

# Spatial Variability of Surface Irradiance and Clouds at the Manus site

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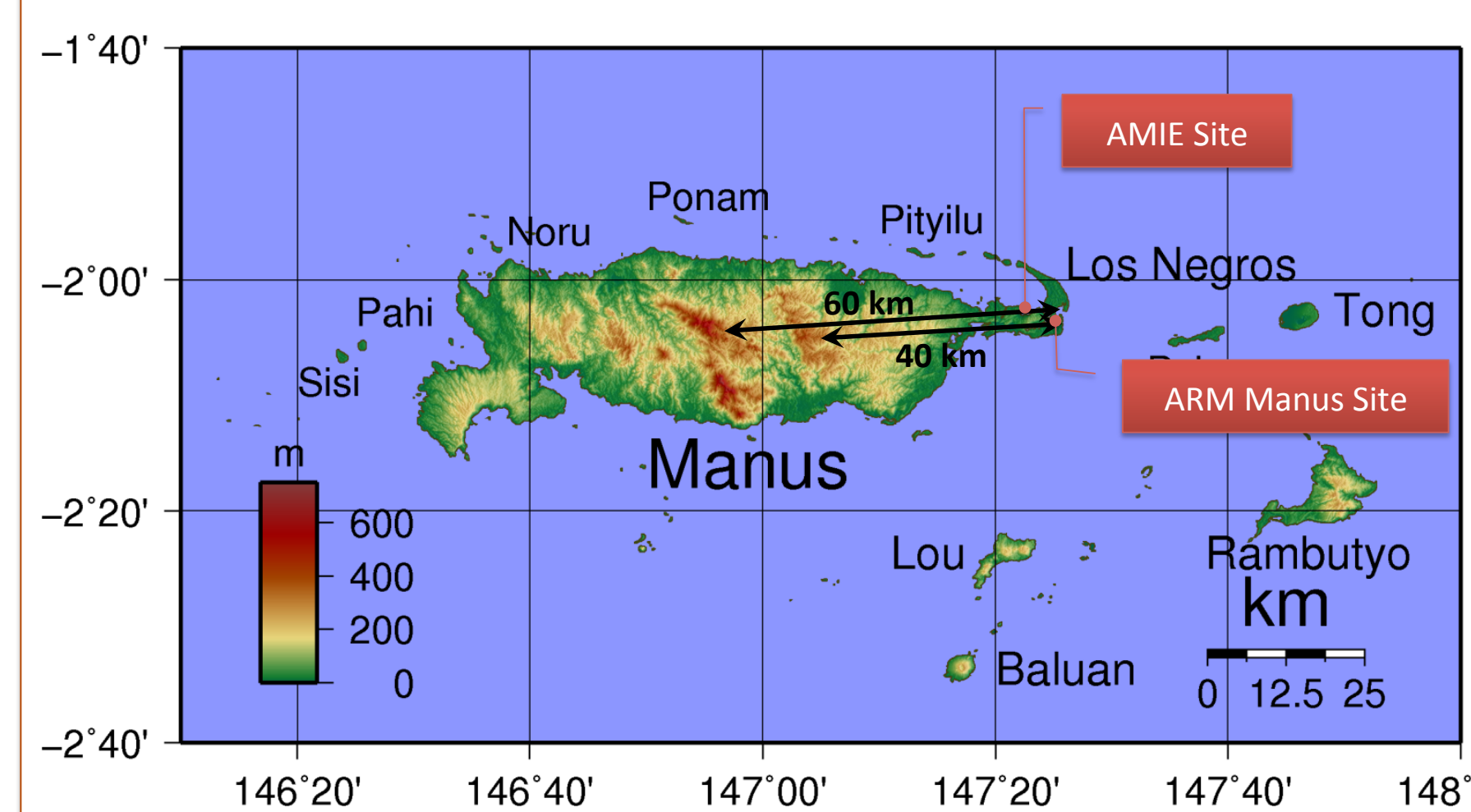
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## Objective

Use 1.5 years of surface irradiance measurements at two sites on Manus Island during AMIE Manus campaign to evaluate whether the DOE ARM site is representative of the clouds and surface irradiance over a larger area, necessary information for comparing to model grid box output or satellite footprint data (e.g. flux closure studies).

## Method

Pyranometer and pyrgeometer measurements at 2 sites analyzed with Radiative Flux Analysis method



Radiometers at standard Manus site



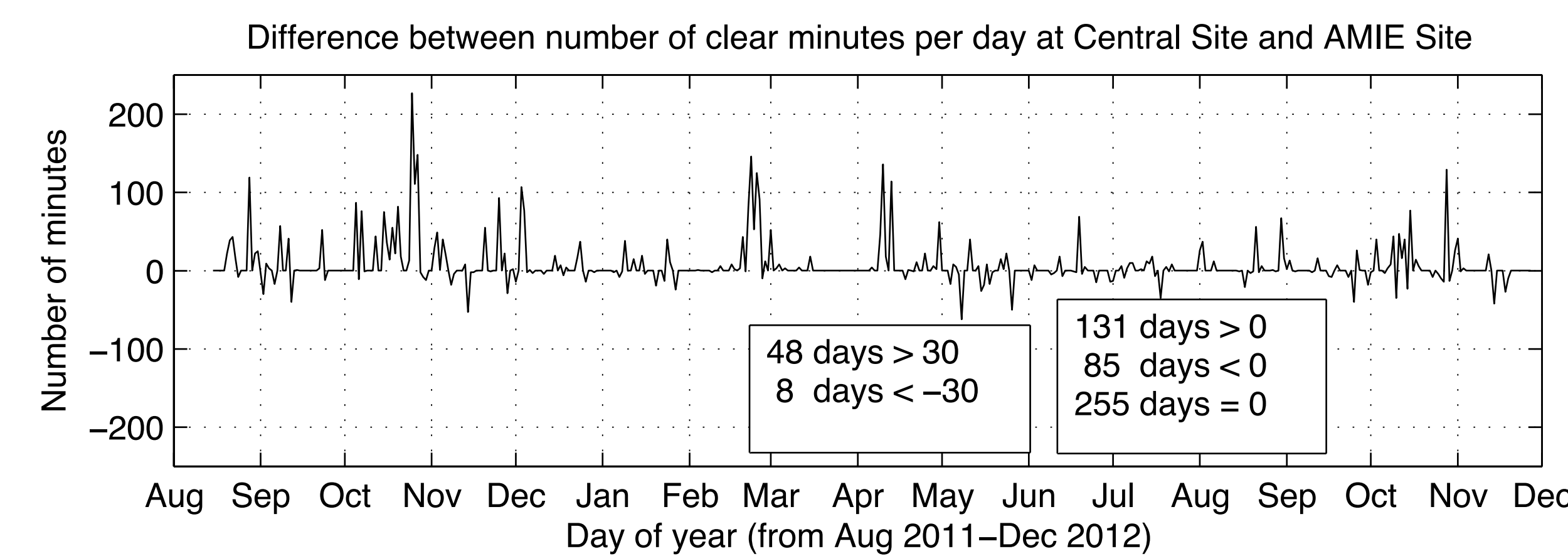
Additional radiometers & ceilometer deployed at AMIE site (elev 36 m) ~7 km WNW of ARM Manus C1 site (elev 4 m) during AMIE campaign 8/16/2011–11/28/2012

We use Radiative Flux Analysis, a well established method (Long & Ackerman, 2000; Long et al., 2006; Long and Turner, 2008) of analyzing surface irradiance measurements to determine:

- Cloud-free periods
- Estimated clear sky irradiances
- Fractional sky cover
- Effective transmissivity (measured/clear SW)
- Cloud radiative effects (clear – measured)

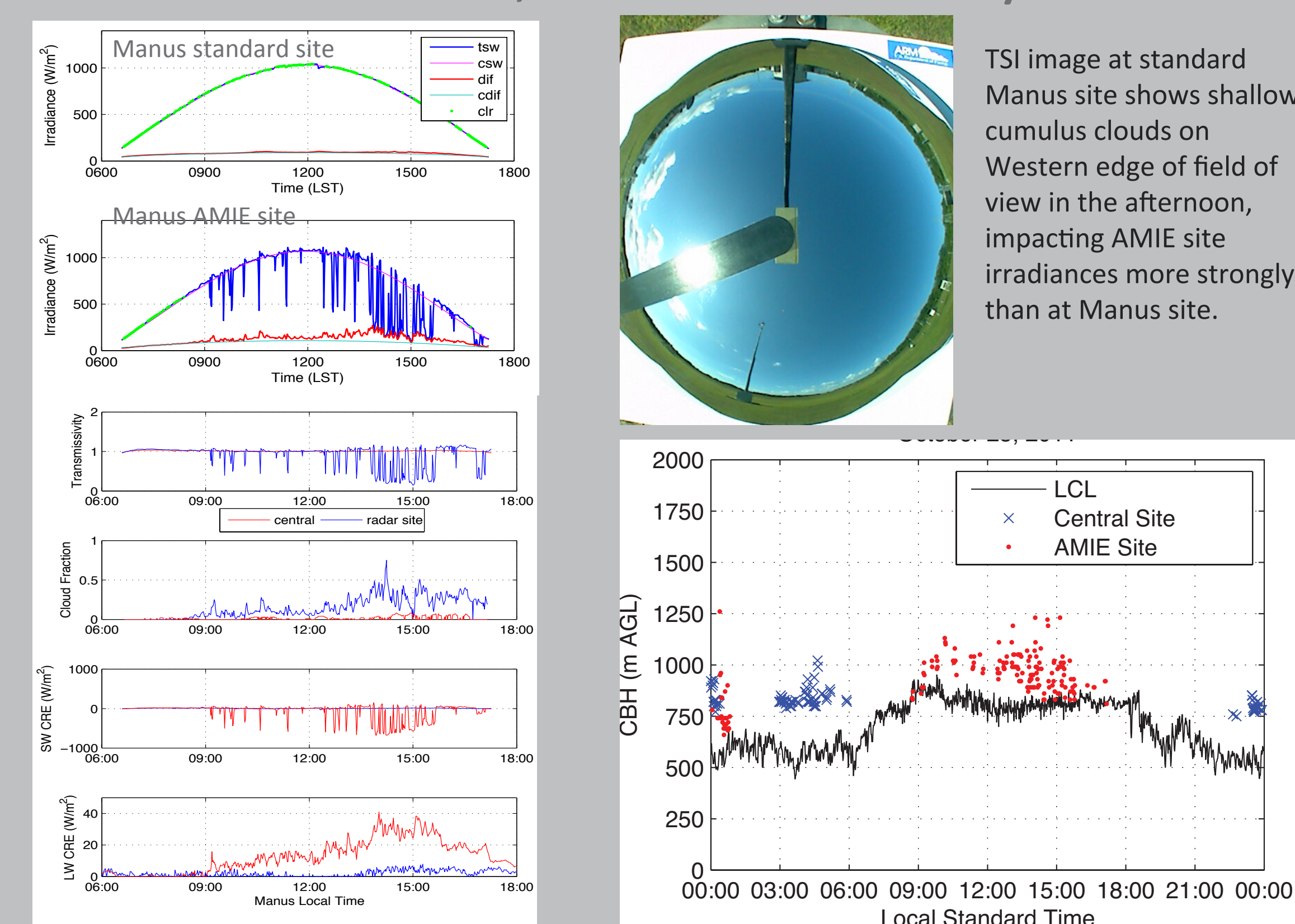
## More clear sky at central site

Standard Manus site has more frequent occurrence of clear skies than AMIE site.



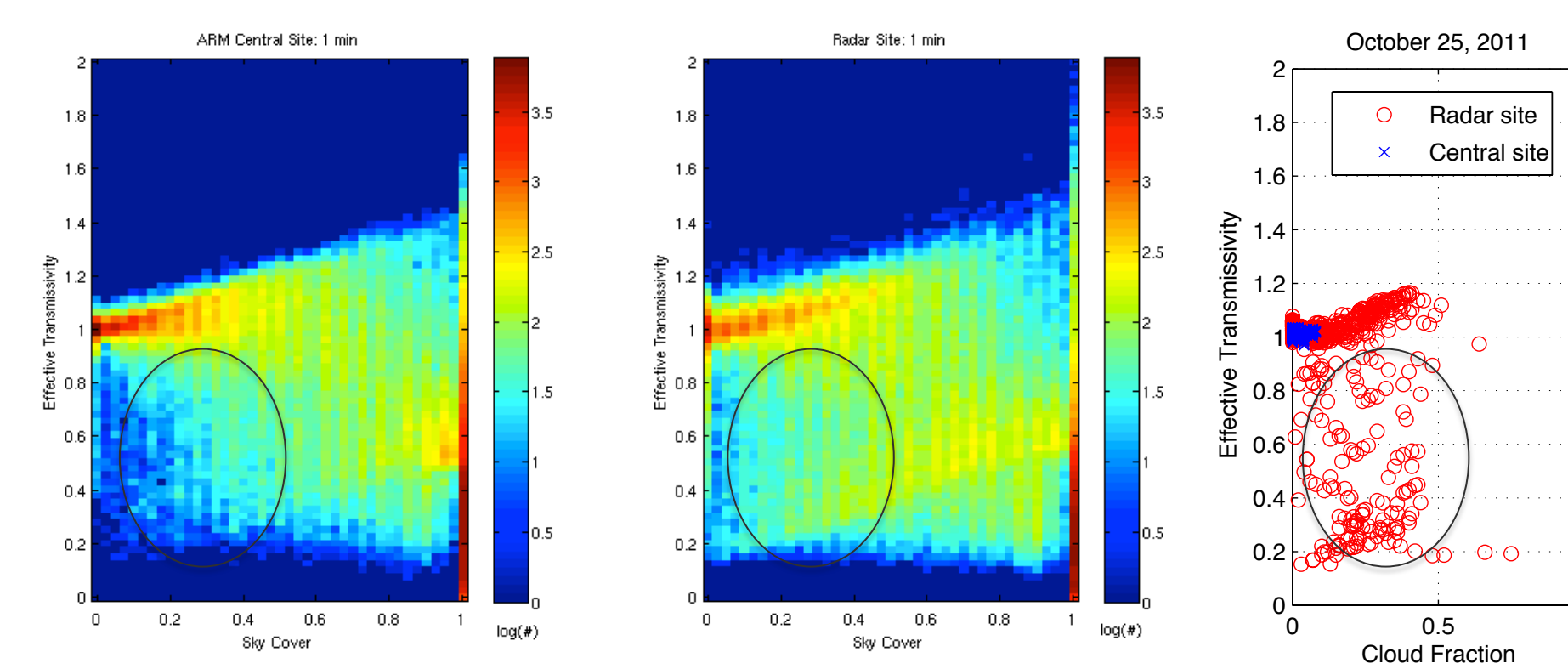
Additional clouds at the AMIE site are primarily broken shallow clouds with low cloud bases, as seen in the case study and cloud fraction/transmissivity plots below.

### Oct. 25, 2011 Case Study



SW irradiance and derived cloud properties show clear skies at standard site, but broken cloudy conditions at the AMIE site.

Ceilometer measures low level clouds over head during the afternoon at the AMIE site (red) but not standard Manus site (blue). Cloud bases are around the Lifting Condensation Level (black).



Number density plots of fractional sky cover vs transmissivity show increased occurrence of low cloud fraction and transmissivities of 0.2-1 at the AMIE site compared to the standard Manus site, matching the case study results.

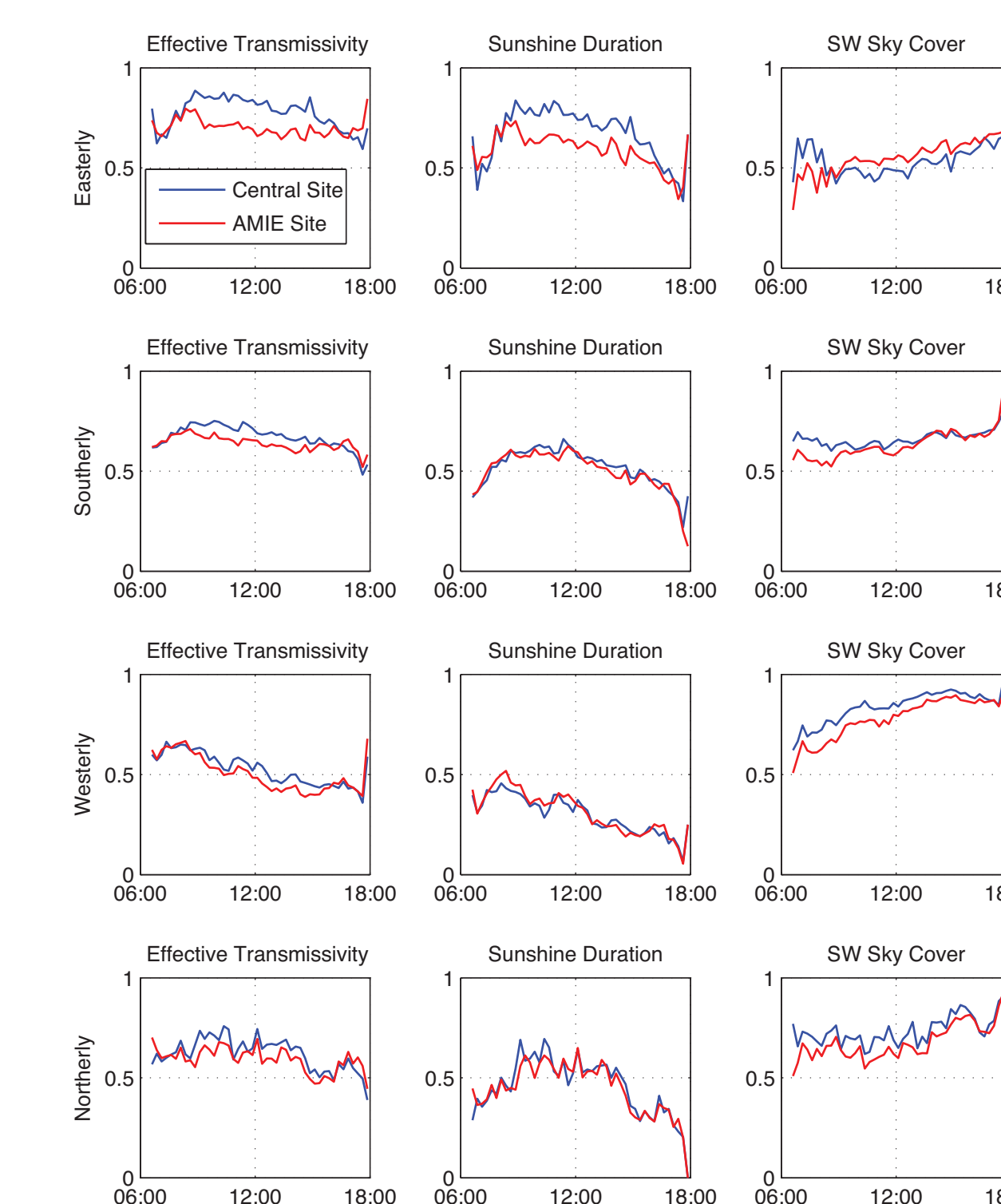
## Conclusions

- ARM Manus surface irradiance at the central site is not biased by island effects compared to a site even 7 km more inland
- The Inland SW cloud radiative effect is  $-20 \text{ W/m}^2$  stronger than at the standard Manus site
- Manus has slightly more frequent clear skies than further inland under easterly and southeasterly winds, with land effects likely the cause.

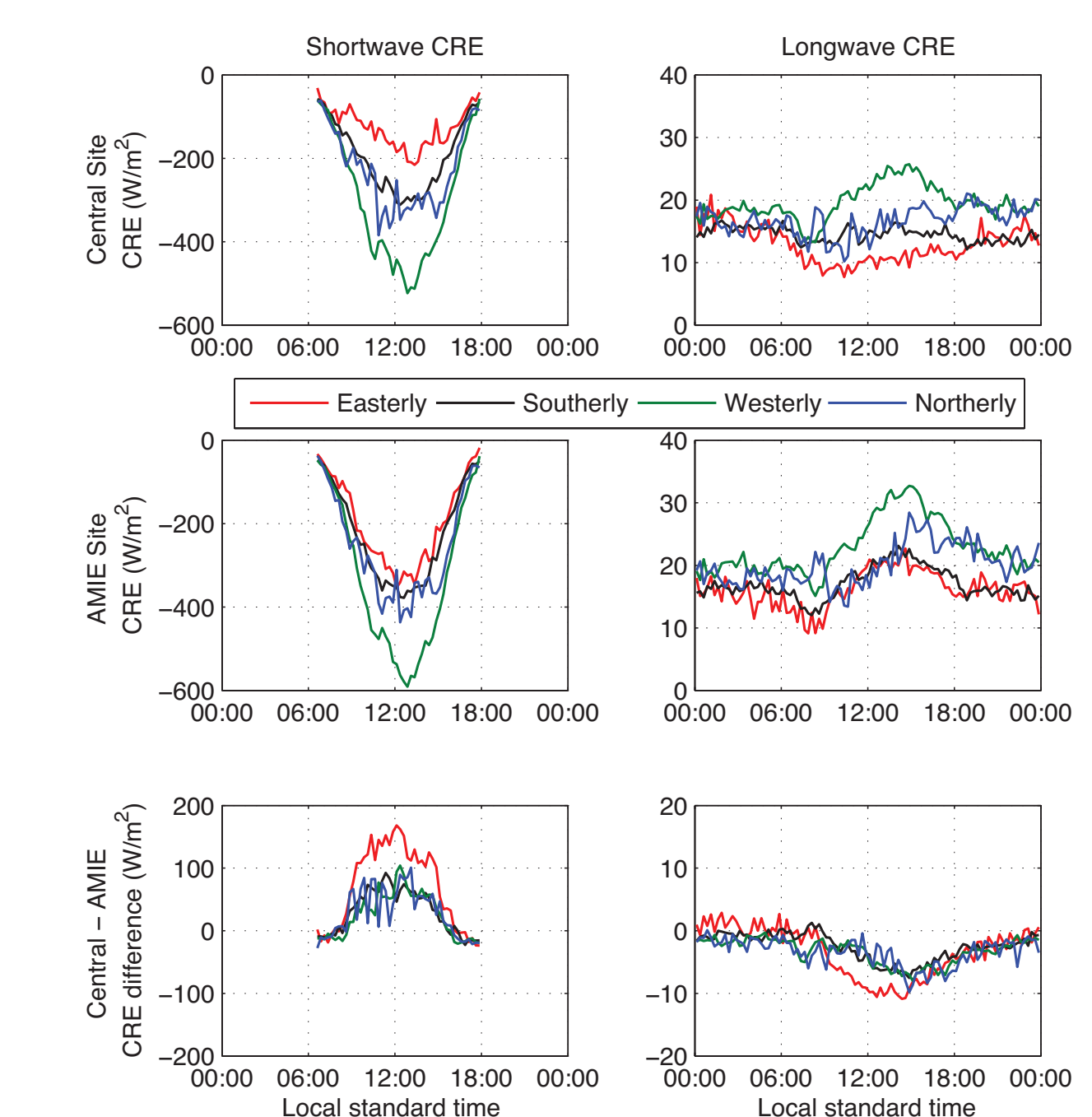
## Statistics by Wind Direction

Increased low cloudiness at AMIE site impacts radiative effects, primarily under easterly and somewhat under southerly winds.

	Central Site	AMIE Site
Ceilometer-derived low cloud (base < 1200 m) frequency of occurrence during daylight hours by wind direction		
Northerly	27%	29%
Easterly	21%	38%
Southerly	25%	32%
Westerly	25%	24%
No Wind	13%	10%



Composite diurnal cycle of Transmissivity, Sunshine Duration ( $\text{DNI} > 140 \text{ W/m}^2$ ), and Fractional Sky cover for different surface wind directions shows largest differences between sites under easterly winds.



Composite diurnal cycle of Cloud Radiative Effects shows largest difference between sites during easterly wind conditions, corresponding to an additional  $-20 \text{ W/m}^2$  SW CRE at the AMIE site than the standard Manus site.