Fiducial Reference Measurements for validation of Surface Temperature from Satellites (FRM4STS)

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Project Brochure

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fiducial reference temperature measurements

FRM4STS:

Fiducial reference measurements for satellite derived surface temperature measurements

Improving accuracy, interoperability and confidence in climate understanding through thermal infrared radiometer international comparisons

Photo: ESA

www.frm4sts.org

Why is measuring surface temperature from space important?

Satellite remote sensing of the Earth's surface is essential to help develop our understanding of the effects and reasons for weather patterns and impacts of climate change. For example by following the trends of surface temperature across the world, we can further our understanding of the air-sea-land-ice interaction and use this as a stepping stone to improve our predictions of the scale and impact of climate change. However, the trends are very small and subject to a range of regional and seasonal fluctuations.

Satellite measurements, therefore, need to be as accurate as possible and provide long term (multi-decadal), data that can be robustly linked between different sensors of many space agencies flying now and with those of the past and future. The recently launched EU Copernicus Sentinel 3A spacecraft is the first of a series of four satellites to be launched over the next two decades and follows on from the previous ATSR+ series of the last two decades. This means anchoring all measurements to an invariant common reference for the measurements, through international system of units (SI) and ensuring that these can be regularly validated across the globe through the use of surface based measurements derived from Ocean Buoys and most accurately, field deployed (on-board ships) Thermal Infrared (TIR) radiometers, which must both also be tied to SI units.

We would like to also acknowledge the considerable contribution and effort of all the participants and their funding agencies in supporting this initiative.

What we're doing to make things better

NPL is working with a number of international institutes, supported by European Space Agency (ESA) on behalf of the Committee for Earth Observation Satellites (http:www.CEOS.org) to identify optimal ways to improve measurement procedures and ensure consistency in uncertainty of measurements. Through the FRM4STS project we have begun to lay the foundations for greater accuracy in temperature measurements for all of the World's surfaces and geographical climatic zones. With scientific teams operating from different countries and using different designs of instrumentation, it can be difficult to ensure that there is global consistency at the levels needed to unequivocally detect climate induced trends from natural variability. This is why it is so important to have international intercomparisons of field radiometers, like the one organised by NPL earlier this year.

During this study, we were able to perform experiments in a multitude of environments:

- ***Cold, icy climates in Qaanaaq, Greenland,***
- ***Open sea from aboard the Queen Mary 2,***
- ***In our own back yard at NPL and***
- ***Soon in the dry, arid deserts of Gobabeb, Namibia.***

This work isn't just helping scientists learn how to use their instruments to their fullest or how to establish links to the international system of units, it is creating the framework of good practise for the next generation to combat impact of climate change by giving them the best tools to use and reference data from which to monitor change.

Findings

The results from the 2016 thermal infrared field radiometer intercomparison have been very positive and encouraging, with most institutes (twelve from four continents) displaying accuracy in their calibrations and strong agreement between instruments when directly compared against primary standard in the Laboratory at NPL. A few radiometers differ by more than the stated uncertainty but when the cause of those anomalies have been identified, we can work towards improving their calibration methods and their testing procedure.

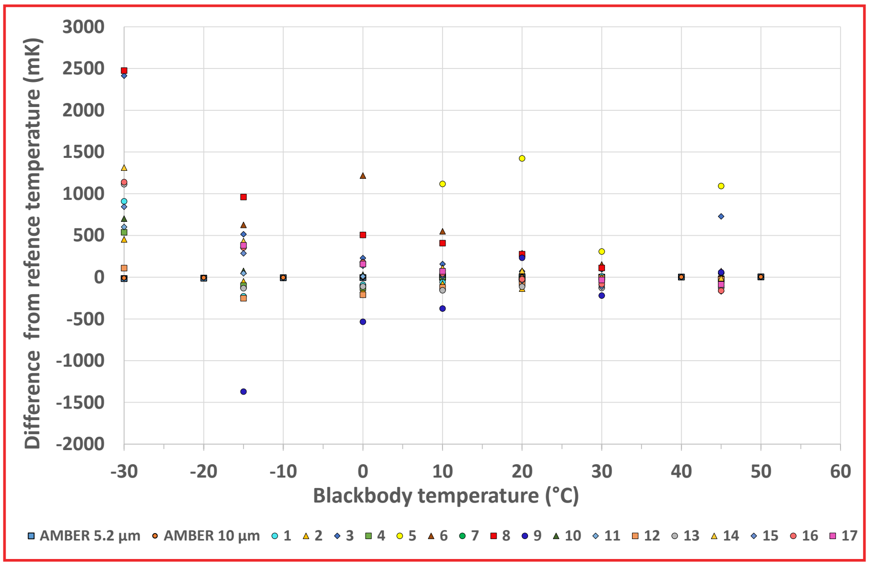

Figure 1: Plot of the difference of the temperature measurements made by the participants from the true values of the reference blackbody temperature, made at seven different blackbody temperatures in the -30 °C to +45 °C range. Data for the NPL AMBER reference radiometer has been included, although these measurements were performed independently and not during the timeframe of this comparison they are still believed to be representative of the black body performance.

Figure 2 shows how small the differences were between the temperature of the NPL reference blackbody and the temperature measured by a participating radiometer, which amounts to an average difference of 19 mK (0.019 °C). The uncertainty attributed to these measurements is large in comparison to the measured difference so we, as an international community, will endeavour to create new methods of data capture to make this as small, and therefore accurate, as possible.

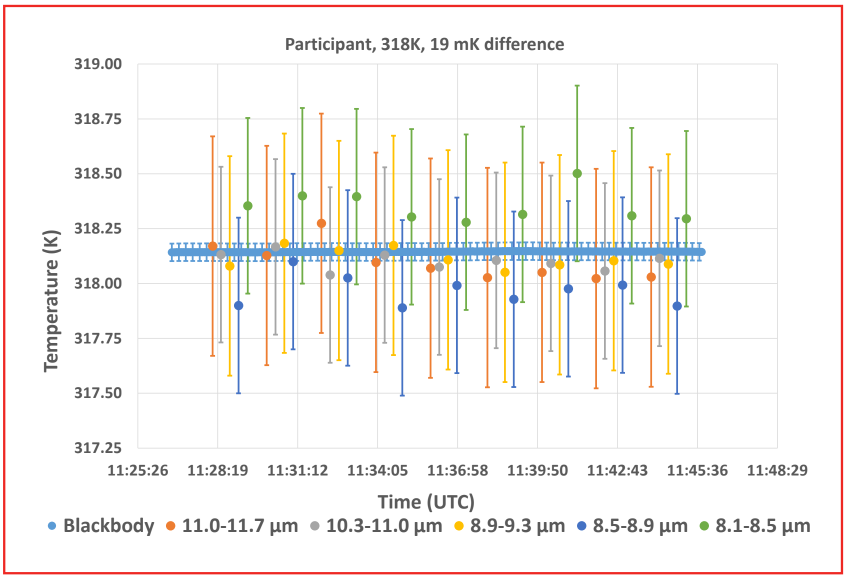

Figure 2: Plot of the temperatures measured by a participant (in different spectral bands) along with the temperature of the reference blackbody made over a 20 minute period. Error bars indicate the combined standard uncertainty of the measurements of the participant and the blackbody

Figure 3 shows the water surface temperature measurements completed at Wraysbury reservoir (near Heathrow airport). Most instruments measured automatically over 5 days with most gaps in data due to periods of rain.

Overall, there was good agreement between participant radiometers, with large deviations in measurements attributed to difference is accounting for effects of the sky brightness or poor initial positioning of the radiometer.

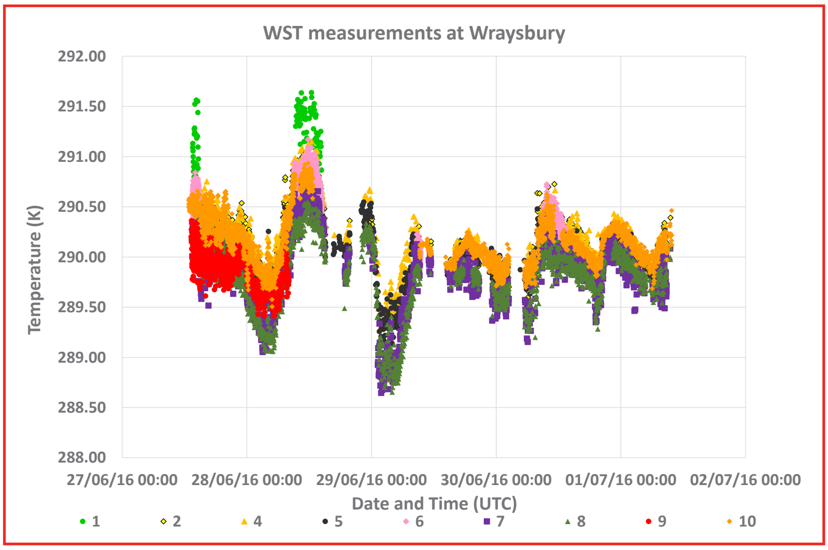

Figure 3: Plot of the water skin surface temperature as measured by the participants at Wraysbury reservoir

Our dedicated team has been working to establish robust traceability between the measurements made by satellites and the SI unit. FRM4STS is an ESA funded project to help establish this link for all global Fiducial Reference Measurements (FRM) for satellite derived surface temperature product validation. This will not only help improve confidence in the data we collect but also make it easier to maintain a high standard of surface temperature measurements globally by being able to identify any weakness in the chain. With the help of ESA and the Committee for Earth Observation Satellites (CEOS), NPL is able to support international research institutes and universities to create a fully anchored database for all present and future surface temperature measurements, ensuring maximum benefit from all space assets and facilitating confidence in the data to enable evidence based decisions on mitigation and adaptation to be made by policy makers.

For more information visit **www.frm4sts.org**

fiducial reference temperature measurements

Our Project Study team:

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