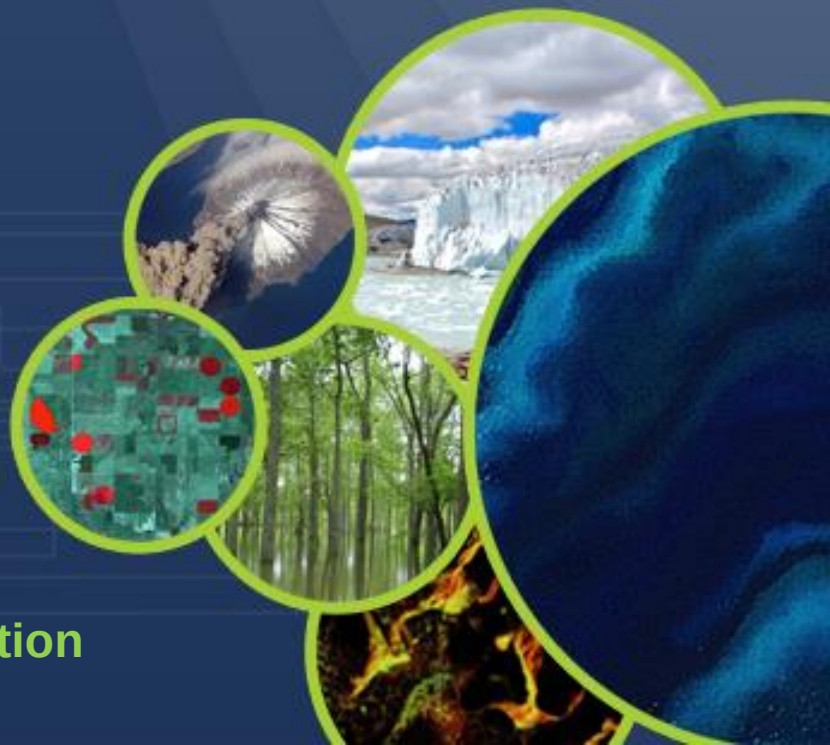
Working Group on Calibration and Validation (WGCV): 42

Infrared Visible and Optical Sensors (IVOS) subgroup: report

Nigel Fox

NPL (with UKSA support)

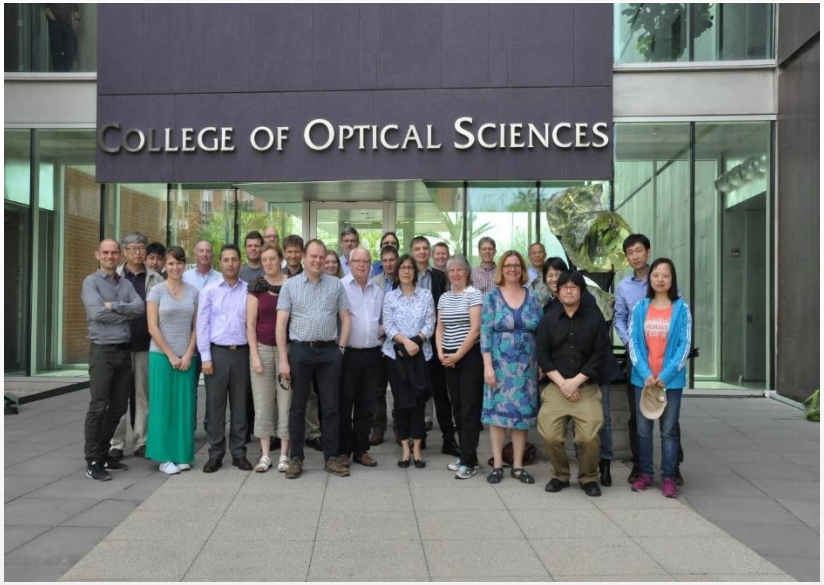
WGCV 41



Summary of activities

- IVOS 29 @ Tucson, Arizona, USA hosted by Uni of Arizona Mar 2017
- 26 agency/orgs represented
- 30 attendees + 10 remote
- All themes and topics (work-plan discussed or summarised
- **3 joint (GSICS) webex on solar irradiance**
- **3 rd MTF workshop (Mar 2017)**
- **2 PICSCAR webex (Joint GSICS)**
  - **1st Meeting (3rd inc pre-cursors)**

IVOS 30 ESA Estec Holland Q1-2 2018



Special Projects:

- **RadCalNet team met Mar 2017@Tucson**
- **Beta testing results workshop**
- **SST/LST comparison (under sponsorship from ESA) took place @NPL (June-July 2016)**
- **O-colour vicarious Cal comparisons started April 2017**

Terms of Reference

1. **Promote international and national collaboration in the calibration and validation of all IVOS member sensors.**
2. **Address all sensors (ground based, airborne, and satellite) for which there is a direct link to the calibration and validation of satellite sensors;**
3. **Identify and agree on calibration and validation requirements and standard specifications for IVOS members;**
4. **Identify test sites and encourage continuing observations and inter-comparison of data from these sites;**
5. **Encourage the preservation, unencumbered and timely release of data relating to calibration and validation activities including details of pre-launch and in flight parameters.**
6. **In the context of calibration and validation encourage the full consideration of "traceability" in all activities involved in the end-to-end development of an EO product including appropriate models and algorithms.**

IVOS: Vision

To facilitate the provision of 'fit for purpose' information through enabling data interoperability and performance assessment through an 'operational' CEOS coordinated & internationally harmonised Cal/Val infrastructure consistent with QA4EO principles.

- ***Pre-flight characterisation & calibration***
- ***Test – sites***
- ***Comparisons***
- ***Agreed methodologies***
- ***Community Good Practises***
- ***Interchangeable/readable formats***
- ***Results/metadata - databases***

Key Infrastructure to be established and maintained independent of sensor specific projects and/or agencies

Work plan

- **Structured into themes and led by ‘champions’ (effectively vice chairs for CEOS WGCV constitution) (Plus specific projects)**
  - **Look to develop good practises**
  - **Organise comparisons**
  - **Shared learning (research activities)**
  - **Shared infrastructure / tools / Methods**
  - **Recommendations as needed**

Land surface reflectance - Czapler Myers (U of Arizona USA)

Ocean colour (link to IOCCG, VC-OCR etc) - Zibordi (JRC, EU) & Murakami (JAXA JPN)

Surface Temperature (link to VC-SST, GHRSST) - Corlett (U of Leicester, UK)

Geo spatial image quality - Helder (SDSU, USA) & Viallefont (ONERA F)

Atmospheric Correction (Link to AC subgroup) - Thome (NASA, USA)

RT codes (context of IVOS use in calibration) - ?

Specific projects/cross-cutting

- RadCALNet - Bouvet (ESA)
- PICSCAR (with GSICS) - Henry (CNES, F)
- SST/LST cross-comparison (+ VC-SST & LPV (instrument Cal for LST) - Fox (NPL, UK)
- O-Colour Vicarious Cal comparions - Fox (NPL, UK)
- Others in progress/development/related
  - Establishing a CEOS Reference and method of use for L1 radiometric interoperability (with GSICS) (including potential tools/databases)
  - Good practise for convolving spectral data sets (solar/surface/sensor bandwidth) Selection of Refererence Solar irradiance spectrum(CEOS WGCV (sub-groups) & GSICS)
  - Comparison of Rayleigh and Sun-Glint methods
  - Vocabulary

IVOS 29 Discussion Topics

- Summary of workshops, MTF, RadCalNet, PICSCAR
- OC Rad validation comparison
- Sat surf Temp measurements- Comparison results, GHRSST, SST-VC
- Terminology
- Sensor to sensor interoperability (support for CEOS intitiative)
- Sensor Pre- and In- flight Cal and Uc assessment
  - Inc Moon, Stars, Mirrors
- New Sensors
- CEOS Ref solar irradiance spectrum
- Collaborations/interactions – WGCV, GSICS, VCs, Climate, Carbon ….
- Metrology and Uc evaluation….

MTF activities & comparison

Geo/Spatial Quality Sub-Committee

Report to IVOS

CEOS-WGCV-IVOS
March 16, 2017

Dennis Helder and Francoise Viallefont

South Dakota State University
Image Processing Lab

ONERA

Establish good practise and community references

Proposed Framework

- Definition and Importance (short introductory section)
- Measurement (background and basic theory)
- Pre-Flight Estimation (to be developed later)
- On-Orbit Estimation (substantial portion of document)
- Recommendations for Determining Geo/Spatial Quality (final effort)

Proposed Framework

On-orbit Estimation (substantial portion of document)

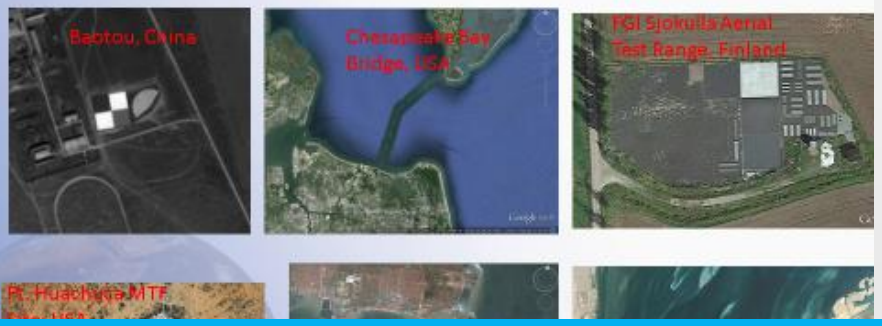
- Field Methods Survey
- Targets
  - Artificial/Man-made
    - Points
    - Lines
    - Edges
    - Pulses
  - Image feature-based
    - Linear ('Rich') features
    - Bridges
    - Moon
  - Matrix of Targets
    - Type vs. GSD
    - Availability/Maintenance
    - Point of Contact
    - Recommended for operational acquisition
  - Database of Reference Imagery for PSF/MTF estimation
- Data Analysis, PSF/MTF Estimation
  - Image data format
  - Models
  - Parametric/Nonparametric Methods
  - Database of Reference estimation methods

Outcome was current Test Site Catalog

Current status: suite of edge images

Last meeting's major activity

Current Website Status



Current Website Status

Catalogue to be migrated to CalVal Portal

IVOS seeks approval of CEOS WGCV to assign CEOS recommendation label to aid community & interoperability following assessment of maintenance

Comparison of methods

Reference dataset

Objectives

Objective 1: share images and begin to understand the MTF differences for each kind of method and target (repeatability and precision)

Objective 2: share images with known parameters (i.e. MTF, SNR) for quantitative comparison (accuracy)

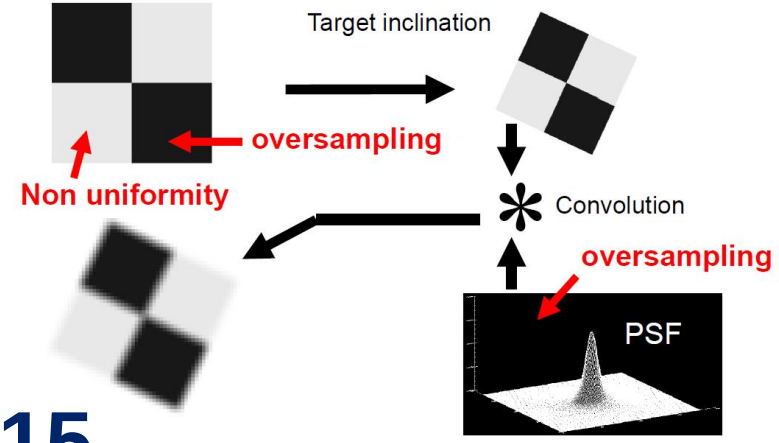
→ A need exists for creation of a reference dataset containing:

Actual images: in the coming slides

Synthetic images: initial effort

NOV 2015

Exemple of synthetic image generation



Current dataset

20 edge or draughtboard images

14 actual images: Worldview3 (DIGITALGLOBE), S6 and S7 (AIRBUS_DS)

6 synthetic images: 2 standard systems (AIRBUS_DS), 4 analytic MTF (CSIR)

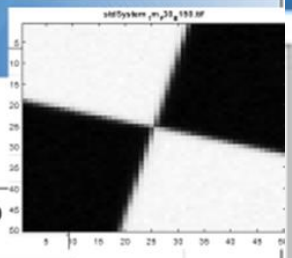
Thanks to all data providers !

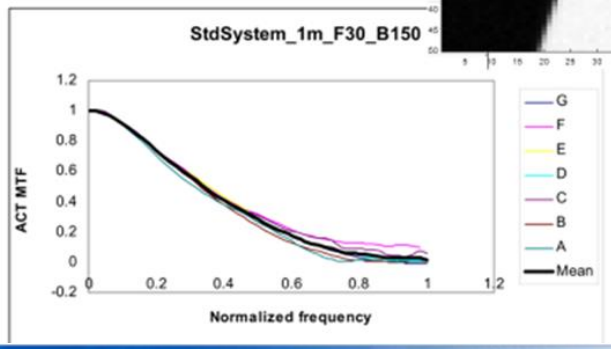
- Discussion of Results
- Some Reprocessing
- Leading to Good consistency for most
- Comparison did its job
  identified errors in processing

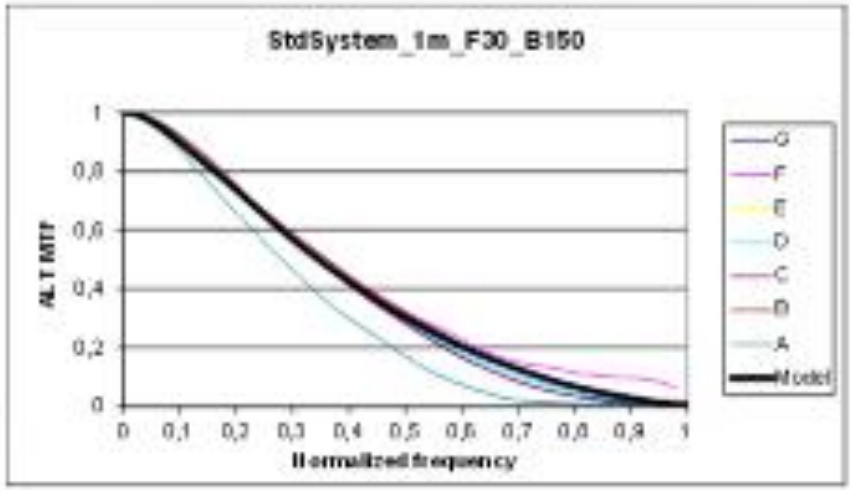
StdSystem_1m : reprocessed by A, B, C and D

First MTF measurement results

StdSystem_1m_F30_B150 :

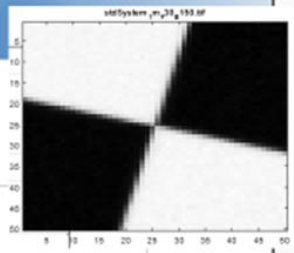


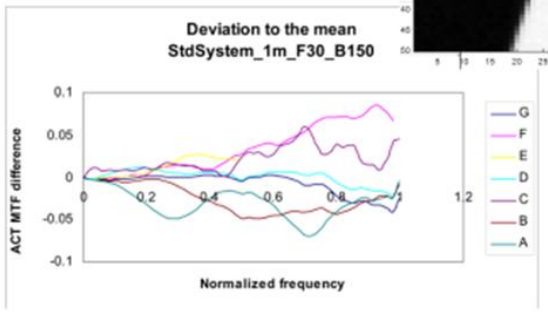


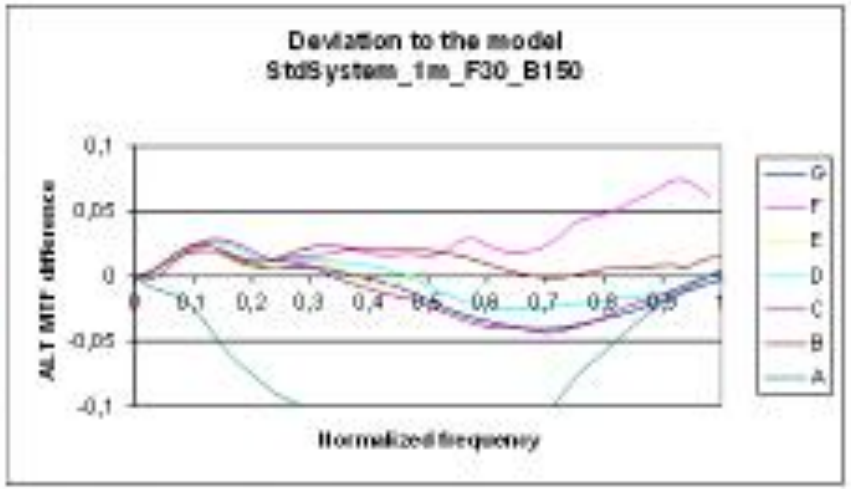


First MTF measurement results

StdSystem_1m_F30_B150 :





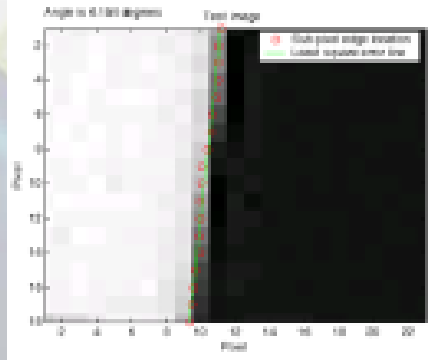


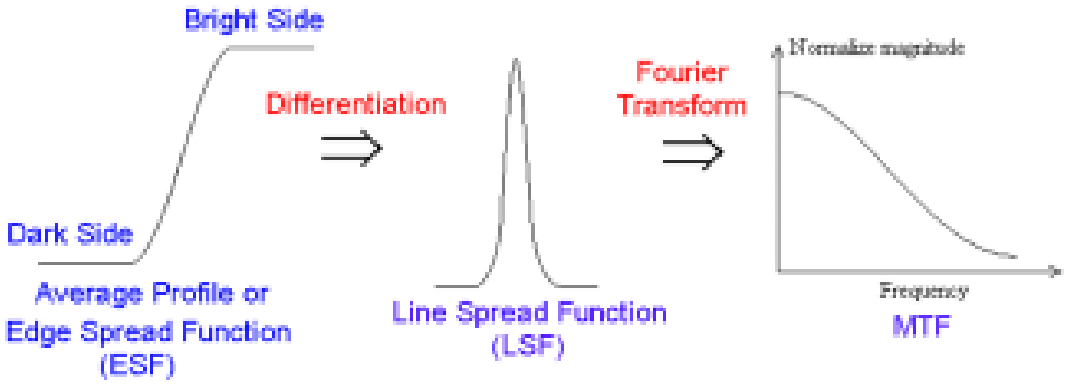
ONERA

Methods discussed, ‘peer review’

SDSU Edge Method Example

- Edge Method Steps
  1. Sub-pixel edge locations were found by Fermi function fit.
  2. A least-square error line was calculated through the edge locations.
  3. Modified Savitzky-Golay filtering was applied on each line.
  4. The filtered profile was differentiated to obtain LSF
  5. MTF calculated by applying Fourier transform to LSF.





Edge Method

Next steps

- **First objective: a journal paper including all participants**
  - Serves as a reference paper for this effort
  - Content: Methods, Estimates generated from ‘High Priority Data’, Discussion, Conclusions
  - Mention of existing standards? (such as ISO 122233)
- **Second objective: creation of a first ‘CEOS reference dataset’ based on six ‘High Priority Data’ images**
  - Create a directory in the CalVal Portal with free access to selected data
  - Define the corresponding reference MTF result for each test image as the mean (with outlier rejection) of the submitted estimates when actual model is not available
  - Ask users to submit their « blind test results » before accessing the reference results in order to improve the reference MTF dataset
- **Future activities**
  - Create additional targets for testing
  - Consider ‘figures of merit’: FWHM, Edge slope, RER etc
  - Assignment of uncertainty and traceability issues

Recommendations/Requests to WGCV

R.2017-3	IVOS recommends that the test sites in the MTF catalogue should be made available as CEOS recommended sites.
R.2017-4	IVOS recommends that a CEOS-recommended reference dataset is provided for the community to test their MTF estimation methodologies

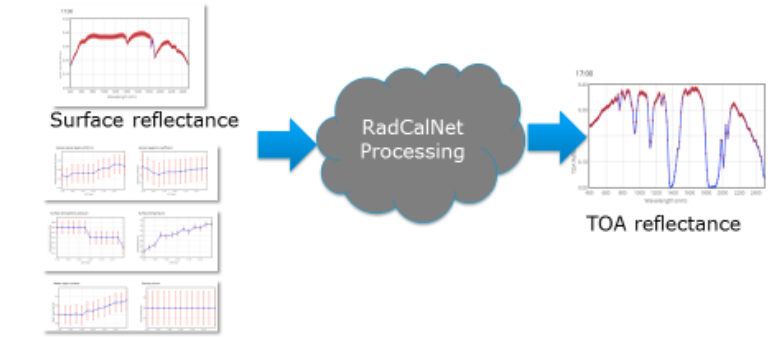
RadCalNet: Wednesday

RadCalNet Status

M. Bouvet on behalf of the RadCalNet WG

The RadCalNet processing

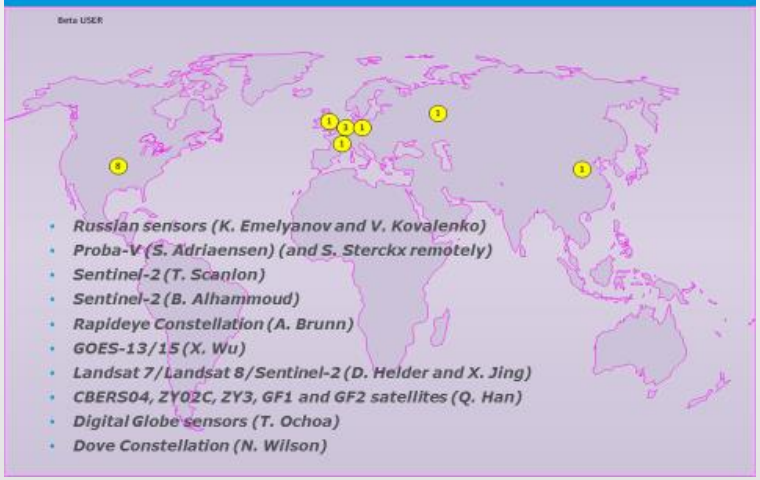
- MODTRAN 5
- On-going work by K. Thome / B. Wenny to **propagate the surface / atmosphere uncertainties to TOA uncertainties** via pre-computed LUT from Montecarlo MODTRAN runs



The sites

- Since have been efforts dedicated to:
  - ✓ Operationally running the sites
  - ✓ Feeding surface and atmosphere data to the RadCalNet processing 'system'
  - ✓ Defining measurement uncertainties

Current beta users



Working

Request to CEOS WGCV

R.2017-1	**Following the successful Beta Testing of RadCalNet, IVOS is looking for CEOS-WGCV endorsement for opening as an operational network (once the remaining tasks listed in the RadCalNet WG minutes are complete). IVOS asks WGCV to set up the necessary governance structure to approve RadCalNet sites.**

Following full operational access: IVOS requests agencies/site owners to consider enhancing RadCalNet through contributing new sites

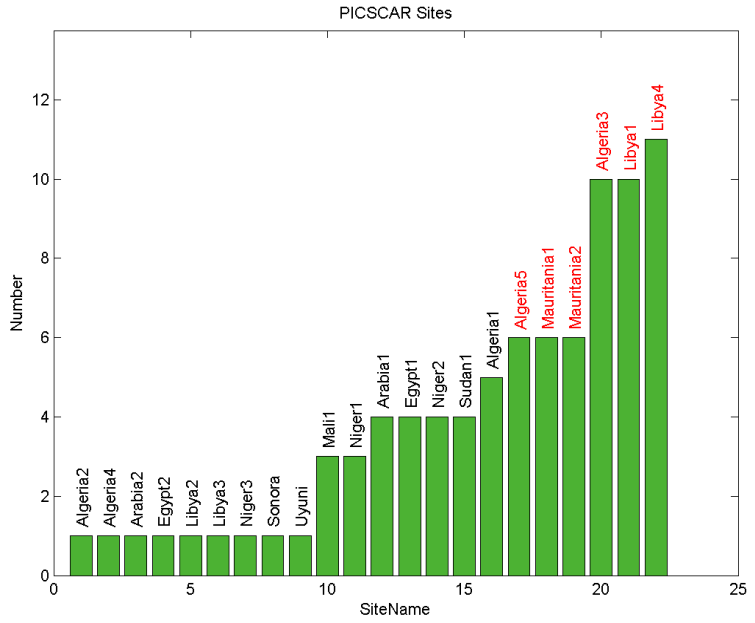
PICSCAR
lead P Henry CNES

Pseuodo invariant sites used for Rad L1 Cal/comparison/monitoring

- Questionnaire sent to ~180 people (CEOS contacts) (Sep 2016)
  - 15 Replies
  - Seek to identify useage, priorities of PICS
- Seek to collect observational data from heritage priority site, Libya 4
  - Standardised format and location
  - 6 teams formally submitted independent data sets (2002 -2017)
- Some initial processing of one data set (FY3) using a common BRDF model
- Two telecons to discuss preliminary inputs and priorities
- Workshop held aligned to IVOS 29 to define a project plan/roadmap

Survey of use

- **30 sites identified as being used by 33 sensors**
- **Top 6 as already identified by CEOS**



Low/Medium spatial resolution Sensor	Reference Number		High spatial resolution Sensor	Reference Number
ASTR, ATSR2, AATSR	1		ASTER	30
AVHRR	2		CBERS	31
MERIS	3		Formosat	32
MSG/METEOSAT	4		FY -2	33
MISR	5		Hyperion	34
MODIS TERRA/AQUA	6		KOMPSAT 1/2	35
OLCI	7		LANDSAT 5 TM	36
PARASOL	8		LANDSAT 7 ETM	37
POLDER 1/2	9		LANDSAT 8 OLI	38
Proba V	10		Pléiades PHR1A/1B	39
SLSTR	11		Sentinel2/MSI	40
VEGETATION1/ 2	12		SPOT 1,2,3,4,5	41
VIIRS	13		SPOT 6,7	42
SeaWiFS	14		Worldview	43
GOME-2	15		Thaichote (THEOS)	44
FY-3	16		DMC	45
GOES	17		LANDSAT 5 MSS	46
OCO2	18			
GOSAT	19			

Identifiant	Organisation	Nom
1	Rayference	Yves Govaerts
2	DLR	Martin Bachmann
3	NOAA Federal	Xiangqian Wu
4	ONERA	Françoise Viallefont
5	SDSU	Dennis Helder
6	AIST	Hirokazu Yamamoto
7	ARGANS	Bahjat Alhammoud
8	NOAA-NESDIS-STAR	Sirish Uprety
9	VITO	Sindy Sterckx
10	ESA	Marc Bouvet
11	CNES	Aimé Meygret
12	CMA	Hu Xiuqing
13	EoSense	Stephen Mackin
14	TPZ	Sébastien Saunier
15	JPL	Carol Bruegge

Information needed and where from

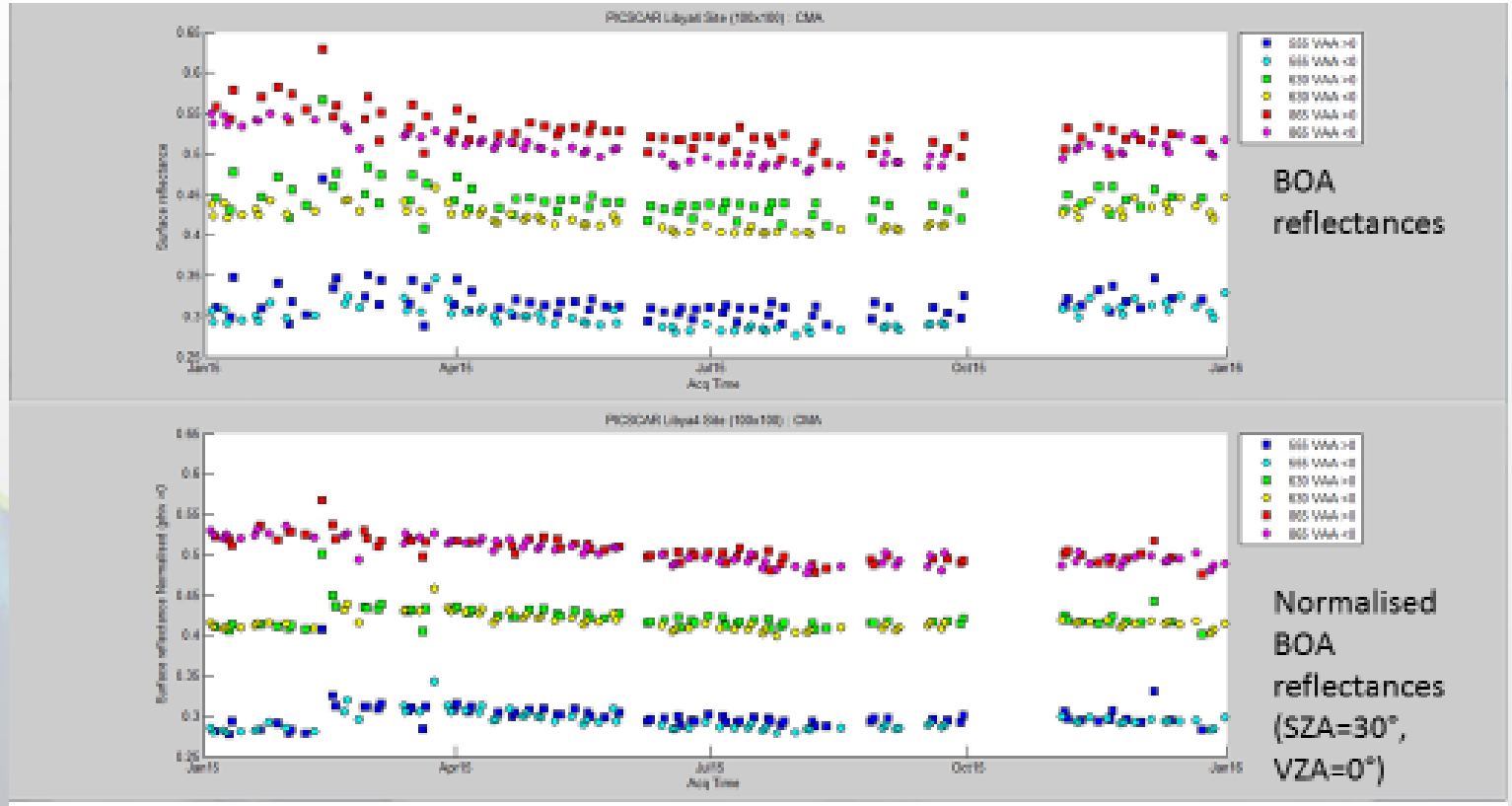
Temporal stability	BRDF	Spectral characterisation	Spatial homogeneity	Atmospheric and cloud properties	Other
15	15	15	13	15	

Data : Acquired by production center
Extracts made available at the centers or by software (SADE or DIMITRI for instance).
Meteorological data : reanalysis ECMWF, NCEP EPTOMS, ou MODIS (CMA), archive US for SDSU
DEM : SRTM or tandem (DLR)
Others : GOME2 (spectre/CNES) + BRDF Polder/parasol (CNES), BRDF (VITO), sand sample (ONERA)
Aerosol: climatology (MODIS/CNES) + VITO, aeronet

- **Look to focus on perhaps 5 to 10 sites**
- **Community keen and willing to work together**

See to use all available data to assess site stability : Harmonise!

A test case for the normalisation of the BRDF on FY-3



Roadmap for the future

Directional characterisation

- Referencing existing BRDF models
  - CNES, ESA, VITO/Rayference (availability?), MODIS std products, MISR std products, Parasol std products, other?
  - How to extend the model to the full spectral range (SWIR, blue?)
  - Is it possible to generate a 'generic' BRDF model using MODIS or MISR std products?
- How to compare BRDF modelling?
  - Direct model comparison: what does it mean?
  - Efficiency of the correction: which criteria? which test dataset?
- Who can do that?
  - Need to find a prior consensus on the methodology
  - Task sharing?

Atmospheric characterisation

- Defining atmospheric correction
  - Need for an atmospheric correction protocol?
  - Which meteo data?
    - could be a problem for past data (ERA Interim from 1979!)
    - what about ozone content?
  - Main (unknown...) contributor: aerosols
- Referencing existing aerosol climatologies
  - CNES, ESA, VITO/Rayference (availability?), other?
  - Which characteristics: optical thickness, aerosol model...
  - How to assess the efficiency of aerosol correction?
- Who can do that?
  - Task sharing?

Spectral characterisation

- Referencing existing studies
  - ESA, CNES, USD, other?
- Need for a reference
  - Based on sand samples laboratory measurements (which ones?)
  - Establishing a physical model based on mineralogy properties
  - Using a reference sensor:
    - which one? - very good spectral bands knowledge and accurate inter-bands calibration
    - multiple sensors? - accurate sensors inter-calibration
    - reference geometry to be defined (need for a directional normalization?)
  - Merging lab measurement, physics and multiple sensors fit...
- Who can do that?
  - Need to find a prior consensus on the methodology
    - comparison of ESA and CNES methodology?
  - Task sharing?

Others

- Temporal Stability
  - identified as the first priority at IVOS 28 meeting
  - Need for combining multi sensors and multi sites results
    - How to proceed?
- Combining multiple sites calibration results
  - How to weight the measurements?
  - Is it necessary to find a common agreement? And to determine a set of common sites (based on QST answers)
- Revisiting the sites
  - Making a synthesis of the studies already performed
  - New sites can be added in a second step

Summary: next steps

- **Bi-monthly community Telecons/webex to discuss methods and how to establish/compare (BRDF, Atmosphere, surface spectral reflectance)**

- **CNES to establish draft web 'portal'**
  - **Hosted on/via CalVal portal**
  - **Good practises on how to use**
  - **Repository of observations**
  - **Repository of comparison results**
  - **Characteristics of PICS and tools for users**

- **NPL & CNES to consider how to evaluate Uc**

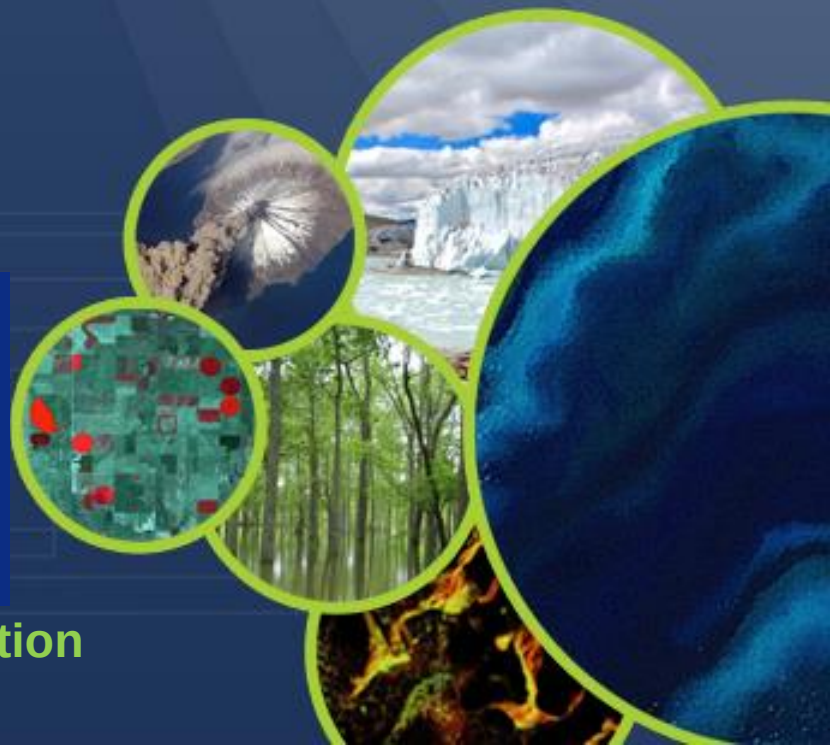
- **Goal to establish a TOA 'Radiance simulator'**

FRM4STS: Fiducial Reference measurements for validation of Surface Temperature from Satellites

www.FRM4STS.org

Nigel Fox

NPL (ESA Project)



Working Group on Calibration and Validation

SI traceability: LCE (June 2016)

Necessary for all participants to assess biases to SI under Laboratory conditions

ITS-90

T= ~250 – 325 K
Non-vacuum

NPL BB

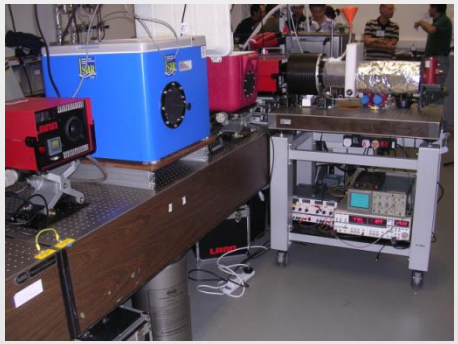
PTB BB

NPL Rad (AMBER)

PTB Rad

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

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

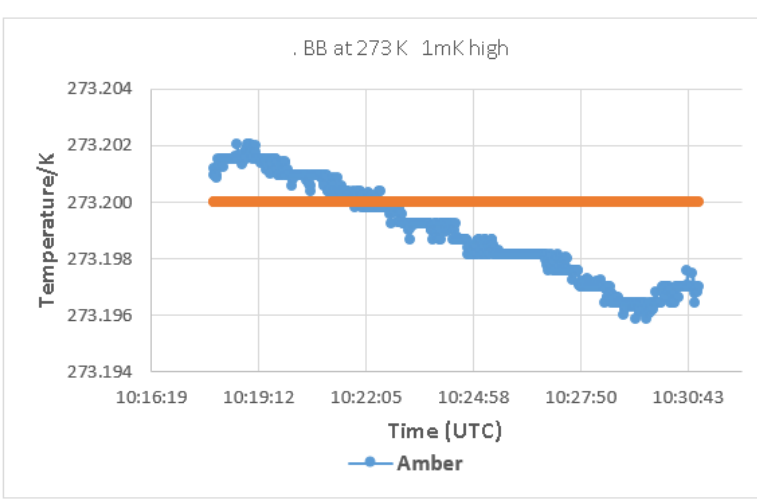


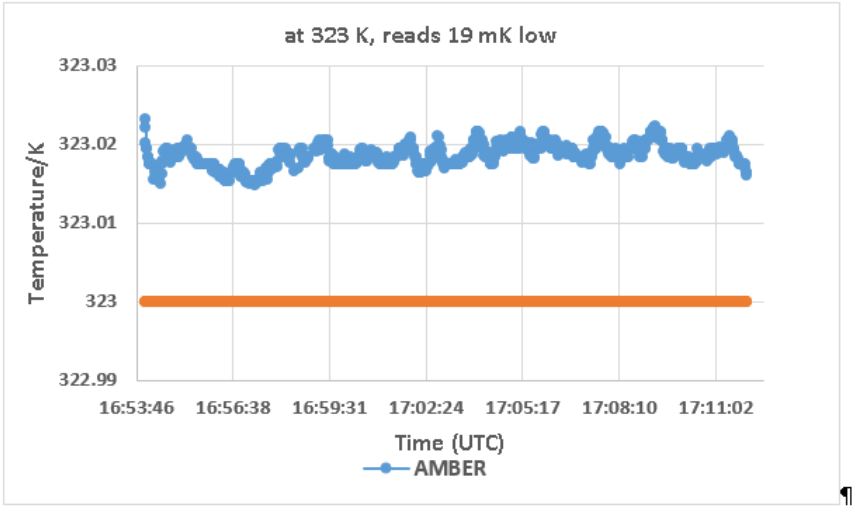
Room Environment with variable T

BB comparison (June 2016)

1. Miami University - USA
2. ONERA - France
3. University of Valencia- Spain
4. University of Southampton - UK
5. Qing Dao -China
6. RAL - UK
7. CSIRO - Australia
8. KIT- Germany

273 K to 323 K (0 to 50 °C)

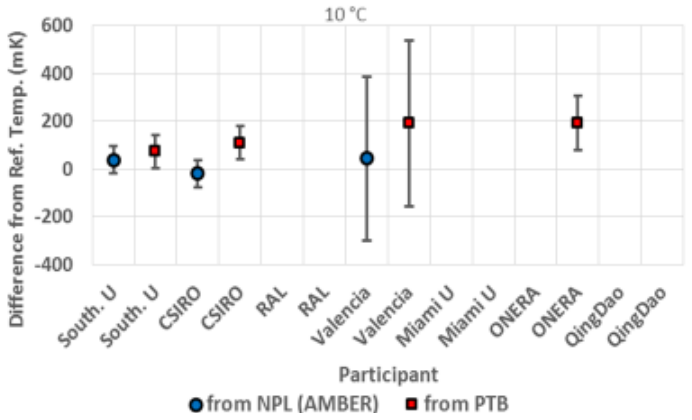




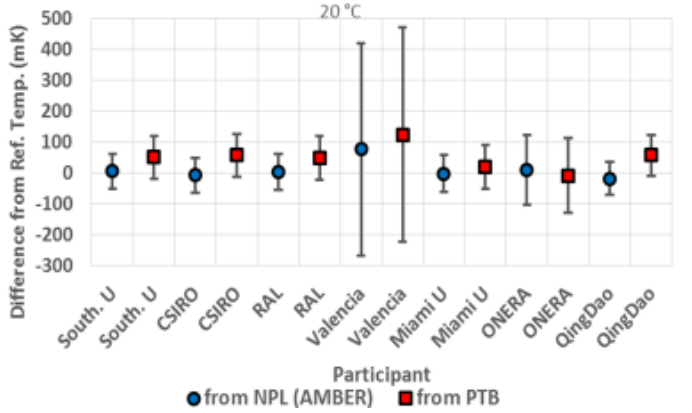
fiducial reference temperature measurements

Selection of Results of BB comparison to SI

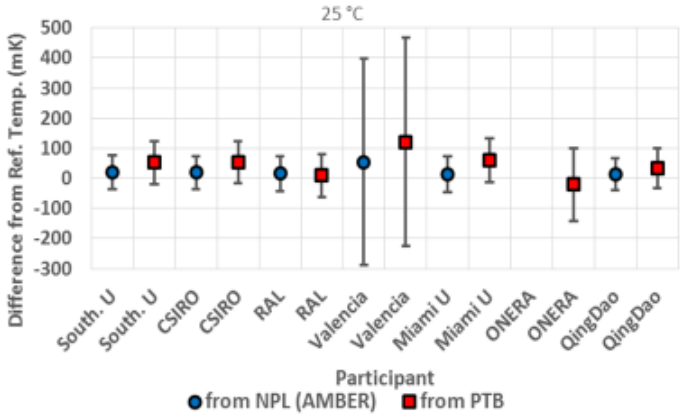
Difference between the mean of the values reported by participating blackbodies from the values measured by AMBER (shown in blue) and PTB (shown in red) for a nominal blackbody temperature of 10 °C.



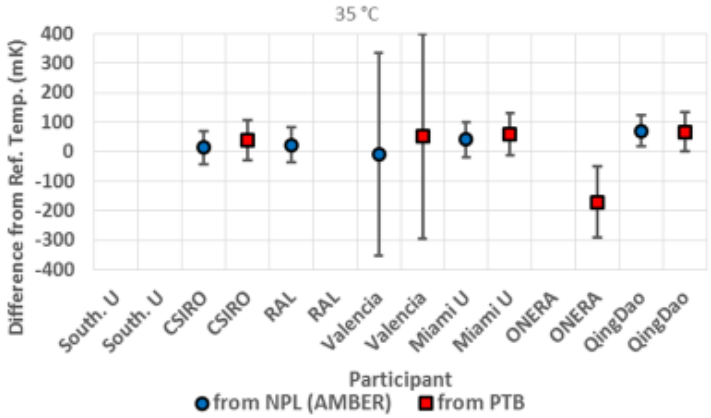
Difference between the mean of the values reported by participating blackbodies from the values measured by AMBER (shown in blue) and PTB (shown in red) for a nominal blackbody temperature of 20 °C.



Difference between the mean of the values reported by participating blackbodies from the values measured by AMBER (shown in blue) and PTB (shown in red) for a nominal blackbody temperature of 25 °C.



Difference between the mean of the values reported by participating blackbodies from the values measured by AMBER (shown in blue) and PTB (shown in red) for a nominal blackbody temperature of 35 °C.



2016 Radiometer comparison

1. Miami University (USA)
2. ONERA (France)
3. University of Valencia (Spain)
4. University of Southampton (UK)
5. Qing Dao (China) -1
6. Qing Dao (China) -2
7. RAL (UK)
8. CSIRO (Australia)
9. KIT (Germany)
10. DMI (Denmark)
11. GOTA (Canary Islands
12. JPL NASA (USA)
13. Ian Barton (Australia)

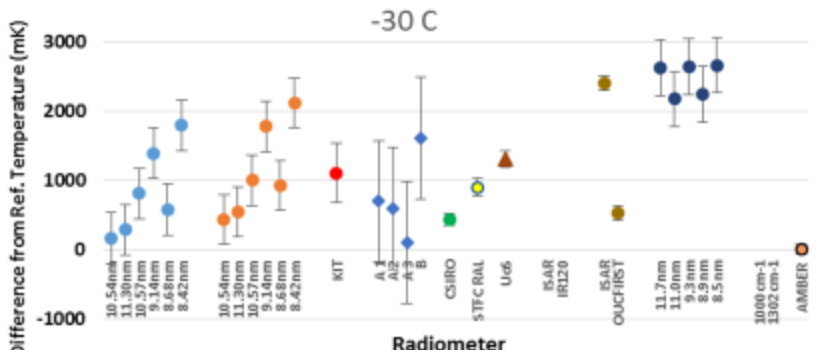
240 K to 318 K

MAERI (UofM) viewing NPL ammonia Heat pipe

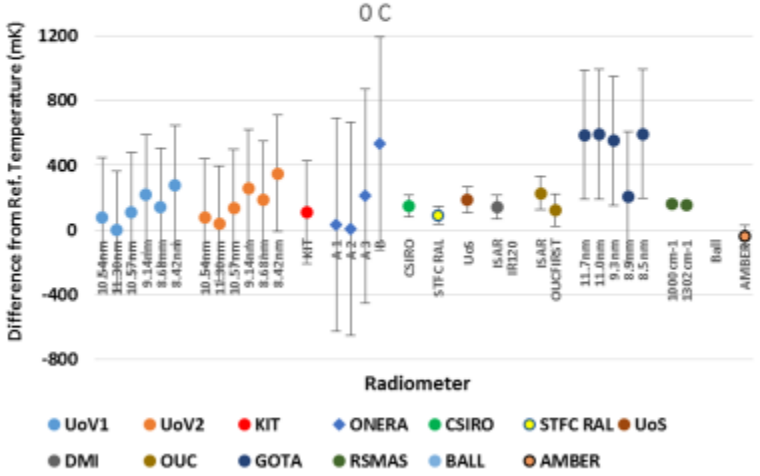
SISTER (RAL) viewing NPL ammonia Heat pipe

Selection of Results of Lab Radiometer comparison to SI

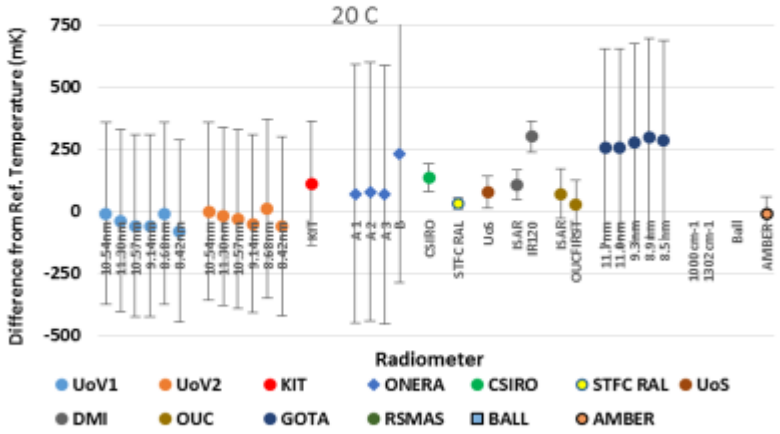
Plot of the mean of the differences of the radiometer readings from the temperature of the NPL reference blackbody, maintained at a nominal temperature of -30°C.



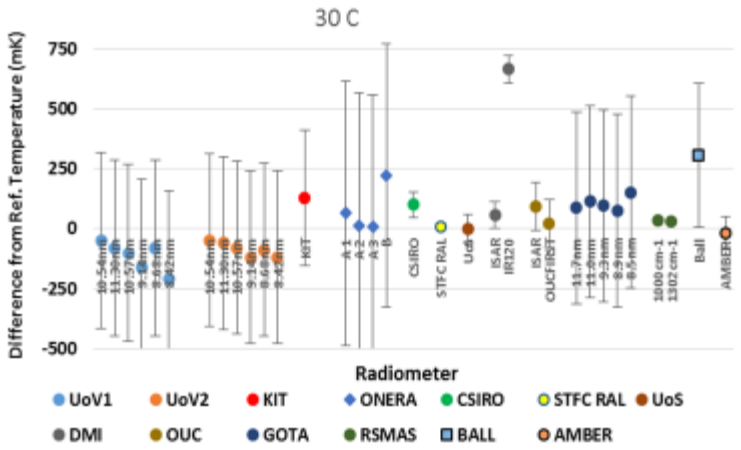
Plot of the mean of the differences of the radiometer readings from the temperature of the NPL reference blackbody, maintained at a nominal temperature of 0°C.



Plot of the mean of the differences of the radiometer readings from the temperature of the NPL reference blackbody, maintained at a nominal temperature of 20°C.

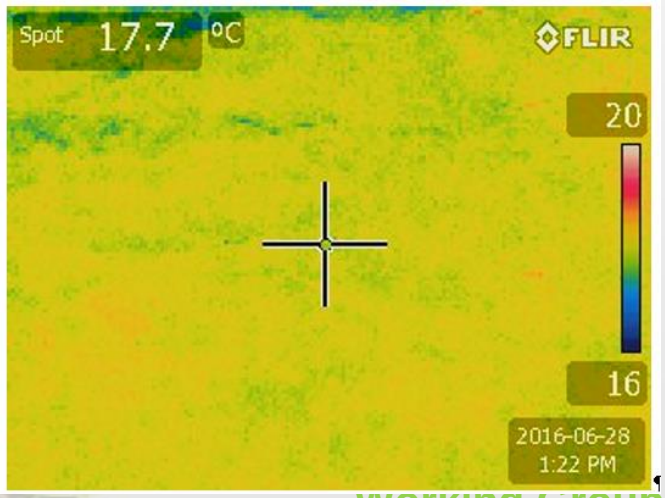


nominal temperature of 30°C.

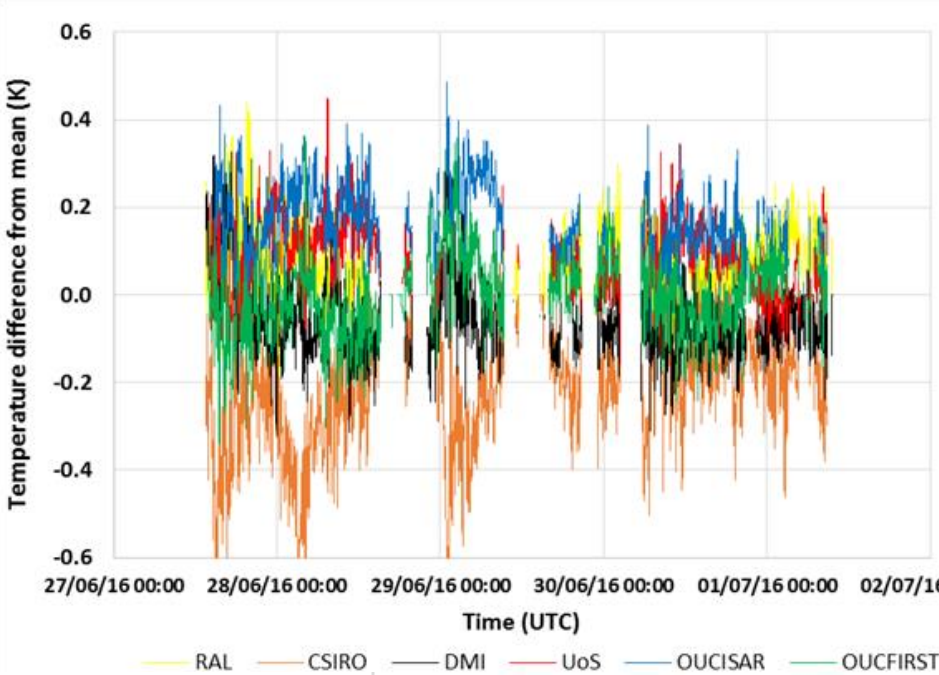


WST comparison

1. University of Valencia (Spain)
2. University of Southampton (UK)
3. Qing Dao (China) -1
4. Qing Dao (China) -2
5. RAL (UK)
6. CSIRO (Australia)
7. KIT (Germany)
8. DMI (Denmark)
9. GOTA (Canary Islands)
10. JPL NASA (USA)



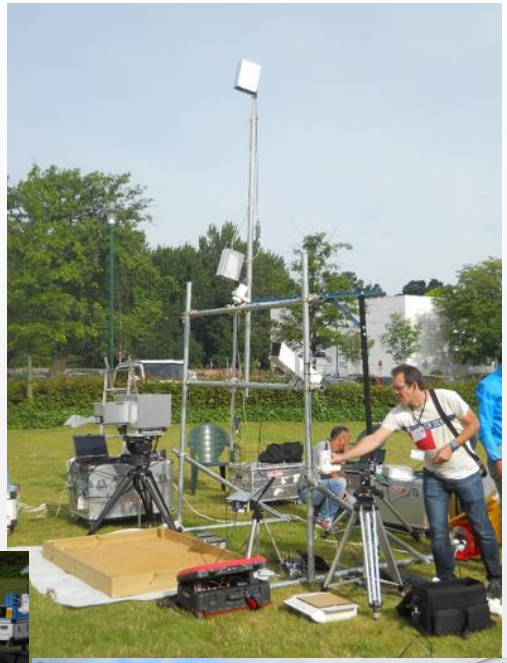
Difference from mean for SST designed radiometers only

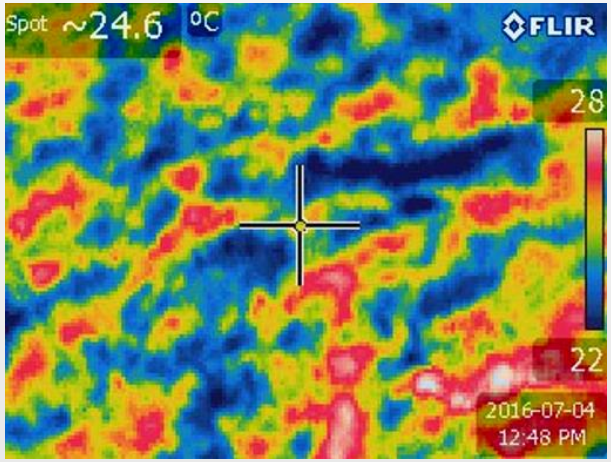


	mean difference from mean (°C)		
Radiometer	All radiometers Included	SST-Measuring Radiometers Only	SST-Measuring Radiometers excl. CSIRO
	°C	°C	°C
RAL	0.123	0.084	0.037
KIT	-0.159		
CSIRO	-0.189	-0.228	
DMI	-0.020	-0.053	-0.106
UoV	0.117		
UoS	0.125	0.090	0.044
OUCFIRST	0.033	-0.002	-0.054
OUC-ISAR	0.206	0.174	0.119
GOTA	0.593		
JPL	-0.109		

LST (Sun & Cloud)

1. University of Valencia (Spain)
2. KIT (Germany)
3. JPL NASA (USA)
4. ONERA (France)

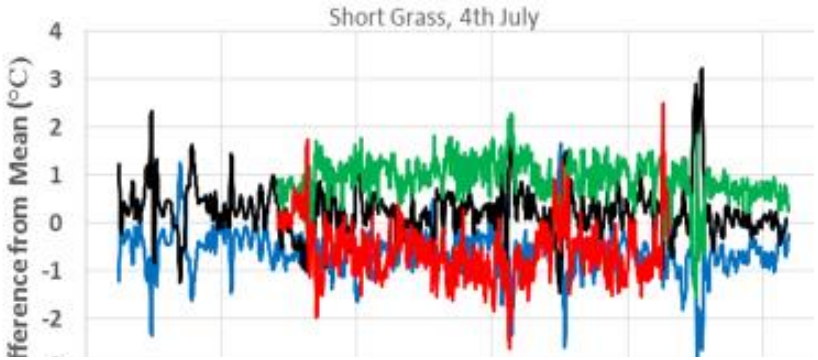




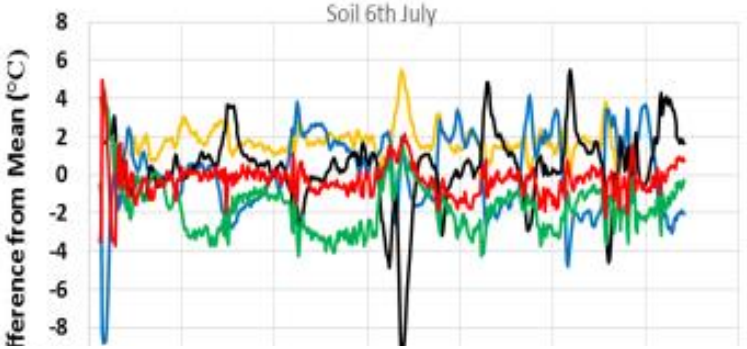
Emissivity

Selection of Results of Radiometer comparison to LST

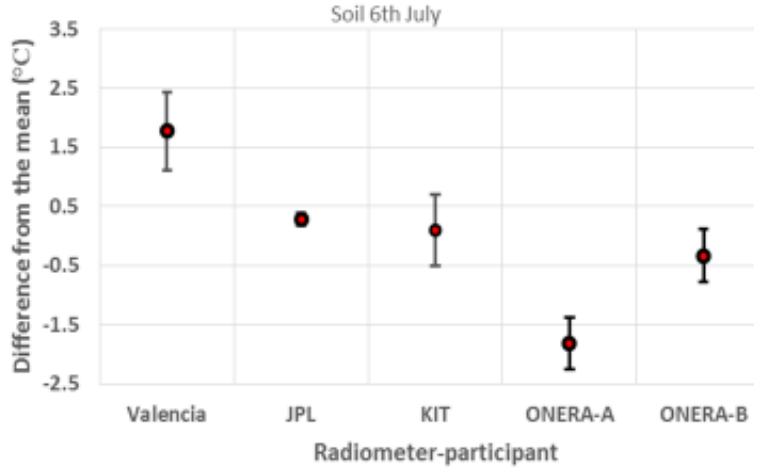
Difference of the measurements of measuring radiometers on the short gr sample from their mean. This Figure shows that the difference is within ±: throughout the monitoring period (mostly within ±2 °C).



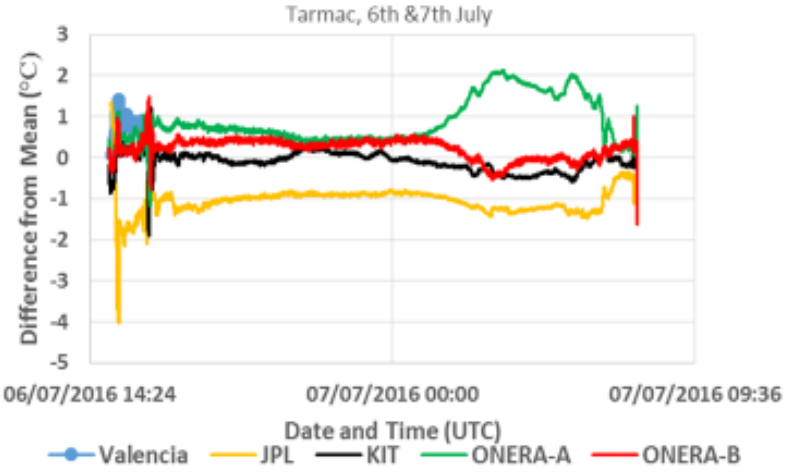
Difference of the measurements of the five measuring radiometers made on the 6th July on the dark soil sample from their mean.



Difference of the mean surface temperature of the dark soil san measured by participants from the mean of the measurements the participants.



Difference of the measurements of the five measuring radiometers made on the 6th July on the tarmac sample from their mean. The bulk of the difference of all five radiometers from their mean is within ±2 °C throughout the monitoring period



LST @ Namibia Jun 2017
5 participants

D-130 FICE-IP for LST

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'

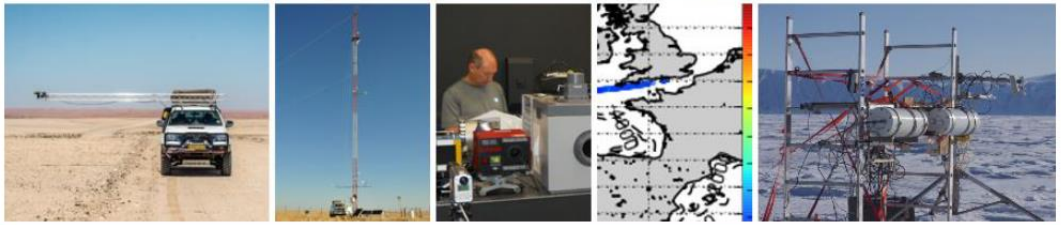
30 m high
'Wind Tower'
in the Namib

fiducial reference temperature measurements

16 – 18 October 2017

FRM4STS International Workshop at NPL, UK

www.frm4sts.org



- Session 1: Science requirements
- Session 2: The space based element
- :• Session 3: Metrological framework:
- Session 4: Post-launch validation: deployed radiometers
- Session 5: Post-launch validation: non-returnable systems
- Session 6: Establishing a sustainable framework

International Workshop on fiducial reference measurements for satellite-derived surface temperature

The objective of this ESA sponsored workshop is to bring together the world's expertise in Earth surface (Land, Water, Ice) temperature measurements under the auspices of Committee on Earth Observation Satellites (CEOS) to review the current state of the art in measurement accuracy for satellite validation. The workshop will consider the needs of current and future satellite missions and their applications together with the outputs and results from the recent CEOS comparison of fiducial reference measurements/instruments and will look to conclude with the development of an internationally coordinated strategy to ensure that the global reference measurement infrastructure is adequate to meet the future needs and aspirations of all users.

The workshop takes place at NPL, Teddington in the United Kingdom and is free to attend. It will consist of both oral and poster presentations and facilitated discussion structured into six half day sessions:

- **Session 1:** Science requirements for LST, IST and SST applications: Climate, Meteorology and Oceanography
- **Session 2:** The space based element: current and future sensors capabilities and challenges
- **Session 3:** Metrological framework: Traceability and uncertainty, sampling and scaling, representativeness
- **Session 4:** Post-launch validation: performance, traceability and uncertainty of field/aircraft deployed radiometers
- **Session 5:** Post-launch validation: non-returnable measurement systems
- **Session 6:** Establishing a sustainable framework of measurements to ensure fit for purpose data to meet the needs of society.

The Workshop is free to attend, but registration is essential. **To register, please follow this link**
If you would like to submit a short abstract (~300 words) for consideration by the international scientific committee please contact: events@npl.co.uk by 15 June 2017

fiducial reference temperature measurements

Ocean Colour

- To help address IOCCG white paper
- Run comparisons of validation instruments
  - Lab
  - Ocean
  - Ref standards
- Ensure SI traceability and Uc to SI
- Draft protocols for how to establish/maintain traceability
- Review requirements for future infrastructure

ESA sponsored project www.FRM4SOC.org

To support CEOS VC-OCR

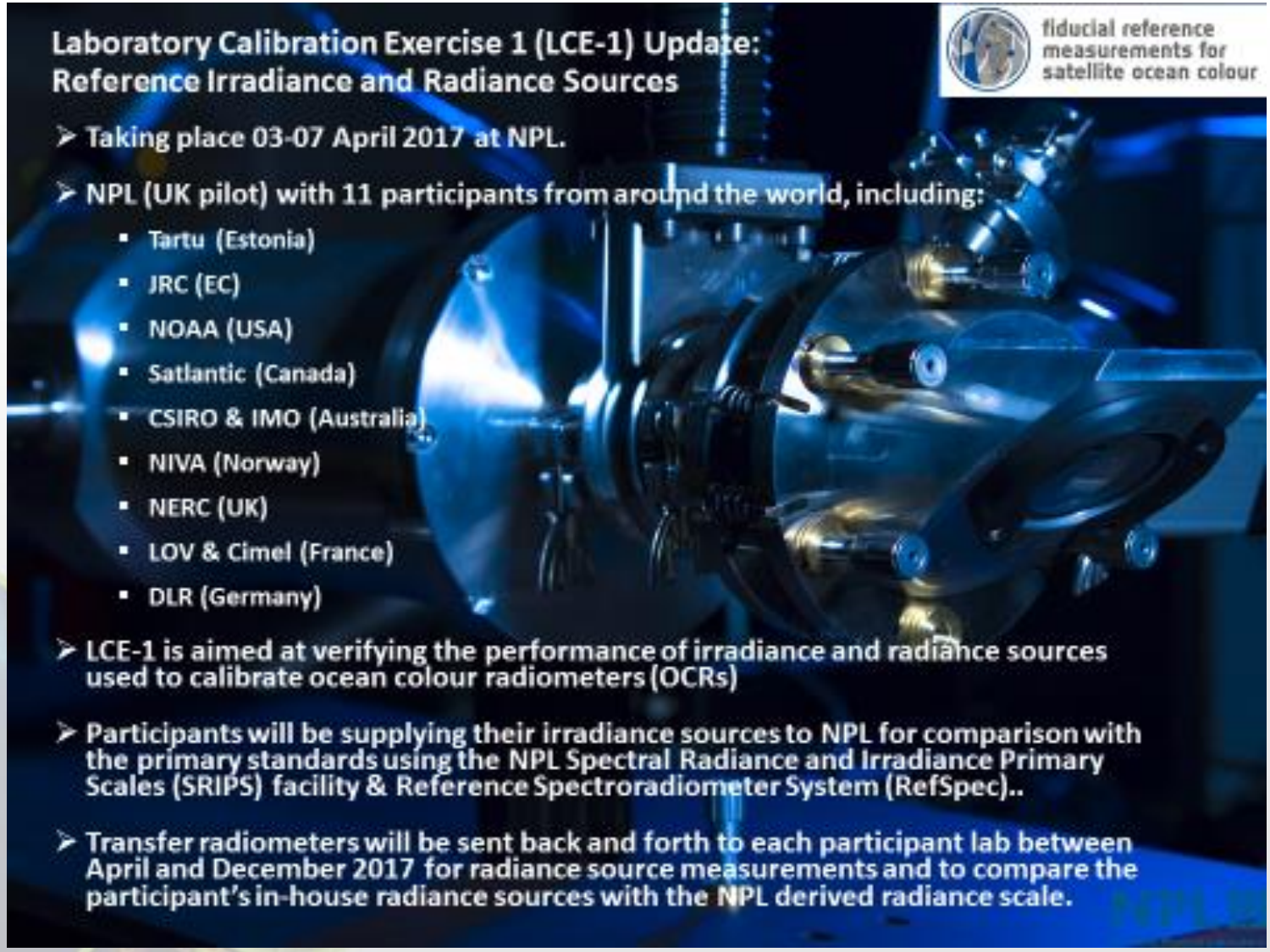
fiducial reference measurements for satellite ocean colour

CEOS

FRM4SOC International Workshop on Options and Approaches to the Long-term Vicarious Adjustment of Sentinel- OLCI & MSI A/B/C and D Instruments

- Took place at ESA-ESRIN, Frascati, Italy, 21-23 Feb, 2017
- 30+ participants from Europe, USA, Canada, Australia & S.Korea
- Included many of the world's leading experts in the field

Laboratory comparison of reference sources



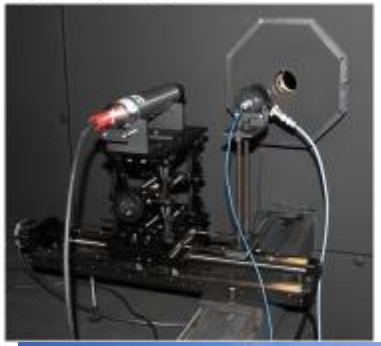
Comparisons of instruments

esa fiducial reference measurements for satellite ocean colour CEOS

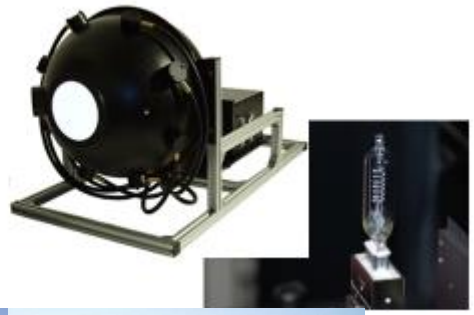
Laboratory Calibration Exercise 2 (LCE-2): Ocean Colour Radiometers (OCRs) 8 – 13 May 2017 at TO, Tõravere, Estonia

Main objective:
Establish and document protocols and best practice to practically verify the performance of FRM OCRs through

1. TO calibrates all participating radiometers



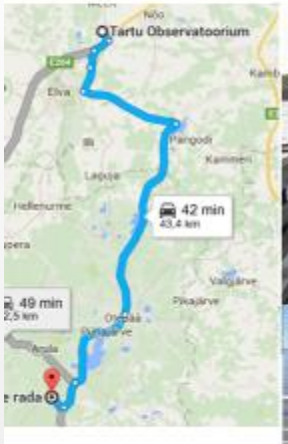
2. Participants measure the targets under controlled laboratory conditions



esa fiducial reference measurements for satellite ocean colour CEOS

LCE-2 outdoor intercomparison - Lake Kääriku, 08-13 May 2017

- Controlled outdoor environment near Tartu Observatory, Estonia



Uncertainty analysis with support

Ocean platforms and ship transects

Terminology

Uncertainty

IS NOT

the same as

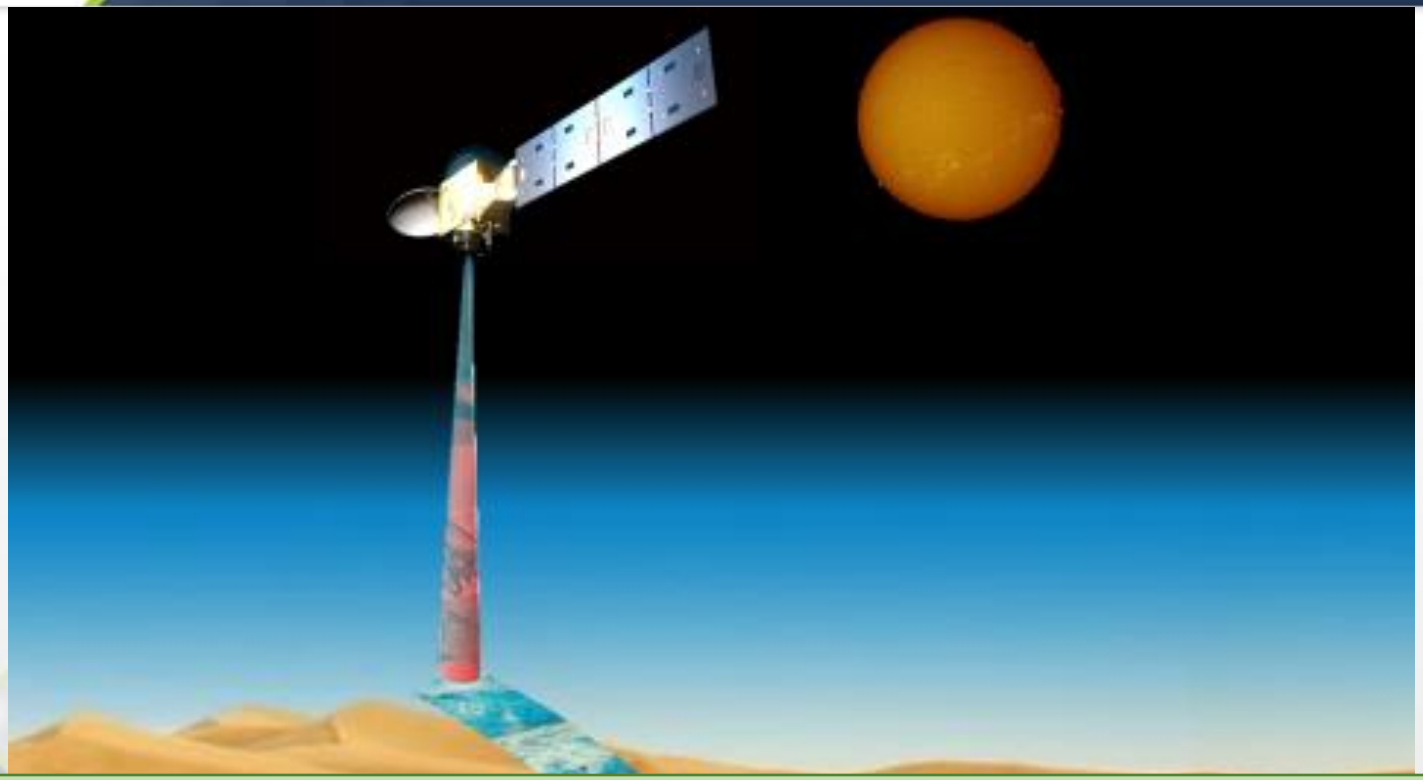
Error

But also many terms have different interpretations e.g. Harmonisation, Levels 1A,1B, 1C …., Ancilliary data ……

IVOS Activity: Also to support wider CEOS WGCV initiative NPL to create and administer 'Wikki' web page (via cal/val portal) to discuss/define terminology and establish 'thesauras' of definitions as necessary also with simple graphic/videos to make clear concepts.

Small international task group in process of being established

CEOS (GSICS) Reference Solar spectral Irradiance (Thursday)



IVOS recommends the selection of a high spectral resolution solar spectrum to become a reference spectrum that is based on the SOLID approach linking the 20 sensor composite inc Thuillier and COSI spectra giving both an extension into the IR and providing higher spectral resolution (target 0.005 nm), along with a technical note on how to interpret and use this model. THIS is AGREED with GSICS as a pragmatic interim solution to update current CEOS recommendation >~380 nm spectral range

Summary

- IVOS active team expanding (good global coverage- agency and industry
- Thematic projects working effectively with motivated champions: Number sometimes make logistics an issue
- New activity on 'CEOS L1 reference and method for interoperability' to be launched at IVOS 30 (IVOS 29 too busy)
- Several recommendations to WGCV for endorsement/action
- Keen to revitalise and use Cal/Val portal as the community interface
  - Minutes and presentations of plenary meetings on portal
- GSICS/CEOS 3rd Lunar workshop Nov 2017, Xi'An China
-