CEOS

Working Group on Calibration and Validation (WGCV): 40

Infrared Visible and Optical Sensors (IVOS) subgroup: report

Nigel Fox

NPL (with UKSA support)

WGCV 40

Working Group on Calibration and Validation

- IVOS 27 @ Toulouse, France hosted by ONERA Nov 2015

- 26 agency/orgs represented

- 50!! attendees

- All themes and topics (work-plan discussed or summarised

- **MTF workshop (16 Nov 2015) (ONERA)**

- **PICS workshop (17-18 Nov 2015) CNES/ONERA**

Special Projects:
- **RadCALNet team met Feb 2015 @NPL**
- **Nov 2015 @ CNES**
- **SST/LST comparison (under sponsorship from ESA) now started call for participants**

IVOS 28 – WK 18-21 July 2016 hosted by AOE   Beijing China

Working Group on Calibration and Validation

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.

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 Best Practices*
- *Interchangeable/readable formats*
- *Results/metadata - databases*

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

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Work scope: for optical sensors: (land/ocean)

Pre-flight

- Sharing best-practise
- Informal peer review
- Ref stds

Vis Sources
Black bodies
MTF
Spectral
…..

Post- launch

AGENCIES

On-Board

- Sharing best-practise
- Informal peer review
- Ref stds

Diffusers
Black bodies
…

Vicarious

Mission specific

Harmonisation /bias removal

- Sharing best-practise
- Informal peer review
- Tools/infrastructure

- Consistency
- Cost
- Suitability
- Usability
- Comparisons
- Traceability

'SHARED'

Test-sites / Methodologies

"Products"

Radiometric

Geometric

"Image quality"

Algorithms/code

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Work plan

- **Structured into themes and led by 'champions' (Plus specific projects)**
  - **Look to develop best 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)   - Widlowski (JRC EU)

Specific projects/cross-cutting

- **RadCALNet**   **- Bouvet (ESA)**

- **Libya 4 (PICS) (with GSICS?) *NEW***   **- Henry (CNES, F)**

- **SST/LST cross-comparison (+ VC-SST & LPV   - Fox (NPL, UK)**
  (instrument Cal for LST)

- **Others in progress/development**
  - **Analysis of comparisons/Uncertainties/establishing and presenting harmonised biases for sensor to sensor comparisons (with GSICS) (including tools/databases)**

  - **Best practise for convolving spectral data sets (solar/surface/sensor bandwidth) (CEOS WGCV (sub-groups) & GSICS)**

  - **Comparison of Rayleigh and Sun-Glint methods**

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IVOS 27 Discussion Topics

- Summary of workshops, MTF, PICS, Lunar, RadCalNet
- OC Rad validation
- Sat surf Temp measurements- Rad aspects of Val
- New candidates for RadCalNet
- Sensor to sensor cross comparison results and tools/databases
- Sensor Pre- and In- flight Cal and Uc assessment
- New Sensors
- Atmospheric effects on Rad Cal
- Collaborations/interactions – WGCV, GSICS, VCs, Climate, Carbon ….
- Cal/Val Portal – Communications/newsletter….

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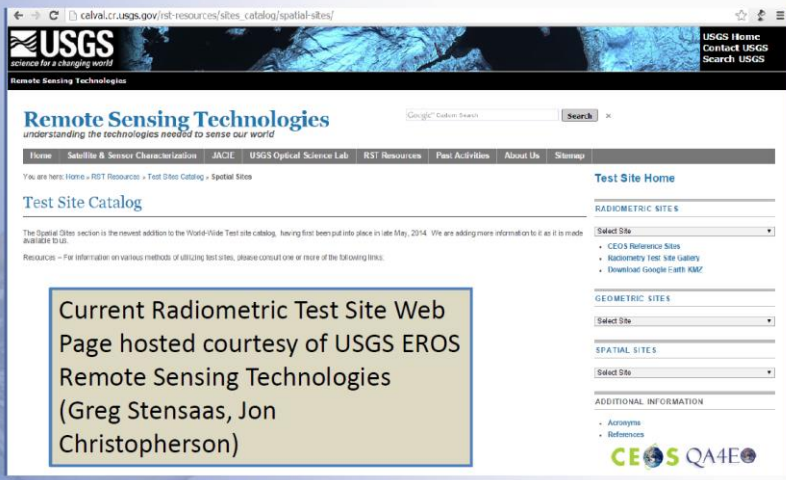
- Approx 20 attendees from space agencies and industry
  - Highly motivated to work together
- Populate   http://calval.cr.usgs.gov/rst-resources/sites_catalog/spatial-sites/s
  - Accessible from cal/val portal
- Establish a prioritised 'CEOS' list of maintained MTF targets. Encourage observation of them
- Artificial targets In common use
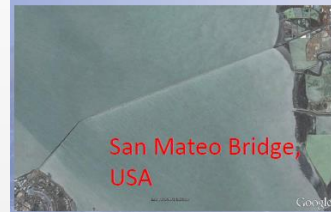- Best practise guidance on their use

MTF progress

Current Website Status

Current Radiometric Test Site Web
Page hosted courtesy of USGS EROS
Remote Sensing Technologies
(Greg Stensaas, Jon
Christopherson)

Current Website Status

Lake Ponchartrain Causeway, USA
Peng-Hu, Taiwan
Salon de Provence, France
Stennis, Mississippi, USA
Big Spring, USA
San Mateo Bridge, USA

• Results of discussion:

  • - provide an exhaustive list of checkerboard targets
  • - provide a fairly exhaustive list of bridges
  • - provide a list of other recommended natural sites (for example: paths, spotlights, stars catalog, urban areas)
  • - lists will be given in order of decreasing interest
  • - maintenance of the checkerboard will be mentioned and taken as the key parameter to recommend the targets
  • - the sites should be presented according to class of spatial resolution
  • - It is hoped that this catalog will encourage systematic acquisitions over common sites (like for radiometric sites)

Work in progress to add sites

Prioritise list my IVOS 28

CEOS WGCV endorse Principle of list?
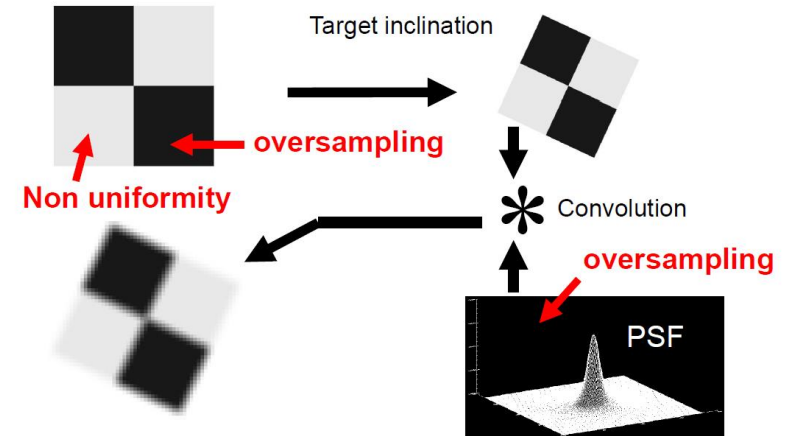
bration and Validation

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:
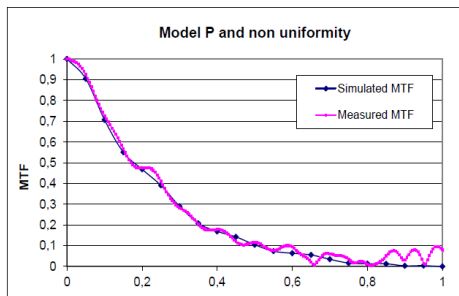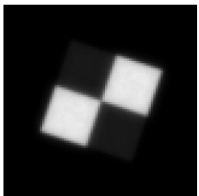
Actual images: in the coming slides

Synthetic images: initial effort

Exemple of synthetic image generation

Target inclination

oversampling

Non uniformity

Convolution

oversampling

PSF

Exemple of MTF estimate from synthetic dataset

- MTF created = FT(PSF)
- MTF measured = MTF measured with the ONERA edge method code
- Case 1 (with non uniformity):

Model P and non uniformity

— Simulated MTF
— Measured MTF

MTF

Reference dataset begins with synthetic checkerboard:

Entity	Model	MTF value	SNR	inclination	Target contrast
AIRBUS DS	Tabled values of PSF	0.1 and 0.3	30 (dark square) 150 (bright square)	3.5/1	Salon de Provence target
CNES (To be confirmed)	MTF analytic model	0.1 and 0.3	30 (dark square) 150 (bright square)	3.5/1	Salon de Provence target

Actual satellite images

Only a small subset of each image containing the target – Salon de Provence – is requested

Name	Target/Landscape	Sensor
Digital Globe	checkerboard	worldview3
CNES (To be confirmed)	checkerboard	Pleiades L0
KARI	checkerboard	Kompsat3 &3A
AIRBUS DS	checkerboard	S6/7

Methodological comparison

- People volonteering to process data from the reference dataset:

CNES	Digital Globe	Airbus DS	KARI
CSIR	TPZ	SDSU	ONERA

- First synthesis of results and meeting (via internet) : June 2016

IVOS recommends to WGCV the establishment of a reference dataset of CEOS recommended sites for MTF and to encourage agencies to collect data over these and to share results with the community.

IVOS recommends the establishment of a pilot project to carry out a comparison of inflight MTF retrieval methods through distribution of synthetic and real images

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IOCCG review

- In-situ OCR white paper and IOCCG report 13 both reviewed from a Cal/Val persepective

- Both documents considered good basis for OC community with some suggested refinements for clarity.
  - Encourage use of term like 'system vicarious calibration' to emphasise combined Sat and RT algorithm
  - Clarify level of confidence in Uc
  - Some suggestions on some rephrasing to make clear that traceability did not oblige common standard methods
  - Docs indicated role of CEOS WGCV but also need to create an independent group for sat pre- and post- launch cal/val
    - o Stimulated much debate!!
    - o Conclusion suggested that if felt necessary to exist but that it should as a minimum report through WGCV
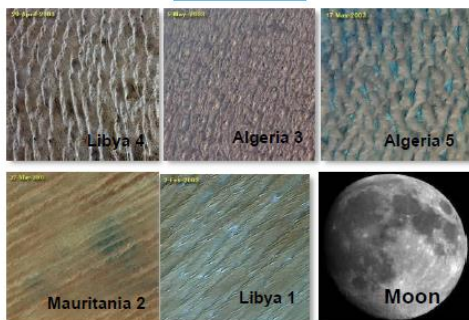
- To help address IOCCG white paper
- Run comparisons of validation instruments
    - Lab
    - Ocean
    - Ref standards
- Ensure SI traceability and Uc to SI
- Draft protocols for how to establish/maintain traceability
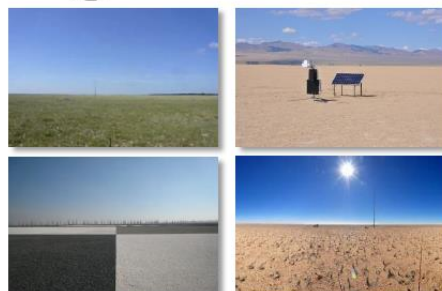- Review requirements for future infrastructure

- Long term strategy is to provide a framework of tools to help assess/correct post launch radiometric gain of sensors

- IVOS 27 significant discussion on what to be done & How?
  - 'Database' of results from comparison databases
    - o Inc different methods
    - o What needs to be stored/format for exchange of data?
  - Tools/methods to facilitate comparison
    - o SBAFs, ref curves (solar irrad) …
    - o Ref sensor, virtual sensor, ground site, 'average res'
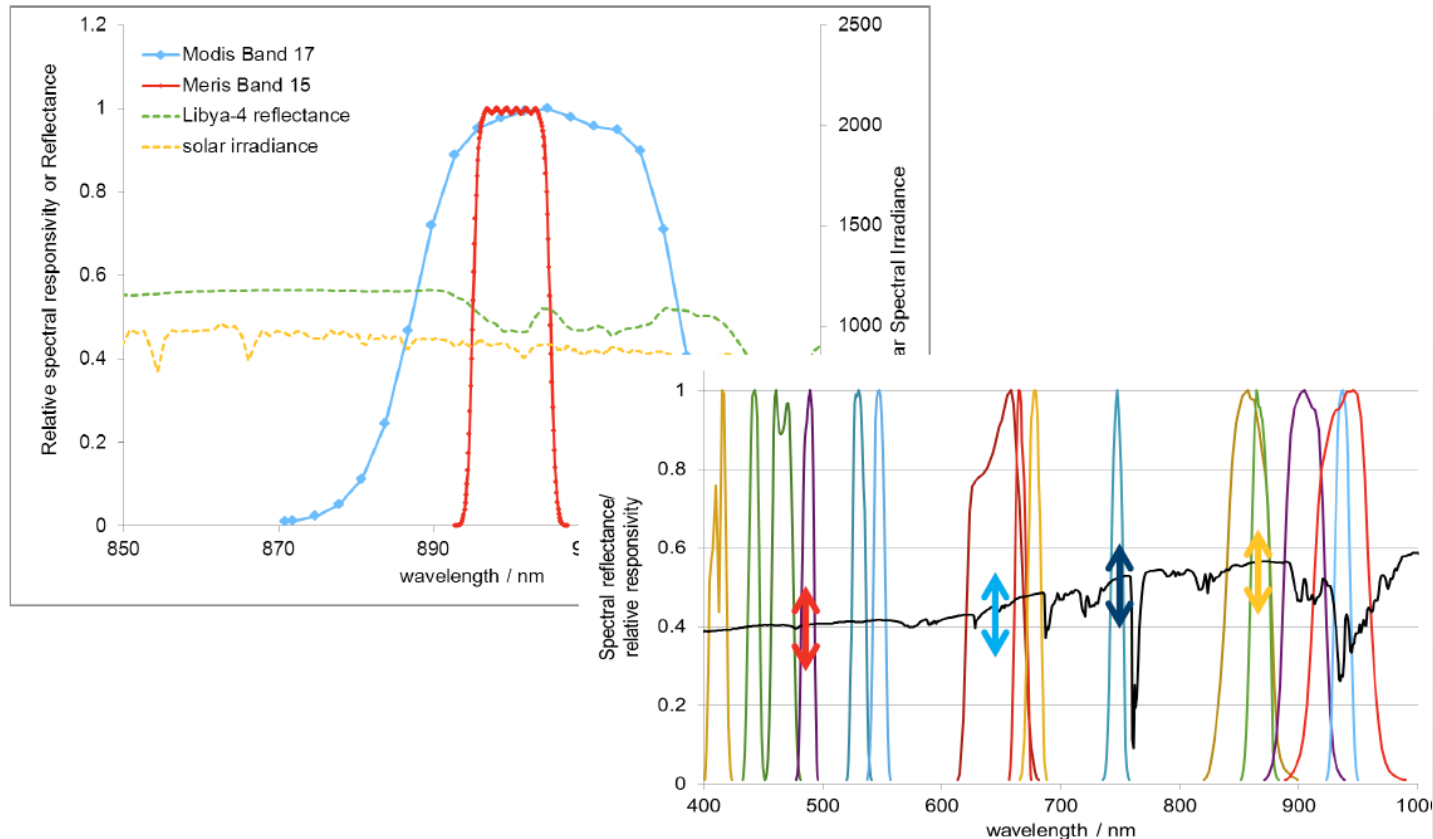- How far do we want to go?

- Variance in curve fitting, convolution between curves, interpolation Uc …
- Ref curves, solar irradiance, ground surface ref of test sites ….

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- Significant debate on how far and how quick we should go?
    - Need to be clear about what is being compared?
    - What should be made available?
    - To whom?
    - How?

- Plan for small 'CEOS' member scoping discussion
    - IVOS sensors
    - Facilitated by non-CEOS agency e.g. NPL
    - Urgently (potentially April)

- Hopefully result in scope for an open meeting/further discussion @ IVOS 28

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PICS Workshop Agenda

Tuesday November 17 at **CNES**			18 avenue Edouard Belin, 31401 Toulouse	
14h00	14h20	General introduction: Main outputs of the previous Lybia-4 workshop, objectives of this 2nd workshop and agenda	Patrice Henry	CNES
14h20	14h50	Progress on PICS Absolute Calibration Model	Dennis Helder	South Dakota State University
15h00	15h30	Recent development in Lybia-4 spectral and directional characterization in the preparation of C3S	Yves Govaerts	Rayference SCS
		Coffee Break		
15h50	16h20	Characterisation of the TOA reflectance in a pixel ROI and the parameter for best estimate (mean, median...), for deviation (standard dev., area of coverage...) and others kurtosis, skewness...)	Javier Gorroño	NPL
16h30	17h00	PICS modelling in DIMITRI	Marc Bouvet	ESA/ESTEC
17h10	17h15	JAXA plans to extract GCOM-C/SGLI data to support PICS	Hiroshi Murakami	JAXA
17h15		Discussion	All	
18h00		Meeting adjournment		

Wednesday November 18 at **ONERA**			2 avenue Edouard Belin, 31400 Toulouse	
9h00	9h30	Current Status of the Landsat Archive (with emphasis on Landsat 8)	Ron Morfitt	USGS
9h40	10h10	Sentinel 2 calibration results using PICs and error budget assessment	Sébastien Marcq	CNES
10h20	10h50	Preliminary results of Sentinel-2A calibration over Libya-4 site using PICS method in DIMITRI: Inter-comparison with LANDSAT-8	Bahjat Alhammoud	ARGANS
		Coffee Break		
11h10	11h40	MISR stability analysis following 15 years on-orbit, using PICS (Sahara Desert and DomeC)	Carol Bruegge	NASA/JPL
11h50	12h20	Use of PICS for MODIS and VIIRS Calibration and Calibration Inter-comparison	Xiaoxiong Xiong	NASA/GSFC
12h30	12h45	Wrap up of the workshop and main actions	Nigel Fox	IVOS Chair

- **~30 attendees for 1 day meeting**

- **Significant progress on methods**
  - **removal of seasonal effects**
  - **efforts to establish surface BRF**
  - **Direct measurements of Sand**
    - **Sonara Desert (SDSU/NASA)**
    - **ESA project sanddatabase**

- **How to use for stability & comparison**
  - **Establish as absolute reference**

- **Agree need to establish new project**
  - **lead P Henry (CNES) with D Helder (SDSU support)**
  - **2 yr workplan being defined likely to**
  - **focus on site characterisation BRF, reflectance, info needed...**

Group on Calibration and Validation

IVOS recommends to WGCV that a PICS task group be set up to enhance collaboration and create a common work plan, with the initial focus likely to include the means to improve the characterisation of the sites

IVOS recommends the establishment of a depository/ database to collect information on the choice, values and reasons for the radiometric gain corrections and calibration results

IVOS recommends holding a workshop on radiometric gain corrections and calibration results, this should initially be scoped out by a subgroup of CEOS members

IVOS recommends to WGCV the establishment of a reference dataset of CEOS recommended sites for MTF and to encourage agencies to collect data over these and to share results with the community.

IVOS recommends the establishment of a pilot project to carry out a comparison of inflight MTF retrieval methods through distribution of synthetic and real images