

# FIDUCEO:

FIDelity and Uncertainty in Climate  
data records  
from Earth Observation

CORE-CLIMAX co-location meeting, Brussels

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# FIDUCEO

- PI: Prof Chris Merchant, Co-PI Dr Jon Mittaz,
- Project Coordinator: Rhona Phipps
- 4 year project starting March 2015
- 5.5M Euros collaboration



# EO-2-2014

## Climate Change relevant space-based Data reprocessing and calibration

- Challenge
  - The data from past remote sensing missions must be made accessible in a way to establish **seamless time series of similar observations, contributing to the generation of Climate Data Records across sensors and technologies over two decades and more.**
  - The relevance of space derived variables and products needs to be critically examined, and enhanced to optimally fit the requirements arising from current policy issues in a variety of EU sectors
- Scope
  - Produce the most reliable, accurate, stable and complete Climate Data Records.
  - Enable quick analyses, bulk reprocessing and wide access to different science and application communities. Interoperability of diverse observation collections (atmosphere and its boundary such as ice, fresh water, sea surface and land surface, tropospheric and stratospheric data, sensor calibration and sensor-to-sensor cross calibration) will have to be included, **as well as estimates of the associated uncertainties, limits and biases.**
  - Coordinate with ESA CCI and/or CEOS/GEO activities
- Impact
  - Proposers should demonstrate how the work performed adds value to existing data repositories and efforts by the respective remote sensing data holding agencies. **Best practices in combining data from different satellites and other sensor in consistent ways should be established and promoted.**

# FIDUCEO core concept

## Develop and apply a rigorous metrology of Earth observation for climate data records

- Metrology is the science of measurement and measurement uncertainty
- The project is focused on the uncertainty budget
  - **comprehensive** and **realistic**
  - **communicated** using internationally agreed standards
  - **traceable** from detector to gridded geophysical product. (Traceability here we talk about the property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty)
    - Note reference does not have to be SI, only community agreed
  - **propagated** rigorously across product levels

# Fiduceo Aims

- Harmonised FCDRs with full L1 uncertainty estimates;
- To derive CDRs/new datasets from the new FCDRs for four ECVs, as valuable exemplars
- (will derive SST ensembles)
- To provide widely re-usable, open and free access, tools and documentation.

# Fiduceo Aims - FCDRs

- Harmonised FCDRs with full L1 uncertainty estimates;
  - To develop and apply new harmonisation techniques across sensor-series and wavelength domains to maximise consistency of infra-red (AVHRR and HIRS) and microwave (SSM/T2, AMSU-B, MHS) FCDRs
- To link thermal infra-red FCDRs (AVHRR-, HIRS- and ATSR-series) to Sentinel 3 SLSTR
- Common “easy-FCDR” + community standard formats
- Widely re-usable, open and free access, read tools

# Fiduceo Aims - FCDRs

- FCDR datasets
  - AVHRR, IR & reflectance, 1982 to 2016
  - HIRS, IR, 1982 to 2016
  - SSM-T2 / AMSU-B / MHS, MW, 1992 to 2016
  - Meteosat 2 to 7, VIS with improved SRFs, 1982 to 2016

# Fiduceo Aims - CDRs

To derive CDRs/new datasets from the new FCDRs for four ECVs, as valuable exemplars

- upper-tropospheric humidity (including joint evaluation of harmonised infra-red and microwave observations), UTH (1992 – 2016) from HIRS and MW sounders
- sea and lake surface temperature - SST (1982 – 2016) from AVHRR, Lake ST (1982 – 2016)
- surface albedo - Albedo and aerosol from Meteosat 2-7 (1995 to 2016)
- aerosol optical depth - Aerosol for Europe & Africa from AVHRR (2002 to 2012)

# Fiduceo Aims - CDRs

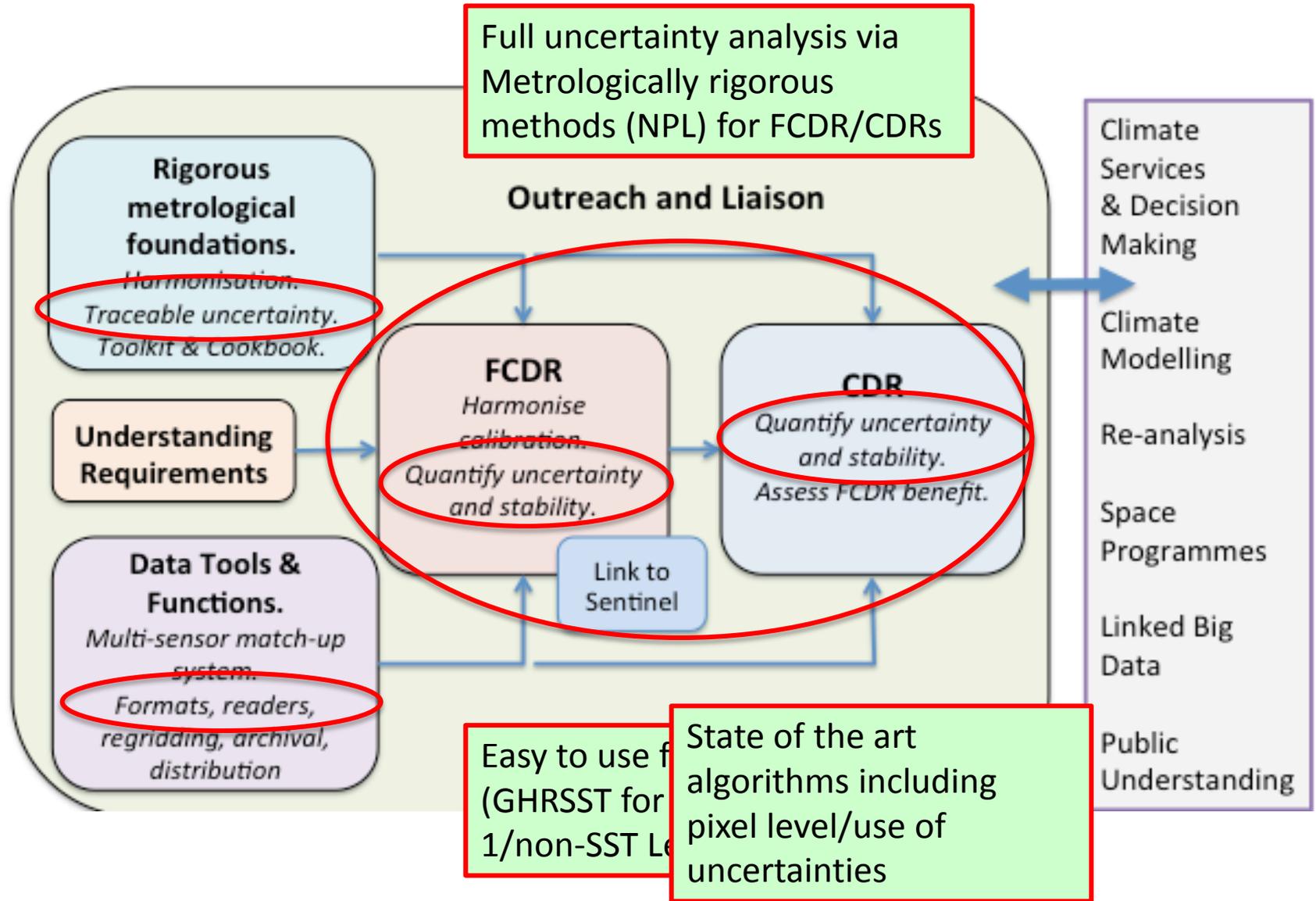
In CDR generation, to set and apply new standards of quality, in relation to

- exploitation of new FCDR uncertainty information
- assessment of accuracy, and (crucial for CDRs) measurement stability
- convenience of access and format
  - Easy to use format

# FIDUCEO Aims IR calibration/SST

- FIDUCEO has plans to both improve and supply
  - Improved Level 1 IR calibration for the AVHRR/HIRS
  - Associated traceable uncertainties at Level 1
  - Provide an SST ensemble based on the above uncertainties
    - No new algorithm development is foreseen
    - Will include harmonisation uncertainties
  - Provide a Lake Surface Temperature ensemble

# Overall Concept



# FIDUCEO FCDR/CDR Improvements

- Proposed improvements

Characteristic	Typical FCDR	FIDUCEO	Typical CDR	FIDUCEO
Ensemble spanning all forms of uncertainty	No	Yes	No	Yes
End-to-end traceability and propagation of uncertainty	No	Yes	No	Yes
Satellite-series harmonisation at radiance level based on rigorous physics	Some examples (e.g. MW); Others seem ad-hoc	Yes	Some examples	Yes
Uncertainty estimates for every pixel	No, usually generic values at best	Yes	Some examples	Yes
Uncertainty components support uncertainty propagation in aggregated data	No	Yes	One known example	Yes

# Scope of project – non data outputs

- To provide the wider community with re-usable and adaptable implementations of best-practice approaches to harmonisation and uncertainty estimation for FCDR/CDRs
  - open-source statistical toolkits (including uncertainty propagation and stability assessment)
  - open-access peer-reviewed publications
  - a “cookbook” guide: “Climate Data Records from Earth Observations: A Guide to Rigorous Practice”
  - Learning opportunities; Workshops at FIDUCEO general assemblies in Lisbon, E-learning modules and courses offered by NPL
- To publish FIDUCEO’s CDRs in innovative ways that express both ECVs and their uncertainty in ways accessible to the general public and policy-makers

# Fiduceo Links

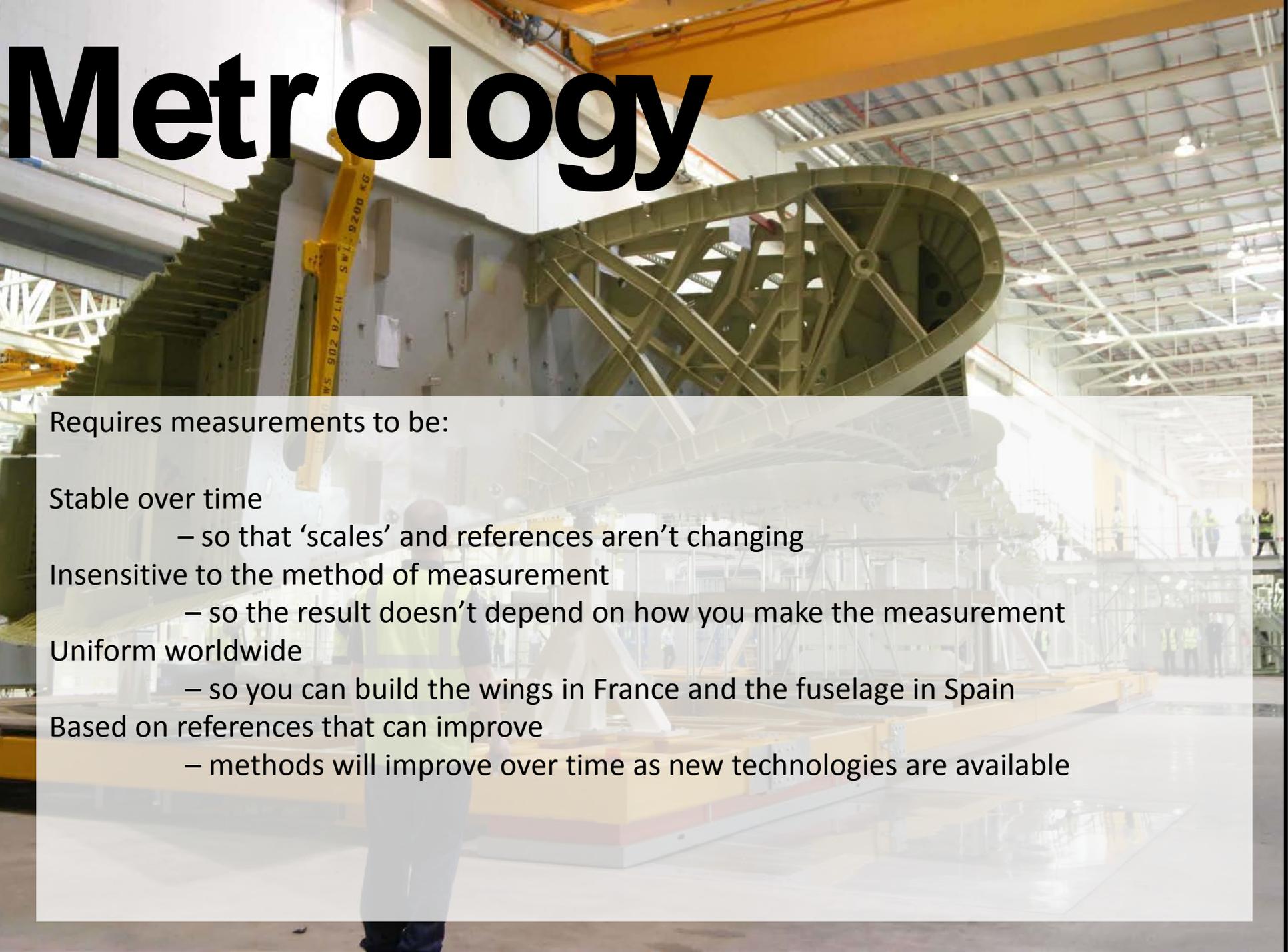
Aiming to create datasets with traceable uncertainties with the participation of NMIs. Current NMI lead projects include

- QA4ECV
  - Develop traceable quality assurance methods for ECVs,
  - Generate multi-decadal satellite-derived global ECV records, including multi-decadal Climate Data Records ([CDR](#)) for terrestrial ECVs and atmospheric ECV's precursors that are based on inter-satellite calibrated data, state of the art retrievals and are fully traceable with uncertainty metrics ready for ingestion into models
    - ECVs concentrate on Atmosphere and Land products
- MetEOC (Metrology for Earth Observation and Climate)
  - Establish a European centre of excellence of Metrology to support Earth Observation and Climate as a 'one-stop-shop': enabling European calibration scientists and engineers to deliver cost effective, fit for purpose SI traceable solutions to meet the needs of industry, funding organisations and the user community.

# Advance notice....

- Kick off meeting early March
- FIDUCEO workshops
  - Spring 2016 and Autumn 2018

# Metrology



Requires measurements to be:

Stable over time

- so that ‘scales’ and references aren’t changing

Insensitive to the method of measurement

- so the result doesn’t depend on how you make the measurement

Uniform worldwide

- so you can build the wings in France and the fuselage in Spain

Based on references that can improve

- methods will improve over time as new technologies are available