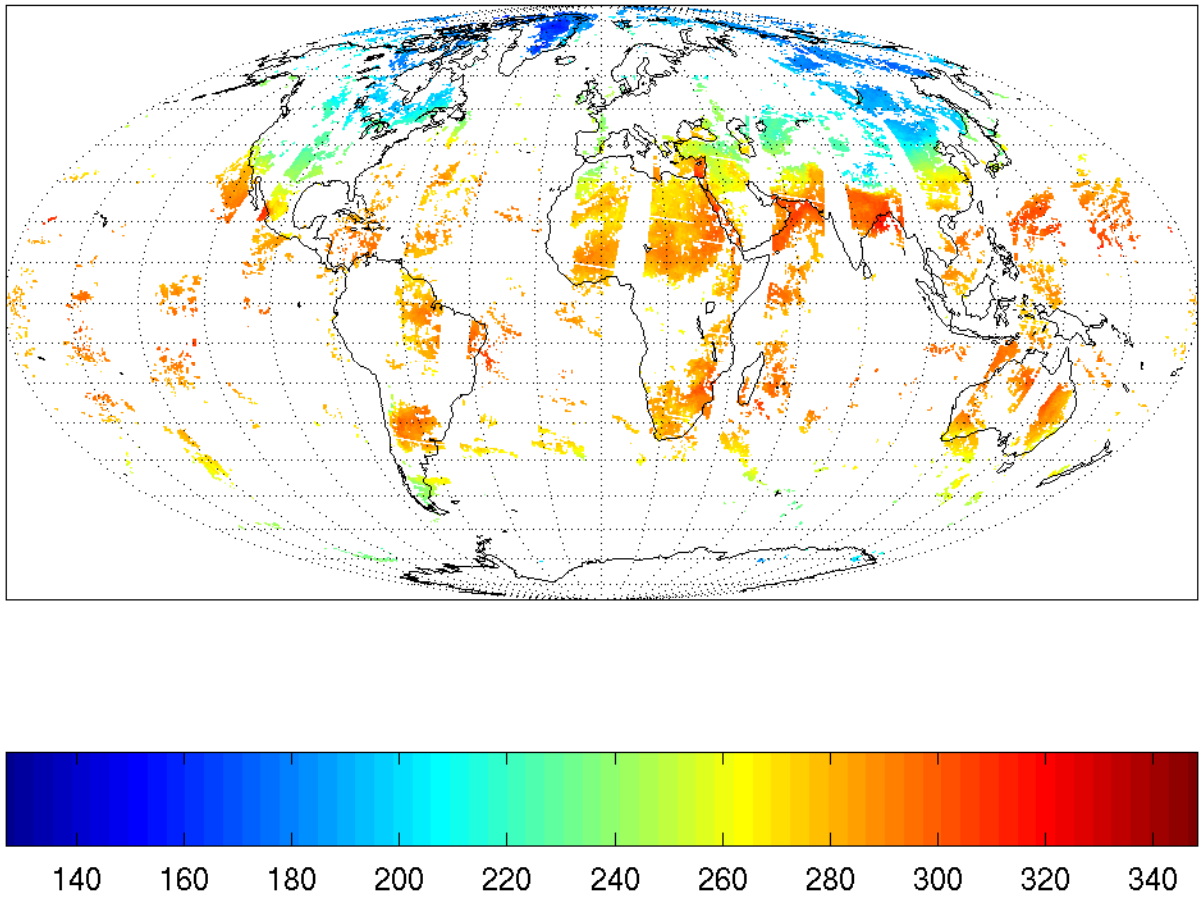
- Day/night differences are greater than the statistical uncertainties indicating a non-Gaussian source of bias.
- Our nighttime uncertainty estimates are elevated to ~1 W/m^2 to reflect this.
- We continue to study the source of the day/night bias; AIRS residuals are not significantly different between day and night, and CERES OLR is total minus solar.

AIRS spectral radiance analysis



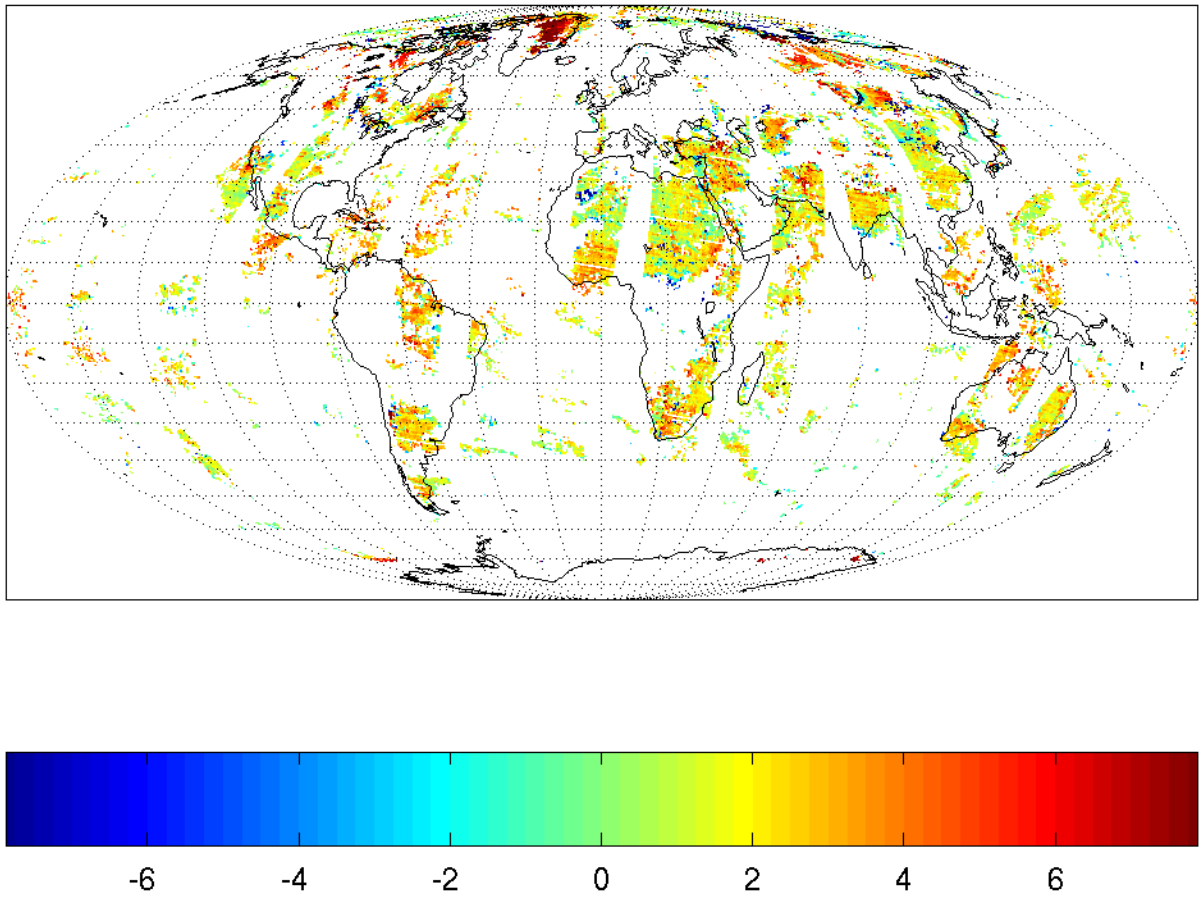
- allows us to evaluate the profiles used as input to RRTM.
- the upper level water bands show a brightness temperature bias ~0.7 K. Reducing the water vapor above 5km by 10% eliminates this bias.
- the far IR is very sensitive to upper level water vapor; the 10% reduction in the water vapor above 5km leads to a 0.2 W/m^2 in the 6.3 μm band and 0.5 W/m^2 in the far IR.

CERES clear sky OLR, W/m^2 nighttime 16 Nov 2002

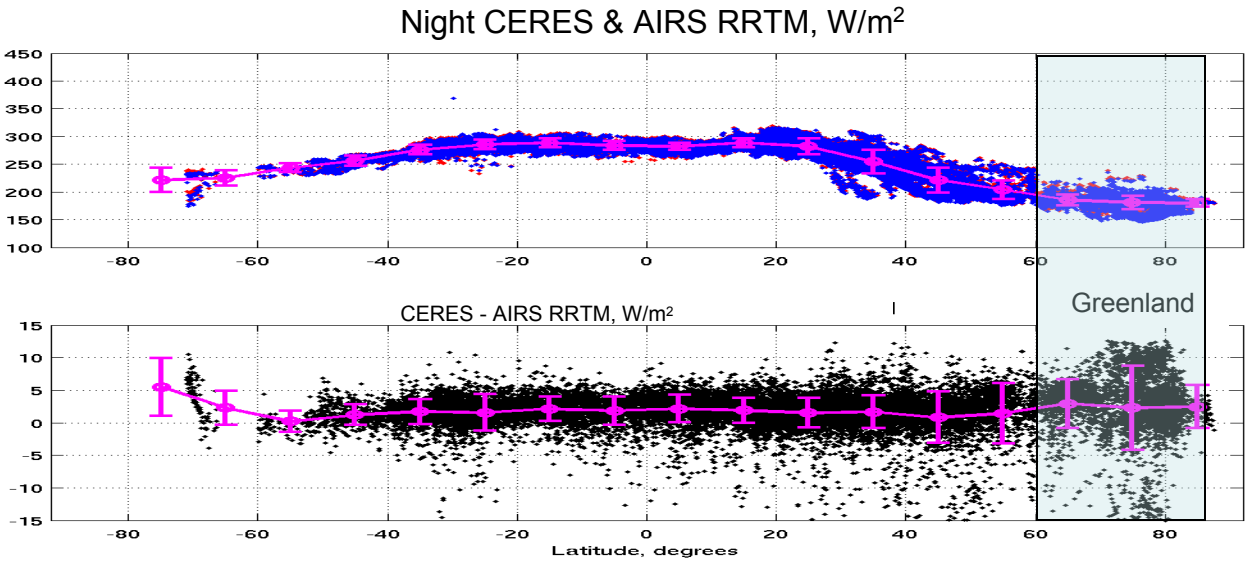


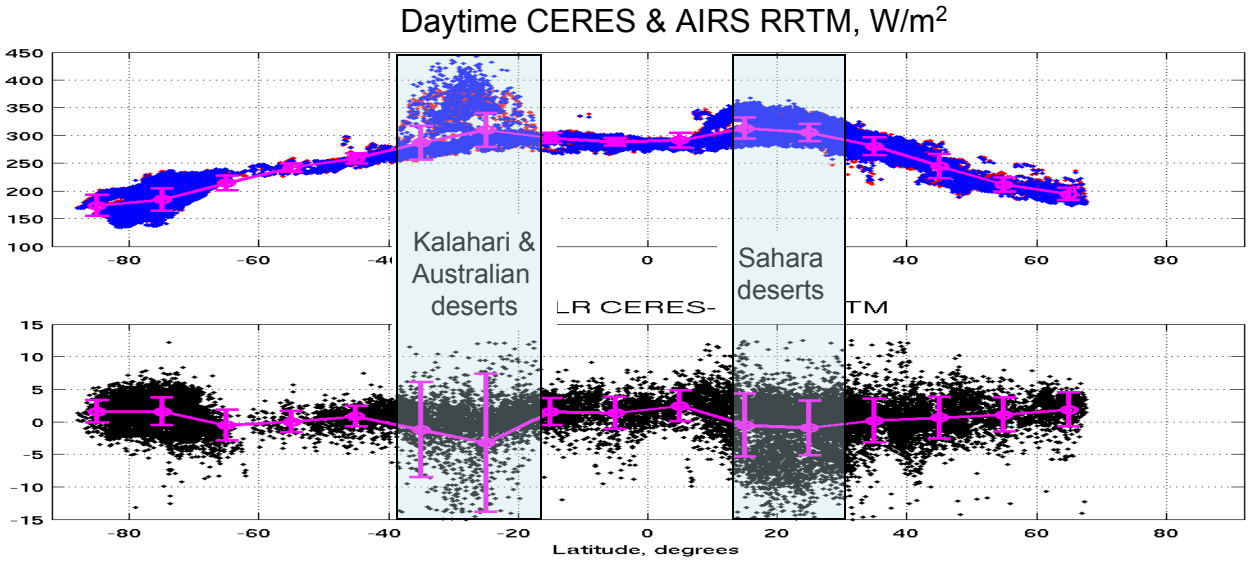
"Clear" from MODIS cloud mask applied in CERES analyses

CERES - AIRS RRTM, W/m^2 clear sky OLR nighttime 16 Nov 2002



Latitude dependence for 16 Nov 2002





Method for determining uncertainty in the mean

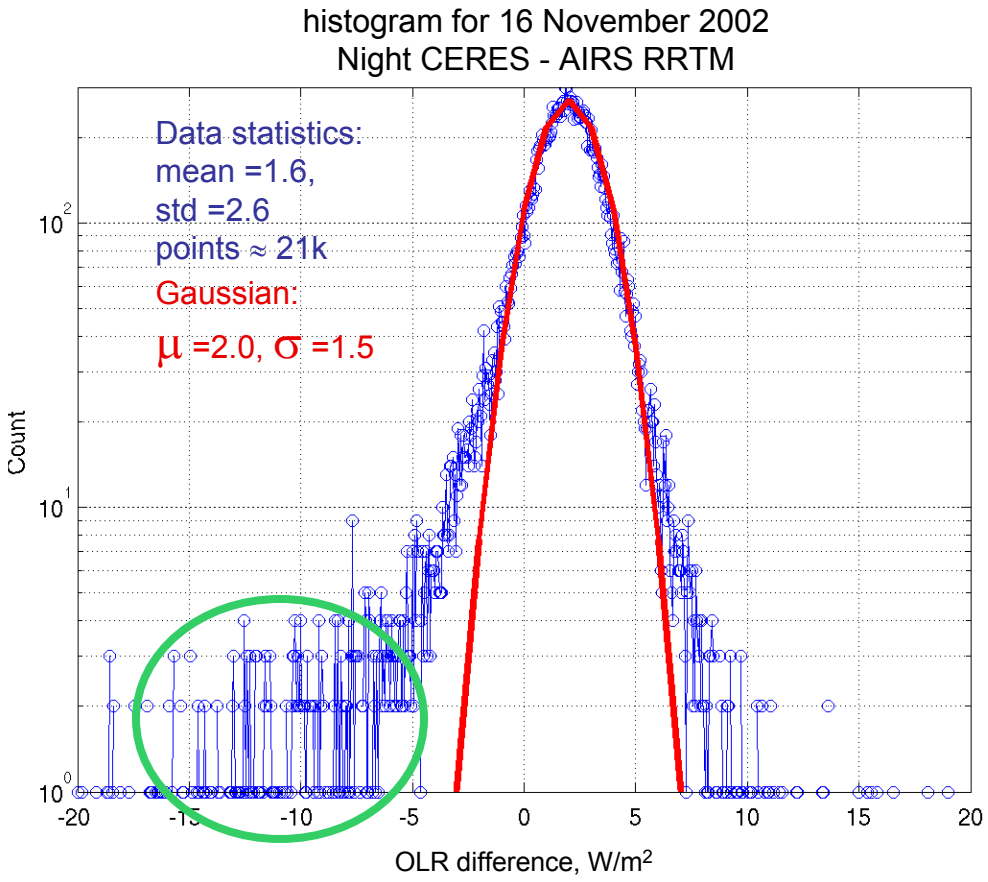
Data restricted to NIGHT time and latitudes between 60S and 60N to exclude known problem regions.

- We attribute the Gaussian component to spatial mismatch between CERES and AIRS footprints. For the Gaussian shown, the statistical uncertainty is very small (0.01 W/m^2) and not representative of the true uncertainty of the mean.

- The negative tail of the histogram is consistent with undetected clouds and distorts the mean.

- Deviation between the mean of the original histogram and the Gaussian is:

$$| \overline{X} - \mu | \approx 0.4 \text{ W/m}^2$$



We assign the complete difference between the mean of the full distribution with uncorrected tail and the mean of the Gaussian component to uncertainty in the mean (<0.5 W/m^2).

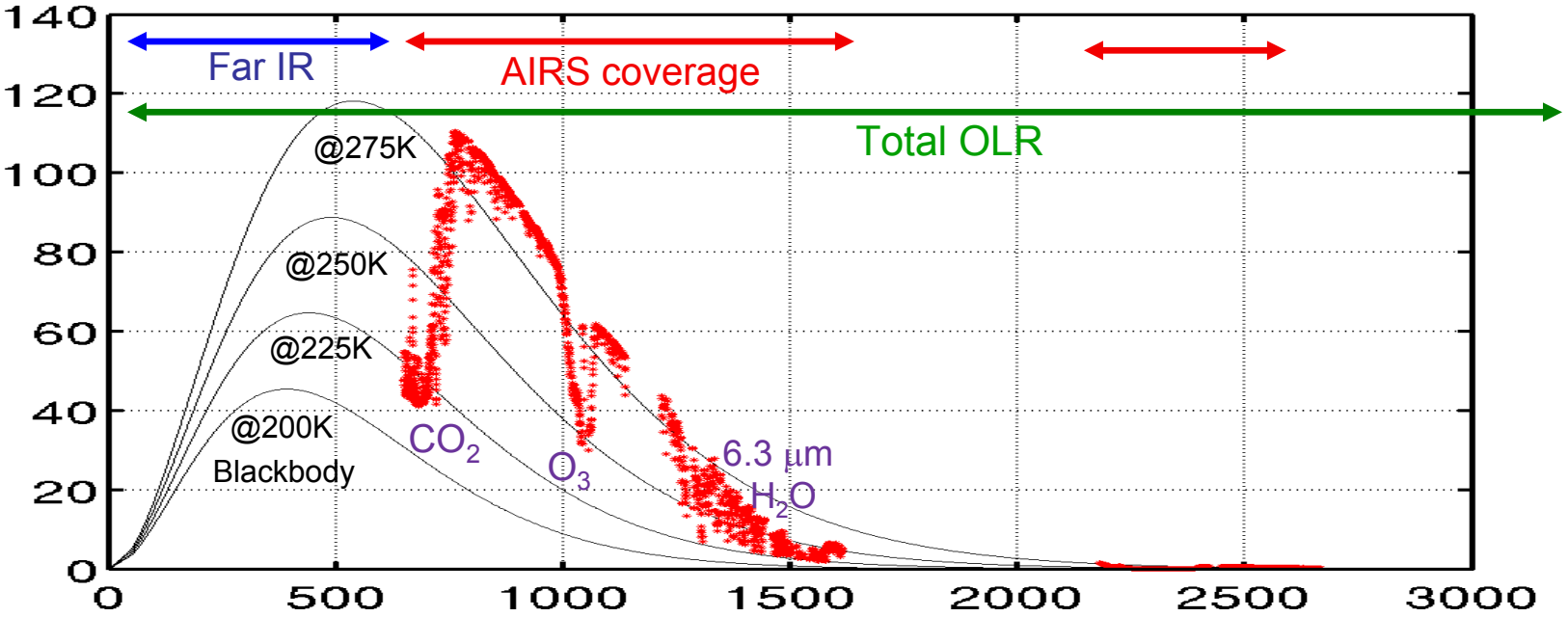
AIRS Spectral flux analysis

AER's LBLRTM and RRTM calculated radiances *and* fluxes for the same set of atmospheric and surface conditions were produced at SGP over a 2.5 year study period. Partial fluxes (fluxes over a spectral range) are calculated from the radiances using:

$$F = \iint radiance \quad d\nu \; d\psi$$

where ν is wavelength, and ψ is solid angle. The residuals are expressed as a fractional error to eliminate errors in the integral over the solid angles.

Earth's spectrum



AIRS spectral flux analysis allows us to:

1) improve the flux derived from AIRS retrievals using RRTM, and
2) infer the error in the far IR.

Spectral Coverage	weight %	Flux W/m^2	Percent Residual Definition	%
Total OLR	100	263	100 * (CERES - AIRS RRTM) / CERES	0.2
AIRS spectra	54	144	$100*(F_{AIRS\ obs} - F_{AIRS\ calc}) / F_{AIRS\ obs,}$	0.3
Far IR	45	116		[0.1-0.3]

Assuming CERES errors are similar throughout the entire spectrum, and that there are no cancellation of errors between CERES and RRTM, we can infer the error in the far IR. (Our analyses show that CERES and AIRS agree in the window channels to approximately 0.1 W/m^2.)

RHUBC is important to confirm these tentative findings in the far IR.

Assessing ARM Clear Sky BBHRP with CERES and AIRS

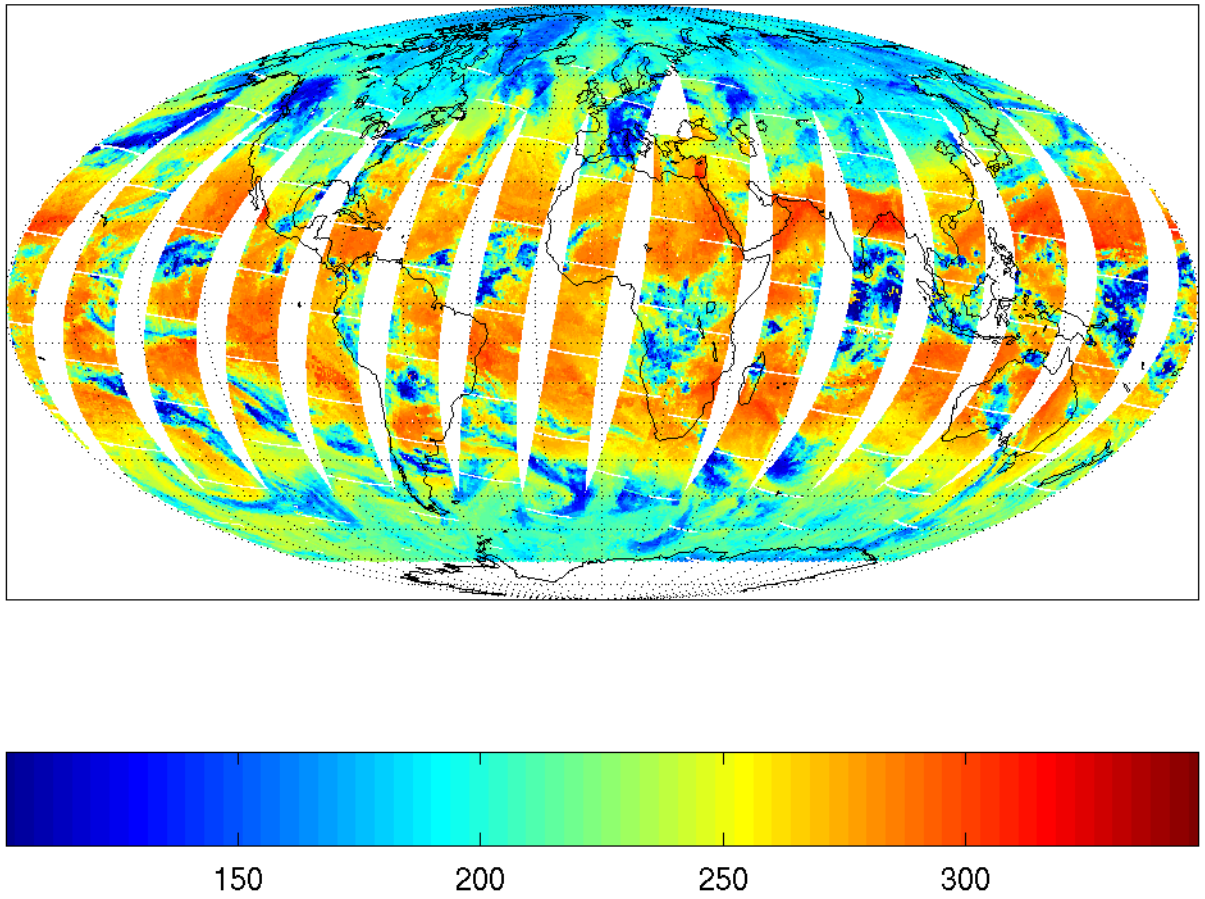
The RRTM calculations of clear sky OLR agree with CERES observations to ~1 W/m^2 with an uncertainty of ~1 W/m^2.

* True at SGP over 2.5 years, true globally (with some *understood* regional exceptions) for study day.
* True using ARM data as input to RRTM, true using AIRS sounding retrievals as input to RRTM.

Next Step includes All Sky Conditions …

All Sky AIRS RRTM calculations for 16 Nov 2002

OLR, W/m^2



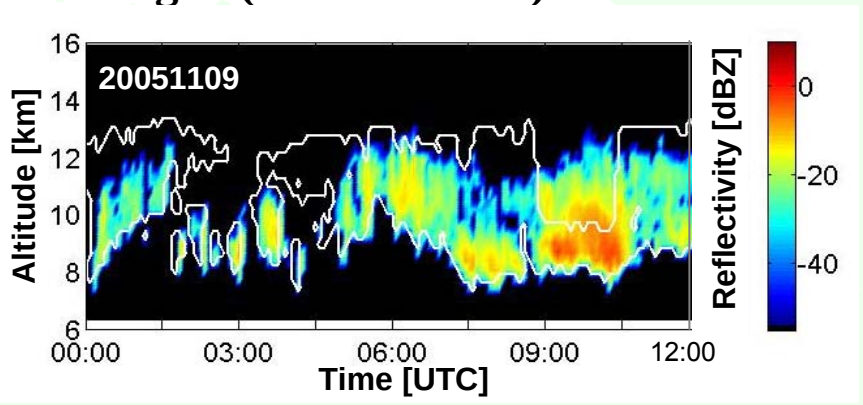
Improving Cirrus Cloud Characterization with Raman Lidar Measurements at SGP

Lori Borg, David Turner, Robert Holz, David Tobin, Bob Knuteson, Leslie Moy, Daniel DeSlover, Ed Eloranta, Hank Revercomb (PI)

Radar (MMCR)

Raman Lidar

Merged (Radar+Lidar) Dataset



1. Derive extinction profiles from Raman lidar
2. Produce merged dataset
3. Compute OLRs & heating rates based on combinations radar & lidar data

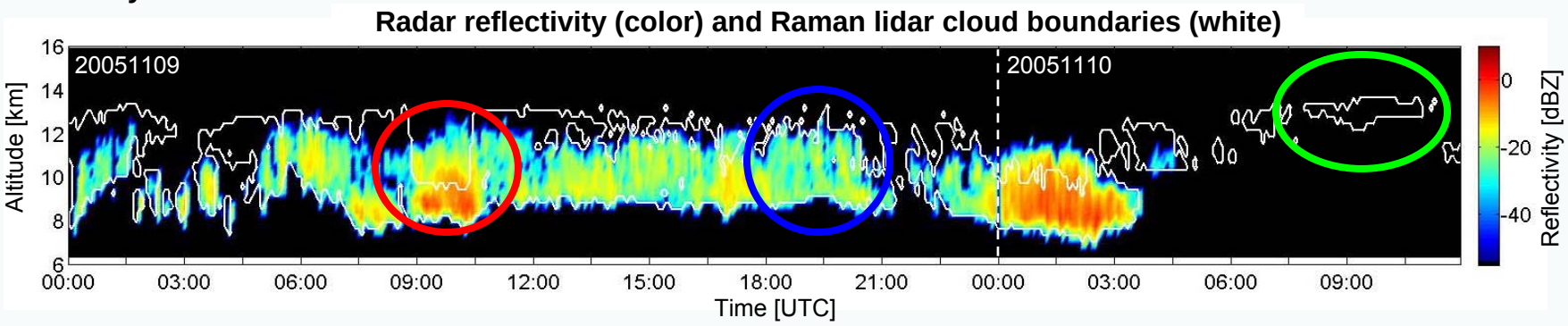
SSEC

THE UNIVERSITY of WISCONSIN MADISON

Improving Cirrus Cloud Characterization with Raman Lidar Measurements at Southern Great Plains

1. Developed ability to derive extinction from the SGP Raman lidar system
2. Lidar retrievals combined with radar data (MMCR) for 3+ years of data

Case Study



The MMCR radar can miss significant upper level cirrus.

This translates into large errors in OLR & heating rates.

Radar & lidar measurements needed to best characterize thin cirrus.

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Poster Plenary Talk: Wed, 9:40AM-10AM

Poster: Wed, 5:30PM-8:30PM, 14C