# SURFACE ALBEDO OF THE INNER ARCTIC: VALIDATION OF THE CLIMATE-SAF SATELLITE ALBEDO PRODUCT WITH IN-SITU OBSERVATIONS

*Aku Riihelä, Vesa Laine and Terhikki Manninen*

Finnish Meteorological Institute, P.O. Box 503, 00101 Helsinki, Finland
Tel. +358 9 1929 4152, Fax +358 9 1929 3146, E-mail: aku.riihela@fmi.fi

## 1. INTRODUCTION

The polar regions are expected to change the most as a result of climate change [1]. Thinning and disappearing sea ice and snow cover will have a dramatic effect on the radiation budget of the Arctic regions, necessitating continuous monitoring of the Arctic environment. As a key driver of the radiation budget, surface albedo is a critical variable in understanding and modeling climate change in the Arctic. Due to the large sea ice concentrations on the Arctic Ocean, monitoring of both land surface albedo and sea ice albedo is needed for complete coverage.

To answer these needs, the Climate-SAF project of EUMETSAT has introduced a new surface albedo product (SAL) specifically for the Inner Arctic region. It is based on the AVHRR instruments on polar-orbiting satellites. The aim of this study is to validate the SAL product against high-quality *in situ* observations of surface albedo over various areas of the Arctic. The coverage of the Inner Arctic SAL product is shown in Figure 1. The user-distributed products are the weekly and monthly means of surface broadband albedo.

## 2. SAL ALGORITHM

The CM-SAF surface albedo (SAL) algorithm defines a broadband surface albedo on the waveband of 0.25 – 2.5 micrometers. The Inner Arctic product uses the AVHRR instrument on board NOAA and Metop-A satellites as the datasource. The product may be described as a “black-sky” albedo product since atmospheric contributions to the reflectance are removed, and the product is only produced for clear-sky areas. The general flow of processing is shown in Figure 2.

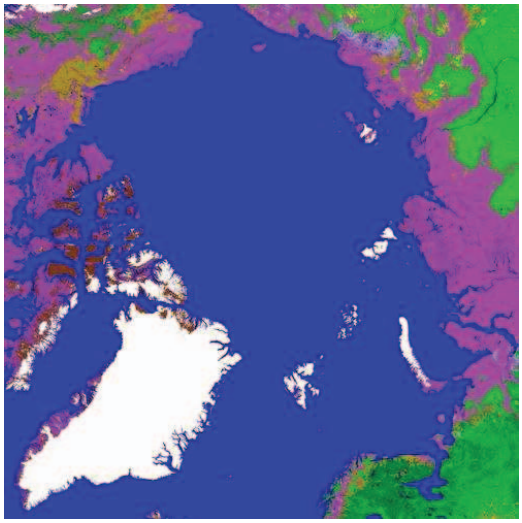

**Figure 1: SAL Inner Arctic coverage**

A notable distinction between SAL albedo retrieval and other snow/ice albedo algorithms is that SAL does not incorporate a BRDF correction at the instantaneous level. This is a calculated choice caused by two factors: Firstly, there are currently no snow BRDF models to the authors' knowledge that could robustly predict the reflective behaviour of all the diverse types of snow. Secondly, the user-distributable IA-SAL products are the weekly and monthly means, which are averaged from a high number of instantaneous observations during the time period due to the high AVHRR observation frequency at Polar latitudes. Thus, we expect that the time-averaging of the products will also result in a sufficient sampling in the viewing and illumination angle domain to ensure that a representative mean value is formed. The full paper will contain an analysis of the achievable sampling in the angular viewing and illumination domains.

Furthermore, the latest SAL version whose retrievals are shown in this paper does not employ a Sun Zenith Angle (SZA) dependency correction for snow albedo. Earlier SAL versions used an algorithm after Briegleb et al. [2] which basically assumes a U-shaped diurnal cycle in the albedo. As several authors have shown [3] [4], snow albedo exhibits a linear negative gradient resulting from snow metamorphism as the day progresses. Until a robust linear correction method is developed, we choose not to use an SZA dependence correction for snow in SAL to avoid introducing artefacts in the data.

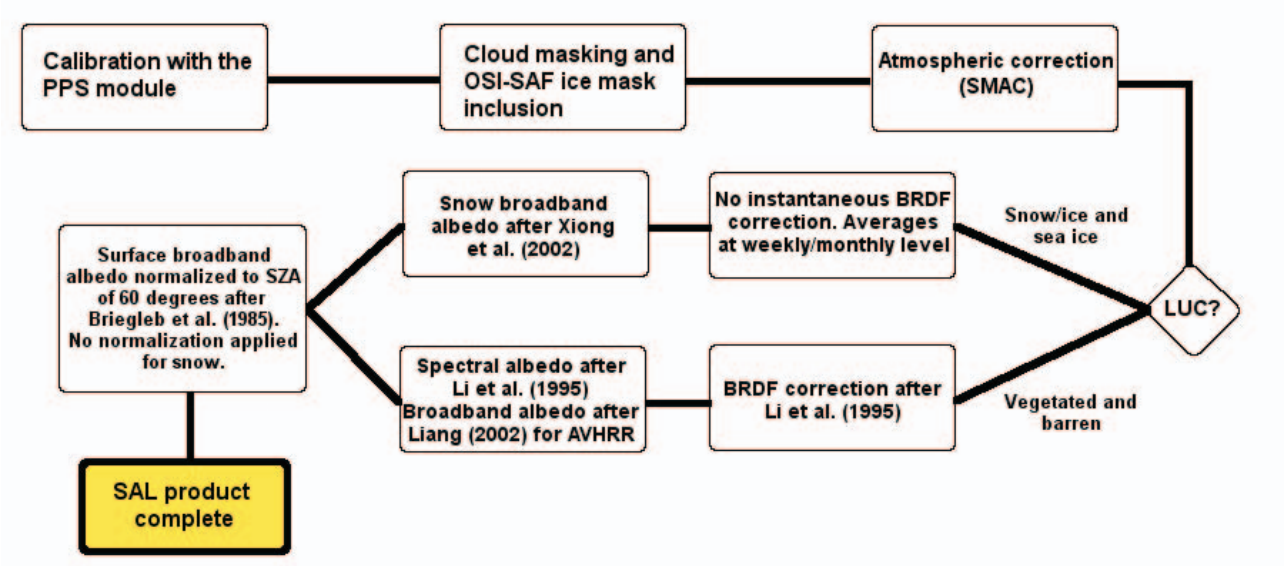


**Figure 2: SAL product processing flow**

## 3. DATASETS

The full AVHRR SAL dataset consists of 2755 overpasses over the Arctic from summer 2007 (1.6. – 31.8.2007). All comparisons in this study are performed between these instantaneous albedo retrievals and corresponding *in-situ* albedo observations. The reference data come from two sources. First, we compare SAL to albedo observations from the Greenland Climate Network (GCN) stations [5]. Second, we perform a similar validation to albedo observations from the Tara ship expedition [6] to evaluate SAL retrieval accuracy over sea ice. The reference data and SAL retrievals are matched temporally, spatially within AVHRR geolocation and resolution capabilities, and spectrally.

## 4. EARLY RESULTS

In this abstract, we present only partial results from comparison between SAL & GCN-Summit station. Full paper shall include validation data from at least two other GCN stations, the full Tara dataset validation and possibly also a comparison between SAL and albedo observations at FMI Arctic Research Center at Sodankylä, Finland to cover Northern Eurasia. Figure 3 shows first results from Summit station (72.58 N, 38.5 W) covering the period 12.6.-15.7.2007.

First validation results indicate that while there is considerable variation within the SAL retrievals, the weekly means have a high degree of correspondence with the reference data (expected retrieval errors are within 5-10% relative). The high instantaneous retrieval variation is explained mostly by the omitted BRDF correction.

However, if the angular sampling is sufficiently high, we maintain that there will not be any major artifacts in the weekly and monthly albedo products.

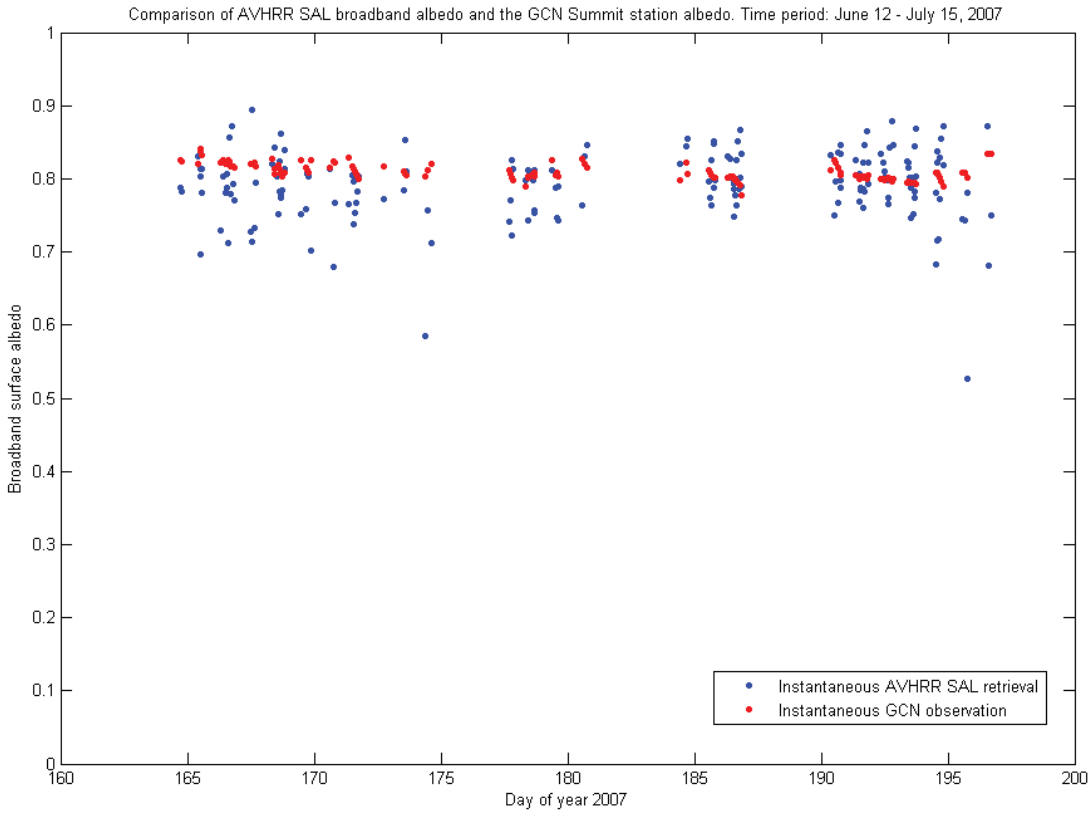


**Figure 3: First validation results from Summit station in Greenland**

## 5. REFERENCES


[1] Holland, M. M.,, and Bitz, C. "Polar amplification of climate change in coupled models". *Climate Dynamics*, Springer, Berlin, Germany. **21**, pp. 221-232. 2003.

[2] Briegleb, B., Minnis, P., Ramanathan, V., and Harrison, E. "Comparison of regional clear-sky albedos inferred from satellite observations and model computations". *Journal of Climate and Applied Meteorology*, American Meteorological Society, Boston, USA. **25**, pp. 214-226. 1986.

[3] Pirazzini, R. "Surface albedo measurements over Antarctic sites in summer." *Journal of Geophysical Research*, American Geophysical Union, Washington DC, USA, **109**, D20118. 2004.

[4] McGuffie, K., and Henderson-Sellers, A. "The diurnal hysteresis of snow albedo", *Journal of Glaciology,* International Glaciological Society, Cambridge, UK. **31**, 188-189. 1985.

[5] Steffen, K., Box, J., and Abdalati, W. "Greenland Climate Network: GC-Net." *CRREL 96-27 Special Report on Glaciers, Ice Sheets and Volcanoes, tribute to M. Meier*, U.S. Army Cold Regions Research and Engineering Laboratory. Special Report. USA. 98-103. 1996.

[6] Vihma, T., Jaagus, J., Jakobson, E., Palo, T. "Metorological conditions in the Arctic Ocean in spring and summer 2007 as recorded on the drifting ice station Tara." *Geophysical Research Letters*, American Geophysical Union, Washington DC, USA**. 35**, L18706. 2008