Global land surface albedo climatology and spatial-temporal variation during 1981–2010 from multiple satellite products

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Introduction

Surface albedo, a variable defined as the ratio of the solar radiation reflected from Earth's surface to the solar radiation incident upon it, is critical to the regulation of Earth's surface energy budget. Significant changes in surface albedo are accompanied by variations in land cover and surface conditions, such as snow, vegetation, urbanization, and soil moisture.

Problems of the Existing Global Satellite Albedo Products

Biases and uncertainties based on validation against ground measurements and products inter-comparison.

- Inaccurate atmospheric correction due to aerosol over/underestimation
- Differences in cloud masking algorithms: separating cloud and snow
- Differences in albedo product definition: black-sky albedo (BSA) and/or white-sky albedo (WSA)
- Differences in temporal compositing: temporal smoothing or tendency to snow free albedo (e.g., MODIS algorithm)
- Narrowband-to-broadband albedo conversions

Objectives

- Identify the differences and potential issues of the existing global satellite albedo datasets
- Make possible suggestions to modeling communities when facing dataset selection for model validation and calibration purposes
- Analyze the global/regional trend of surface albedo due to climate change in recent decades

Data

Table 1. Global satellite albedo products used in this study.

Albedo datasets	Input source	Resolution	Frequency	Temporal coverage	Type of albedo
GLASS	AVHRR and MODIS	0.05°	8-day	1981–present	BSA & WSA
GlobAlbedo	AATSR, MERIS, VGT, and MODIS	0.05°	Monthly	1998–2011	BSA & WSA
MERIS	MERIS	0.25°	Monthly	2002–2006	BSA
MODIS	MODIS	0.05°	8-day	2000–present	BSA & WSA
CLARA-SAL	AVHRR	0.25°	10-day and Monthly	1982–2009	BSA
ERBE	ERBE	2.5°	Monthly	1985–1989	BSA

Table 2. Global satellite surface shortwave radiation products used in the comparison.

Albedo datasets	Full name	Spatial resolution	Temporal coverage
GEWEX	Global energy and water exchanges project	1°	1983–2007
ISCCP	International satellite cloud climatology project	280 km (2.5°)	1983–2009
CERES	Clouds and Earth's radiant energy system	1°	2000–2012

Results

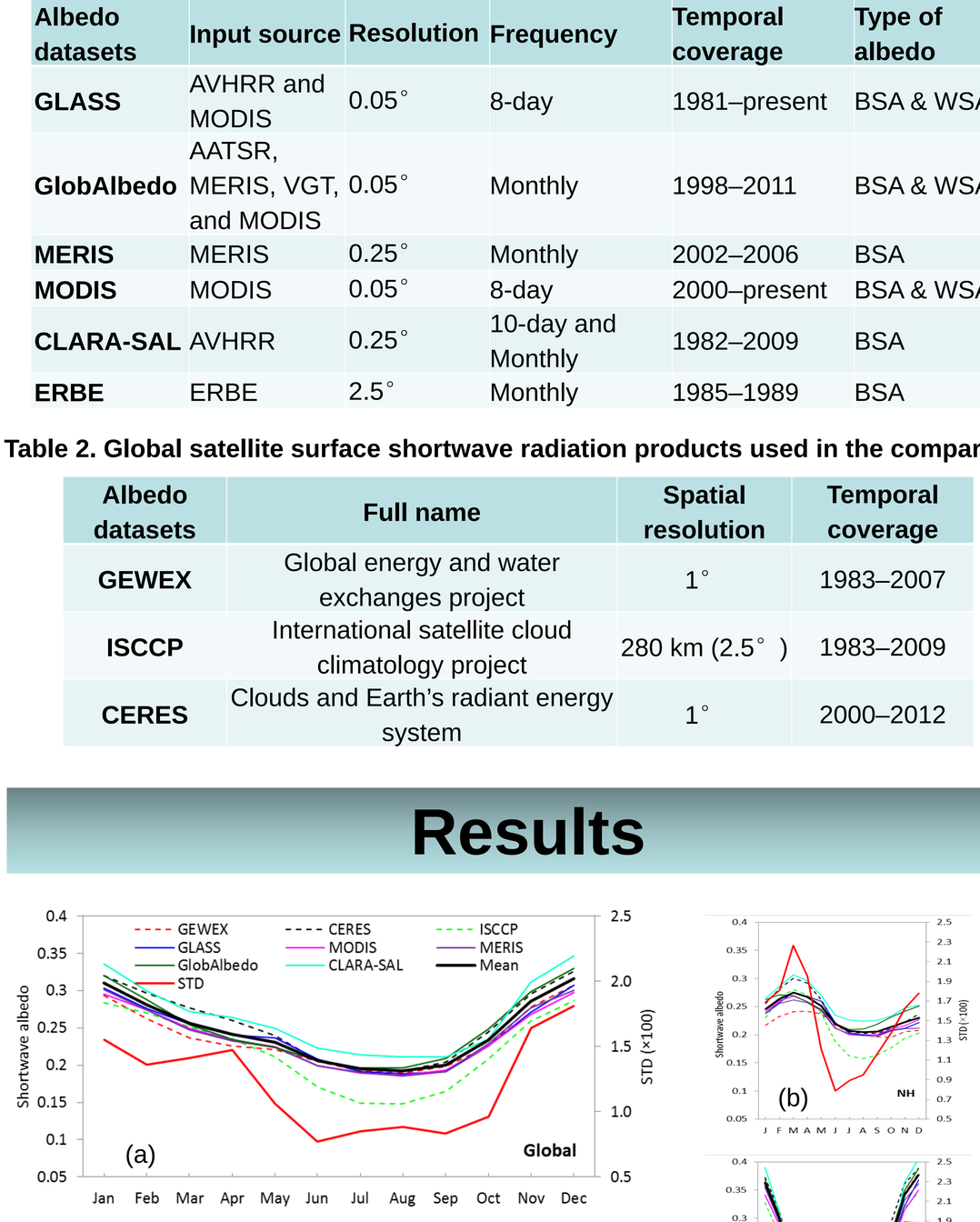

Fig. 1. Monthly climatological surface shortwave albedo derived from satellite-based albedo datasets for the globe (a); the Northern Hemisphere (b); and the Southern Hemisphere (c). The "mean" and "STD" are calculated from all the datasets except the ISCCP.

Results (cont'd)

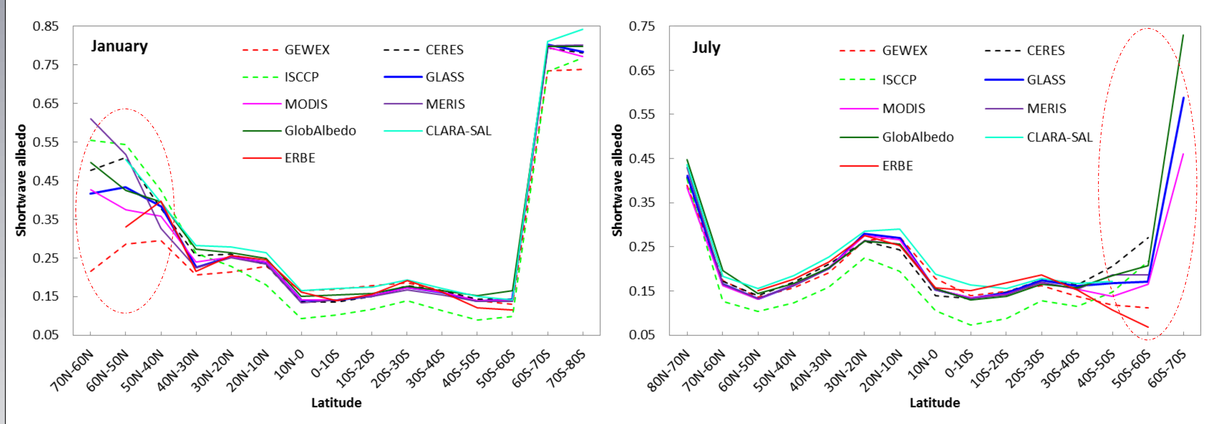

Fig. 2. Climatological surface shortwave albedo at different latitudes for: January (a) and July (b).

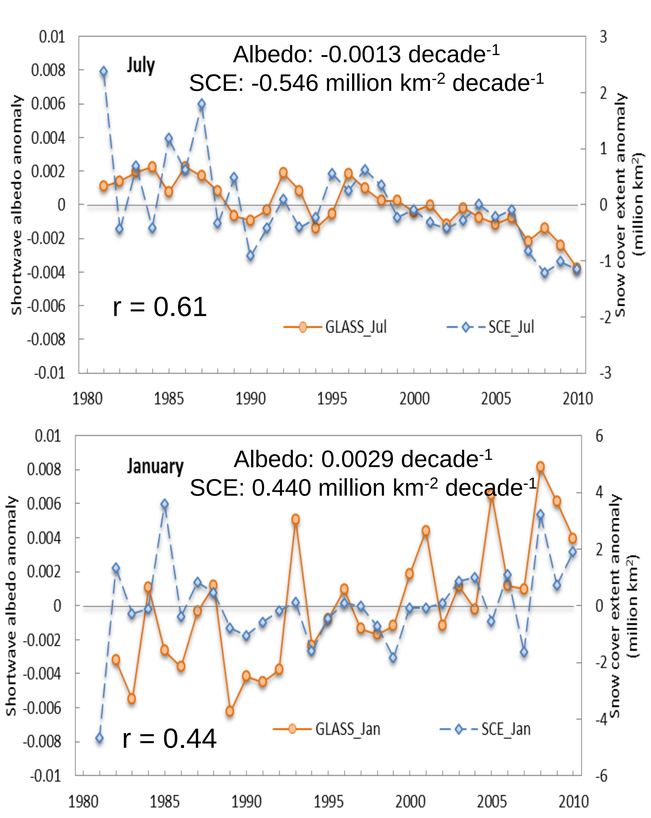

Fig. 3. Surface albedo anomalies for the Northern Hemisphere in July and January, from the GLASS albedo product and snow cover extent anomalies for 1981–2010.

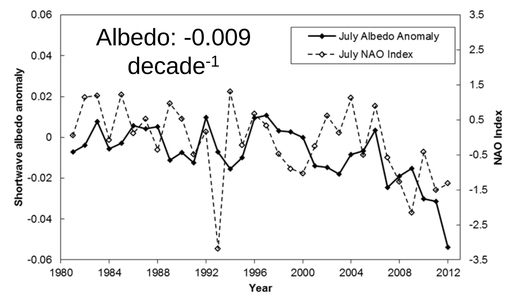

Fig. 4. Surface albedo changes over the entire Greenland from GLASS data in July and NAO index (1981–2012).

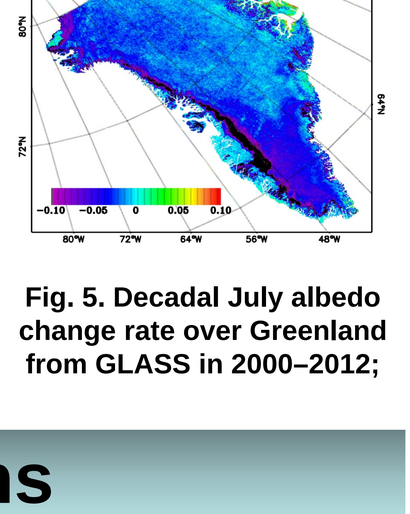

Fig. 5. Decadal July albedo change rate over Greenland from GLASS in 2000–2012;

Conclusions

- Most of the albedo products can achieve an agreement with a difference of 0.02-0.03 in global climatological albedo values, except ISCCP
- Albedo climatology from GLASS, MODIS, and MERIS are the best choices for climate modeling
- Large differences of albedo values are found at high-latitude in winters
- Albedo changes are significant both globally and regionally and are accelerating
- In the Northern Hemisphere, albedo is decreasing with decreased snow cover in summer and increasing with increased snow cover in winter, during the past three decades
- A more accurate long-term global albedo dataset can be derived to resolve observed inconsistences, relying on the recent techniques of data fusion

References

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