

Consultative Committee for Photometry and Radiometry (CCPR)
25th Meeting (on-line 10-11 May 2022)

**CCPR member report on activities in radiometry and photometry since the last
CCPR meeting (2019)**

Reply from: National Physical Laboratory (NPL, UK)

Delegate: Nigel Fox

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1. Summarize the recent progress in your laboratory with respect to measurement standards, research projects, and metrology services to fulfill the demands of customers in:
 - (a) broad-band radiometric quantities:
 - (b) spectral radiometric quantities:
 - **Development of STAR-cc-OGSE**
Spectroscopically Tuneable Absolute Radiometric, calibration and characterisation, Optical Ground Support Equipment (STAR-cc-OGSE) – A transportable facility to provide spectrally tuneable, radiance, irradiance, linearity, polarisation and image quality calibrations of imaging spectrometers with entrance apertures up to 200 mm diameter from 260 nm to 2600 nm based on a full automated tuneable CW laser system has been built primarily for the pre-flight calibration of satellite spectrometers at uncertainty levels targeting a <0.5%. Designed to calibrate sensors in a clean room and under vacuum the first calibration is currently being carried out in Toulouse France on the MicroCARB satellite which will measure GHGs. One of the major demands is to characterize very narrow spectral bandpasses but with 0.1 pm tuneability this is readily achieved. Due to demand a second system is being built using an OPO laser for lower specification requirements such as terrestrial cameras.
 - **Upgrade of National Reference Reflectometer (NRR) – ongoing**
The goniometric stages on NRR have been replaced with a robotic arm to improve the versatility of the system (e.g. to enable off-axis sample measurement), and the light source and monochromator have been upgraded to improve signal levels and reduce noise. Other improvements have been made to increase reliability and minimise uncertainties. Work to characterise the facility and evaluate uncertainties in the visible is nearing completion. The facility will then provide BRDF and Diffuse reflectance measurements from the Near UV to SWIR spectral regions

- Upgrade of the Spectral Radiance and Irradiance Primary Scale (SRIPS) facility to reduce uncertainties in the NIR region and improve reliability is close to completion. Investigations into the safety of the blackbody in respect of emission of nanoparticles are also largely complete.
- (c) photometric quantities:
None
- (d) other area(s) relevant to CCPR:
- **TRUTHS metrology satellite in space.**
Following selection and funding at ESA, work has been on-going to support the detailed design of the satellite and its on-board calibration system. TRUTHS is targeting to make spectral radiometric measurements of the Earth and Sun from space with uncertainties of 0.3% $k=2$. The satellite will then additionally serve as a calibration reference in space for other satellites. In effect, taking the place of the STAR system described above into a space environment.
 - **Surface reflectance reference test sites for Earth observation and climate**
We have been working with various international collaborators to establish 'natural' targets as reference test sites for satellites. These range from deserts, oceans and forests. Each has different challenges, but the goal is to establish SI traceability of the surface reflectance and subsequently propagated through the atmosphere to top of the atmosphere to enable satellite measurements to be validated and/or calibrated to SI. In performing this activity best practices are established for use by the international community. One of these, the RadCalNet network of instrumented sites, has more than 500 registered users. In addition, we are working on measurements of the reflectance/radiance of the moon for the same purpose.
 - **FRM community comparisons**
The criticality and high accuracies required of space-viewed Earth parameters has led to many initiatives to ensure that the world's EO measurement community have consistency and SI traceability. This has led to comparisons being organised, many by NPL, to establish equivalence of instruments under laboratory conditions and also field conditions. The guides developed by CCPR are being reinterpreted and adopted for these applications.
2. What work in PR has been/will be terminated in your laboratory, if any, in the past /future few years? Please explain the reasons and provide the name of the institution if it has been/will be substituted by a DI or accredited laboratory.
- No PR work has been/is planned to be terminated.

3. Summarize the Capacity Building and Knowledge Transfer activities undertaken by your institute in photometry and radiometry (courses, training, ...):
 - Development of eLearning course “[Climate Data Records from Satellites: A Metrological Approach](#)” – available for free on NPL website. ~60 people have used it.
 - Development of the www.ga4eo.org website with training material about how to apply metrological techniques to satellite data records
 - Participated in virtual training programmes for different Earth observation communities (e.g. practical training for ocean colour, Earth surface reflectance, Land and Sea surface brightness temperature (spectral radiance in TIR, uncertainty analysis training)
 - ‘Fundamentals of Metrology: Candela’ lectures – currently in proposal stage for September 2022 delivery
4. Summarize the research projects currently performed within a collaboration with one or more NMIs or Dis (name of the project, participants):
 - Solar Radiometry with PMOD Davos,
 - Surface based radiance measurements in the field CMI
 - BRDF measurements for remote sensing, Sand, and artifacts to test radiative transfer models AALTO/MIKES
 - NPL leads an EU EMPIR research project called MetEOC (now in its fourth version). This project undertakes a variety of activities and currently includes: CMI, PTB, AALTO/MIKES, and PMOD.
 - TRUTHS satellite development – PMOD
 - NPL (Emma Woolliams) Chairs the European Metrology Network for Climate and Ocean Observation and its land and Earth observation section (Nigel Fox)
 - For lunar spectral irradiance measurements our consortium (led by the European Space Agency) is collaborating with a NASA led consortium that NIST is involved with – thus NPL-traceable lunar irradiance measurements from Tenerife are being compared with NIST-traceable lunar irradiance measurements taken from an aircraft.
5. Are there any other research projects where you might be looking for collaborators from other NMIs or are there studies that might be suitable for collaboration or coordination between NMIs?

[There are several Earth Observation projects where we would be happy to collaborate with other NMIs.](#)
6. Have you got any other information to place before the CCPR in advance of its next meeting?

[No](#)
7. Bibliography of radiometry and photometry papers of your laboratory since the last CCPR (September 2019):

NPL authors in bold.

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