Evaluation of the MOD10A1 Albedo Product over Greenland

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Introduction

Since there is minimal validation of the MOD10A1(Terra) and MYD10A1 (Aqua) daily snow albedo products, validation work is needed to access the usefulness of these products for science applications. This study aims to give users of MODIS snow albedo products insight into the accuracy of the daily snow albedo product through comparisons with ground measurements of surface albedo available from several Greenland Climate Network Automatic Weather Stations (AWS) as in previous validation studies of the 16-day MODIS albedo product (e.g. MOD43). These comparisons improve our understanding of the accuracy of the daily MODIS albedo product and will help determine the applicability of the various MODIS snow albedo products for particular research problems.

Methodology

A prototype snow albedo algorithm for MODIS was developed by *Klein and Stroeve* [2002]. Beginning in September 2003, this algorithm was incorporated into the routine processing of Terra and Aqua MODIS snow products (i.e. MOD10A1 and MYD10A1, respectively, referred to here collectively as MxD10A1).

For evaluation of the product, *in situ* albedo from 5 different AWS in Greenland were used (Figure 1). Greenland is a good target for validation studies because: (1) several albedo monitoring sites are in operation around the ice sheet in different snow zones; (2) the relatively homogenous surface of the ice sheet allows for comparisons between the area viewed by the satellite and the much smaller AWS measurement footprint; (3) the ice sheet is less cloudy than elsewhere in the Arctic; and (4) the AWS data have been used in several earlier validation papers [e.g. *Stroeve et al.*, 2001; *2005*; *Liang et al.*, 2005].

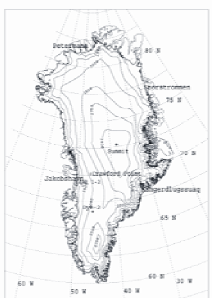


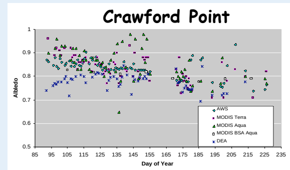
Figure 1. Map of the Greenland ice sheet showing locations of AWS used in this study.

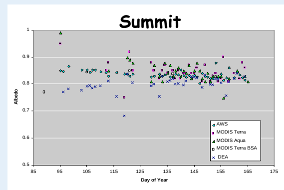
Processing of AWS Data

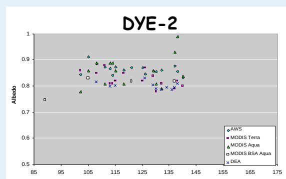
Daily integrated albedo (Ai) are used instead of hourly-mean albedo measured closest in time to the satellite overpass. *Ai* is less sensitive to instrument level and cosine response errors. Only AWS albedo for time-periods when leveling errors are less than 3° are used. *Ai* is computed as: $Ai = \sum S\_ / \sum S\_$
where *S_* is the upward shortwave irradiance and *S_* is the downward shortwave irradiance, both summed daily using 24 hourly averages.

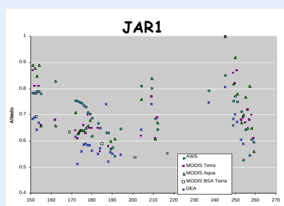
Results

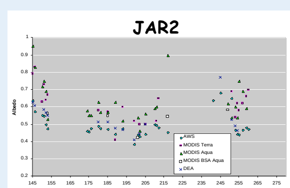
MOD10A1/MYD10A1 vs. Greenland AWS







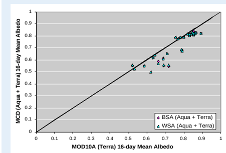




MOD10A1 vs. MCD43

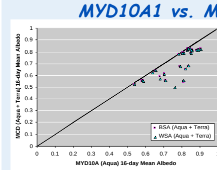
Comparisons are made between the MCD43 16-day albedo product (derived from Aqua and Terra observations) and 16-day averaged albedo derived from the MOD10A1 and MYD10A1 daily albedo products (obtained by averaging over the same time-period that the MCD43 observations refer to). Results are shown for both the black-sky and white-sky albedo (BSA and WSA) given in the MCD43 product.

MOD10A1 vs. MCD43



MOD10A1: 16-day averaged MOD10A1 albedo is ~ 0.035 larger than MCD43 BSA and ~ 0.039 larger than MCD43 WSA.

MYD10A1 vs. MCD43



MYD10A1: 16-day averaged MYD10A1 albedo is ~ 0.085 larger than MCD43 BSA and ~ 0.053 larger than MCD43 WSA.

Note: when the solar zenith angle is large (e.g. greater than 75º), the MODIS 16-day albedo product is subject to large errors because of algorithm problems when the sun is low in the sky [*Stroeve et al.*, 2005]. Including data obtained under high solar zenith angles results in worse agreement between the two data products. Additionally, algorithm assumptions in the daily albedo product break down under conditions when the solar zenith angle exceeds 75º.

Potential Error Sources

BRDF Errors

An important source of errors in satellite albedo retrievals is the representation of anisotropic surface reflectance in the complicated context of differing viewing and solar illumination geometries.

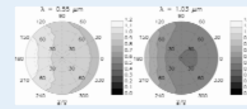


Figure 9. Hemispherical-directional reflectance factor measurements of snow at 0.55 μm and 1.03 μm made with Automated Spectro-Goniometer (ASG) [*Painter and Dozier*, 2004]. SZA was 49º, snow grain radius was 284 μm.

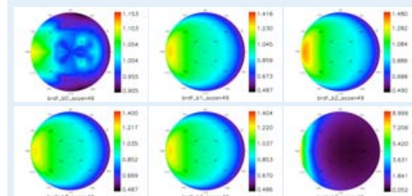


Figure 10. Hemispherical-directional reflectance factors used in MOD10A1/MYD10A1 products for MODIS channels 1-5 and 7 (SZA=49º)

Conclusions

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