Minutes of the 2023 Annual GSICS Joint Working Groups Meeting

27 Feb – 3 March 2023, College Park, MD



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| Plenary Mini Conference 2023 | |
| **Chair** | Fangfang Yu |
| **Minute Taker** | Tim Hewison |
| **Attendance** |  |
| **Remote Attendance** |  |

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| **Agenda Item: 1a - Opening Remarks** | |
| **Presenter** | Mitch Goldberg (NOAA) |
| **Overview** | Mitch provided an introduction to GSICS, its products and services, including the GSICS State of the Observing System Report. He gave some examples and encouraged participants to align a simple common reporting format. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |

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| **Agenda Item: 1b - NOAA Welcome** | |
| **Presenter** | **Doug Howard** |
| **Overview** | Doug welcomed participants and stressed the importance of inter-calibration, which is now being taught to students at UMD. He reviewed several application areas of inter-calibration and emphasised the importance of data sharing. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |

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| **Agenda Item: 1c Intro. to Mini Conference** | |
| **Presenter** | **Fangfang Yu** |
| **Overview** | Fangfang provided a surprisingly good introduction to GSICS by ChatGPT AI system, but went on to provide a very human overview of the range of GSICS activities. She introduced the mini conference. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Jon Mittaz encouraged GSICS to define the terminology used – e.g. traceability, harmonisation,  Mitch confirmed that the QA4EO definitions had been adopted so far. Fangfang and Fred added that the GSICS definition of traceability was taken from NIST, while harmonization was developed at EUMETSAT and is still under discussion. | |

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| **Agenda Item: 1d - Logistics information** | |
| **Presenter** | **Larry Flynn** |
| **Overview** | Larry already covered. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Confirmed that minutes are being taken in this document, and that minute takers would be nominated for each session. | |

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| **Agenda Item: 1e - Monitoring of FY-3E Instruments' performances using RTM and NWP data** | |
| **Presenter** | **Fangli Dou** |
| **Overview** | Fangli provided an overview of the performance of various Chinese LEO instruments, using NWP-based Obs-Background (O-B) method and SNO – in particular, MWHS, MWTS, NSCAT-4, HIRAS, GNOS, … - as well as selected instruments from other agencies as references – e.g. ATMS.  CMA now use various NWP models as input data, including the new Chinese Re-Analysis (CRA), in different combinations with a range of RTM models. CRA gives comparable results to ERA, and is more convenient for use in China. There is a general trend towards reduced biases for the later instrument models in each series (FY-3C, 3D, 3E, …) - reflecting the incremental improvements.  Fangli showed that bias correction schemes can be developed from O-B results to understand the instruments’ calibration and apply empirical corrections to allow the data to be assimilated into NWP. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 1f - Feedback MODIS to VIIRS L2 Products Continuity** | |
| **Presenter** | **Robert Levy** |
| **Overview** | Found long-term trends in Aerosol over land between Terra and Aqua in Collection 5. Interactions with calibration teams and detrending based on analysis of desert site observations, which resulted in Collection 6, which produces much more consistent cloud product trends. Dark scenes products also require accounting for SRF differences.  Rob went on to compare L2 products (AOD) from MODIS and VIIRS – some of the systematic differences could be explained by sampling and filtering differences.  U. Wisc “Matchfiles” uses ray-matching over homogeneous targets, with LUTs to account for SRF differences. This gave mostly consistent results over dark ocean and bright clouds. When calibration adjustments were applied based on this approach, some improvements were found in L2 products (but not all).  Now looking to combine L2 products from LEO and GEO satellites.  GOES18 v GOES17 – during period with close separation (0.3 degree longitude). GEO-GEO of L1 was mostly within 1%, but resulted in proportionately larger differences in AOD. Robert was able to develop simple L1 harmonisation, which improves L2 consistency. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Changyong: Calibration issues with SNPP/VIIRS resulted in the recommendation to use N20/VIIRS as the reference instrument for GSICS.  Robert has not looked at diurnal variations in the GEO-GEO differences, but could do so.  Fred Wu encouraged Rob to evaluate NOAA-generated GSICS harmonization products for GOES16 | |

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| **Agenda Item:– 1g - QA4EO: Applying metrological principles** | |
| **Presenter** | **Emma Woolliams** |
| **Overview** | Emma reviewed the QA4EO, noting some compromises in the original aims stated in 2010.  Following several projects, NPL has produced guidelines for uncertainty analysis to support QA4EO – see [www.qa4eo.org](http://www.qa4eo.org). Emma reviewed the steps in establishing traceability – the first is to define the measurand, then establish an uncertainty tree. This requires a consideration of all the correlations in the observations (spectral, temporal, …), which require a full understanding of the instrument and its data processing. The uncertainties are then propagated to a combined uncertainty, according to the GUM.  NPL have developed an open-source toolkit “CoMet” to assist in this propagation. (www.comet-toolkit.org)  NPL recognises this can be overwhelming to apply at first – the QA4EO website has step-by-step guides and training. Recently, ESA has requested development of “metrology readiness levels” to support people working towards this. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| CEOS have a task group reviewing terminology used in different projects, and welcome other participants. Inconsistencies have already been identified. Offline Discussion: considerations when averaging offset and gain components on different timescales?   * Possible using structured uncertainty concept – may require two different time-scales, but could be possible to combine, after reviewing relative uncertainty components. However, in many cases, e.g. when developing a long-term trend based on time series analysis, the natural variability of the Earth system is such that these differences are negligible. | |

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| **Agenda Item: Developing QA4EO: Comparisons as a system and steps towards metrological approaches** | |
| **Presenter** | **Emma Woolliams** |
| **Overview** | Emma is establishing a group to consider various aspects of comparisons and seeking further participation from GSICS members. If you’re interested in participating in such a group, then fill in this: <https://forms.office.com/e/vDt5JchCWR>  The metrology community is based on mutual Recognition relies on comparison to a “key comparison reference value” - a consensus of the global ensemble of observations, rather than a single reference. EO is more complex, and need to include conversion factors in the comparisons, but could be considered a system of systems. Could also consider defining a virtual sensor as a reference (e.g. with Top Hat SRF, and average gain).  The first question is to consider the aims of the comparison. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| ChengZhi – different treatment of uncertainties in establishing FCDR and NRT products?   * Good time to review the different approaches – and check that “noise” does indeed cancel out in the long-term – and even it does cancel out, this does not break traceability   Different comparison – could include different NWP, RTM, … - specially to account for differences between observing systems.   * Yes – important to account for uncertainty in all auxilliary data sources   Any specific comments on how GSICS GEO-LEO IR?   * Need to know more specific details   Recommendations for GSICS? E.g. movement from use of single reference instruments to consensus blend of reference instruments? May be different approach needed for different spectral bands, depending on the availability of reference instruments.   * Unless one reference Is clearly superior, it may be better scientifically and politically to define a consensus reference. To generate a synthetic hybrid reference instrument requires the propagation of all the uncertainties associated with converting and combining the reference instruments. | |

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| **Agenda Item: 1i** | Planning Contuinty for Critical Earth Observations |
| **Presenter** | **Betsy Weatherhead** |
| **Overview** | Betsy reviewed plans for Continuity of observations to support science and climate services, noting there is no systematic approach to evaluate which climate parameters need continuous monitoring.  KISS review focused on needs for energy, carbon and water.  Betsy considered how this review could be extended further and internationally towards defining the architecture for future climate observing networks |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Jumps in Total Ozone column amount – should be clear from uncertainty analysis   * Sometimes the jumps are less than the stated uncertainty, but still systematically consistent   Q: What role for education as part of this process? (Users don’t always know best)   * Benefit of bringing everyone together to decide the architecture   Q: Relationship to GCOS? And European Commission   * Involved Chair of GCOS, and with Joerg Schulz (EUMETSAT) but so far from US perspective. | |

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| **Agenda Item: 1j - OCO-2/3: Unique Challenges of Trace Gas Spectrometers** | |
| **Presenter** | **Rob Rosenberg** |
| **Overview** | Rob reviewed the basic principles of the OCO-2/3 instruments, which are grating spectrometers covering 3 spectral bands in the O2A, week CO2 and strong CO2 bands (although the instruments are not identical). He reviewed the issues faced in processing and calibrating the data from OCO, focusing on radiometric degradation in space, since characterization pre-launch against NIST standards. CO2 bands on OCO-2 are stable within ~2% over mission life, but O2 band shows stronger and faster degradation between decontaminations. OCO-3 calibration behaves quite differently – partly due to the increased frequency of the solar diffusor acquisitions. Vicarious calibration validate absolute calibration. Instrument Line Shape is confirmed by spectral calibration using laser sources. Lunar acquisitions are used to characterize spatial response.  Previous comparisons with MODIS is complicated by channel mismatches. Need to revise with VIIRS bands.  OCO-2/3 SNOs – near glint-spot. Modes are consistent for O2 and strong CO2 band, weak CO2 consistent with vicarious calibration. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q>: other inter-comparisons planned? E.g. GSICS?  Q: Are Uncertainties provided with covariances?   * Yes for short noise, but does not cover other effects   Seb Wagner encouraged the OCO team to attend the lunar calibration workshop | |

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| **Agenda Item: 1k - The CO2M mission - overview and status of Cal/Val planning** | |
| **Presenter** | Ruediger Lang |
| **Overview** | Ruediger introduced the CO2 mission, its 3 instruments and objectives, noting that it is timely to develop detailed inter-calibration algorithms, which are required as part of the Cal/Val Plan. These use comparisons with Microcarb and Sentinel-4/5.  The CO2I/NO2I spectrometer has 4 spectral bands in VIS, NIR and SWIR – would be covered by UVNS Sub-Group  Multi-Angle Polarimeter (MAP) - covers 40 views from 4 telescopes in 7 spectral channels from 410-865nm  Cloud Imager (CLIM) / simple 3-channel in VIS, NIR + SWIR with very high spatial resolution. MAP and CLIM would be covered in VIS/NIR Sub-group  Aim is to combine the data from 3 instruments to make one hyper-GHG/NO2 instrument – at the spectrometer grid. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Discussion on requirements. | |

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| **Agenda Item: 1l – NOAA-21 cal/val overview** | |
| **Presenter** | **Changyong Cao** |
| **Overview** | First ATMS data within 1 week of launch, reduced noise correlation between channels, and much reduced striping  VIIRS VIS/NIR from 5 Dec 2022 – with reduced polarization sensitivity; TEB only after switching to Slide B electronics, following anomaly – all channels now working well; DNB from 9 Feb 2023 – with improved straylight correction and nonlinearity – will improve SD characterization with pitch & roll maneuvers – aim for validated maturity in Summer 2023. Validation  CrIS - first light images from 12 Feb 2023, now working well – comparable to J1  OMPS – very sensitive to contamination – from 17 Feb 2023- improved spatial resolution cf N20/SNPP - now with limb profiler  Metop SG/MWS and ATMS – planned comparison workshop |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How is VIS/NIR calibration of N21 compared to N20/SNPP? Important now CLARREO-Pathfinder launch until 2025(?)   * Seems closer to N20 so far, but only preliminary results. | |

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| **Agenda Item: 1m – ESA Cal/Val Strategy for Optical Land-Imaging Satellites: Overall Approach and Pathway towards Interoperability** | |
| **Presenter** | **Paolo Castracane** |
| **Overview** | Paolo explained ESA’s vision to work towards interoperability of its current and future fleet of optical land imagers: Sentinel-2, -3, Proba-V, Flex, CHIME – based on QA4EO principles (traceability, and uncertainty estimation). To address gap in capability to provide full traceability to SI on-orbit, ESA proposes use of SITSats, GSICS, RadCalNet for L1 and Fiducial Reference Measurements (FRMs) - particularly for L2 product validation. L2 BOA product validation is currently less mature – priorities are to establish best practices, operational ground-site and establishing uncertainties. Paolo reviewed initiatives to address these priorities, including the establishment of ground-based hyperspectral radiometers, HYPERNETS; and the establishment of a community-agreed RTM for Cal/Val - Eradiate; the GBOV to harmonize protocols and formats for ground networks.  See also Remote Sensing paper – add reference |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 1n - The error budget for satellite radiance assimilation** | |
| **Presenter** | Andrew Collard |
| **Overview** | Andrew introduced the conceptual data assimilation of observations into NWP, highlighting the roll of the forward model operator, the observation error covariance matrix and bias corrections.  Noise budget: Andrew showed how most of the correlated error covariance matrix is dominated by representativeness errors – although apodisation also introduces some correlation.  Bias Correction is now also based on a variational method, to tune the coefficients of different predictor variables. But , some observations, such as radiosondes or GNSSRO are not bias corrected to ensure the model is anchored to reality.  It is essential to have good monitoring of observations, to ensure any erroneous observations can flagged and investigated. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How to account for representativity errors in use of radiosondes as an anchor?   * This tends to be a catch-all term, including many model biases – inter-channel correlations are critical here for radiosondes.   Q: Use of instrumental parameters as predictors in bias correction model?   * Yes – has been done at NCEP to perform antenna correction   Q: Use of bias correction from GSICS – does it help linearize the bias correction, or allow more information to be used from observations?   * Scope to explore – but NWP will always need bias correction | |

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| **Agenda Item: 1o - CRTM science updates and accuracy improvements for satellite-based sensor simulation** | |
| **Presenter** | Mark Liu on behalf of Ben Johnson |
| **Overview** | Mark reviewed the developments of different components of the Community Radiative Transfer Model (CRTM), including aerosol, surface emissivity and recent improvements in v3.0. He reviewed the outstanding challenges for further development, including accurately accounting for SRFs and apodization to address the increasingly stringent demands for NWP. He also explored issues related to the application of AI to fast RTM development, which is now progressing in the modelling the Jacobians, which were previously deficient due to the lack of model physics. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Can CRTM be used to simulate limb profiles?   * Not in its current form, but could be added in future   Q: CrIS unappodised application to OSS model?   * Working on an option to allow negative radiances – alternatively, could perform calculation as for IASI and apply a transformation to unapodised   Q: Relative merits of CRTM and RTTOV?   * Both channel/band-based models – similar issues with scattering | |

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| **Agenda Item: 1p – Image Navigation and Registration Assessment for ABI at NOAA STAR** | |
| **Presenter** | Vladimir Kondratovich |
| **Overview** | Vladimir reviewed INR tools used for ABI, including landmarks and stars. These are used for only to validate absolute geolocation in E-W and N-S components, but also relative channel-to-channel error estimates and swath-to-swath registration (specific to ABI). Production pipeline also generates warning flags. CENRAIS is available on the web: e.g. <https://www.star.nesdis.noaa.gov/GOESCal/G18_ABI_INR_NAV.php>  Long-term trending has helped identify issues with radiometric calibration. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What parameters would be adjusted on-orbit to correct geolocation errors?   * Monitoring 5 parameters – followed-up offline | |

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| **Agenda Item: 1q - Merging satellite data to create long-term records** | |
| **Presenter** | **Betsy Weatherhead** |
| **Overview** | Betsy started by challenging traditional wisdom on guidance to dealing with overlapping data record. See Weatherhead et al 2017 – for details of overlap accounting for autocorrelation, drifts and noise. She reviewed recent and ongoing work in this field, with examples from overlap of spectral solar irradiance data from TSIS-SORCE. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What about (nonlinear) drifts beyond the overlap period? & Distinction between harmonization and homogenisation? (Don’t necessarily expect trends to be the same). Jon Mittaz experience with tuning SRF for MSU shows folded in sensititivity to different non-linearity.   * Agreed – examination of overlaps can contain multiple issues. Betsy agrees this is not a solved problem | |

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| **Agenda Item: 1r – MICMICS: an advanced infrastructure dedicated to the radiometric monitoring of EUMETSAT-operated missions** | |
| **Presenter** | **Mounir Lekouara** |
| **Overview** | Mounir started with an overview of operational calibration and inter-calibration systems running at EUMETSAT – focusing on Meteosat/SEVIRI. He explained the motivations for developing an integrated system, MICMICS, which will eventually generate GSICS products for SEVIRI, FCI and other optical imagers once operational. He provided an overview of the prototype system, which is already generating results for SEVIRI, AVHRR, OLCI and SLSTR. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What was the greatest challenge in integrating diverse software? What is the ramp-up for integrating new modules?   * We started afresh, based on coding standards, rather than trying to integrate old code.   Q: Plan to make intermediate products publicly accessible? (Jon Mittaz)   * Not intended for public consumption, but welcome interested partners for specific projects.   Q: What about the microwave instruments?   * Potential to apply to microwave imagers, but also sounders, and hyperspectral. Currently under assessment. MICMICS provides a framework for collocation and job order management   Q: Plans for Rayleigh Calibration and inter-calibration?   * Calibration is based on RTM. Inter-calibrate uses this to transfer calibration from a reference. Similar to Ray-matching Inter-Calibration System. Planned development for future. | |

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| **Agenda Item: 1s – Feedback from ISCCP-NG** | |
| **Presenter** | **Andrew Heidinger** |
| **Overview** | ISCCP/L1G Demo data has been released on UW/CIMSS FTP for December 2018 – to allow comparison with ISCCP-Classic – and sample data for 2020.  NOAA, CMSAF and ESA-CCI are generating L2 products from this, including particle size (from NIR channels), day/night consistent cloud pressure products, which improves consistency with GCOS requirements.  ISCCP-NG embeds GSICS coefficients into products – but users need to convert between BT and radiance (and back) to apply  Feedback from users: data access interface difficult; want more products for other VIS/NIR channels – e.g. SEVIRI.  Martin Stengel developed Spectral Band Adjustment Factors using IASI and SCIAMACHY – needed by users – e.g. to train neural networks  ISCCP-NG requests:   * Work with other external users * Group RAC in one file per sensor * NOAA/NASA reprocessing of GOES-R L1b – application of existing GSICS products * Integration of GSICS Coefficients into data * Satpy / pytroll integration * SBAF |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: SBAF using NASA tool?   * Martin has performed some limited comparisons * Dave Doelling notes the SBAF results are application specific – is there a general solution?   C: NOAA are encouraged to work together on the application for ABI  C: Not aware of other users trying to do GEO-ring  Q: Are ISCCP-NG doing further adjustments based on overlapping grid-box?   * No – but have the data - so could do   Q: How to get uncertainty from machine learning L2 retrievals?   * Would need to check with experts who are doing this – e.g. DWD   A.GWG.20230227.1: Andy Heidinger (NOAA) to analyse GEO-GEO overlaps in ISCCP-NG L1G products and present at web meeting, including ESA CCI and EUMETSAT LandSAF to consider potential application to diurnal cycle in land-surface temperature  A.GWG.20230227.2: Manik Bali (NOAA) to consider the development of tool to interface GSICS Correction coefficients from GSICS Server with Satpy as external calibration coefficients. | |

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| Plenary GRWG+GDWG Agency Reports Session | |
| **Chair** | Fangfang Yu |
| **Minute Taker** |  |
| **Attendance** |  |
| **Remote Attendance** |  |

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| **Agenda Item: 2b CMA Agency Report** | |
| **Presenter** | Chengli Qi |
| **Overview** | CMA have continued to expand their portfolio of satellite instruments, and rolled out numerous improvements to the processing of existing ones.  She also reviewed import contributions to GRWG activities on GEO-LEO IR and DCC inter-calibration algorithms, particularly as applied to FY-4B/AGRI, also including analysis of stable targets. Other improvements include FY-4B/GIIRS spectral calibration, correction for out-of-band response in MWTS-III, Ch7-8.  See recorded presentation for full details |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Access to missing FY-4B/GIIRS data due to being restricted by quality issues – even if only 1 of 128 spectra are missing?   * Email Chengli for support | |

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| **Agenda Item: 2c CNES Agency Report** | |
| **Presenter** | Elsa Jacquette |
| **Overview** | IASI-A was switched off on 28 Nov 2021, but IASI-B and –C continue to perform very well, and CNES continue to monitor them in comparison with CrIS.  CNES studies on hyperspectral lunar observations, and uncertainty budget for IRRefUTable report.  IASI-NG test campaign for PFM completed, and now integrated onto satellite. TVAC testing planned for 2023Q2. IASITEC started development of Cal/Val tools, incl tools to inter-calibrate with IASI and CrIS.  C2OMODO – French contribution to AOS based on SAPHIR-NG microwave sounders.  TIRCalNet – land sites to characterise TIR sensors – coordinated by WGCV., to provide surface temperature and emissivity – CNES proposing to incorporate La Crau. Also PICSAR characterize PICS BRDF for VIS/NIR |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Availability of data from Moon observations?   * From EUMETSAT archive as routine external calibrations, but access may be restricted. Will be released once CNES study finished by end 2023   Sebastien Wagner encouraged CNES to join lunar calibration workshop  Q: Will MicroCarb be part of GSICS in 2024?   * Elsa will check with Microcarb team | |

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| **Agenda Item: 2d JAXA Agency Report** | |
| **Presenter** | Hiroshi Murakami |
| **Overview** | JAXA have applied GIRO to update gain degradation for SGLI and CAI-2, and regularly compare SGLI to AHI via SST retrievals and buoy comparisons, which resulted in the reduction of the (small) bias.  Hiroshi-san reviewed current and future instruments.  JAXA have also applied vicarious calibration to GSLI polimetry |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 2e ISRO Agency Report** | |
| **Presenter** | Pradeep Thapliyal |
| **Overview** | ISRO launched [Oceansat-3](https://space.oscar.wmo.int/satellites/view/oceansat_3_eos_06) on 26 Nov 2022, and Microsat-2.  ISRO continue to perform routine monitoring of INSAT-3D/3DR IR channels using IASI, and this is now being processed at IMD. ISRO also updated GSICS plotting tool to use NRTC results (as well as RAC). Yaw-flips generate calibration changes, which are being addressed by reprocessing.  ISRO are continuing to work on GEO-LEO VIS ray-matching method, and have started analysis of GEO-GEO. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How are GSICS products now being generated for INSAT?   * Using ISRO-developed software running on servers at IMD | |

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| **Agenda Item: 2f WMO Agency Report** | |
| **Presenter** | Heikki Pohjola |
| **Overview** | New head of WMO Space Programme: Natalia Donoho  Jesse Andries also joins WMO for Space Weather and Radio Frequencies  WMO renewed the Unified Data Policy, which now includes the concept of core satellite data, which is defined in WIGOS.  OSCAR/Space workshop took place 7-8 Feb 2023 – included GSICS with use case to identify reference channels and instruments, which is supported by a JSON API – to be further developed.  Please check agency focal points are up-to-date at gsics.wmo.int! |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 2g IMD Agency Report** | |
| **Presenter** | A.K.Mitra |
| **Overview** | IMD are implementing GSICS Correction for INSAT/3D/DR in MMDRPS, and perform regular comparisons with SEVIRI, which show clear, but small diurnal variations.  IMD use EUMETCAST to support their severe weather warnings system.  IMD also plan to reprocess older Kalpana GEO satellite data. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 2h JMA Agency Report** | |
| **Presenter** | Arata Okuyama |
| **Overview** | JMA have focused on the analysis of Himawari-9/AHI, which took over from Himawari- on 13 Dec 2022 and include updates of ray-matching and DCC and vicarious calibration approaches. New web pages now allow the display of their results, and navigation monitoring. IR inter-calibration with IASI and CrIS continues, and has been checked with GEO-GEO approach.  Although Himawari-9 continues lunar acquisitions, no further analysis has been performed.  Arata reviewed the calibration accuracy of AHI VNIR channels based on ray-matching and vicarious methods, confirming most results range from –5% to +2% - although Band 06 has a larger bias. Similarly, the GEO-LEO IR results confirm all channels are within 0.3K bias at clear sky conditions. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Direct comparisons of Himawari-8 and –9?   * Will be reported in IR section   Q: Is there an explanation for the different results with VIIRS on SNPP and N20?   * Will be covered in VIS/NIR session | |

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| **Agenda Item: 2j EUMETSAT Agency Report** | |
| **Presenter** | Mounir Lekouara |
| **Overview** | Mounir reviewed EUMETSAT contributions to GRWG activities, including the further development of the GEO-LEO IR algorithm, and analysis of its impact on L1 and L2 products. EUMETSAT have also re-engineered the desert calibration, and are supporting the revision of the GSICS Plotting Tool.  End of Life tests Metop-A/GOME2 and Meteosat-8/SEVIRI - analysis of the latter is ongoing.  Several new FCDRs have been released by EUMETSAT, including some recalibrated based on GSICS algorithms.  The first of the next generation Meteosat, MTG-I1 was launched on 13.12.2022. Commissioning of the FCI and Lightning Imager is ongoing, and will include various GSICS methods.  Mounir also reviewed the numerous forthcoming EUMETSAT missions, and their involvement in GSICS, and the staff supporting these. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 2k ESA Agency Report** | |
| **Presenter** | Philippe Goryl |
| **Overview** | ESA supported the GDWG development of notebooks to read and visualise GSICS products from the servers.  Philippe reviewed ESA’s contributions to GRWG activities, and the outcome of the ministerial conference, which confirmed an increased budget for Earth Observations, including Copernicus, Climate Space and TRUTHS.  Forthcoming launches relevant to GSICS: EarthCARE (2024), Biomass (2024), Flex (2025), FORUM (2026), 3rd units for Sentinel-1, -2 and –3., CIMR, …  Sentinel-2 Collection-1 will be generated by reprocessing full S2 archive, including inter-calibration of S2A-B over PICS to correct small bias (1.1%) in bands 01-09.  Philippe also reviewed Fundamental Data Records generated by ESA, including GOME/SCHIAMACHY, AVHRR, and other |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Is TRUTHS launch still planned for 2027?   * Check the presentation later! | |

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| **Agenda Item: 2L KMA Agency Report** | |
| **Presenter** | Jiyoung Kim |
| **Overview** | KMA now generate GSICS products for the VIS/NIR channels of GK2A AMI as well as the IR channels. KMA have applied the gap-filling method to allow use of CrIS as a reference, and continue to develop GEO/GEO direct comparison with long/term analysis of AMI-AHI.  KMA is developing a plotting tool environment, and setting up a GitHub project for GDWG.  Jiyoung reviewed the KMA Cal/Val portal, which now includes instrument status, radiometric and INR validation, as well as GSICS performance.  Lunar calibration results show seasonal variations |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Are Demo products for GK2A still being sent to EUMETSAT server?   * Will be covered in IR session   Q: would be interested in more details of lunar calibration results?  Q: did gap-filling method improve GEO-LEO IR results?   * Yes | |

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| **Agenda Item: 2m NASA Agency Report** | |
| **Presenter** | Jack Xiong |
| **Overview** | NASA contributions to GSICS include improvement in pre-launch and on-orbit calibration, lunar calibration and enhancements to test equipment.  LASICS – Langley Automated Sensor Inter-calibration System – open access tools for imager collocation and inter-calibration  NASA missions relevant to GSICS: Terra, Aqua, S-NPP, Landsat-7/8/9, N20, GOES-T, -U, EMIT, JPSS-2, SWOT, TEMPO, TROPICS, PREFIRE, CPF (delayed from 2023), …  Increased importance of smallsats.  New data releases planned for 2023: MODIS C7 L1B, AIRS V8 L1B/C, OCO-2 B11 reprocessing  Ed Kim provided a further update on microwave activities:   * Supporting the development of the NOAA next generation backbone microwave sounder – notional plans include all ATMS channels, plus 118, 229GHz, RFI detection and hyperspectral capabilities. * See NOAA workshop on MW sounders * Phase A studies RFP released 23 Feb 2023 * First SMBA launch – early 2030s – 10year overlap with ATMS * One final ATMS is planned to be launched in 1730 orbit |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Changyong: RFI mitigation similar to SMAP?   * Expect different type of RFI at sounder frequencies – so will include different approaches * Most likely to be detection and flagging, not mitigation, given the stringent calibration requirements for sounding   Q: Possible promotion of LASICS through GDWG?   * Planned as part of CLARREO-Pathfinder - Will be discussed on Thursday | |

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| **Agenda Item: 2n NIST Agency Report** | |
| **Presenter** | Stephen Maxwell |
| **Overview** | Reviewed recent developments of interest to GSICS:  MarONet-1 buoy – follow-on from MOBY in support of PACE  Microwave Reference BB  Libera (ERB) mission  Compact Total Irradiance Monitor – cubesat demonstrator  Mauna Loa Observatory MLO-LUSI started taking data in Nov 2022 – disrupted by power, instrument, and access issues following first eruption in 35 years! |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: altitude of MLO?   * 3400m amsl | |

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| **Agenda Item: 2o NOAA Agency Report** | |
| **Presenter** | Fred Wu |
| **Overview** | Fred reviewed NOAA’s contributions in 2022:  Promoted GSICS as a stakeholder in BIPM workshop on Metrology for Climate Action  Lunar Calibration: Used GIRO for ABI and VIIRS – and started evaluation of SLIMED  Used TSIS-1 HRSR as spectral solar irradiance for ABI  Developing Global Regional Validation Site (GReVS) for VIRRS  Commissiong GOES-18 ABI  Siena Iacovazzi expected to take over as co-chair of MWSG  Other innovations of interest to GSICS:   * AI-based RTM development, …   NOAA-21 launched 11/10/2022, GOES-18 launched 3/1/2022, GOES-U scheduled to launch April 2024. GOES017 drifted to storage at 105W  Fred included a review of NOAA State of Observing System report for ABI, highlighting the 0.1-0.2K difference between NPP/CrIS and N20/CrIS |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 2s USGS Agency Report** | |
| **Presenter** | Tom Stone |
| **Overview** | Tom provided an update on the Landsat-8 and –9 OLI-2 performance: VIS&NIR bands are stable to within 0.5% since launch in Sept 2021 (similar to Landsat-8 early performance, although short-wave channels have degraded since), SWIR bands more variable and include annual oscillations for Landsat-8.  Landsat Next – will be constellation of 3 satellites from same launch, but with different equator crossing times, and include higher resolution, and new bands. Currently phase A.  Lunar Calibration Working Group at EROS – aims to redevelop ROLO, including new high accuracy lunar observations, and refine processing of OLI lunar observations. Lunar Calibration expertise will be transferred to EROS  JACIE evaluates land surface imagers. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Not possible | |

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| **Agenda Item: 2o Proposed revision of GSICS Product Class to include VNIR channels and new GEO-LEO IR algorithms** | |
| **Presenter** | Tim Hewison |
| **Overview** | Tim proposed a proposal for revisions of GSICS products addressing the evolving needs:   1. Combining the IR and VIS-NIR in a single product, include validity date/time/dynamic range 2. Appending additional metadata 3. Accommodating several algorithm improvements |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: what are the benefits of combining IR and VIS-NIR into one product?   * To make it easier for users   Discussion: we should provide tools to access the GSICS corrections and guidance on the best set of coefficients/reference sensor. An alert system on changes or degradation of the reference sensors could be considered.  The different levels of maturity between IR and VNIR would need to be addressed before combining them. Also different maturity levels can confuse the users.  An ensemble of inter-calibration results with a way to blend them easily (weighting coefficients) could be provided in the GSICS product.  Larry: the critical information for the super-users should always be the first one accessible.  Then intermediate products may capture the different methods and references.  There should be enough information in the product to allow users to properly trace their calibration.  Sienna: we should not overcomplicate the products if there are not many users.  Three mechanisms were proposed to provide users access to combined GSICS products for different spectral bands of the same instrument:   1. Generate a combined GSICS product. This may be provided in one of two variant options: 2. Just provide the coefficients derived from the recommended best blend of references/algorithms for general use 3. Provide best blend, plus access to all contributing sub-products derived from different algorithms/references 4. Provide users with software to identify different products from the GSICS server and generate combine products 5. Provide users with readers to read L1 data, identify corresponding GSICS products, read these from the GSICS server, and implement directly (e.g. SatPy)   From Option 1, there is a consensus that including all the methods and references for both the IR and VIS-NIR products added-value for users do not outweigh the additional complexity on the definition, validation and production side. The group would propose to first generate a simple combined product based on the best blend (1a), and only consider extending to option 1b if needed – but ensure the data format would allow. However, before committing development effort, to consider options 2 and 3.  Stephen Maxwell (NIST) recommended consulting NIST data librarians [Andrea Medina Smith](https://www.nist.gov/people/andrea-medina-smith) and [Regina Avila.](https://www.nist.gov/people/regina-l-avila)  **A.GWG.20230228.1:** Manik Bali to engage with Copernicus climate archive experts (via Betsy Weatherhead) and NIST data librarians on strategies to provide users with guidance to access best GSICS products for their application.  The Data working group is requested to analyze the possibility to have Satpy readers access the various GSICS products.  The topic will be revisited on Friday morning. | |

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| Session 3: UV/Vis/NIR Spectrometer Subgroup Meeting | |
| **Chair** | Larry Flynn |
| **Minute Taker** | Alessandra Cacciari |
| **Attendance** | Banghua Yan (NOAA), Mijin Eo (EWHA), Yeeun Lee (EWHA), Sergey Marchenko (SSAI/NASA), Larry Flynn (NOAA), Dave Doelling (NASA), Diego Loyola (DLR), etc. |
| **Remote Attendance** | Yuan Li (CMA), Melanie Coldewey-Egbers (DLR), Antje Ludewig (KNMI), Alessandra Cacciari (EuMetSat), Jay Herman (UMBC), Xiong Liu (CFA), Thomas Kurosu (JPL), etc. |

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| **Agenda Item:** 3a. CMA OMS pre-launch calibration & instrument performance | |
| **Presenter** | Yuan Li (CMA) |
| **Overview** | The first presentation by Yuan Li (CMA) gave the status of calibration for the OMS instrument. The planned date of the OMS Launch on FY-3F is August 2023. The first part of the talk covered the OMS Limb instrument specifications, L1 product processing flow with a description of all the calibration steps. The second part of the talk covered the OMS Nadir instrument design, a description of the on-ground calibration campaign in thermal vacuum, the L0 - L1 data processing flow, and the L1b products. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3b. TropoMI Calibration | |
| **Presenter** | Melanie Coldewey-Egbers (DLR) |
| **Overview** | The second presentation by Melanie Coldewey-Egbers (DLR) gave information on the status of TropoMI calibration and reprocessing. It covered the independent evaluation of S5p TROPOMI L1 data in the frame of the ATM project This is done through the following: 1) ground-based location for monitoring long-term stability of the sensors, 2) comparative studies using various satellite instrument with similar characteristic, 3) comparison with radiative transfer model calculation. Data records for the presentation were from versions v2 and v1, it is planned to redo exercise after the upcoming reprocessing. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3c. Changes in observed straylight in TROPOMI | |
| **Presenter** | Antje Ludewig (KNMI) |
| **Overview** | The third presentation by Antje Ludewig (KNMI) continued with results for the full mission reprocessing with emphasis on the improved straylight corrections for TropoMI. It included a description of the in-flight straylight monitoring strategy – the signal in the straylight regions seems to increase in time. The straylight calibrations are derived from the key laboratory data; Re-analysis of on-ground data was used to determine a new source/target kernel. The use of improved convolution kernel decreases the discrepancy with the observation in the straylight regions. It is not yet determined if this is improving the straylight correction — still to be clarified/validated. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3d. **Metop-A GOME-2 EOL** | |
| **Presenter** | Alessandra Cacciari (EUMETSAT) |
| **Overview** | The fourth presentation by Alessandra Cacciari (EUMETSAT) gave a summary of end-of-life tests and analysis for the Metop-A GOME-2. There were four campaigns taking place from the end of 2019 to the end of 2021. This presentation concentrated on six specific tests: 1) A change in the solar measurement frequency, 2) A change in the scan unit spinning cycle, 3) A decrease in the detector temperature, 4) Cross-Calibration with Metop-B and Metop-C GOME-2 with orbital change, 5) Extended spectral lamp source (SLS) measurements, and 6) the introduction of temperature gradients during the SLS measurements. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3e. ESA FDR4ATMOS Project | |
| **Presenter** | Melanie Coldewey-Egbers (DLR) |
| **Overview** | The fifth presentation by Melanie Coldewey-Egbers (DLR) introduced the ESA FDR4ATMOS project with initial target of harmonization of GOME and SCIAMACHY Level 1 records. Task A consists of the reprocessing of SCIAMACHY L1b and incorporation of lunar data in the L1 data record. Task B consists of harmonization of Lev1 data irradiance and reflectance for generating a FCDR from GOME and SCIAMACHY. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3f. OMPS Calibration | |
| **Presenter** | Banghua Yan (NOAA) |
| **Overview** | The sixth presentation by Banghua Yan (NOAA) gave an update on the validation of the new NOAA-21 OMPS Nadir Mapper and Nadir Profiler measurements. The instruments are performing well and the target for provisional validation and release to the public is April 2023. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3g. GEMS Calibration and Solar measurement | |
| **Presenter** | Mijin Eo (EWHA) |
| **Overview** | The seventh presentation by Mijin Eo (EWHA) gave information on the status of GEMS in-flight characterization and reprocessing including solar measurements. GEMS shows expected characteristics with a few exceptions. Near future activities include changes to the solar BRDF (and reprocessing of previous irradiance measurements), improved straylight corrections, and updates to the calibration parameters. The GEMS dark current and LED monitoring are performing well. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.h. Status of DSCOVR EPIC | |
| **Presenter** | Jay Herman (UMBC) |
| **Overview** | The eighth presentation by Jay Herman (UMBC) discussed the use of EPIC and its hourly measurements of the full sunlit disk for comparisons to instruments on all platforms. EPIC is working well and has resources for ten more years. EPIC images the full sunlit Earth all day including polar summers at 10 channels: 317.5, 325, 340, 388, 443,552, 68, 687.75, 764.0, 779.5 nm. Data are available from the NASA LARC DAAC. See <https://epic.gsfc.nasa.gov/> . Future plans are to intercalibrate the three GEO Sensors: GEMS, TEMPO and UVNS by comparison to EPIC. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.i. TEMPO L0 to L1B and Calibration | |
| **Presenter** | Xiong Liu (CFA) |
| **Overview** | The ninth presentation by Xiong Liu (CFA) gave an extensive description of the planned pre- and post-launch calibration and validation activities for the TEMPO instrument (April 2023 launch date). He also provided detailed outlines of the L0 to L1B processor steps. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.j. OMI / TropoMI Solar Irradiances | |
| **Presenter** | Sergey Marchenko (SSAI/NASA) |
| **Overview** | The tenth presentation by Sergey Marchenko (SSAI/NASA) looked at the state-of-the-art capability of using solar measurements of Fraunhofer lines to identify drifts in stray light correction performance with OMI and TropoMI as examples. The study used the OMI Collection 4 and the TropoMI V2.01 Collection 3 products. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.k. GEMS Intercalibration with GEO and LEO Sensors | |
| **Presenter** | Yeeun Lee (EWHA) |
| **Overview** | The eleventh talk by Yeeun Lee (EWHA) gave the status of current and planned comparisons of GEMS measurements to other GEO and LEO instruments. Comparisons with AMI for the 470 nm channels show differences that can be traced to solar measurements and degradation. Comparisons to OMPS NM and TropoMI have just started. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.l. OCO-3 / GEMS CO2 and NO2 | |
| **Presenter** | Thomas Kurosu (JPL) |
| **Overview** | The twelfth talk by Thomas Kurosu (JPL) looked at SNO comparisons (under-flights) of OCO-3 XCO2 and GEMS NO2 products. The products show good correlations for urban pollution/emissions. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item:** 3.m. V8TOz as a Radiative Transfer code for three channels – 318, 331 and 372 nm | |
| **Presenter** | Larry Flynn (NOAA) |
| **Overview** | The thirteenth talk by Larry Flynn (NOAA) presented results using the V8TOz retrieval algorithm to compare the calibration of sensors in the UV for three channels (318 nm, 331 nm and 372 nm) for OMPS, GOME-2, TropoMI and GEMS. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| GRWG Space Weather Sub-Group Session (SWxSG) | |
| **Chair** | Tsutomu Nagatsuma |
| **Minute Taker** | Ingmar Sandberg, Terry Onsager + Tim Hewison |
| **Attendance** |  |
| **Remote Attendance** |  |

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| **Agenda Item: 4a. ESA Assets and Intercalibration Capability** | |
| **Presenter** | **Piers Jiggens ESA (Remote)** |
| **Overview** | Presentation focused:  Overview of the elements of ESA the contribute;  ESA assets that could be included in an intercalibration system;  Introduction to methods for accessing the data;  Thoughts on how the GSICS framework could look. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Piers discussed the involvement of ESA on near-real-time data sets and mentioned a large number of assets that can contribute, including sensors on telecommunications and navigation satellites, including: Standard Radiation Environment Monitor; Environment Monitoring Unit; Next Generation Radiation Monitor; Rad-hard electron Monitor; ICARE-NG, and others. These assets are in GEO, MEO, LEO, HEO, and in interplanetary space. Including ERSA system on board Lunar Gateway that includes SREM, NGRM and ICARE-NG. Indicative measurements from the NGRM units on-board Sentinnel-6 and EDRS-C were presented.  Cross-comparisons among GEO satellites show good results.  The ESA data are accessible through a Heliophysics API and an open-access interface supporting many computer languages. ESA datasets are stored in ODI MySQL database.  ESA has also started a “standard vocabulary” to define the various levels of data processing. Piers described a possible “operational framework” to support the data intercalibration and access.  Q: Look direction of sensor on Metop-SG?   * One direction only   Q: ESA plans on monitoring high energy protons ~ >500 MeV relevant to GLEs   * A new activity has been kicked off. Development of Cerenkov detector by University of Surrey.   Q: Inter-calibration for near real time measurements?   * We can make use of calibration results based on historical measurements. | |

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| **Agenda Item: 4b. Space Weather Observation related to SWARM and SMOS missions** | |
| **Presenter** | **Raffaele Crapolicchio ESA (Remote)** |
| **Overview** | ESA is developing a set of Earth-observing missions. SWARM and SMOS are within the science focus, and they are making some measurements of value to space weather. Earth observation missions can contribute to SW observations. Need to interact with SWx community.  SWARM and SMOS data are shown to be useful for space weather applications. New products are under development, including electron density gradients, spatial TEC gradients, and a current sheet index. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Swarm – Measures magnetic and electric fields; electrons and ions; and it has an accelerometer. Exploring the measurement of ionospheric irregularities. Current ionosphere models do not include the small-scale fluctuations. A new empirical model, swarm-vr, is showing significant improvement in describing small-scale electron density irregularities. Focus on polar, auroral, and mid-latitude structure.  Intens project is striving to create a new geomagnetic index based on swarm data. Swarm-ae at high latitudes; a dst-like index, an electron density irregularity index, which corresponds to gnss loss of lock.  Sifacit project – focus on joule heating in the e-layer ionosphere, including joule heating at various spatial scales.  Migras, switch, swesmag: three recent projects based on swarm data products  Smos – esa's water mission, the first radiometer mission  L-bald solar flux and its influence on the ionospheric total electron content (tec). They can estimate tec from the faraday rotation observed in the solar flux. This can fill the gap in measurements over the oceans. This is also being used to monitor solar radio bursts. These radio bursts are useful for monitoring and identifying coronal mass ejections occurrences. The energy flux in the solar radio burst correlates with the cme properties. Solar radio burst polarization is another data product that can be used for gps anomaly analysis.  Q: Intention of distributing data in near real time  A: With a 24 hr delay, data are being delivered (smos)  Q: Faraday rotation technique to measure tec seems very interesting. Have you validated it using gnssro data?  A: in progress | |

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| **Agenda Item: 4c. Intercalibration of electron flux measurements, on-going results and lessons-learnt** | |
| **Presenter** | **Ingmar Sandberg SPARC** |
| **Overview** | Discussed a recent effort to intercalibrate electron measurements on GEO, LEO, MEO, and HEO satellites. This presentation included the motivation, a list of datasets, the approach for intercalibration, the results, and the lesson learned.  Determining “reference” datasets is important. It would be useful to standardize the selection criteria for the observation conjunctions. It’s important to define the scaling factors and to quantify and propagate errors. It is important to specify instrument response functions and to make raw data accessible. GTO is highly important for intercalibration.  Overall result: Measurements are largely consistent among the various satellites, and more collaborations and interactions would be valuable. We can agree on conjunction conditions, diagnostic techniques, metrics, and statistics, etc. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| An important motivation was the in-flight validation and calibration of ESA radiation monitors. This enables the creation of high-level data products (level-2). Another motivation is to create a database with historical, clean intercalibrated data.  Their roadmap includes a set of “reference” datasets (RBSP, ARASE, GOES 16-18) and a set of “Target” datasets, including other orbits. “Reference” datasets are chosen based on a set of evaluation steps.  An intercalibration system has been developed to retrieve data from an open-interface database, identify conjunctions when data can be compared, and then to compare and determine scaling factors.  Good agreement was found between RBSP and ARASE electron measurements, and scaling factors were determined. Giove-A/SURF and Arase data also show good agreement. Galileo and ARASE measurements showed good agreement up to ~2.6 MeV. Higher energies had high noise levels.  EDRS-C/NGRM has been evaluated using ARASE and during the GTO transit orbit phase. GOES-17 and ARASE showed good agreement. Differences between GOES-17 and ARASE are similar to differences between GOES-16 and GOES-17. Similar results are seen in comparisons with Himawari-8.  Q: Is the sensor response likely to have calibration errors in response on a logarithmic or linear scale?   * Plotted on log scale to cover dynamic range, but most likely errors are in threshold of response to low energies. * Tim Hewison encouraged the group to consider the necessary form of the function to map one sensor's response to another. | |

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| **Agenda Item: 4d. Space Weather Products for the Satellite Industry** | |
| **Presenter** | **Terry Onsager NOAA (remote)** |
| **Overview** | Need to monitor and provide SW products for MEO, LEO – in addition to GEO, using inter-calibrated measurements. Need also to focus on low-energy electrons which are critical for surface charging effects. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| * Challenge to intercalibrate low-energy “Ring-Current” Electrons due to different gradients. * Critical for Surface charging * Distributed, intercalibrated data would improve data assimilation studies * OSE/OSSE studies to be required to quantify the value of data in operational products and to establish priorities for future investment. * Q: Is there any inter-calibration effort with focus on the low-energy measurements? * A1: Very limited due to absence of measurements from different units. In principle, the coverage in such energies is rather limited. * A2: Such studies have been performed in the past by Juan Rodriguez using the highest energy electron channels from LANL SOPA (?) sensors and comparing them with the lowest energy electron channels from GOES. These studies were based on long time period averages | |

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| **Agenda Item 4e. Cross Calibration between Himawari-8/SEDA and GOES-16/SEISS** | |
| **Presenter** | **Tsutomu Nagatsuma NICT** |
| **Overview** | Described instruments on Himawari-8 SEDA detector and the GOES-16 SEISS detector. Results of comparison are good for lower energies, but SEDA background noise is present at high energies. Increasing bias current may play a role in the increasing background count level. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Findings:   * No significant long-term variability in the detectors, but the noise in the SEDA detector seems to be increasing. * No seasonal dependence was found in the comparison. * Investigation of the BIAS current induced by temperature: ground-based measurements versus in-flight ones. Deviations were found for particular channels. | |

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| **Agenda Item 4f. Seasonal and yearly intercomparison results of electron flux between geostationary satellites** | |
| **Presenter** | **Dae-Hyeon Oh KMA (remote)** |
| **Overview** | Overview of KSEM detector and comparison with GOES-16.  GOES, GK-2a, and Himawari-8 measurements cover a large range of locations in geostationary orbit, which can provide more precise studies on radiation belt dynamics. The KSEM data are available in near real time. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| KSEM measures: 100 keV – 3.8 MeV – Similar to GOES MPS-Hi  Overall the detectors are measuring similar flux levels. Correlation coefficients show a weak semi-annual changes. This will require additional research to understand.  Seasonal flux spectra comparisons were presented.  Comparisons of magnetic field measurements were presented  Real-time multi-point in situ GEO measurements allow the study of SW phenomena manifested through the asymmetry of the flux profiles | |

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| **Agenda Item 4g. FY-3E/X-EUVI calibration improvements and applications** | |
| **Presenter** | **Qiao Song/Jinping Dun CMA (remote/recorded)** |
| **Overview** | Described calibration and improvements in the EUV measurements made by the FY-3E satellite. FY-3 has a solar x-ray instrument and an extreme ultraviolet imager. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item 4h. Initial observation with the TriIPM on the FY3E satellite** | |
| **Presenter** | **Qian Song CMA (remote/recorded)** |
| **Overview** | Presentation of the Triple Ionospheric photometer on-board FY3E satellite.  Operates in Day and in Night Modes. Characteristics such as spatial and temporal resolutions were summarized. Iner-calibration results between its probes were demonstrated. TriPM observations are in agreement with AURICA model. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item 4i. About Space Weather Subgroup** | |
| **Presenter** | **Tsutomu Nagatsuma NICT** |
| **Overview** | The following issues are introduced and discussed.   * Chairmanship of GRWG SW sub-group * Confirmation of the membership * Scope of GRWG SWx sub-group (draft) * Action item and next sub-group meeting |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| In the breakout session, it was confirmed that Tsutomu Nagatsuma (NICT) will be a chair of Space Weather sub-group. According to the membership, several members from the space agencies are to be replaced. The issue of adding new members from university and research institute as a space weather expert, it will be an agenda of cross-cutting session.  The draft about the scope of GRWG SWx sub-group is introduced, it will continue discussing via e-mail and the next meeting. And it was confirmed that the next meeting (remote) will be held in May. | |

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| GRWG VIS/NIR Sub-Group – Lunar | |
| **Chair** | Tom Stone |
| **Minute Taker** | Tom Stone, Tim Hewison |
| **Attendance** |  |
| **Remote Attendance** |  |

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| **Agenda Item: 7n. EUMETSAT activities in 2022: outcome of the measurement campaign with S3 and MSG1 end-of-life tests** | |
| **Presenter** | Seb Wagner (remote) – EUMETSAT |
| **Overview** |  |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7o. Status of the Lunar Irradiance Model of ESA (LIME)** | |
| **Presenter** | Emma Wooliams – NPL |
| **Overview** | LIME is developed from ground-based lunar irradiance measurements acquired with Cimel 318-TP9 photometer, calibrated at NPL and Univ. Valladolid, and deployed at Teide peak and Izana Atmospheric Observatory, Tenerife. Iterative regression approach to get coefficients for model, which is based on ROLO model formulation. Model uncertainties derived using Monte Carlo approach applied to lunar Langley analysis and CoMet toolkit. This Cimel also has polariser channels – DOLP measurements used to develop a polarisation model for lunar irradiance vs. Phase angle. Lunar calibration comparisons vs. LIME presented for Pleiades-1B, S3A/B OLCI, Proba-V and GIRO. Spectrally resolved measurement acquired at Izana with ASD; preliminary lunar disk reflectance measurements presented. LIME toolbox in development, to generate lunar irradiance fromLIME for input sensor position and spectral bands; expected to be available to the community late 2023. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7p. Using the Moon for MODIS and VIIRS Reflective Solar Bands Calibration Inter-comparison** | |
| **Presenter** | Jack Xiong – NASA |
| **Overview** | First moon observations by JPSS-2/NOAA-21 VIIRS acquired today! MODIS Terra and Aqua, SNPP and J1/N20 VIIRS lunar measurements normalized by ROLO model, comparisons show biases with similar trends vs. Wavelength for all 4 instruments. Biases are less when measurements are rederived using TSIS-1 HSRS solar spectrum; solar correction approaches presented. Initial J2/N21 VIIRS lunar observation normalized using GIRO shows ~2% differences to J1/N20. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7q. airborne Lunar Spectral Irradiance (air-LUSI) Mission –**  **First Operation Campaign** | |
| **Presenter** | Kevin Turpie – NASA |
| **Overview** | Objective: to make fiducial reference measurements of lunar spectral irradiance. Joint project of UMBC, NASA, NIST, USGS, McMaster Univ. Preparations for operational campaign and deployment on NASA ER-2 high-altitude aircraft in March 2022, after successful demonstration campaign in November 2019. Pre-flight calibrations conducted each night agree within ~0.5% over most of the spectral range. Intention to make calibrated data publicly available, and to apply toward improvement of the ROLO model. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7r. Lunar Calibration Activities at USGS – EROS** | |
| **Presenter** | Sandy Preaux – USGS |
| **Overview** | The Moon is one of many calibrators used for Landsat OLI, now have a nearly 10-year record of lunar calibrations for Landsat-8. New processing of OLI Moon images by USGS-EROS team was compared to previous work done at NASA-GSFC. Time series of computed oversampling factors show significant differences between the USGS and GSFC methods. Also seeing differences related to the direction of the scan pass across the Moon. Analysis is ongoing, intent to engage the geometric calibration team at EROS regarding oversampling factors. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7s. ARCSTONE: Calibration of Lunar Spectral Reflectance from Space** | |
| **Presenter** | Constantine Lukashin (remote) – NASA |
| **Overview** | Cubesat mission to collect lunar spectral reflectance measurements by viewing the Moon and Sun with the same optical system, only changing integration times. In-flight spectral calibrator: NIST SRM2035b filter inserted in optical path. Planned twice-daily Moon observations, Sun observations 3 times per month. Currently in instrument fabrication phase, planned launch Fall 2024. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 7t. Comparing SLIMED with GIRO using ABI** | |
| **Presenter** | Bikash Basnet – NOAA |
| **Overview** | Bikash has set up Hugh Kieffer’s SLIMED model at NOAA and operated it and GIRO for GOES-16 and 17 ABI Moon observations. Comparisons of ABI/GIRO and ABI/SLIMED show differences between the models, with SLIMED more closely matching the ABI measurements. Plots vs. phase angle show phase dependence in ABI/GIRO comparisons, strongest in SWIR bands. Recommendation: a public python version of SLIMED would be useful. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Tom: the phase dependence of the ABI/GIRO comparisons shows that the GIRO needs to be updated or replaced; can run the current ROLO model and check for reduced phase dependence. | |

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| **Agenda Item: 7u. Discussion – Implementing SLIM as a GSICS Lunar Model** |

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| **Agenda Item: 7v. Introduction to the discussion** | |
| **Presenter** | Tom Stone – USGS, and Hugh Kieffer (remote) – Celestial Reasonings |
| **Overview** | Tom presented a framework for modular construction of the software system. Modules are: 1) ingest and geometry processing; 2) disk reflectance model calculation; 3) spectral post-processing. No particular programming language is specified, but python targeted. Intention is to have standardized inter-module data transfer files; this would allow the disk reflectance model to be interchanged, if an agency writes a substitute module. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Emma Woolliams stressed the importance of tracking uncertainties in model development and implementation. Emma: this task looks similar to the LIME toolkit, why not use it for the implementation? The LIME toolkit is still in development, expected to be available to the community late 2023. Fred Wu: NOAA might commit resources to developing a python implementation of SLIMED. | |

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| GRWG IR Sub-Group | |
| **Chair** | Likun Wang |
| **Minute Taker** | Tim Hewison, Likun Wang |
| **Attendance** |  |
| **Remote Attendance** | 32 online |

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| **Agenda Item: 5c FY-4B/AGRI accuracy and monitoring** | |
| **Presenter** | Xingwei He/Zhiwei Wang (remotely) |
| **Overview** | CMA now include radiance-slicing method to analyse the AGRI-IASI collocations, which confirm the radiance-dependence is small (<1K).  The bias at standard scenes is <0.4K in all IR channels (except CH\_09)  Checked spatial distribution of bias – no obvious issues |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Gap-filling for CH\_09?   * Applied JMA method   Day-time? Hot land bias over Australia?   * Will check | |

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| **Agenda Item: 5d FY-3/HIRAS and FY-4/GIIRS status and future plan** | |
| **Presenter** | Lu Lee (remotely) |
| **Overview** | FY-3E/HIRAS/II   * Raised interferometer temperature to overcome influence of temperature fluctuations experienced in by 0530 orbit * NEDT stable and in spec for 8/9 FOVs, but with some jitters due to temp var * Seasonal spectral offsets wrt LBLRTM but <10ppm * Inter-comparison with IASI by SNO show little improvement in relative bias, despite recent processing improvements. Bias still 0.5K in LWIR, 0.5-1K in MWIR   FY-4B/GIIRS   * NEdR stable, and only show small increase since inclusion of spectral calibration * Spectral calibration wrt LBLRTM about 5ppm on average (in spec) * SNO with IASI – filter out cloudy scenes in daytime using integrated imager – results show bias 0.5K in MWIR, 1K in LWIR * Bias in LWIR CO2 band shows diurnal variation – may be due to contamination of thermal emissions within the optics   Future Plans   * FY-3F/HIRAS in TVAC – launch scheduled for Aug 2023 * FY-4C/GIIRS in design phase |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Reason for relatively long time difference threshold of 1200s?   * To generate sufficient SNOs – will also test impact of reducing to 300s * Impact is partly mitigated by filtering to only use clear scenes - and could be further mitigated by only using ocean collocations   Q: Cause of oscillation in spectral calibration on Slide 17 top left plot?   * Binning of spectral calibration coefficients in monthly windows, but subject of ongoing research   Q: FY-3F – also on early morning orbit – any difference in design?   * Same as FY-3E | |

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| **Agenda Item: 5e - IASI-A End Of Life Test Results** | |
| **Presenter** | Dorothee Coppens (EUMETSAT) |
| **Overview** | Tests divided into Campaign #3 (disseminated to users) and #4 (not disseminated) - both include instrument tests + spectral tests, which needed more analysis.  Confirmed redundancies can be used without any alignment adjustments.  Relaxed threshold in corner cube speed quality had no impact on L2 products.  CNES confirmed the detector noise could be reduced.  Checked impact of locking LFD and CD on PC and ghosting due to micro-vibrations – as expected – including scan angle effect  Super-sample mode – with overlapping pixels - confirmed improvement in L2.  Inter-calibration – SNO of IASI-A/B for first time – very good agreement – could also detect impact of Doppler shifts during yaw flips when compensation deactivated.  Limb view and deep space acquisition during back-flip – check spectra of different species – confirmed could capture CH4 profile – and checked spectral calibration |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What is most important/unexpected?   * Use of redundant side, super sampling – could benefit from longer test   Q: NOAA can share lessons learned from analysis of Metop-A/AVHRR EOL tests – will be covered at EUMETSAT conference | |

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| **Agenda Item: 5f - GEO-GEO Radiance Inter-Calibration of INSAT-3D with MSG-SEVIRI** | |
| **Presenter** | Prajjwal Rawat & Pradeep Thapliyal (Remotely) |
| **Overview** | Prajjwal started by reviewing the benefits of performing GEO-GEO comparisons and compared the SRFs of INSAT-3D and MSG imagers, focusing on the ozone channel.  Collocation criteria: dsec(theta)<5%, dx<3km, dt<300s + 3-sigma filter  SBAF based on RTTOV12.3 - INSAT-3D showed differences of 7K  INSAT-3D showed diurnal difference in bias wrt SEVIRI – impact on L2 (Total Ozone Column) |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Calculate actual position of GEO satellites?   * Please contact EUMETSAT for details on how to calculate, ISRO are encouraged to contact EUMETSAT   Q: How is diurnal bias correction applied?   * On hourly basis   Comment: GEO can have diurnal calibration error – especially older GOES-13 imager. Could also be an issue with INSAT-3D | |

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| **Agenda Item: 5g GEO-LEO thermal emissive bands comparison method** | |
| **Presenter** | Tiejun Chang |
| **Overview** | Tiejun started by showing the differences between ABI and VIIRS SRFs  d(theta)<1deg, ray-matching + quasi ray-matching, dRAA<? Deg  dt<5min  Clear sky selected based on Binary Cloud Mask  Checked histograms of pixel-pixel comparisons with VIIRS on SNPP and N20   * Mean Double difference (DD) <0.07K   Seasonal variations in ABI-VIIRS due to SRF differences – cancel out in DD  Checked view angle effect – also due to SRF differences – cancel out in DD  Checked difference between ray-matching and quasi-ray-matching – found small differences – probably over land   * Also applied to GOES16-17 comparison on 3 sites along longitude line (including cloud mask) - SBAF correction needed for Bands 9 & 16 – based on MODTRAN over typical scenes – could also use NASA-Langley SBAF tool * relative bias within 0.3K |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Relative advantage of comparisons with VIIRS over CrIS/IASI? - Double difference comparison of VIIRS  Q: Evidence of GOES ABI Band 7 is subject to stray light?   * Yes – also found some reference   Q: Need for matching azimuth angles in TIR?   * Some evidence of differences over land   Q: Does different view perspective cause the intercomparison uncertainties? | |

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| **Agenda Item: 5h SNO analysis of AIRS/IASI/CrIS** | |
| **Presenter** | Dave Tobin |
| **Overview** | SNO Analysis – paper by Loveless et al. – submitted to JGR ESS   * Larabee Strow found strong warming trend in upper Trop O3 channels * Important to account for time symmetry –> uncertainty component * Agreement with IASI now within uncertainty bounds * Small differences with AIRS – but all good * Uncertainty propagation, including CrIS uncertainty product + noise covariance   NOAA-21/CrIS inter-calibration   * Just passed beta maturity review * Checked all 9 FOVs have similar characteristics * Obs-Calc – double-difference with NOAA-20 <0.1K and FOV-independent * VIIRS-CrIS comparisons – stable to ~mK/yr   Spectral Ringing   * Borg et al, Remote Sensing 15, No.2, 334 * Impact of Sinc un apodised Instrument Line Shape for different sensors * EUM & UW already has correction algorithms for this effect |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Combining results with SSU – to discuss with Likun  Q: Content of L1B   * Currently includes the spectral ringing effect – but corrections available | |

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| **Agenda Item: 5i GEO-LEO algorithm v2** | |
| **Presenter** | Tim Hewison |
| **Overview** | Review current GEO-LEO IR algorithm 1) colocation; 2) spectral match, 3) compare  Issues with current algorithm, 1) formulation not user friendly, 2 large biases at cold end, 3) hot land bias, 4) high view angle impacts, 5) diurnal vairation  .  Proposed V3 algorithms: 1) Quadratic function, 2) inverting relationship of GEO-LEO radiances, 3) radiance slicing, 4) definition of standard scenes  He gave examples of radiance slicing and choosing standard scenes.  He discussed the issue of how to deal with multiple references.  Hot land issue was reviewed: large diurnal variation at hot land pixels.  Volunteers are needed to investigate further improvements:   1. Parallax mask 2. Using multiple GEO imagers per LEO overpasses 3. Detect and filter collocation of hot land 4. Multiple references/Diurnal Variations 5. Define standard scenes |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Comments (Fred Wu): GOES-E is warmer than GOES-W for GEO-GEO intercomparison at Rocky Mountains due to orography – even in less extreme terrain, systematic differences can be expected.  A.GIR.20230301.1: Likun Wang (NOAA) will investigate parallax effects for GEO-LEO IR v2 algorithm and report back to the IR group in early May 2023.  A.GIR.20230301.2: Chengli Qi (CMA) will investigate 1) diurnal variations 2) GEO and LEO hyperspectral sounder comparison, 3) GSICS correction  A.GIR.20230301.3: KMA will investigate hot land biases for GEO-LEO IR v2 algorithm.  A.GIR.20230301.4: Pradeep Thapliyal (ISRO) will investigate 1) diurnal variations, 2) multiple references, and 3) reference temperature for GEO-LEO IR v2 algorithm.  For the item of using multiple GEO imagers per LEO overpasses, it begins Xin Jin’s work presented in the IR web meeting and find out the next step.  A.GIR.20230301.5: Fred Wu (NOAA ) will investigate the formula of the GSICS correction.  Comments (Dave Doelling): The different users have different perspectives. He emphasised the importance of the 3.7 micron channel calibration for cloud products – especially in the 270-300K range. This is also important for SST retrievals. Discussion of **inter-channel correlations**, which should be addressed in the analysis of the results of any revised algorithm.  Comments (Cheng-Zhi): Diurnal cycle difference between ascending and descending in MW instruments can be used for IR inter-calibration.  A.GIR.20230301.6: Likun Wang (NOAA) to send out reminder and monthly web meetings to check progress and milestones.  Recommendation from Fangfang: Investigation of the hot land issue could be performed by performing regression excluding daytime land data, then analyse residuals when applying to all data.  A.GIR.20230301.7: Tim Hewison (EUMETSAT) to revise uncertainty analysis for GEO-LEO IR v2 algorithm by 2024-03  Gap-filling could also be investigated, although this problem is considered satisfactorily resolved, as the most recent PCR-based approach applied by Hui, Likun and Ali Mousivand introduces neglibile uncertainties for the 3.7 micron channels of current GEO imagers. | |

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| **Agenda Item: 5j IASI L1 CDR new release** | |
| **Presenter** | Bertrand Theodore (EUMETSAT) |
| **Overview** | He reviewed the IASI-A and IASI–B differences, which is now very small. But there was systematic bias ~0.2K in the 15 micron spectral range, which could be caused by detector nonlinearity.  Nonlinearity was updated on 02/08/2017 for IASI-B and 30/09/2019 for IASI-A.  Reprocessing the L0 data is not possible. Because whole interferogram data are not sent back to the ground (information loss). However, a semi-empirical correction has been developed, which provides good levels of accuracy |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Why using HIRS as validation instruments because is not well calibrated.   * Used reprocessed HIRS data   Q: For IASI-C, the is no need for nonlinearity correction issues. Did IASI-C send back the whole interferogram?   * This is only possible during special operations (e.g. commissioning) | |

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| **Agenda Item: 5k** | |
| **Presenter** | Cheng-Zhi Zou |
| **Overview** | He first reviewed the SSU instruments and the calibration issues of SSU datasets (CO2 cell leak). The NOAA preprocessed and recalibrated the SSU operational data records. The stratospheric temperature CDRs were developed and released to the public. He discussed the merger of AMSU-A and SSU to extend stratospheric temperature CDRs. The trend comparison between the models and AMSU-A/SSU were presented.  Finally, he discussed the near-term plan to merge SSU with AIRS and CrIS. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 5l GEO-GEO analysis of Himawari-8/9 parallel observation** | |
| **Presenter** | Kazuki Kodera |
| **Overview** | Both Himawari-8 and –9 are around 140.7E - with very similar ABI imagers  (SRF differences are not corrected.)  Both stable and within 0.3K at Tb\_std -at 220K: larger biases  Check diurnal variation – some variations for B11  And scan-dependent biases – now much reduced also for Himawari-9  Diurnal variations are obvious in B07 (3.9micron) - and ~0.1K for 13.4 micron channel but is ~0.01K for other channels  Larger Tb bias (~0,2K) seen over land in daytime in window channels  Also checked for scan-position dependence – E-W gradient – some due to SRF difference |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Could E-W gradient in GEO-GEO difference plots be related to variations in actual satellite position?   * Unlikely as the actual positions vary by <0.1 degree   Q: Could check in radiance scale too (rather than BT difference)?   * JMA will check   Recommendation: to look at sea pixels only | |

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| **Agenda Item: 5m GEO-GEO inter-comparison for GOES ABI IR channels** | |
| **Presenter** | Fangfang Yu |
| **Overview** | NOAA GEO-GEO algorithm:   * Ocean only, <20N/S, dcos(zen)<2%, dt<1min, 5x5 array TbSTD<10NEdT * Comparison in radiance, converted to Tb difference at 300K   Land results show strong diurnal variations  Time difference checked with ABI in different modes  5x5 pixel binning mitigates parallax effects  G17-G18 Results when 0.3 degree apart:   * G17 midnight problem with loop heat pipe * Used to validate predictive calibration   Use Hovmöller-type plot to show bias at 300K as function of time of day/year  Using GEO-GEO at same viewing geometry as GEO-LEO can validate impact of SRF difference  Fangfang also showed sensitivity of bias to uniformity criteria |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Application to VISNIR?   * Started to look at them   Recommendation: look at land only  Q: How did you conclude that the B07 and B16 differences are due to SRF effects?   * By comparison with GEO-LEO results, which account for true SRF using hyperspectral reference | |

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| **Agenda Item: 5n GEO-GEO inter-calibration algorithm with Parallax Correction** | |
| **Presenter** | Likun Wang |
| **Overview** | Likun addressed the quantification of the parallax effect due to high cloud, considering the viewing geometry of different GEO-GEO satellite pairs.  He reviewed the use of *Optical Flow* techniques to account for perspective, which reduced the STD of the GEO-GEO scatterplots significantly |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Cloud Top Height can be inferred from window channel TB in the Cloud Height L2 product  A.GIR.20230301.8: Likun Wang (NOAA) to check application of cloud top height L2 product in optical flow parallax correction  Q: Separation of systematic and random part of uncertainty (e.g. consider asymetry in scatterplot)?  A.GIR.20230301.9: Likun Wang (NOAA) to quantify reduction in random uncertainty of GEO-LEO IR correction due to cloud parallax – and consider quantification of systematic component of uncertainty.  Recommendation: Compare application of 2-sigma or 3-sigma filter to mitigate parallax errors  Recommendation: to use 2D histogram of collocations instead of scatterplots to show distribution.  Q: Is it possible to quantify biases per detector using this technique   * Depending on the availability of sufficient number of samples | |

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| **Agenda Item: 5o Discussion: Moving Forward for GEO-GEO inter-calibration** | |
| **Presenter** | All |
| **Overview** |  |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Agency Plans to continue GEO-GEO analysis:   * EUMETSAT>: FCI-SEVIRI – needed to add sun-glint filter * JMA: no further comparisons planned * KMA: GK2B-GK2A, based on method presented by Ewha * NOAA: will continue * ISRO: not available – can add offline   Consensus towards common algorithm   * Aim: validation of diurnal variations – agreed this is a powerful tool   A.GIR.20230301.10: Likun Wang (NOAA) to set up web meeting for agencies to present updates on GEO-GEO analysis  Comment: important to consider inter-comparisons with different GEO imagers – noting the importance of involvement of CMA in inter-comparisons with GK2A/B, AHI-8/9 | |

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| **Agenda Item: 5p LEO-LEO: SLSTR+AVHRR results** | |
| **Presenter** | Tim Hewison (EUMETSAT) |
| **Overview** | He introduced LEO-LEO IR Inter-Calibration algorithms, which is direct comparison with reference instruments. It needs to collocate in space, time, and angle. IASI is the reference instrument. The last step is to perform weighted regression for inter-comparison. The results for IASI-SLSTR are presented, including bias for standard scenes. They are stable for all channels.  He proposed several ideas to optimize the algorithm.  The IASI-AVHRR inter-calibration results are consistent with a previous implementation of this algorithm, confirming the long-term stability of the AVHRR calibration |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Question: Request for collocation data with clear information and traceable information back to level 0 or level 1  R: We need to discuss how to release these intermediate data with enough information, but it is not a standard GSICS product.  Comments: SLSTR has two blackbodies, and it is great for calibration in the SST/LST temperature regime where the two blackbodies can reduce sources of error if present.  SLSTR fire channels have a different footprint to the other channels due to a shorter integration time  Because SLSTR has 2 bb around 260 and 305 K going to cloud temperatures means you are extrapolating which requires an accurate calibration function. So observed deviations below 260K may be real  For the AVHRR on the MetOp satellites the orbit does not drift, so calibration errors are likely quite stable. For earlier AVHRRs where the orbit drifted, this is not the case and the operational calibration is far less stable.  The AVHRR also shows a temperature/view angle bias which is unexplained | |

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| **Agenda Item: 5q Straylight Rejection for ABI 3.7 um channel** | |
| **Presenter** | Hui Xu |
| **Overview** | Different zones were identified within the ABI FOR, according to their susceptibility to stray light – in particular in the B07 channel in eclipse season, depending on the relative position of the Satellite-Earth-Sun.   * Good method to detect stray light: compare successive images * Convert ABI Fixed grid to Sun-centered coordinates * Evaluate bias signal as function of angular radius around the Sun   Results show Sun stray light is much reduced for GOES-18 compared to –17/16 - although these mostly met requirements.  Extended analysis to AHI on Himawari-8 and –9 – similar levels |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How to define Sun-centered coordination?   * Solar zenith and azimuth   Q: Have you tried to use Deep Space to characterize stray light (would simplify analysis)?   * Do not keep deep space data   Q: Analysis of VIS/NIR channels?   * Was previously checked around midnight by a colleague – but there is no requirement   Q: What changed in GOES-18?   * Not known   Q: Do you filter the clouds (e.g. with cloud mask) to reject fast-moving features?   * No, but could try   Q: Can this information be passed onto SST teams? Could recommend it is not used around midnight, as for previous GOES-13   * Stray light correction scheme is published, but it is not known how it is used. | |

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| **Agenda Item: 5r Progress Report ICVS activities related to GSICS – Inter-sensor Comparison Modules** | |
| **Presenter** | Ninghai Sun (NOAA) |
| **Overview** | NOAA have implemented Inter-sensor Comparison Modules in ICVS for Long-Term Monitoring (LTM)  This has been implemented for a multiple instruments (add list)  Ninghai demonstrated the use of the tool and gave examples of ABI-CrIS and CrIS-IASI, VIIRS-ABI, OMPS-GOME2, ATMS-AMSU/MHS inter-comparisons.  For the microwave sounders, double differences using NWP are also available.  Now have interactive functionalities.  Plans: NOAA-21, apply GSICS GEO-LEO algorithms |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Comment: The inclusion of instrument events is much appreciated  Q: Addition of other instruments processed/distributed by NOAA?   * Limited by funding be provided by JPSS – could justify adding instruments based on the benefit of their comparisons | |

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| **Agenda Item: 5s Validation of a model of the disk-integrated Lunar radiance in the thermal IR channels** | |
| **Presenter** | Martin Burgdorf (University of Hamburg) |
| **Overview** | Martin reviewed the lunar model first from Thomas Mueller 2021.  There are many available IR observations for the Moon, CrIS, HIRS ….  This has not been analysed by astronomical observatories.  He showed the lunar radiances varying with wave number – with spectral oscillations at wavenumbers <800cm-1  Ratio of observed to model irradiances range 5-10% in MWIR, 1-7% in SWIR   * Large biases in shorter wavelengths are due to direct solar contributions not being included in the model   Analysis of long-time record: 3mK per decade  Issues – day-side ~400K – saturate. Night-side ~100K too cold   * Applicable to new Moon conditions limited by model applicability   Could also use Venus, or special SEVIRI observations without saturation |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Access to IASI lunar observations? And special SEVIRI observations from Meteosat-8 EOL and >90 degree phase angle? Could also provide SLSTR Moon acquisitions in fire channels   * To be discussed with Sebastien Wagner (EUMETSAT)   Q: How does half-Moon acquisitions work without saturation?   * For LEO instrument, whole moon is contained in FOV   Q: Main potential benefit: long-term monitoring of calibration changes for older missions?   * Yes   Q: Applicable to absolute calibration, or mainly calibration trending?   * Skeptical about achievement of absolute calibration | |

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| **Agenda Item: 5t Summary of 3.9 channel inter-calibration bias** | |
| **Presenter** | Likun Wang (NOAA) |
| **Overview** | Likun reviewed previously-reported findings from various GSICS members related to the calibration of these channels on different instruments, and recommended follow-up actions.   * Large bias for cold scenes in AMI and AHI, but not ABI * Do not change or omit negative radiance observations from IASI! * Strongly non-linear response to radiance biases when plotting as Tb   His slides provided links to presentations given at previous GSICS meetings and summarised specific recommendations in the processing of IASI observations. These will be combined and submitted as a manuscript to be published in a peer-reviewed journal. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Comment: Uncertainties in the observations should be considered when processing data!  Q: Could negative radiances be avoided in future IASI instruments?   * No – they are real (noise) and need to be kept to ensure biases are unbiased.   Q: Is this approach for keeping negative radiances generally applicable for other sensors?   * Yes – also emphasizes importance of using a finite offset term when scaling radiances as counts stored as positive integers | |

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| GDWG Breakout Session | |
| **Chair** | Kamaljit Ray |
| **Minute Taker** | Manik Bali/Paolo Castracane |
| **Attendance** | 15: Paolo Castracane, Manik Bali, Kamaljit Ray, Tsutomu Nagatsuma, Nitant Dube, Pradeep Thapliyal, Tae-Hyeong OH , Arata Okuyama, Bernd Husemann, R. K Giri , Thomas Kurosu |
| **Remote Attendance** |  |

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| **Agenda Item: 6** | |
| **Presenter** | Kamaljit Ray, IMD |
| **Overview** | Welcomed the GSICS Data Working Group. |
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| Kamaljit (Chair GDWG) informed members about the key activities that GDWG took up in the past year. Kamaljit informed that the GDWG continued to support the CAL/VAL activities of the GSICS Research Working Group as well as the hosting satellite agency. Data processing tools have been developed.  Kamaljit welcome the new GDWG member Tae-Hyeong Oh from KMA. Kamaljit then reviewed the progress on the GDWG Actions . | |

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| **Agenda Item: 6a** | |
| **Presenter** | Tian Lin, CMA |
| **Overview** | CMA GDWG Report |
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| CMA shows an impressive progress in thir GDWG activities. Tian mentioned that CMA retained and updated the CMA GPRC Website and alo the WMO-OSCAR landing pages. New instruments include FY-3E, FY-4B and Tan-Sat.  CMA also worked closely with WMO and contributed to the new WMO Unified Data Policy. International users were informed through the website that NSMC has adopted the UDF. . CMACast is a crucial data providing platform.  CMA provided updates to the CMA GDWG activity of providing support to the RICH-CEOS Program. Founded in 2018 the program has supported retrospective calibrating of FY, ZY and HY focused satellites.  Future goal for FY series include generating FCDR for several sensors including FY-1/3 VIRR, FY-3 MERSI, FY-2 VISSR and extends to Microwave sounders and imagers. Rich reprocessing data can be accessed via richceos.cn. Tian also mentioned that reprocessed data is much more stable with biases removed. | |

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| **Agenda Item: 6b** | |
| **Presenter** | Kamaljit Ray/R. K Giri, IMD |
| **Overview** | IMD GDWG Report |
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| R. K Giri informed that ISRO and IMD working together to sort out issues relating to regularization of the GSICS coefficients with a mirror copy at RAPID server and IMD to fetch coefficients. GSICS coefficients will be updated as NetCDF files in website already developed by ISRO with a copy at IMD and global GSICS website portal. It is planned to generate GSICS coefficients for GISAT, Oceansat-3 and next generation weather satellites | |

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| **Agenda Item: 6c** | |
| **Presenter** | Paolo Castracane, ESA |
| **Overview** | ESA GDWG Report |
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| Paolo provided updates on EVDC, CEOS Cal/Val Portal, PI-MEP Salinity, QA4SM, Maturity Matrix for dataset evaluation( ESDAP and WGISS) and discussed and contributed to GDWG plans for the coming future. •EVDC aims to be the main European source of access to the correlative data for validation of atmospheric composition products from satellite platforms. New tools include GEOMS, Overpass and Look and Feel. The main updates of the Cal/Val portal include SARCalNet, SALVAL, ACSG, TSIS-1 HSRS and MSG website. Pi-MEP Salinity is an ESA-NASA Platform for sustained satellite surface salinity validation.  ESA has developed a maturity matrix with NASA that can be applied to commercial Small sat Data. Paolo explained that next step is to increment the CEOS/GSICS interaction and continue working on Maturity Matrix.  A.GDWG.20230301.1: Paolo to give a talk on Overpass tool to GSICS | |

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| **Agenda Item: 6d** | |
| **Presenter** | Arata Okuyama, JMA |
| **Overview** | JMA GDWG Report |
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| Arata informed about the status of JMA GSICS products. He mentioned that the following Corrections are available from the GSICS server in EUMETSAT  Near-Real Time Correction  •Himawari-8 **and 9** / AHI / IR with reference to IASI-A/-B, AIRS: Demo. phase  •MTSAT-2 / IMAGER / IR with reference to AIRS, IASI-A: Demo. phase  Re-analysis Correction  •Himawari-8 **and 9** / AHI / IR with reference to IASI-A/-B, AIRS: Demo. phase  •MTSAT-2 / IMAGER / IR with reference to AIRS, IASI-A: Demo. phase  IASI-A had been supported until Oct. 2021. Implementation of IASI-C and CrIS is ongoing. JMA is also maintaining the GPRC website.  A.GDWG.20230301.2: Arata to contact GCC for inclusion of new JMA products into | |

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| **Agenda Item: 6e** | |
| **Presenter** | Tae-Hyeong Oh, KMA |
| **Overview** | KMA GDWG Report |
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| Tae, incumbent GDWG member from KMA, presented the KMA GDWG report. Tae provided an overview of the KMAGDWG activities. After providing current status of GSICS corrections, Tae mentioned that KMA plans to utilize NOAA-21 CrIS as a reference. KMA added new instruments on their GPRC and new INR performance. KMA also contributed to developing landing pages at NMSC. | |

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| **Agenda Item: 6f** | |
| **Presenter** | Rob Roebelling, EUMETSAT |
| **Overview** | Update on InstrumentSpecifications and Calibration Information |
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| Rob, presented the status of the Action on Landing page by CGMS on GSICS. He reiterated that the CGMS white paper recommends to CGMS operators to maintain landing pages for past and present satellites and integrate it with WMO-OSCAR. Agencies have to various degrees implemented the landing pages. GDWG also reviewed the Landing page link placement on the OSCAR webpage. Rob opened the floor for discussions. Included were how to include more members in CGMS Task – Team and what role can the GSICs play in moving towards common standards and nomenclature. | |

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| **Agenda Item: 6h** | |
| **Presenter** | Manik Bali, NOAA |
| **Overview** | NOAA GDWG Report |
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| **Agenda Item: 6h** | |
| **Presenter** | |
| **Overview** | |
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| Manik presented the GDWG activities at NOAA. He mentioned that the NOAAGDWG intersects with GCC and attempts to support the larger GRWG activities. Tools developed at NOAA include Actin Tracker, Alert System Product Catalog. Platforms such as New Class of GSICS products, and support utilization of OSCAR API.  Moving to next year adding new features to alert system, Sync GSICS Wiki wo GitHub and support to landing pages.  A.GDWG.20230301.3: Manik to contact WMO (Heikki Pohjola) to discuss integration of OSCAR API with Colab. | |

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| **Agenda Item: 6i** | |
| **Presenter** | Manik Bali, NOAA |
| **Overview** | NOAA White Paper |
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| GRWG Vis/NIR Sub-Group on Cal/Val Status | |
| **Chair** | David Doelling |
| **Minute Taker** | David Doelling |
| **Attendance** |  |
| **Remote Attendance** | None |

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| **Agenda Item: 7a** | |
| **Presenter** | Jin Qi, CMA |
| **Overview** | FY-3E/SIM-II on-orbit performance  CMA FY-3E/SIM-II measures the total solar incoming flux (TSI) and she compared it to the NASA SORCE TIM observations and tracked the TIM observations within –0.0002 with a very small temporal variation of half the value. This is the follow on instrument to the FY3D/SIM-II sensor with improved monitoring of the on orbit degradation. Many of the onboard calibration systems were presented, such as the temperature control, solar tracking, solar diffuser monitoring. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Jin Qi presented remotely and there were many technical difficulties.  A discussion ensued of the novel idea of having 3 onboard solar diffusers, that were used every 4 days, every 16 days and for every observation. Solar diffusers degrade with every measurement exposure.  By tracking the main solar diffuser with two other solar diffusers allowed the degradation tracking of all diffusers. | |

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| **Agenda Item: 7b** | |
| **Presenter** | Jack Xiong, NASA |
| **Overview** | SNPP/NOAA20 VIIRS performance  N21 launched in late l022  The NPP and N20 and N21 VIIRS performance was normal  Early results indicate the N21 has a very similar instrument to N20.  Long-term stability monitoring indicates that the SNPP and NOAA20 VIIRS reflectances are stable to within 1% over mission for all bands, except for a few short wavelengths from SNPP VIIRS that show more upward drifts in high-radiance conditions.  Known biases between SNPP and N20 VIIRS RSB (table below). Preliminary results indicate that N21 VIIRS agrees well with N20 VIIRS to within 3% (average of all approaches) for each RSB |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Because the NPP and N20 VIIRS visible channels differ in calibration by 4%, the question was asked if N21 VIIRS calibration was more similar to N20 or NPP. Jack replied that the N20 and N21 calibration were more similar based on preliminary results.  Initially the N21 spacecraft had an antenna issue, which was resolved by employing the b side antenna. No further issues were discovered, no tungsten dust degradation that NPP VIIRS encountered | |

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| **Agenda Item: 7c –** | |
| **Presenter** | Raj Bhatt, NASA |
| **Overview** | CLARREO status  CLARREO will demonstrate both on orbit SI traceability within a uncertainty of less than 0.3% which is 5-10 better than the best RSB imagers  CLARREO will demonstrate inter-calibration with VIIRS uncertainty of less than 0.3%. CLARREO will take account the spatial knowledge, pixel point spread function, spectral matching, angular difference, instrument polarization, and target instrument noise. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| The CLARREO CPF mission has been delayed, since the instrument ground characterization revealed an uncertainty greater than mission specifications. Since CLARREO is a calibration mission, the decision was made to delay the mission, which meant giving up their ISS launch slot. The instrument issues should be resolved no earlier than spring 2024. And the next scheduled launch date will be late 2025. | |

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| **Agenda Item: 7d –** | |
| **Presenter** | Thorsten Fehr, ESA |
| **Overview** | TRUTHS status  TRUTHS is in phase A/B1  TRUTHS will have a SI Traceable radiometric uncertainty <0.3% similar to CLARREO  TRUTHS will be in a processionary 90° polar orbit  The TRUTHS payload is comprised of the CSAR, OBCS, HIS components |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Everyone is hoping that the TRUTHS and CLARREO mission will overlap. The instrument designs differ, therefor if TRUTHS and CLARREO observations were compared that would give the uncertainty of their SI traceable observations and validate the on orbit calibration mission concept.  TRUTHS will launch in 2030 and CLARREO late 2025. Discussion ensued about how long the ISS will be operational. The date of 2031 as the end of ISS was mentioned    TRUTHS will be in a processionary orbit and will be a reflective solar band mission only. | |

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| **Agenda Item: 7e** | |
| **Presenter** | Marta Luffarelli, Rayfrence |
| **Overview** | FDR4VGT: towards a 20+ years harmonised data record of land surface reflectances derived from VGT-1, VGT-2 and Proba-V sensors  The 3 VEGETATION program (SPOT-VGT-1, SPOT-VGT2, PROBA-V) have 20+ years of operation. The goal is to produce a Fundamental Data Record (FDR), which harmonizes the observations to a common SI traceable calibration reference using Libya-4 PICS.  CISAR tends to systematically overestimate the BHR with respect to MAIAC/MODIS, especially at lower wavelengths.  At longer wavelengths, the BHR retrieval shows better agreement between CISAR and MAIAC products. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Concerns were raised with the low BHR for the blue band over the Sahara Desert | |

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| **Agenda Item: 7f** | |
| **Presenter** | Jessica Matthews, NOAA |
| **Overview** | GOES-FCDR  Geostationary SMS/GOES imager data located on tapes was rescued by improving the decoders that detect errors in the synch patterns. Image quality was also improved, such as stray light identification  The GOES FCDR project entails defining an FCDR format similar to EUMETSAT and the review of the existing calibration approaches.  The GEO-Ring FCDR project is a combined effort from NOAA and EUMETSAT |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Dave Doelling suggested for the NOAA group to use the NASA CERES project GEO calibration coefficients.  There was praise for NOAA was going through the effort of reading through all of the old tapes. | |

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| **Agenda Item: 7g** | |
| **Presenter** | Kerry Meyer, NASA |
| **Overview** | MODIS and VIIRS cloud property retrieval continuity  The NASA VIIRS and MODIS cloud retrieval group is trying to seamlessly combine the MODIS and VIIRS record cloud retrievals for a combined MODIS/VIIRS cloud retrieval dataset.  The MODIS and VIIRS visible channel reflectance ratios were performed at the top of bright stratus clouds.  The group has also designed an operational VIIRS channel calibration stability visualization web pages to monitor any changes in the VIIRS calibration |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| It was brought up that MODIS and VIIRS cloud property consistency is not just a difference in the MODIS and VIIRS reflectance differences, but also dependent on spectral response, pixel size, etc. How do the calibration and retrieval communities come together to achieve continuity of retrievals | |

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| **Agenda Item: 7h** | |
| **Presenter** | Misaki EIKI, JMA |
| **Overview** | Impact analysis of new JMA atmospheric reanalysis data on the vicarious calibration by RTM using water clouds  JMA utilizes MODIS cloud retrievals, reanalysis, and OMPS/OMI ozone retrievals to compute the Himawari-8/9 predicted pixle reflectances over the GEO domain  JMA performed sensitivity studies with the JRA-55 and FRA-3Q reanalysis products and found that the computed reflectance changed by 0.2%  The OMPS/OMI computed reflectance difference was 0.9%  The computed reflectances appear to have a strong seasonal component  JMA is migrating their radiative transfer algorithm to use VIIRS inputs rather than MODIS inputs |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| The seasonal variability in the computed reflectances were mentioned. JMA is looking into it. | |

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| **Agenda Item: 7i** | |
| **Presenter** | Thomas Kurosu, NASA/JPL |
| **Overview** | Radiance Comparison from OCO-3 and OCO-2 Simultaneous Nadir Observations (SNOs)  The OCO2 sensor is on the Atrain (1:30 MLT) sun-synch whereas the OCO-2 is on the processionary ISS orbit. The orbit intersect SNO provided direct comparisons of the OCO radiances.  The OCO3 relies on lamps for on orbit calibration whereas OCO-2 also employs solar and lunar observations.  The average O2 A band, weak and strong CO2 bands OCO-2/OCO-3 ratios were 0.995, 0.955, and 0.985 |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| The GSICS VIS/NIR members welcomed the OCO participants. Should there be a separate GSICS research working group, since the team utilizes absorption band channels. | |

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| **Agenda Item: 7k** | |
| **Presenter** | Seb Wagner, EUMETSAT |
| **Overview** | Moving from MODIS to VIIRS: evolutions of EUMETSAT implementation of the GSICS DCC algorithm  Seb talked about migrating the SEVIRI GSICS DCC and lunar calibration algorithms into the MICMICS system. The MICMICS will incorporate MTG, EPS-SG, AVHRR, 3MI, OLCI etc.  He presented preliminary DCC stability plots for the visible channels on SEVIRI  On both Met-11 and Met-9 |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Dave Doelling asked about the code programming effort to develop a modular and scalable framework. EUMETSAT hired 5 programmers for this task. The 5 programmers did not utilize existing code but developed all algorithms from first principles. He also asked if the code can be made available through GSICS | |

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| **Agenda Item: 7l** | |
| **Presenter** | Kazuki KODERA, JMA |
| **Overview** | Evaluation using the DCC & Ray-matching method and SNPP & N20/VIIRS through parallel observation of Himawari-8/9  Himawari-9 will become the operational imager on 13th December 2022 and a calibration comparison of the visible channels between Himwari8/9 is needed to properly inter-calibrated. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| It was noted that the JMA DCC invariant target results were noisy, especially for a satellite over the TWP region. Should revisit this during a GSICS monthly web meeting.  Although Himawari-8 and 9 have onboard solar diffusers, JMA does not use the solar diffusers to correct for the optical degradation but is another method to detect trends. | |

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| **Agenda Item: 7m** | |
| **Presenter** | Dave Doelling,NASA |
| **Overview** | Discussion of GSICS DCC VIS calibration to GSICS product  The basis for the GSICS visible DCC calibration paper are discussed in Raj’s and Seb’s ATBD.  The remainder of the presentation focused on the DCC invariant target uncertainty estimate, which is based on the Aqua-MODIS absolute calibration, sensor stability, reference and target DCC domain natural variability, SBAF, and methodology. The methodology is a function of the PDF mode interval and BT threshold, the DCC BRDF, and pixel resolution. Pixel resolution has not been studied and will be addressed in follow on GSICS monthly web meetings. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| The second part of the talk centered on other VIS/NIR calibration strategies with a request of GSICS members to lead the calibration effort, for example, Rayliegh scatter, ray matching and PICS.  Tim Hewison mentioned that the IR group is reexamining IR sensor pair intercalibration. Having VIS/NIR and IR synergy in developing a VIS/NIR ray-matching strategy would be beneficial since many agencies already have the IR ray-matching code. The current VIS/NIR activities will focus on the following   1. Promote the DCC visible calibration to product status 2. Develop the DCC SWIR calibration methodology across agencies 3. Work with IR group to develop the ray-matching approach in the visible | |
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| **Agenda Item: 7m** | |
| **Presenter** | Raj Bhatt, NASA |
| **Overview** | Implementation of the GSICS DCC NIR methodology to product  Raj went over the GSICS DCC invariant target calibration methodology for SWIR bands. The following improvements over the VIS approach are  Migrate to N20 VIIRS reference, Raj has computed the DCC domain reflectances.  Perform IR BT threshold normalization between GEO and VIIRS  Seasonal corrections of the GEO DCC response over the domain  Raj laid out an implementation with a joint agency ATBD and paper. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| It was discussed that the IR BT threshold dependency on the DCC mean reflectance. For visible bands there is a weak dependence for SWIR band it is strong. Plan on follow on GSICS monthly web meetings on this topic. | |

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| **7n. EUMETSAT activities in 2022: outcome of the measurement campaign with S3 and MSG1 end-of-life tests** | |
| **Presenter** | Sebastien Wagner (EUMETSAT) |
| **Overview** | Seb described the regular maneuvers now performed with Sentinel-3 to allow OLCI and SLSTR to observe the Moon and presented some latest results, highlighting the importance of straylight correction, which is being improved using these acquisitions. He explained how the oversampling factor and solid angle are calculated, which are critical for developing lunar calibration on an absolute scale. He showed a small sensitivity to the exact SRF used, which can vary between OLCI cameras and outlined plans to analyse SLSTR results.  Seb went on to show results from the Meteosat-8 End of Life tests, which included extended series of lunar acquisitions including some without saturation in the infrared, with reduced gains (which need more work) |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: SEVIRI acquisitions during EOL tests – in one day or mulitple?  Two days of 8hr each - to verify the medium-term stability requirement  Q: Impact and calculation of oversampling factors?  Can be discussed offline | |

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| **Agenda Item: 7o. Status of Lunar Irradiance Model of ESA (LIME)** | |
| **Presenter** | Emma Woolliams (NPL) on behalf of Marc Bouvet (ESA) |
| **Overview** | LIME model based on observations from CIMEL 318-TP9 from Tenerife. Instrument was characterised to SI-standards at NPL. Standard uncertainty ~1% from 400-1640nm. Calibration further validated in the field using solar Langley method, which was repeated to show stability of the instrument in operation. Uncertainty analysis propagated via Monte Carlo using [Comet tool](https://www.comet-toolkit.org/).  Plaiedes observations show reduced bias with LIME compared to ROLO.  For 3 months in Spring 2022, installed hyperspectral instrument (ASD) adjacent to CIMEL to define new function to perform spectral irradiance spectral interpolation (instead of relying on Apollo samples, as used in ROLO). Yearly updates to LIME model are provided on the Cal/Val portal and an easy-to-use toolkit is under preparation. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Progress with ASD hyperspectral radiometer?   * Ran for 4 months, but considering an extension from 2024   Q: Anything published on the ASD fore-optics?   * Just using scrambler – with only addition of enclosure and thermal control environment   Q: Does CIMEL see Sun and Moon with same optical path?   * Yes – with different gains within the instrument. Also performed with ASD, using neutral filters   Q: Langley plot extended beyond 2.0?   * Currently under investigation * Also considered in uncertainty propagation   Q: ROLO observations found variations of <1hr suggested variabilty on atm length scale ~1km. Same for the Tenerife environment?   * Some days are better than others | |

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| **7p. Using the Moon for MODIS and VIIRS Reflective Solar Bands Calibration Inter-comparison** | |
| **Presenter** | Jack Xiong (NASA) |
| **Overview** | By careful selection of Moon viewing geometry, can avoid the need for oversampling corrections.  Compared to ROLO: Aqua/Terra MODIS , SNPP/N20/N21 VIIRS   * Can then compare MODIS-VIIRS by double-difference * Highlighted sensitvity to solar spectral irradiance!   SNPP typically ~5% higher than N20  First preliminary N21 results agree with N20 within ~2% |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Time series of results show systematic pattern with seasonal cycle?   * (Tom) suspected libration dependence – largely resolved with SLIMED model   Q: Other Moon acquisitions available?   * Yes – but only samples from dedicated manouevres shown here | |

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| **7q. air-LUSI - First Operational Campaign** | |
| **Presenter** | Kevin Turpie (NASA) |
| **Overview** | 4 successful flights in March 2022 –12.9 to –60.3 degrees phase angle  Estimated uncertainty on calibration ~0.6% in mid-VIS  Will provide public access to data and processing |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: When can we expect data release?   * Within a few weeks/months | |

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| **7r. Lunar Calibration Activities at USGS-EROS** | |
| **Presenter** | Sandy Preaux (USGS) |
| **Overview** | Seasonal variations in Landsat/OLI v ROLO – strongly related to Moon size   * Channel dependence due to position on focal plane * Calculated oversampling from viewing geometry (new) and aspect ratio from thresholds (old) - new method more stable   Uses acquisitions close to full moon, sampled in opposite directions, giving rise to residual uncorrected bias  Developed in-house implementation of ROLO – plan to rework to make accessible |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Hugh Kieffer reported on oversampling factor accurately   * Will send to Sandy   Q: Direction issue is suggestive that movement of Moon against celestial background is not corrected   * Will communicate offline   Q: validity of ROLO model at low phase angles?   * 6-8 degrees   Q: Would be interested to see over sampling equations   * Complicated part is figuring out viewing geometry – covered in Lunar Calibration Workshops | |

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| **7s. ARCSTONE InVEST project** | |
| **Presenter** | Costy Lukashin (NASA) |
| **Overview** | ARCSTONE InVEST – tech demonstration in space  CubeSat – 550km, 6-month flight time. Spectrometer with 0.7deg fov   * Excellent pointing stability (2 star trackers) |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How much do you expect temperature of optical bench to change?   * Should be stable to 0.1K - will need to take frequent dark views | |

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| **7t. Comparing SLIMED with GIRO using ABI** | |
| **Presenter** | Bikash Basnet (NOAA Affiliate) |
| **Overview** | Used ABI acquisitions from GOES-16 and –17 over a broad range of lunar phases and compared to GIRO and SLIMED lunar irradiance models.   * Mean irradiance is higher from SLIMED than GIRO – esp at short wavelengths – and provides better fit to ABI observations in terms of bias, and reduced phase angle dependence in Ch06 (SWIR) - for both G16 and G17   Requested package for SLIMED model similar to GIRO – with a public version, preferably in Python |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Tom has ideas for underlying cause of phase-angle-dependence in GIRO and is trying to work out  Q: Is the reduced bias and improved phase-angle-dependence of SLIMED expected?   * (Tom): yes – it is expected, and needs to be revised * (Tim) it is entirely expected, as the SLIMED model is based on observations, and this reflects the consensus understanding of the old ROLO biases – however, it is reassuring to see it works!   Q: SLIMED normalised STD actually higher than GIRO in Ch01 and Ch02?   * The fact that these channels have a larger scatter is indicative of the observations, not the model | |

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| **7u. Discussion: Implementing SLIM as a GSICS lunar model** | |
| **Presenter** | All |
| **Overview** | Tom’s recent developments of the ROLO model have resulted in divergence from GIRO  Tom recapped the history and motivation for the GIRO lunar model and continued the discussions from the monthly web meetings on how to take this forward, based on a draft document circulated by Tom 2023-02-23, which proposes the development of a modular system, which allow the core disk-equivalent reflectance module to be interchanged and interfaces to standardised intermediate data file for input and output. He proposes keeping the GIRO input files.  Hugh Kieffer provided a review of the SLIMED model and the issues restricting the use of it in its current form. The key different to ROLO is spectral multipliers of solar irradiance and nominal albedo (instead of disk-equivalent reflectance, although that can easily be derived). Slides describe details of SLIMED model. Community must first reach agreement on the input and outputs, including units.  The modular approach allows the non-trivial development effort to be distributed |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Distributing software is a challenge, especially across agencies. Costy recommends ncStream to handle intermediate files.  Comment: LIME team have been developing modular toolbox collaboratively in 3 institutes – and includes uncertainties built into the framework.  Q: Can we just use the LIME toolbox?   * It is still under development   Comment: Calculation of distance corrections should be done in ingest module   * agreed   Comment: Could learn from CRTM experience – based on a core of calculating transmittance  Q: Can we include the full range of foreseen observation types (e.g. hyperspectral)?   * Yes. Relies on complete specification of all interfaces, following GIRO IO specification doc   A.GVNIR.20230302.1: Marc Bouvet (ESA) to provide information on LIME toolbox  A.GVNIR.20230302.2: Fred Wu (NOAA) to investigate possible mechanisms to fund development of lunar irradiance framework | |

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| GRWG Microwave Sub-Group (MWSG) | |
| **Chair** | Mark Liu + Qifeng Lu |
| **Minute Taker** | Tim Hewison |
| **Attendance** |  |
| **Remote Attendance** |  |

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| **Agenda Item: 8a. Welcome and Introduction** | |
| **Presenter** | **Mark Liu and Qifeng Liu** |
| **Overview** | Welcomed the group to the meeting and outlined the agenda. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Agenda Item: 8b. SI-Traceable Microwave TB Targets Development at BIRMM** | |
| **Presenter** | **Chunyue Cheng - BIRMM (Beijing Institute of Radio Metrology & Measurement)** |
| **Overview** | Introduced the concept of a standard radiometer which can be used to validate the brightness temperature of black bodies constructed either as an array of pyramidal metal tines, or a single hollow metal cone. Different blackbody designs have been tested by substitution. Modern pyramidal blackbody designs feature tapered absorber thickness near the base or curved metallic kernels. Blackbody temperature control is achieved by combination of liquid nitrogen cooling and PID-controlled heater panels in the base of the target. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Is the conical black body intended to fly on a space-based instrument?   * No – it is intended for characterisation on ground   Q: Relative advantages of conical and pyramidal targets?   * Conical targets require a lot of space but have smaller temperature gradients. The pyramidal targets on the other hand can be placed easily on satellite-based radiometers to save space, but significant thermal gradients can exist.   Q: What temperature sensors do you use in the blackbodies and how are they mounted?   * The temperature sensors are PT100 PRTs. Their mounting locations were determined by thermal modeling to calculate smoothest areal average temperature in the aluminum substrate to mount the PRTs   Q: What is the range over which the targets can be temperature controlled?   * 90-330K, temperature gradients depend on the target’s contrast to ambient temperature * Although gradients of several kelvin can exist in the target tips, these only contribute ~5% to the areal average brightness temperature | |

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| **Agenda Item: 8c. Calibration improvement of MWTS on FY-3D and FY-3E** | |
| **Presenter** | **Juyang Hu (CMA)** |
| **Overview** | Both MWTS are still working well. Another will soon be launched on FY-3F  **FY-3D MWTS:**  UK Met Office assessed the bias characteristics of MWTS and found a cross-track bias variation.  Instrument temperature varies around the orbit and affects the gain.  CMA revised the smoothing algorithm applied to the calibration target view, which improved the O-B statistics  **FY-3E MWTS:**  The manufacturer re-checked spectral characteristics of Ch7 and Ch8 and found an out-of-band response which introduces sensitivity to the surface.  CMA updated the operational calibration, which reduced bias SNO comparisons with ATMS. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: How is the calibration consistency in the MWTS in different orbits?   * They all use the same calibration principle, but have some algorithm differences – e.g. smoothing and antenna pattern corrections   Q: Are the SNO algorithm results between these instruments with ATMS available?   * Time and location matchups – can share details by email. | |

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| **8d. FY-3E/WindRAD instrument status and calibration accuracy evaluation** | |
| **Presenter** | Mei Yuan (CMA) |
| **Overview** | WindRAD is the first active mission in the FY series  Dual-frequency C + Ku-band – both VV+HH  Radiometric accuracy <0.6dB  Instrument is quite stable – except for impact of high-energy particle events  CMA have rolled-out several updates to the processing in the last 2 years  L1 products have been validated by different methods:   * over ocean – using NWP – confirming the calibration accuracy is <1dB; * SNO method, comparing with Metop/ASCAT, CFOSAT/SCAT - only in polar areas – and with HY-2/SCAT where the SNOs can be global |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What is the cause of the large bias in C-band HH   * Seems to be related to model, and is subject of ongoing research   Q: Can you say more about the impact of high energy particles in the data?   * Can have different consequences – sometimes the instrument needs to be reset, other times it is stable   Q: Cause of larger bias over ocean in Ku HH?   * May be caused by higher SNR | |

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| **8e. Atmospheric humidity and temperature sounding from the CubeSat TROPICS mission** | |
| **Presenter** | John Yang UMD |
| **Overview** | Applied NOAA 1D-VAR MiRS retrieval to early TROPICS Pathfinder data  The aim is to test the impact of 118GHz and 205GHz channels.  John reviewed several examples of TROPICS data in comparison to ATMS, which were broadly consistent. However, 205GHz was shown to reveal more detailed structure of typhoon than 190GHz, due to stronger scattering  He also compared the retrieved TPW and temperature and WV profiles with that from ECMWF and contrasted with the performance of ATMS and MHS, which had substantially lower Std Dev.  The early performance is encouraging, and the successful MiRS extension paves the way to explore more data and TROPICS potential |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: What is ATMS subset used in comparisons?   * 12-channels matching TROPICS channels’ weighting functions   Q: TPW from TROPICS is substantially higher Std Dev wrt ECMWF fields than ATMS or MHS. Is this due to instrument limitations (e.g. channel selection) or a retrieval problem?   * Different in 205GHz channel’s sensitivity to cloud – and higher NEDT * Ed Kim noted the importance of the Ku-band (12 to 18 GHz) to TPW retrievals   Q: CubeSats’ low cost offer potential for higher temporal resolution – but how can they be combined with ATMS?   * Future instruments from EUMETSAT will allow the benefit of the 205GHz channels to be quantified.   Q: Any comparison of F-band channel from TROPICS with those on other satellites?   * Not yet – but worth doing | |

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| **8f. NOAA-21 ATMS Performance Report** | |
| **Presenter** | Ninghai Sun (NOAA) |
| **Overview** | Ninghai reviewed NOAA-21/ATMS Pre-launch and on-orbit tests   * NEDT similar to N20, and all better than SNPP and much less than requirements * Striping index (variance along/cross-track) - better than N20, much better than SNPP * Less inter-channel noise correlation than N20 & SNPP   During NOAA-21 orbit raising, there were opportunities for direct comparison with N20/ATMS by SNO. A relatively low bias in initial results was found, and analysis is ongoing  L2 products (T,q profiles) also evaluated against ECMWF  Used AI to generate limb-corrected and interpolated imagery to assist forecasters |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Did any design changes cause improvement in striping and inter-channel correlation?   * No – the reasons for the noted improvements are not understood | |

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| **8g. TROPICS lunar data processing** | |
| **Presenter** | Juliana Chew (MIT LL) |
| **Overview** | Juliana reviewed the use of lunar intrusions into deep space view to monitor calibration drift with the Yang & Burgdorf 2022 lunar BT model, and accounting for the relative size of the Moon in the FOV  The pathfinder scans at 30rpm, with 81 Earth spots each ~1.5 degrees.  A Gaussian is fitted to the lunar instrusion signals, using Markov Change Monte Carlo (MCMC) method  Comparison of final fit and neighbouring fits are used as an indicator of uncertainty. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Is the 44% illumination typical? What range of lunar phases are seen?   * As low as 2% until last quarter – no full moon so far   Q: Is all the data acquired from the cold-calibration sector? Could there be more data available from full sky scan data?   * Could check with Tiger Yang   Q: Does Markov Chain Monte Carlo algorithm provide uncertainty on fit?   * Yes – used to generate range of all fitted parameters | |

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| **8h. ESA microwave activities - GSICS 2023 report** | |
| **Presenter** | **Raffaele Crapolicchio (ESA-ESRIN)** |
| **Overview** | Raffaele provided an update of the microwave activities at ESA-ESRIN in 2022  SMOS mission extended to 2025 – and developing new space weather products, including L-band solar flux, vertical TEC and solar radio burst bulletin (workshop Nov 2022) and updated other L2, L3 and L4 products.  L1 and L2 algorithms are under review in preparation for 4th mission reprocessing in 2024. Mean bias with respect to ocean model remains good (bias<1K, stddev<1K) mostly, except for some high energy participle events.  Raffaele went on to describe the RADOMEX L-band radiometer at Concordia, which has been used to validate SMOS and SMAP observations in Antarctica over 13 years.  Quality Assurance for Soil Moisture (QA4SM) platform provides standardised validation system for satellite-derived soil moisture with respect to in-situ observations or models. Similar functionality is provided by Pi-MEP Salinity  ESA monitor RFI: <https://rfi.smos.eo.esa.int/>  ESA studying TriHex concept for high-resolution passive L-band. This includes formation-flying 3 spacecraft 5-7.4m apart at low orbit (500km)  CIMR 1.4-3.65GHz - passed PDR, now in Phase C-D. Launch 2028 + B few years later – L1 will be generated by ESA. L2 split polar+land (ESA), ocean+atm (EUMETSAT) |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Potential for CIMR inter-calibration?   * Mostly L2 comparisons for ROSE-L and CRISTAL, but hopefully L1 with SMOS | |

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| **8i. Review of past year open action items** | |
| **Presenter** | Siena Iacovazzi |
| **Overview** | The GSICS MW Subgroup open action items. Since many of the open items have been updated within a month of the conference by the action points of contact, the session focused on one particular action. This is action  A.GMW.20210330.2, which states the following: “Consider the GRWG desire that the Microwave Subgroup focus on 1) the development of MW GSICS standard products – e.g., O-B and SNO for the microwave sounders, GNSS-RO and microwave imagers, and 2) in the near future the definition of reference instruments and sharing of SNO common codes.” The discussion points and associated actions from this session are provided below. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Siena reviewed the core competencies of the GSICS MW Sub-Group, which are given as follows:   * Exchanging technical information about MW sensors and their cal/val methods deemed releasable by the GSICS member agency’s management. * Creating sharable MW cal/val data sets or models * Establishing and fostering relationships with other MW instrument-related working groups where allowable and appropriate   + Committee on Earth Observation Satellites (CEOS) Working Group on Cal/Val (WGCV) Microwave Sensors Subgroup (MSSG)   + National Standards Laboratories (NIST, NPL, NIM, etc.) * Providing current status, and make recommendations about the future of, the MW satellite constellation to the GSICS Executive Panel. This information is presented to the Coordination Group on Meteorological Satellites (CGMS), Group on Earth Observations (GEO), and CEOS. * Developing and maintaining relationships with data users   + NWP community   + Climate community   She also considered possible expansion of collaboration, focusing on the generation of common products. Possible products include O-B Double-Difference and SNO, as well as lunar calibration and possible vicarious calibration  GPM XCAL has been through this process for window channels and have started extending it to sounders.   * Need to check status of XCAL and identify contacts – now led by Rachael Kroodsma (NASA) * Identify corresponding instruments/channels * Consider review of L1 processing algorithms – noting that identification of the measurement equation is first step in establishing metrologically-traceable uncertainty   Discussion on definition of inter-calibration:   * GSICS considers inter-comparison as an important step as a precursor to possible inter-calibration, being a function to convert the calibration of one instrument to be consistent with that of a community-defined reference (instrument) - and these can support the development of FCDRs from multiple instruments. * Ultimately, inter-calibration should be to a SI-traceable reference standard. However, such a standard still needs further development for the microwave. Meanwhile, a full uncertainty analysis is needed to define a community-defined reference. Jon Mittaz recommends following QA4EO principles to achieve this, which have been updated since 2020, following FIDUCEO. He also discussed the potential to define a synthetic reference as a blend of different instruments, each with well–understood uncertainties. One example is from Inke Hans as part of FIDUCEO, who looked at microwave humidity sounders: Remote Sens. **2019**, 11(5), 548; [**https://doi.org/10.3390/rs11050548**](https://doi.org/10.3390/rs11050548) * A similar uncertainty analysis needs to be performed for the inter-comparison algorithm – and this may inform components of the instruments’ uncertainty analysis. * Choice of Reference Sensor for microwave imagers – e.g. GMI – stable calibration, but also being in an orbit that generates collocations globally-distributed. * The MWSG could focus on the development of recommendations for how to characterise different aspects of these uncertainty analyses – e.g. using O-B statistics to diagnose scan-angle dependence. * The Fiducial Reference Measurements provide another approach to establishing SI-traceability through retrieved geophysical parameters * The importance of agreeing a glossary of terminology for GSICS was again reiterated. * The use of FCDRs was discussed – comparisons of observations with FCDRs can be useful, and can bring new understandings of the instruments’ calibration, but care is needed to ensure its uncertainty is fully understood. * Use of vicarious calibration methods – potential application to L-band   A.GMW.20230302.1 Ed Kim (NASA) to invite GPM XCAL to present inter-calibration algorithms to GSICS at web meeting  A.GMW.20230302.2: Martin Burgdorf to invite Imke Hans (now Imke Krizek and at EUMETSAT) to present uncertainty tree developed for microwave sounders within FIDUCEO  A.GMW.20230302.3 Tim Hewison (EUMETSAT) to brief MWSG on experience in developing GSICS products for IR channels of GEO imagers – and uncertainty analysis | |

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| **8k. Chairing the GSICS Microwave Sub-Group** | |
| **Presenter** |  |
| **Overview** | Mark & Qifeng need to step down as co-chairs of the microwave sub-group. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| A.GMW.20230302.4: Siena Iacovazzi (NOAA) to circulate announcement inviting proposals to chair or co-chair the sub-group | |

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| **9a. GDWG Report** | |
| **Presenter** | Kamaljit Ray |
| **Overview** | Reviewed actions and presentations from GDWG breakout session, and outline plans for the coming year |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: More details on discussion on Maturity Matrix? Recalling the GSICS Procedure for Product Acceptance is built on the QA4EO maturity matrix   * Reviewing alignment to a common framework through CEOS WGCV including potential application for small sats from new space   A.GWG.20230301.1: Paolo Castracane (ESA) to brief GRWG on proposals to align GPPA with WGCV maturity matrix | |

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| **9b. GRWG IR Report** | |
| **Presenter** | Likun Wang (NOAA) |
| **Overview** | Reviewed achievements of IR-Subgroup in 2022, open and closed actions from previous meetings  Likun announced his intention to step down as chair of the IR sub-group and requested proposals for a successor, emphasising that he could continue to support them. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **9c. GRWG MW Report** | |
| **Presenter** | Siena Iacovazzi |
| **Overview** | Siena reviewed the outcomes of the recent 2-day microwave sub-group meeting, as well as discussion at this meeting, which included technical presentations, and a detailed discussion on the analysis of uncertainty in microwave radiometers’ calibration, as well as that of inter-comparison algorithms. The development of these will form the focus of common developments from the sub-group over the coming year – and beyond – defining a path to start generating GSICS products. This plan is supported by 4 new actions. Existing actions were also reviewed. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Report of SMOS RFI – important due to influence of 5G. Reach out to SMAP community.   * So far stewarded by ESA, but could follow-up.   Glossary of terminology – generic to GSICS – and beyond   * Emma Woolliams in WGCV on glossary task force – this has gathered material from different existing terminologies onto the CalVal Portal (<https://calvalportal.ceos.org/t-d_wiki),> but needs doing properly as a hierarchical, consistent terminology – will feed back to CEOS WG in April, requesting someone to take this on, including use of software package to generate hierarchical glossary. She offered to act as a point of contact Suggestion: nominate one person from each sub-group to act on task force | |

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| **9d. GRWG Vis/NIR Report** | |
| **Presenter** | Dave Doelling (NASA) |
| **Overview** |  |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| VIS/NIR sub-group to continue with monthly web meetings on 2nd Thursday of each month, but aim to group discussions into a common theme for each meeting, identified on the Wiki. | |

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| **9e. GRWG SWx Report** | |
| **Presenter** | **Tsutomu Nagatsuma (NICT)** |
| **Overview** | Tsutomu-san introduced the new Space Weather sub-group, which had a first kick-off meeting in Dec 2022. Despite this, the session included 8 presentations, which included some relatively mature inter-calibration algorithms. He also proposed a scope for the sub-group's activities – which will be continued by email and in an online meeting – in mid-May. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Larry proposed SWx sub-group could hold web meetings on the 4th Thursdays of each month.  Question for Exec Panel: How to invite and endorse members from non-member organisation?   * Similar situations in other sub-groups * At a working level, there are no obstacles to participation from non-members   Q: Direction of group focused on GEO – can the group address the impact on LEO satellites?   * Need more information from upstream (solar wind, solar magnetosphere) to make forecasts * Group focusing on observations | |

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| **9f. GRWG UVN Report** | |
| **Presenter** | Larry Flynn |
| **Overview** | Reviewed topics of presentations from this meeting.  Group is gradually adopting GSICS-recommended TSIS-1 HSRS as a reference solar irradiance spectrum. The group is using a range of GSICS methods, including DCC, ray-matching, SNOs, RTM, Rayleigh scattering, PICTS (including land and ocean sites)  Will continue to work with OCO/GOSAT/TropoMI calibration team, but not attempt to absorb their work. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Use of RTM?   * Most of community use VLIDORT as a reference RTM - in   Feedback from IR sub-group on use of TSIS-1/2 HSRS reference solar spectra   * Changes in v2 is mostly in IR * Operational users need stability   Discussed in 9e. | |

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| **9g. GCC Report** | |
| **Presenter** | Larry Flynn |
| **Overview** | Reviewed activities of GSICS Coordination Center, and actions. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| EUMETSAT has offered to host the 2024 Annual GSICS Working Groups’ meeting  DONM: 11-15 March - tentatively  2025 Asia?  2026: NASA LARC (CLARREO) or LASP (TSIS) | |

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| **9h. Users' Workshop** | |
| **Presenter** | Larry Flynn |
| **Overview** | Larry proposed a new survey of potential users of GSICS data, seeking feedback on priorities for channels, issues to be resolved, required levels of uncertainty, targeting both NWP and Climate communities. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Tim proposed to first establish which of the solutions discussed under agenda item 2o are technically feasible, then include a question in the survey to ask potential users which of these solutions are acceptable/preferred.  Jack proposed to include a question on the applicability of GSICS Correction to different scenes? (e.g. bright cloud)  Discussed whether corrections should be applied, and by who – and implications if traceability is broken. Jon Mittaz emphasized the need to ensure any corrections can be reversible, as well as traceable. Sebastien Wagner highlighted the balance between completeness and complexity, and suggested the GSICS Corrections should not replace the operational calibration.  Proposals for new GSICS Product Class – or alternative approaches   * Recalling discussion from Day 2 – Agenda Item 2o:  1. Generate a combined GSICS product. This may be provided in one of two variant options: 2. Just provide the coefficients derived from the recommended best blend of references/algorithms for general use 3. Provide best blend, plus access to all contributing sub-products derived from different algorithms/references 4. Provide users with software to identify different products from the GSICS server and generate combine products 5. Provide users with readers to read L1 data, identify corresponding GSICS products, read these from the GSICS server, and implement directly (e.g. SatPy)   A.GWG.20230303.1: Larry Flynn (NOAA) to initiate a strawman survey and prepare canned set of slides to introduce GSICS and its products and set up a web meeting on this topic. | |

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| **9i. New Action Items & Items that can be closed** | |
| **Presenter** | All |
| **Overview** | Covered in minutes |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Tim/Larry Chairs are encouraged to finalize the minutes by 17 March 2023. Manik will then import them to the action tracker tool  Q: Can we rationalize old actions?  A.GDWG.20230303.2: Manik Bali (NOAA) to add option in tracking tool to label actions as no longer relevant, and ensure a lead is clearly identified for each action. | |

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| **Agenda Item: 9j Chairing in GSICS Working Groups** | |
| **Presenter** | Fangfang Yu (NOAA Affiliate) |
| **Overview** | GRWG:   * EUMETSAT proposed Mounir Lekouara as incoming GRWG chair * Follows rotation Asia-America-Europe * To be approved by Exec Panel   Space Weather SG:   * Tsutomu Nagatsuma (NICT) - approved by GRWG Chair   Microwave SG:   * Working on chair   GDWG:  A.GDWG.2023.2: Kamaljit Ray to invite nominations as incoming chair to propose to EP.  A.GDWG.2023.3: Paolo Castracane (ESA) to get directions from ESA Management if he can take up the Chair GDWG |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **9k. Lunar workshop** | |
| **Presenter** | Sebastien Wagner |
| **Overview** | Seb recalled the frist 3 lunar calibration workshops:   * 2014 EUMETSAT, 2017 Xi’an, 2020 Online * 2023 EUMETSAT planned 4-day workshop, hybrid: mini-conference and workshop, possible posters   EUMETSAT will setup a registration website, with letters of support for visa applications  Topics: Moon observations, SI-traceability, Model development, instrument monitoring, thermal IR and microwave, inter-calibration, other applications (MTF, Stray light, co-registration, …)  Session Chairs to be confirmed  Identified potential contributions, including LIME, Air-LUSI, Mauna Loa LUSI, ARCTONE & CLARREO/TRUTHS, new campaigns, GSICS Lunar Observation Datasat, SLIMED, LASP HSRS, model inter-comparison,  A.GWG.20230303.4: Mounir Lekouara (EUMETSAT) to setup a registration website, with letters of support for visa applications |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Dates proposed:   * 4-7 December 2023 (preferred) * 13-16 November 2023 * 11-14 December 2023   Q: Could it be combined with the annual meeting?   * Will consider, but running in series could be prohibitive for participants * Budget for meeting is assigned for 2023 – will complicate to move to 2024   Q: Possible extension for additional half day to accommodate more discussions?   * It is an option   Q: Could dedicate half-day with core team to thrash out interface specification of software development   * To be put on agenda   Q: Kevin Turpie offered to report on recent mini-workshop on lunar observations and any follow-up   * Welcomed! | |

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| **9l. GSICS and CEOS WGCV** | |
| **Presenter** | Paolo Castracane and Philippe Goryl |
| **Overview** | Philippe highlighted some WGCV activities of interest to GSICS:   * SITSAT Coordination Group – to be proposed to WGCV in 23 June 2023 - As a joint task team with GSICS. He outlined provisional objectives of this group * Fiducial Reference Measurements (FRMs) - as part of a generic approach to satellite cal/cal, as outlined in agenda item 1m. Possible role of CEOS in endorsing FRMs, following the approach for Analysis Ready Data, and following a non-binary maturity matrix * Newspace – developed a cal/val maturity matrix following EDAP Best Practice Guidelines / see also 6-minute YouTube talk by Sam Hunt (NPL): [**https://www.youtube.com/watch?v=IRjR\_611-ao**](https://www.youtube.com/watch?v=IRjR_611-ao) * Workshop on preflight calibration and characterisation – need to revise membership of organisation committee – probably 2023Q4/2024Q1 |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Could you consider the Moon as a FRM?   * Agreed, and has been discussed – in particular through ARCSTONE   Q: FRM focus on validation of L2 products – can provide important feedback on L1 performance – hence need for GSICS-WGCV interaction   * Indeed – but not only L2. FRMs include RadCalNet, which can provide TOA radiances for L1 validation and corner cube reflectors – so these site measurements are   Involvement in CEOS New Space Group?  Q: Could consider running preflight calibration workshop in parallel with 2024 GSICS Annual Working Groups meeting?   * Could consider but depends on participants – Albrecht will be in touch   Comment: Workshop could provide feedback to NASA to improve pre-launch characterisation of VIIRS   * Important to share lessons learned in workshop, which is not limited to space agencies – so could get users involvement (e.g. Fred Wu could be nominated for the committee) | |

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| **Annual State of the Observing system (Template, Quarterly Newsletter)** | |
| **Presenter** | Larry Flynn |
| **Overview** | Reminder that reports are due. Reference instruments will be covered in newsletter |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
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| **Next Meeting and Chairs** | |
| **Presenter** | Fangfang Yu |
| **Overview** | Mounir Lekouara, nominated by EUMETSAT, has been elected as the incoming chair of the GRWG.  Tsutomu Nagatsuma, elected by the space-weather (SW) subgroup, has been confirmed as the chair of the SW subgroup.  The next annual meeting of GSICS will take place from 11-15 March 2024 in Darmstadt, Germany |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| A.GRWG.20230303.1: GRWG chair (Fangfang Yu) to recommend the GRWG incoming chair and notify the EPs about the SW subgroup chairs’ confirmation in the coming EP meeting.  R.GWG.20230303.1: Chairs to follow the selection procedures described in the "Selection of Working Group & Sub-Group Chairs and Vice Chairs" Section of "Roles And Responsibility of GSICS Working Group and Sub-Group Chairs" (http://gsics.atmos.umd.edu/bin/view/Development/RolesAndResponsibilities) | |

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| **OSCAR Workshop** | |
| **Presenter** | Manik Bali |
| **Overview** | Manik introduced the OSCAR portal, which links to Instrument landing pages, which can include GSICS products and other information relating to calibration. He highlighted recommendations to further improve OSCAR, which led to the development of a Python API to access the content. First applications could include identifying instruments with similar characteristics – ultimately it could be part of an inter-calibration processing system. |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Q: Tim Hewison encouraged GDWG to work first on simple applications for the API   * Manik showed the example of identifying instruments with common channels and discussed further developments   R.GDWG.20230303.5: Manik Bali (NOAA) to work closely to develop to utilize OSCAR API for retrieving information of interest | |

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| **9n. Plotting tools or in GDWG** | |
| **Presenter** | Manik Bali |
| **Overview** | Covered in existing actions |
| **Discussion point, conclusions, Actions, Recommendations, Decisions** | |
| Question of way forward on products and their access already discussed under the user survey. | |

**Participants list - 2023 GRWG/GDWG Annual Meeting**

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| Lawrence E. Flynn | Mitch Goldberg | Fangfang Yu |
| Likun Wang | Dave E Doelling | Ben Scarino |
| Manik Bali | Xianqian Wu | Xioxiong Xiong |
| Kamaljit Ray | Betsy Weatherhead | Tim Hewison |
| Rob Roebeling | Johnathan Mittaz | Emma Wooliams |
| Paolo Castracane | Philippe Goryl | Ashim Mitra |
| R. K Giri |  |  |
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