

Terra Snow and Sea Ice Angular Distribution Model

Seiji Kato and Norman G. Loeb
Hampton University

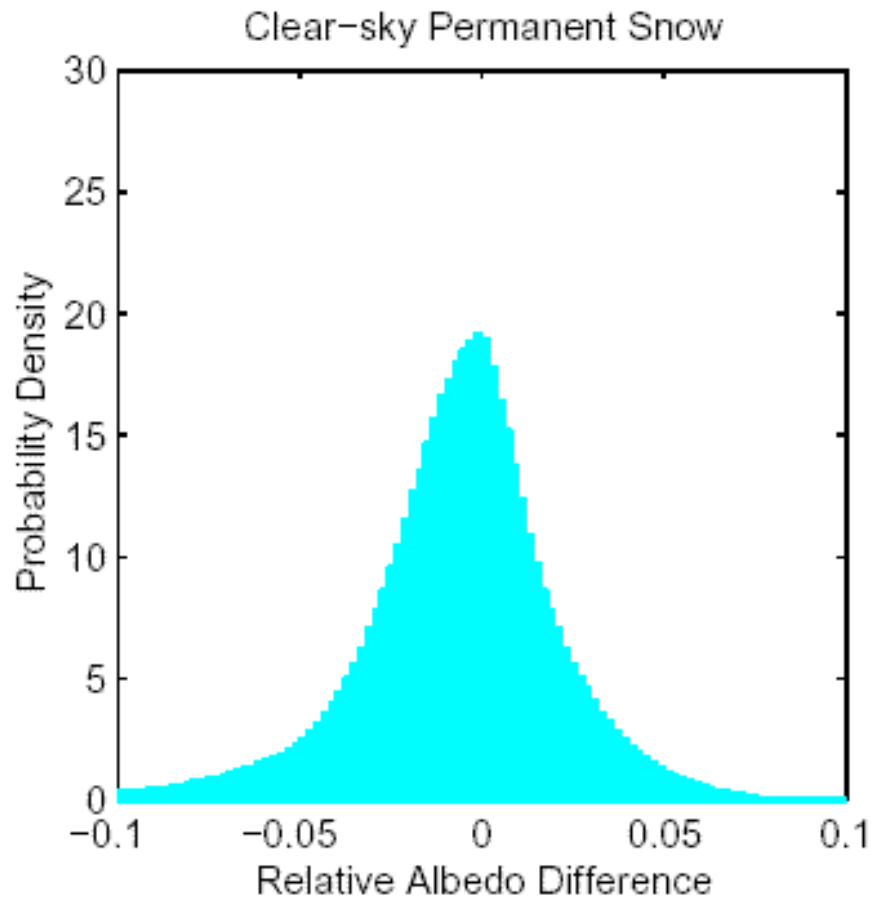
2nd CERES-II Science Team Meeting
Nov. 2-4, 2004



Outline

- Irradiance Error Estimate
- Comparison of ES8 – SSF irradiances derived over snow/sea ice surfaces
- Net irradiance over sea ice surface

Comparison of Permanent Snow Clear-sky Irradiance



$(\text{Land} - \text{Snow}) / \text{Snow}$

Mean Difference = -0.6 %
= -1.4 W m^{-2}
(Instantaneous value)

RMS Difference = 2.8 %
= 7.4 W m^{-2}

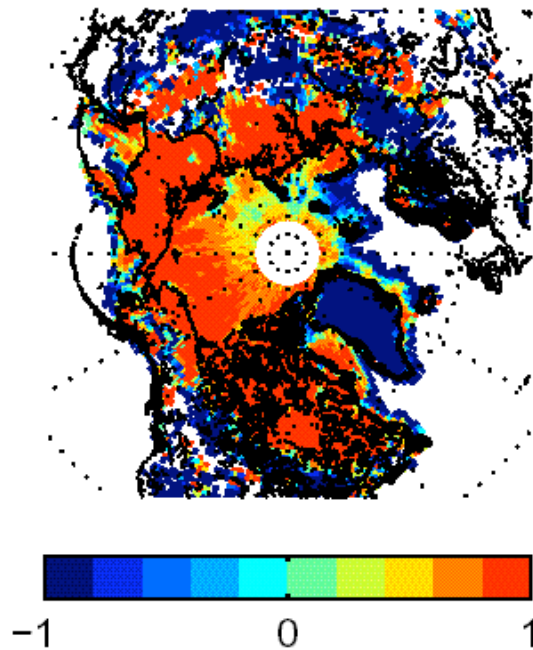
Sea Ice ADM Error Estimate

How much error in the flux caused by seasonal variations of sea ice properties?

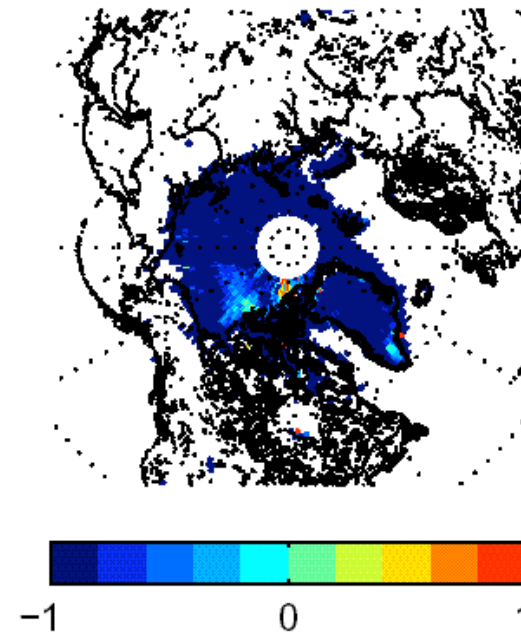
Surface brightness map from MODIS nadir-view reflectance

-1: Very Dark

1: Very Bright April



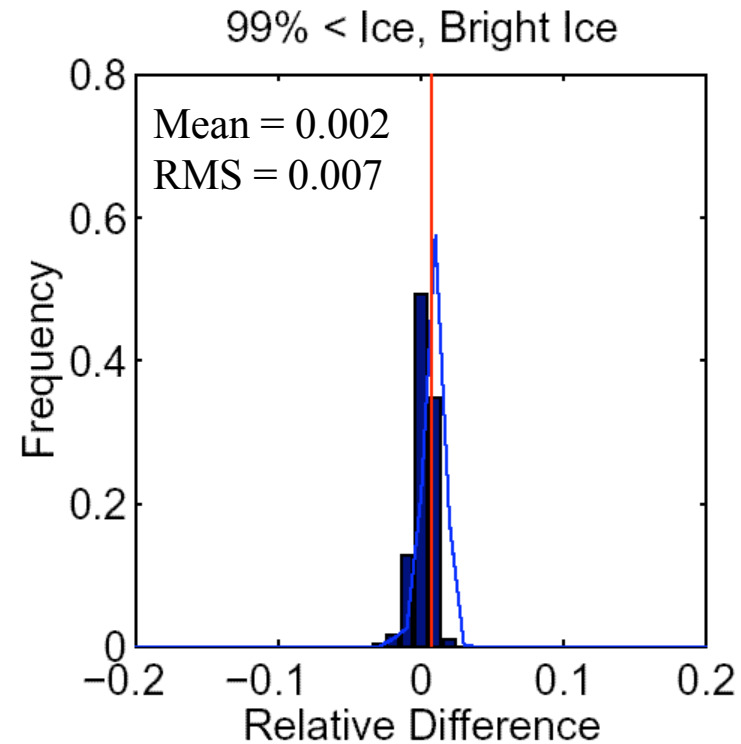
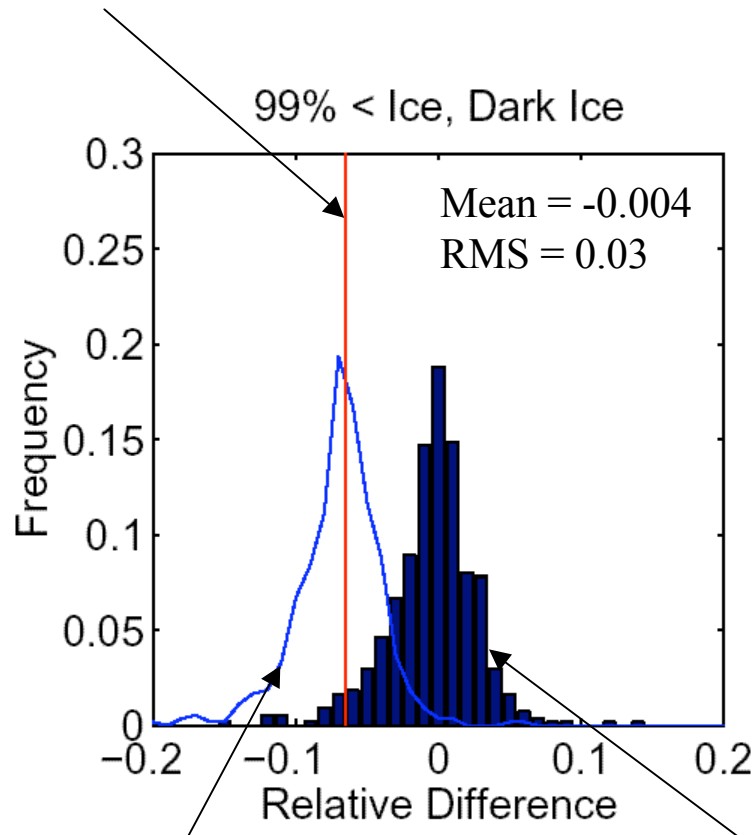
August



Dark and Bright Sea ice

Error caused by applying ADM to very dark or bright scenes.

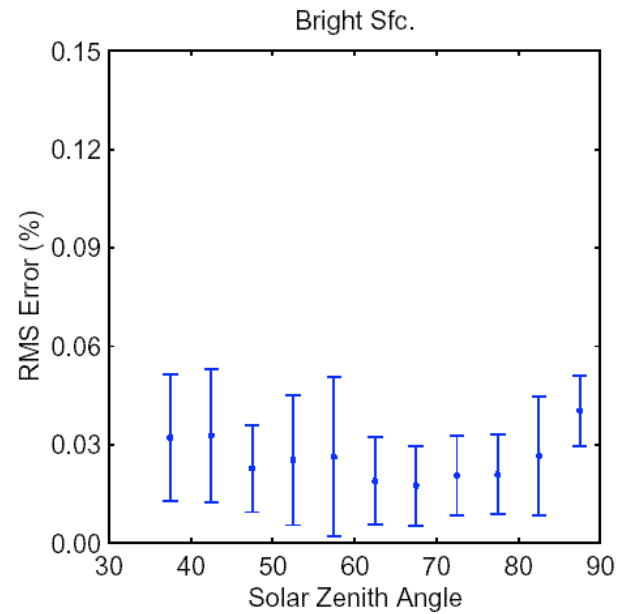
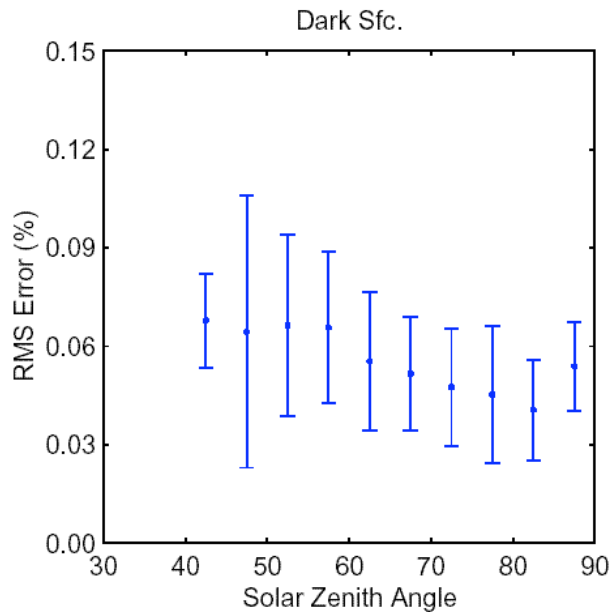
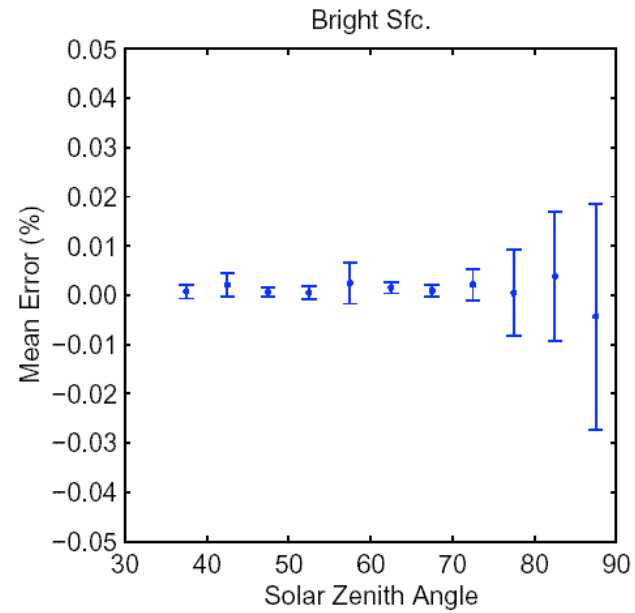
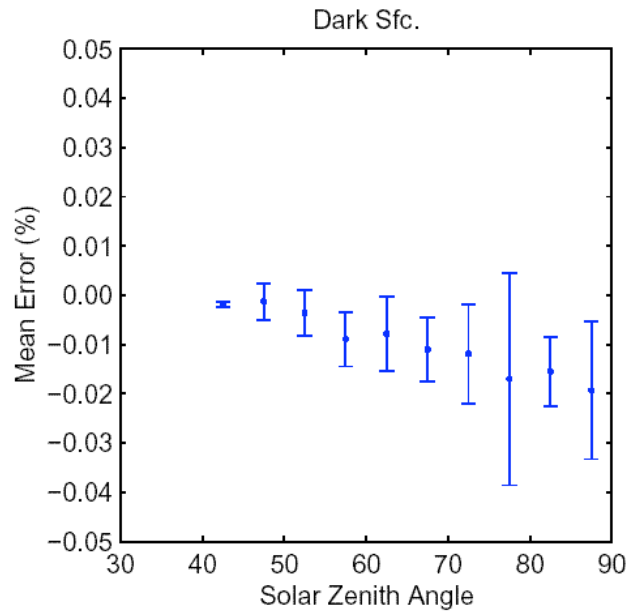
Relative Albedo Difference



Relative Anisotropic Factor Difference

Relative Reflectance Difference

Sea Ice Irradiance Mean and RMS Error



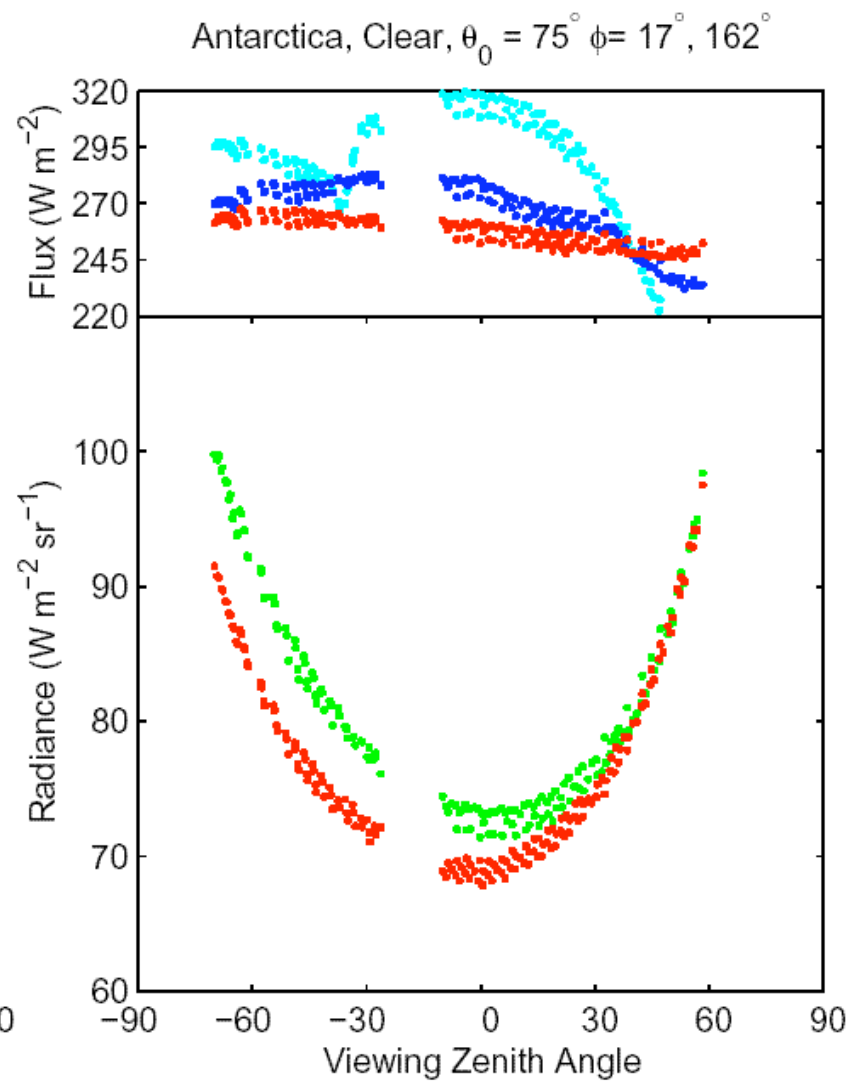
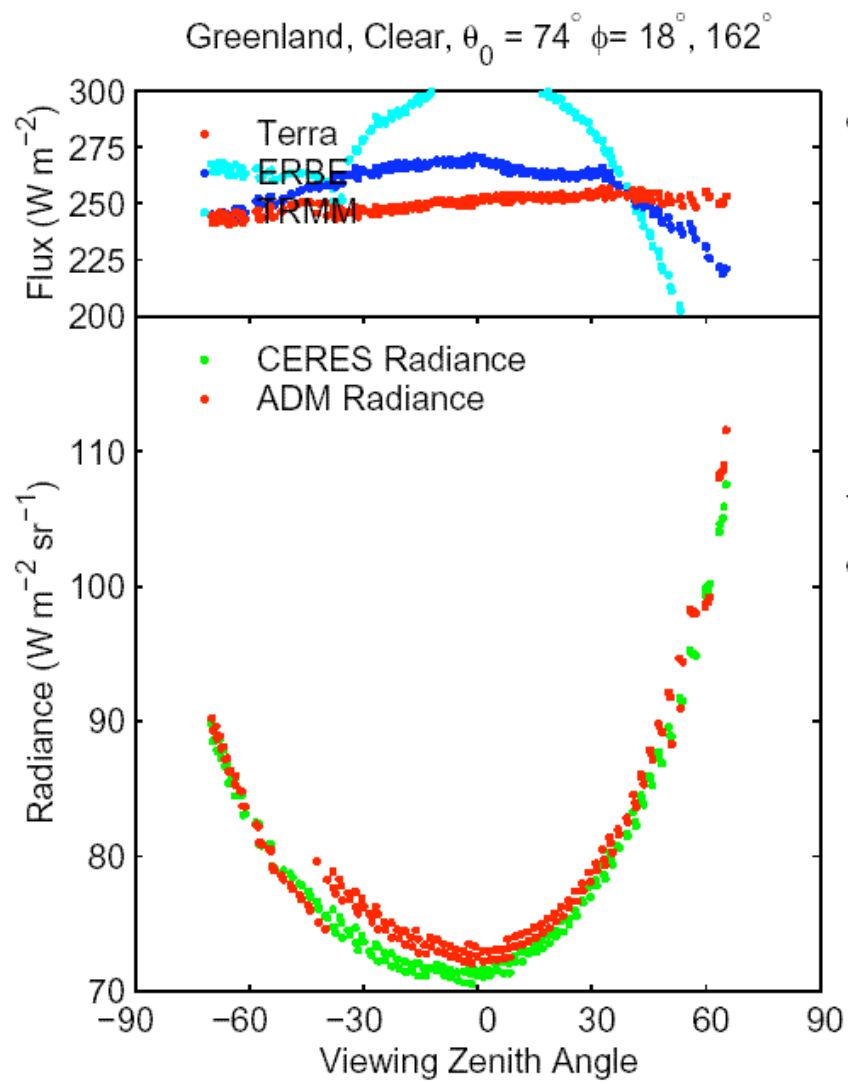
Regional Irradiance Error Estimate

Surface and Scene Type	Average Error (%)	RMS Error (%)
Permanent Snow, Clear-sky ^a	0.6	2.8
Fresh Snow, All-sky		
Bright Snow	0.1	5.0
Dark Snow	-0.1	3.5
Sea Ice, All-sky		
Bright Sea Ice	0.1	2.6
Dark Sea Ice	-1.0	5.6

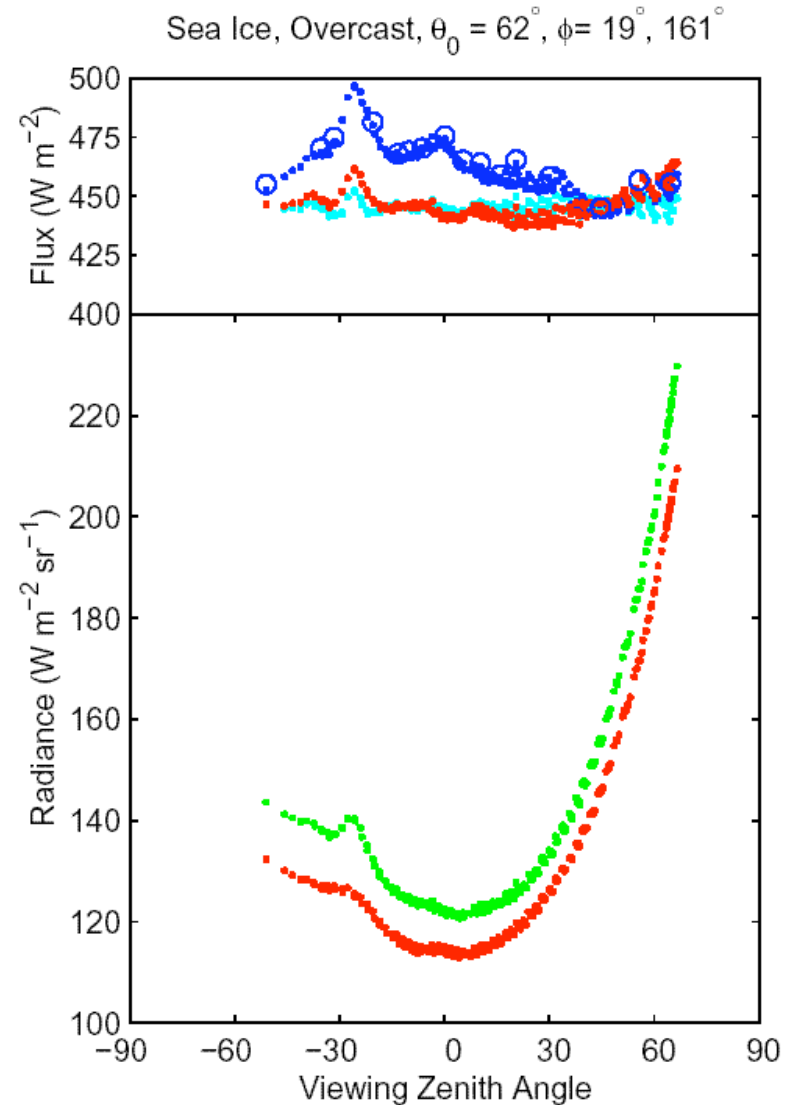
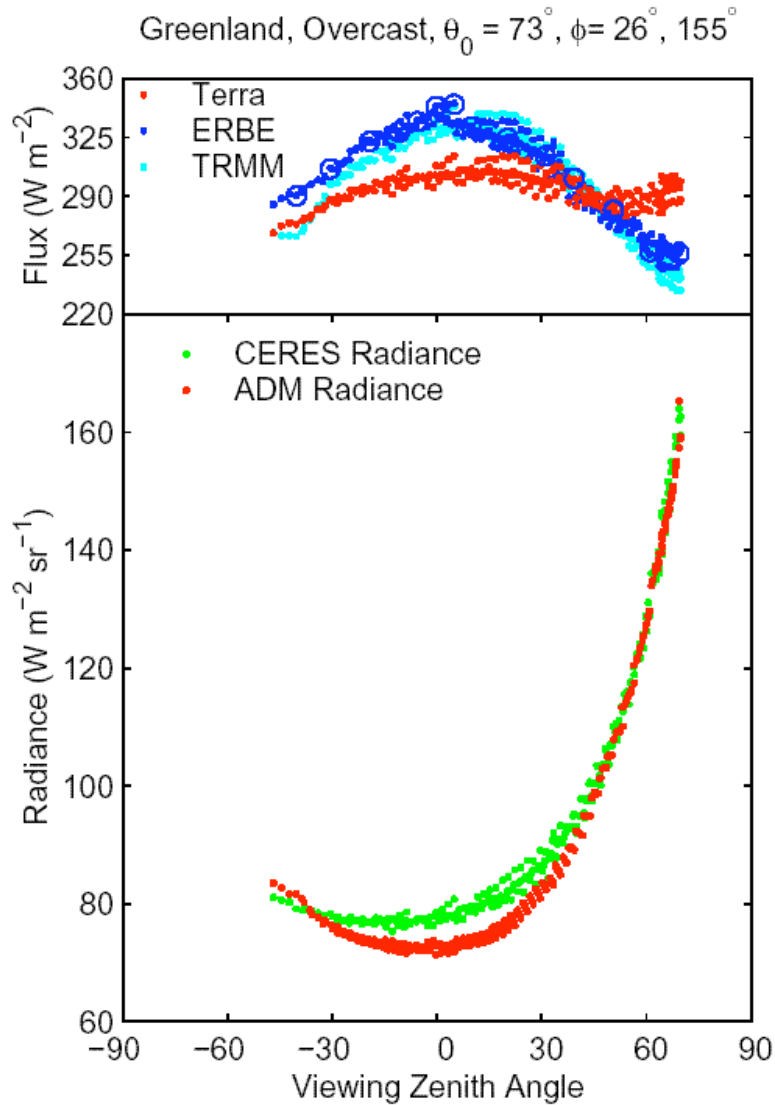
^a Difference from two independent ADMs

Terra, TRMM, and ERBE Snow ADM comparison

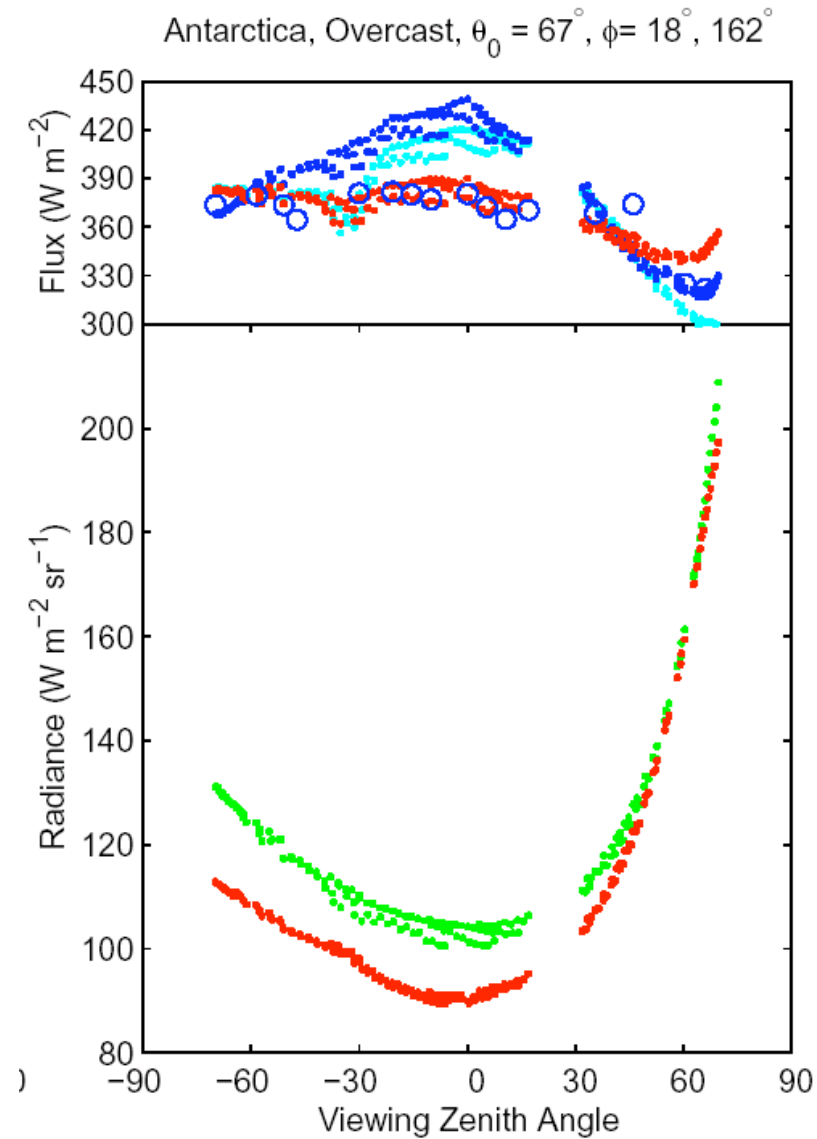
Clear-sky



Terra, TRMM, and ERBE Snow ADM Comparison: Overcast

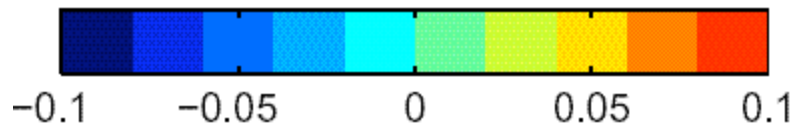
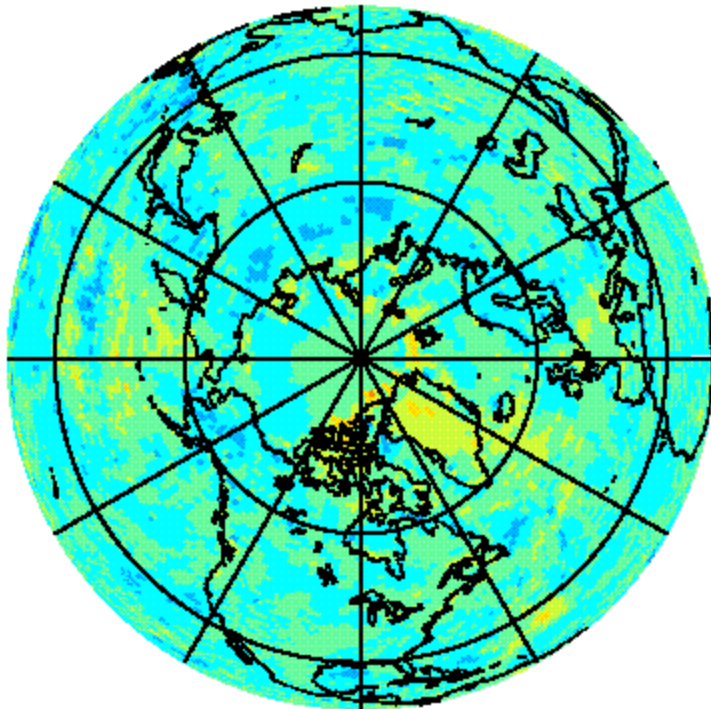


Permanent snow Overcast

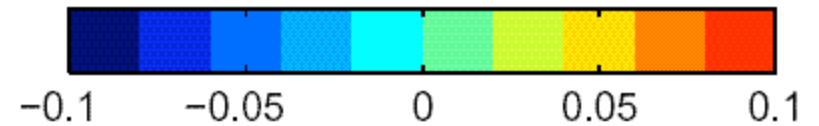
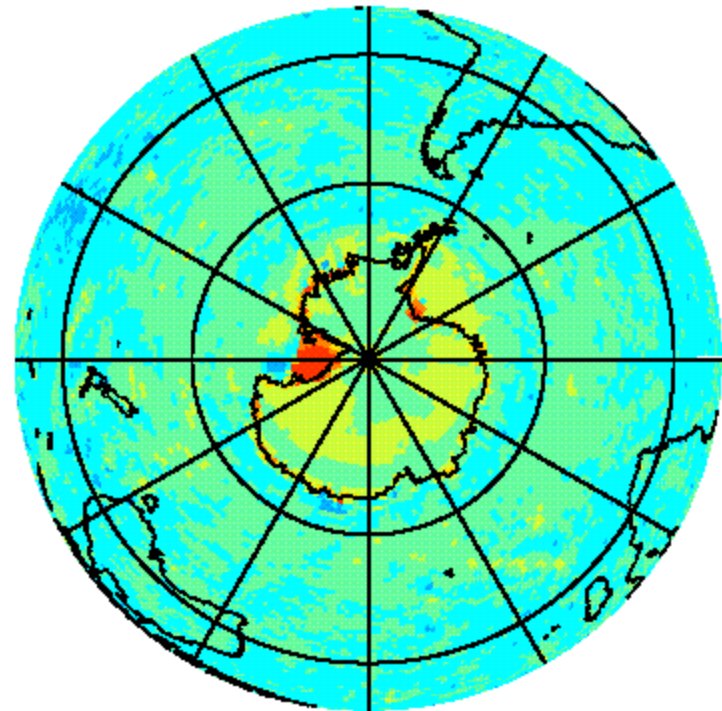


ERBE – SSF Albedo Difference

Albedo ES8 – Albedo SSF

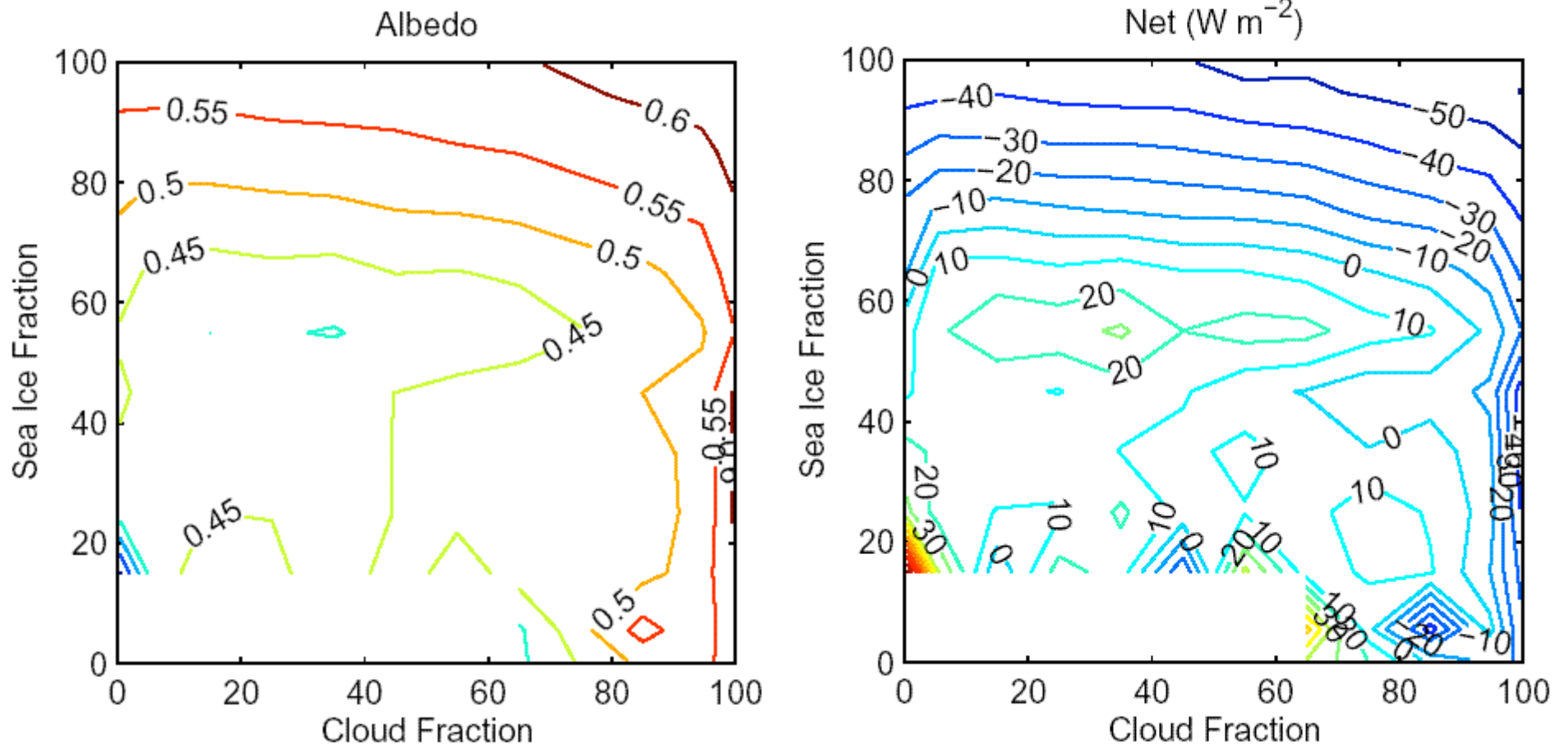


June



December

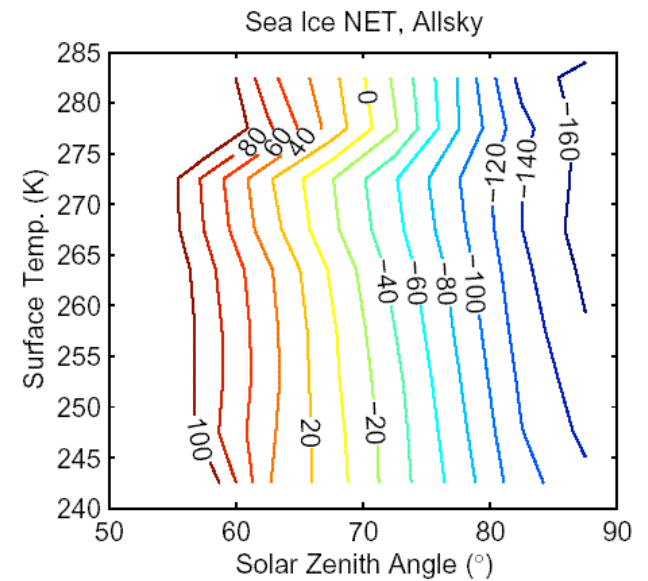
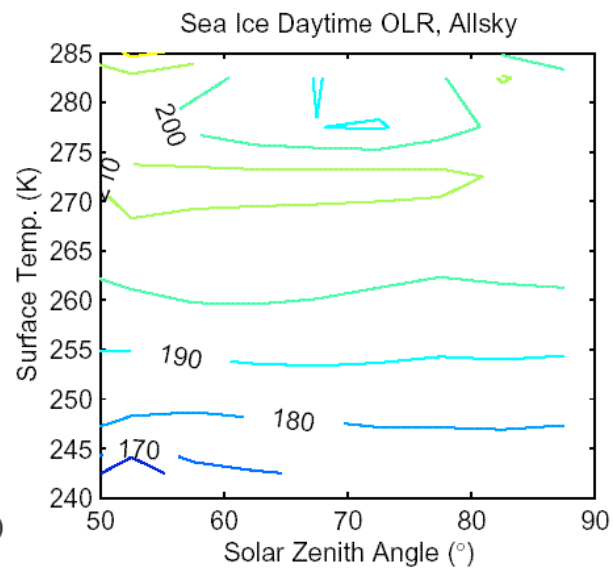
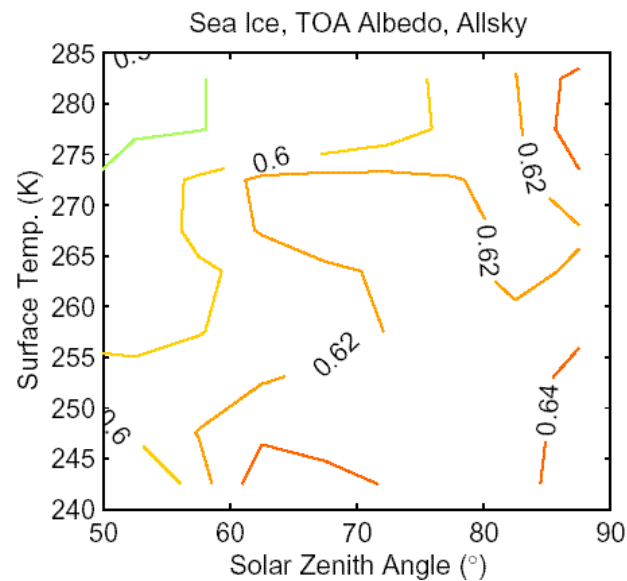
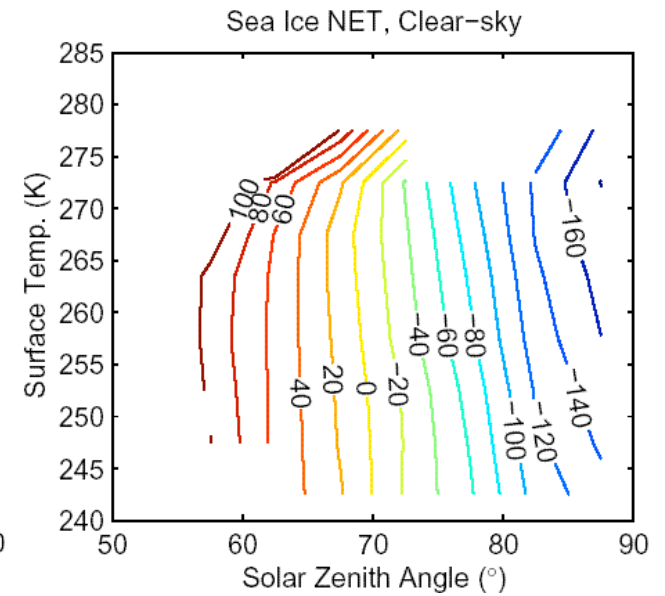
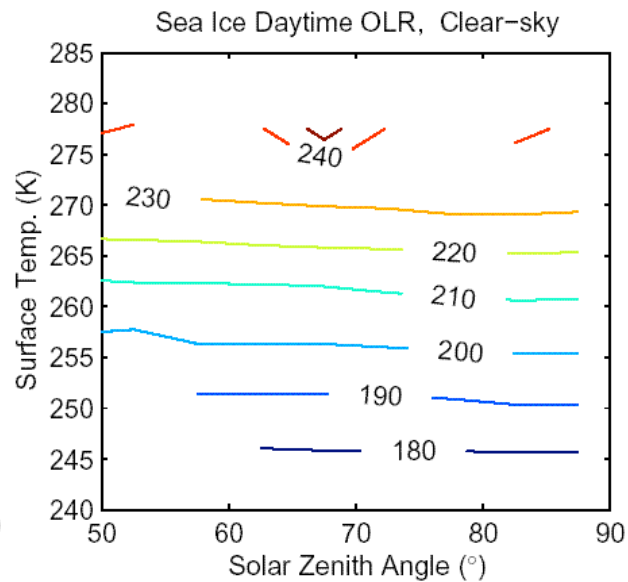
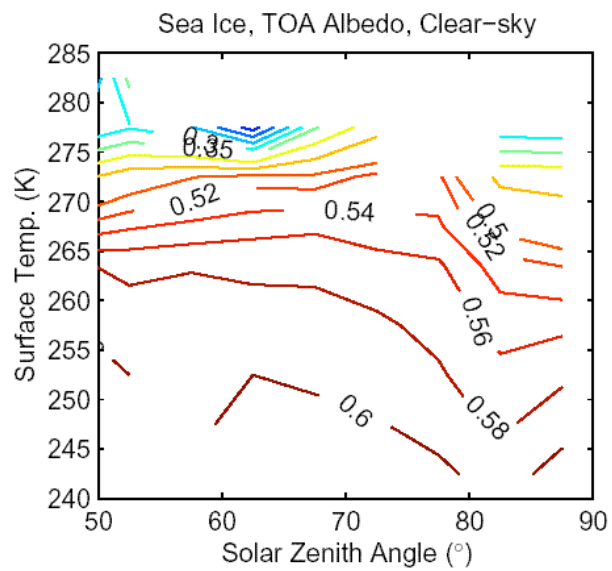
Effect of Clouds



Surface temperature: 260 K – 265 K

Solar Zenith Angle: 70 – 75°

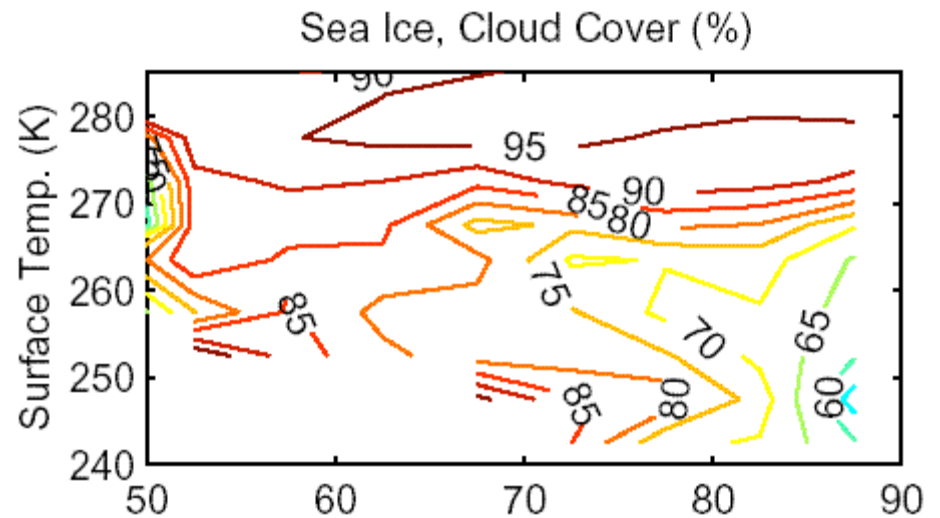
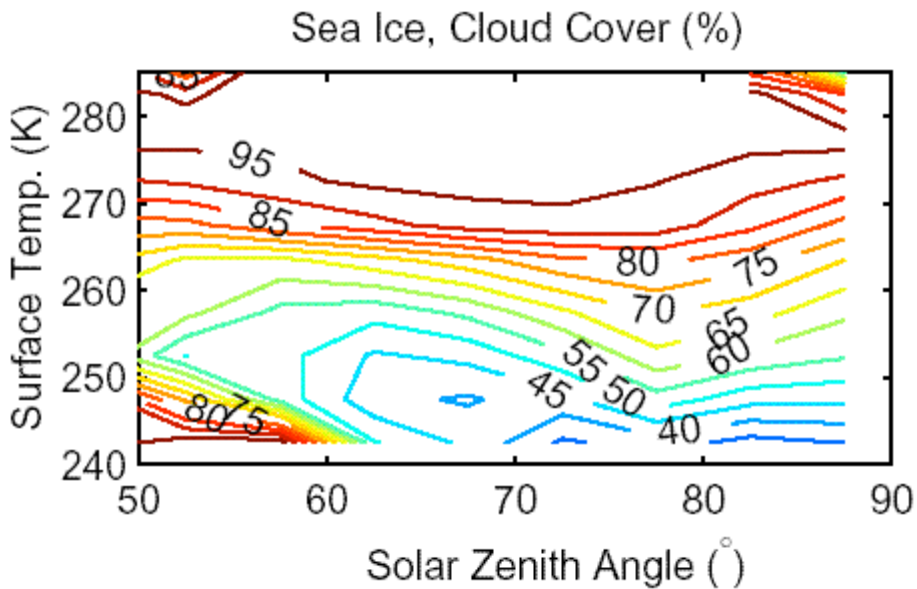
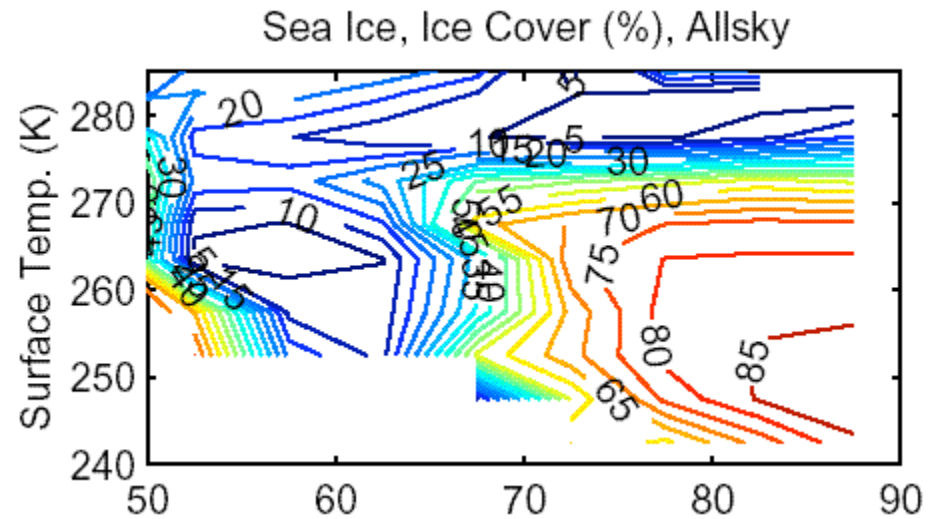
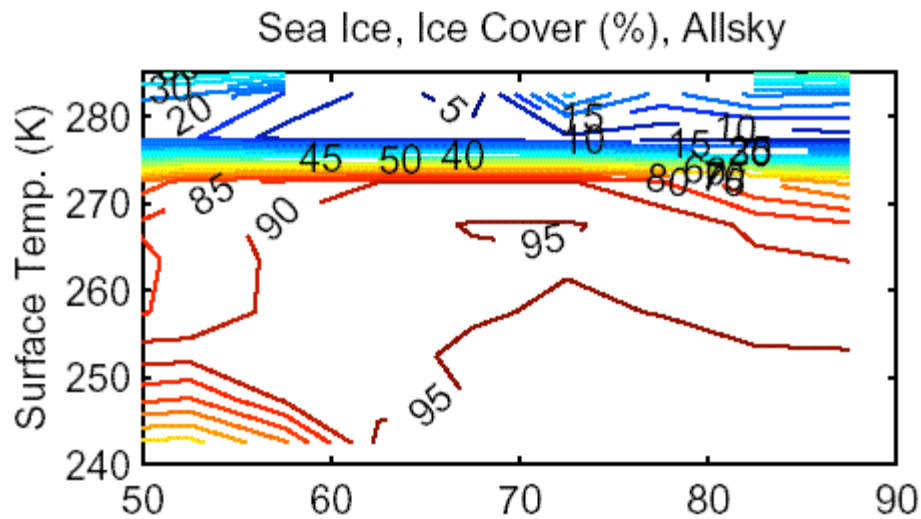
Net Irradiance over Sea Ice



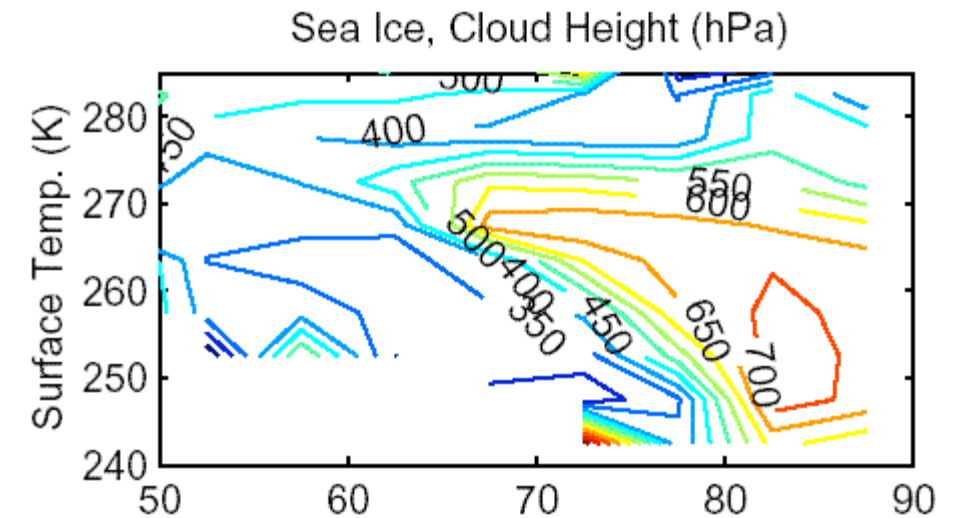
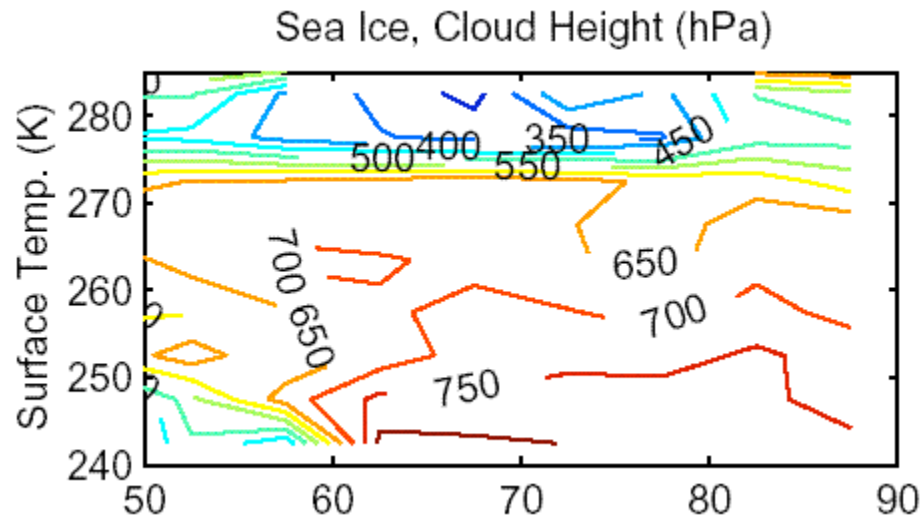
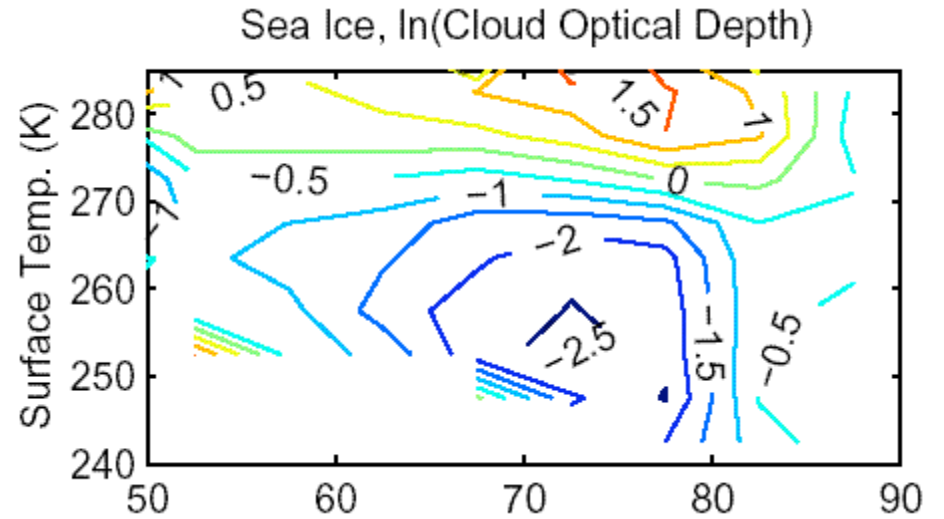
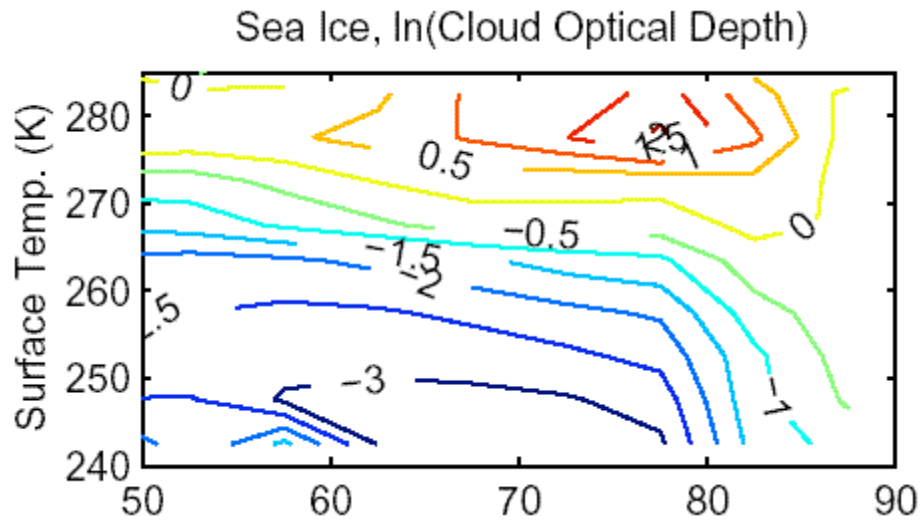
Summary and Conclusions

- Clear-sky permanent snow irradiance from two independent ADMs consistent to within 0.6%.
- Estimated regional irradiance error over sea ice approximately 1% and RMS error is 5.6%.
- Estimated regional irradiance error over fresh snow approximately 0.1% and RMS error is 5%.
- ERBE irradiance error over snow/ice is due to clouds and scene identifications.

Cloud and Sea Ice Properties



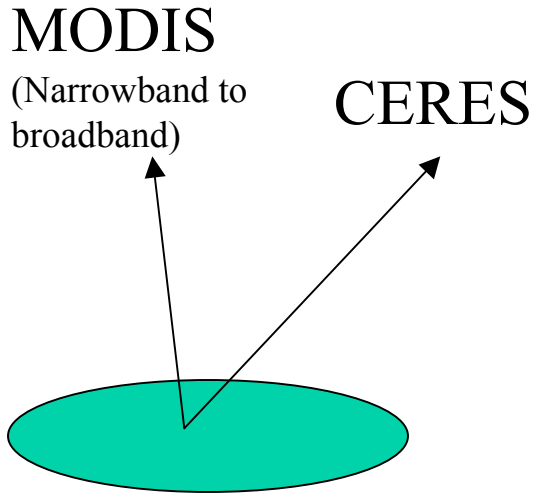
Clouds over Sea Ice



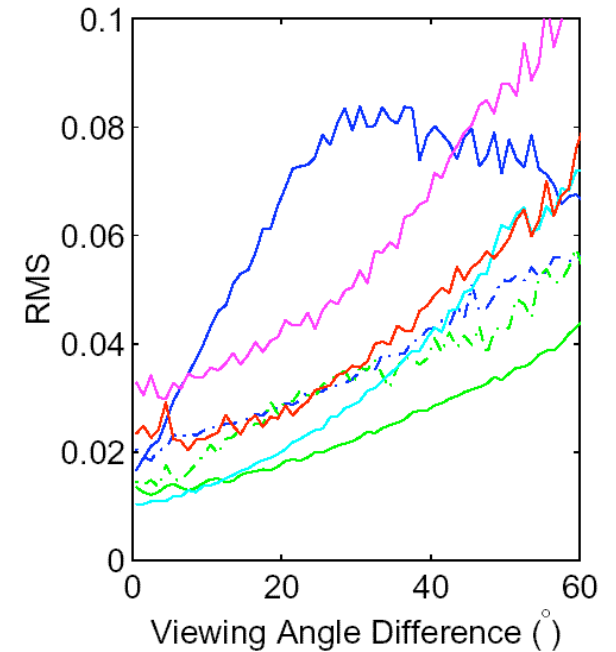
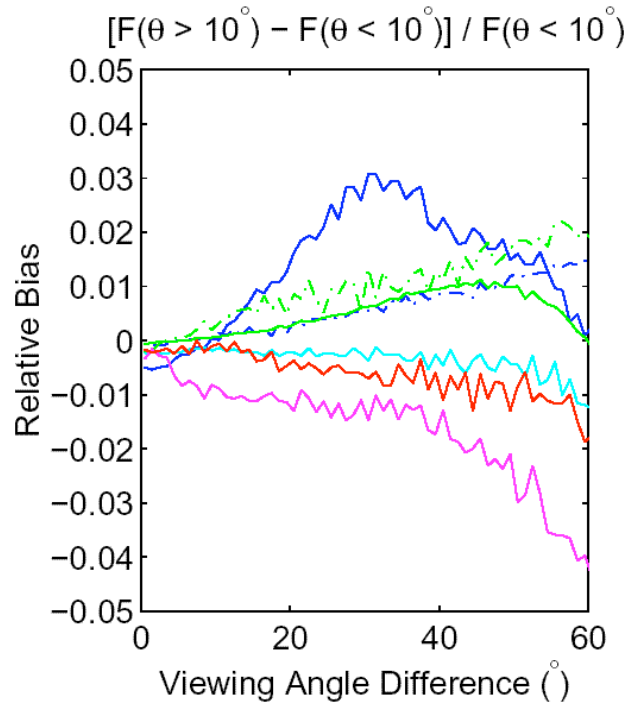
Snow and Ice ADM Scene Type Classifications

	Shortwave	Longwave
Permanent Snow SW (10) LW (24)	Cloud Fraction (6) Cloud (2) Snow Brightness (2)	Cloud Fraction (6) Tsfc (2) Tsfc-Tcld (2)
Fresh Snow SW(25) LW (24)	Cloud Fraction (6) Snow Fraction (6) Snow Brightness (2) Cloud Optical Depth (2)	Cloud Fraction (6) Tsfc (2) Tsfc-Tcld (2)
Sea Ice SW (25) LW (24)	Cloud Fraction (6) Ice Fraction (6) Ice Brightness (2) Cloud Optical Depth (2)	Cloud Fraction (6) Tsfc (2) Tsfc-Tcld (2)

Along-track Data SW

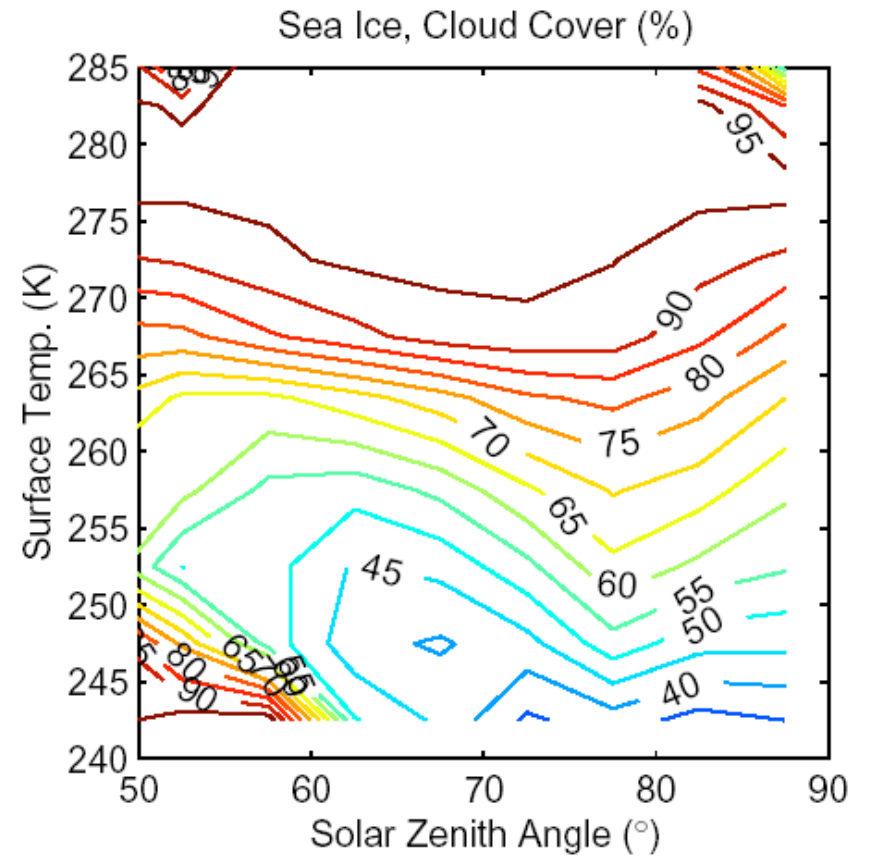
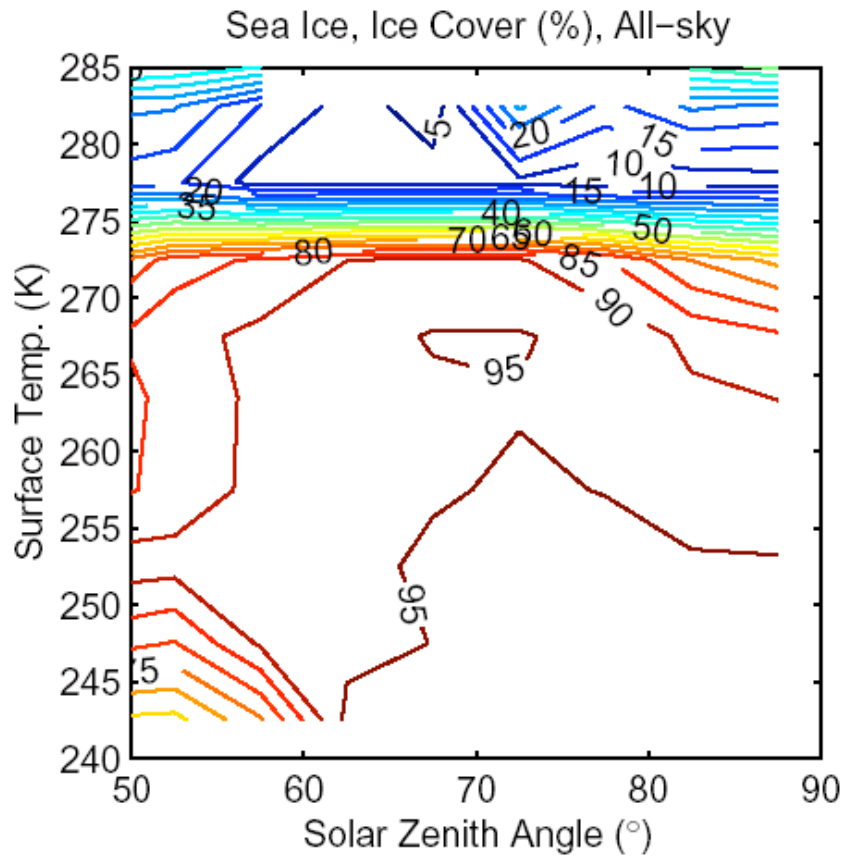


Narrowband to broadband
conversion gives 2sets of
irradiance from a footprint



- Ocean, Clr
- - - Ocean, Clc
- Land, Clr
- - - Land, Clc
- Permanent Snow
- Fresh Snow
- Sea Ice

Sea ice and Cloud Fraction



Surface Type Definition

Surface Type	Source	Description
Permanent Snow	IGBP surface type	Ice sheets Glaciers Ice shelf
Fresh Snow	NSIDC snow map and Imager	Seasonal snow over land
Sea Ice	NSIDC snow map and Imager	Sea ice Lake ice

Cloud Properties over Sea Ice

