FRM4STS: Fiducial Reference measurements for validation of Surface Temperature from Satellites (ceos cv8)

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NPL (ESA Project)

WGCV Plenary # 40

Working Group on Calibration and Validation

Overview of project

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Aim: to establish and maintain SI traceability of global Fiducial Reference Measurements (FRM) for satellite derived surface temperature product validation and help develop a case for their long term sustainability

Requires:

- Comparisons to ensure consistency between measurement teams
- Accessible common descriptions and evaluation of uncertainties
- Robust links to SI
- Experiments to evaluate sources of bias/uncertainty under differing operational conditions
- International community buy-in (customer and supplier) of added value and how to achieve – through provision of guidance and best practises and access to standards and comparisons

Context: CEOS plenary (2014) endorsed a project to carry out a series of comparisons of instrumentation & methods used to validate satellite IR measurements of surface (Ocean, Land) Temp to ensure international harmonisatio

ESA sponsored project (FRM4STS) to:

National Physical Laboratory

- Design and implement a laboratory-based comparison of the results of participants calibration processes for FRM TIR radiometers (SST, LST, IST)
- Design and implement a laboratory-based comparison to verify TIR blackbody sources used to maintain calibration of FRM TIR radiometers.
- Conduct external comparison ‘experiments’ of LST and WST to evaluate environmental effects e.g. sky radiance
- Design and implement field inter-comparisons of SST using pairs of FRM TIR radiometers on board ships to build a database of knowledge over a several yrs
- Conduct field-campaigns for FRM TIR of LST and IST to assess environmental effects in real world sites.
- Develop a set of best practise protocols for the calibration, operation and performance of FRM of Surface temperatures.
- Carry out comparisons and analysis to SI standards with full metrological rigour (e.g. detailed uncertainty breakdown).
- Perform a study of means to establish traceability and potential benefits to satellites validation and CDRs of high accuracy Ocean temperature measurements using buoys and similar floating systems.

Activities and participation

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All teams making satellite validation measurements (particularly for S3, are strongly encouraged to participate)

Activity / Action	Key Date
Completion of 'expression to participate' form	1 December 2015
Final Invitation to participate distributed with draft protocols	10 January 2016
Webinar on comparisons- community Q&A	5 February 2016
Formal commitment to participate in comparisons	1 March 2016 (for Ice comparison-10 February 2016)
Ice Surface Temperature comparison start in Greenland	April 2016 (exact date to be confirmed)
Laboratory comparison and calibrations @ NPL, UK	20 June 2016
External comparisons of Land and water Temp measurements (environmental effects) @ NPL, UK	27 June – 9 July 2016
Land Surface Temperature comparisons, Namibia	November 2016

For info on the project: www.FRM4STS.org

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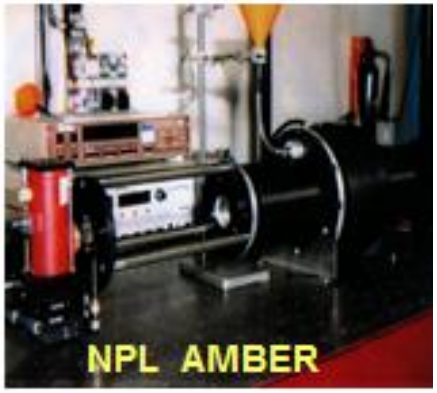
SI traceability: LCE (June 2016)

Necessary for all participants to assess biases to SI under Laboratory conditions **18 participants inc 2 from Australia**



ITS-90

NPL BB

PTB BB

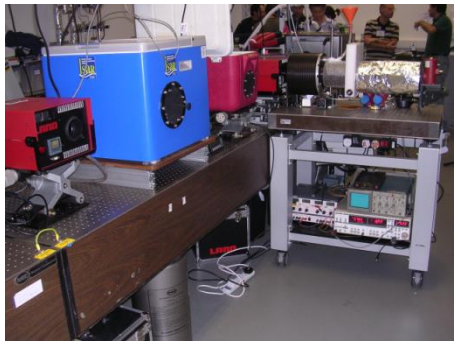
T= ~250 – 325 K
Non-vacuum
+ 77 K for sky radiance

NPL Rad (AMBER)

PTB Rad

Rad 1 | Rad 2 | Rad 3 | Rad 4 | Rad n

BB1 | BB 2 | BB 3 | BB 4 | BB n

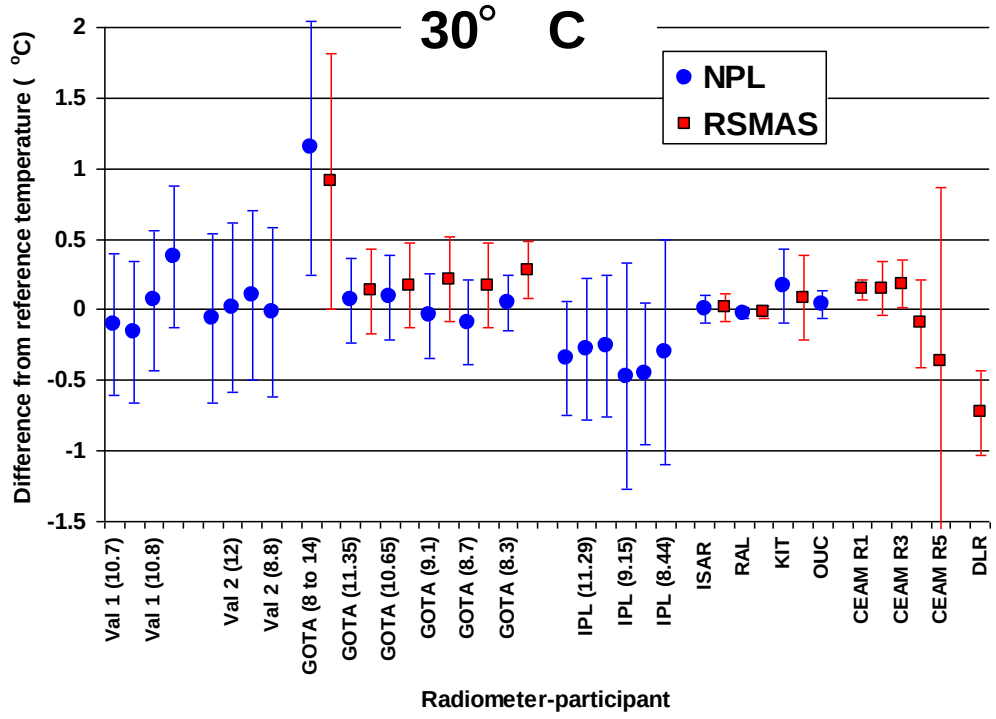


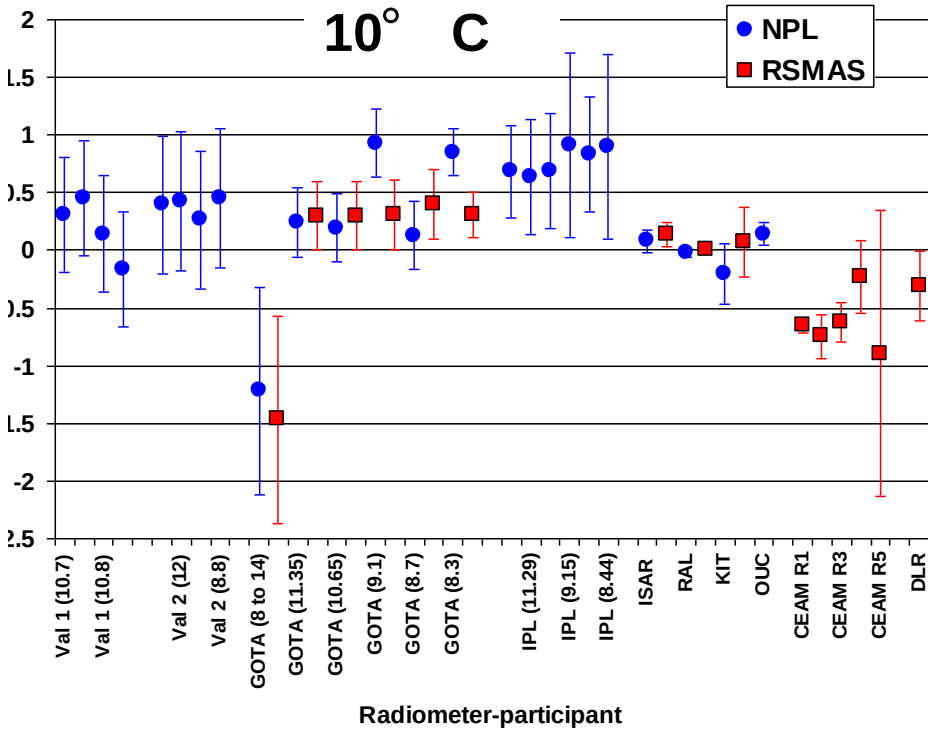
Room Environment with variable T

MIAMI 3 (2010)Results of radiometers to a "standard black body" in Lab (NPL and RSMAS (NIST))

- Excellent agreement near ambient but increased variance between participants at cooler temperatures

- Results in UK and US consistent showing stability of radiometers and also agreement between NPL and NIST





Water Surface Temp (near NPL) (Jun/Jul 2016)

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The floating platform from which WST measurements are due to take place is in the middle of the Wraysbury reservoir. The depth of the reservoir is 20 m.

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LST measurements @ NPL (impact of environment e.g. sky in context of ε) July 2016

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Planned LST measurement targets

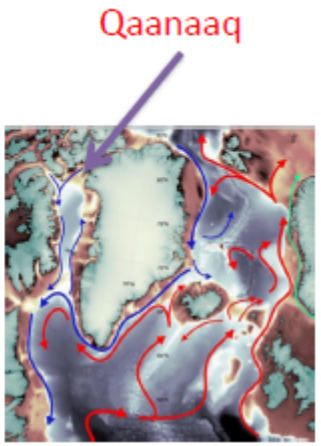
- The following "targets" are being planned (on the advice of KIT):
- Short green grass (high emissivity at 10 μm).
- Short dry grass (low emissivity at 10 μm).
- Sand / gravel with different SiO_2 contents and grain sizes
- "Dark soil".
- Tarmac.

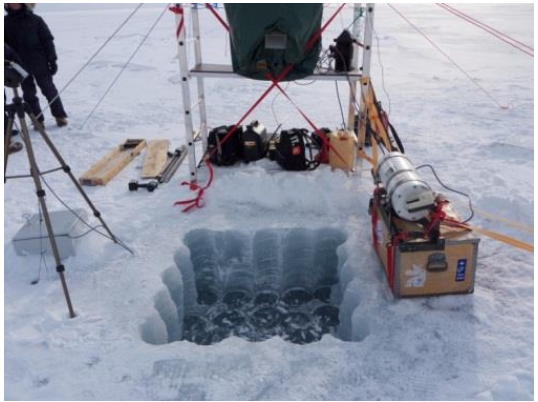
IST 'pilot' comparison (April 2016)

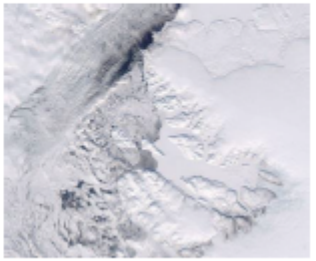
The aim with this study is to evaluate potential variances (non-equivalences) in FRM of TIR radiometers under high latitude sea ice field conditions.

This option will be conducted as four main tasks:

- *Plan and arrange a FICE with focus upon FRM for Ice surface temperature*
- *Conduct an IST FICE in Qaanaaq, Greenland with at least 2 independent FRM TIR radiometers*
- *Process the field campaign data with focus upon SI traceability*
- *Report the results in a technical report/publication*







LST @ Namibia Nov 2016

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Implementation plan for the FRM4-CEOS field Inter-comparison Experiments (FICE) in Namibia

ESA Contract No. 4000113848_15I-LG

Prepared by Folke Olesen (KIT)

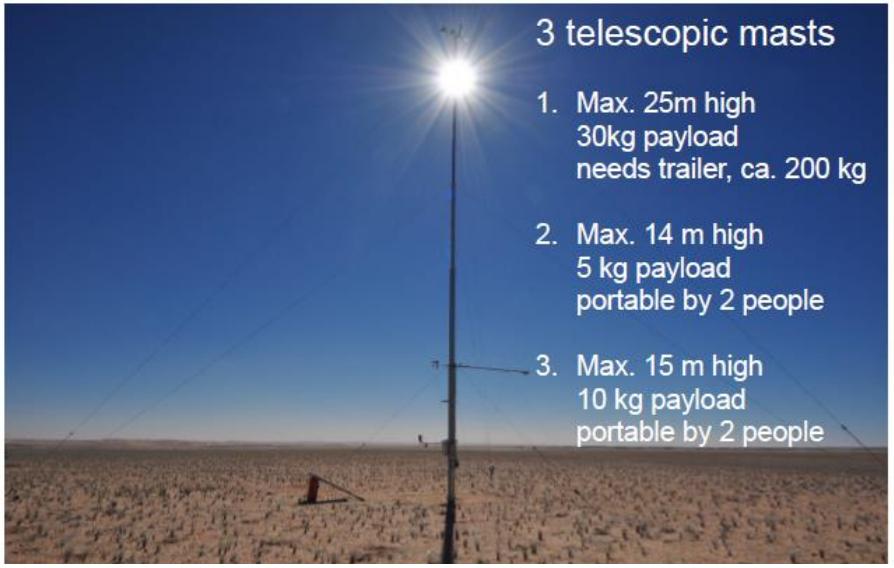
Gobabeb
'station dune'

30 m high
'Wind Tower'
in the Namib

LST comparison with various methods

(under expertise of KIT)

- **Gobabeb gravel plains**
- **Kalahari bush**



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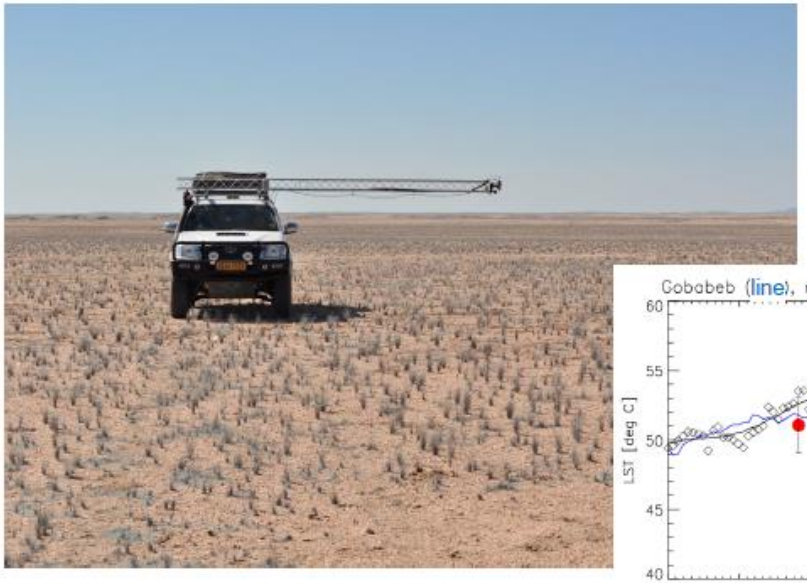
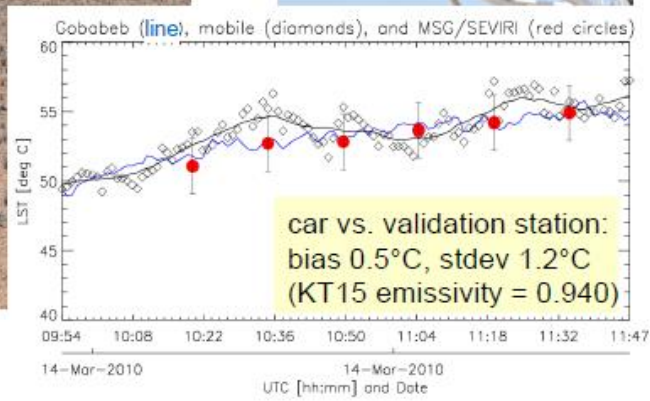
Spatial averaging over gravel plains





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Summary / Actions / Next steps

- Major set of international comparisons planned with defined dates
- Detailed protocols and guidance on Uncertainty evaluation are being be provided
- To be considered ‘Fiducial’ participation is required

International Conf/workshop @ NPL, UK 7-9 March 2017