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

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1. Background

GAIA-CLIM is an H2020 project funded under the space programme 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in greater consistency and cross-calibration/validation of long term space based measurements with ground-based historical references, providing a better overview of uncertainty of available data to generate Climate Data Records, including impacts on information from space data.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. To date, satellite to in-situ comparisons have been ill-posed if we desire definitive answers.

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. A tiered approach to observing can help us understand and make best use of available observations. GAIA-CLIM shall concentrate upon identifying and utilising high-quality reference measurements, as well as mapping additional capabilities, which may be useful.

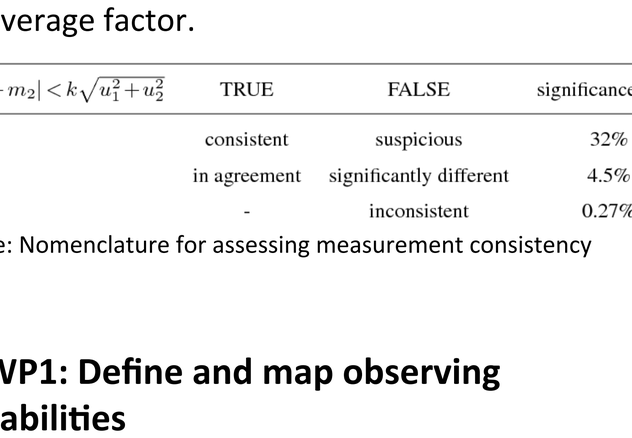

Fig.: Cascade of observing networks.

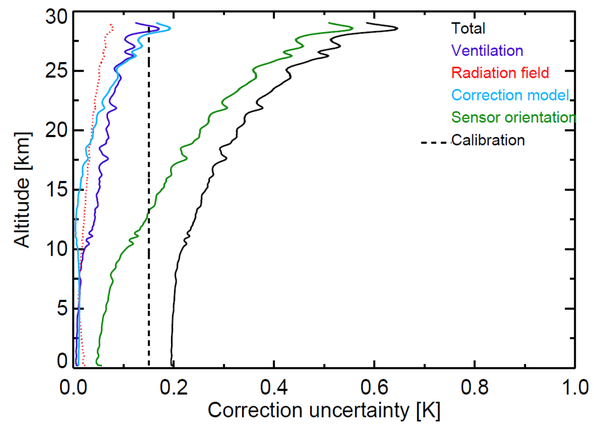

Fig.: Uncertainty components in a GRUAN-processed radiosonde profile.

4. WP2: Improve metrological characterisation of existing measurements

Reference-quality measurements require metrological traceability through an unbroken chain to SI or community accepted standards. GAIA-CLIM will use a number of existing streams and develop such understanding for other instruments. This will benefit greatly these measurement programs by providing increased understanding of the instrumentation and its characteristics.

Instruments / programme	T	q	CO_2	CH_4	O_3	Aerosols	CO	HCHO	NO_2
Pre-existing / already in process on GAIA-CLIM timescales									
Radiosondes (RS92 and various others)	■	■							
Frostpoint hygrometer sondes		■							
Ozonesondes					■				
QA4ECV project (various instruments)							■	■	■
Planned in GAIA-CLIM									
Lidars	■	■			■	■			
Microwave radiometers	■	■							
FTIR / FTS		■	■	■	■				
UV/visible spectroscopy					■				
MAX-DOAS/Pandora					■				
GNSS-PW		■							

Table: Data streams to be developed.

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 fluid body so these differences matter – we do not expect the two measures to be identical on a geophysical basis. WP3 shall explore several different ways to account for this building upon several precursor analyses.

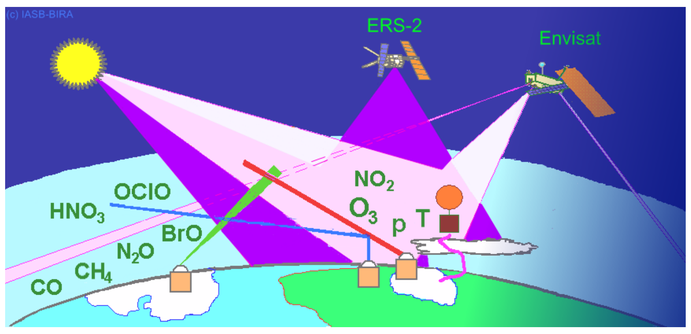

Fig.: Example schematic of different measurement techniques and footprints for trace gases using satellite and sub-orbital data.

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. This Work Package will explore the potential use of reference data to 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 uncertainties

A virtual observatory will be developed to enable end-users to visualize, interrogate and download co-locations between satellite data and high-quality sub-orbital data. The virtual observatory facility will be hosted by EUMETSAT and built in such a way as to enable a sustainable operational facility in the future following project completion.

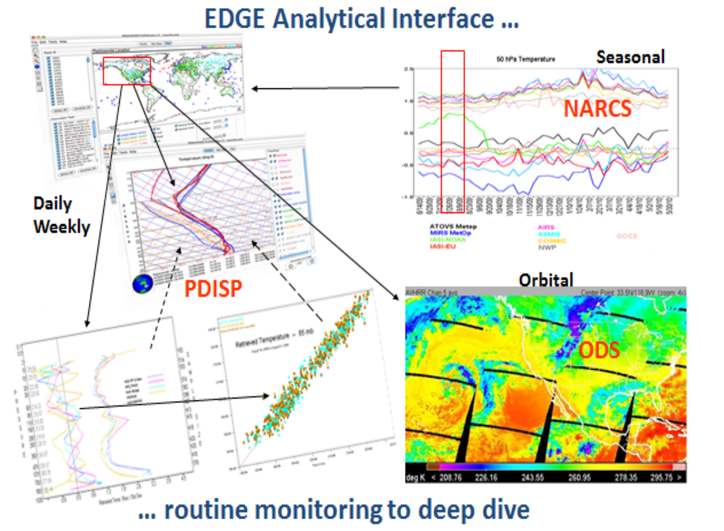

Fig.: Examples of the type of co-location output tools that may be able to be provided through the virtual observatory facility.

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 assessment of gaps and their impacts. Strong community input is both welcome and required. Gaps can relate to observing capability, understanding of measurement metrology, tools to enable the use of sub-orbital data, etc.

There will be a series of **user workshops**. The first will occur on **October 6th in Rome, Italy**. Please get in contact if interested in attending.

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.

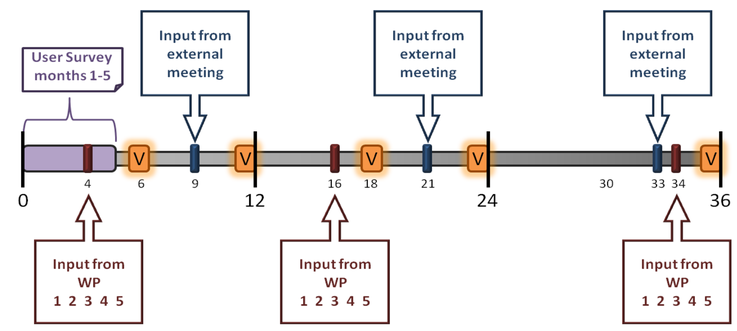

Fig.: Assessment of gaps and impacts shall be iterative and include external input.

Further information

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