



**DMI**

Center for Ocean and Ice

# Ice Surface temperatures, status and utility



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# Outline

- **IST from satellite**
  - Infrared
- **IST from in situ**
  - Examples
  - Comparison with satellites
- **Challenges for users**
  - Representativeness
- **Examples of applications**
- **Summary**





# Existing IST products

- **Modis Aqua and Terra**
- **AVHRR Polar Pathfinder dataset**
- **Metop\_A**
- **ATSR**
- **AMSR-E**
- **VIIRS**
- **Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)**
- **IASI**
- **Enhanced Thematic Mapper Plus (ETM+)**



# Modis IST observations

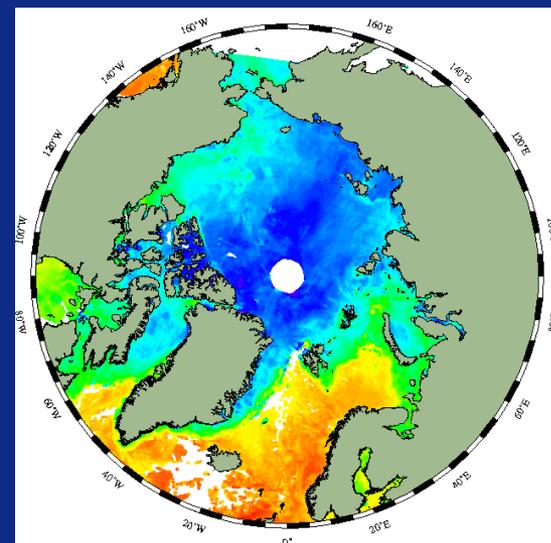
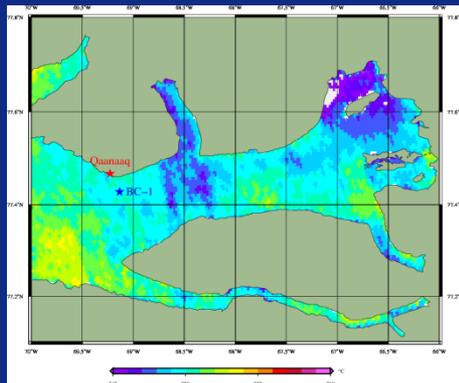
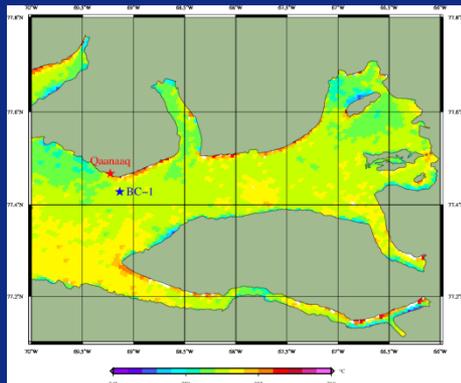
- Produced by NSIDC
- 1 km spatial resolution
- Aqua and Terra
- Using Modis cloud mask
- Data available since 2000





# OSI-SAF Metop-A IST product

- 3 minute granules of 1 km AVHRR data from the NWC SAF PPS software.
- Integrated HL SST, IST and Marginal Ice Zone Temperature product, based on Metop AVHRR
- SST for HL
  - **Regional algorithm coefficients (separate day/night )**
- IST
  - As Key et al., 1992, compared with buoys
- MIZ
  - Scaled linearly between IST and SST, using T4
  - Vincent et al., 2008





# In situ observations

- **Challenging to obtain a good coverage of accurate validation data.**
  - Infrared radiometers (broad band, narrow band, sky correcting or not)
  - Drifting buoys
  - Thermocrons
  - Ice mass balance buoy (thermistor string)
  - AWS (T2m + skin)
- **Each type of observations has specific sampling characteristics**





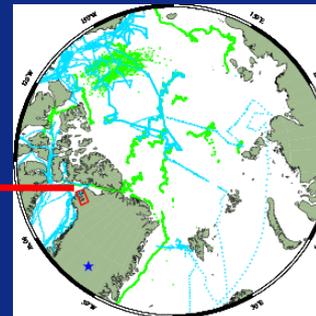
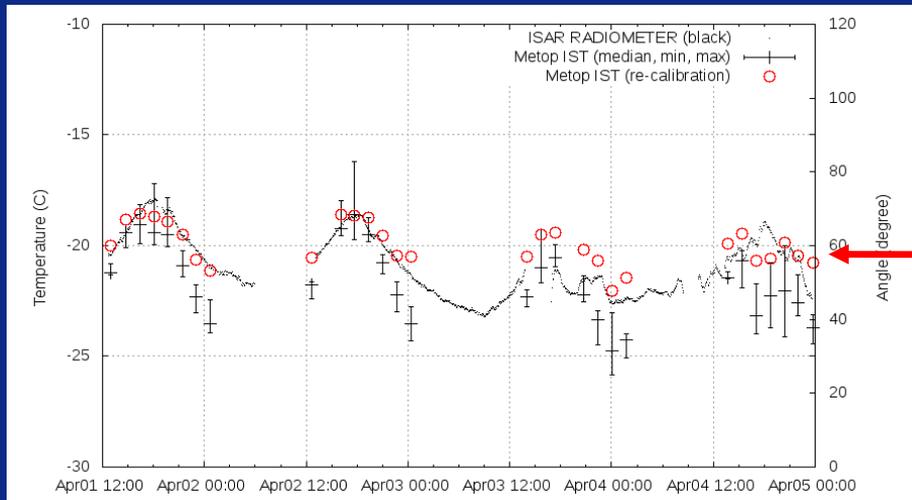
# Comparison, Satellite vs in situ

- **Validation studies carried out**
  - Modis: Hall et al., 2004, 2012 + Scambos et al., 2006
  - AVHRR: Key and Haefliger, 1992, Key et al., 1997, Scambos et al., 2006,
  - Metop\_A: Dybkjær and Høyer, 2012, Dybkjær et al., 2012
- **Compared to AWS stations + drifting ice buoys:**
  - Typical cold bias in the IST products: 1-3 °C
  - Typical standard deviations: 1-3 °C
- **Improved results obtained with:**
  - Infrared radiometers (Scambos et al, 2006, Dybkjær et al., 2012)
  - Multisatellite intercomparisons (Modis vs. ASTER vs. ETM+ ) (Hall et al., 2008)
  - Additional cloud masking (Dybkjær et al., 2012)

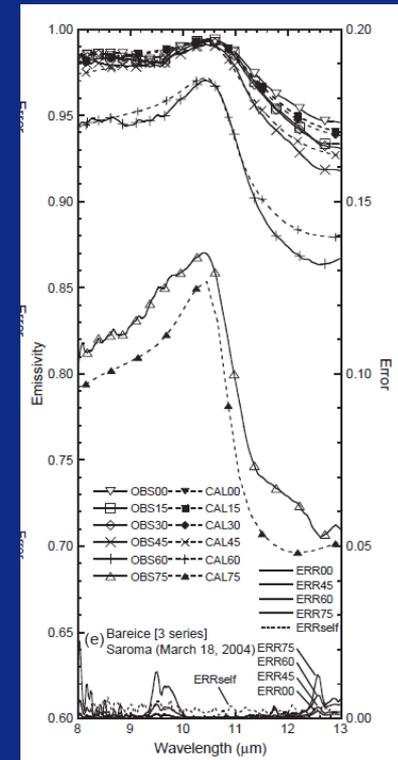


# Infrared Radiometer observations

- Radiometers deployed on ships, ice stations & AWS on land
- Validation results significantly better than temperature sensors and T2m
- Very cold sky temperature (173 K in Qaanaaq) results in underestimation of up to 1.3 K if no skycorrection is performed
- $T_{skin} = (TB_{ice} - (1-\epsilon) \cdot TB_{sky}) / \epsilon$



Directional emissivity

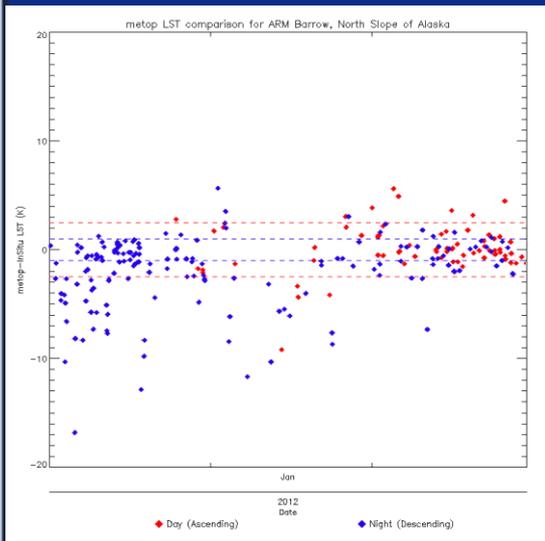


Hori et al., 2006

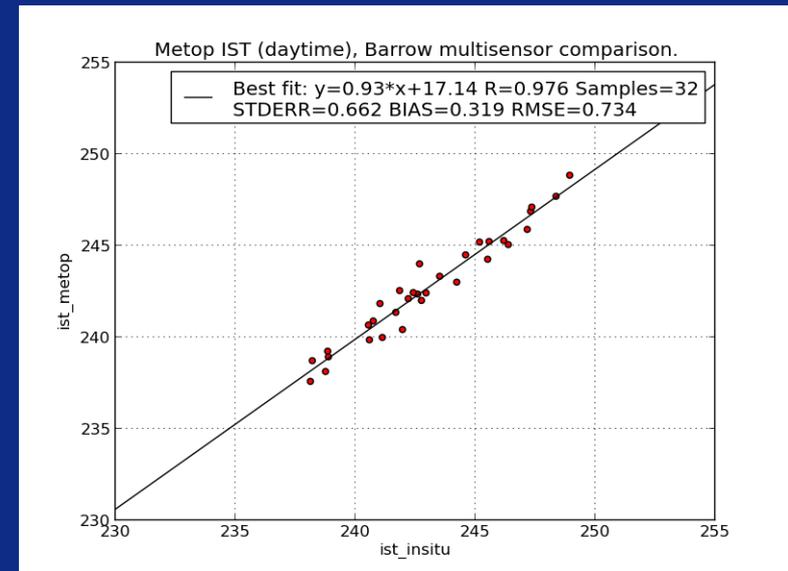


# Multisensor Match-up dataset

- Very useful to explore strength and weaknesses in the different data set
- Until now only one point for 3 months. Sea ice and Ice sheet MDs needed.
- Ensure right data is put in and extracted !



Same MD, correct use of cloud flags

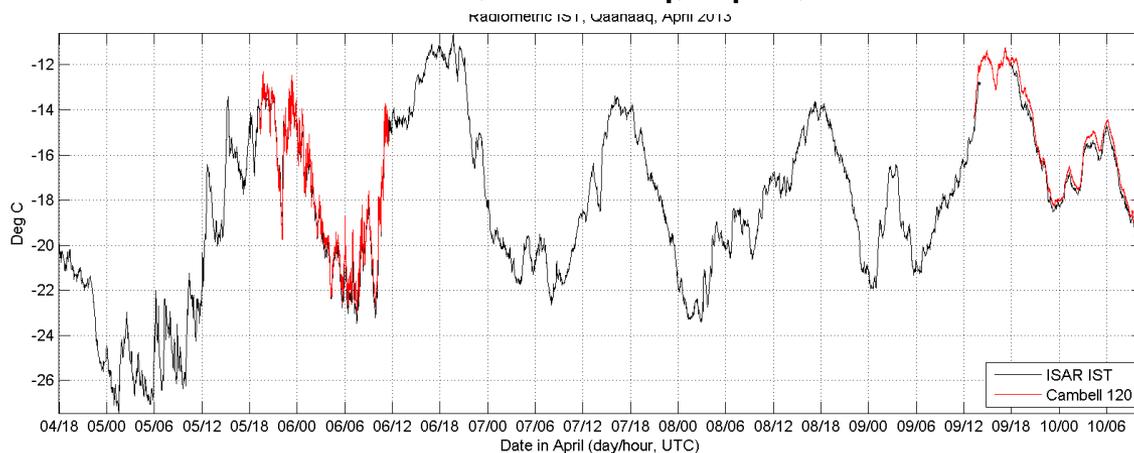




# Representativeness

- Large diurnal variation, even on hourly scale
- Uneven sampling with large diurnal and hourly IST variations
- Clear sky bias

ISAR Radiometer IST, Qaanaq, April, 2013

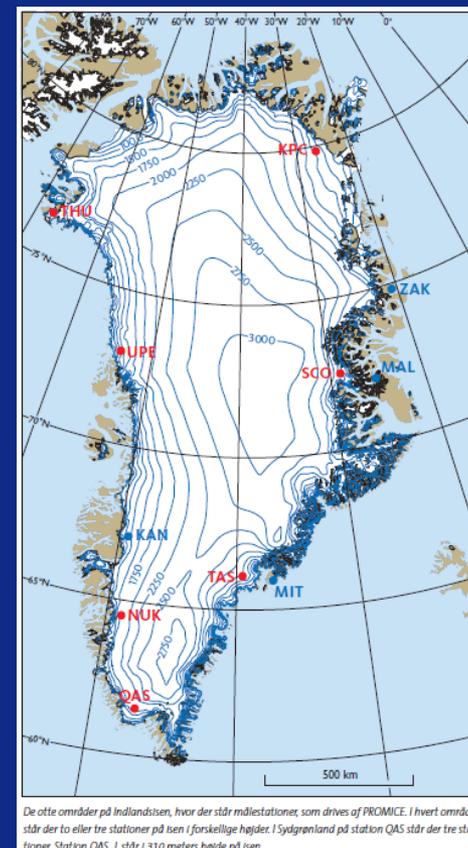
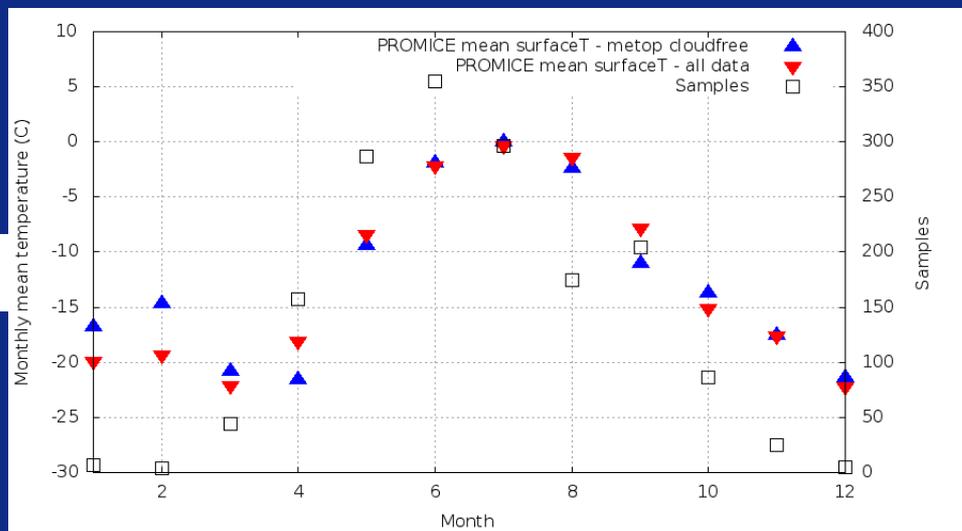




# Representativeness

- Clear sky bias from satellite ?
- Promice monthly mean surface temperature
  - All observations
  - Subsampled to Metop\_A clear sky
- Needs more attention

[www.promice.org](http://www.promice.org)

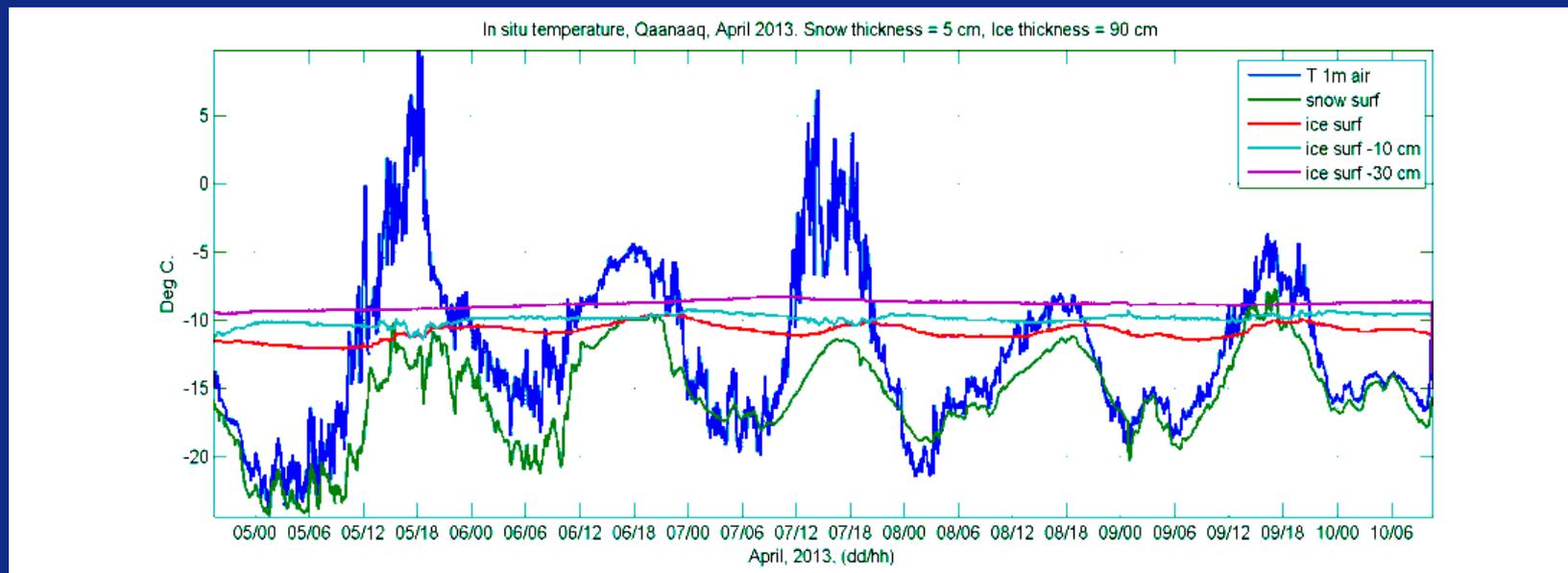




# Vertical Temperature variability

- Large gradients within snow and sea ice
- T2m often used as proxy for IST
- Snow very effective insulator

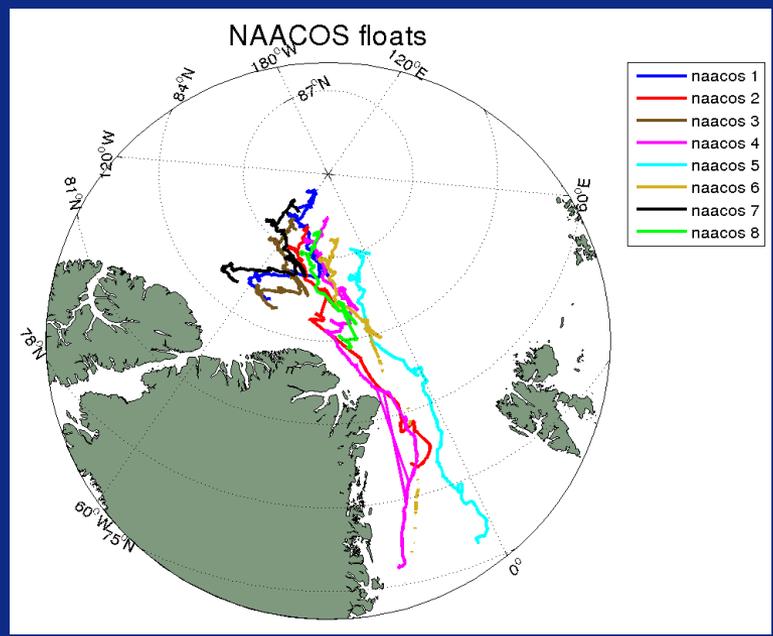
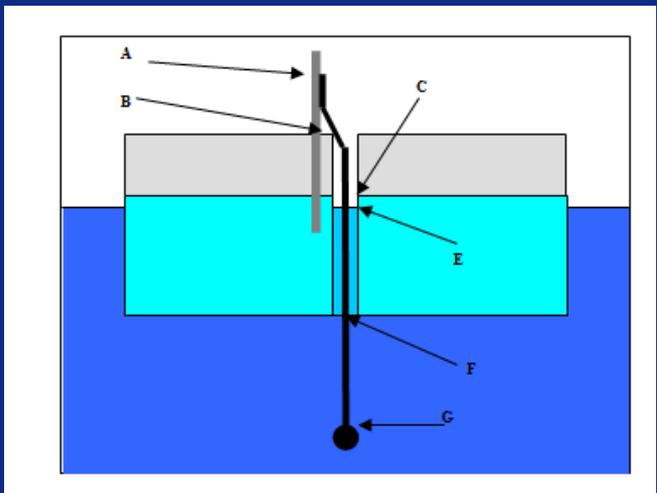
In situ temperature at different levels





# Ice mass balance buoys

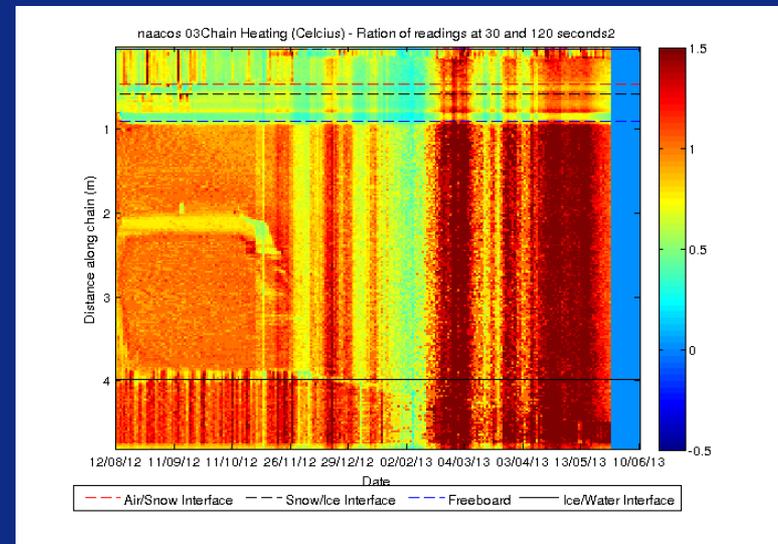
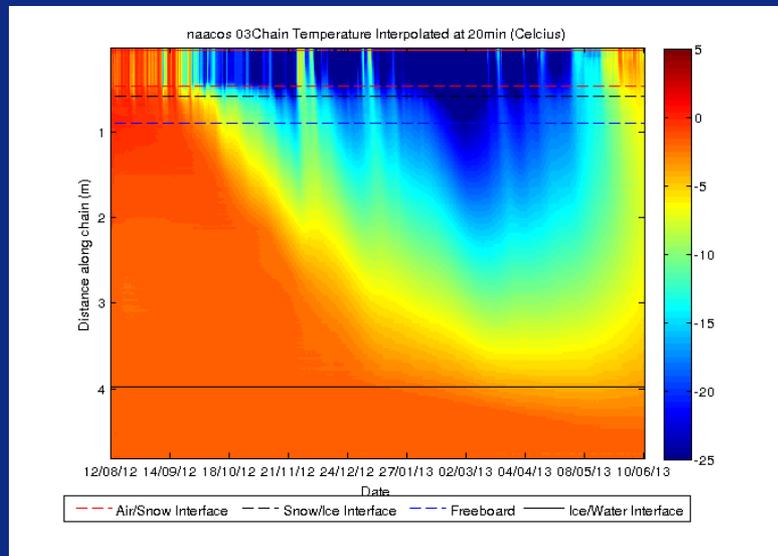
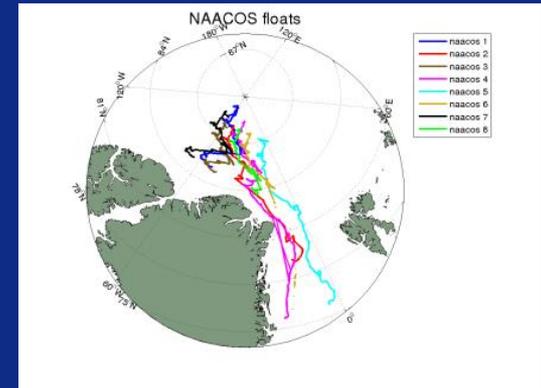
- 8 ice mass balance buoys deployed North of Greenland, summer 2012 (2-3 still alive)
- SAMS IMBs
- Sensor interval: 2 cm
- Observation: water, ice, snow and air
- Transmit data in NRT





# Vertical Temperature variability

- Temperature observations from Multiyear ice floe
- 10 months data
- Initial conditions
  - ice thickness: 3.4 meters
  - 12 cm snow
  - 45 cm air



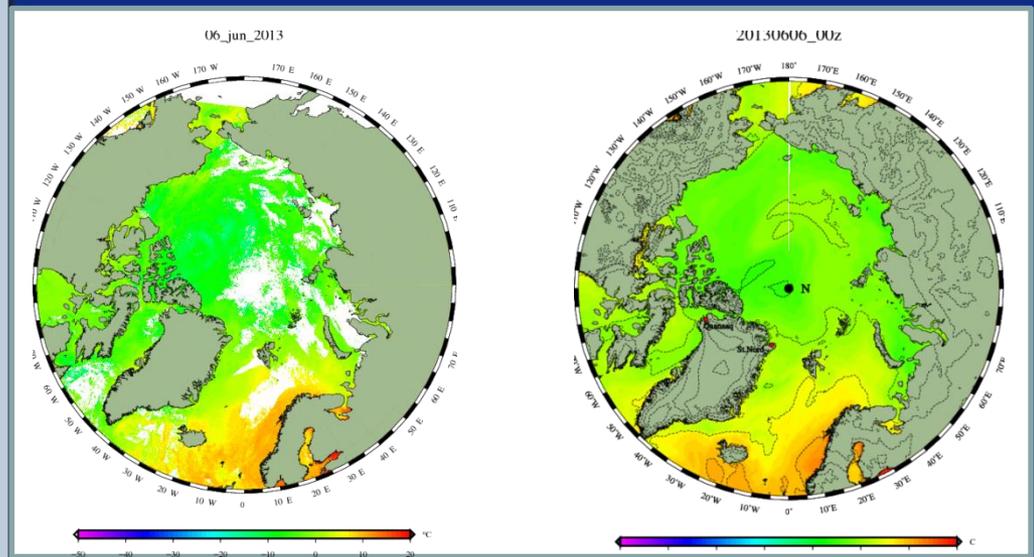


# Daily monitoring of Arctic surface temperatures

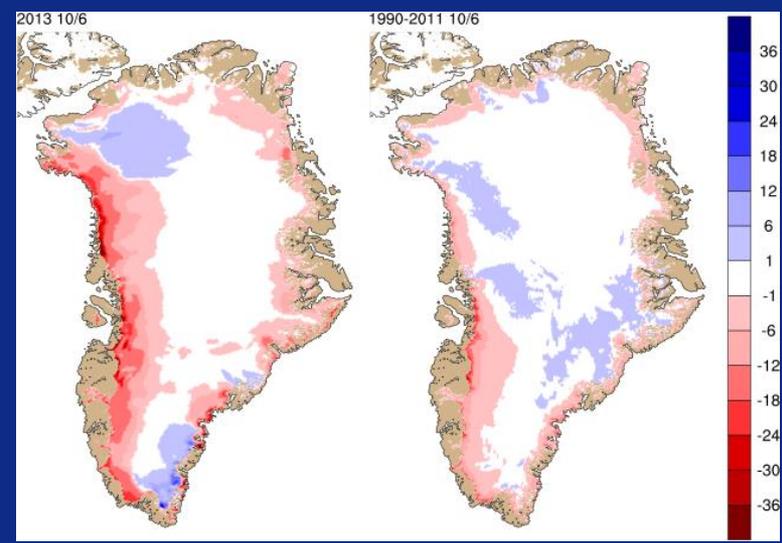
- At: [ocean.dmi.dk](http://ocean.dmi.dk) and [dmi.dk](http://dmi.dk)
- Figures updated every day
- New website available 21st June: [polarportal.dk](http://polarportal.dk)

Metop\_A surface temp

ECMWF T 2m



Ice sheet mass balance (climate model)





# Summary

- **Several IST products out there (IR + PMW)**
- **Challenging to use the observations due to measurement uncertainty and sampling characteristics**
- **Validation results depend upon in situ observations**
- **Need for proper validation and intercomparisons**
- **Large potential for inclusion in models and reanalysis but sampling characteristics complicate assimilation**