Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring (GAIA-CLIM)

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1. Background

GAIA-CLIM is an H2020 project expected *"to lead to significant advances in greater consistency and cross-calibration/validation of long term space based measurements with ground-based historical references, providing a better overview of uncertainty of available data to generate Climate Data Records, including impacts on information from space data. Based on the work done, best practices regarding calibration/validation campaigns should be promoted."*

2. Rationale

Comparing two imperfect measurements of a non-coincident snapshot of a fluid dynamical system, they will always differ.

Q. Does that difference matter?

To answer that, we need to fully understand at least one of the two measurements and the expected geophysical difference arising from non-coincidence.

$$|m_1 - m_2| < k\sqrt{\sigma^2 + u_1^2 + u_2^2}$$

m_1 and m_2 are measurements, u_1 and u_2 are uncertainties and σ is a mismatch uncertainty. K is a coverage factor.

$\lvert m_1 - m_2 \rvert < k\sqrt{u_1^2+u_2^2}$	TRUE	FALSE	significance level
k=1	consistent	suspicious	32%
k=2	in agreement	significantly different	4.5%
k=3	-	inconsistent	0.27%

Table: Nomenclature for assessing measurement consistency

3. WP1: Define and map observing capabilities

We cannot observe perfectly everywhere for technological, logistical and economic reasons. Adopting a tiered approach to observing capabilities can help us understand and make best use of the available observations.

GAIA-CLIM is concentrating upon identifying and utilising high-quality reference measurements using an assessment of measurement technique maturity, as well as mapping additional capabilities. See poster by P. Thorne and colleagues on this aspect.

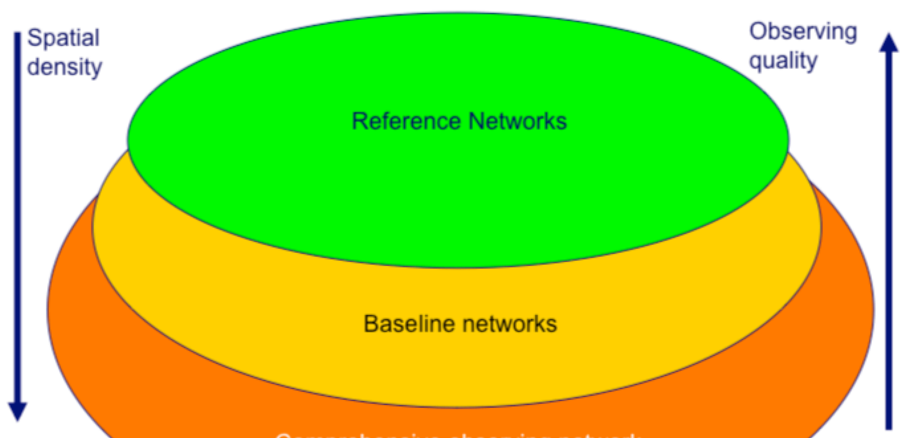

Fig.: Cascade of observing networks.

4. WP2: Improve metrological characterisation of existing measurements

Reference-quality measurements require a thorough comprehension of the uncertainties and metrological traceability through an unbroken chain to SI or widely accepted standards. GAIA-CLIM is using a number of existing streams and developing such understanding for additional instruments. These will benefit these measurement programs by providing increased understanding of the instruments, their characteristics and uncertainties.

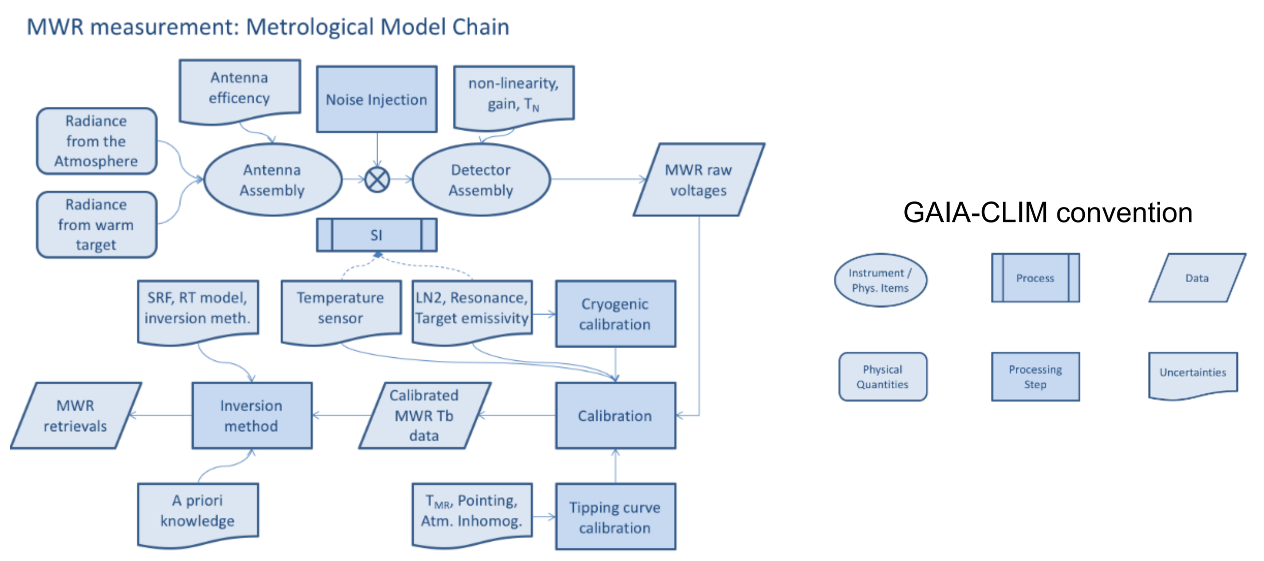

Fig.: Uncertainty chain for Microwave Radiometer

5. WP3: Account for non-coincidence of space-based and sub-orbital measurements

Observations from a spaceborne instrument and a sub-orbital measurement are never exactly coincident. They may measure at:

- A different location;
- A different time;
- Over a distinct averaging interval;
- Over a distinct vertical integral;
- Or any combination of these.

The atmosphere is a variable and inhomogeneous, so these differences matter – we do not expect the two measures to be identical on a geophysical basis. GAIA-CLIM explores several different ways to account for this, building upon precursor analyses.

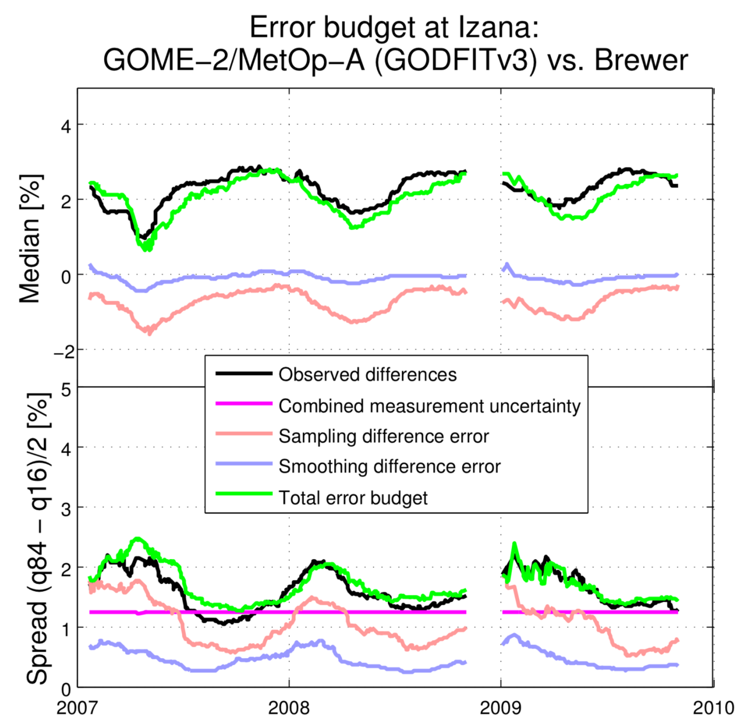

Fig:. First results in WP3 deal with a case study on total ozone column validation. The black solid lines represent the median and spread on the differences between co-located measurements. The combined measurement uncertainty (u_1 and u_2 from WP2, shown in magenta) cannot explain the observed differences. When taking into account smoothing (blue) and sampling (red) differences, and the impact of local orography simulated differences (green) match very well those observed. From Verhoelst et al., 2015, AMT.

6. WP4: The use of data assimilation as integrators

The reference-quality data will only ever be available at a small finite set of locations. GAIA-CLIM is exploring the potential use of reference data to more broadly monitor the quality of satellite data, through data assimilation, in both NWP and re-analyses settings.

7. WP5: A "Virtual Observatory" to visualise, interrogate and download co-location data and corresponding uncertainties

A Virtual Observatory is being developed enabling end-users to select, extract, visualize, interrogate, analyse and download co-locations between satellite data and high-quality reference network data. The Virtual Observatory is being developed with pilot users, following a selection process. It is designed in such a way as to enable a sustainable operational facility in the future following project completion.

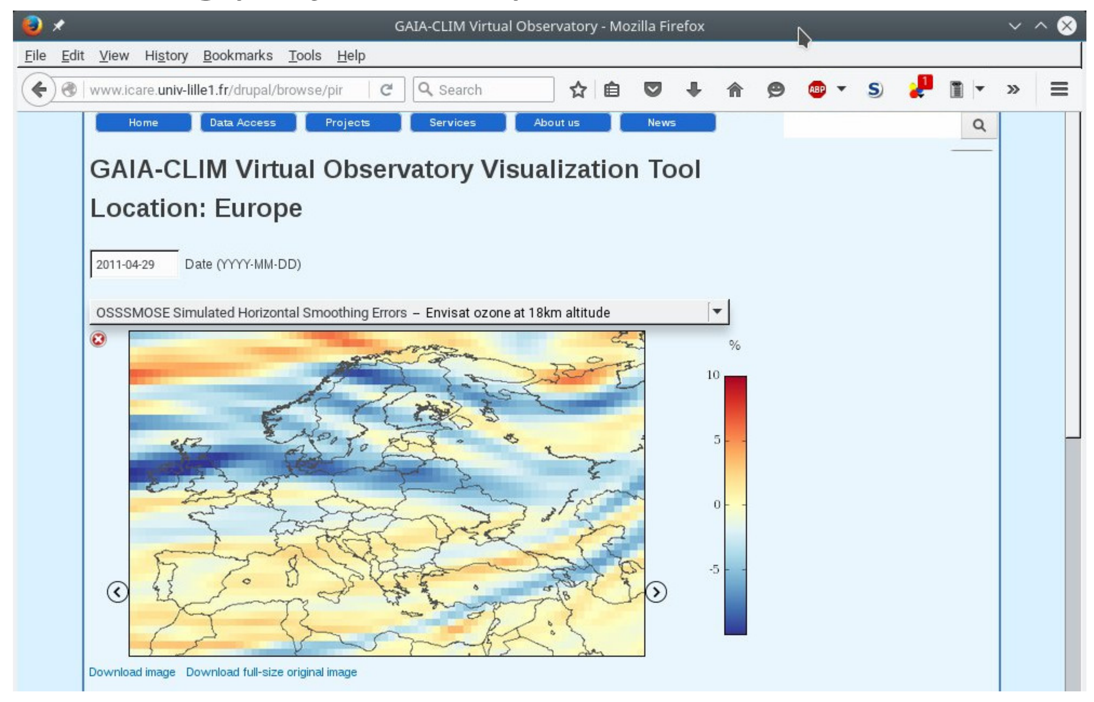

Fig.: Example of a co-location mismatch error map provided through the Virtual Observatory web-site facility (work in progress).

8. WP6: Outreach and engagement including assessment of gaps and impacts

There is a strong outreach and engagement component to GAIA-CLIM. This includes an iterative internal and external assessment of gaps in coverage, capability, knowledge etc. and their impacts. Strong community input is both welcome and required. Further details are in the poster by Michiel van Weele and colleagues. A second version and invitation for input are available at: http://www.gaia-clim.eu/page/gaid

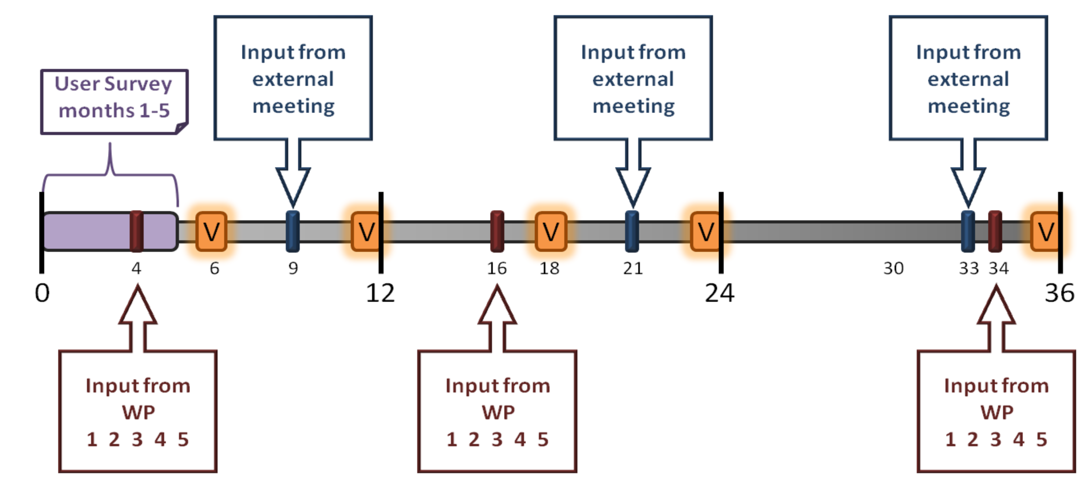

Fig.: Assessment of gaps and impacts shall be iterative and include external input.

There will be a series of user workshops. The first took place October 6th 2015 in Rome. Others shall occur in Nov 2016 and again in 2017. Expressions of interest in participation welcomed.

We are also looking for users interested in testing and providing feedback on early versions of the virtual observatory. Please contact the project coordinators if interested.

Further information

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