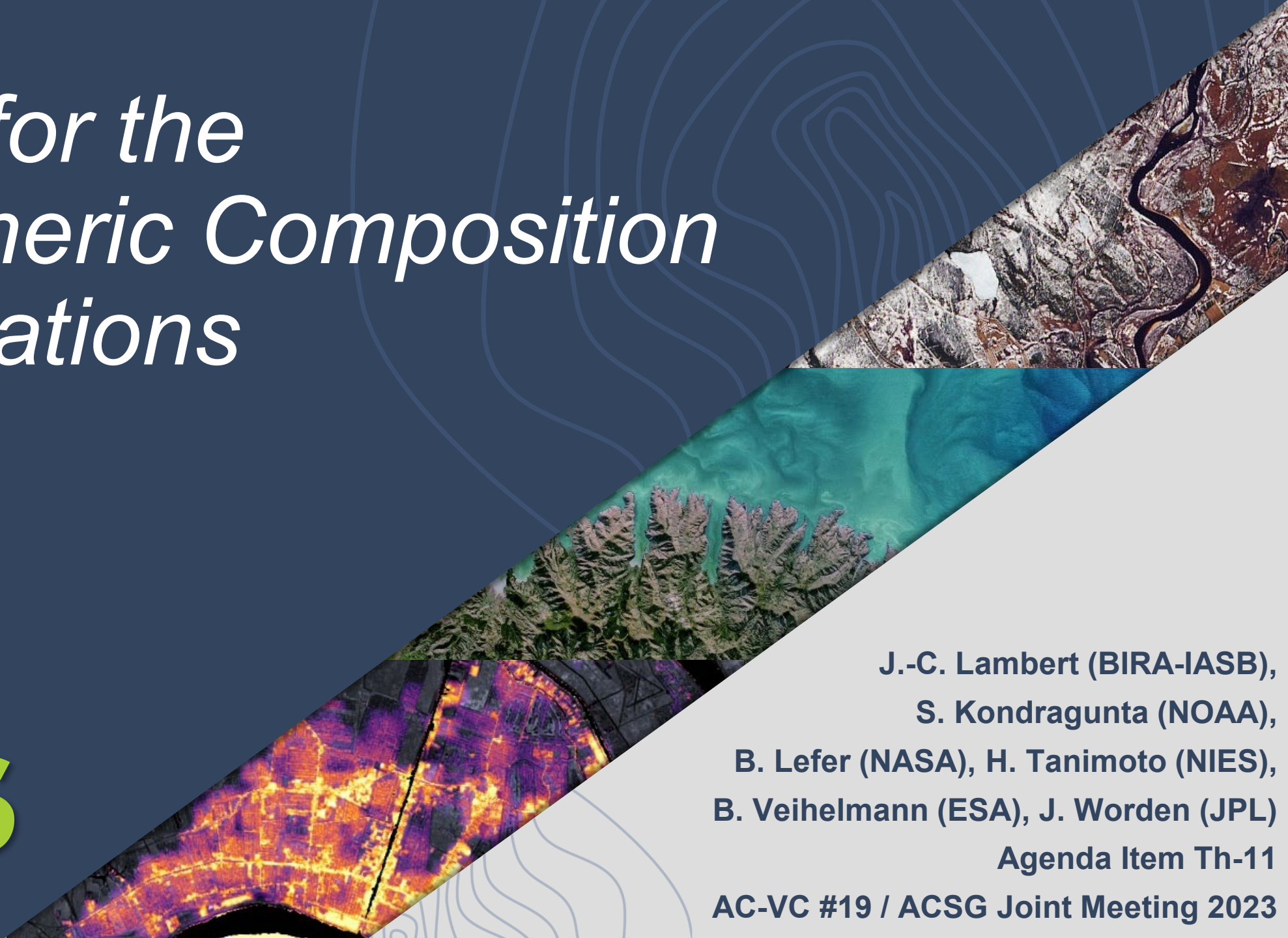
Cal/Val for the Atmospheric Composition Constellations



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Agenda Item Th-11

AC-VC #19 / ACSG Joint Meeting 2023

CEOS
Committee on
Earth Observation Satellites

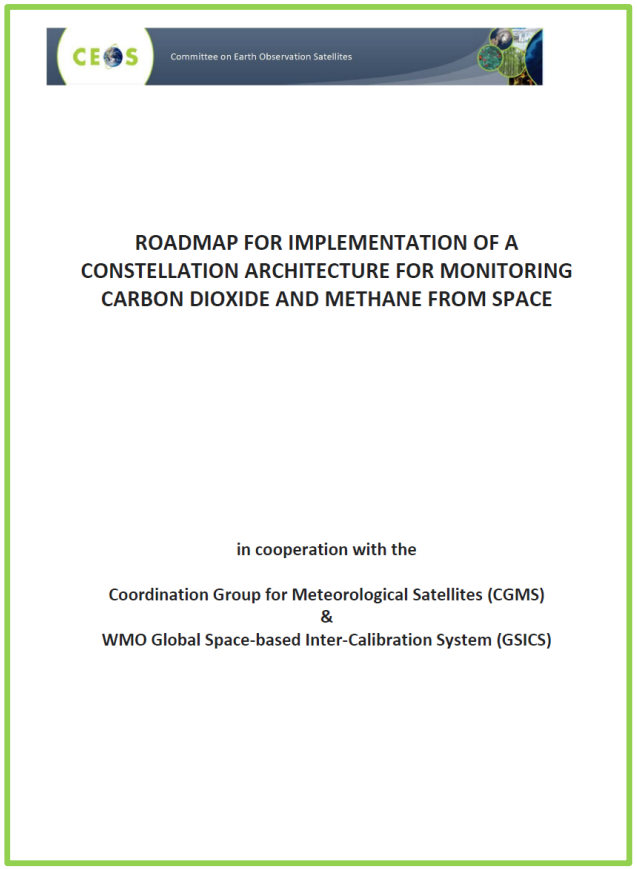
Cal/Val for the Constellations

12:00 - 13:00	Th-11 - Panel review of Cal/Val needs for the AER, GEO-AQ and GHG constellations. Discussion on the way forward (suggestions): need for framework documents, Cal/Val protocols, Task Teams, match-up databases, field activities…? General Q&A, wrap-up

GHG Satellite Constellation

GHG constellation roadmap – Annex C: Implementations actions – Calibration & Validation

AREA	ACTION ID	ACTION DESCRIPTION
Calibration & Validation	CV-1	Address existing CEOS Action by Q1 2020 on "Greenhouse gas reference standards for interoperability": Develop a list of **reference standards for CO_2 and CH_4 products** that are suitable for use in inter-comparison of multiple missions.
	CV-2	Identify the current **shortcomings/gaps/sustainability in GHG calibration and validation capabilities**, and formulate recommendations on the medium- to long-term way forward, that is with a specific focus on GHG Fiducial Reference Measurement (FRM).
	CV-3	Identify gaps and suggest improvements in the **inter-calibration of a future LEO/GEO constellation of GHG sensors**
	CV-4	Define **protocols for comparing and validating GHG retrieval algorithms**
	CV-5	Identify gaps and suggest improvements in **ground-based and airborne validation infrastructure** (i.e. geographical/geophysical gaps for FRM) and other long-term validation needs (at horizon 2025-on).
	CV-6	Work towards an **operational reporting on the quality of space-borne GHG measurements** and the underlying calibration and validation infrastructure.
	CV-7	Identify a repository for hosting quality-controlled CO2 and CH4 products - see Rec#13: CEOS and CGMS agencies should consider a [centralized or possibly geographically distributed] repository for hosting quality-controlled CO2 and CH4 products, with internal capability for product inter-comparison



v2.3, March 2020
Update in progress

GHG Satellite Constellation

GHG constellation roadmap v2.3 – Annex C: Implementation Actions – Calibration & Validation
Recommendations to CEOS SIT TW 2023 for Cal/Val networks capabilities, infrastructure and operational capacity

1. **NETWORKS DESIGN AND EVOLUTION:** to support gap analysis studies with a view to tailoring CO_2,CH_4 and N_2O networks deployments to Cal/Val needs of the GHG satellite constellation: background/hot spots, land/ocean, low/high albedo, full range of atmospheric temperature…
2. **INSTRUMENT DEPLOYMENT:** (i) to further develop (low-cost, light-weight, mobile) low-resolution infrared instruments; (ii) to support standardized production of enclosures for their deployment in the field; (iii) to maintain a supply of spare parts.
3. **CALIBRATION:** to support the development of and maintain mutually consistent calibration and QA/QC of the GHG Cal/Val networks – within and across networks. Key actions: (i) traceability towards internationally agreed standards; (ii) more regular and network-wide deployment of traveling standard; (iii) more regular intercomparisons within and across networks, and between in situ (AirCore…) and remote sensing (networks); (iv) facilitate AirCore deployment; (v) establish a central AirCore data archive.

GHG Satellite Constellation

GHG constellation roadmap v2.3 – Annex C: Implementation Actions – Calibration & Validation
Recommendations to CEOS SIT TW 2023 for Cal/Val networks capabilities, infrastructure and operational capacity

4. **DATA PROCESSING:** to support GHG Cal/Val network data processing improvements needed to maintain FTIR data precision/accuracy and meet future goals: formal intercomparison exercise of the GGG and PROFFAST retrieval algorithms, development and standardization of profile retrievals, spectroscopy studies.
5. **DATA ACCESS:** to establish interoperable GHG Constellation Cal/Val Data archives and tools for tailored network data (traceable, open, metadata, co-located…) and 'hidden' data (e.g. campaigns), ideally coupled to New Space related matchup database(s).
6. **TIMELINESS:** to organize concertation between stakeholders and with networks data providers to support rapid and continuous availability and improved access to networks-wide GHG data.

GHG Satellite Constellation

GHG constellation roadmap v2.3 – Annex C: Implementation Actions – Calibration & Validation
Recommendations to CEOS SIT TW 2023 for Cal/Val networks capabilities, infrastructure and operational capacity

7. **CENTRAL PROCESSING FACILITIES (CPF):** to establish central processing facilities for every network product, which will directly support harmonized calibration **(3)**, data processing, QA/QC and tailoring **(4-5)** and timeliness **(6)**.

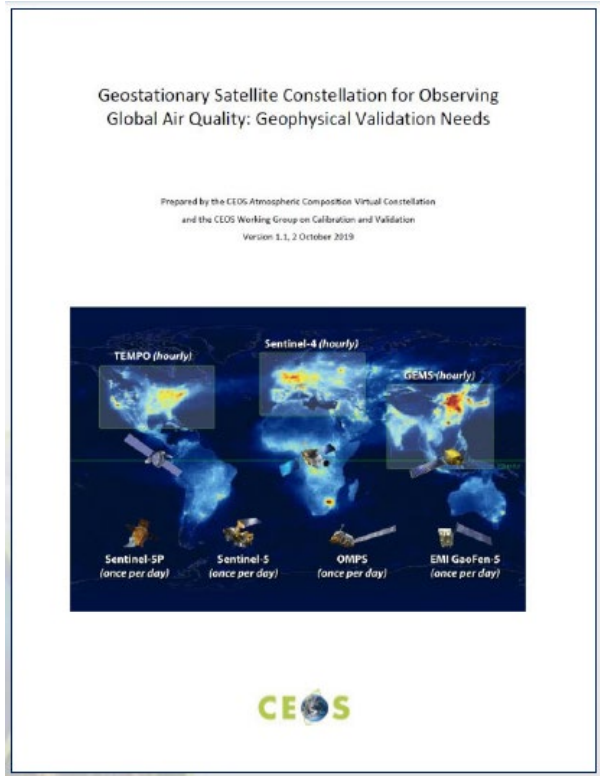
8. **GHG EMISSIONS AND ATTRIBUTION:** to support the development of new Cal/Val protocols for satellite derived GHG emissions and fluxes, in collaboration with relevant bodies and initiatives (global stocktakes, WMO GGGW, UNEP IMEO, New Space…) Consider co-located measurements of GHG and tracers of anthropogenic/biogenic contributions for better attribution of emissions.

Air Quality Constellation

Recommendations

1. Consistently perform intensive campaigns dedicated to the validation of the capability of the Geo-AQ missions to observe the diurnal cycle of the target species. Such campaigns are conducted at several supersites within each Geo-AQ mission domain where a comprehensive suite of correlative reference measurements is made and a comprehensive set of auxiliary data from a variety of sources is exploited.
2. Conduct joint validation campaigns with exchange of reference airborne and ground-based instruments.
3. Further develop and eventually apply approaches to the radiometric inter-calibration of the Geo-AQ missions, based on comparisons of Earth radiance data acquired over known targets, SI-traceable test sites where available, precise and approximate ray matching between GEO and LEO pairs of missions, and by taking the LEO missions as a travelling standard. These activities should be pursued within the frame of the WMO GSICS initiative.
4. Further develop and eventually apply approaches to the inter-calibration of the Level-2 products of the Geo-AQ missions. These approaches include the comparison of products with inter-calibrated ground-based network data, cross-validation of Level-2 algorithms by exchanging Level-1b data, comparing zonal mean values of the stratospheric sub-column in the Level-2 ozone products, and taking validated LEO missions as a travelling standard.
5. Systematically process the Level-2 Constellation Products of the Geo-AQ missions, using one selected common algorithm per Constellation Product.
6. Further pursue the harmonization of the reference data used for validation and inter-mission consistency verification of Level-2 products, aiming at common measurement protocols, common QA protocols, common data formats, harmonized data policy and open access.
7. Implement a data centre for storage and exchange of all validation data collected for the Geo-AQ missions. Make these data accessible to the entire community involved in the validation of the Geo-AQ mission products and their inter-mission consistency, very soon after acquisition.
8. Implement a coordinating unit for ensuring the consistency of the approach and the metrics used for validating the Geo-AQ mission products and their inter-mission consistency.

Next steps:
roadmap, gap analysis

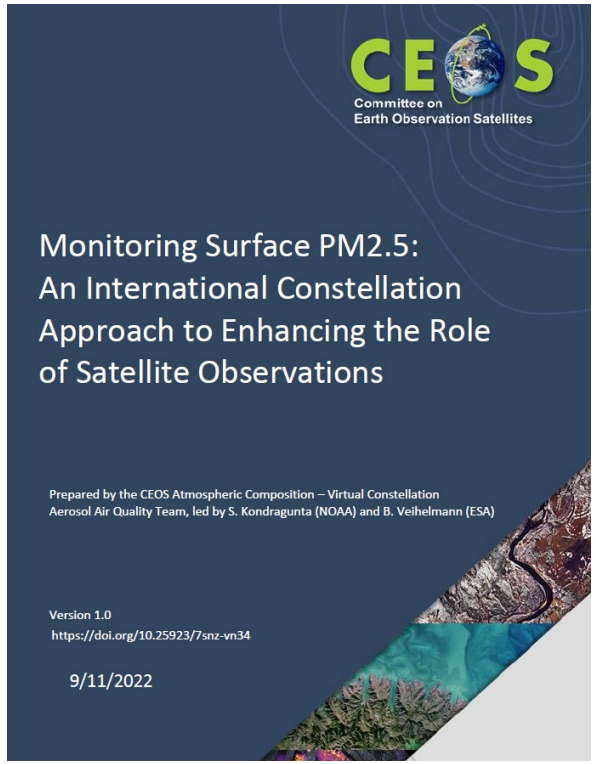


Air Quality Constellation – Surface PM2.5

- Whitepaper “Monitoring Surface PM2.5” (VC-20-05) endorsed at plenary 2022
- Cal/Val related recommendations:

6. Continue efforts to establish, monitor, and enhance the radiometric calibration consistency of space-borne multispectral imagers. Continue and strengthen related efforts made by the Global Space-based Inter-Calibration System (GSICS).

14. Collect and analyze comprehensive reference data sets including measurements from ground-based in-situ PM sensors and co-located radiometers and ceilometers, in order to enhance the understanding of the link between satellite observables and near-surface PM concentrations.
15. Validate satellite-informed PM products, using ground-based in-situ PM data from operational networks. Pursue extending the source of PM reference data by calibrating low-cost $PM_{2.5}$ sensors and developing correction methodologies.
16. Create a data center for providing access to validation data.



Next steps: Cal/Val needs → roadmap