

Fidelity and Uncertainty in Climate Data Records from Earth Observation (FIDUCEO)

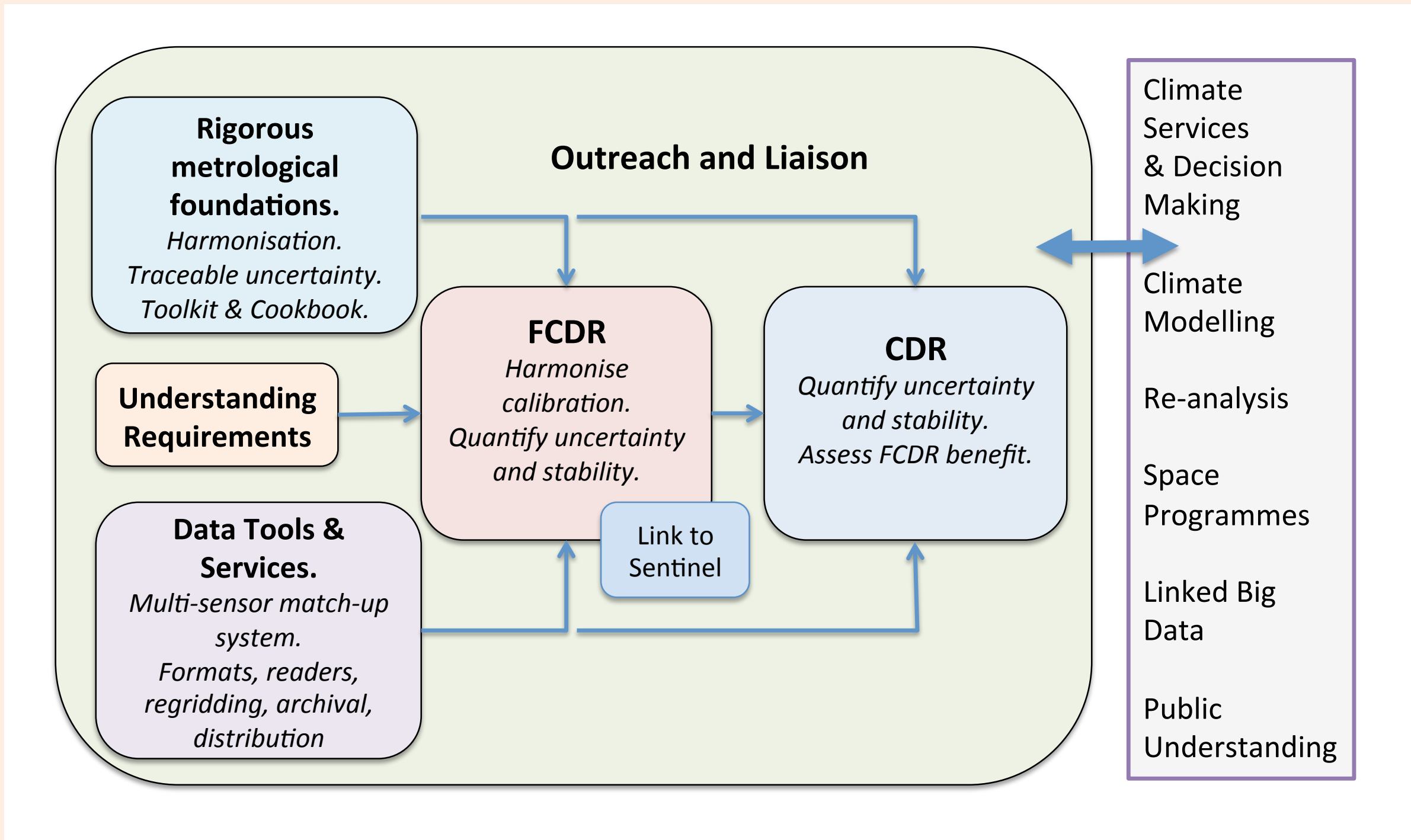
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Overview

Well-characterised uncertainties are crucial if Climate Data Records (CDRs) are to be properly exploited. Our understanding of CDR uncertainties is, however, currently limited. For example, how trustworthy is the uncertainty on a given measurement of a climate variable? If we compare a measurement now with one obtained a few decades earlier, how uncertain is the apparent change? To what extent do instrumental and multi-mission (in)stability limit the conclusions that can be drawn about climatic trends?

The objective of the FIDUCEO project is to develop new methods to such these questions for CDRs derived from satellite observations. The methods will be developed by adapting insights and techniques from the discipline of metrology, the “science of measurement uncertainty” and of uncertainty traceability. They will be demonstrated across microwave, infra-red and visible domains.

Concept of FIDUCEO project



FIDUCEO will create new methods, tools, training and datasets.

The new methods will address new physics-based harmonisation techniques for series of key sensors, and corresponding estimation of all significant components of uncertainty (including pixel level and long term stability) in a metrologically robust manner.

The application of these methods within the project will lead to four new Fundamental Climate Data Records (FCDRs) – Meteosat (VIS), AVHRR & HIRS (IR) and microwave humidity sounders (MW).

Based on these FCDRs, within FIDUCEO we will demonstrate extension of the metrological approach to geophysical datasets (CDRs). The CDRs will address upper-tropospheric humidity, surface temperature and albedo, and aerosol optical depth.

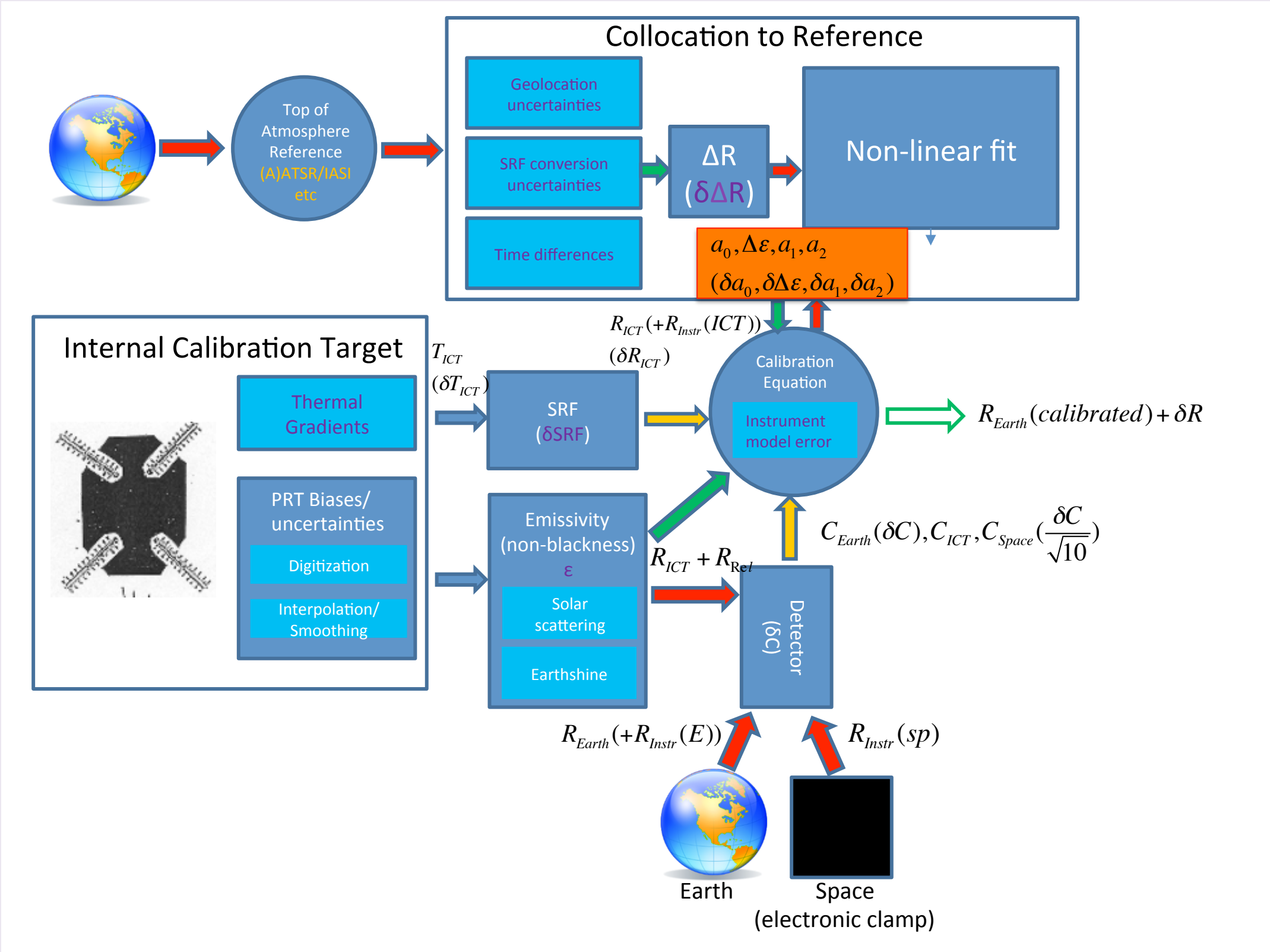
| Characteristic | Typical FCDR | FIDUCEO | Typical CDR | FIDUCEO |
|--|---|---------|-------------------|---------|
| Ensemble spanning all forms of uncertainty | No | Yes | No | Yes |
| End-to-end traceability and propagation of uncertainty | No | Yes | No | Yes |
| Satellite-series harmonisation at 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 |

Workshops, cookbooks, open-source tools and e-learning will be among the ways in which FIDUCEO will disseminate the methods and datasets from the project.

Example metrology-based analysis: Tracing cumulating uncertainties in AVHRR thermal radiance data

An “instrument model”, such as that below, captures the physical effects and data transformations that determine the calibrated radiance that is the “level 1” product from a sensor such as the Advanced Very High Resolution Radiometer.

In this example below, reference measurements from other sensors are used for cross-calibration, to improve on the nominal pre-launch characterisation using data in flight.



The magnitudes and correlation properties of error distributions for radiance data given the new calibration and instrument behaviour can be characterised by error modelling and propagation through all elements of the corresponding “uncertainty chain”.

In FIDUCEO, new harmonised level 1 datasets in an easy-to-use FCDR format will be created. This will apply state-of-the-art calibration, and include rigorous uncertainty information, using uncertainty chains as discussed above.

Easy-FCDR datasets will make it much easier for uncertainty-characterised, harmonised geophysical datasets to be derived from several important series of instruments (AVHRR, HIRS, AMSU, Meteosat). In this way, FIDUCEO is intended to enable widespread rigorous exploitation of long-term satellite data for new climate variables.