

Ver2. Cryosphere Products

Evaluation Summary

Product	Release threshold	Standard accuracy	Target accuracy	Status* ¹	Evaluation Methods
Snow and Ice covered area (incl. cloud detection)	10%	7%	5%	○	Comparison with other satellites data (e.g. MODIS, VIIRS, Sentinel-3...).
Okhotsk sea-ice distribution	10%	5%	3%	○	Comparison with other satellites data (e.g. MODIS, VIIRS, Sensinel-3...).
Snow and ice surface Temperature	5K	2K	1K	◎	Comparison with in-situ observation (Automatic weather station thermal radiometer data) and other satellites data (e.g. MODIS, VIIRS Sentinel-3...).
Snow grain size of shallow layer	100%	50%	30%	○ → ◎	Comparison with climatology (relationship between snow surface temperature and snow grain size) for the release accuracy threshold. In addition, comparison with in-situ data for the standard and target accuracy thresholds.

*1 Symbols denote as follows; ○: the release threshold achieved, ◎: the standard accuracy achieved, ☆: the target accuracy achieved.

Validation results of Cryosphere products - SICE



- Version 2 Major changes and validation data details

Major Change for the C1AB - Snow and Ice cover area algorithm

- Revised cloud detection/surface classification algorithm from ordinary threshold method to Neural network machine learning method
- All training data were simulated by DISORT radiative transfer model

Major change for the C1C - Okhotsk sea-ice distribution algorithm

- Revised cloud detection/surface classification algorithm from ordinary threshold method to Neural network machine learning method partly.
- All training data using Neural network were simulated by DISORT radiative transfer model

Validation data for the C1AB/ SICE - Snow and Ice cover Extent product (snow/ice fraction > 15%*)

- Snow area: MOD10C2 Snow Cover Extent Product
- Sea ice area: MOD29E1D Sea Ice Product

Validation data for the C1C/OKID - Okhotsk sea-ice distribution product (sea ice fraction > 15%*)

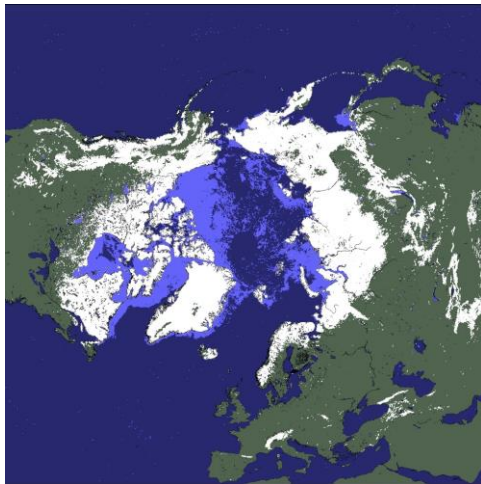
- Sea ice area :MOD29E1D Sea Ice Product

*NSIDC defines sea ice exists in case of the ice fraction/ice concentration more than 15%.

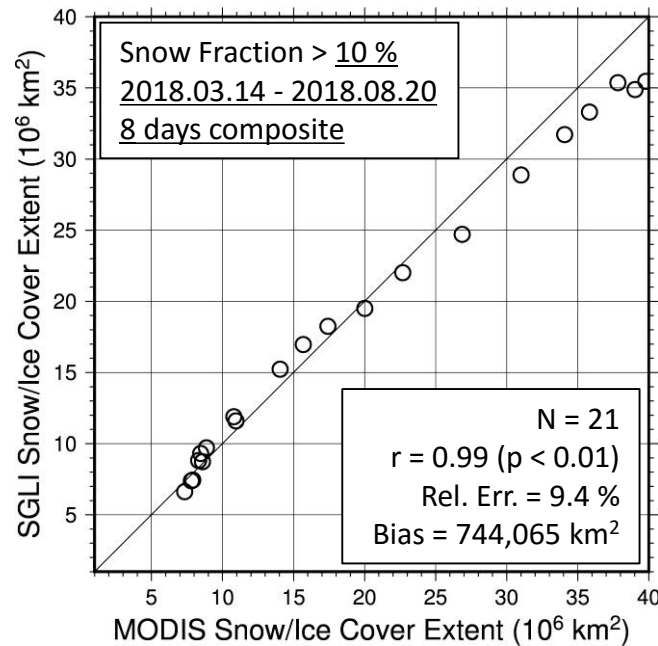
Validation results of Cryosphere products - SICE

- Snow and Ice cover extent product validation results using other satellite products

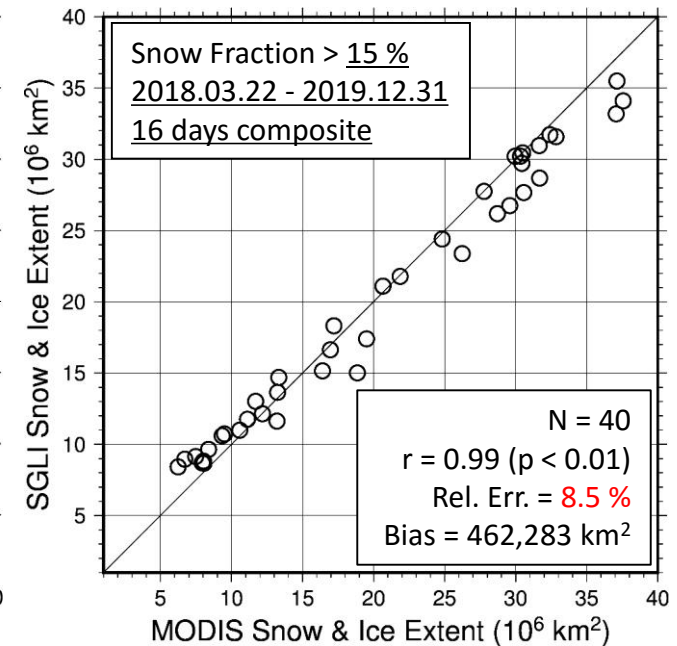
Ver.2 sample image
2019.05.09 - 2019.05.24



Validation result of Ver. 1



Validation result of Ver. 2



1. Validation period was expanded: 0.5 year to 1.5 year.
2. Composite period and valid snow/ice fraction were revised: 8 day to 16 days, 10% to 15% .

Validation result	Release accuracy	Standard accuracy	Target accuracy
Ver.1: 9.4 % (Mar. 2018 - Aug. 2018)	10 %	7 %	5 %
Ver.2: 8.5 % (Mar. 2018 - Dec. 2019)			

Accuracy improved and SICE product is likely to achieve the standard accuracy

Validation results of Cryosphere products - OKID

- Version 2 Major changes and validation data details

Major Change for the C1AB - Snow and Ice cover area algorithm

- Revised cloud detection/surface classification algorithm from ordinary threshold method to Neural network machine learning method
- All training data were simulated by DISORT radiative transfer model

Major change for the C1C - Okhotsk sea-ice distribution algorithm

- Revised cloud detection/surface classification algorithm from ordinary threshold method to Neural network machine learning method partly
- All training data using Neural network were simulated by DISORT radiative transfer model

Validation data for the C1AB/ SICE - Snow and Ice cover Extent product (snow/ice fraction > 15%*)

- Snow area: MOD10C2 Snow Cover Extent Product
- Sea ice area: MOD29E1D Sea Ice Product

Validation data for the C1C/OKID - Okhotsk sea-ice distribution product (sea ice fraction > 15%*)

- Sea ice area :MOD29E1D Sea Ice Product

*NSIDC defines sea ice exists in case of the ice fraction/ice concentration more than 15%.

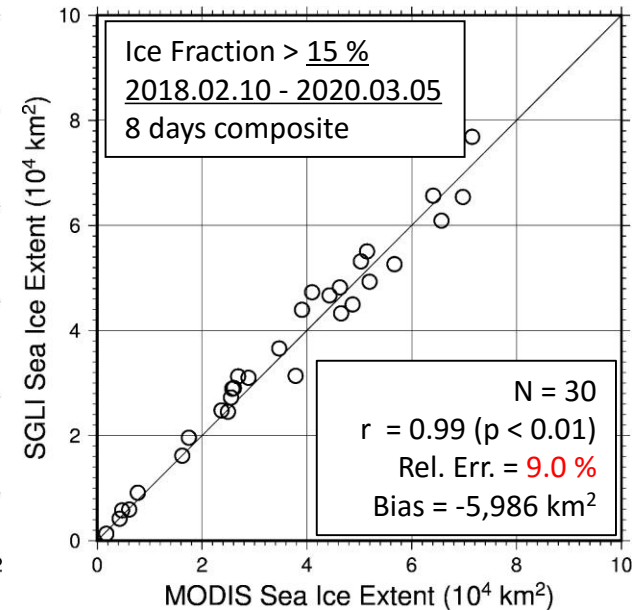
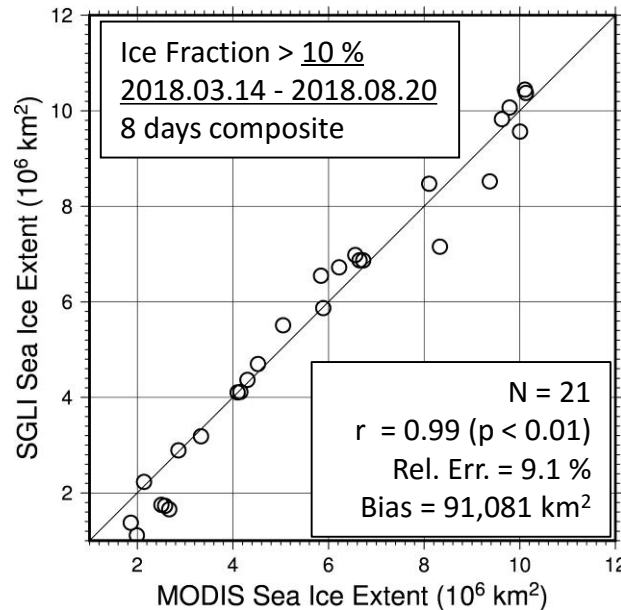
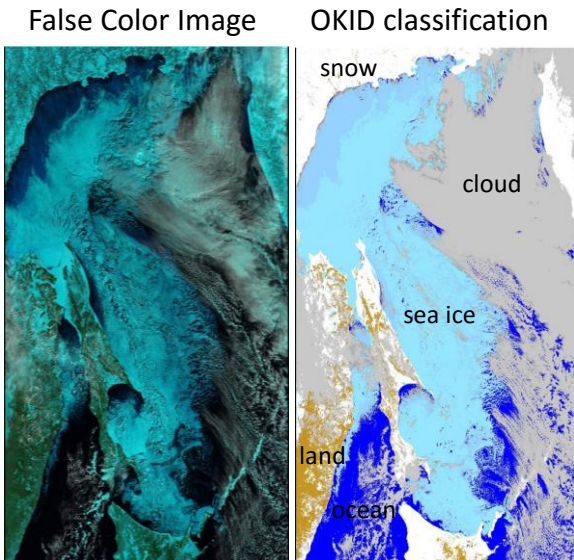
Validation results of Cryosphere products - OKID

- Okhotsk sea-ice distribution product validation results using other satellite products

Ver.2 sample image
2020.02.27

Validation result of Ver. 1

Validation result of Ver. 2



1. Validation period was expanded: 0.5 year to 2 year.
2. Surface classification was improved from visual evaluation compared with False color image.

Validation result	Release accuracy	Standard accuracy	Target accuracy
Ver.1: 9.1 % (Mar. 2018 - Aug. 2018)	10 %	5 %	3 %
Ver.2: 9.0 % (Feb. 2018 - Mar. 2020)			

OKID product needs more detail evaluation using high resolution satellite images

Validation results of Cryosphere products - SIPR



- Version 2 Major changes and validation data details

Major Change for the C2AB - Snow grain size of shallow layer

- Revised snow grain size estimation algorithm using Neural network machine learning method
 - Add the layer numbers of Neural-net: improved the processing speed
 - Revised the training data set (BRDF data set) using Neural-net: improved inversion accuracy

Major change for the C2AB - Snow and Ice surface temperature

- Revised the emissivity table

Validation data for the C2AB/ SGSL - Snow grain size of shallow layer

- Field campaign carried out on the Greenland Ice Sheet East-GRIP site (Jul. 2018) and Japan/Hokkaido Nakasatsunai site (Feb. 2020)
- Surface Specific Area (SSA) measured by IceCube and HISSGraS and converted to optical equivalent snow grain size
- All data match-up conditions are in 10 minutes and 250 meters from nearest point of satellites

Validation data for the C2AB/ SIST - Snow and Ice surface temperature

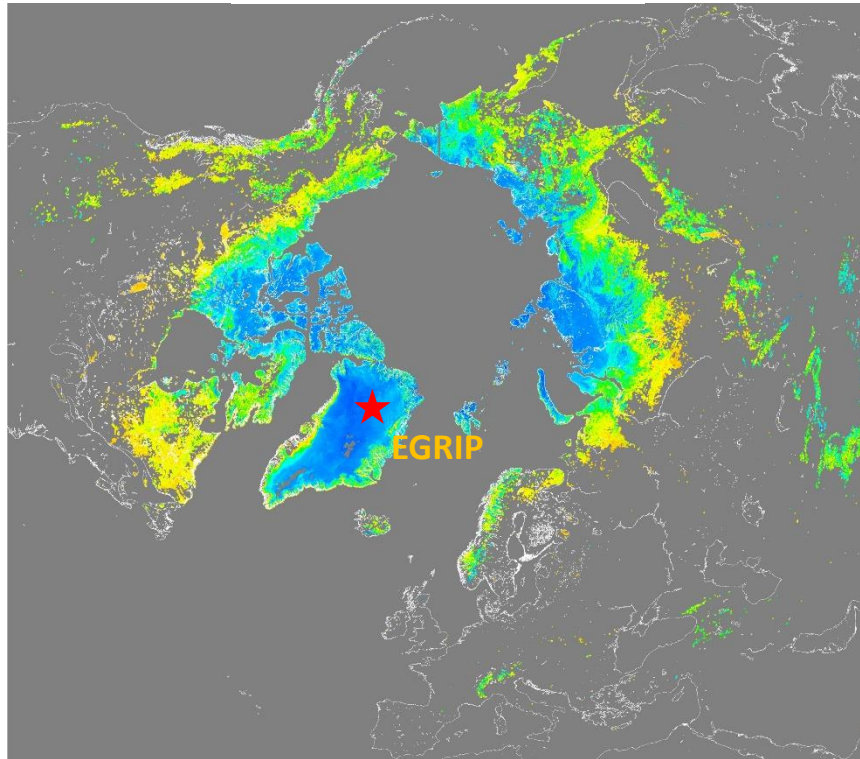
- Automatic Weather Station (AWS) installed by PROMICE (Fausto and van As, 2019) have measured the Upward/Downward Longwave Radiation Flux
- Ground surface temperature was converted from Longwave radiation Flux observation
- All data match-up conditions are in 10 minutes and 250 meters from nearest point of satellites

Fausto, R.S. and van As, D., (2019). Programme for monitoring of the Greenland ice sheet (PROMICE): Automatic weather station data. Version: v03, Dataset published via Geological Survey of Denmark and Greenland. DOI: <https://doi.org/10.22008/promice/data/aws>

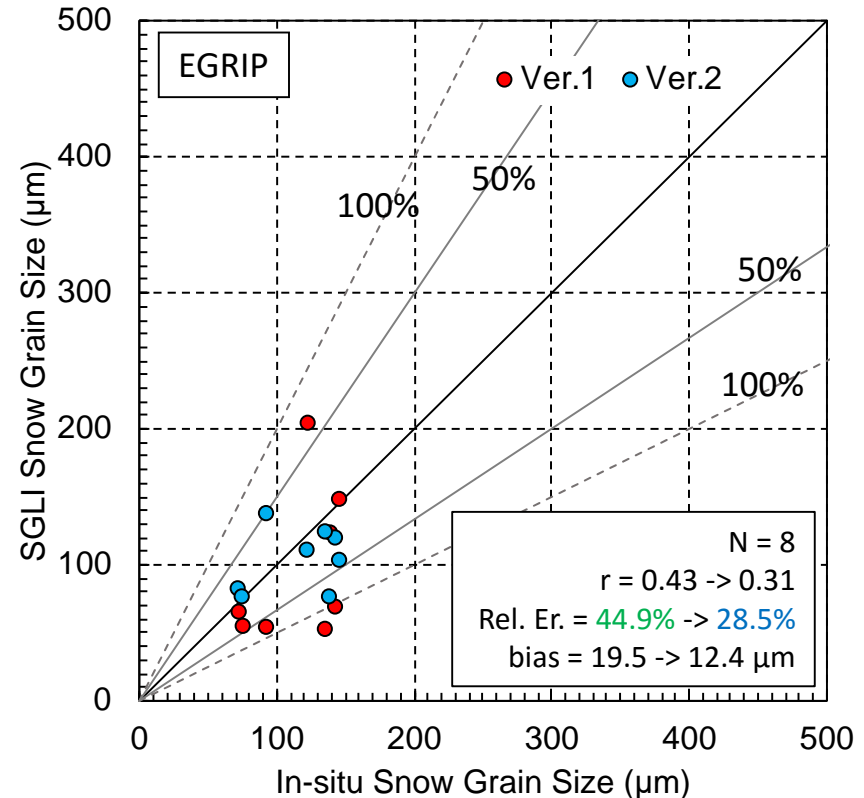
Validation results of Cryosphere products - SIPR

- Snow grain size of shallow layer product validation results using in-situ observation data (only E-GRIP)

Ver.2 sample image
2019.05.09 - 2019.05.24



Snow grain size estimation accuracy evaluation by comparison between Ver.1 and Ver.2 results in same quality control condition using Ver.2 SICE result



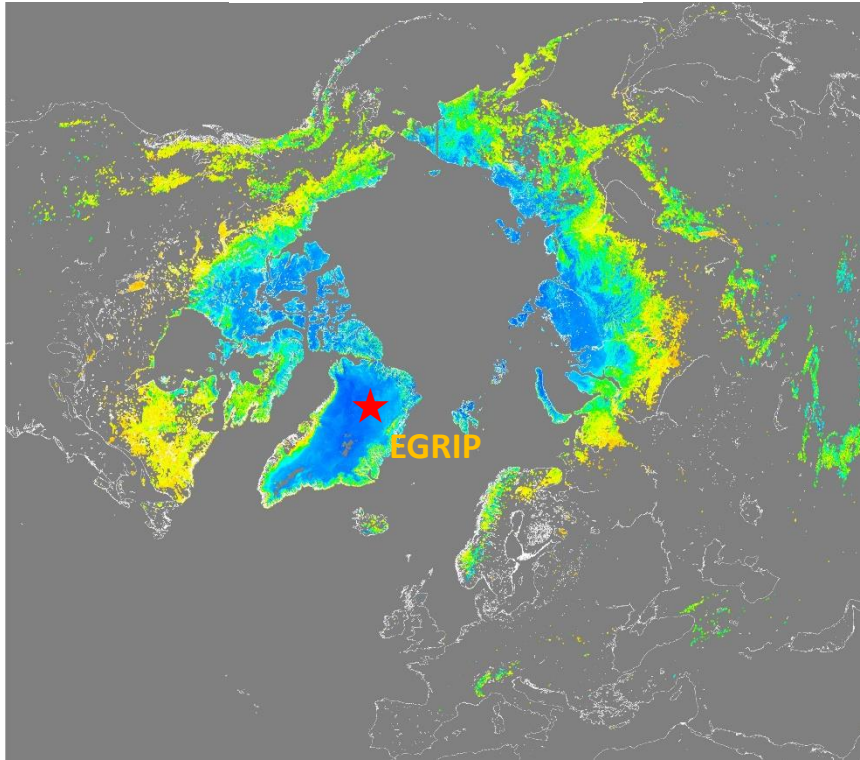
Validation result	Release accuracy	Standard accuracy	Target accuracy
Ver.1: 45 % (E-GRIP, QC: Ver.2)	100 %	50 %	30 %
Ver.2: 29 % (E-GRIP, QC: Ver.2)			

Quality control was improved by cloud detection algorithm revision of SICE.
 Snow grain size estimation accuracy improved by revision of C2 algorithm.

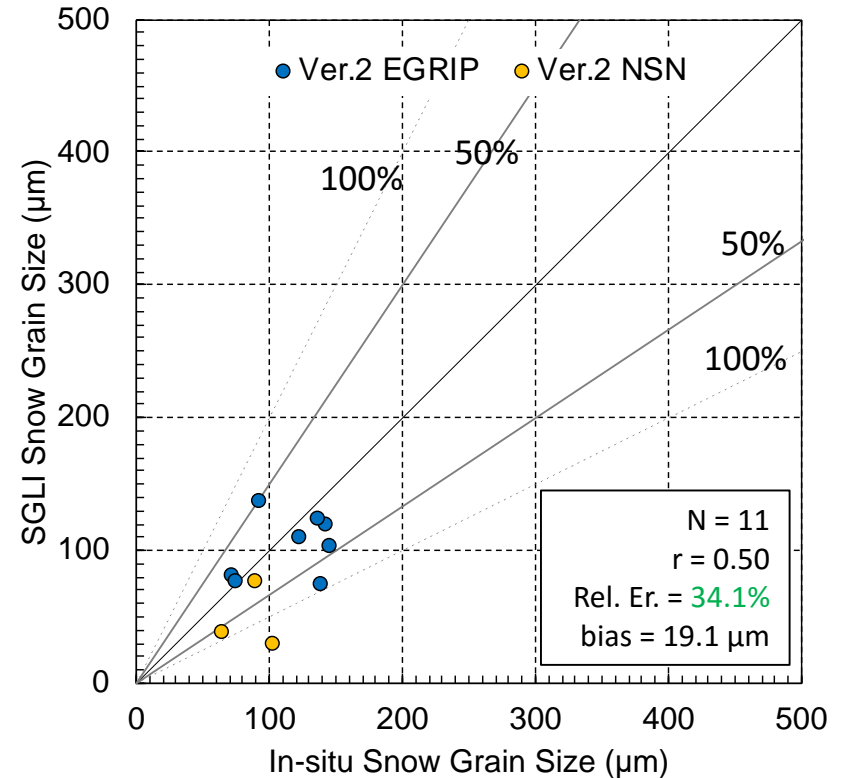
Validation results of Cryosphere products - SIPR

- Snow grain size of shallow layer product validation results using in-situ observation data (wide-range)

Ver.2 sample image
2019.05.09 - 2019.05.24



Adding the in-situ data measured in Nakasatsunai, Hokkaido, Japan
SGSL was evaluated in a wide-range of arctic and mid-latitude region



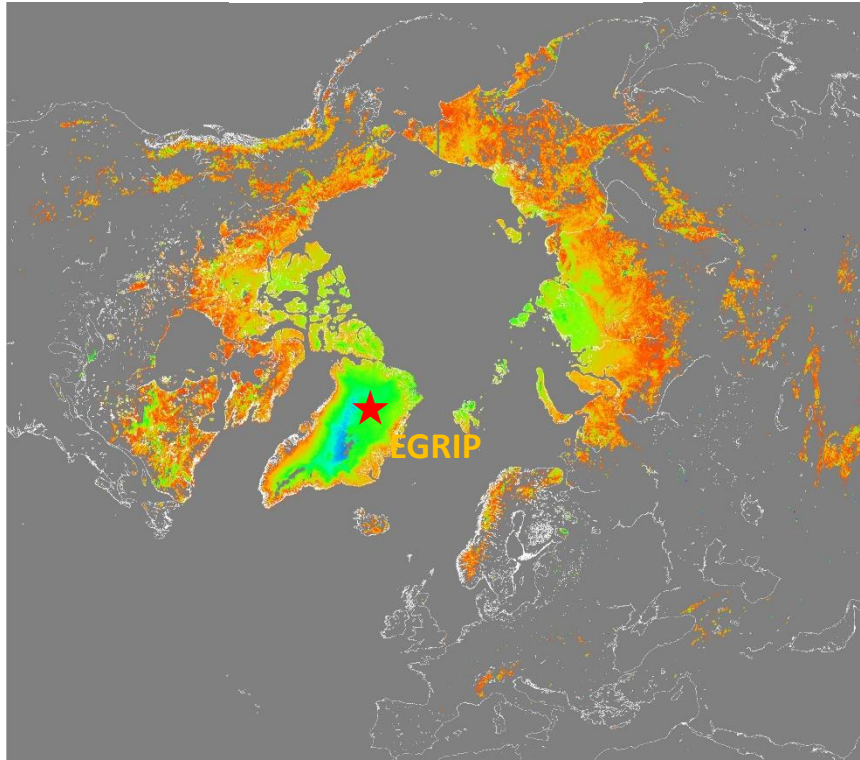
Validation result	Release accuracy	Standard accuracy	Target accuracy
Ver.1: 45 % (only arctic, QC: Ver.2)	100 %	50 %	30 %
Ver.2: 34 % (wide-range, QC: Ver.2)			

Accuracy improved and SGSL product achieved the standard accuracy

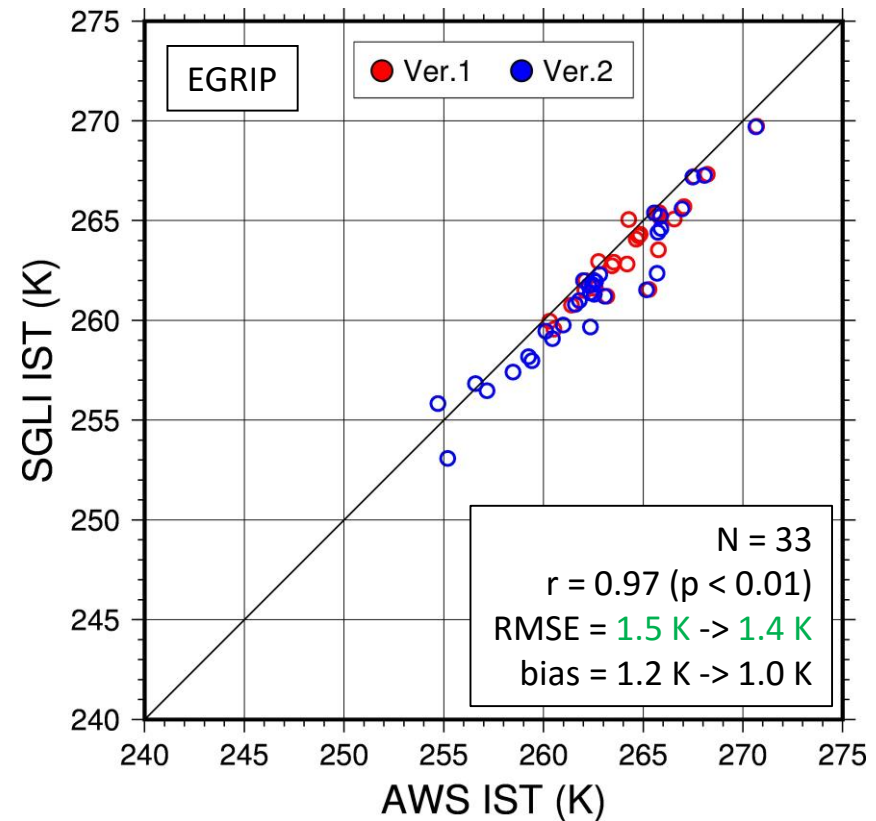
Validation results of Cryosphere products - SIPR

- Snow and Ice surface temperature product validation results using AWS observation data (only E-GRIP)

Ver.2 sample image
2019.05.09 - 2019.05.24



Snow and Ice surface temperature estimation accuracy evaluation by comparison between Ver.1 and Ver.2 results using E-GRIP observation data



Validation result	Release accuracy	Standard accuracy	Target accuracy
Ver.1: 1.5 K (EGRIP)	5 K	2 K	1 K
Ver.2: 1.4 K (EGRIP) & 2 K (GrIS, next page)			

Accuracy improved and SIST product achieved the standard accuracy

Validation results of Cryosphere products - SIPR

- Snow and Ice surface temperature product validation results using AWS observation data (whole GrIS)

Snow and Ice surface temperature estimation accuracy evaluation
using all AWSs installed whole region of the Greenland Ice Sheet

