**Traceable Radiometry Underpinning Terrestrial- and Helio- Studies (TRUTHS): Establishing a climate and calibration observatory in space.**

***N. Fox1, R. Bantjes2 H. Brindley2, J. Gorrono1,P. Green1, D. Lobb3, A. O’Neill4 J. Reed5, J. Russell2, R. Winkler1***

*1National Physical Laboratory, Teddington, UK, 2Imperial College London, UK, 3Surrey Satellite Technology Ltd, Guildford, UK, 4University of Cambridge, Cambridge, UK, 5Airbus, Stevenage, UK*

Climate change; reliably forecasting its impact (reducing variance), and monitoring mitigation strategies requires reliable long term climate data records (CDR) of the essential climate variables (ECVs). The majority of ECVs require observations from satellites. These must be trustable, and of sufficient accuracy to facilitate the detection of small trends from a background of natural variability. Since the size of the trend is small, robust detection and attribution takes many decades and consequently multiple satellites. Each must be unequivocally harmonised with no risk of unaccounted bias or instrumental drift to provide the evidence needed to implement and sustain action by the World’s policy makers.

Traceability to international standards (SI) in-orbit is a key requisite to ensure integrity of the data collected by satellites but achieving this at an appropriate level of uncertainty remains a significant challenge. Space agencies and international bodies like CEOS and WMO (Global Space Inter-calibration System, GSICS) strive to develop methods to aid interoperability and consistency but as yet cannot achieve uncertainty levels much below a few percent and even in these cases struggle to demonstrate full SI traceability. However this is recognized and has led to a strategy for climate monitoring from space, <http://www.wmo.int/pages/prog/sat/documents/ARCH_strategy-climate-architecture-space.pdf>. This strategy identifies the critical need for an SI traceable climate observing system and recommends the launch of a few well-calibrated reference satellites to underpin it. Such sensors would also make benchmark measurements of the state of the Earth’s climate from which to monitor change.

TRUTHS, (this paper), and its US sister CLARREO, are designed to address this challenge. Between them they provide SI traceable spectrally resolved measurements of the Earths radiation; incoming and reflected solar radiation and in for CLARREO emitted thermal infrared radiation at uncertainty levels close to that of the ideal observing system so that their data and ability to detect a trend is limited by natural variability and not instrument or sampling errors.

TRUTHS takes a primary standard into orbit as an on-board reference and provides measurements of incoming and global reflected (320 - 2350 nm at 5 nm FWHM) at 50 m GIFOV with an uncertainty of 0.3% (0.01 % for total solar irradiance). These fundamental climate (Ir)radiances can be convolved into the building blocks of many ECVs and EO applications (e.g. Carbon cycle). Although not necessarily delivering all of them itself it will enable an integrated global observing system through reference calibration.