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Short-term variations of spaceborne microwave brightness temperature on the Greenland ice sheet during the 2012 melting season.

Takumi Suzuki[1], Rigen Shimada[1], Misako Kachi[1], and Tomonori Tanikawa[2]

[1]Japan Aerospace Exploration Agency (JAXA), Earth Observation Research Center (EORC), Tsukuba, Japan (suzuki.takumi@jaxa.jp)

[2]Japan Meteorological Agency (JMA), Meteorological Research Institute (MRI), Tsukuba, Japan

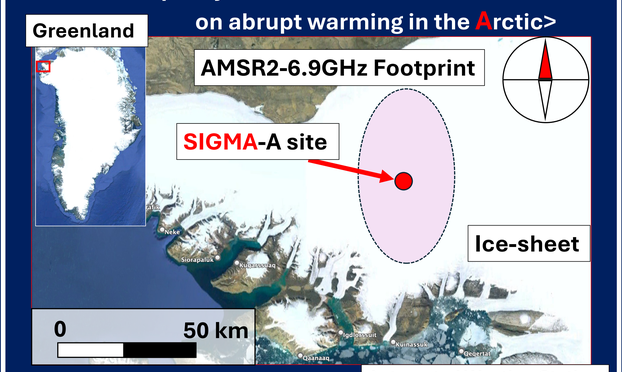
1. Introduction

Several analyses have focused on the melting of the **Greenland ice sheet** due to recent global warming, utilizing **snowmelt** indices derived from **spaceborne microwave brightness temperatures**. However, there is a notable lack of studies examining the **diurnal variation** of these temperatures. This study aims to elucidate the short-term relationship between satellite microwave brightness temperatures and snowmelt during **the summer of 2012**, a period marked by extensive melting of the Greenland ice sheet, using the JAXA-operated microwave radiometer (GCOM-W/AMSR2).

2. Study site & Method

The study site was selected as the **SIGMA-A site** in the northwestern part of the Greenland Ice Sheet (Fig.1). The automated weather station (**AWS**) was installed at this site on June-July 2012. The study period was defined as **the melting season from July to August, 2012**, coinciding with the commencement of observations by GCOM-W/AMSR2. The melting period was defined as the period when the snow surface temperature reaches 0°C, calculated from the AWS-acquired longwave radiation. During this period, **spaceborne microwave brightness temperatures** and **meteorological data** were collected.

<Snow Impurity and Glacial Microbe effects on abrupt warming in the Arctic>



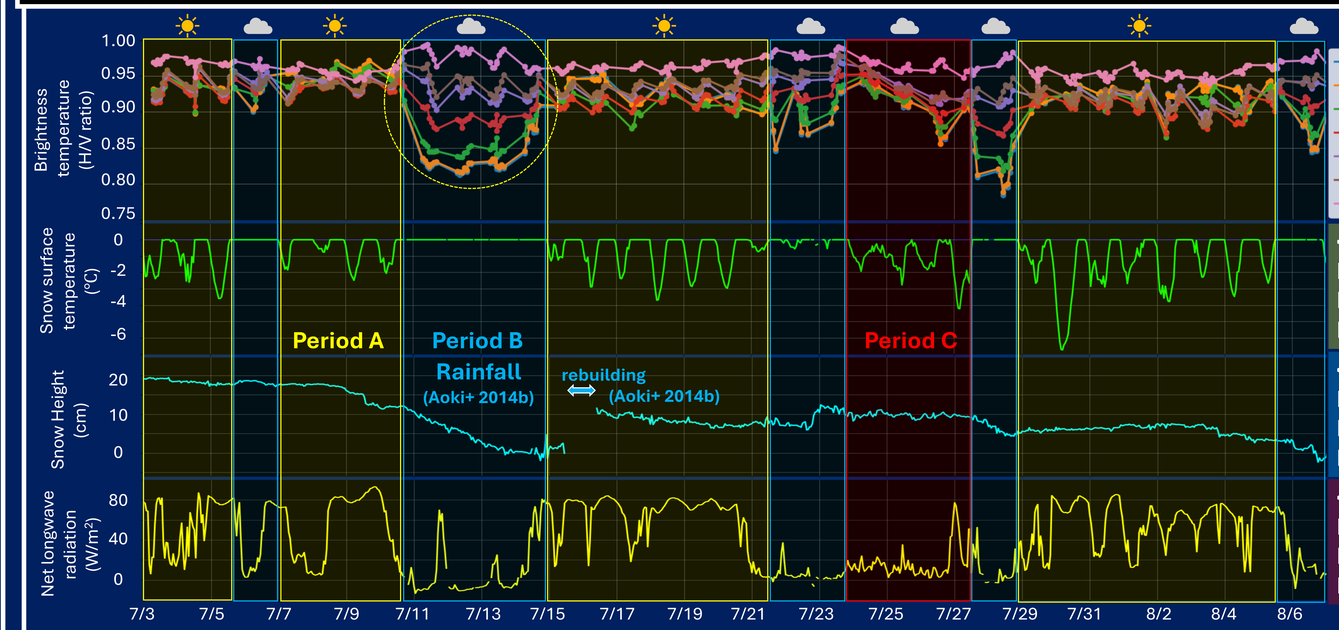
(Fig.1) (↑)SIGMA-A site located in the northwestern part of the Greenland Ice Sheet (GoogleEarth), (→) AWS at SIGMA-A site (Aoki et al., 2014).

3.1 When is the melting period at SIGMA-A in 2012?

(Fig.2) Temporal changes in brightness temperatures. All channels, including horizontal and vertical polarization, from July 3 to December 31, 2012 are shown.

In 2012, microwave brightness temperatures, particularly at low frequencies of **vertical polarization** (6.9 GHz, 7.3 GHz, and 10.7 GHz), remained relatively high until early August, began to decrease from mid-August, and stabilized at relatively low values from mid-September. The period of **high low-frequency brightness temperatures** coincides with the period when the snow surface temperature reaches 0°C, indicating **the snowmelt period**.

3.2 Temporal changes in brightness temperatures and meteorological data during the 2012 melting season



(Fig.3) Temporal changes in brightness temperatures (H/V ratio) and meteorological data, from July 3 to August 6, the 2012 melting season are shown.

Weather (Sunny or Cloudy)
Net longwave radiation data were used to determine the weather.

T_{snow} = Snow surface temperature
Three periods were categorized by snow surface temperature patterns.

<Period A>: T_{snow} = 0°C during the day
High H/V ratio at almost all of the channels
Decreasing Snow Height
High Net longwave radiation

<Period B>: T_{snow} = 0°C all day
Low H/V ratio at 6, 7, 10 GHz (Low frequency)
Decreasing Snow Height
Low Net longwave radiation

<Period C>: T_{snow} = below 0°C most of the time
Decreasing H/V ratio at all the channels
No Change Snow Height
Low Net longwave radiation

The timing of the **major melting event** was reported to have had **rainfall**, and the polarization ratio of **low-frequency** was significantly lower than the other channels.

4. Conclusions

- ✓ The melting period on the GrIS can be estimated from the high brightness temperature of the vertically polarized wave observed by the spaceborne microwave radiometer.
- ✓ Especially during large-scale melting accompanied by rainfall, the polarization ratio of the low-frequency brightness temperature were found to decrease significantly.
- ✓ Water clouds may increase the high-frequency brightness temperature, while the increased moisture content of the snow surface may increase the low-frequency.
- ✓ **Spaceborne microwave data may be able to detect large-scale melting that may increase in the future, even at sites where meteorological data are not available.**