



Danmarks Meteorologiske
Institut
The Danish Meteorological Institute

Ioanna Karagali, Magnus Barfod Suhr, Ruth Mottram, Jacob L. Høyer

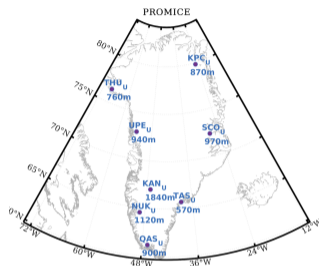
Multi-sensor L4 IST product for the Greenland Ice Sheet

LST_cci User Workshop 2022, LST_cci Phase I User Case Studies

Background

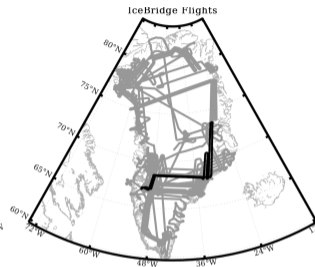
- One of four User Cases during ESA LST_cci I
- Derive Ice Surface Temperature over the Greenland Ice Sheet (GIS)
- LST_cci MODIS, 1km
- AASTI v2, 4km
- Final result: L4 OI IST product for 2012
- Validation with PROMICE stations & IceBridge flights
- Ingestion of L4 product in a Surface Mass Balance (SMB) model
- Assessment of simulations
- Karagali et al., A new Level 4 multi-sensor ice surface temperature product for the Greenland Ice Sheet, The Cryosphere, <https://doi.org/10.5194/tc-16-3703-2022>.

In Situ Obs



PROMICE

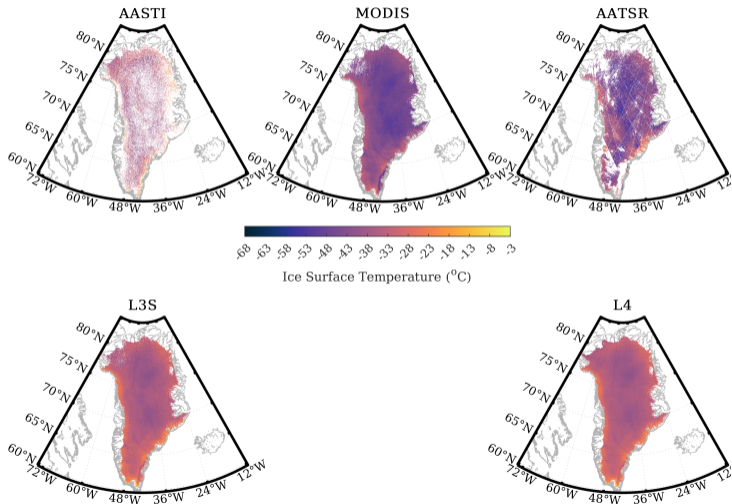
- Programme for Monitoring the Greenland Ice Sheet
- Geological Survey of Denmark & Greenland
- ST: upwelling longwave rad (Kipp & Zonen CNR1/4 radiometers, emissivity)
- Upper ablation & accumulation zones



Operation IceBridge

- NASA flight campaigns
- KT19, frequency interval \sim AVHRR Ch.4 (9.6-11.5 μ m)
- ST: BT, constant emissivity 0.97
- 27 IceBridge flights (v2), March-May 2012

Input data and L4 product: 09/01/2012



Satellite Data Inter-Comparison I

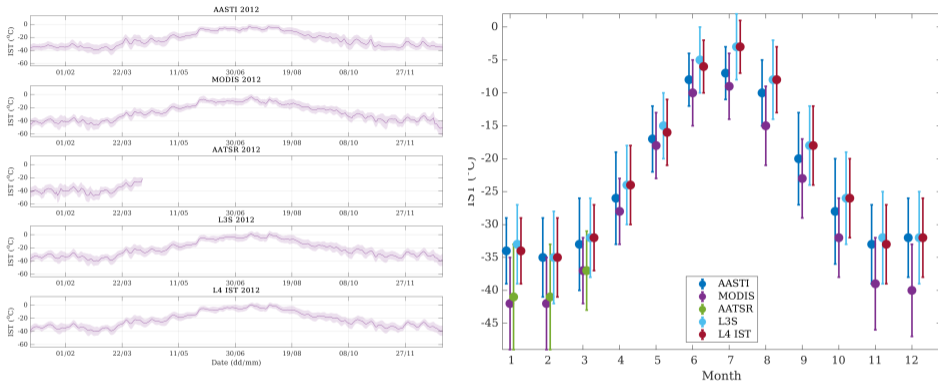


Figure: Mean daily (left) and monthly (right) IST and its standard deviation (shaded area/bars) from AASTI, MODIS, AATSR, L3S and L4.

Satellite Data Inter-Comparison II

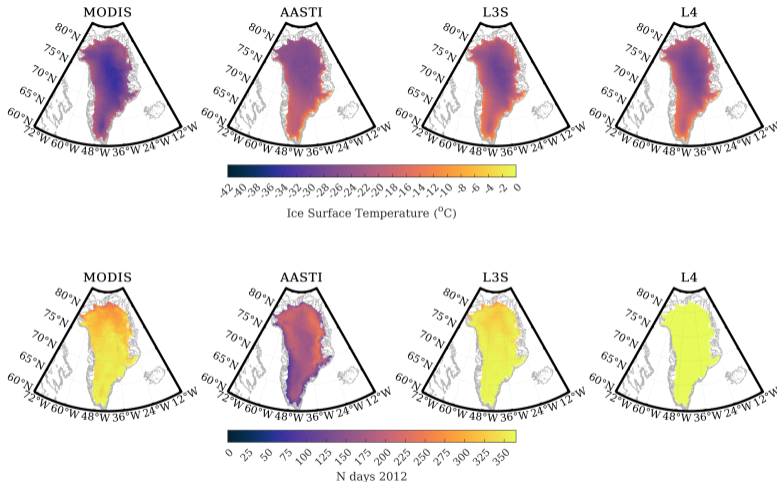
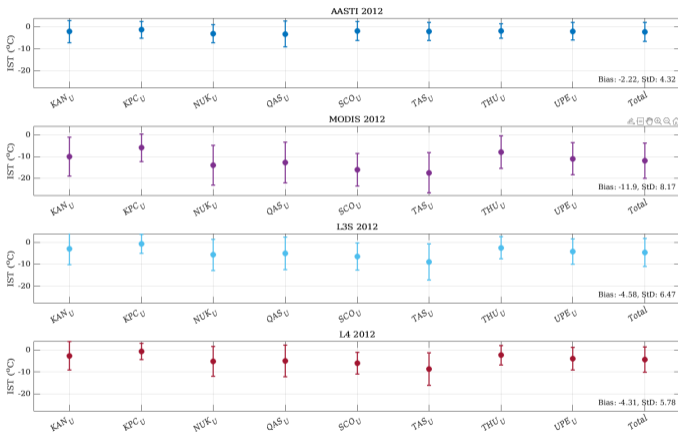


Figure: Mean annual IST (top) & N. obs (bottom) from MODIS, AASTI, L3S and L4.

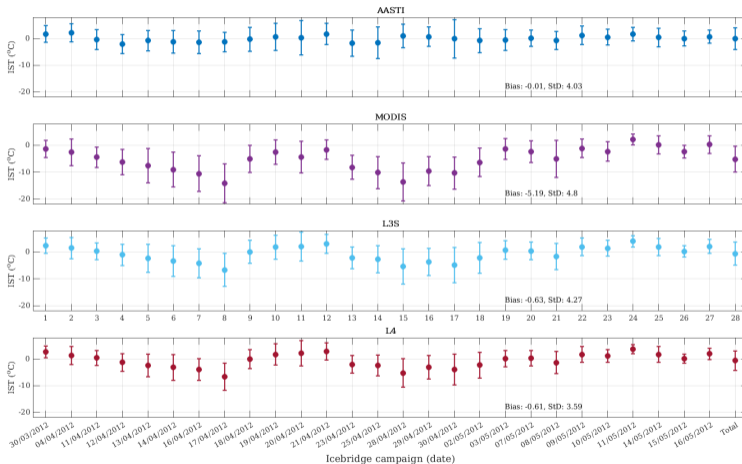
Validation with PROMICE

- AASTI: μ -2.22, σ 4.32
- MODIS: μ -11.90, σ 8.17
- L3S: μ -4.58, σ 6.47
- L4: μ -4.31, σ 5.78



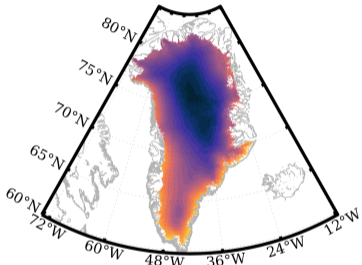
Validation with Icebridge flights

- AASTI: μ -0.01, σ 4.03
- MODIS: μ -5.19, σ 4.80
- L3S: μ -0.63, σ 4.27
- L4: μ -0.61, σ 3.59



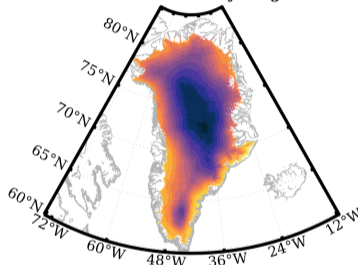
IST for 2012

Mean IST 2012



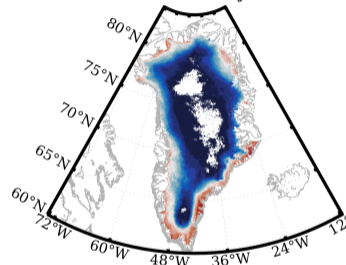
Ice Surface Temperature (°C)

Mean IST May-Aug



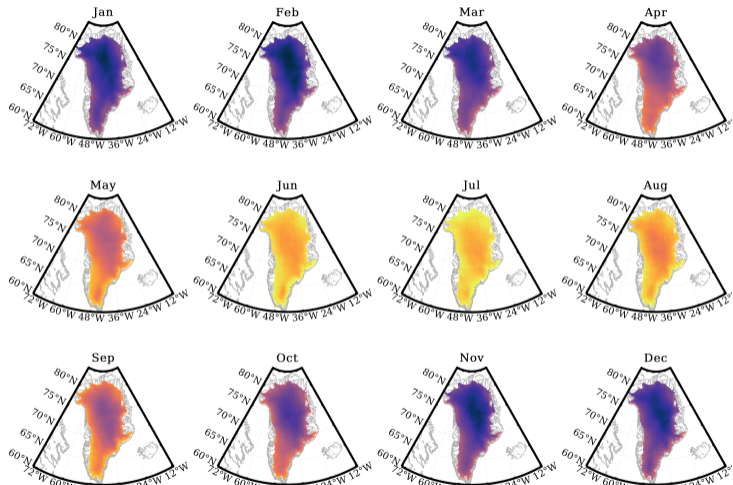
Ice Surface Temperature (°C)

L4 Melt Days



Melt days (IST >= -1 °C)

Mean monthly IST



Ingestion in SMB model

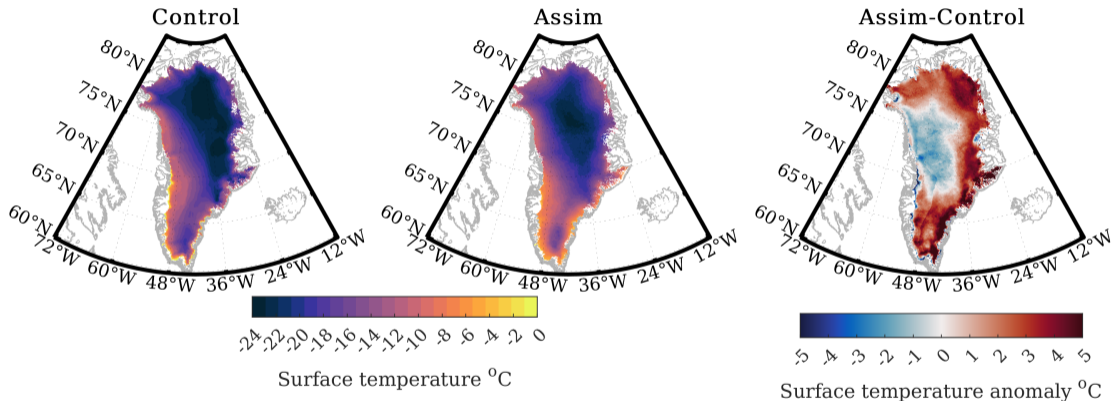


Figure: Mean May 2012 surface temperature; control (left), updated (middle) simulation, anomaly (right).

SMB vs PROMICE

- Control: μ -2.16, σ 2.09
- Assim. : μ -1.14, σ 3.55

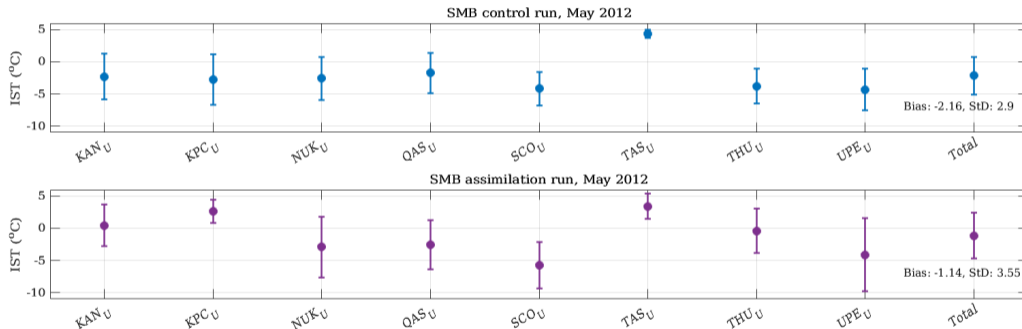


Figure: Mean bias & standard deviation for control (top), updated with assimilation of L4 IST (bottom) against PROMICE stations.

SMB vs IceBridge

- Control: μ -3.73, σ 5.05
- Assim. : μ -1.27, σ 4.61

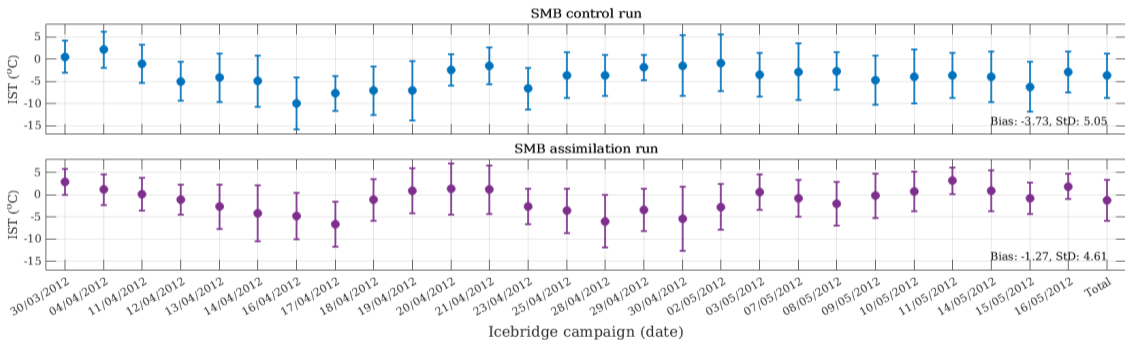
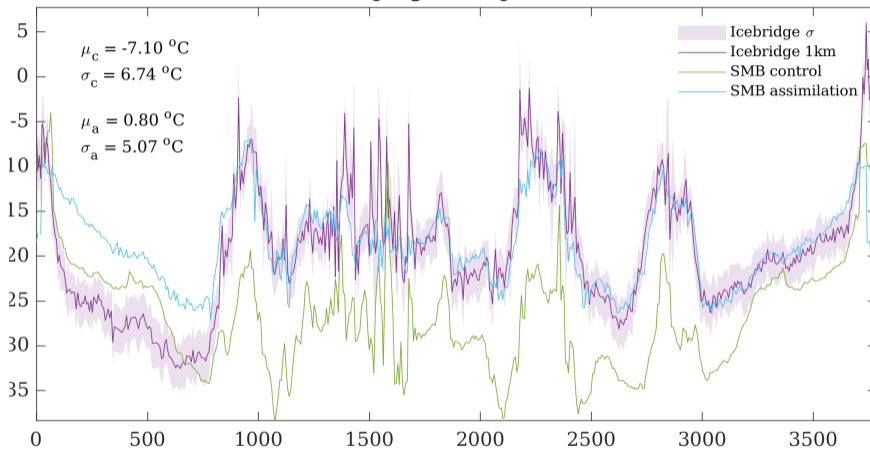


Figure: Mean bias & standard deviation for control (top), updated with assimilation of L4 IST (bottom) against IceBridge flight campaigns.

Example of IceBridge flight

Campaign 19 Apr 2012



Conclusions

- LST_cci MODIS data cold-biased by several degrees
- Larger biases against PROMICE partly associated to higher uncertainty of in-situ instruments & locations
- Daily L4 IST: stable, of high quality when compared to PROMICE & IceBridge
- Findings of L4 IST spatial & temporal variability over the GIS during the challenging year of 2012 in agreement with other studies
- For the melt onset in May, assimilating L4 IST into an SMB → more realistic surface temperatures, when compared to PROMICE & IceBridge