Climate Working Group
ITSC-25

Co-chairs: Bill Bell (ECMWF), Nathalie Selbach (DWD)

ITSC-25 Climate Working Group (CWG) Report

Saturday 10th May 2025 13:30 - 16:15.

v1. Tuesday 13/05/25

Participants:

Bill Bell (co-chair), Nathalie Selbach (co-chair), Joe Taylor, Timo Hanschmann, Roger Randriamampianina, Heikki Pohjola, Reima Eresmaa, Indira Rani, Pradeep Thapliyal, Quentin Cebe.

Structure

1. Input on High Level Priority Plan, specifically on items of relevance to CWG
2. Update on Actions & Recommendations
3. Summary of discussions
4. Summary of outstanding Actions & Recommendations

[HLPP 4.4.1] Establish a common vocabulary and methodology, with appropriate error propagation to include the errors associated with validation data (e.g. radiosonde temperature, water vapour, precipitation and winds), in validation studies

Considering validation as the comparison of two independent estimates of a climate variable (say X and Y), given the uncertainties in both (U(X) and U(Y)), members of the group are currently committed to a study to compare the temperature & humidity fields in the ERA6 reanalysis with independent observations (from the CrIS instrument) *in observation space*, given the uncertainties in both. This requires new work on quantifying the uncertainties in reanalysis fields (particularly regarding the systematic component of the uncertainties in those fields), the uncertainties in the radiative transfer (including spectroscopic uncertainties, fast model parameterisation & assumptions about CO_2 fields). The selection of CrIS as a reference instrument is driven by: (i) the high quality of the observations & (ii) the availability of comprehensive radiometric and spectral uncertainty analyses.

The study involves EUMETSAT and ECMWF/C3S and requires collaboration with experts on radiative transfer (at M-F/CNRM & ECMWF), observation uncertainties (U. Wis) and will benefit from insights gained from previous work in this area (AEMET). The study will conclude in 2028 and it is expected that progress can be reported at ITSC-26 and conclusions by ITSC-27.

It is anticipated that the study will provide a template / example / case-study of the methodology and associated vocabulary to be used for validation studies in this particular domain.

It is expected that insights gained from this study will help contribute to the evidence base for defining the requirements for future observing systems (in terms of absolute calibration requirements and calibration/validation methodologies) meeting the needs of climate monitoring.

[HLPP 4.4.1] Establish a common vocabulary and methodology, with appropriate error propagation to include the errors associated with validation data (e.g. radiosonde temperature, water vapour, precipitation and winds), in validation studies

Summary for HLPP

"Members of the ITWG (CWG) [EUMETSAT and ECMWF, with support from U.Wis & MF-CNRM] are undertaking a study to validate ERA6 reanalysis fields with high quality independent observations from the CrIS instrument. This study, due to report in 2028, will involve evaluation of the uncertainties in both and draw upon expertise in reanalysis, radiative transfer modelling and observation uncertainties taking into account previous work in this area by ITWG. It is anticipated that the study will provide an example of the methodology and vocabulary to be used for subsequent validation studies in this domain.

It is expected that insights gained from this study will help contribute to the evidence base for defining the requirements for future observing systems (in terms of absolute calibration requirements and calibration/validation methodologies) meeting the needs of climate monitoring."

[HLPP 4.9] Identify AI/ML technologies for applying to product processing and data management infrastructure and develop best practices

Three developments in the use of AI/ML applied to product processing were noted:

- **The use of climate reanalysis data (ERA5) for training ML forecast models** (AIFS, GraphCast and Pangu weather being 3 examples) was noted. The performance of these ML models now exceeds that of physically-based forecast models for several variables and phenomena and are now run operationally at ECMWF. It is likely that this particular application of ML will continue to evolve and will play an increasingly significant role in operational medium-range weather forecasting. This particular approach to ML forecasting is reliant on reanalyses for training & future climate reanalyses may benefit from an increased focus on the development and production of improved climate reanalyses.

- One study shows how **ML models can be used to update initial conditions** in order to improve medium range forecasts. The application of this methodology as a post-processing step applied to climate reanalyses could help improve the accuracy of reanalyses. The group should monitor further developments in this area.

- **ML methods applied to data curation and format conversion.** (Covered in Products and Software WG)

[HLPP 4.9] Identify AI/ML technologies for applying to product processing and data management infrastructure and develop best practices

Summary for HLPP

"ITWG-CWG noted several applications of ML-AI to climate products: (1) the use of climate reanalysis as a training dataset for ML forecast models & of the growing importance of this approach in operational medium-range weather forecasting; (2) the potential use of ML models for post-processing & improving climate reanalyses, and; (3) the importance of data curation and data transformation in order to create high-quality datasets needed to train, test, and validate machine learning models effectively"

Actions and recommendations

Global Observing System design. **Action Climate-1 (ITSC-22)** on Heikki Pohjola: Provide information on the status of information about FCDRs in OSCAR to the Climate WG. This information will also be added to the Climate WG webpage.

- This activity is ongoing at ITSC.25. Heikki Pohjola: gave short presentation on the current activites in OSCAR Space during the working group meeting and showed the new gap analysis filter for ECVs in WMO-OSCAR (see also presentation 1.04 at ITSC-25). There is now a prototype in place. Information on FCDR is not included yet, but work on this task is ongoing.

- It was noted that this is potentially an important tool for the coordination of ECV development efforts, *e.g.* to identify gaps in the provision of ECVs & to minimize duplication of effort across various initiatives. For example, in Europe, it could assist the coordination between the EUMETSAT Satellite Application Facilities (SAF), the core EUMETSAT Climate Services Programme Plan, ESA (CCI) & C3S activities. These projects on gap analysis are therefore seen as an important task. The GCOS ECV Inventory (https://climatemonitoring.info/ecvinventory/) is an open resource to explore existing and planned data records from space agency sponsored activities and provides a unique source of information on CDRs available internationally. This inventory is filled in by many projects (such as e.g., the EUMETSAT CM SAF) and can feed back into the gap analysis.

Actions and recommendations

Recommendation Climate-1 from ITSC-23 to meteorological satellite agencies and other providers of CDRs: To provide updates to CWG / CGMS on the status of their current activities relating to user uptake and impacts of CDRs.

- Update on reanalysis uptake:
  - EU's C3S Global (ERA5/ERA6) and regional (European & Arctic) : 200K+ users
  - Independent study on wider societal & economic benefits of ERA5 available soon (link is in report)
  - IMDAA : 5K+ users
- EUMETSAT update on FCDR / CDR production
- CMSAF update
- Unfortunately, no NOAA or CMA representatives

- **Recommendation Climate-2 from ITSC-24 to space agencies**: To note the link between (on the one hand) a tendency to small satellite technology, potentially entailing compromised calibration capabilities and (on the other hand) the scientific case for independent on-orbit calibration missions, such as CLARREO, which support long term climate monitoring.

  - Calibration accuracy is of particular importance for climate monitoring.
  - Need to **'future proof'** the requirements and specifications as far as possible (note link to earlier discussion on HLPP4.4.1).
  - Backbone capability in disaggregated system.
  - On-orbit maneuvers should be built into the plans for Cal/Val from the outset
  - The shift in emphasis from Cubesat to smallsat has reduced the risk of compromised capability

Role of GSICS in ensuring quality of long-term satellite records for CDRs

Recommendation Climate-3 to GSICS: Extend the calibration and harmonisation activities to historic sensors to support climate applications, including CDR / ECV production and reanalysis.

- Carry over from previous ITSC
- Emphasis is extension of GSICS methodology to cover older missions, where possible, to support production of the highest quality FCDRs/ CDRs

Long term stewardship of climate records

Recommendation Climate-4 to satellite data providers to catalogue available data and supporting information for all FCDRs/CDRs and establish infrastructure and procedures to sustain this over decadal timescales, make information available to users

& following a discussion topic ..

Resilience of climate data set holdings ? – given recent developments in the US, does the current system have sufficient redundancy to cover loss of a major 'node' ?

(New) Recommendation (Climate-5) to CGMS WG-2: Work towards a review the resilience of climate dataset holdings across agencies and work towards achieving multiple geo-redundancy (*i.e.* achieving redundancy across international agencies in addition to within nations) for prioritized datasets.

Discussions

- *Does the likely operational implementation of ML-based models (either trained on reanalysis, or directly from observations) have implications for how we specify requirements for sounding data?*
- *Resilience of climate data set holdings ? – given recent developments in the US, does the current system have sufficient redundancy to cover loss of a major 'node' ?*
- *The cancellation of POES. Possible measures to mitigate?*
- *Update on use of the moon as a calibration source.*
- *Visible reflectance assimilation work. Does it belong in ITWG ?*
- (post-meeting) ITSC ought to be a relevant meeting for a wider group of reanalysis teams (who have an interest in data assimilation, sounding data, biases and uncertainties, reprocessed datasets, …). ACTION to invite relevant groups to ITSC-26.