IROWG-9 Climate Subgroup

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IROWG-9 meeting minutes:

Updated recommendations of climate subgroup
Key recommendations to CGMS
Todo: Best Practise Document

Climate Subgroup - Members/Visitors

Members: Julia Danzer (WEGC, Austria), Eric DeWeaver (NSF, USA), Ulrich Foelsche (Univ. Graz, Austria), Hans Gleisner (DMI, Denmark), Ben Johnston (UCAR, USA), Florian Ladstädter (WEGC, Austria), Kent Lauritsen (DMI, Denmark), Stephen Leroy (AER, USA), Anthony Mannucci (JPL, USA), Francisco Martin (EUMETSAT, Germany), Johannes Nielsen (DMI, Denmark), Sebastiano Padovan (EUMETSAT, Germany), Bahareh Rahimi (Univ. Graz, Austria), Bill Randel (UCAR, USA), Ben Santer (UCLA, USA), Torsten Schmidt (GFZ, Germany), Marc Schwarz (WEGC, Austria), Endrit Shehaj (ETH, Switzerland), Andrea Steiner (WEGC, Austria), Matthias Stocker (WEGC, Austria), Panagiotis Vergados (JPL, USA), Axel von Engeln (EUMETSAT, Germany), Kamilya Yessimbet (WEGC, Austria), Zhen Zeng (UCAR, USA).

Visitors:

1. Climate Subgroup – Recommendations to CGMS: (Main Recommendations)

1) **Ensure continuity and long-term availability of climate quality RO measurements with global coverage and full local time coverage. Operational GNSS RO missions for continuous global climate observations need to be established and maintained as a backbone to ensure continuity with at least 20,000 occultations per day, in at least three evenly-spaced orbital planes. Low-level data need to be freely available for reprocessing**.
The community is currently short of 20,000 **randomly-distributed occultations** per day, but IROWG acknowledges the recommendation of CGMS to achieve this target. For climate studies, the effects of local time-related sampling errors should be examined and minimized. We acknowledge the contributions of commercial data providers, pending validation of their climate data quality, including long-term and full access to the data by independent processing centers. We need more climate-tailored measures and to ensure the long-term availability and continuity of the commercial data. Climate requirements should be taken into consideration when purchasing commercial data. This may necessitate targeted launches of satellites in order to cover the diurnal cycle at middle and high latitudes.

2) **Acknowledging CGMS recommendation WGIIA50.04 on long-term data access, we recommend that data providers ensure that all information necessary for independent processing towards climate data products is freely available (following WMO Unified Data Policy Resolution 1), including long-term archiving of all measured and acquired data without filtering (i.e. including the data not passing quality control), starting with low-level data, and public data access, thus assuring full climate traceability.**
This needs to include information on instrument/software updates and full documentation of the processing chains that keep track of any introduced changes/updates (e.g., POD-induced uncertainties). We also recommend that the impact of instrument software updates on climate products be evaluated beforehand. All level 0 data providers should make available phase data, amplitude data, and satellite orbit data in a well-documented format (e.g. NetCDF).

3. Actions to IROWG-8 From CGMS:

1. Climate Subgroup – Recommendations to CGMS: (Main Recommendations)

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1. Climate Subgroup – Recommendations to CGMS:

3) **Data providers should ensure parallel data streams of RO climate data products: one regularly updated data version and one uniformly reprocessed version.** The reprocessed version should always cover the full data time period until a new processing version takes over.

4) IROWG recommends that processing centers **increase efforts on uncertainty estimation and make uncertainty calculations publicly available through peer-reviewed publications.** One method of uncertainty quantification is to produce ensembles of processed observations ("perturbed retrieval ensembles") that include different processing assumptions and initialization information where the SI-traceability chain may be less robust (in accordance with the GCOS-143 Document).

5) **Promote funding of various reprocessing activities of RO climate data records from different RO processing centers** along the principles for reprocessing climate data records of the WCRP Observation and Assimilation Panel (WOAP). Documentation of the historical evolution of processing systems for the provision of climate data records is important. **This should include gridded data together with uncertainty and algorithm descriptions.**

1. Climate Subgroup – Recommendations to CGMS:

6) We recommend to assess the **uncertainty in the refractivity coefficients that impacts the accuracy and traceability of RO climate time series and trends.** Significant progress was made at JPL in implementing an experiment to measure the refractivity of air, but such experiments currently lack the needed precision by the climate group. Required steps to improve precision have been identified by NASA/JPL, however further financial support is needed. **IROWG is pleased to see these initial laboratory refractivity experiments and encourages CGMs agencies to support this activity.**

7) We acknowledge the **success of the 3G meeting** which brought together the GNSS RO community, the GRUAN community and the GSICS community in May 2014 in Geneva and recommend **organizing such meetings periodically by WMO**.

8) We recommend that **operational data providers additionally supply occultation prediction products**, aiding coordinated ground-based collocated measurements.

2. Climate Subgroup – Recommendations Within IROWG:

1) We recommend that IROWG continues to **contribute to the development of GNSS RO as a climate monitoring system** by **a) assessing the structural uncertainty of RO retrieval data**, including differences between processing centers and between different RO instruments and missions,
b) supporting the generation of multi-center ensembles of RO climate data records,
c) studying the effect of changing spatial coverage, characterizing errors related to incomplete spatial & temporal coverage
d) clearly communicating the usability and limitations of RO products to the **climate community**.

2) Continue to **assess RO water vapor products** in terms of climate quality, information content, and random and systematic uncertainties, including characterization of the stability and inter-center homogeneity, guided by GEWEX & GCOS requirements.

3) Encourage research into **assessing the sources of bending angle uncertainties from different receivers and processing centers (which include SNR, clock noise, ionospheric residuals, calibration techniques etc.) and their impact on the estimates of long-term changes**, which is likely to extend the benchmarking capability of GNSS RO more robustly into the troposphere and higher into the stratosphere. We acknowledge the ROM SAF effort within the IROWG to investigate the lower troposphere measurement and algorithm uncertainty among various processing centers.

2. Climate Subgroup – Recommendations Within IROWG:

4) Issues of **ionospheric correction and high altitude initialization should be further investigated to optimize the climate utility in the entire stratosphere**.

5) We recommend that the **IROWG community continues to compare RO products with other observations and foster contributions to IPCC Assessment Reports and other international climate reports**.

6) Continue **participation in the wider scientific community.**

7) Ensure a complete **archive of navigation data bits in a standard format.** Making this information available to the community. We recommend that current providers to come up with a common nav bit format.