**GSICS Microwave Subgroup General Meeting**

**1100-1330 UTC May 22, 2024**

**Attendees:**

**CMA:** Shengli Wu, Juyang Hu

**DWD:** Karsten Fennig

**EUMETSAT:** Tim Hewison, Timo Hanschmann

**Hamburg University:** Martin Burgdorf

**Max Planck Institute for Extraterrestrial Physics:** Thomas Müller

**NIST:** Dazhen Gu

**NOAA:** Flavio Iturbide-Sanchez, Siena Iacovazzi, Yong-Keun Lee

**UK Met Office:** Fabien Carminati

**University of Maryland:** Hu Yang

The meeting will be used to communicate status and path forward plans for the Focus Groups, as well as for developing/adopting microwave related uncertainty framework(s) and glossary(ies).

**1. [120 mins] Focus Groups (Shengli Wu – CMA and Flavio Iturbide-Sanchez - NOAA)**

This portion of the meeting was focused on out briefs from the focus group leads.

* Direct MW Radiometer Inter-comparison Method Focus Group (Tim Hewison – Included a [presentation](http://gsics.atmos.umd.edu/pub/Development/20240522/Microwave_SNO_Focus_Group_SNO-review.pptx))
  + Details were provided regarding the “Way of Working” for the focus group. It also provided a description of the framework for the literature review on the SNO method, the [spreadsheet](https://umd0-my.sharepoint.com/:x:/g/personal/mbali_umd_edu/EdPaC8EUzdVPj8J3P4NRNqoBwqa3udRuLn-JIxWLcgiEhA?rtime=d29V7mBu3Eg) that chronicles past developments of this method, and a path forward for the group.
  + This spreadsheet includes preliminary reviews of vicarious and NWP inter-calibration methods, which could be continued within the respective focus groups.
  + *Question and Answer*
    - Siena - How do we know what level of uncertainty is adequate for the user, since each application of the method may require different uncertainties?
      * Tim has started looking into defining requirements for the accuracy of inter-calibration algorithms for different spectral band/applications. During the meeting, he added some slides to his [presentation](http://gsics.atmos.umd.edu/pub/Development/20240522/Microwave_SNO_Focus_Group_SNO-review.pptx) for discussion at a future meeting.
    - Fabien
      * There is currently EUMETSAT research related to a radiosonde-focused application of vicarious calibration that could also be tied with inter-comparison methods, such as SNO.
      * This work will soon be published on the EUMETSAT Science web pages.
    - Siena – Is there a path-forward for the group?
      * Fill in the literature review spreadsheet, and identify the issues and strengths and weaknesses.
      * Extract the level of uncertainty already achieved by these methods.
      * Want to see an evolution in time, where there is convergence of an optimal method to use. This may be unrealistic, but in the process a lot will be learned from intercomparing the methods.
* MW Radiometer Technology and Instrument Pre-Launch Testing and Post-Launch Characterization Focus Group (Dazhen Gu and Juyang Hu – Did not include a presentation)
  + Have not started focus group activities yet. We will start by organizing a meeting.
  + *Question and Answer*
    - Flavio - Any initial comments about what you may provide or recommend as a focus group?
      * Dazhen – Plan to be responsible for providing information and guidance from the calibration standards perspective. Provide a survey existing technology, especially for emergent techniques.
    - Flavio - Any new technology or concept that you want to discuss today. For example, cal targets?
      * Dazhen - Had a split duty with two parallel research thrusts funded by NASA ESTO that will end in August/September 2024.
        + Calibration artifact evaluation for a cone-shaped blackbody developed at NIST. Trying to improve uniformity of a cone-shaped target. Emissivity properties studied up to 220 GHz. Could not verify thermal properties due to lack to TVAC. At Northrop Grumman, they completed the thermal study, and was not good as expected.
        + NASA ESTO funded exploration of miniaturized blackbodies for CubeSat. Traditional blackbodies are too heavy for CubeSat, and want to make smaller or lighter warm load. Put surface on printed circuit board (PCB) that exhibits high emissivity in the frequency range. Requires new research activities.
    - Tiger – Any short side for using an electromagnetic meta-surface – e.g., frequency limit or thermal limit?
      * Dazhen – Definitely have encountered several issues
        + Relied on a PCB manufacturer. That is a limitation. At higher frequency the dimension of patterns become smaller. For smaller PCBs, the commercial fabrication becomes unreliable, since the dimension tolerance is too big.
        + Transitioned to clean room nanotechnology fabrication as used for semiconductors.
        + The PCB is a mature technology, while for nanotechnology fabrication the material is not space qualified.
        + The other problem is that MW instrument channels can be multi-band. Integrating multi-band channel warm load onto one piece requires putting different patterns onto one substrate – i.e., spin coating the dielectrics onto one carrier wafer. So far only single layer coating has been talked about. Idea is to extend to more than one layer.
        + One positive is that the thermal property is easy to deal with because it is a simple planer surface. Temp homogeneity will be very well controlled.
    - Tiger – Will NIST provide a calibration standard for microwave for new or traditional technology?
      * Dazhen
        + Want to explore this for a traditional calibrator.
        + Emissivity of conical warm load is as good as 0.999 corresponding to 30 dB down up to 220 GHz.
        + One the thermal characteristics are improved, hope to finish this blackbody and hand over to commercial partners, so they can use it for testing. NIST resources are too limited to build, store, deploy and maintain the standard blackbody for those that need it.
    - Siena - Can you provide some insight about holding a workshop
      * Flavio’s vision of the workshop – Assume that there will be representatives for certain topics. It will showcase new technologies, as well as how are we going to take advantage of these new technologies.
      * Dazhen - Many points of contacts that may support the workshop will attend IGARSS.
      * ACTION(Dazhen): Will send out an email to possible points of contact that may contribute to the workshop. Also, will have a small group discussion at IGARSS and EUMETSAT meetings to get this started. Will also draft an email that can be sent to the whole MW Subgroup alerting people of these small group discussions at the upcoming IGARSS and EUMETSAT meetings.
      * ACTION(Siena): Send out Dazhen’s email alerting people of these small group discussions at the upcoming IGARSS and EUMETSAT meetings.
    - Shengli – Do you already have ISO paper’s regarding the blackbody standard?
      * Dazhen - Don’t have an ISO document on that. We have information about material we used. The blackbody is not considered a “standard” yet due to poor thermal performance. Hopefully, the next run will be better.
    - Tiger – Wasn’t there a previous proposed standard for microwave?
      * Dazhen - A former team member designed a blackbody. He organized IEEE standards group. It did not pan out due to various reasons. This effort is in limbo.
    - Tim – Can this group consider defining requirements for striping due to 1/f noise? (or gain stability, Allan Deviation, shape of the noise power spectral distribution, …)
      * Dazhen expressed that it was an excellent idea.
      * Tiger
        + Worked on this for QuickSounder.
        + Developed a method to evaluate 1/f noise that provided a number, a percentage of the 1/f noise, to help evaluate the impact to the instrument noise performance.
        + There is a 2022 document about this.
        + ACTION(Tiger): Share with Siena the link to the 2022 document regarding evaluation of 1/f noise that provided a number, a percentage of the 1/f noise, to help evaluate the impact to the instrument noise performance.
        + ACTION(Siena): Distribute the link to the GSICS Microwave Subgroup.
      * Shengli – Tiger, can your method be used in TVAC?
        + Tiger – sometimes it is different. It should be different, because their behaviors and environments are different.
      * Juyang
        + Responsible for characterizing and mitigating MWTS noise, and has read the paper on the new method. Plan is to try to implement the method, and show results to the group. It could be as early as next meeting.
      * Flavio recommends that the group needs to identify approaches to identify and mitigate striping artifacts. Determine what methods are used, and what’s next. Need to highlight approaches that GSICS recommends regarding these striping artifacts.
    - Juyang - Regarding the focus group plans. In the near term, will have a conversation soon about a meeting with group numbers. Also, plans to share slides.
* MW Radiometer Vicarious Calibration Focus Group (Shengli Wu – Did not include a presentation)
  + Have not started focus group activities yet.
  + *Question and Answer*
    - Flavio – Is there any clear thought about difference of vicarious calibration versus other groups?
      * Tim
        + In the past, quasi-invariant scenes – e.g., Amazon and Libyan Desert - helped to reduce the complexity in simulating the radiative transfer needed to predict and compare to satellite measurements.
        + With the availability of NWP and GNSS RO soundings, comparisons of simulated MW instrument measurements with observations can be made over the globe relatively easily. So, the difference between “Vicarious Calibration” and other satellite inter-comparison methods in not so clear, and its main role is to increase skill by reducing uncertainties of the radiative transfer – e.g., eliminating regions with highly variable surface emissivity in space and time.
      * Karsten – Proposed that maybe this “Vicarious Calibration” Focus Group can be absorbed into other groups. Perhaps the other methods can be applied to dedicated sites that can be evaluated over a long time.
      * Tiger – We just want to make sure that this method is not completely dismissed. Each method has different strengths and weakness: SNO, O-B, Vicarious and NWP Double Difference. Can use different method to see if the bias features are the same. This provides confidence.
    - SUBGROUP DECISION(Flavio and Shengli): The activities of the “Vicarious Calibration Focus Group” will be absorbed into other subgroups, where appropriate, since its overlap with these other methods a significant.
* Radiative Transfer Model (RTM) Facilitated MW Radiometer Inter-calibration Focus Group (Ninghai Sun – Not present)
  + Have not started focus group activities yet.
  + ACTION(Siena): Will send an email to Ninghai requesting a Focus Group status report.
  + *Question and Answer*
    - Shengli – CMA has an SNO and O-B system to track and trend MW instrument performance.
    - Karsten??
      * In the process creating a system to inter-compare O-B results using three sounding sources (ECMWF, GFS and GNSS RO) and two different RTMs (CRTM and RTTOV).
      * Tiger - Is Zeeman correction in RTTOV. Yes. Version 13.2 has it. Version 14 will be even better in August Sept. It is updated.
    - Juyang – What is the advantage of using GNSS RO soundings instead of just NWP soundings for computing O-B brightness temperature biases.
    - Siena
      * GNSS RO data soundings are completely independent to the satellite MW radiometer data, and have notable skill between 8 km to 30 km.
      * GNSS RO refractivity measurements are traceable to an SI traceable parameter – Time.
      * ACTION(Siena): Send Juyang the link to the COSMIC Data Analysis and Archive Center, and also links to papers about using them to compute O-B antenna temperature biases.
* MW Radiometer Lunar Calibration Focus Group (Tiger Yang – Included a presentation)
  + - There will be three main activities of the group:
      * MW Lunar RTM model development,
      * Lunar radiance measurements based on satellite observations,
      * Lunar observations applications.
    - Progress goals include working with CMA on FY3C MWTS/MWHS Lunar sample retrieval, and working on validation of the Lunar model using ATMS Lunar observations.
      * Need to have satellite observations to validate models. Most lunar observations used to validate the models are from ATMS and AMSU/MHS. Can we use FY3 and TROPICS?
      * Compare the Fudan (Nutao), TPM (Thomas Mueller) and Calibrated Lunar RTMs (Tiger)
    - *Question and Answer*
      * Martin – Can we have Niutao participate in the group? He wanted data from MHS. His model agrees quite well with MSH lunar observations?
        + Tiger – Yes, Niutao can participate, but hopefully he can submit the details of his model so we compare it with the others.
      * Martin - Thomas visited Hamburg University, and worked with the MW data. He compared the TPM and Calibrated Lunar models and found discrepancies around full moon.
        + Thomas

Looks like Tiger’s model lags in phase of maximum Tb.

Thomas accounts for distance between the sun and moon.

Major difference between the model is the Moon phase angle shift of the peak.

Tiger accounts for the lag of thermal response of the moon. Tangent loss of lunar regolith is considered with his model using a tangent loss model. Tiger found that validations are agreeing quite well with his model.

Thomas’ model is based on the real data only. Martin says he not sure which model is correct.

ACTION(Tiger): Tiger will provide the doc about how the Tangent loss model is implemented.

Need data at zero phase angle to understand what is going on here.

Tiger’s recommended path-forward to resolve the discrepanices.

Compare models

Compare with the satellite observations

This can be used to explain the differences

We can try to find the root cause

* + - * Martin - N19 has drifted so much that is had produced observations of almost all phases of the moon! Quite useful.
* MW Radiometer Applications Focus Group (10 Members led by Chengzhi Zou)
  + Have not started focus group activities yet.
  + ACTION(Siena): Will send an email to Cheng-Zhi requesting a Focus Group status report.

**2. [30 mins] Other Business (Shengli Wu – CMA and Flavio Iturbide-Sanchez - NOAA)**

* Next meeting – August/September time frame. Shengli recommends an August meeting.
* ACTION(Siena): Set up a Doodle Poll for the next general meeting.
* ACTION(Siena): Add the Focus Group points of contact information on the MW Subgroup page of the GSICS Wiki.
* ACTION(Tim): Create a [page](http://gsics.atmos.umd.edu/bin/view/Development/20240522) for this meeting on the GSICS Wiki: closed
* Flavio supports the idea of GSICS MW Subgroup members meeting face-to-face at IGARSS/EUMETSAT meetings, so we can talk in person.