



ships4sst

shipborne radiometers for sea surface temperature

High latitude SST radiometer deployments

Jacob L. Høyer, Gorm Dybkjær, Nis Jepsen and
Rasmus Tonboe

Danish Meteorological Institute

Outline

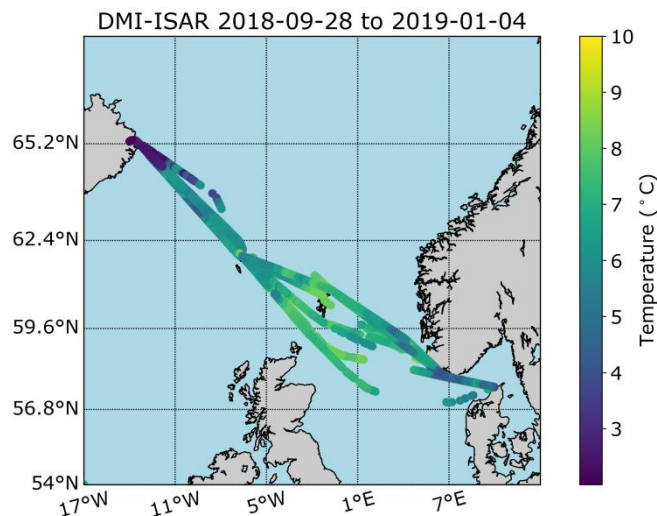
- Motivation
- DMI Deployments
- FRM4STS results
- Calibration procedures
- Future plans
- Conclusions

Motivation for high latitude TIR FRMs

- SST observations have elevated uncertainty in high latitudes
- Persistent cloud cover
- Sparse in situ observations (drifting buoys and Argo floats)
- Need for FRM TIR observations at high latitudes

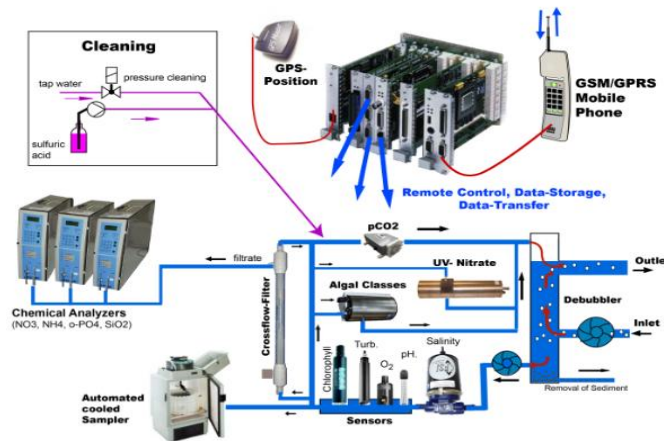
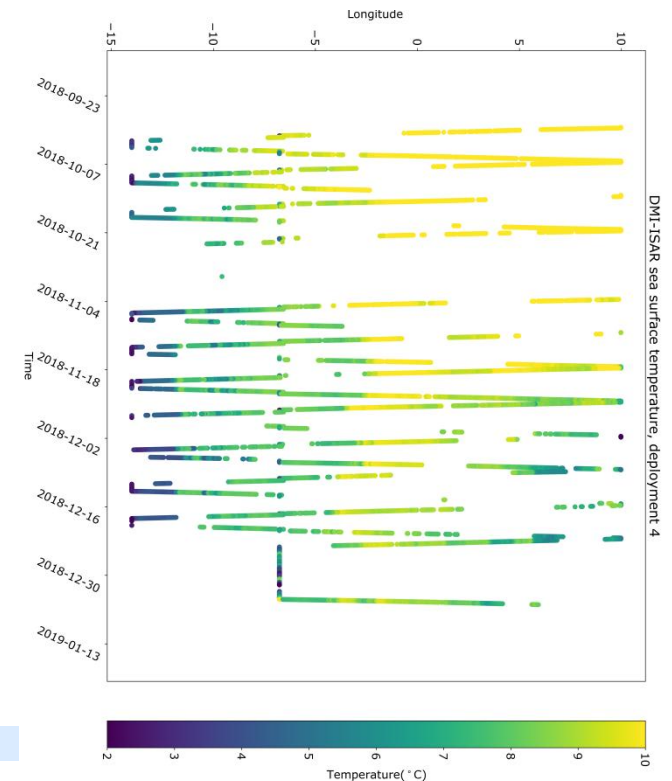
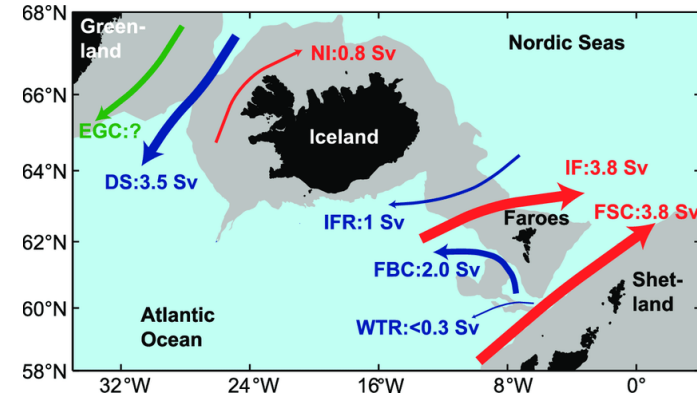
Operational Deployments

- DMI ISAR installed on Smyril line ferry Norrøna, December 2017
- Incidence angle: 25 degrees
- Routine operations between Denmark, Faroes and Iceland
- Round time: 1 week
- Year round service
- Servicing and calibration: 2-3 months



Why Norrøna ?

- Open ocean observations
- Monitoring the Atlantic inflow to the Nordic Seas, AMOC
- Additional instrumentation:
 - Ferrybox (NIVA, Norway)
 - ADCP (Woods Hole)



Operations within Ships4SST

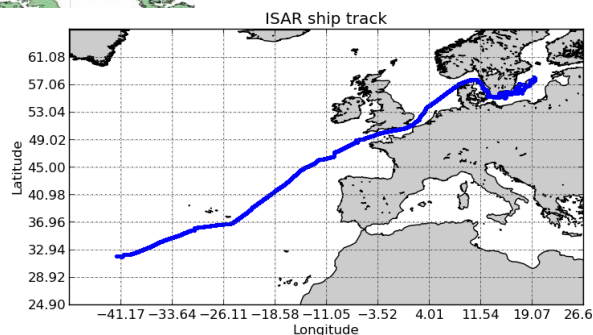
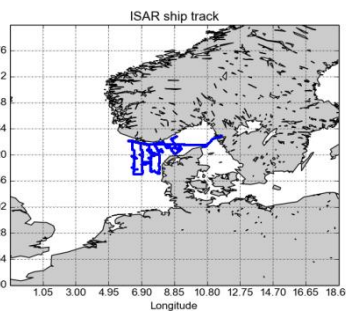
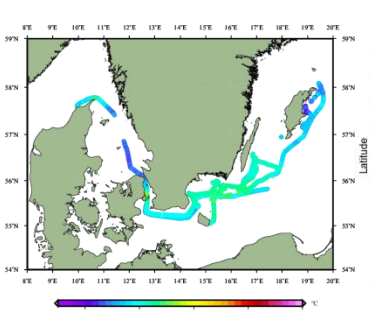
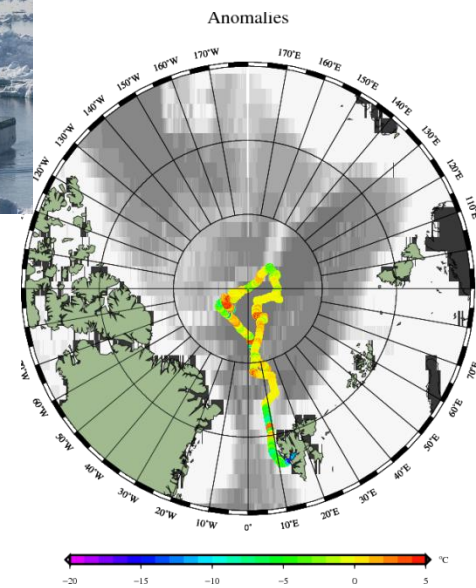
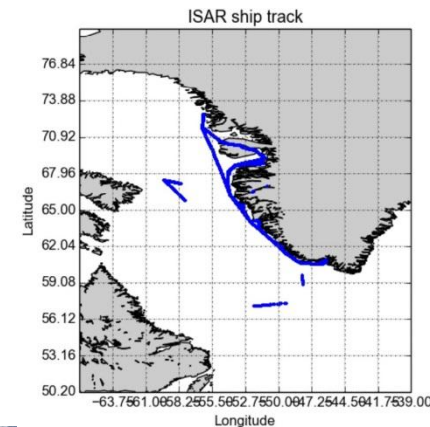
- Ongoing since December 2017
- Routine calibration and data processing
- L2R format, including
 - TBs
 - SST
 - Uncertainty components
 - Quality flags
 - Pitch/roll/yaw
- Delivered to Ifremer ftp server
- Part of the SLSTR MDB
- Regular tweets from servicing



Deployments –scientific campaigns

The DMI ISAR participated in several campaigns, mainly in high latitudes:

- RAL vessel: Irena Arctica
- Danish research Vessel, DANA
- Oden Icebreaker
- Danish Defence Vessel: Einar Mikkelsen



end: 20140310 18:30:11

ships4SST

ISFRN Ser

February 2019

Page 7

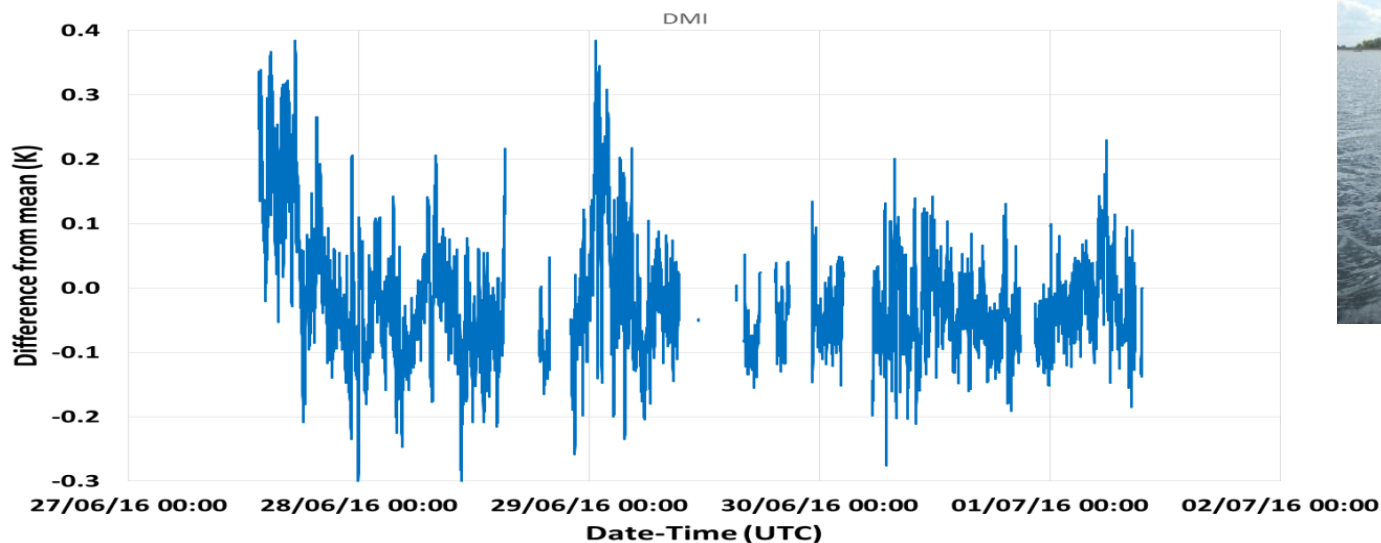
Participated in FRM4STS campaigns

Water inter-comparison

DMI ISAR:

- Mean difference: $-0.02\text{ }^{\circ}\text{C}$
- Within $0.2\text{ }^{\circ}\text{C}$ From mean of all radiometers

Radiometer	Mean difference from the mean ($^{\circ}\text{C}$)
STFC RAL	0.123
KIT	-0.159
CSIRO	-0.189
DMI	-0.020
UoV	0.117
UoS	0.125
OUCFIRST	0.033
OUC-ISAR	0.206
GOTA	0.593
JPL	-0.109





fiducial reference
temperature
measurements



Ice radiometer inter-comparison

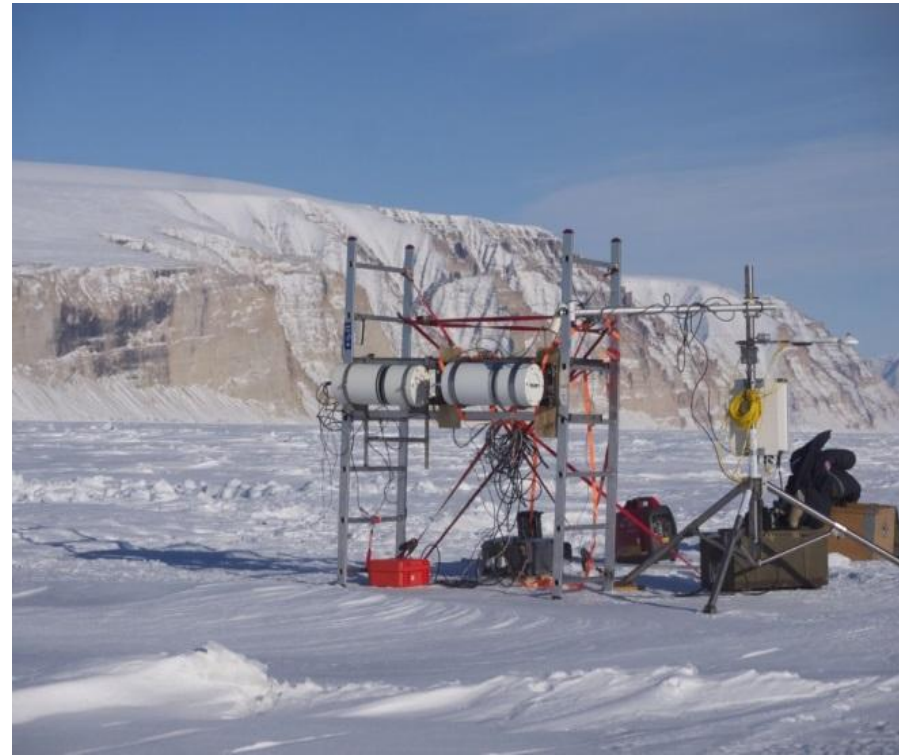


Meeti



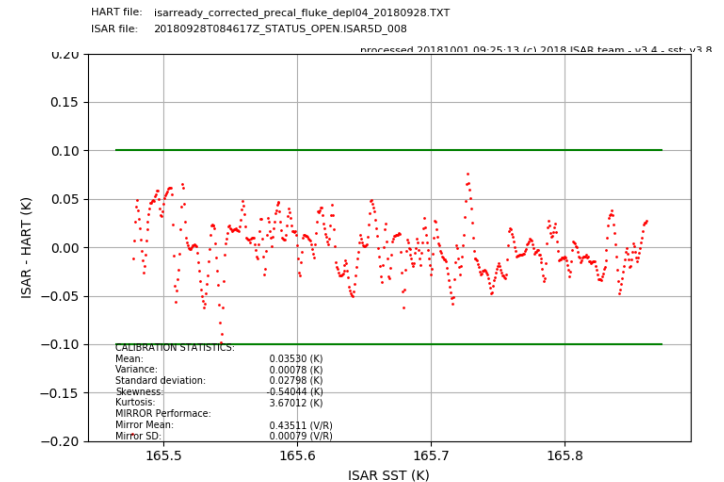
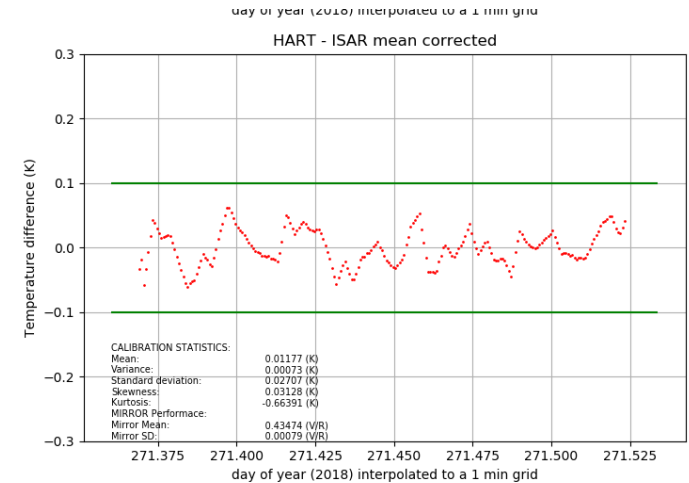
IST FICE

- Field campaign: March 30 – April 7, 2016
- Successful campaign conducted with 3 research teams and 6 TIR radiometers
- All instruments mounted on sea ice for intercomparisons
- Other instruments:
 - Automatic Weather stations
 - Ice Mass balance buoys
 - Ocean buoys (T,S, Currents)
- Additional experiments:
 - Spatial variability
 - Freeze up experiment
 - Angular emissivity experiment



Calibration procedures

- As a part of the operational FRM procedure, servicing include calibration experiments.
- Service every 2-3 months include:
 - Inspection of instrument, cleaning/changing mirror and other parts
 - Post and pre deployment calibration
- Calibration experiments:
 - Use the CASOTS blackbody
 - Calibrated in situ fluke thermometer
- Latest calibration experiment:
 - Mean difference (ISAR – in situ) = 0.01K
 - Standard deviation (ISAR – in situ) = 0.03K

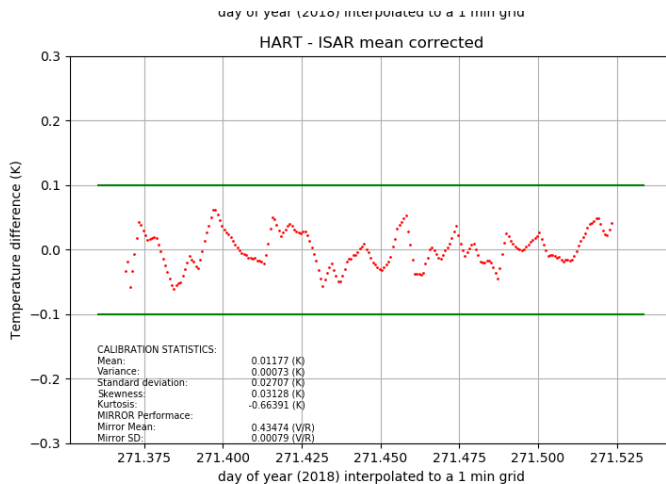
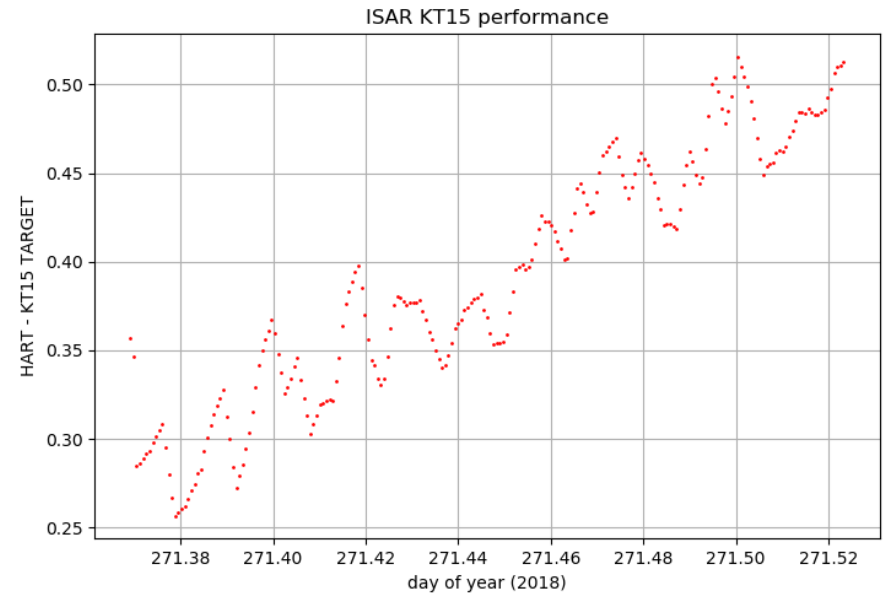


HART file: post_deployment02_20180614_HART.txt
ISAR file: 20180614T095842Z_STATUS_OPEN.ISARSD_008

processed 20180615 12:23:35 (c) 2018 ISAR team - v3.3 - cst - v3.6

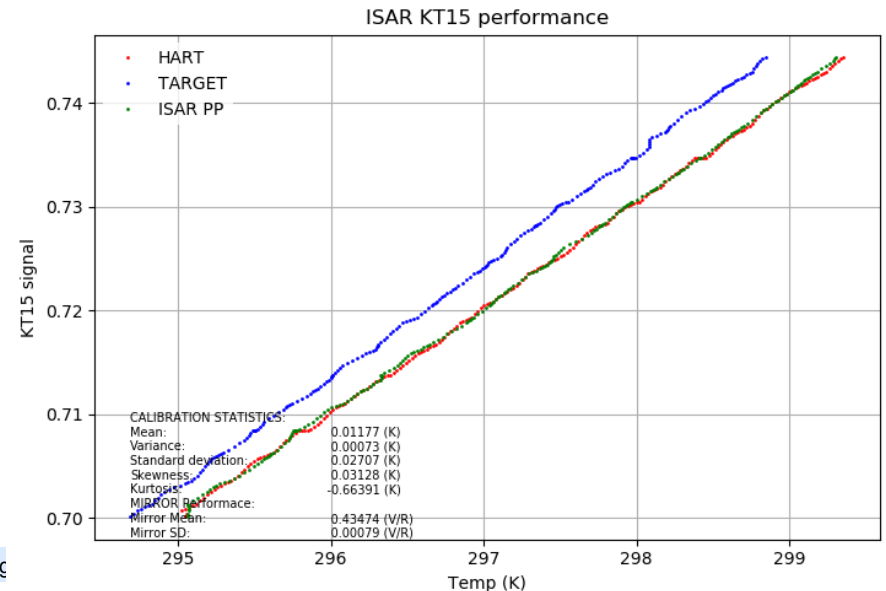
Blackbody references

- Important with ongoing blackbody referencing
- Can correct several degrees
 - Largest correction when mirror is dirty



HART file: isarready_corrected_precal_fluke_depl04_20180928.TXT
 ISAR file: 20180928T084617Z_STATUS_OPEN ISAR5D_008

processed 20181001 09:25:13 (c) 2018 ISAR team - v3.4 - sst - v3.8



Conclusion

- Valuable thermal Infrared FRM observations are routinely collected in the high latitudes
- The radiometer observations are used for Sentinel 3, SLSTR validations.
- Important with sustained funding to collect operational FRM data
- Lacking FRM TIR for IST
- Using ships of opportunity can be a challenge for planning
- Important with FRM4STS work to ensure FRM for satellite validation

Future plans

- Continue of the high latitude FRM SST collection and validation of the SLSTR SST products.
- Validate the SLSTR SST products using the updated MDB
- Set up online monitoring and real time transmission of observations
- Use drone with TIR camera to assess SST variability around Norrøna
- Satellite referencing and collection of FRM SST/ISTs has increased focus from management
- DMI will purchase two new ISARs (Q2, 2019) to increase the data return from Norrøna and to collect more data from scientific campaigns (Ocean and Sea Ice).

Questions ?