

# Methodology for Calculating Spectral Surface Albedo Using ARM Data: Estimating Broadband and Spectral Surface Albedos

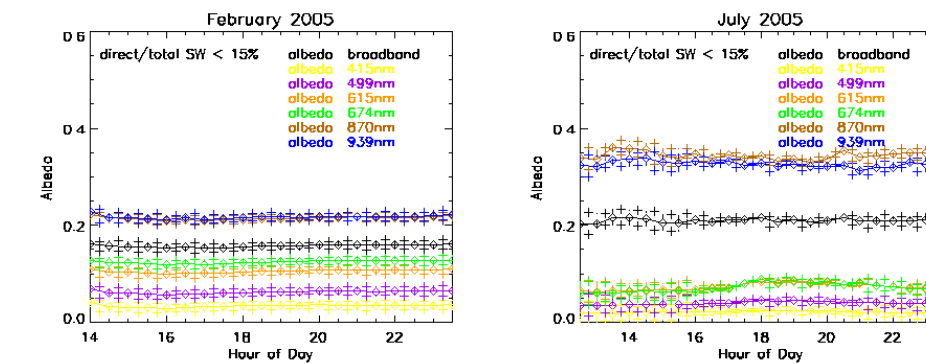
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## Methodology

- Quality assess upwelling and downwelling broadband and spectral irradiance values.
- Missing irradiance values are filled by:
  - Calculate average ratio of nearby 'good' irradiances to appropriate broadband irradiance reference.
  - Use resultant ratio and reference broadband to estimate missing values.
- Calculate broadband and spectral albedos of data passing all testing.
- Estimate the albedo of all remaining samples using the relationship of albedo to cosine solar zenith angle separated as to whether the ratio of direct to total irradiance is less than or greater than 15%.

## 'Diffuse' Diurnal Albedo

- Exhibits no solar zenith angle dependence across all months and channels.



30 Minute Bin Monthly Averages of 'Diffuse' Albedo

## Summary

- Broadband and spectral albedo can be successfully estimated using the relationship of the 'direct' and 'diffuse' albedo as plotted against the cosine solar zenith angle.
- Future work will explore how the mfr spectral albedos can be used to estimate albedo of the RRTM bands.

## Process for Estimating Broadband and Spectral Albedo

'Diffuse' Albedo – refers to albedo when direct/total SW < 15%

- broadband and spectral albedo for a given day are nearly constant, and nearly equal to the albedo of clear sky conditions for a period shortly before and following solar noon.

'Direct' Albedo Slope and Offset – refers to albedo when direct/total SW >= 15%

- broadband and spectral broadband albedo are relatively linear with respect to the cosine solar zenith angle.

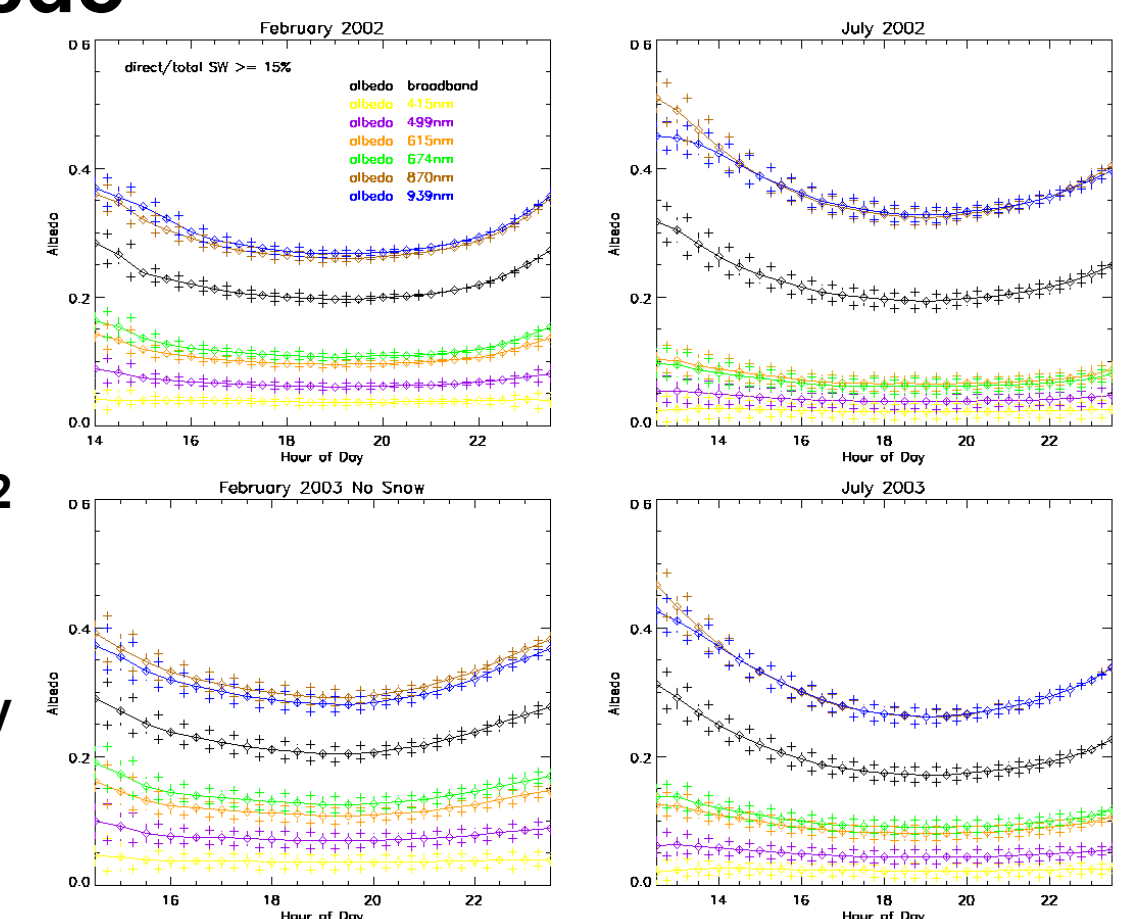
### Albedo Estimation

- Albedos characterized as either 'diffuse' or 'direct' based on whether the ratio of best estimate direct to best estimate total downwelling irradiance is above or below 15%
- Missing albedos estimated using either the albedo noon value for 'diffuse' conditions, or using the 'direct' albedo offset and slope based on current irradiance conditions.

## 'Direct' Diurnal Albedo

Winter (left hand plots)

- Snow Periods are excluded.
- Albedo in morning and evening are almost equal with decrease at noon.
- Shorter wavelengths are distributed between 0.05 and 0.2

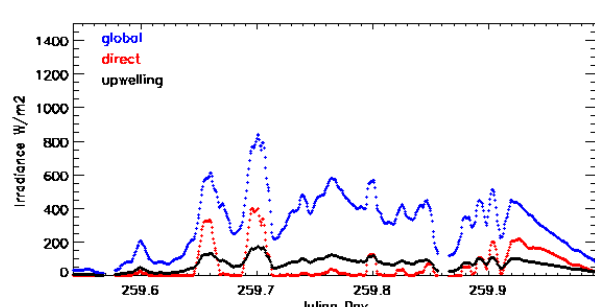


Summer (right hand plots)

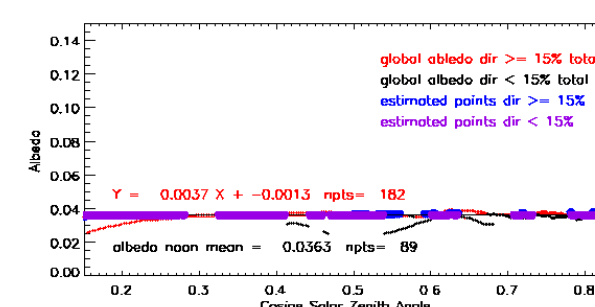
- Albedo in morning is slightly higher than albedo at end of day
- Shorter wavelengths typically fall below 0.15.

30 Minute Bin Monthly Averages of 'Direct' Albedo in Winter and Summer

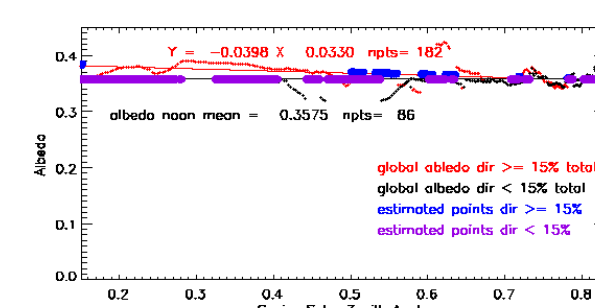
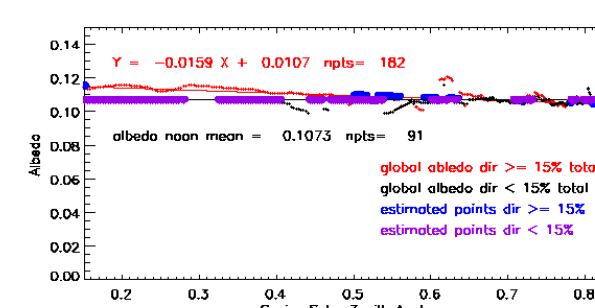
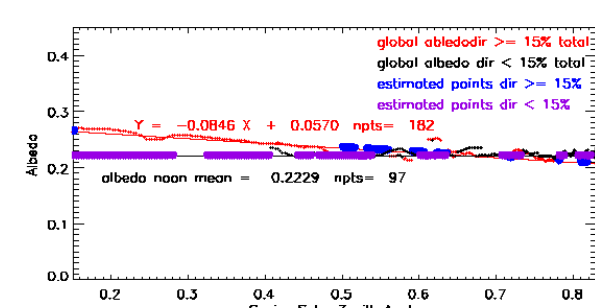
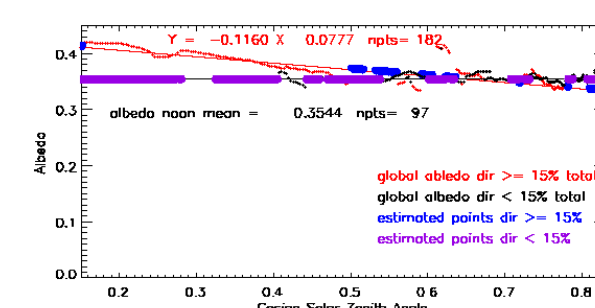
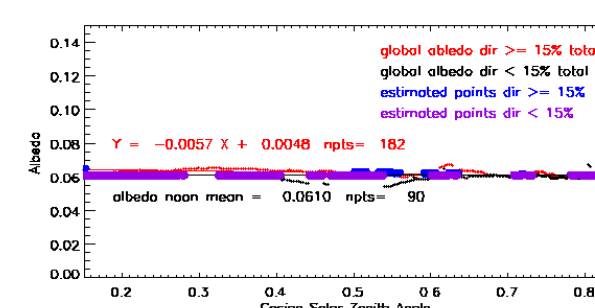
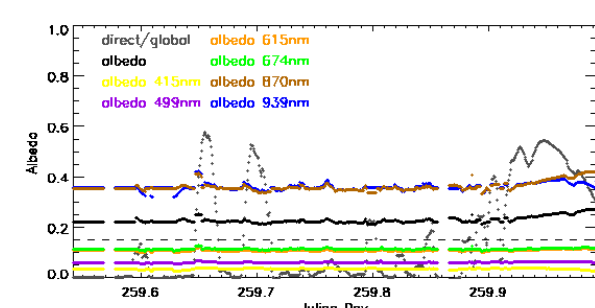
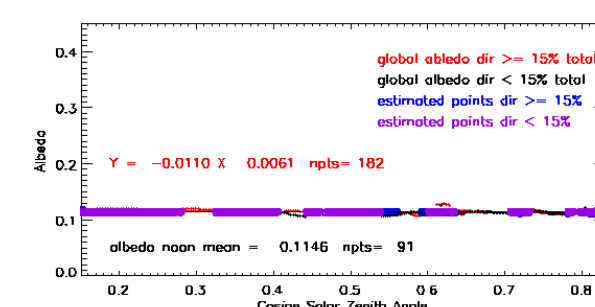
Albedo for SGP C1, 15 Sep 2004



Albedo for 415 nm, 499 nm, and 615 nm data for sgp C1, 15 Sep 2004



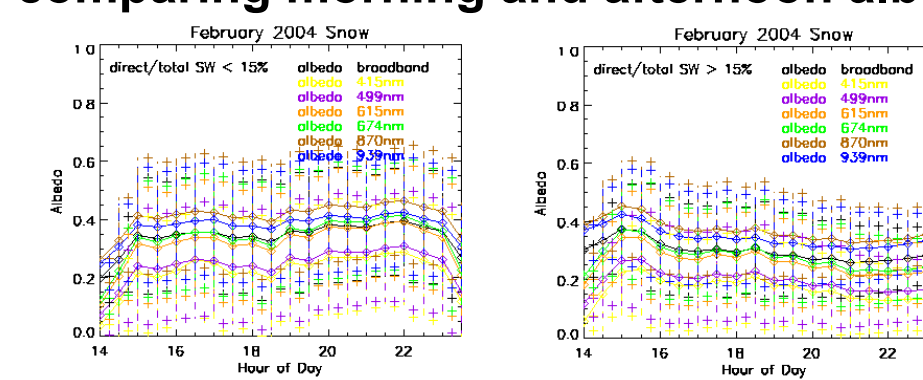
Albedo for 674 nm, 870 nm, and 939 nm data for sgp C1, 15 Sep 2004



Plots of Actual and Estimated Albedo for Partly Cloudy Day

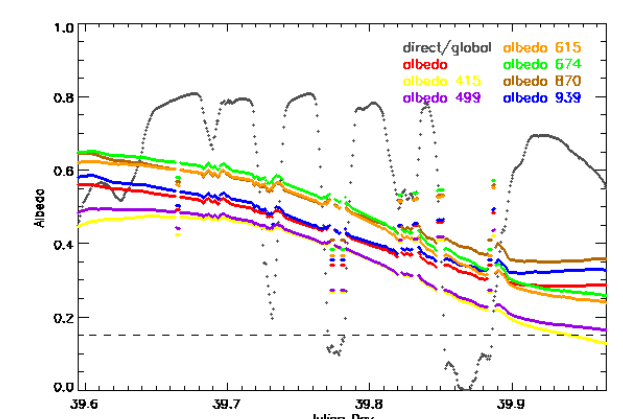
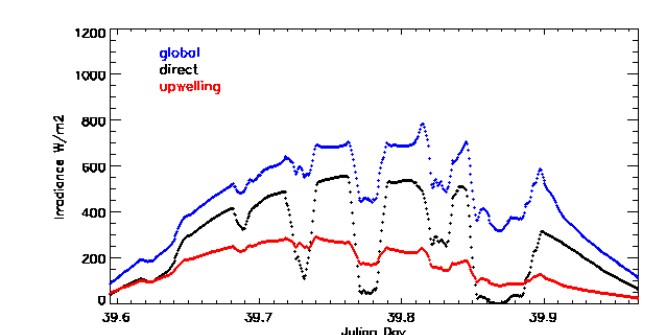
## Snow Events

- Characterized by rapid changes in albedo unrelated to solar zenith angle.
- Diurnal monthly average albedos characterized by large standard deviations.
- Identify snow accumulation/melt by comparing morning and afternoon albedos.



30 Minute Bin Monthly Averages Including Snow

Albedo for February 08, 2004



Albedo for Day with Snow Melt