

Error Estimate in the Irradiance Derived from Snow/Ice ADMs

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Objectives

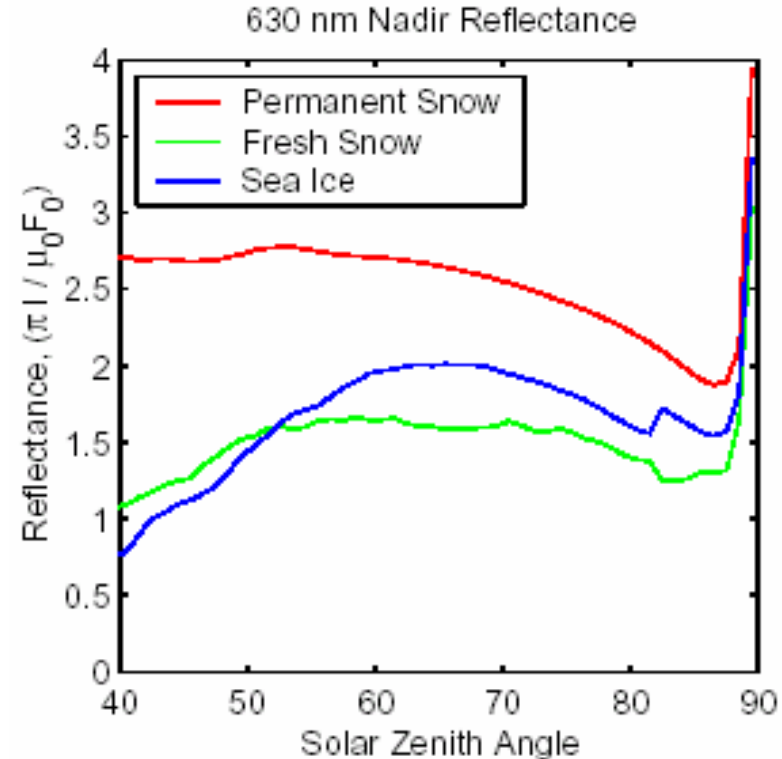
- Check if ADMs can treat large albedo seasonal variations of sea ice and fresh snow scenes.
- Estimate the error in the irradiance derived from ADMs using two sets of sea ice ADMs.

Snow/Ice ADM Scene Type

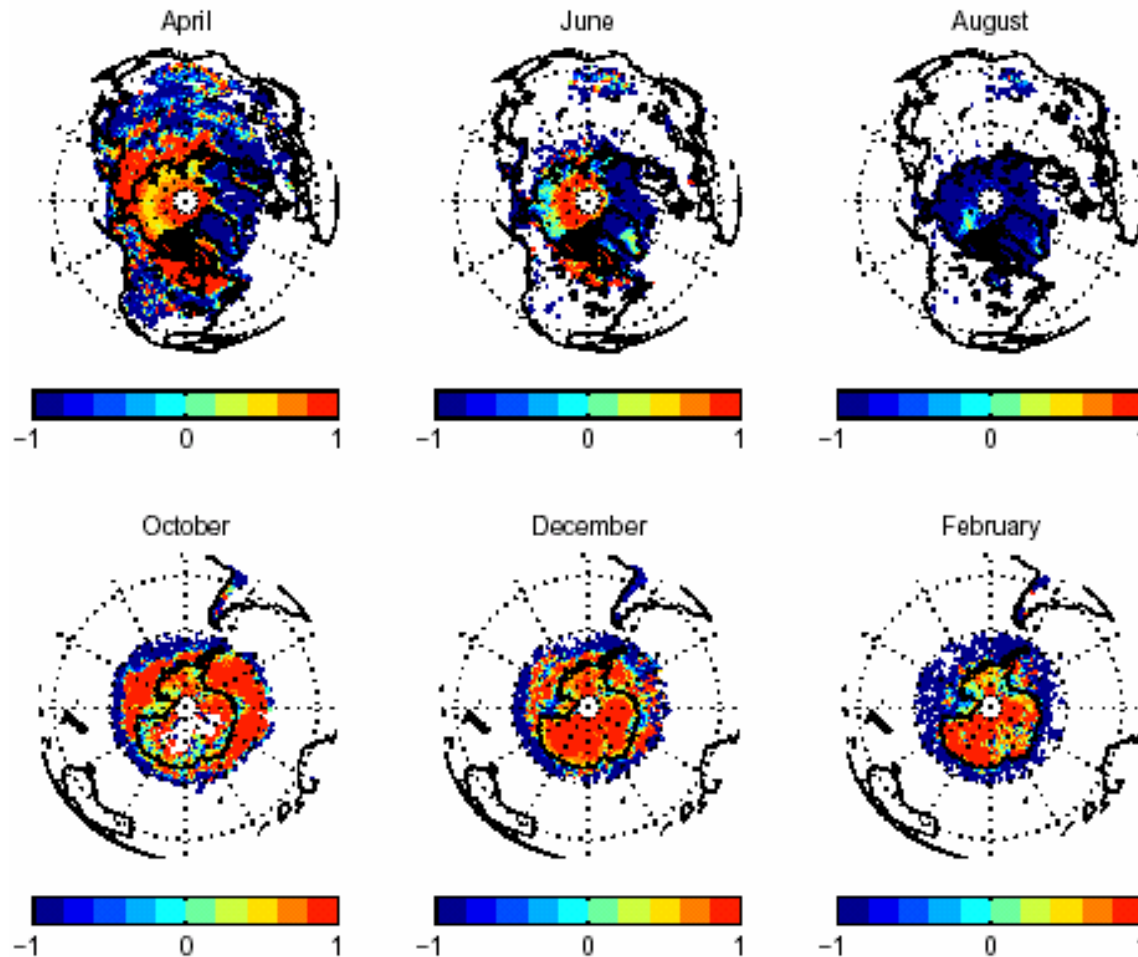
	Cloud Fraction	Snow/Ice Fraction	Optical Thickness	Surface Type
Permanent Snow	0, 0.001, 0.25, 0.50, 0.75, 0.999, 1.0	1.0	$\tau \leq 10$ $\tau > 10$	Bright Dark
Fresh Snow	0, 0.01, 0.25, 0.50, 0.75, 0.99, 1.0	0, 0.01, 0.25, 0.50, 0.75, 0.99, 1.0	$\tau \leq 10$ $\tau > 10$	Bright Dark
Sea Ice	0, 0.01, 0.25, 0.50, 0.75, 0.99, 1.0	0, 0.01, 0.25, 0.50, 0.75, 0.99, 1.0	$\tau \leq 10$ $\tau > 10$	Bright Dark

Determine Bright/Dark Snow and Sea Ice

1. Obtain nadir view MODIS reflectance at 630 nm as a function of solar zenith angle
2. Compute the probability of the snow and sea ice surface reflectance in a 1° by 1° area that is greater than the mean value.



Monthly Snow maps derived from nadir view reflectance at 630 nm



$P = 1$
Reflectance is
always greater
than the mean

$P = -1$
Reflectance is
always less
than the mean

Probability of the reflectance that is higher than the mean is

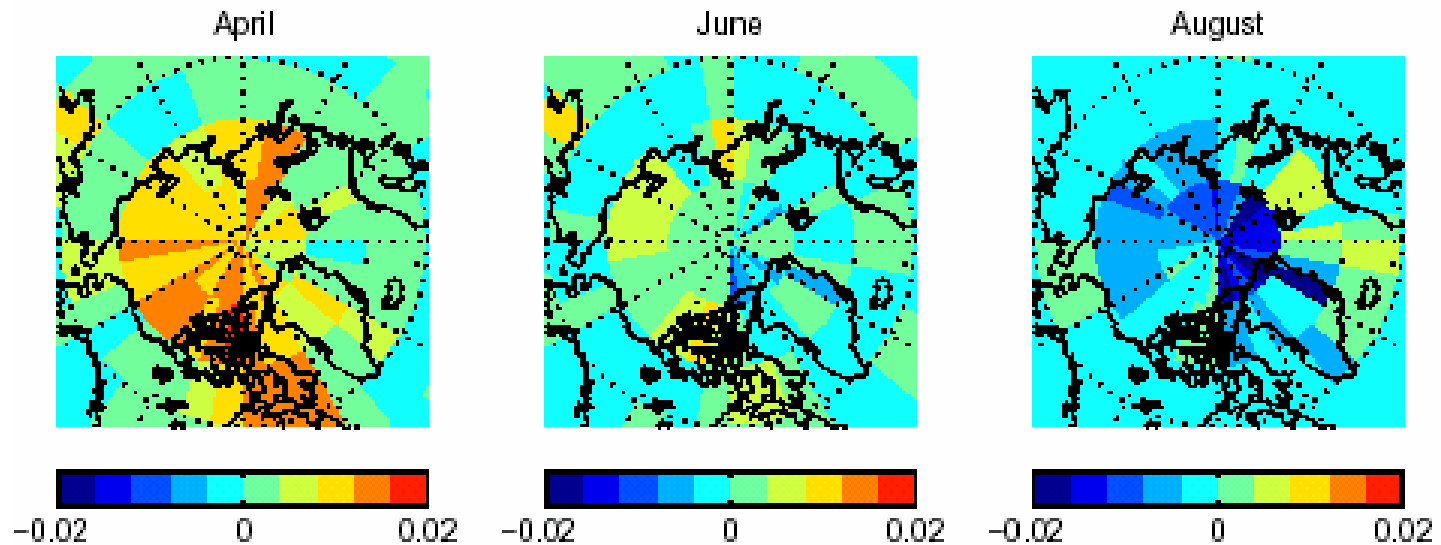
$$Pr = (P+1)/2$$

Comparison of A derived by $A = \frac{I}{\bar{I}} \bar{A}$ and \bar{A}

where A is the albedo derived from ADMs

\bar{A} is the mean Albedo of a given scene type

Albedo Difference Averaged over 10 by 10 Grid Boxes



Albedo difference caused by atmospheric and surface property differences

How large is the irradiance error caused by the surface property difference?

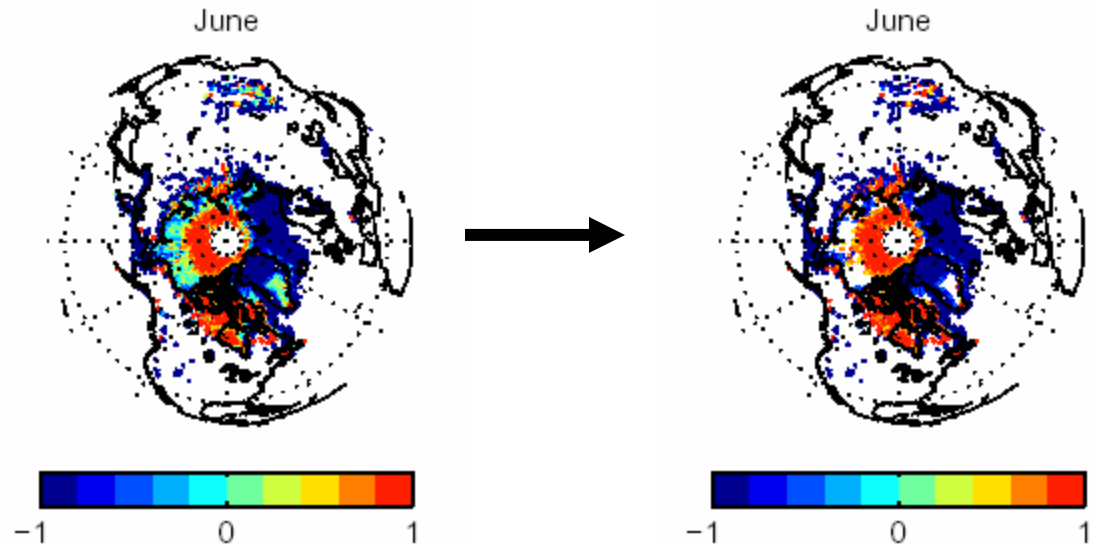
- The error is not equal to $F - \bar{F}$
- The irradiance error is approximately equal to the relative difference between the anisotropic factor used to derive the irradiance and the true anisotropic factor.

$$\frac{\Delta F}{F} = \frac{\Delta R}{R}$$

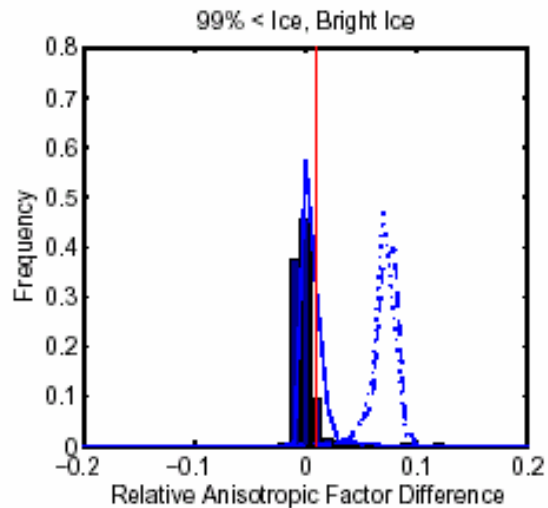
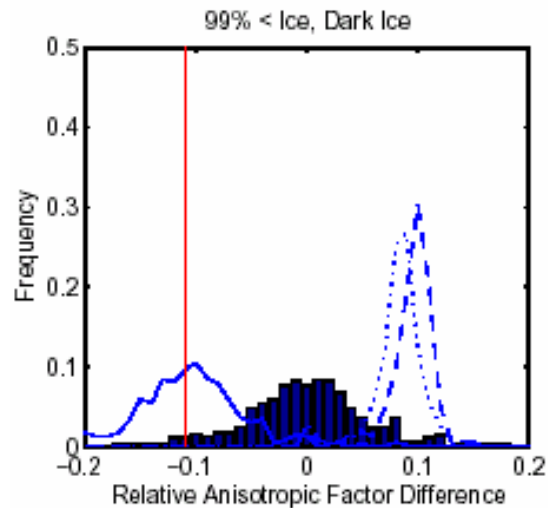
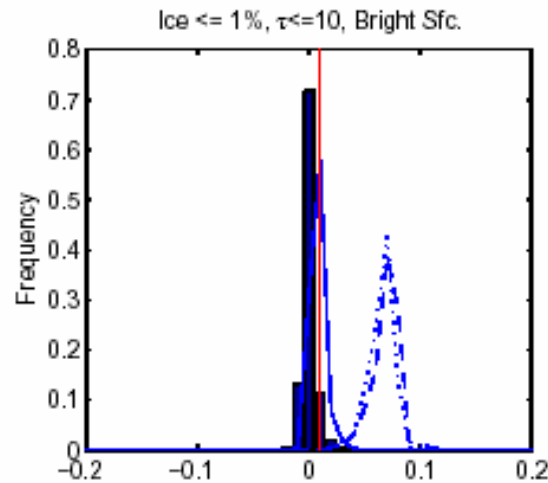
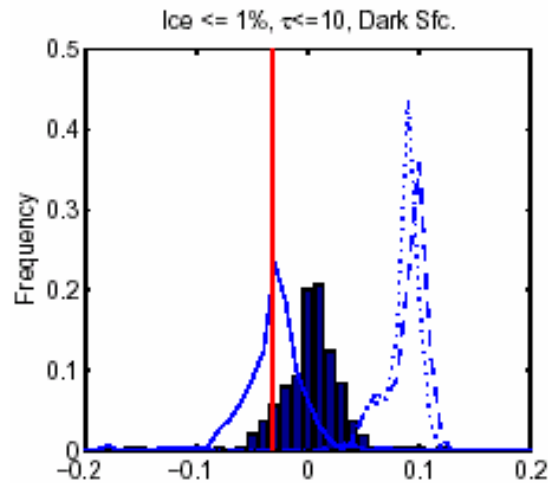
- Use a different set of ADMs to estimate the error.

Second ADM Set

- Instead of using 0 as a threshold to determine dark and bright snow and sea ice surfaces, use 0.5 for the bright surface threshold and -0.5 for the dark surface threshold.



Comparison of Two Sets of ADMs



Histogram:
relative anisotropic factor
difference $(R_2 - R_1)/R_1$

Relative radiance
difference $(I_2 - I_1)/I_1$

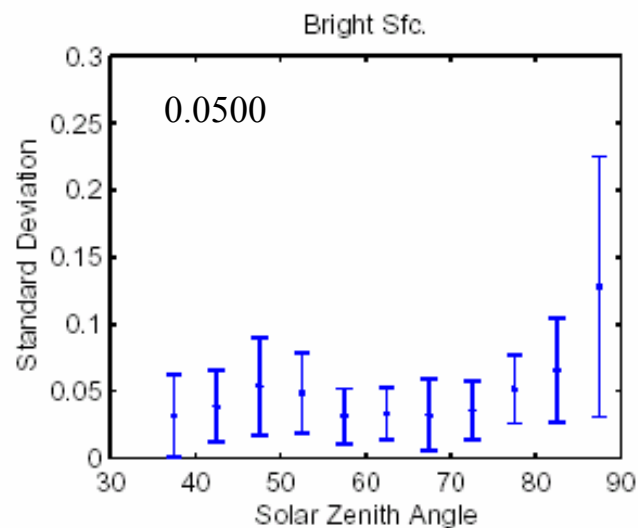
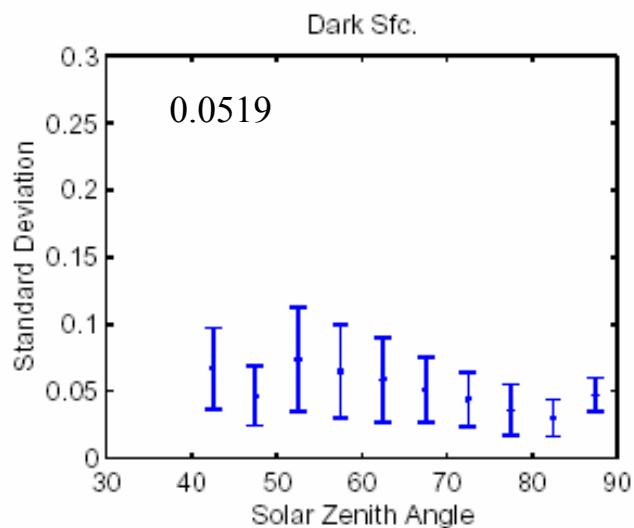
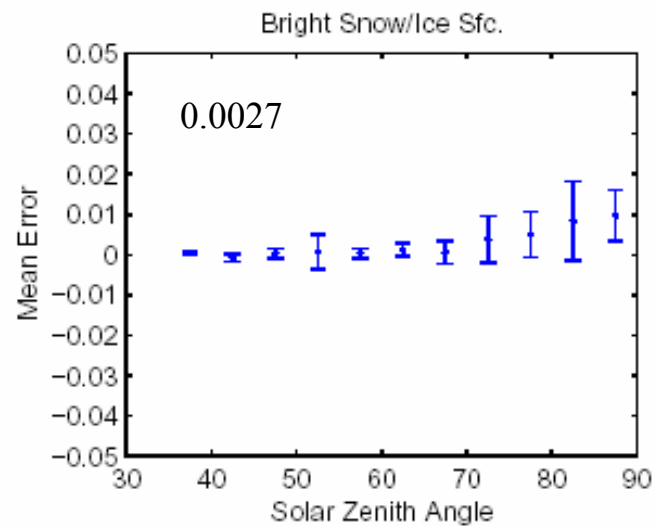
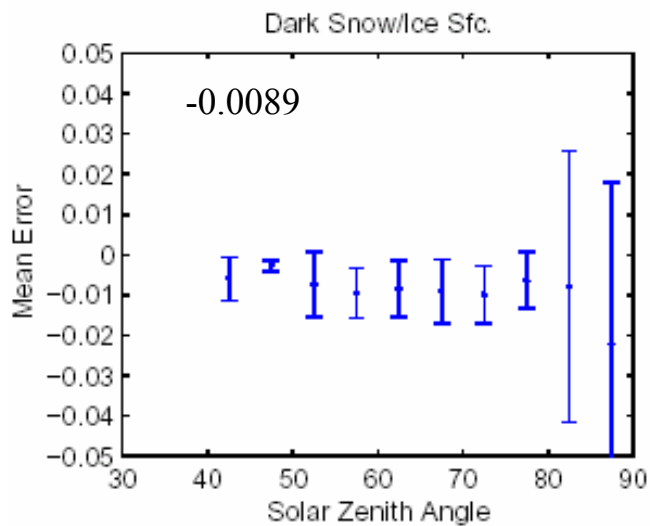
Relative albedo
difference $(A_2 - A_1)/A_1$

St. dev. of radiance (1st set)

St. dev. of radiance (2nd set)

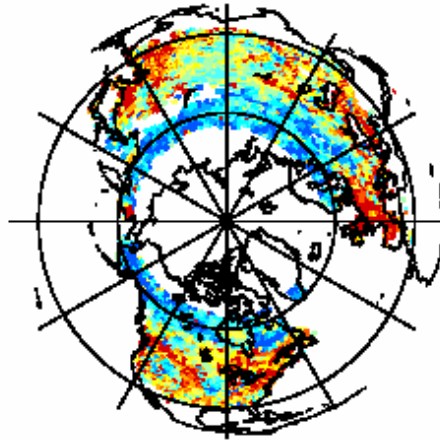
Solar zenith angle between 60 to 65 degrees

Bias Error and Standard Deviation

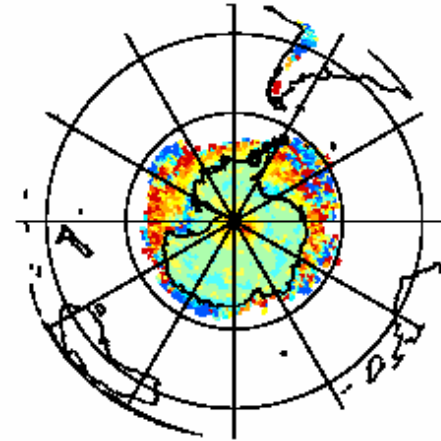
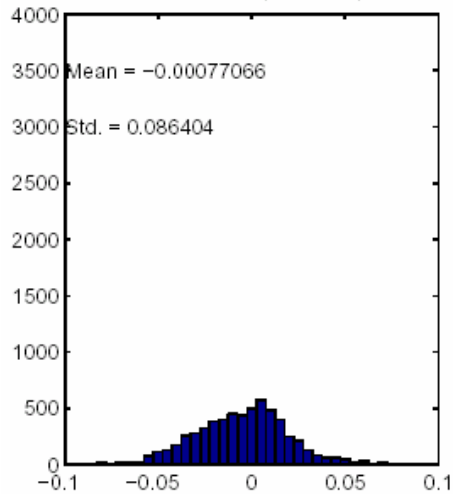


Clear-sky Land ADMs

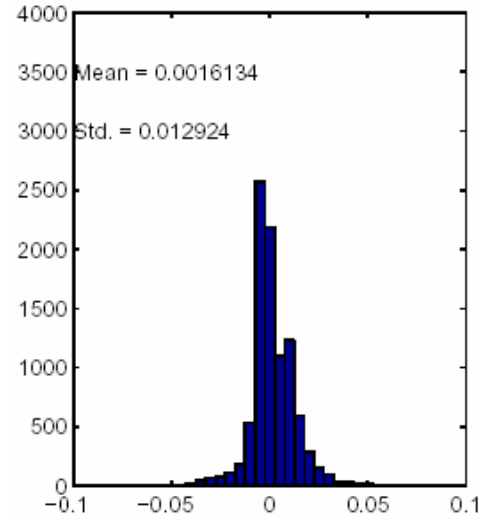
(Irradiance derived from FIT – Irradiance Derived from SIB) / SIB



Albedo Difference, Fit - SIA, N.H.



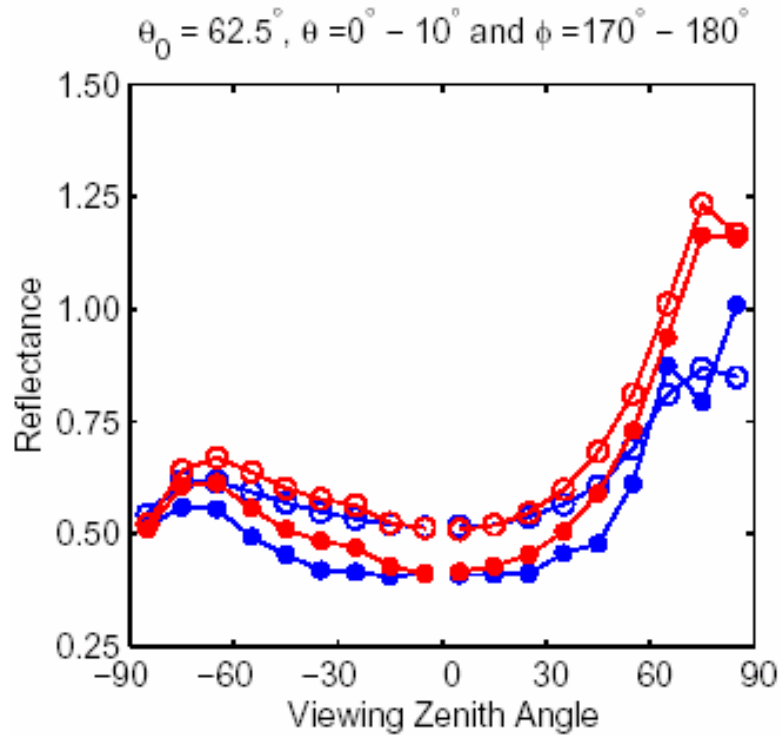
Albedo Difference, Fit - SIA, S.H.



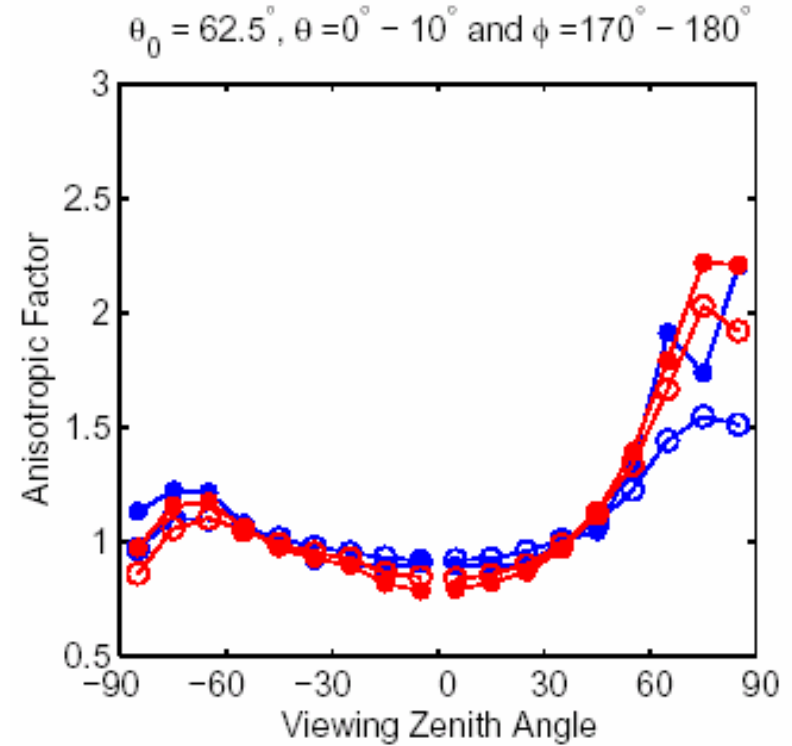
Conclusions

- Estimated bias error in the irradiance derived from sea ice ADMs is **-0.9%** for very dark ice and **0.3%** for very bright sea ice, if viewing angles are uniformly sampled.
- Estimated error in the instantaneous irradiance derived from sea ice ADMs is approximately **5%**.
- Mean albedo difference derived from two sets of clear-sky permanent snow ADMs is **0.002** and the standard deviation is **0.013**.

Radiance



Anisotropic Factor



- 99% < Bright Ice
- 99% < Dark Ice
- Ice <= 1%, $\tau <= 10$, Dark Sfc.
- Ice <= 1%, $\tau <= 10$, Bright Sfc.

Angular Bin Size

	Viewing Zenith Angle	Relative Azimuth Angle	Solar Zenith Angle
Permanent Snow	5	5	2
Fresh Snow	5	5	5
Sea Ice	5	5	5