NPL National Physical Laboratory | Centre for Carbon Measurement

Supporting climate research and a low carbon future

Metrology for Earth Observation and Climate MetEOC (1&2)

Dr Nigel Fox
Head of EO & climate

National Measurement System

EURAMET European Association of National Metrology Institutes

Metrology for Earth Observation and Climate

EU FP7: Metrology for Earth Observation and Climate (MetEOC):
Project coordinator: (Nigel.Fox@npl.co.uk)

EURAMET European Association of National Metrology Institutes

National Physical Laboratory

Partners:

NPL National Physical Laboratory

PTB

INRIM Istituto Nazionale di Ricerca Metrologica

pmod wrc

MIKES

LNE Sharing a passion for progress

EUROPEAN COMMISSION DIRECTORATE-GENERAL Joint Research Centre

JÜLICH FORSCHUNGSZENTRUM

BERGISCHE UNIVERSITÄT WUPPERTAL

DLR

GEODEETTINEN LAITOS GEODETISKA INSTITUTET

A!

Collaborators:

esa

EUMETSAT

SURREY SATELLITE TECHNOLOGY LTD

CEOS

cnes

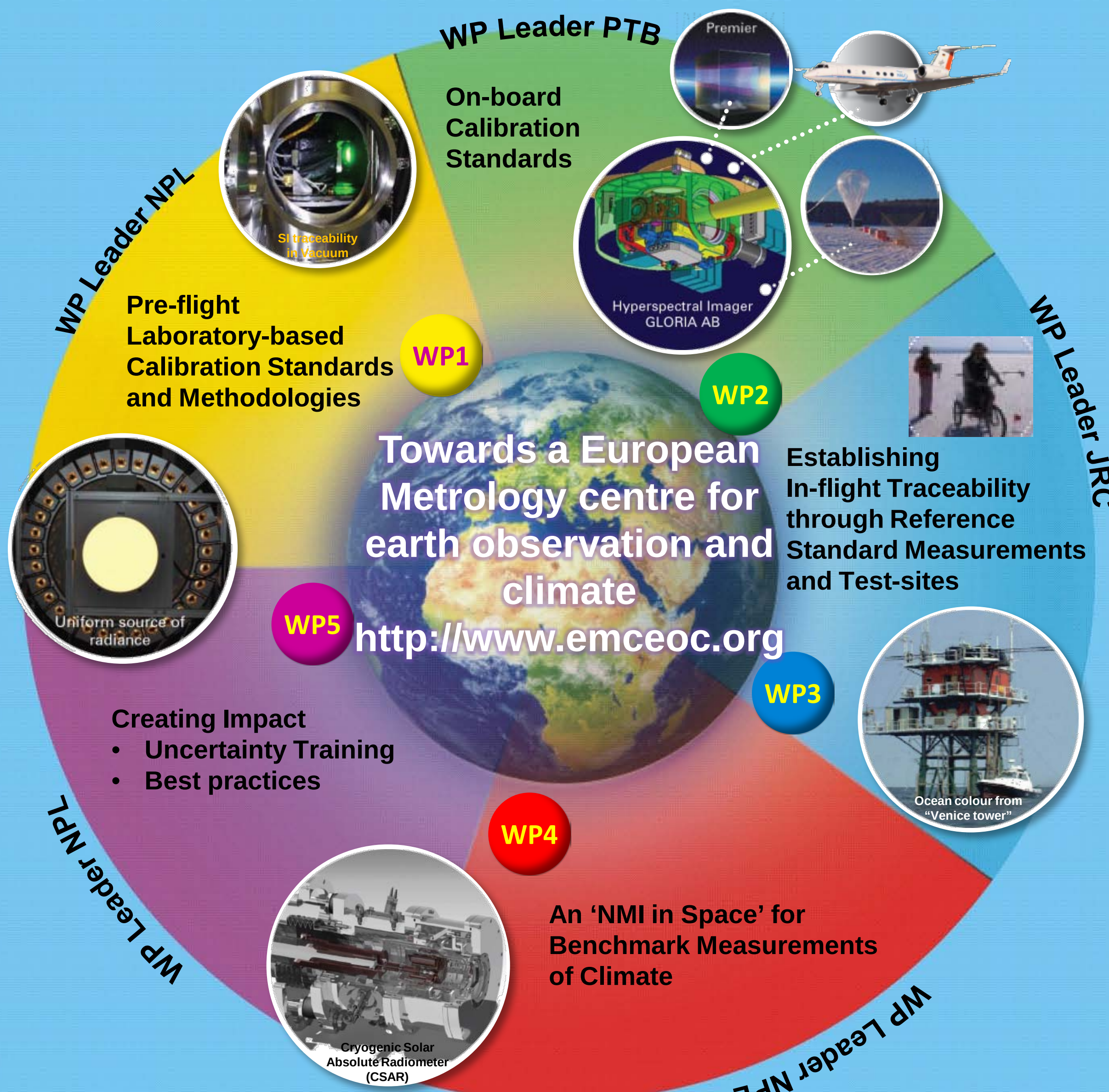
KIT Karlsruhe Institute of Technology

GEO

ECMWF

Science & Technology Facilities Council Rutherford Appleton Laboratory

QA4EO A QUALITY ASSURANCE FRAMEWORK FOR EARTH OBSERVATION



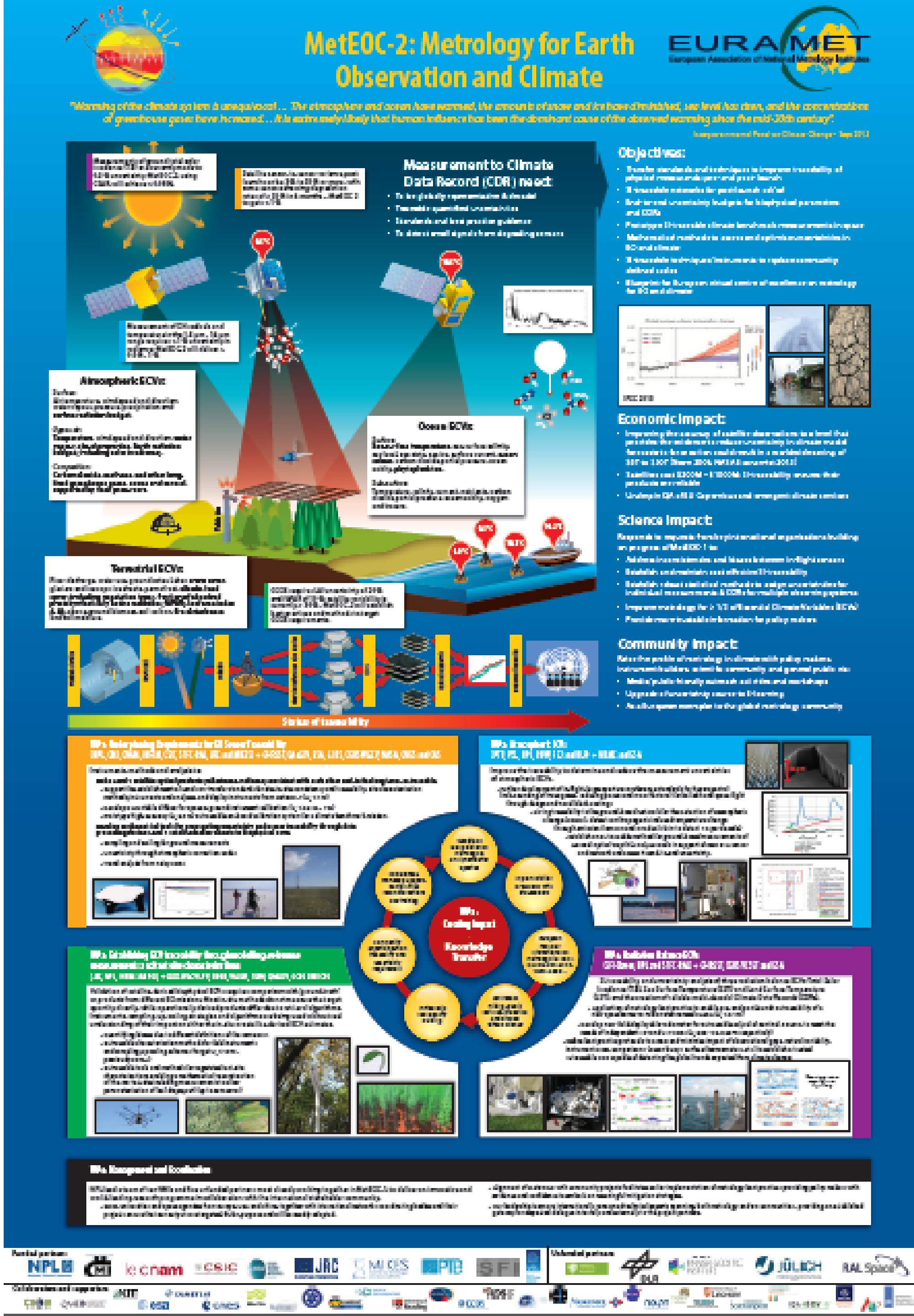
JRP ENV-04

Metrology for Earth Observation and Climate

MetEOC-2 (Jun 2014 start)

~ 40 man years of effort
- aligned to CEOS, CCI etc

- NMIs from, UK, F, D, Fi, I, NL, Cz, Sp, CH & EU (JRC)
  + RAL, DLR, FGI, BUW, UJul
- Concentrates on Post-launch
- End to End Traceability & ECVs
- 2014- 2017 – Open spring for some funded research partners (not NMIs)
- Aim for a real virtual centre next H2020 project poss 7 yrs look for alignment with ESA, Eumetsat (core metrology)



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WP1: Underpinning Requirements for EO Sensor Traceability

(NPL, CMI, CNAM, INRIM, CSIC, STFC-RAL, JRC and MIKES) + GHRSST, QA4ECV, ESA, GCOS, CEOS WGCV, NASA, CNES and CAS

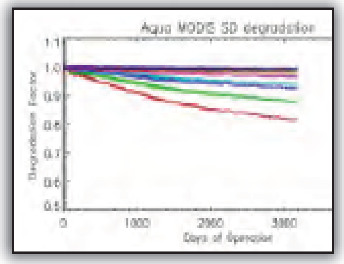
Instruments, methods and analysis to:

Make Level 1 satellite optical products (reflectance, radiance) consistent with each other and, in the long term, SI-traceable.

- Support the establishment of LandNET: transfer standards for site-to-site consistency and traceability, site characterisation methods/instruments and analyses, and deploy instruments from MetEOC-1 (U_c < 1 %)
- Develop a UV-stable diffuser for space & ground instrument calibration (U_c < 0.2 % – 1 %)
- Prototype high-accuracy (U_c 0.3 %) SI-traceable on-board calibration system for a climate benchmark mission.

Develop mathematical tools for propagating uncertainty and assess traceability through data processing chains: Level 1 satellite measurements to biophysical ECVs.

- Sampling and scaling for ground measurements
- Uncertainty through atmospheric correction codes
- Trend analysis from noisy CDRs



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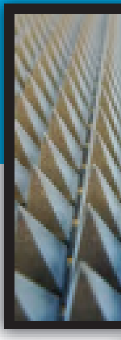
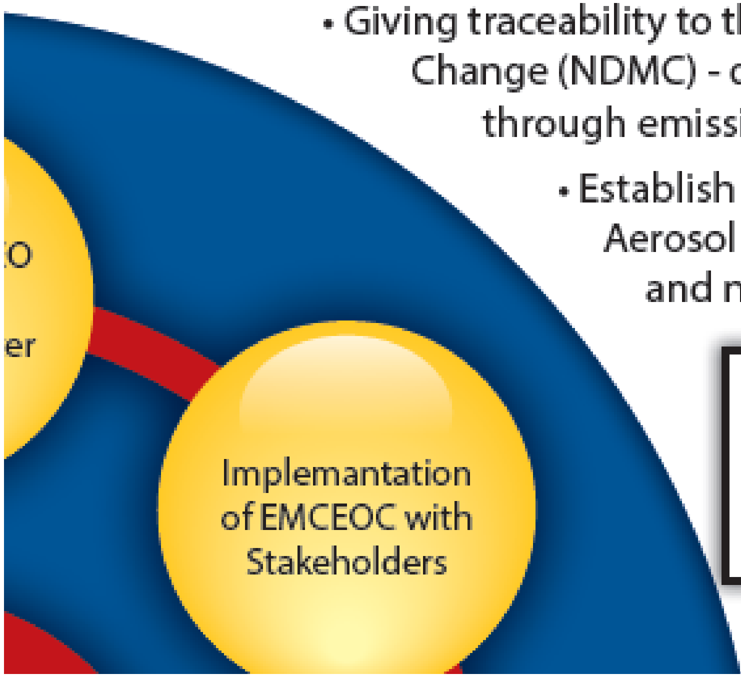
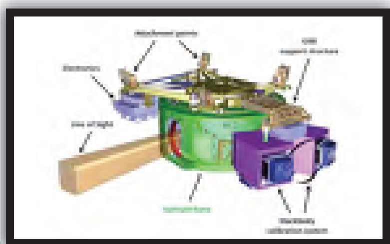
WP2: Atmospheric ECVs
(PTB, VSL, NPL, BUW, FZJ and DLR) + NDMC and ESA

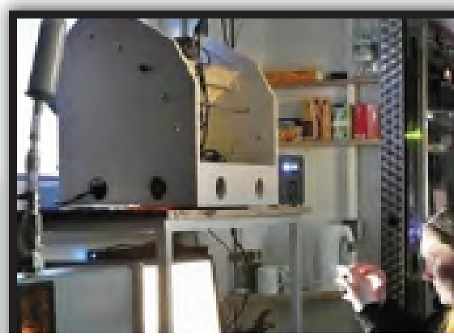


Improve the traceability to determine and reduce the measurement uncertainties of atmospheric ECVs.

- Further development of in-flight, large aperture IR reference standards for hyperspectral limb-sounding of trace gases - reducing power and mass (factor 5) for balloon and space flight through design and novel black coatings
- Giving traceability to the ground-based Network for the Detection of Mesospheric Change (NDMC) - detects anthropogenic induced temperature change through emission from OH and O radicals (aim to detect 1 K per decade)
- Establish an SI-traceable method for ground-based measurements of Aerosol Optical Depth (AOD)/Aerosols in support of new ESA sensor and network and assess its end-to-end uncertainty.





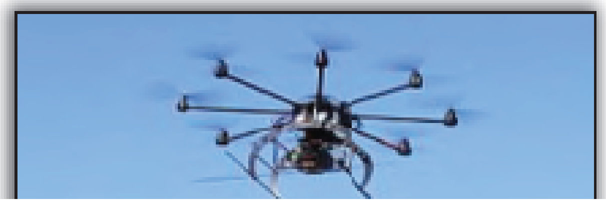


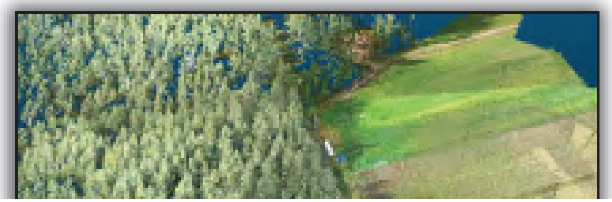
WP3: Establishing ECV traceability through modelling, reference measurements and test-site characterisations

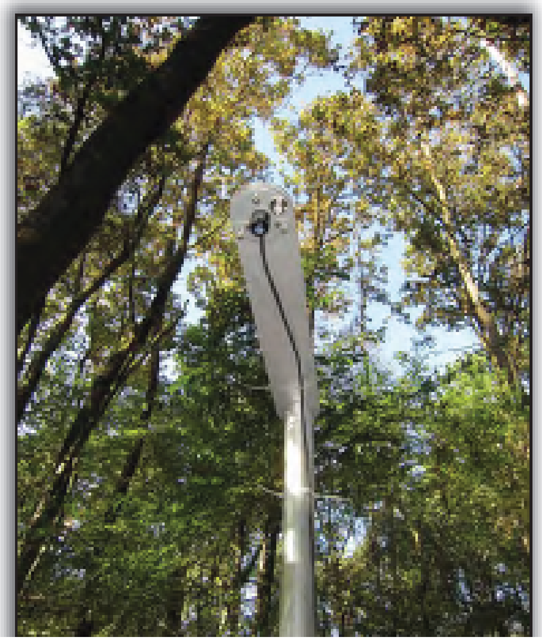
(JRC, NPL, INRIM and FGI) + CEOS WGCV LPV, NEON, VALERI, TERN, QA4ECV, GCOS and ICOS

Validation of satellite-derived biophysical ECVs requires comparison with 'ground-truth' or products from different EO missions. Most in-situ methods do not measure the target quantity directly, while operationally derived products differ due to retrieval algorithms. Instruments, sampling, up-scaling strategies and algorithms are being used without real understanding of their impact on either the in-situ or satellite-derived ECV estimates.

- Quantifying biases due to different definitions of the same ECV.
- SI-traceable characterisation methods for field instruments and sampling/upscaling schemes (target $U_c < 10\,\%$ - previously 30 %+)
- SI-traceable tools and methods for vegetated test-site characterisations enabling a mathematical reconstruction of the JRC test-site including measurements to allow parameterisation of leaf shape/curl (up to 50 % error)







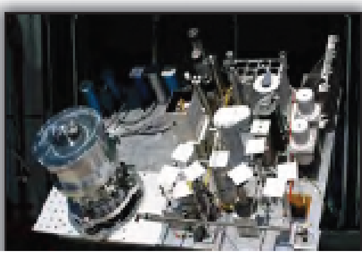
European focus for International EO metrology; i.e. CEOS, QA4EO, GEO, GCOS, WMO, GSICS…

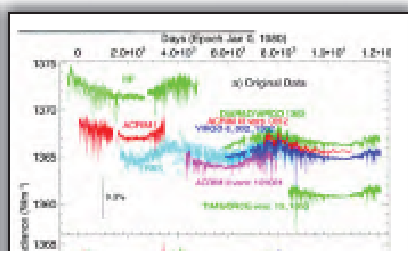
WP4: Radiation Balance ECVs

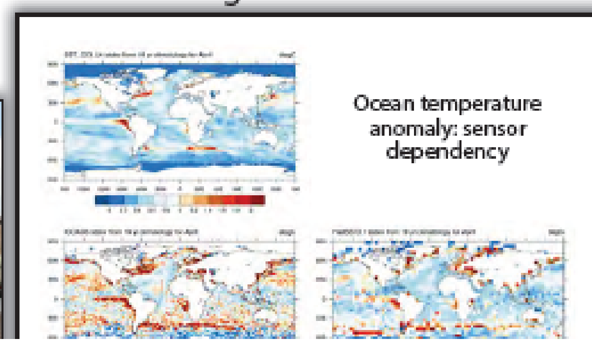
(SFI-Davos, NPL and STFC-RAL) + GHRSST, CEOS VCSST and ESA

SI-traceability and uncertainty analysis of three radiation balance ECVs: Total Solar Irradiance (TSI), Sea Surface Temperature (SST) and Land Surface Temperature (LST), and the creation of reliable multi-decadal Climate Data Records (CDRs).

- Application of metrology best practice to enable pre- and post-launch SI-traceability of a new spaceborne TSI radiometer named CLARA (U_c < 0.1 %)
- Develop new 'field-deployable' radiometer for SI-traceable cal/val of Sentinel 3 SLSTR, to meet the needs of independent SST and LST CDRs (U_c 0.05 °C & 0.25 °C respectively)
- Define best practice protocols to assess and minimise impact of observational gaps, natural variability, instrument cross-comparisons, (ocean buoys, surface thermometers, etc.) to establish a trusted SI-traceable CDR capable of detecting the global trends expected from climate change







Ocean temperature anomaly: sensor dependency

Uncertainty Analysis for Earth Observation

Course will run in June (dates to be confirmed) at NPL.
Contact Ella Garnham: ella.garnham@npl.co.uk for more details

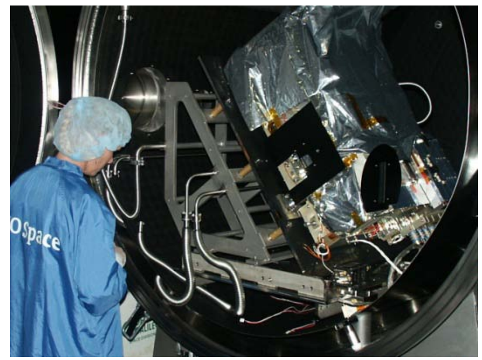
Day 1: Beginner

- Takes measurements
- Has never made an uncertainty budget
- Wants the basics – but not too much maths

Aims:

To provide scientists with the tools required to develop a straightforward uncertainty budget for the measurements that they are making or using.

Day 2: Intermediate



- Uses or makes calibrations or validation campaigns
- Has performed some uncertainty analysis – but has lots of questions

Aims:

To explain the concepts behind uncertainty analysis so that the scientist becomes comfortable with developing a detailed uncertainty budget from scratch

You can take either, or both, days. Day 2 builds on Day 1

NPL National Physical Laboratory Training

Uncertainty Analysis for Earth Observation

Course will run in June (dates to be confirmed) at NPL.
Contact Ella Garnham: ella.garnham@npl.co.uk for more details

Day 1: Beginner

- Introduction
- Measurement traceability and uncertainty (and QA4EO)
- Basic statistical concepts (standard deviation, the Law of Propagation of Uncertainties – GUM)
- Steps to an uncertainty budget
- Example uncertainty budgets
- Introduction to correlation
- Problems from the audience

Day 2: Intermediate

- Recap of Day 1, QA4EO, GUM
- Errors and Uncertainties and the statistical basis of the GUM equation
- Steps to an uncertainty budget with more mathematics – using the calibration of a hyperspectral airborne imager as an example
- Straight line calibration equations
- Sensitivity coefficients by modelling, experimentation and calculus
- Problems from the audience

Problems from the audience: pre-arranged – send in your requests with your application form. One example will be worked through each day!

There will also be several breaks to allow the ideas to sink in and to allow one-to-one discussions with the trainers.

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