The GAIA-CLIM project

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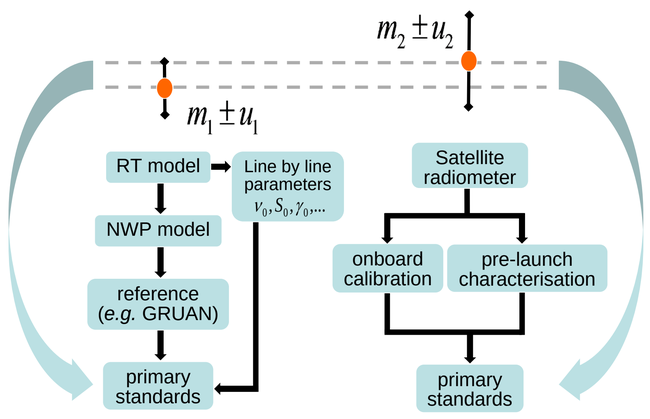
GAIA-CLIM (Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring) is an EU Horizon 2020 project undertaken to assess and develop our capability for the calibration/validation of long-term Earth Observation (EO) data sets using non-satellite reference measurements. The long-term environmental monitoring of essential climate variables (ECVs) from space relies on traceable uncertainty estimates for the reference as well as an understanding of the additional uncertainties that result from spatial and temporal mismatches in location and scale. Part of the project focuses on developing the use of numerical weather prediction (NWP) as a comprehensive reference and aims to establish traceability for the model fields through comparisons with high quality (though sparse) comparator data such as selected radiosondes. A number of new satellite missions have undergone assessments within the NWP framework by comparing observed with simulated top of atmosphere brightness temperatures. Tools such as the Virtual Observatory will allow users to interrogate a collocation database for visualising match-ups between target satellites and reference quality measurements for a number of different ECVs.

Aim: robust validation of EO data



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

Fig. 1 Using simulated measurement m_1 from NWP model to validate EO measurement m_2. Traceable calibration chains are needed to determine their respective uncertainties u_1 and u_2. Given the mismatch uncertainty σ, the expected difference m_1–m_2 is related to a coverage factor k (agreement within 2 standard deviations for k=2).

GAIA-CLIM develops the use of NWP as a reference for EO characterisation. We aim to understand the constituent uncertainties (Fig. 1) associated with NWP fields themselves as well as uncertainties related to interpolation and radiative transfer models used to generate brightness temperatures.

Departure based assessments

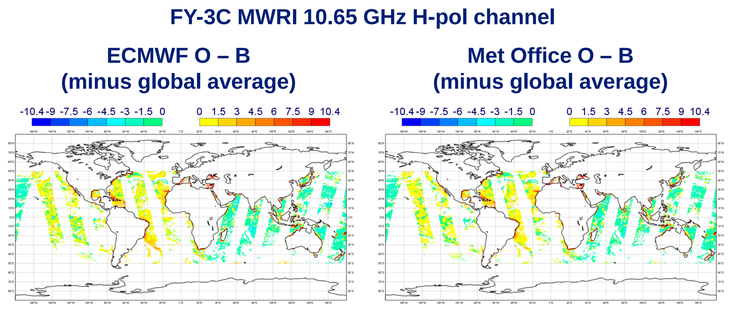


Fig. 2 Brightness temperature departures (O-B) for FY-3C MWRI channel 2 (10.65 GHz H-polarisation) ocean scenes for both ECMWF and the Met Office. The same 12-hour sample period is shown in both plots.

NWP and reanalysis fields offer key advantages for EO validation, being spatially continuous, constrained by large numbers of observations and physically consistent. Assessments using observed minus background (O-B) departures can reveal instrument artefacts such as ascending/descending biases of 1-2 K for FY-3C MWRI (Fig. 2).

NWP-GRUAN traceability

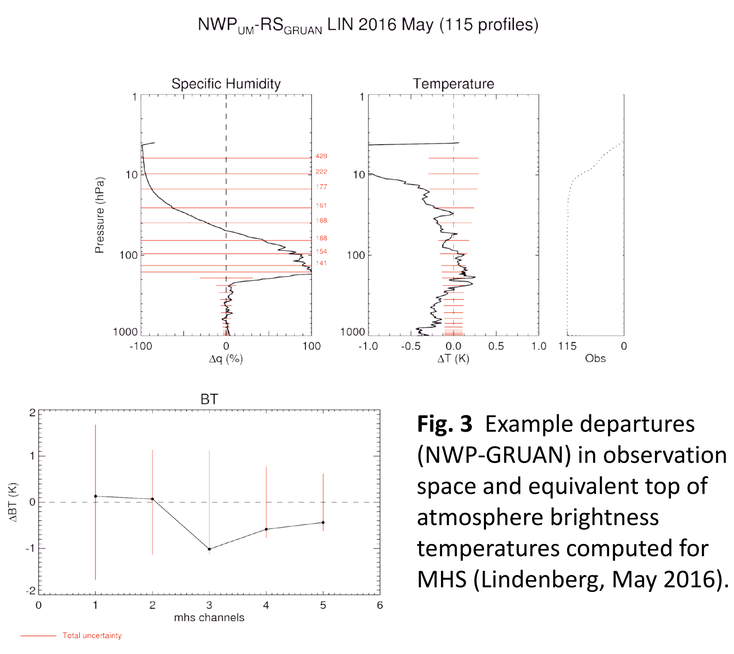


Fig. 3 Example departures (NWP-GRUAN) in observation space and equivalent top of atmosphere brightness temperatures computed for MHS (Lindenberg, May 2016).

The GRUAN processor is a collocation and radiance simulation tool that quantifies differences between NWP fields and radiosonde profiles in both observation and radiance space. Known GRUAN uncertainties are propagated into the radiative transfer calculation. Fig. 3 shows example NWP-GRUAN differences that help inform our knowledge of the uncertainty in NWP fields.

The Virtual Observatory

The GAIA-CLIM Virtual Observatory is a searchable database for visualising match-ups between EO data and collocated reference measurements. See our interactive exhibit in the poster area.

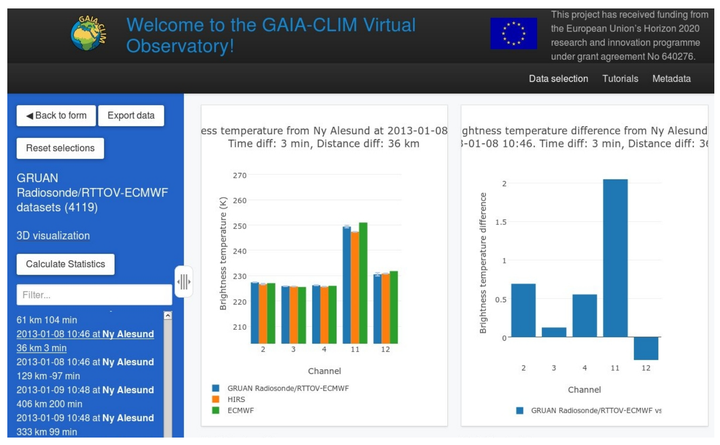


Fig. 4 Example screenshot from the Virtual Observatory comparing HIRS brightness temperatures with collocated GRUAN radiosonde profile processed by RTTOV.

GAID and recommendations

Unfulfilled user needs ("gaps") in the availability of truly reference quality measurements to support ECV monitoring are documented in the Gaps Assessment and Impacts Document (GAID, http://www.gaia-clim.eu/page/gaid). A recommendations document (http://www.gaia-clim.eu/page/recommendations) aims to distill the findings into a set of high level proposals for tackling the gaps.

Come along to our workshop

The potential of NWP for calibration and validation of EO data and ECV monitoring is explored in a special workshop at ITSC-21. Come along to the Neon meeting room on Thursday 30 November after the conclusion of the Technical Sub-Group meetings at 18.30 to find out more.

Links with FIDUCEO

Fidelity and uncertainty in climate data records from Earth Observations (FIDUCEO) is a related Horizon 2020 project targeting metrological traceability of EO data sets. These uncertainties are represented as u_2 in Fig. 1. GAIA-CLIM and FIDUCEO partners are collaborating on an uncertainty budget closure exercise for MHS. O-B comparisons (see Fig. 5) will be repeated with FIDUCEO FCDR products to assess whether departures are consistent with estimated uncertainties in the observations and model.

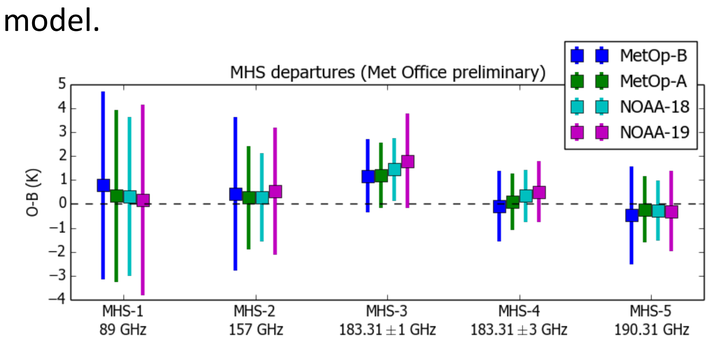


Fig. 5 Preliminary assessment of MHS departures at the Met Office (single cycle, output from 1dVar preprocessor, RTTOV 11, FASTEM-6).

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