

Minutes of the 22nd Meeting of the Joint CEOS-CGMS Working Group on Climate (WGClimate-22) and the 5th Meeting of the Greenhouse Gas Task Team (GHG-TT-5)

11 - 13 February, 2025

ESA ECSAT, Harwell, UK

Table of Contents

Day 1: Tuesday 11th February, 2025	4
Session 1: Opening Session	4
1.1 - Welcome & Review of Agenda	4
1.2 - WGClimate Work Plan	4
1.3 - GHG Roadmap and Activities	5
1.4 - Review of UNFCCC COP-29 and Earth Information Day	7
1.5 - UNEP International Methane Emissions Observatory (IMEO)	9
1.6 - The skill of Earth Observation for Tipping Points research	11
1.7 - Strengthening the climate modelling - observation interface	12
Session 2: WGClimate - ECV Inventory & Climate Data Records	14
2.1 - Future plan for ECV inventory and support for gap analysis and coordinated action plan	14
2.2 - Response to GCOS Implementation Plan	16
2.3 - GCOS Update	17
2.6 - AVHRR Fundamental CDR & Heritage Dataset recovery	18
2.5 - CDR definition	20
2.7 - GCOS guideline for generating climate data records	21
2.8 - Discussion	21
Session 3: GHG-TT	23
3.1 - GHG Best Practices Update (BP-01)	23
3.2 - Sensor development	24
3.3 - Calibration and Level 1 Products: Annual vicarious calibration campaigns (L1CAL-01)	25
3.4 - Level 2 Products: Validation	26
3.5 - Level 2 Products: Intercomparison Algorithms	29
3.6 - Flux Inversion Modelling: Assess adaptation of current CEOS practices for G3W applications (INV-01)	30

Day 2: Wednesday 12th February, 2025	32
Session 4: Stakeholders	32
4.1 - UNFCCC: GST/RSO	32
4.2 - UNFCCC: Adaptation	33
4.3 - CEOS-CGMS GST Lessons Learned	35
4.4 - Future CEOS GST Strategy	36
4.5 - Discussion	37
Session 5: Partnerships	38
5.1 - WMO Global Greenhouse Gas Watch (G3W)	38
5.3 - Copernicus Atmosphere Monitoring Service (CAMS)	39
Session 6: National emission estimates	42
6.1 - Opportunities and challenges for the use of space-based observations to inform carbon fluxes	42
6.2 - GHG Budget: Results from RECCAP-2	43
6.3 - Global GHG reconciliation: UNFCCC GHG inventories and atmospheric inversion	45
6.4 - Improving the UK GHG Inventory	47
6.5 - EO Data in the French LULUCF Inventory	48
6.6 - Germany	50
6.7 - Steps to improve Norwegian and European emission estimates	51
6.8 - Denmark	52
6.9 - Discussion	54
Day 3: Thursday 13th February, 2025	55
Session 7: GHG-TT - System Development & Stakeholder Engagement	55
7.1 - System Development: Inventory of use cases (SYS-02)	55
7.2 - Engaging with GCP & RECCAP (STAKE-05)	56
7.3 - G3W & IMEO Engagement (STAKE-03)	59
Session 8: Other Topics	60
8.1 - Participation and contribution to UNFCCC events	60
8.2 - Expanding the Utility of ECV Inventory to Address Emerging Priorities	63
8.3 - Roadmaps combined: comprehensive monitoring of the carbon budget	64
8.4 - Capacity Development: EOTEC DevNet Climate Change Communities of Practice	66
8.5 - WIGOS 2050 Vision	69
Session 9: Other Business & Closing	70
9.1 - WGClimate Summary and Action Review	70
9.2 - GHG Task Team Summary and Action Review	70
9.4 - Closing remarks	70

Appendix A: List of Participants	71
Appendix B: WGClimate-22 Actions	73
Appendix C: GHG-TT-05 Actions	77

Day 1: Tuesday 11th February, 2025

Session 1: Opening Session

1.1 - Welcome & Review of Agenda

Susanne Mecklenburg (ESA) reported [[slides](#)]:

- Welcomed all to the meeting. Wenying Su (NASA, WGClimate Chair) sent her apologies for not being able to attend in person.
- ESA ECSAT is where the Working Group on Climate was initiated in 2010.

Harshbir Sangha (UKSA, CEOS Chair Team):

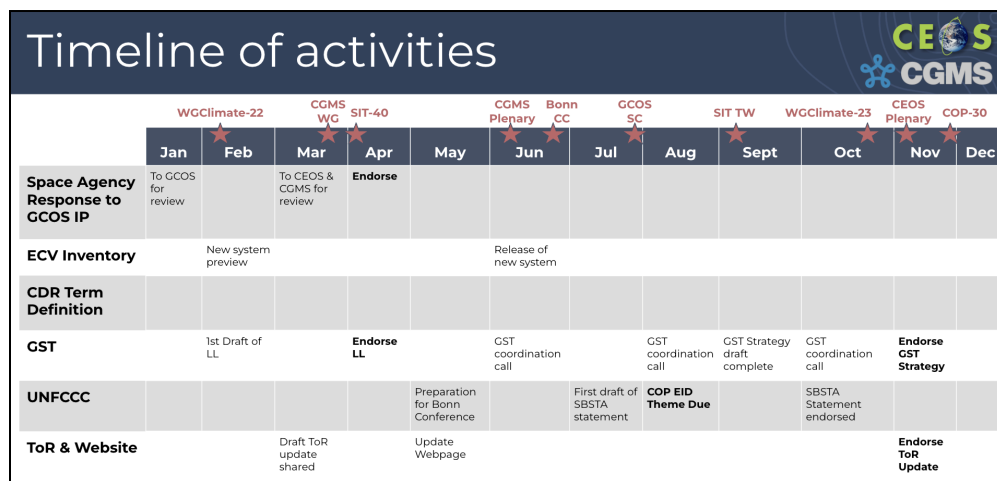
- Welcomed all to the Harwell campus, which hosts a number of research organisations and laboratories, including the Diamond Light Source building adjacent.
- The UK Space Agency is the current CEOS Chair, and Paul Bate (CEOS Chair) sends his apologies for not being able to attend today.
- There has been a huge amount of progress over the last two years to improve the credibility of space for monitoring Earth, noting the first space leaders meeting at COP-28.
- UKSA's CEOS Chair themes focus on "EO for Society", in particular for climate applications.

1.2 - WGClimate Work Plan

Mark Dowell (EC-JRC) reported [[slides](#)]:

- WGClimate was established in 2010 at ECSAT, as a working group of CEOS initially, then jointly with CGMS two years later. The emphasis was on Essential Climate Variables (ECVs), working closely with GCOS to maintain an overview of available climate data records.
- Activities now include policy support activities, such as that for UNFCCC COP and SBSTA.
- The ECV Inventory has been systematically providing an overview of Climate Data Records, and reviewed through the Gap Analysis and Coordinated Action Plan. This allows agencies to consider where best to place their investments in support of climate data records.

- In 2025, WGClimate will work to align the various website instances across the CEOS, CGMS and climatemonitoring.info sites.
- The ECV Inventory architecture is undergoing a restructure, which is expected to be completed in June 2026.
- The Lessons Learned from the first Global Stocktake have been compiled, and the draft was circulated for comment. The document is expected to be endorsed by CEOS at SIT-40, and virtually by CGMS shortly after.
- The Space Agency Response to the 2022 GCOS Implementation Plan has been shared with GCOS Panels for comment. The comments will be compiled and responded to towards the end of February, and then shared broadly with CEOS and CGMS. The document is expected to be endorsed by CEOS at SIT-40, and virtually by CGMS shortly after.
- New deliverables and activities will be discussed this week, and may include expanding the utility of the ECV Inventory, supporting the SIT Chair Team on delivering Issue 2 of the GST Strategy, and increasing country engagement regarding the use of satellite data for national inventory reporting.



1.3 - GHG Roadmap and Activities

Yasjka Meijer (ESA, GHG-TT Lead) reported [\[slides\]](#):

- GHG Task Team (GHG-TT) resides within WGClimate, and includes inputs from a number of groups across CEOS and CGMS. The primary task for GHG-TT is the implementation of the GHG Roadmap and associated activities.
- Issue 1 of the GHG Roadmap (March 2020) was focused on supporting the Global Stocktake. In 2024, Issue 2 was completed, to respond to other emerging priorities.

- One particular focus of Issue 2 was the transition from research to operations, as well as co-developing activities with stakeholders. GHG-TT engaged with G3W and IMEO to capture this process and to create a stepping stone to other stakeholders.
- To ensure smooth coordination with these two key stakeholders, John Worden (NASA JPL) was identified as the GHG-TT point of contact for IMEO, and Vincent-Henri Peuch (ECMWF) as the GHG-TT point of contact for G3W.
- Regarding IMEO coordination, a meeting is planned to discuss follow up from the joint CEOS-IMEO Harvard meeting held in June 2023. A letter from the CEOS and SIT Chairs was also recently sent to IMEO leadership to express support for the activity.
- The activities are broken into thematic areas, each with identified leads and deputies.
- The current focus is on updating the short term actions found in Annex C of the GHG Roadmap.

Discussion

- Jörg Schulz (EUMETSAT) reinforced the importance of transitioning to an operational system. Prior to the 2024 CGMS Plenary, a workshop was held with the GHG-TT. Jörg informed that a similar meeting is planned for this year prior to the CGMS Plenary (4-6 June) on 3rd of June in Evian, France, to understand the pathways for an operationalised GHG monitoring system.

GHG-TT-01	Yasjka Meijer to work with Simon Elliott to prepare a joint meeting between GHG-TT and CGMS Working Groups ahead of CGMS Plenary in June. Involve G3W in this.	Due: June 2025
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- Mark Dowell (EC-JRC) noted that it would be good to get dynamic feedback from key stakeholders regarding the actions identified, including national inventory teams.
- Yasjka Meijer (ESA, GHG-TT Lead) noted that some activities, once started, will likely find a better home within G3W, as GHG monitoring may start going beyond the remit of space agencies.
- Richard Engelen (ECMWF) noted the work to operationalise is already in progress, and lessons have already been learned.
- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) recognised the approach to operationalise GHG observations should be based on work already done, such as that for weather forecasting.

1.4 - Review of UNFCCC COP-29 and Earth Information Day

Beth Greenaway (UKSA, CEOS Chair Team) and Clement Albergel (ESA) reported [[slides](#)]:

- COP-29 saw large participation from CEOS Agencies, across both Earth Information Day and the Space Leaders Summit. However, Earth Information Day preparations were very last minute, and the event was largely unorganised. For future years, CEOS should be more engaged with the preparation for Earth Information Day.
- WGClimate moderated the breakout session on “Observations for climate change mitigation”.
- WGClimate prepared the joint CEOS-CGMS statement to SBSTA, which was read out by the UK delegation. It is important to ensure the delegation making the statement is well prepared, and linked well with the CEOS Chair.
- UKSA also promoted the engagement efforts across their media channels, noting that this work is often left unheard. The fact that space-based observations can support climate monitoring is sometimes missed.
- The STBSA committee included conclusions around EW4All and G3W.
- The Copernicus statement regarding the hottest year on record was refuted, noting that it didn’t constitute a climate record as it was only one year.
- The conclusions noted that EID themes and proposals for 2025 should be submitted by 29 August 2025. UKSA hopes CEOS and associated organisations can organise ahead of this date, to ensure early preparation.
- The ESA delegation’s mission was to showcase how EO missions and long-term datasets can contribute to the Paris Agreement targets and ensure a transparent and reliable global stocktake. They also aimed to raise awareness with the public around how space can support climate change research and action, as well as emphasise ESA’s leadership role within the international community.
- Earth Information Day had an opening session from various stakeholders, alongside a panel with updates on the state of the climate. This was followed by five breakout discussions for climate change discussions.
- SBSTA recognised the importance of robust EO systems and related long-term data records, innovation, and technologies.

Discussion

- Mark Dowell (EC-JRC) noted that Earth Information Day is a mandated event, where any of the discussions can also be taken up within negotiations. WGClimate should have a team preparing a proposal by June, as that allows us to first reach out through CEOS/CGMS Principals and create links to delegation teams. Any proposal put forward by WGClimate could be reiterated by national delegates.
- The SBSTA statement last year provided a more compelling statement than in previous years, however ensuring a good platform to present it is critical. EUMETSAT, as an observer to UNFCCC, could also be a helpful angle to use.
- In 2017-2018, CEOS activities were explicitly mentioned in SBSTA conclusion, however this seems to have been lost in recent years. Partnering with WMO and other organisations will show the cumulative added value of space agency contributions.
- Gianpaolo Balsamo (WMO) recognised great collaboration between CEOS, CGMS and WMO for COP-29. The G3W Implementation Plan now has full endorsement from the WMO Executive Council, and progress will need to continually be reported on.
- Jörg Schulz (EUMETSAT) noted that it would be helpful if climate services, like Copernicus Climate Change Service (C3S), could highlight how much space-based information is used in arriving at their conclusions. The traceability from decision making back through the value chain is important.
- Susanne Mecklenberg (ESA) suggested that WGClimate ensures that representation across other events throughout COP, including with IPCC.
- Beth noted that over the last 20 years, COP has mostly proven that climate change is happening, and now, most people are there to negotiate what to do about it. The robust science should continue, but should be relevant to specific actions that need to be taken.
- Heather Maseko (UNFCCC) was involved in planning Earth Information Day at COP-29, and appreciates the feedback from the systematic observations community. The success of Earth Information Day relies on engaging early with stakeholders, and responding to what parties need. However, care needs to be taken in drawing the line between factual science and direct policy recommendations.
- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) recommended that WGClimate should work on making the take-home messages as compact as possible, and targeted to the correct audience.
- Steven Hamburg (EDF) noted fit for purpose, policy-relevant data is needed, which isn't always straightforward. The requirements for this are still not clear, and there have

been a lot of parallel conversations at previous COPs on this topic which could be better integrated.

1.5 - UNEP International Methane Emissions Observatory (IMEO)

Steven Hamburg (EDF) reported:

- IMEO's goal is to drive substantive change with data, by producing fit-for-purpose, policy-relevant data to drive a reduction in methane emissions.
- Over the last 15 years, scientists have worked to improve the quality and resolution of GHG data to build empirical measurements of methane emissions from the oil and gas industry.
- UNEP commenced global campaigns to better understand GHG missions, following which IMEO was formed to coordinate more holistically.
- IMEO's role is to use integrated and consistent data sources to create a user-friendly interface of data legible to stakeholders. To do so, a radical data transparency and revolution is needed, both for space-based and ground-based measurements.
- IMEO hosts the Global Oil and Gas Methane partnership 2.0, under which Oil and Gas companies are committed to ensuring accurate and transparent reports on their emissions.
- As a more accurate understanding of high spatio-temporal GHG emissions is developed, higher spatial resolution data is needed.
- The satellite community is at the core of these data requirements.

Discussion

- Yasjka Meijer (ESA, GHG-TT Lead) noted there is a lack of clarity around IMEO's short-term goals and milestones towards the larger goals. IMEO has recently agreed to restart the working groups, and Yasjka would like to focus on the Use Cases first, in the target sectors, and with the relevant stakeholders.
- Steven recognised it is important to look at global budgets as they will be affected by facility scale emissions. Previously, IMEO has used indirect methods for global budgets. However, as understanding around some portions of the budget are improved, it is also important to consider how this affects other portions.
- Simon Pinnock (ESA) noted ESA kicked off the Methane Emissions Detection Using Satellites Assessment (MEDUSA) project a year ago, which looks at all the different products from different providers, with intercomparison to understand the relative

capability of different instruments and products. The estimates from controlled release experiments are also compared. The team is working towards understanding how the associated uncertainties are calculated and compared.

- Steven noted that while point sources are critically important, they are not representative of global emissions. GOSAT-GW, CO2M and other global mappers will help build the complete picture.
- Mark Dowell (EC-JRC) asked about IMEO's stakeholder approach. With the Oil & Gas sector, reducing emissions also has financial savings, so it is a win-win situation. However, a lot of other sectors may not need the same benefit, e.g. for landfills. What's the approach for diversifying the approach to these other sectors?
- Steven noted that IMEO is the furthest along working with the Oil & Gas sector, however they are actively working with waste, and also starting with agriculture. For the dairy industry, there are ways to manage manure and optimise biomass which help reduce methane. There are ongoing projects in the Mekong Delta and New Zealand on these topics. However, it is hard to get good remote sensing data for these emissions.
- IMEO is currently setting up an Agriculture subgroup to tackle this sector more specifically.
- Dave Crisp (SIT Chair Team) recognised the CEOS AFOLU Roadmap Team have been having similar issues regarding remote sensing data applicable for measuring agriculture GHG emissions. An initial investment is needed to provide insight and optimise the relevant systems to make progress in this area, but would need IMEO to provide the relevant requirements.
- Jörg Schulz (EUMETSAT) asked how far away IMEO is from a real time system that would monitor facility scale emissions and how stable the funding of IMEO is.
- Steven noted that IMEO is currently funded directly through governments and some foundations. It was decided that public sector funding (government and philanthropic) was necessary for the success of IMEO, to ensure data trust and integrity.
- IMEO is still working to define what 'near-real time' means. The Methane Alert and Response System (MARS) data is processed within two weeks, which is a similar timeframe IMEO is hoping for other data. The goal is to build an automated platform that brings these data together, with a data latency of a few weeks maximum. Quarterly aggregates will also be provided to show overall progress.

1.6 - The skill of Earth Observation for Tipping Points research

Tim Lenton (U of Exeter) reported [[slides](#)]:

- ‘Tipping Points’ refers to when minor changes to a stable system force the system into a different stable state. Characteristic warning signs are often shown before the system tips over, due to less damping feedback.
- The characteristic early warnings are seen in the melting of Arctic sea ice and the Greenland ice sheet, as well as the Atlantic meridional overturning circulation. These warning signs are often detected using remote sensing data.
- Core tipping elements would have significant effects on the planet if they tipped, as they wouldn’t act in isolation and could cause a cascade effect of other tipping points. A number of regional impact tipping elements also exist, which won’t affect the global climate if they tip, but will significantly affect their surrounding regions.
- EO can monitor relevant feedback processes to improve the models, as well as detect alternative stable states and abrupt changes. EO can observe system dynamics over time, including changes in resilience and associated early warning signals.
- There are four categories of tipping that EO can probe: macro tipping - operating across large spatial scales; clustered tipping - localised tipping near-synchronously across a large area; propagating tipping - small scale tipping cascading into larger scales; and societal impact tipping - localised tipping with large societal impacts.
- Remote sensing data has identified a loss of resilience in the Amazon, through Vegetation Optical Depth (VOD) measurements.
- EO can advance the understanding, detection and anticipation of tipping points, and their interactions, across scales. A tipping point sensing system could be established bringing together the Earth system and EO communities, which can provide vital information to support policy-making and risk management.
- The Global Tipping Point report will be updated for UNFCCC COP-30 this year.

Discussion

- Yasjka Meijer (ESA, GHG-TT Lead) recognised these messages make the impact of a couple of degrees warming more clear, which is a key message to communicate to a wider audience.
- Tim’s team has tried lots of strategies for communications, however are struggling to get the message of the potential impacts to a wide audience. Changes in the average

temperature isn't the crux of the issue, as is reported by most media. Destabilisation and amplifying change is the key issue for climate change.

- For space agencies to develop resilience indicators systematically, it would have to be a collaborative effort. The VOD analysis was anchored on the VODCA dataset from Copernicus, which contains data from a number of different sensors.
- Steven Hamburg (EDF) noted there have been a lot of state changes when it comes to biodiversity. However, this doesn't necessarily always result in bad outcomes. For example, loss of a coral reef could produce a more lucrative fishery, improving the economic situation for local communities.
- Jörg Schulz (EUMETSAT) suggested that remote sensing data could be used for precipitation analyses to understand water availability. Model-based reanalysis is weak in some respects of capturing extremes of precipitation in the Tropics, in particular when it comes to moisture recycling via vegetation.

1.7 - Strengthening the climate modelling - observation interface

Eleanor O'Rourke (ESA), Claire Macintosh (ESA) and Amy Doherty (UK Met Office) reported [\[slides\]](#):

- The 'climate modelling multiverse' describes a model's temporal and spatial coverage, resolution, size, and complexity.
- Earth System Modelling & Observations (ESMO) is a new project within World Climate Research Programme (WCRP), with three core aims:
 - Advancing predictions and projections of the Earth system
 - Improve monitoring, understanding, and attribution of Earth system changes and impacts
 - Advancing and harnessing emerging technologies in modelling and observations
- The Working Group for Observations for Researching Climate (WGORC) within ESMO has a mission to identify and address research gaps in climate observation data and act as a facilitator for collaboration across diverse research and industry sectors. The call for members is currently open, and WGClimate members are invited to participate.
- Coupled Model Intercomparison Project (CMIP), another WCRP project, requires that datasets are, spatially complete, with at least 1 degree spatial resolution and monthly temporal resolution. However, the length of the satellite data records are not long enough for the models, and hence the transition from pre-satellite to the current era needs to be carefully considered.

- For example, satellites have helped detect smaller volcanic eruptions. However, no record of these types of eruptions exist from before 1979. Satellite data adds about 40% more sulfur dioxide to the atmosphere compared to the ice core record.
- Over a 20 year period that includes MODIS, the models predict an extra 0.4 degree warming in the Northern hemisphere. However, this is purely associated with the increased variability of EO.
- CMIP is developing a rapid evaluation framework focused on preparing inputs for the IPCC 7th Assessment Report (AR7), known as the 'AR7 fast track'. The goal is to provide a tool to support the wider community, with a number of diagnostics for model intercomparison.
- CMIP recognises the need to develop strategies together with the modelling and observations communities to understand the data cycle and interface between the two.
- Improved data sharing and communication between the modelling and observation communities will enhance scientific outcomes. WGORC would like to have regular joint meetings with WGClimate to review the community interface, and to work with WGClimate to develop an accessible database to improve interface requirements.

Discussion

- Mark Dowell (EC-JRC) noted the CEOS MIM Database, supported by ESA, could provide some of what was asked for regarding the database.
- WGClimate has a good dialogue with GCOS on their requirements, but it's good to hear requirements from other communities. However, it is important to make a distinction on what CEOS and CGMS can provide on projects and activities, and types of requirements for systematic CDR production.
- Jörg Schulz noted that an application-dependent typology for GCOS requirements might be the best way for addressing the topic as modelling forms part of the proposed suite of applications – further addressed under agenda item 8.2.
- Caterina Tassone (GCOS) recognised that GCOS has been engaged in these discussions, and some requirements would fit in well with the GCOS requirements. GCOS is happy to participate in WGORC.

<p>WGClimate-22-01</p>	<p>WGClimate Chair to share the call for members for the Earth System Modelling & Observations (ESMO) Working Group for Observations for Researching Climate (WORC) (POC Claire Macintosh). Ensure GCOS also receives this invite and is represented in the Working Group.</p>	<p>Due: March/April 2025</p>
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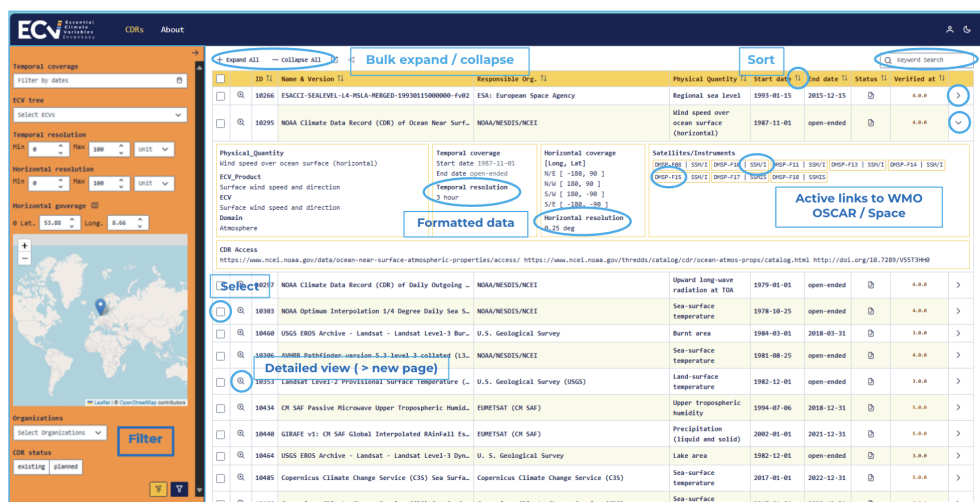
WGClimate-22-02	WGClimate Chair and Vice-Chair to plan a joint 2-hr meeting with ESMO science steering group (POC Claire Macintosh). The recommendations presented (slide 19) should be discussed, and an action plan for the way forward agreed. GCOS should also be involved in these discussions.	Due: Q3 2025
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Session 2: WGClimate - ECV Inventory & Climate Data Records

2.1 - Future plan for ECV inventory and support for gap analysis and coordinated action plan

Jörg Schulz (EUMETSAT) and Alexandra Nunes (EUMETSAT) reported [[slides](#)]:

- The ECV Inventory provides a comprehensive and accessible view of existing and planned Climate Data Records, as well as delivering further climate data records through best use of available data. This assists in optimising the planning of satellite missions.
- The ECV Inventory is transitioning into the 'CDR Inventory', with a new technical baseline and simplified process to populate and verify the datasets. The Inventory will have continuous publication, with individual time tags used for record updates.
- Previously, the Inventory was published at specific points in time, when some information was already out of date. Now, the information will be live, and updated continuously.
- Below is the user interface for the new CDR Inventory:



- The CDR Inventory structure will allow for evolution, in particular for updates made by GCOS, and in support of emerging priorities.
- Gap Analysis Report summarises all analyses done in the period 2020-2024. All comments received were editorial, and the document can be considered finalised.
- For the Coordinated Action Plan, 9 actions remain open from 2018, and 6 from 2024. Two comments were received that need to be addressed.
- NOAA commented on action #2018-13 (plan to address the measurement gap for stratospheric CH4 profiles in order to provide FCDR/CDR in the future), noting the lack of progress in developing a plan for stratospheric CH4 profiles is concerning, as these profiles provide critical insights into upper-atmosphere methane dynamics, transport, and long-term climate impacts. The recommendation is to consider a workshop or task force involving agencies with relevant measurement systems to evaluate the feasibility of leveraging existing sensors to initiate a pilot study for long-term FCDRs/CDRs. WGClimate should work with AC-VC to respond to this.
- WGClimate-20 decided to keep action #2018-09 (development of FCDRs) open with the understanding it describes a long-term goal for the community. However, before this can be successfully addressed, the FCDR definition needs to be acknowledged and largely followed by agencies. NOAA recommended that an additional action be created for all agencies with geostationary imagers to support the GEO-Ring efforts. It is suggested that this be covered mostly through CGMS.
- It is proposed to exercise future gap analyses together with GCOS based on their Implementation Plan (IP) Actions. The Space Agency Response to the GCOS IP provides some answers, but mostly on the space segment and not climate data records.
- The joint meeting next year with GCOS will be a good opportunity to reassess prior to the next GCOS IP.

Discussion

- Mark Dowell (EC-JRC) questioned why the CDR Inventory provides links to satellite missions in WMO's OSCAR/Space Database, and not the CEOS MIM Database. Alexandra noted this has not been evaluated recently, however previously there were issues with the MIM Database not containing historical missions.

WGClimate-22-03	ECV/CDR Inventory team to review the information available on the CEOS MIM Database, and consider establishing linkage with the CDR Inventory.	Due: June 2025
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- Darren Ghent (Uni. Leicester) noted there might be some issues where datasets met previous GCOS requirements, but not the most recent requirements.
- The CDR Inventory’s approach to the variables tree will allow connection to previous versions of the GCOS ECVs. The CDR Inventory will also use a process in which the team gathers the information themselves, and then asks agencies to verify. If an agency does not verify, the datasets will have an uncertainty flag.

WGClimate-22-04	WGClimate Secretariat to publish the Gap Analysis Report on the CEOS Website.	Due: 21 Feb 2025
WGClimate-22-05	Jörg Schulz to provide the list of open actions from the Coordinated Action Plan for input into the CEOS Work Plan.	Due: 18 Feb 2025

2.2 - Response to GCOS Implementation Plan

Jörg Schulz (EUMETSAT) reported [[slides](#)]:

- The GCOS Implementation Plan (IP), produced every 5-6 years, provides recommendations for a sustained and fit for purpose Global Climate Observing System (GCOS).
- The 2022 GCOS IP has a different form, with fewer, more focused actions. The stakeholders responsible for responding were also identified.
- 16 Actions were included in the Space Agency Supplement, each containing multiple activities. Responses from CEOS and CGMS via WGClimate were provided to each of the activities listed - 21 activities responded to in 2023, and 27 in 2024.
- The report was shared with GCOS Panels in mid-January, with feedback to be provided by the end of this week. This feedback will be incorporated, and then shared with CEOS and CGMS for comment. WGClimate will seek endorsement of the Space Agency Response to the GCOS IP at SIT-40 in April 2025.
- The Space Agencies’ Response to the 2022 GCOS IP will be updated before the joint meeting with GCOS Panels in February 2026, to provide the most up-to-date information for the 2027 GCOS Status Report.
- The goal of the joint meeting with GCOS Panels is to collaboratively develop the GCOS Status Report and Implementation Plan.
- The WMO Integrated Global Observing System (WIGOS) 2050 Vision is also currently in development, which is an additional opportunity to ensure these topics are represented.

Discussion

- Darren Ghent (Uni. Leicester) noted the Terrestrial Panel will share their feedback by the end of this week. There remains an issue on the response regarding permafrost measurements.

2.3 - GCOS Update

Caterina Tassone (GCOS) reported [[slides](#)]:

- All actions from the 2022 GCOS IP are in progress.
- The GCOS IP included many joint activities between GCOS and WMO INFCOM. GCOS Atmospheric Networks are working with INFCOM, in particular on systematic observations financing facility (SOFF).
- The WMO Climate Infrastructure Task Team was established in October 2024, met for the first time in January 2025, and will conclude their work in October 2025. Their purpose is to provide a report identifying gaps and overlaps within the WMO infrastructure components supporting climate apps and services.
- GCOS is working on the ECV Rationalisation process, which has involved consultation with selected stakeholders to revise the list of ECVs. The new list has 42 ECVs, down from 55, on which WGClimate was invited to provide initial comments in December 2024. In April 2025, the changes will be shared for public review. The biggest potential change is around surface temperature measurements.
- WGClimate is invited to comment again when it is shared for broad public comment. The comments will be discussed at the end of the year, and a paper drafted to describe the process and introduce new procedures.
- GCOS operates two references networks:
 - GRUAN (GCOS Reference Upper-Air Network) contains 33 sites. However, there are issues with global distribution of sites.
 - GSRN (GCOS Surface Reference Network) has 17 pilot stations, each measuring temperature and precipitation.
- The iClimateAction project addresses the need of increased coordination and synergies among GCOS, GEO and WMO to improve the international alignment across organisations regarding creation, management and utilization of climate data.
- At the previous GCOS Steering Committee meeting, GCOS was asked to consult with WGClimate and CEOS WGCV regarding permanent calibration/validation stations.

- The EUMETSAT Polar System-Second Generation-B (EPS-SG-B) instruments MWI and ICI identified a need for a dedicated radiosonde campaign, to support their Cal/Val activities. A GRUAN site in Potenza will be the single service provider for EUMETSAT for this Cal/Val activity.
- The next Joint Panel Meeting will be held jointly with WGClimate. This will be in one of the first two weeks of February, however a host is still required. This meeting will be the kick-off for the GCOS Status Report and Implementation Plan.
- GCOS invites WGClimate to participate regularly in the GCOS Steering Committee.

Discussion

- Jörg Schulz (EUMETSAT) recognised that the design of the WMO climate infrastructure is best suited for in situ observations, and some elements don't apply to satellite data. Peter Thorne gave a presentation at WMO INFCOM last year about what the proposed infrastructure would mean for satellite data.

WGClimate-22-06	EC-JRC (Mark Dowell) and ESA Climate Office (Susanne Mecklenberg) to discuss the potential for hosting the joint WGClimate-GCOS meeting in the first two weeks of February 2026. Let WGClimate Chair know of the decision reached.	Due: 28 Feb 2025
WGClimate-22-07	WGClimate Secretariat to connect GCOS with CEOS WGCV, to respond to action A31/1 from the GCOS Steering Committee: <i>GCOS to invite Space Agencies to enter a dialogue to establish permanent calibration/validation stations to make sure that the increasing amount of data that is being generated can be validated. Participate/do a presentation on GCOS (reference) networks in WGCV - WGClimate/CEOS Working Group on Cal/Val. GCOS Secretariat – Next WGClimate Meeting (February 2025).</i>	Due: 28 Feb 2025

2.6 - AVHRR Fundamental CDR & Heritage Dataset recovery

Mirko Albani (ESA) reported [[slides](#)]:

- The WGISS Data Preservation and Stewardship Interest Group (DSIG) has been working to extend the observations back in time through the use of heritage (historical) datasets, in support of climate related applications.

- Request that WGClimate members identify any datasets not currently accessible, and share with WGISS to trigger a global recovery effort.
- WGISS has worked to recover data from AVHRR from 1978 onwards, at 1 km resolution (Local Area Coverage - LAC), to complement the 4 km resolution data (Global Area Coverage - GAC).
- LAC AVHRR data acquired at ESA network stations (Terranova, Nairobi, Manila, etc.) during the period 1992-1999 have been processed up to Level-1C and are disseminated via ESA systems as open data. ESA is now working to develop a 40+ year fundamental CDR of AVHRR data at 1 km resolution for Europe. All data will be processed into Level-1B and Level-1C data, and available freely and openly.
- Data in stitched format (.arch files) from USGS network stations have been identified, but are not processable due to an uncommon file format. WGISS is now working with experts to convert the data into an accessible file format.
- A full collection of (1981–2020) of AVHRR data over Europe from different platforms (NOAA POES and MetOp series) has been recovered, and is a unique source to retrieve Essential Climate Variables (ECV) to investigate climate change over the last 40 years.
- WGISS has been working to pull together the global record, with support from NOAA, USGS, Argentina, Brazil, University of Hawaii, SANSA, ASI/UniRoma (Kenya coverage), ISRO and CSIRO.
- For the Hawaiian records, they were shipped as exabyte tapes to ESA, and a special device was constructed to roll/unroll the tapes at very slow speed and clean the tape surface from moisture.
- WGISS is still missing a good contact point for China and Mongolia, to recover any datasets which may be available there.
- Also looking at other organisations, including meteorological organisations, who might have AVHRR data in their archives.
- Will perform a worldwide data gap analysis, to understand where AVHRR data might still be needed to complete the archive.
- A common access point for the complete AVHRR worldwide dataset is planned, through the WGISS Connected Data Access (FedEO and IDN).

Discussion

- Jörg Schulz (EUMETSAT) suggested that the ESA Local Area Coverage and EUMETSAT Global Area Coverage archives should be cross-calibrated. EUMETSAT is also doing a

complete reprocessing of the global MetOp LAC AVHRR data and all historic GAC AVHRR data, including uncertainty estimates.

- Jörg also has contacts within CMA who may be able to assist finding useful data in China. However, China is unable to share raw data, and hence ways need to be found to conduct useful business, e.g., by sharing processors.
- Shorter time-series datasets may also be good candidates for recovery, as they can be used for validation of global reanalyses in times of only very few satellites.
- Mark Dowell (EC-JRC) recognised that anything that was distributed through these High-resolution picture transmission (HRPT) stations prevalent in the 80s and 90s would be a good candidate for a recovery effort.
- Mirko Albani (ESA) noted that the Heritage Data Center at ESA is not planning to process to Level 2 themselves, but already know of many ESA CCI activities that will make use of the Level 1C data and reprocess to higher level products. In general, it is expected that others will make use of the open data to produce higher level products.

WGClimate-22-08	WGClimate members to let WGISS know of any other datasets which may benefit from a global recovery effort.	Due: WGClimate-23
WGClimate-22-09	Jörg Schulz to meet with Mirko Albani regarding the EUMETSAT AVHRR collection, and potential to fill gaps over China and Mongolia. Connect with Misako Kachi regarding Mongolian contacts if necessary.	Due: Q2 2025

2.5 - CDR definition

Jörg Schulz (EUMETSAT) reported [\[slides\]](#):

- WGClimate has struggled for a while to succinctly define the term ‘Climate Data Record’ (CDR).
- The uses of CDRs are very wide and growing wider. The data sources are also becoming more diverse, with satellites, in situ, and model-generated datasets. The content of the CDRs are varied, from observations to radiances and derived products. The production system also varies, and should also be considered in the definition.
- Furthermore, while ‘long time-series’ of a dataset is a typical characteristic of a CDR, shorter datasets can still be useful.

- The definition should anticipate the fluidity of the concept, and define what characteristics are needed. The ideal definition would also be less specific, with fewer caveats.
- Is ‘useful to an application’ needed, or is it enough to just contain time-variant climate information?
- The definition proposed is: A CDR is a time series of Earth environmental data that contains time-variant climate information.
- A small team should be established to make progress on this task. This team would eventually publish a peer-reviewed article, and produce guidance for producers e.g. on what characteristics are required for what application typology. The team should also consider what application typology and what data sources should be covered in the CDR Inventory.

2.7 - GCOS guideline for generating climate data records

Stephan Bojinski (EUMETSAT) reported [[slides](#)]:

- Guideline for the Generation of Datasets and Products Meeting GCOS Requirements (GCOS-143) was written in 2010. The document was based on the guidelines for the generation of satellite products, and is also quoted in the WGClimate Terms of Reference.
- However, the document doesn’t give a clear definition of CDRs.
- The original goal of the document was mostly a call to make data producers aware of GCOS principles, and self-certify their activities.
- The document outlines 12 ‘needs’ for data producers to pay attention to when producing CDRs and FCDRs.
- The document is missing many items which have evolved over the last decade, including new concepts such as ICDRs, broader range of climate data applications and ECV Inventory documentation practice.

2.8 - Discussion

- Mark Dowell (EC-JRC) recognised that WGClimate may not have all the competences to craft a generic definition for CDRs - especially on the application typologies. Mark is also a bit concerned that it is proving difficult to separate the basic characteristics from the more general typology approach.

- Mark agreed that it may be good to update the GCOS-143 guidelines document. The initial questions for the ECV Inventory were based on these guidelines.
- Jörg Schulz (EUMETSAT) recommended that a simple definition be created, and elements added on top for applications, with different categories of guidance as well. A core definition of a CDR should be always valid, and shouldn't be distinct for producers and users.
- Mark asked, if the time-varying characteristic defines a 'data record', what defines the 'climate' part?
- Stephan Bojinski (EUMETSAT) recognised the need to distinguish between writing a paper on climate applications of remote sensing datasets, and the definition of a CDR. WGClimate should be careful to not create a watered down definition which hinders the ability to defend the resources needed for generating CDRs. Stephan would advocate for a 'gold standard' definition.
- Jörg noted that adding an uncertainty requirement into the definition would constrain CDRs to a limited set of datasets, and means other useful datasets may be forgotten about.
- Caterina Tassone (GCOS) suggested that a reference tier could be used, which GCOS also uses in the frame of their reference networks.
- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) noted that the term 'data record' could include a very basic set of requirements. Then, requirements for 'climate' can be added on top to match the requirements for certain application areas. The term 'climate' is likely too broad for a general definition.
- Mark recognised that ICDRs don't have to follow all the characteristics of a CDR - the main requirement is that the same processor is used.
- Susanne Mecklenberg (ESA) suggested the target audience for the definitions be clarified, to help understand what type of definition is required. Mark suggested the user community is the target, to help them understand what is in a dataset which is called a 'CDR'. Stephan noted it is also for the data producers as well, to provide guidance on what products to develop.
- The phrase 'useful in a climate related application' could be used to adapt what the definition means. The intention of the dataset should be (objectively) considered when defining whether or not it is a CDR.
- The difference between a data record and a climate data record is that a climate data record captures time-dependent climate variability - it is a subset of all data records.

- Jörg recognised that if a ‘gold standard’ definition is defined, then nothing will be able to be called a CDR. But when the definition is watered down, where is the limit before it is not specific enough?
- Mark suggested that the activity be extended for one more year. If an agreement on a definition or approach is not reached in 12 months time, WGClimate should think about concluding the activity.

WGClimate-22-10	Jörg Schulz to establish a small team to review the CDR definition. If no progress is made in one year, consider concluding this activity. WGClimate members to contact Jörg if they would like to join these discussions.	Due: 28 Feb 2025
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Session 3: GHG-TT

3.1 - GHG Best Practices Update (BP-01)

Paul Green (NPL) reported [\[slides\]](#):

- The Global Methane Pledge has been signed by 155 countries and seeks to reduce methane emissions by 30% between 2020 and 2030. Public and New Space observations of methane and carbon dioxide are increasingly being used to identify high emitters to improve production efficiency of drilling, support regulation, and report obligations in the carbon market.
- Community appetite for common practices measuring emissions with remote sensing was identified at COP28 in 2023 in a UKSA-NPL workshop.
- Version 0.2 of the common practices for facility scale methane emissions has now been drafted, and is open for review. The document describes common practices from Level 0 to Level 4 data, and its validation and quality assessment.
- Controlled releases are designed for testing super-emitter quantification and validation. A single blind test is currently being conducted where a site will emit randomly to make the tests more accurate.
- The quality assessment framework is aligned with that developed by EDAP / CSDA for consistency across GHGs and other ECVs. The product is tested under a number of different criteria within the quality framework.
- Future work will include similar documentation for CO₂, and expanding to cover wide area mappers.

Discussion

- Paul Green (NPL) recognised that the accuracy of the controlled releases is driven by atmospheric parameters, and hence they are no better than the uncertainty of the satellite measurements.
- Jean-Christopher Lambert (BIRA-IASB, WGCV ACSG Chair) noted that fiducial reference measurements (FRM) should be considered for validation. WGCV have developed the CEOS-FRM Maturity Assessment Framework (including maturity matrices), and could consider a near-future task to apply CEOS-FRM maturity matrices and assessment to the controlled release experiments.
- Version 0.3 of the document will be completed by mid March, and version 1.0 will be shared with CEOS and CGMS more broadly in July. The document will then get a DOI and will remain static for the next six months.

GHG-TT-02	GHG-TT members to review v0.2 of the Methane Best Practices.	Due: 28 Feb 2025
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3.2 - Sensor development

Dave Crisp (SIT Chair Team) reported [[slides](#)]:

- The requirements of stakeholders in the GHG monitoring sector must be considered when developing sensors. For example, IMEO needs plume measurements, while G3W needs large fluxes. The combination of these requirements needs to be propagated to the wider CEOS and New Space communities.
- Sensors also make ancillary measurements like aerosols, which are continually identified as integral by AC-VC as they will increase the accuracy of emissions estimates.
- The biggest measurement gaps are for ocean fluxes, for which nothing meaningful has been optimised yet.
- There is currently a spatial gap in GHG measurements. With current missions, facility scale emissions on the order of 10-100 km can be measured, however city-scale emissions (representing approximately 70% of emissions) are not. GOSAT-GW and CO2M will help address this.
- The [CEOS GHG Portal](#) includes all current and planned GHG missions, as well as a timeline of their operations. Future missions can be hard to track as mission launches often slip. A large portion of facility scale missions are commercially owned.

Discussion

- Richard Engelen (ECMWF) noted that support to auxiliary data is often forgotten, and contingency plans should be developed. Some agencies have this data, but are unaware of its importance or how to distribute it.
- Yasjka Meijer (ESA, GHG-TT Lead) proposed a meeting with GCOS to discuss the measurement gap over oceans. AC-VC can deal with the city-scale gap, but the ocean gap needs work. The topic could be presented and discussed at SIT Technical Workshop in September 2025.

GHG-TT-03	Yasjka Meijer to arrange a side meeting at SIT Technical Workshop 2025 to discuss space-based ocean carbon measurements with GCOS.	Due: SIT-TW 2025
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3.3 - Calibration and Level 1 Products: Annual vicarious calibration campaigns (L1CAL-01)

Hiroshi Suto (JAXA) reported [\[slides\]](#):

- Years of vicarious calibration have been conducted jointly between the US, Europe, and Japan at the Railroad Valley (RRV) site in the US. The 2024 RRV campaign included five instruments: GOSAT, OCO-2, TROPOMI, GOSAT-2, and TEMPO. OCO-3 could not join the campaign as it was undergoing its second in-orbit checkout at the time.
- 15 years of surface reflectance campaign data was reprocessed with an improved processing algorithm and a forward model. The 2024 campaign acquired five days of clear sky data which were used to evaluate the spectral radiance of each sensor.
- The common forward processing algorithm applied across past campaign data found that almost all sensors have a $\pm 5\%$ deviation. The goal is to reduce the radiometric errors to 3%, which GOSAT currently achieves for all of its bands.
- There are a limited number of MODIS products available to correct BRDF for sensors with small footprints, so the footprints were expanded by 200 m. This resulted in a good agreement between OCO-2's observed spectral and forward calculation.
- The 2025 summer campaign is being planned, and will revisit RRV to conduct surface reflectance measurements and gather EM27SUN data to simultaneously take GHG concentration measurements.
- The fall campaign is currently under discussion. The US team for OCO regularly conducts campaigns in autumn, which could overlap with the launch of GOSAT-GW.
- The [GHG Vicarious Calibration portal](#) has recently been updated.

- A [match-up dataset](#) has been released for GOSAT and TROPOMI L1 and L2 calibration.

Discussion

- Hiroshi Suto (JAXA) added that GOSAT-GW (TANSO-3) has a similar footprint to TROPOMI, and hence would be able to join the campaign once launched. GOSAT-GW has two modes, 10x10 km and 3 km, both of which the team hopes to perform vicarious calibration on. The wide mode would be difficult due to albedo and its big footprint.
- The next steps for the project are to hold a discussion with the international coordination team for campaigns. The July campaign needs to begin in the March-April timeframe, for which contribution is welcome.
- Yasjka Meijer (ESA, GHG-TT Lead) has a good contact for TROPOMI, and organised a CO2M meeting for cal/val lessons learned to exploit existing expertise, which was very useful.

GHG-TT-04	Hiroshi Suto to coordinate a discussion on vicarious calibration campaigns for CO2M.	Due: Q4 2025
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3.4 - Level 2 Products: Validation

Dave Crisp (SIT Chair Team) reported [\[slides\]](#):

- Level 2 algorithm validation methods primarily look at ways to trace satellite estimates of dry air mole fraction back to a standard for these gases in the air. Five transfer standards are applied to produce traceability of space-based measurements into in-atmosphere, through a combination of ground, airborne, and satellite datasets.
- These transfer standards include TCCON, the fundamental basis for measurement traceability; NDACC, currently focused more on methane; COCCON, a set of ground-based spectrometers; AirCore, an in-situ balloon system; and fixed-wing aircraft campaigns.
- TCCON is a near-infrared network with high spectral resolving power, around 200,000 - 1,000,000, and excellent signal/noise with resistance to aerosol scattering. Measurements are made with fixed-wing aircraft, along with 25 stations worldwide with records dating back to 2004. Almost all GHG missions flown use TCCON as a standard.
- The retrieval algorithm for TCCON was updated in 2020, and the standards are updated every year.
- AirCore is a sub-millimetre diameter tube wound into a spool in a large weather balloon that ascends up to 25 km in altitude. The tube is filled with air as the balloon falls,

preserving the atmospheric column. However, it can be difficult to find and analyse the data after each drop, as horizontal travel causes issues when working in remote areas.

- There is a supersite near Boulder, Colorado, US to cross-calibrate AirCores with OCO-2 measurements. They are also extensively used in Finland in conjunction with the TCCON station.
- COCCON uses a low spectral resolution (~0.5 cm) Fourier Transform Spectrometer to observe SWIR direct sunlight, which can calibrate spacecraft in areas where TCCON cannot be installed.
- EM27/SUN FTIR spectrometers have been deployed across the UK and Spain. These instruments can view meso- and microscale concentrations of CO₂, with current plans to improve spectroscopic data.
- In operation since 1991, the NDACC network of FTIR spectrometers is a parallel system to TCCON that is working in the MWIR region to produce vertical columns and profiles of CH₄, CO and two dozen other species at about 25 stations worldwide. NDACC, TCCON and COCCON are being used as a validation standard for Sentinel-5P TROPOMI methane column data. The primary limitation of NDACC is that it doesn't measure O₂ as a reference gas, so its CH₄ errors are larger. NDACC strengths are its ability to retrieve vertical profiles and to deliver FRMs with a timeliness of a few weeks to a few months.
- The combined network is more valuable than any other individually. However, there is limited activity in the tropics. Coordination through CEOS and CGMS is increasingly important to maintain the combined network.

Ruediger Lang (EUMETSAT) reported [[slides](#)]:

- Validation systems are not only for commissioning, and need to be implemented into any operational framework for monitoring GHGs. The availability of GHG ground-based data needs to be improved, with a threshold latency of one week and a goal of less than 3 days.
- The calibration of CO₂M is planned to be developed alongside GSICS approved standards. They are involved in a lot of missions and a key point of Cal/Val. GSICS is instrumental for methodologies and guidelines.
- A lot of ground-based networks cannot yet provide operational support. Auxiliary frameworks can and should be exploited in the development of an operational cal/val system.
- Information from all networks are collated into a database, which includes surrounding details of the sites such as topography, albedo, weather, along with overpass statistics

of the satellite. This effort seeks to develop a full picture of what we can expect for a certain period of reporting and to identify potential gaps.

- Identifying systematic biases is also important not only for the satellite sensor but for the ground too. The ‘stocktake’ is targeted to be completed by the end of 2025.
- Operational capabilities and a framework for existing missions could be developed within the next few years.

Discussion

- Richard Engelen (ECMWF) recognised that IGOS is a useful network, however integrating it with TCCON would be difficult. IGOS is more focused on surface measurements, and depends on national subscriptions.
- Ruediger Lang (EUMETSAT) noted that EUMETSAT is kicking off Cal/Val Phase 2 which will supply processing when needed and the transition of data to EUMETSAT for CO2M.
- Richard highlighted that all these networks are based mostly on research funding, where publications in peer-reviewed journals are important. Operational systems have a different focus.
- Dave Crisp (SIT Chair Team) recalled that TCCON colleagues brought up the issue of data ownership and recognition. CEOS/CGMS Agencies would have to partner closely with the research bodies who fund these networks, to make data available for operational use. ECMWF has come up with clever licensing that could be exploited.
- Gianpaolo Balsamo (WMO) noted that the essential quantities in research to operations are systematic observations and timeliness. Several networks operate with a QA process, delaying the delivery of data. The WMO information system allows for data that is not public with automatic QA and QC, with no risk to uncertainty.
- Jean-Christopher Lambert (BIRA-IASB, WGCV ACSG Chair) noted that evolution of the three GHG Cal/Val networks is followed recurrently by ACSG, with a list of gaps and issues for operational validation services already in development. The next AC-VC / WGCV-ACSG joint meeting will be held in Japan in parallel with IWGGMS, and will also feature participation of TCCON, COCCON, and NDACC. The networks will jointly hold their annual meeting 2025 the week after in India.

GHG-TT-09	Validation thematic lead (Dave Crisp) to add an action in Annex C of the GHG Roadmap for tracking needs & gaps in the validation system.	Due: 15 Mar 2025
GHG-TT-10	Jean-Christopher Lambert to share slides of last ACSG/WGCV	Due:

3.5 - Level 2 Products: Intercomparison Algorithms

Dave Crisp (SIT Chair Team) reported [[slides](#)]:

- In the development of Level 2 algorithms, there have been a number of extensive Level 2 algorithm intercomparison activities, aiming to produce products with 0.25% accuracy. However, better resolution is required.
- Current datasets are becoming much more dense, and the processing power cannot keep up. Faster algorithms that remain accurate and interoperable are needed.
- Algorithms need to effectively ingest data from multiple satellites to produce harmonised products. The goal is now to cover facility scale sources as a starting point.
- Detailed information on the column CO₂ and column dry air can greatly reduce uncertainties.
- A number of cases show that there are viewing geometry and surface differences that affect aerosol retrievals. There is no best scheme to account for aerosols in full physics retrievals. The alternative is CO2M's plan for aerosols, which will fly a dedicated sensor for aerosols that can work up to 0.7 optical depths with better correlations for aerosol abundance.
- Instead of full physics models, machine learning models offer concentration distributions without retrieving the radiances. However, the CSU simulation environment will likely not include spectroscopic errors, 3D effects, subscene effects, and instrument calibration errors.

Ruediger Lang (EUMETSAT) reported [[slides](#)]:

- In the transition from research to operations, it is important to retain knowledge about algorithms on the scientific level. It is crucial to understand the algorithm individually and what is contributing to the overall performance.
- Robustness of algorithms should also be considered, and the responses to external factors in intercomparison exercises explored.
- Three algorithms for CO2M take a huge amount of information from each instrument, and each algorithm reacts differently to changes in the data flow. The CO2M system provides a testbed for mimicking auxiliary and a priori scenarios.
- The aim is to evaluate the sensitivity of algorithms to these inputs and build knowledge of how biases are transferred through processing environments.

- The medium/long term goal is to improve the traceability and interoperability of GHG product results and reference data. In 2025/26, a sandbox will be set up with TOA radiance scenarios and various flavours of auxiliary and a priori information.

Discussion

- Dave Crisp (SIT Chair Team) noted that a list has been made of all ongoing intercomparison exercises, but it is very extensive. The biggest sources of errors on the research side and sensitivity studies on the operational side are being considered in parallel.
- Ruediger Lang (EUMETSAT) has a list of things not currently addressed, such as 3D effects, which will be revisited when a solution can be considered with the existing hardware in space. CO2M may provide the required information to conduct an intercomparison exercise.
- Simon Pinnock (ESA) suggested that an intercomparison exercise could be run under the GHG component of ESA CCI if the need is clear.
- Yasjka Meijer (ESA) noted that cloud filtering is an important step, and is necessary for plume monitoring. Filtering bias correcting is just as important as the core algorithm.
- Chris O'Dell (CSU) noted the goal is to have all elements of a retrieval system as close as possible.
- Ruediger recognised that if the surface is changed a priori, the aerosol retrieval will be compromised and a different aerosol will be shown. An algorithm using radiances might be more robust to BRDF assumptions, but needs to get two instruments consistent on the radiances level.
- Chris noted some bugs in RAL's testing, in which the 1.6 and 2.0 micron surface reflectance band was set to MODIS 650 nm, which is wrong. The RAL supercomputer next door in Harwell is working to fix these errors.

3.6 - Flux Inversion Modelling: Assess adaptation of current CEOS practices for G3W applications (INV-01)

Dave Crisp (SIT Chair Team) reported [\[slides\]](#):

- Fluxes are currently modelled by batch processing every couple of years at levels of 1 x 1 degree. G3W requires monthly intervals at the same resolution.
- In its initial set-up, the Global Greenhouse Gas Watch (G3W) will deliver the following products:

- Monthly CO₂ net fluxes between the Earth surface and the atmosphere with 1°x 1° horizontal resolution delivered with maximum a delay of one month,
 - Monthly CH₄ net fluxes between the Earth surface and the atmosphere with 1° x 1° horizontal resolution delivered with a delay of one month,
 - 3-Dimensional fields of CO₂ and CH₄ abundance with hourly resolution and data latency to be defined (tentatively on the order of a few days), and
 - N₂O abundances and net fluxes, with resolution and latency still to be defined.
- From a space-based perspective, there is no measurement that can distinguish N₂O measurements important to climate.
 - There is an ongoing effort to produce a harmonised system that integrates OCO-2,-3, and GOSAT data, with the goal to process all GOSAT data into a product that extends over a longer period of time.
 - Machine learning algorithms have helped identify biases and random errors beyond mechanical bias filtering corrections. Current systems developing this have substantially increased the number of observations available for datasets.
 - Latency needs to go from a couple of years to a couple of months. OCO delivers two different data streams: the forward stream uses extrapolated calibration data to deliver in less than a week, while the retrospective stream collects and interprets a month's worth of data. Over TCCON stations, the forward and retrospective streams are giving the same information, suggesting they are reliable to derive fluxes from.
 - GOSAT-GW has two different observation methods that vary in latency from 2 days to 1.5 months. CO2M has three processing algorithms for L2 products with stringent latency requirements of 24 hours. However, fusing data from these three satellites will be difficult on a short timescale.
 - The biggest issue is that existing space-based systems don't provide the sampling to support very high resolution systems. Transport systems are barely capable of supporting 1x1 degree resolution, indicating that grid resolution is not equal to the true resolution.
 - A large number of different types of data are needed as inputs to an inverse model and independent information of CO₂ emissions from fossil fuel combustion.

Discussion

- Hiroshi Suto (JAXA) noted that the GOSAT-TROPOMI blended product is reducing spatial biases, and wondered how this would work for the CO₂ case given that OCO-2 and -3 have some spatial inconsistencies.
- Dave Crisp (SIT Chair Team) noted the importance of expanding datasets, and the resources necessary to explore biases and how they affect flux inversions.
- Chris O'Dell (CSU) added that the TROPOMI-GOSAT activity to match TROPOMI to methane is a great example of a harmonised in-orbit reference dataset. The same could be done for CO₂M.
- The forefront of this work should include atmospheric chemistry (NO₂) in the inversions. It's easier to measure, but the inversion becomes much more complicated.

Day 2: Wednesday 12th February, 2025

Session 4: Stakeholders

4.1 - UNFCCC: GST/RSO

Heather Maseko (UNFCCC) reported [[slides](#)]:

- Systematic Observations inform climate actions, as well as the Global Stocktake (GST) and reporting. They contribute throughout UNFCCC work.
- A lot of colleagues in WGClimate were involved in the first GST in different capacities. The GST1 synthesis report reflected greatly on the latest scientific findings, and there was considerable engagement of systematic observations and the scientific community.
- UNFCCC received over 1800 submissions for GST1, including many large data sources which were used for the synthesis report.
- Space-based data can support GST2 by providing a comprehensive, transparent and up-to-date data source to inform tracking GHG emissions, observe climate impacts, and determine the effectiveness of climate action. GST2 will be a pivotal moment that allows for the evaluation of progress towards the climate goals.
- UNFCCC is also working to plan anticipatory action. Accurate data is needed to inform which sectors are making progress towards their goals and which are not.
- The discussions on modalities from COP-29 in Baku will be continued throughout 2025. Information Collection will launch at CMA-8 in 2026, followed by technical work in 2027 and political work in 2028.

- Other considerations include global data accessibility, cooperation and engagement of countries, the role of innovation, addressing gaps in underrepresented regions, socio-economic considerations, and the periodic review process.
- The GST strategy can also be adapted to support the periodic review process, with the goal to assess the effectiveness of the long-term global temperature goal.

Discussion

- Yasjka Meijer (ESA, GHG-TT Lead) recognised a number of opportunities listed, and asked who would be the recipients of their outputs. Heather would recommend dealing with Parties themselves. The connection between the observations community and the Parties is important, to inform the reduction of emissions across various sectors. UNFCCC Secretariat is an ally in this.
- Clement Albergel (ESA) asked whether there is a clear calendar of when the inputs are needed for the periodic review process. Heather noted the modality discussions will be closed after the June conference, before COP-30 in Belem. It is likely there will be some small changes in how GST2 is conducted compared to GST1. However, this doesn't necessarily align with the IPCC timeline, which UNFCCC will consider in developing the timeline later this year.
- Mark Dowell (EC-JRC) recognised WGClimate hopes to continue the productive dialogue with the UNFCCC Secretariat. Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) will attend the Summer SBSTA sessions in Bonn, and also hopes to connect with Heather in advance of this.

WGClimate-22-11	Vincent-Henri Peuch to connect with the UNFCCC Secretariat to plan the discussions for the Bonn Climate Conference in June. Other members interested in joining these discussions should contact Vincent-Henri.	Due: 28 Feb 2025
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4.2 - UNFCCC: Adaptation

Maryam Navi (UNFCCC) reported [\[slides\]](#):

- The Paris Agreement, in Article 7.1, established the Global Goal on Adaptation (GGA) of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2 of the Agreement.

- The GGA framework was adopted in 2023, which saw the launch of a two year work programme on indicators. The Baku adaptation roadmap was launched in 2024, and the list of indicators is set to be adopted later in 2025.
- There are 11 targets, 7 of which are around thematic sector areas. The remaining are focused on impact, vulnerability and risk assessment, planning, implementation, and monitoring, evaluation and learning.
- GCOS provided inputs regarding quantitative measures which were synthesised by the Secretariat.
- A workshop will be held in March to facilitate expert work, followed by another workshop to take stock of this expert work, and a final workshop later in the year to reflect on the final list of potential indicators.
- A special SBSTA event will be organised in June, following on from the mandate to compose a technical paper on this topic.
- The list of indicators is aimed to number no more than 100.
- The goal is that Parties will report on these indicators, to feed into the GST process.

Discussion

- Mark Dowell (EC-JRC) suggested that WGClimate could assess which indicators could be measured by EO data. When will there be a version of the indicators that could be analysed?
- Maryam Navi (UNFCCC) noted there is already a list available online, however the consolidated list is going through review at the moment. The list should be available 4 weeks prior to the June sessions. However, the experts are not restricted to coming up with 100 indicators, the mandate is only for Parties to adopt no more than 100.
- Frank Martin Seifert (ESA) asked whether an expert with EO background should be nominated to participate in the upcoming workshops.
- Maryam noted the expert meetings and workshops are separate. Over 600 recommendations for experts were received. While GCOS was recommended to make a nomination, no nomination was received. However, experts are invited to consult other specialists, and WGClimate members are invited to get in touch with relevant experts.
- The workshop is not only for experts but is open to parties and observers as well.

WGClimate-22-12	WGClimate members interested in engaging on the definition of the UNFCCC Global Goal on Adaptation (GGA)	Due: June 2025
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	Indicators should contact Maryam Navi (UNFCCC) with their specific area of interest. Maryam will connect any interested members with the relevant experts.	
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4.3 - CEOS-CGMS GST Lessons Learned

Jörg Schulz (EUMETSAT) reported [\[slides\]](#):

- The GST1 Lessons Learned were discussed at both SIT Technical Workshop and CEOS Plenary in 2024. The document will be submitted for endorsement at SIT-40 in Japan in April, so this is an opportunity for any final feedback.
- For GST1, CEOS/CGMS provided pilot top-down CO₂ and CH₄ inventories, two types of flux maps. These datasets received positive recognition at UNFCCC COPs, however it was recognised that national inventory compilers don't often use the capability of space-based data.
- There was limited advocacy and fragmented representation of the EO community at UNFCCC events. The recommendation is to build stronger relationships with COP delegates and leverage CEOS and CGMS member countries at key UNFCCC events.
- There was also a lack of collaboration with national inventory agencies. Session 6 later today is a starting point for improving coordination.
- The engagement with IPCC processes and the global carbon process needs to be strengthened. IPCC is built on peer-reviewed publications, and hence CEOS/CGMS should engage with the IPCC reports as authors and contributors. It would be worth having someone in WGClimate close to this process.
- IPCC also goes beyond reporting on carbon, also including things such as loss and damage, to which EO can also contribute.
- Knowledge gaps among inventory compilers should be combated with targeted training and resources.
- In general, the awareness and communication of space-based data needs to be better shared with COP delegates.
- WGClimate members and other community members are invited to provide comments on the document.

WGClimate-22-13	WGClimate members and other community members to provide feedback on the GST Lessons Learned . Members are also invited to share the document with their national	Due: 28 Feb 2025
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negotiators for review.	
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4.4 - Future CEOS GST Strategy

Osamu Ochiai (JAXA) reported [\[slides\]](#):

- The JAXA SIT Chair Team's two priorities are:
 - o Climate Policy Impact - addressing obstacles and opportunities for CEOS Agency data to have maximum impact in key climate policy processes such as the GST
 - o GHG Observations from space - addressing coordination for data continuity challenges ahead
- The current CEOS GST Strategy contains nine recommendations. In response to the GST1 Lessons Learned produced by WGClimate, the Issue 2 of the GST Strategy aims to take forward priority recommendations from the Lessons Learned and understand the changing landscape with stakeholders to optimise CEOS engagement.
- The draft GST Strategy Issue 2 will be presented for discussion at SIT Technical Workshop in September 2025, and the final version presented for endorsement at CEOS Plenary 2025.
- In order to effectively develop this strategy, the SIT Chair is looking for champion authors to help draft this issue of the strategy.
- CEOS needs more proactive, strategic, and long term engagement with UNFCCC, including through more coordinated RSO community preparation between CEOS, CGMS, GOOS, GCOS, WMO, and others.
- A larger emphasis on country engagement and uptake will also be addressed, including by direct interaction with national inventories, and a greater emphasis on and coordination of our in-country work for data uptake. A GFOI Methods and Guidance Documentation (MGD) approach could be taken to develop more corporate memory and faster and shared progress.
- The SIT Chair will also hold additional climate policy impact calls on these topics.

WGClimate-22-14	WGClimate members interested in supporting the drafting of Issue 2 of the CEOS Global Stocktake Strategy to contact the SIT Chair Team.	Due: 28 Feb 2025
WGClimate-22-15	SIT Chair Team to share the draft GST Strategy with UNFCCC (Heather Maseko) once prepared.	Due: Sept 2025

4.5 - Discussion

- Mark Dowell (EC-JRC) suggested that the GST Strategy draft be shared with UNFCCC in September for review of the document's recommendations.
- Jörg Schulz (EUMETSAT) suggested that it may be beneficial to make the GST Strategy a joint CEOS-CGMS document, noting the need to operationalise services.
- He also asked if the topic Solar Radiation Modification (SRM) should be considered in the GST Strategy. This may raise an increased need for more accurate information about the consequences of these human made changes that could be fulfilled with e.g., better measurements of changes in water vapor content in the stratosphere and of the radiation budget. Pressure from UNFCCC Parties could reinforce these needs, and perhaps require a strategy from CEOS and CGMS to respond.
- Susanne Mecklenberg (ESA) noted DG Clima has just begun two studies on this topic, to improve understanding of solar radiation. This could be discussed at a future meeting.
- Jörg recalled that EUMETSAT is hosting a climate symposium in Darmstadt, Germany, 28-30 October 2025, which will include needs coming from policy requirements and a discussion of needs emerging from potential Solar Radiation Modification actions.
- Beth Greenaway (UKSA, CEOS Chair Team) noted that the TRUTHS mission will produce these microwave sounding measurements, planned for launch in 2030.
- Heather Maseko (UNFCCC) recognised that one role for this platform between UNFCCC and space agencies is to highlight any anticipatory issues. However, how and when those issues should be raised remains unclear. It should be brought into the formal process, likely following a similar process used for GST1. The recent RSO conclusions saw several different issues brought up, so there is always room to bring in relevant issues, but there needs to be awareness within Parties to ensure they are brought into the process.
- John Remedios (NCEO) noted that, due to the timeline, CEOS would almost have to start working on pursuing recommendations before Issue 2 of the GST Strategy is endorsed. Additionally, regarding the indicators for adaptation, WGClimate may want to examine the applicability of EO for measuring these indicators and organise a collective response.
- Yasjka Meijer (ESA, GHG-TT Lead) suggested that space-based observations could provide more frequent updates on progress towards the goals, rather than the five-year increments of the GST. This would demonstrate the capability of space-based data and

bring more attention to the datasets. Some work done under ESA CCI and RECCAP2 could address this.

- Dave Crisp (SIT Chair Team) noted that while the focus of the USA may shift away from the Paris Climate Agreement, they may still contribute to Global Stocktake efforts. Their focus may shift to natural biosphere and ocean emissions, as well as the AFOLU sector. From an adaptation standpoint, AFOLU measurements will make a bigger impact, in particular agriculture and crop health.
- Richard Engelen (ECMWF) recognised that the GST is only one part of the process, and countries still report annually on their emissions. Europe is already moving towards the pre-operational implementation processes, so will be able to offer more for the GST2.
- Osamu Ochiai (JAXA, SIT Chair Team) suggested the GST Strategy may have to address more than just the GST. Perhaps it is a Paris Agreement strategy?

Session 5: Partnerships

5.1 - WMO Global Greenhouse Gas Watch (G3W)

Gianpaolo Balsamo (WMO) reported [[slides](#)]:

- G3W was established following the concept presented to EC-76 and adopted by the 19th Meteorological congress, and aims to respond to climate risks by developing a sustainable operational framework for monitoring GHGs.
- The Implementation Plan was drafted and endorsed by WMO INFCOM-3 in June, 2024. The implementation pre-operational phase began thereafter, and will run until 2027, followed by the initial operational phase from 2028-2031. From 2032 onwards, the enhanced operational phase is expected to start.
- G3W was identified in the 2022 GCOS Implementation Plan, with an action to proceed with an integrated operational global GHG monitoring system.
- Cooperation with the Global Atmosphere Watch Programme (GAW) will be key to the success of G3W.
- G3W was presented at Earth Information Day at COP-29, which was also a great venue to showcase the CEOS-CGMS GHG Roadmap, to which G3W also contributed.
- The G3W system will be able to provide monthly CO₂ and CH₄ net fluxes at 1x1 degree horizontal resolution, and 3D fields of atmospheric CO₂ and CH₄ abundance with hourly resolution. N₂O abundances and net fluxes will also be provided, but resolution and latency requirements are still to be defined.

- The G3W action plan is split into six priorities: observing system, prior information, R&D needs, modelling system, data management, and user engagement & uptake.
- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) has been selected as co-chair of the advisory group.
- Three task teams have been created: Network, Modelling, and Data.
- For INFCOM-4, G3W will deliver a comprehensive inventory of the GHG observations, as well as initial network design concept.
- To expand the in situ observation network, GHG tall towers have been implemented at five sites across Indonesia, with more sites planned. These sites make measurements at 30 m, 70 m, and 100 m from ground level.
- Hands-on training on GHG measurements was conducted at the GAW station in Indonesia in October 2024, with participants from 14 countries from around the Asia-Pacific region.
- A G3W Data providers workshop will be held online from 5-7 March 2025 by the Modelling and Data task teams.
- G3W welcomes support from WGClimate, with letters of support for G3W welcomed.

Discussion

- Mark Dowell (EC-JRC) recognised the plea for support. G3W is a key counterpart in allowing CEOS/CGMS Agencies to build up the value chains for space-based EO data to go into the necessary processes and support various policy needs.
- It would be good for G3W to identify specific actions which WGClimate can contribute to, for inclusion in future work plans.

WGClimate-22-16	WGClimate Chair to compose a letter from CEOS Chair and SIT Chair to WMO leadership regarding support for G3W. Share a draft at SIT-40.	Due: mid-March
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5.3 - Copernicus Atmosphere Monitoring Service (CAMS)

Hugo Zunker (European Commission) and Richard Engelen (ECMWF) reported [[slides](#)]:

- Certain characteristics, including spatial resolution, of space-based products need to be improved to improve relevance for local and regional policy actors.

- The European Commission’s new priorities include a proposal for a 90% emission reduction target by 2040. Europe plans to continue to be a leader in international climate negotiations.
- The Copernicus Atmosphere Monitoring Service (CAMS) aims to integrate observations and modelling to produce emission monitoring data products and policy tools, to support both the Paris Climate Agreement and at the local and regional goal level. The users, across industry, government, scientific community and policy, receive consistent reliable information to support decision making processes.
- Have identified a number of products relevant for the GST, as well as tools for countries to support their climate monitoring measures.
- Tip and cue is a method that utilises global mappers to identify broad areas of interest, after which commercial missions are tasked to investigate the areas with a finer resolution.
- Interactions with the user communities are key to ensure the data generated is used and in a useful way.
- CAMS is now in the second phase of Copernicus, and offers activity, inventory, and tipping-based emissions, daily GHG fluxes, and annually updated flux inversions for CO₂, CH₄, and N₂O.
- Local methane hotspot detection by Sentinel-5P allows for the characterisation and verification of local sources of emissions. This has now been operationalised within CAMS, to provide weekly overviews of methane hot spots.
- Working with ESA on the Copernicus Contributing Missions programme with a focus on emissions detection from European SmallSat missions. Use cases have been established with GHGSat, Satlantis, and Absolut Sensing to explore the quality and maturity of these observations.
- The comprehensive emissions monitoring services are planned to be available operationally in 2026/2027, and will provide near-real time monitoring and multi-annual reprocessing.

Discussion

- Antony Delavois (ESA) recalled the EU’s new policy, which is more focused on individual sectors, many of which would need very high resolution observations. How will Copernicus react to these new policies?

- Richard Engelen (ECMWF) noted that CAMS is listening carefully to new policy requirements, aiming to fulfil requirements as best as possible while managing expectations. Copernicus Contributing Missions (CCMs) can also play a role in this, and Copernicus is exploring how best to use those capabilities.
- Hugo Zunker (EC) recognised the strength of this system approach is the ability to support user requests.
- Mark Dowell (EC-JRC) noted that Japan has also recently started exploring concepts for a GHG Center.
- Gianpaolo Balsamo (WMO) highlighted that cal/val stations and supersites are of interest as they support both the G3W observing network and QA/QC. WMO is interested in collaborating with space agencies regarding the site selection process.
- Ruediger Lang (EUMETSAT) recognised the path to operations is difficult, as it can mean different things for different parts of the community. In particular, there are concerns on the operational nature of the cal/val networks. CEOS/CGMS support for site operators to support operational needs would be appreciated. A major barrier is around data sharing from these cal/val sites.
- Yasjka Meijer (ESA, GHG-TT Lead) suggested recommendations should be provided to WMO Member States regarding which types of cal/val instrumentation should be installed. CEOS/CGMS could provide support and expertise to ground site operators.
- Jean-Christopher Lambert (BIRA-IASB, WGCV ACSG Chair) recognised that AC-VC and WGCV ACSG are currently discussing the concept of Cal/Val supersites, which will be explored further during their June meeting in Japan.
- Clement Albergel (ESA) noted that ESA’s CARBONARA campaign in Brazil has made good progress on this topic.

WGClimate-22-17	Hiroshi Tanimoto, on behalf of AC-VC and WGCV ACSG, to invite WMO G3W and IMEO to their June meeting, in particular for a discussion around cal/val super sites.	Due: 28 Feb 2025
WGClimate-22-18	ESA to liaise with G3W in the context of the CARBONARA campaign.	Due: ASAP
GHG-TT-12	Define a joint deliverable for the CEOS Work Plan between GHG-TT, WGCV ACSG, AC-VC to explore the concept of GHG cal/val super sites and understand gaps in the existing networks, in particular to support G3W and IMEO.	Due: 16 Feb 2025

- Hiroshi Tanimoto (NIES, AC-VC) thanked those who have provided inputs to the Japan GHG Centre survey. The project is still in the scoping period, but national emission verification and supporting G3W are key topics.
- Dave Crisp (SIT Chair Team) noted that ground-based systems, like those supported by G3W and CMAS, can help fill measurement gaps in the case of clouds.
- Gianpaolo recognised the requirement for monthly observations for G3W is connected with user requirements. It was the result of a number of consultations, and was a compromise between user requirements and capabilities of data centres.

Session 6: National emission estimates

6.1 - Opportunities and challenges for the use of space-based observations to inform carbon fluxes

Kevin Bowman (JPL) reported [\[slides\]](#):

- The Greenhouse Gas Inventories (GHGI) provide a consistent methodology to calculate GHG emissions and removals, especially for Annex I countries. Consistent comparisons can be made between inventories. However, consistency is not accuracy.
- The US has a good agreement between bottom-up and top-down estimates calculated from OCO-2 data, but in Brazil, top-down fluxes are shown to be three times larger than self-reported emissions.
- 52 countries have not reported their emissions in the last 10 years, which makes it difficult to close the carbon budget and understand global emissions.
- There is also currently no way to quantify emissions from the non-Annex 1 countries.
- Beginning to see a new suite of facility-scale GHG satellites, such as GHGSat and Carbon Mapper. The challenge is to reconcile the low temporal resolution from these satellites with the high spatial resolution for global mappers, in order to attribute fluxes to specific sectors.
- If the uncertainty values for a sector are known, as are the values for one sector plus the value for the entire grid, the emissions from the other sectors can be calculated. Additional information from another sector can provide further insights into the probability distribution of each sector.
- Facility level reporting can be used with existing accounting models to develop annual sectoral emission inventories. The model parameters can be updated from observation-based annual sectoral emissions.

- Additional information from unknown sources (e.g. gas leaks) can be informed by satellite observation.
- A critical step in linking these activities is better understanding of bottom-up uncertainties, both accuracy and precision.

Discussion

- Richard Engelen (ECMWF) recalled a lot of work was done in the last few years to adapt the uncertainties presented in inventories to something usable by the modelling community.
- Kevin Bowman (JPL) recognised co-emitted species such as NO₂ can be used to improve the signal to noise ratio (SNR) of CO₂ observations. NO₂ has a short lifetime, so observations of NO₂ can be used to identify anomalies in CO₂ and improve the SNR. Co-emitted species can also help attribute emissions to a particular sector, as different species are typically emitted by different sectors.
- Kevin also noted the EPA UNFCCC download probably doesn't have the covariance values, however EPA has provided it separately as a research tool.

6.2 - GHG Budget: Results from RECCAP-2

Ben Poulter (NASA) reported [\[slides\]](#):

- The take-home message from RECCAP-2 is that National GHG Inventories assess anthropogenic emissions and removals, but don't explain atmospheric GHG growth.
- RECCAP-2 aims to provide the most comprehensive, process-based attribution of GHG emissions and removals in a timely way.
- The CEOS Carbon Roadmaps (GHG, AFOLU, and Aquatic) play a key role in identifying key satellite products and strengthening international partnerships.
- The Global Carbon Budget is published annually every fall, while the Global Methane Budget is published every three years. The semi-annual Nitrous Oxide (N₂O) budget is now being considered in super-pollutant assessments coordinated by UNEP.
- RECCAP is a regional assessment of the carbon cycle for land and ocean regions. RECCAP-1 wrapped up in 2011, covering carbon budgets from 1990 to 2009. The project reconciled top-down and bottom-up carbon budgets from aquatic and trade lateral flows, the impacts of heterotrophic respiration, and the sensitivity to the carbon cycle and temperature change.

- RECCAP-2 was proposed in 2017 at the 10th International Carbon Dioxide Conference, and kicked off in spring 2019. The project faced some obstacles over the pandemic, but received significant support from ESA to facilitate contributions across Europe.
- RECCAP-2 covered 2010-2019, with 10 land regions and 5 ocean basins assessed. An emphasis was placed on lateral fluxes, as well as special topics on polar regions, permafrost and future GHGs.
- RECCAP-2 has an aspect of flexibility, in which the team is not bound to the IPCC methodology.
- On the ocean side, the series of 12 papers tried to explain the discrepancy between ocean biogeochemical model-based and pCO₂-data product based estimates.
- A land assessment in Africa found a declining carbon uptake over the past decade and an approximately neutral carbon sink at present. The Australasian budget has a neutral carbon sink, but with a high inter-annual variability.
- Satellite remote sensing datasets in RECCAP are deeply integrated, however the link between products and emissions are sometimes hard to find. There is a disconnect between the products and outputs due to the added value that comes with modelling.
- RECCAP-3 will pay closer attention to the use of satellite data, integrating new AI methodologies, and attempting addressing the latency issues of budgets.
- Key areas of interest in RECCAP-3 include closing the gap between NGHGI's and global GHG budgets, and moving from regional to national budgets. The transition from research to operational budgets is needed to reduce latency, and updated information on trade flows of embodied carbon is needed.
- RECCAP-3 will have a specific focus on involving early-career postdoctoral scientists. Any other agencies interested are welcome to get involved.

WGClimate-22-19	Agencies interested in supporting post-doctoral researchers for RECCAP-3 to contact Ben Poulter.	Due: Q4 2025
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Discussion

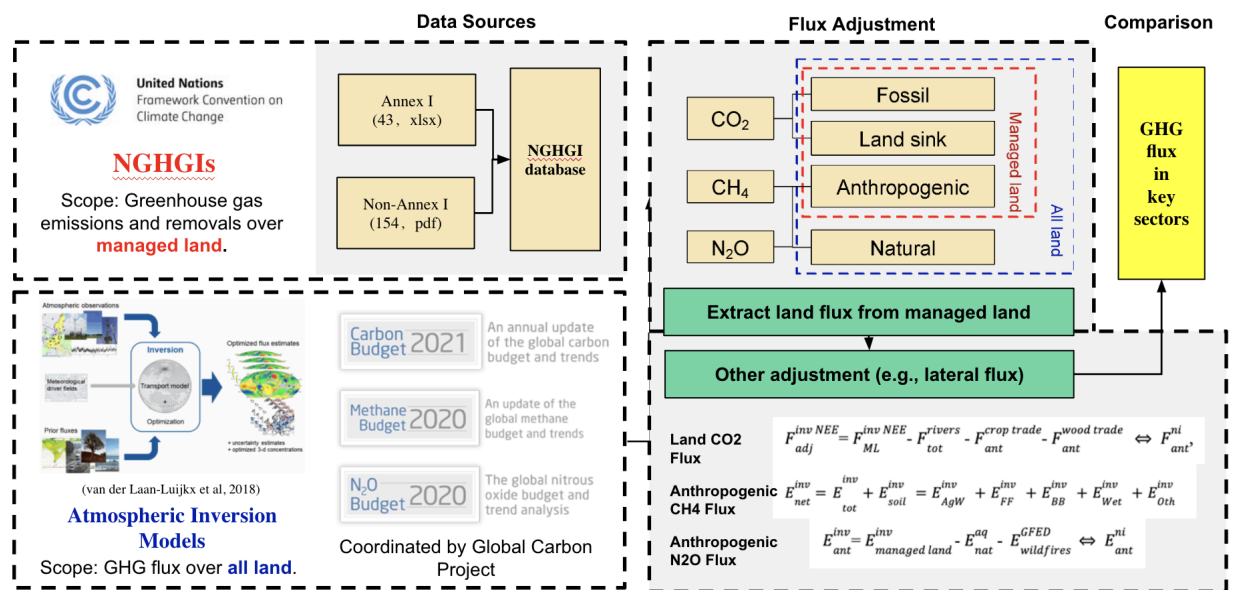
- Clement Albergel (ESA) recognised that support from ESA for RECCAP-2 has led to excellent scientific outcomes. ESA has also now started developing activities for the ocean.
- Ben noted the move from regional to national GHG budgets changes the management structure of activities like RECCAP. It will be interesting to see how more nationally based budgets can be done, paying attention to the latency issue.

- One key aspect of the global carbon project activities is that they're all voluntary. ESA has provided a tender for European teams, but for other regions the work is voluntary.

6.3 - Global GHG reconciliation: UNFCCC GHG inventories and atmospheric inversion

Phillipe Ciais (LSCE) reported [slides]:

- National inventories are compiled by activity data and emission factors, however these have latencies of at best two years, many of which lag behind by up to ten years.
- A harmonised NGHGI dataset has been developed, with data extracted from over 600 PDF documents.
- The Paris Agreement's enhanced transparency framework (ETF) will improve frequency, format and continuity of reporting, to ensure consistency across the datasets.
- A lot of countries will retain the flexibility to report the NDC baseline year and time series data from at least 2020 onwards. Some countries however have not reported for many years.



- For methane, the difficulty is for quantifying factors such as wetland emissions. A mask can be applied to remove the natural emissions.
- National net CO₂ land fluxes found more year-on-year variability than is in inventories, and consistent changes between satellite and surface inversions.
- Canada, Russia, Europe and Kazakhstan have much more carbon sink in the inversion models than reported via their inventories. Tropical countries also show variability, but we see greater emissions from the atmosphere than is reported in inventories.

- Another key issue is that Inventories only report fluxes over managed land. Managed land often has much larger sinks than unmanaged land. Hence, higher carbon emissions are estimated by the inversion than inventories for Brazil. Meanwhile, inversions estimate a higher carbon sink over managed land for Canada and Russia than is reported in their inventories.
- In some countries, there is a large uncertainty in separating natural and anthropogenic emissions in inversions. Emissions are underestimated by national reports in Persian Gulf countries, India, and Russia.
- There is often high agreement by satellite inversion and in situ inversions.
- It is important to note that the trend of the inversion models depends on the trend of the inventories.
- Have set up a pipeline for methane emissions of major fossil fuel basins from Sentinel-5P TROPOMI images. These basins contribute to about 20% of global methane emissions from fossil fuels, with the highest contributions from Permian, Appalachian, Iran, Iraq, and Turkmenistan basins. There is fair agreement between NGHGs and inversions for most largest emitters, as well as consistency between surface and satellite inversions.
- Atmospheric inversions can aid the quality control of national reports. However, they work better for large-area countries with global models, and their accuracy depends on surface network density (no station in the tropics). Satellites offer a more balanced sampling of all the countries.
- The potential to develop inversions with higher resolution for quality control of inventories requires more accurate spatial maps of emissions from inventories (priors), and dense regional atmospheric networks combined with satellites.

Discussion

- Dave Crisp (SIT Chair Team) recognised an issue with reconciling different capabilities, e.g. space-based inversions and RECCAP. How do we merge the different systems together, to produce a product we can all stand behind?
- Philippe Ciais (LSCE) would suggest an approach using a Bayesian average of independent observations. Then, a 'model of models' could be created, perhaps using Vector Moving Average (VMA), similar to a weather model.
- Kevin Bowman (JPL) noted that to do this programmatically, mathematical frameworks would need to be used.

- Ben Poulter (NASA) recognised recent coordination efforts at the national level, especially with WMO and G3W. There is a need for national level integrated observing system tasks to continue, but it needs to remain interoperable with international efforts. CEOS and CGMS roadmaps being developed are a key activity to support this.
- Lesley Ott (NASA) commented via chat: *Do we need a single product (reconcile RECCAP and space-based)? There is also strength in a few complementary but somewhat independent approaches as we use for global temperature analyses.*
- Yasjka Meijer (ESA) commented via chat: *I think the fear is that it might be acceptable for us but confusing for externals and give almost the impression of choice.*
- Stephan Bojinski (EUMETSAT) recalled the discussion from Session 2 regarding the characteristics for CDRs. For these applications, are long, homogeneous records needed, or are NRT products from the satellites used instead?
- Philippe noted the CO₂ inversions can be compared directly. However, blindly merging two satellites identifies gaps however.
- Mark Dowell (EC-JRC) recognised a fundamental issue of language and terms between the satellite community and inventory compilers. The Global Carbon Budget now has a correction term to account for differing definitions, which is helpful for transparency and education.

6.4 - Improving the UK GHG Inventory

Onoriode Esegbue (Energy security) reported [[slides](#)]:

- The UK is currently working on improving their national GHG inventory. It has been reviewed several times by UNFCCC, and found that inventory needs several continuous improvements.
- In 2017, the UK Committee on Climate Change (CCC) recommended that the process for identifying improvements to the methodology could be strengthened. The process for prioritising improvements should be more transparent and should have a stronger focus on sources that contribute a large proportion of uncertainty and priorities needed for policy development.
- An in-depth review involving several UNFCCC experts detailed what the UK GHG inventory needed to improve. 50-60 recommendations were delivered.
- Have now completed 16 different improvement projects over the last two years in response to these recommendations.

- Six tall tower sites around the UK take GHG measurements and report them annually. The Greenhouse Gas Emissions Modeling Advancement (GEMMA) verification programme will augment measurements from these sites, with ground-based and remote sensing instruments.
- The UK is aiming to produce a transparent, complete, and accurate GHG Inventory that is fit to track progress towards net-zero emissions. Improvements to the inventory should reduce delivery risk, improve transparency, and provide value for money.
- GHGSat data is used for validation, comparing facility scale data with reported emissions. Still working on how the EO data can be included in the inventories.
- Plan to create a new platform with data tools that facilitate the efficient, flexible, transparent and traceable flow of information which supports National Atmospheric Emissions Inventory (NAEI) compilation from raw data to a single emissions database.
- Considering how to use EO for improving the inventory, in particular for reducing uncertainties.

Discussion

- John Remedios (NCEO) recognised that running multiple models is helping provide robustness for the top-down estimates. However, this may not be possible for a larger country.

6.5 - EO Data in the French LULUCF Inventory

Mélanie Juillard (CITEPA) reported [[slides](#)]:

- CITEPA is the French national GHG inventory team that compiles the country's GHG emissions for UNFCCC reporting.
- Methods mostly focus on a sectoral bottom-up approach, following IPCC guidelines and country-specific activity data and emission factors.
- EO data is used for Land Use, Land-Use Change and Forestry (LULUCF) and shipping sectors.
- Spatialisation of the CO₂ estimates aims to provide the emission estimates on a more precise grid. Monthly reports are also generated for more frequent monitoring.
- The usual approach for UNFCCC inventories is to calculate emissions as the activity data multiplied by the emission factor. EO data can further develop this model to track land use and management change.

- The LULUCF Regulation established as EU 2018/841 is a “geographically explicit” monitoring of land use change expected from EU member states.
- The process was a challenge to see what data was available for this spatially explicit monitoring. A 0.25 hectare gridded model was used to collect spatial data on land use, carbon stocks, and regional management practices.
- The objective is to have a time series dataset for the whole region, where each cell’s land use is mapped annually from 1990. However, the detection of true changes can be difficult, and it is also hard to define what a ‘true change’ is.
- The products integrated into the grid include a number of national products, as well as some from Copernicus for land cover change. The visualisation tool allows for the classification to be overlaid on an visual image of the area, to provide transparency and justification.
- EO data is also used for French overseas territories, however it can be difficult to find good quality data.
- The exercise has demonstrated that geographic monitoring can help to better fit the efforts / policies and measures results at different scales (data published at municipality scale)
- Interoperability & transparency is a key benefit for space-based data.
- On some territories like French Guiana estimates are not available, so having EO data is vital despite difficulties in evaluating the maturity and suitability of datasets. A lot of European countries would also benefit from timely datasets.

Discussion

- Clement Albergel (ESA) is working with the CITEPA team to understand their methodology and how EO data is used. The national inventory teams should contact WGClimate if there are datasets which could be useful but are not yet fit for purpose.
- Jörg Schulz (EUMETSAT) recalled the recent EUMETSAT Wildfire workshop, noting it is good to see these products being used. This is also a good use case for the CDR Inventory mapping work, which could help national inventory teams choose the right datasets which meet requirements and product specifications.
- Mélanie Julliard (CITEPA) recognised it is useful to know if a product is going to be updated, and the methodology should be provided alongside any product. Jörg noted this information is included in the CDR inventory.

- Mark Dowell (EC-JRC) recalled the CEOS AFOLU Roadmap that was recently completed. Copernicus will also start generating a new global land cover and forest monitoring product from the end of 2025, at full Sentinel-2 resolution. This will be an operational product, produced annually, which may be useful for the outermost regions.
- Onoriode Esegbue (Energy security) noted that the UK has just completed a wildfire project, and found that EO data does not always match the fire fighter database.
- Dave Crisp (SIT Chair Team) noted a two way exchange is needed to understand the requirements from both sides. At the moment, space-based GHG products are most useful for constraining LULUCF over fossil fuel emissions. By combining activity data with flux measurements from satellites, regional emissions can be constrained, and can help evaluate the validity of the emissions factors.

6.6 - Germany

Andrea Kaiser-Weiss (DWD) reported [\[slides\]](#):

- Germany has a large national project to operationalise the production of national inventories. The first generation inventory aims to include more data sources, especially satellite data.
- CAMS data is used to understand the methane emissions which arrive in German air space from other countries. Around 50 tracers are used to understand how methane is moving in the atmosphere across Europe.
- CH₄ scaling inversions are only reasonable if the forward model can capture an observed variability and if the observation accuracy can be trusted. Far-field corrections are necessary to achieve the inversion.
- These analyses have shown confidently that the emission estimates are larger than the prior.
- It has also proven difficult to separate agricultural emissions from wetlands.
- A framework to compare results between countries to avoid confusions would be helpful. ICOS is a good start, but more unbiased observations are needed.
- TROPOMI data was used to check the model outputs. The model was found to be accurate over Europe generally. However, the model for the Moscow region did not perform well, likely due to bad priors. Turkmenistan is also a problem region for the model, perhaps due to topography.
- It would help users if there was a subset of data available starting with unbiased European retrieval datasets. Later on, more sophisticated data can be used.

- The University of Bremen is working on methane source detection with Sentinel-5P.
- TROPOMI data has helped to monitor the decarbonisation of the German steel industry.
- Other groups are looking at process-based modelling for various applications including N₂O emissions from agricultural soil, and biogenic CO₂ fluxes.
- German top-down CH₄ estimates using ICOS are successful and would like more data. The uncertainty structure of the observations also needs to be better understood.

Discussion

- Ruediger Lang (EUMETSAT) asked whether biases in satellite data have an impact on creating consistent models.
- Andrea Kaiser-Weiss (DWD) noted the difference between the model and fluxes is used to correct for biases. Alternatively, satellite data could be used to correct for boundaries.
- The long-term goal is to improve the latency, but currently it is synced up with the reporting of the inventory with a 1-2 year latency.

6.7 - Steps to improve Norwegian and European emission estimates

Glen Peters (CICERO) reported [\[slides\]](#):

- The Norwegian GHG Inventory is based on fossil fuel emissions of CO₂, CH₄, N₂O, and fluorinated gases, with a recent decline in LULUCF. Fossil fuels dominate the GHG emissions, with uncertainties up to 35%.
- Global average Tier 1 approaches are applied to compare the Norwegian estimate with independent inventories (e.g. EDGAR). Inversion estimates reduce the size of emission sources from oil and gas facilities which indicate that the EDGAR estimate is too high for Norway.
- Aggregated totals of methane inversions are compared to ground-based measurements from the ICOS network. There is a poor coverage of satellite observations over the high northern latitudes, largely due to clouds, which means there is little constraint provided on fluxes in those regions.
- LULUCF emissions are much more uncertain. The national forest inventory (NFI) sites are only visited once every five years, which means only 20% are covered each year.
- Compared to Land-Surface Models (LSMs) in the 'TRENDY' simulations, with full land history and climate, the Norwegian LULUCF estimates look consistent, though with large variability and uncertainties.

- Bookkeeping models, with preindustrial accounting and land-use transitions, give much higher emissions, suggesting the Norwegian sink is dominated by climate and CO₂ fertilization.
- Comparisons with global carbon project inversions are broadly consistent with the Norwegian LULUCF estimates, but the uncertainties are too large to have any confidence.
- Have developed the Norwegian roadmap for CO2M/CO2MVS, funded by the Norwegian Space Agency, to plan how best to use CO2M measurements once available.
- Norway has a high latitude and rough topography, making satellite observations difficult. There are few large point sources which are often in challenging locations.
- Inventory compilers are often interested in specific uncertainties e.g. for fluorinated gases and landfills.

Discussion

- Clement Albergel (ESA) questioned why the LULUCF bookkeeping approach produces a vastly different estimate. To what extent do the different approaches use the same type of information?
- Glen Peters (CICERO) noted that as land cover is not fixed in time, one of the models is more based around FAO data and gross fluxes, while others are more based around early wasteland datasets. Differences are mostly due to the fact that the inventory is driven by the definition of land use cover, whereas bookkeeping is mostly tracking land use change.
- CICERO colleagues are also working on inversion modelling using satellite data products for methane and also increasingly for CO₂.
- Glen added via chat: *On the question on the difference between the bookkeeping models and inventory in Norway, the 'Grassi' translation essentially closes the gap, which would imply climate and CO₂ fertilisation explain the gap. Though, I am not sure the GHG inventory compilers would be convinced of that (they argue the climate / fertilisation effect is small, and most of the growth is due to response to previous disturbance). Overall, I think there is a way to go to be confident of the differences and what they mean, which really requires pulling the datasets apart and the grid level and comparing with the national forest inventory data.*

6.8 - Denmark

Ole Krarup Leth (National Centre for Climate Research, Denmark) reported [\[slides\]](#):

- The Danish Meteorological Institute (DMI) has key responsibilities in the operational monitoring and warning of extreme ocean and weather events, climate research, and advice on green transition and adaptation.
- DMI is involved in Copernicus Marine Service and C3S projects, with a focus on operational production, monitoring, and climate time series.
- National emission estimates for GHGs and air pollution are based on activity data and emission factors.
- The Danish National Centre for Environment and Energy (DCE) and Institute for Environmental Sciences at Aarhus University is responsible for producing [national emission estimates](#).
- A workshop was held at DMI in March 2022 to gather user requirements and get a common understanding of the possibilities and challenges. Participants also discussed a possible way forward towards a national GHG monitoring service based on CO2M.
- The workshop motivated the preparation of a report, mapping the needs in Denmark for space-based GHG monitoring, entitled: *“Mapping interests and potentials in satellite data for monitoring greenhouse gas emissions”*. The paper concluded that CO2M may be a game-changer compared to previous and current satellite missions, and there is a great national demand for independent measurements of methane, nitrous dioxide and CO2 emissions for land use.
- There are many national competences on the processing of satellite data, but none specifically on greenhouse gases. Denmark is also lacking relevant national competences in inverse modelling.
- DMI has ongoing dialogues with relevant authorities to highlight the potential and future needs for satellite-based CO₂ and CH₄ observations for the verification of national emission inventories.
- Looking to establish funding for building up and operating a national satellite-based monitoring activity.
- The plan is to use the CAMS GHG Monitoring & Verification Support (MVS) as much as possible and adapt products to national needs and requirements to support national decision makers.

6.9 - Discussion

- Kevin Bowman (JPL) asked about the purpose of using satellite observations to improve inventories. To what extent can EO be used to trace emission reduction to specific policies?
- Richard Engelen (ECMWF) noted CAMS includes an emissions scenario tool, which allows the user to play with different measures in the atmosphere.
- Glen Peters (CICERO) noted that inventories are used to track progress of the countries, however not many inventories pull out emissions by sector. It is likely there isn't the level of precision needed for this with the current methodologies.
- Kevin suggested that by using additional covariant species, there could be better attribution to the processes for more policy-relevant applications.
- Mark Dowell (EC-JRC) recognised that EO and modelling can contribute to policy evaluation - measuring emissions against milestones and targets. Attribution of emissions to different sectors may only be useful if progress is not made towards the targets.
- Glen noted an underlying issue regarding whether the inversion is evaluating the inventory or the inventory is evaluating the inversion. Which method has higher confidence?
- Ole Krarup Leth (National Centre for Climate Research, Denmark) recognised the capabilities of current and future satellites will be a game changer to reduce uncertainties. Denmark would like to be more prepared for this than they are right now.
- Mark asked the national inventory teams what they might need from space agencies over the next 12-18 months to support inputs for GST2.
- Mélanie Juillard (CITEPA) noted that new products are not necessarily needed, but rather a guidebook on how to find the right products and how to use them.
- Dave Crisp (SIT Chair Team) recalled the CEOS AFOLU team's work to develop a harmonised biomass product. However, for GHGs, the work is not yet at the point of being able to identify a 'best product'.
- The 2019 update of the IPCC guidelines included information on using EO for verification and quality purposes. The field has advanced since then, so this document may need to be updated, or further training provided.

- Yasjka Meijer (ESA, GHG-TT Lead) noted each country is approaching the use of satellite data differently. WGClimate plans to have more exchanges like this, bringing together national inventory compilers in various regions.
- There is no central platform for different national inventory teams to meet and discuss. EC-JRC organises a workshop every year for LULUCF, and inversion teams talk through IGOS, but no global forum exists. DG Clima operates globally, but with only one country at a time, not multi-laterally.

WGClimate-22-20	WGClimate, with UNFCCC and IPCC TFI, to consider establishing regional satellite data experts to advise national inventory compilers.	Due: WGClimate-23
WGClimate-22-21	WGClimate to consider how best to provide capacity development resources around using satellite data for national inventories. This could be done as an expansion to the CEOS GST Portal .	Due: WGClimate-23

Day 3: Thursday 13th February, 2025

Session 7: GHG-TT - System Development & Stakeholder Engagement

7.1 - System Development: Inventory of use cases (SYS-02)

Richard Engelen (ECMWF) reported [[slides](#)]:

- The original roadmap focused on development of an operational system, with observations to address user needs. However, the landscape of new initiatives in this domain is rapidly evolving, with various national and international efforts being developed. CEOS/CGMS should coordinate the provision of the required satellite data that all greenhouse gas monitoring systems need.
- Looking at putting together an inventory of use cases could show what can be done with space-based and other observations from CEOS Agencies. Various use cases were collated on the [GST Portal](#) to support GST1.
- To effectively provide these use cases and facilitate discussions with the user community, the target audience needs to be defined, as well as what exactly should be showcased and how it will be communicated.

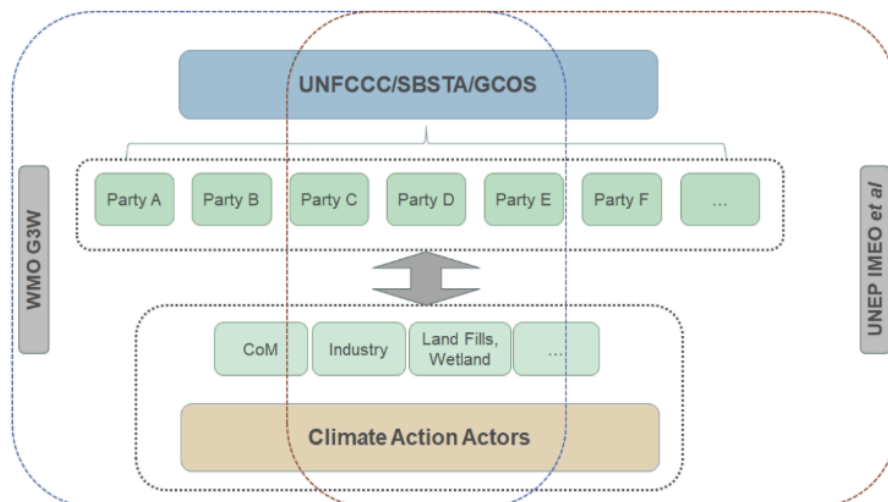
Discussion

- Mark Dowell (EC-JRC) asked whether the G3W community has a common understanding of what is meant by ‘the system’ - including the components and who is contributing.
- Gianpaolo Balsamo (WMO) noted there is awareness of the value of WMO in combining information of different systems. However, use cases are not easily presented in G3W, as it is more complex to find use cases for the global products.
- Yasjka Meijer (ESA, GHG-TT Lead) highlighted that it is important to have a clear view of the users and exactly what they need. WGClimate is engaging with IMEO’s Use Case working group to identify sectors where EO data can help reduce emissions.
- Gianpaolo recognised the importance of integrating data into the infrastructure, including the storage of historical data such as that generated for hot spot monitoring.
- Richard Engelen (ECMWF) noted that G3W and IMEO have different objectives, and hence it may be hard to harmonise the systems.
- Vincent-Henri Peuch (ECMWF) recognised G3W is modelled off of World Weather Watch (WWW), which can be used to understand the steps to an operational capability. Use cases are a lightweight step to understand the gaps between the science and needs of the users. Leveraging concepts from the meteorological community will be beneficial.
- Mark noted that the use cases work shouldn’t be a distraction for the long-term ambitions, although they are useful to build awareness and capacity. There are good methodologies in building dynamic narratives, which will require a lot of thought in what is prioritised.
- Yasjka recognised that data sharing between national meteorological agencies is key to the global meteorological community. Ideally, a similar system will be eventually built for GHGs.

7.2 - Engaging with GCP & RECCAP (STAKE-05)

Mark Dowell (EC-JRC) reported [\[slides\]](#):

- The below diagram is included in the updated GHG Roadmap, and shows the interaction between different stakeholders.



- The prime focus of the GHG Roadmap is to support stakeholders with fit-for-purpose, space-based GHG observations that enable the production of data products to meet the user needs.
- The stakeholder actions in Annex C of the roadmap concern engagement with UNFCCC, G3W, UNFCCC Parties, and GCP & RECCAP.
- A common interface to GCP/RECCAP should be established to avoid saturating users with requests. Inventory compilers sometimes receive many requests from the observation and modelling communities, so it may be best to combine efforts.
- While RECCAP-2 used a lot of EO data, it can be difficult to trace their use, especially as it is obscured through models.
- GHG Task Team has already established points of contact for G3W and IMEO, and should consider having a formal link with GCP and RECCAP as well. While colleagues participate in these activities, formal agency representation would be beneficial.

Discussion

- Jörg Schulz (EUMETSAT) suggested a formal connection should be made with WCRP, including inviting them to present at the next WGClimate meeting.

WGClimate-22-22	WGClimate Chair to invite WCRP representatives to WGClimate-24 (Feb 2026) to discuss their activities and opportunities for collaboration.	Due: Q4 2025
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- Clement Albergel (ESA) agreed with the suggestion to establish a formal connection with GCP, noting that at COP-29, representatives from University of Exeter presented on the Global Carbon Project.

- Mark Dowell (EC-JRC) recognised that by identifying where satellite data is used in various analyses, it provides both justifications for programme budgets, as well as a mechanism for feedback on the data.

GHG-TT-11	Stakeholder thematic lead (Mark Dowell) to add an action in Annex C of the GHG Roadmap for collecting ideas for reaching stakeholders to provide actionable information leading to mitigation.	Due: 15 Mar 2025
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- Susanne Mecklenberg (ESA) recalled that national agencies all have different approaches to using satellite data. How can their different approaches be reconciled to be compared? A future operational service could help streamline this across different agencies with differing resources and expertise.
- Richard Engelen (ECMWF) noted that Copernicus has received feedback that there are a few countries that get lost amongst activities, and would appreciate better coordination. The requirements for different countries are highly variable. Even in Europe, some countries don't have the capacity to develop their inventories.
- Mark recognised the link to national inventory providers is the end goal, but if there's added value in a more coordinated approach with respect to programmes like GCP and RECCAP, they should be explored. Should WGClimate and GHG-TT put additional effort on a coordinated approach to GCP, RECCAP, and, in future, ESMO?
- Richard recalled that IG3ES is now working on national guidelines. Part of the role of IG3ES is to make use of available expertise to build these state of the art documents.

WGClimate-22-23	Richard Engelen to share the IG3IS guidelines document with WGClimate members.	Due: ASAP
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- Mélanie Julliard (CITEPA) sees two main use cases of EO: the first for when data is lacking, and the second is for external validation. The IPCC 29 requirements are unclear as to what is mandatory. Some agencies are starting to acquire dedicated personnel to run comparisons, however Citepa are unsure if this is necessary. They are not finding that there is a saturation of communication.
- Yasjka Meijer (ESA, GHG-TT Lead) recognised these discussions are currently very European-centric, and hence whatever is learned should be communicated as guidelines to other agencies around the world.
- Clement noted RECCAP-2 is working with agencies in Colombia and Brazil, and DG Clima is also doing training in other regions. However, other regions can often be difficult to involve from a monetary perspective.

- Claire Macintosh (ESA) noted via chat: *ESMO is scoping the formation of a task team on Carbon Cycle with the following objectives to identify the Carbon Cycle work within WCRP and how they relate, and improving transparency in how modeling frameworks and structures are reported in outputs. Initial discussions are planned for the end of February / early March. Please reach out if you are interested in joining.*

7.3 - G3W & IMEO Engagement (STAKE-03)

Mark Dowell (EC-JRC) reported [[slides](#)]:

- One reason the GHG Roadmap was updated was that the landscape has changed with the emergence of G3W and IMEO. Space agency coordination activities with respect to these programmes should be done through WGClimate.
- There has been an attempt to reinvigorate communications with IMEO in January 2025 with a letter sent by the CEOS Chair and SIT Chair. A big aspect of this request is regarding the common practices document and the idea of how it is taken up and implemented. There is a concrete proposal to organise a community workshop in 2025 between IMEO and CEOS to ensure we have buy-in from all public and private partners involved.
- Regarding G3W, it was raised that CEOS should support the cal/val site needs of G3W, in particular consider establishing supersites. This would involve the GHG-TT, WGCV, and AC-VC.
- Vincent-Henri Peuch (ECMWF) is designated as the formal point of contact for G3W, while other CEOS/CGMS colleagues are participating in the various task teams and working groups.
- John Worden (NASA JPL) is identified as the primary point of contact for IMEO with support from Yasjka Meijer (ESA, GHG-TT Lead).
- A dedicated G3W and GHG-TT virtual meeting in mid-2025 is planned.

GHG-TT-05	Mark Dowell & Vincent-Henri Peuch to organise a dedicated virtual meeting between G3W and GHG-TT in mid-2025. The timing should consider the various G3W workshops.	Due: Q2 2025
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Discussion

- Yasjka Meijer (ESA, GHG-TT Lead) noted CEOS is supporting IMEO in restarting the Use Case Working Group. WGClimate colleagues are invited to participate. The first meeting will likely be in Q3 2025.

GHG-TT-06	Members interested in joining the IMEO Use Cases Working Group should contact Yasjka Meijer. The group aims to meet in Q1 2025.	Due: ASAP
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- Clement Albergel (ESA) recalled that IMEO has a team working on campaigns in as many countries as they can. IMEO will join ESA’s CARBONARA campaign in Brazil. IMEO should also be involved in the cal/val supersite discussions.
- Yasjka Meijer (ESA) suggested a central database for controlled release experiments could be used. Is this something IMEO can set up?
- Itziar Irakulis-Loitxate (UNEP IMEO) noted that IMEO is interested in participating in controlled releases, but it is unclear whether they could centrally coordinate a database.
- Dave Crisp (SIT Chair Team) noted that CEOS could set up a central database, and work with IMEO to see if it may also meet their needs. However, near-real time data for GHG missions is something CEOS Agencies don’t have a lot of expertise in.
- John Remedios (NCEO) noted that messaging around the common practices at COP-30 should be well coordinated, including with IMEO.
- Yasjka recognised that, while space-based data are contributing to the GST, there are other opportunities to provide actionable information that are missed. How can actionable information be provided to the right people?
- Clement suggested the CEOS GST Portal be updated with datasets made for GST2. Use cases could also be featured.

GHG-TT-07	John Worden to discuss with IMEO the establishment of a central database of controlled release experiments. Discuss whether this should be led by GHG-TT or IMEO.	Due: Q4 2025
GHG-TT-08	UKSA CEOS Chair Team to develop communications with IMEO regarding the methane best practices, to ensure consistent messaging around COP-30. Work with the Australian 2026 CEOS Chair Team, who will be CEOS Chair at the time of COP-30.	Due: COP-30

Session 8: Other Topics

8.1 - Participation and contribution to UNFCCC events

Mark Dowell (EC-JRC), WGClimate reported [[slides](#)]:

- WGClimate inputs for Earth Information Day at the annual UNFCCC COP have inputs previously been provided on an ad hoc basis through partners such as GCOS and WMO. Discussions led by the SIT Chair Team have suggested establishing a ‘tiger team’ within WGClimate, to be led by the WGClimate Vice-Chair.
- The mandate of this team would be to develop a long-term plan for inputs into UNFCCC events such as Earth Information Day. More thought needs to be put into how these events are used as inputs to negotiations.
- The tiger team would also look at how to better prepare for individual Earth Information Days. By June each year, a concrete proposal for Earth Information Day should be developed. Thought should also be put into how CEOS/CGMS should be represented in the Plenary sessions and in eventual round-table discussions. This will allow agencies to ensure messages are reflected in their respective national delegations.
- CEOS/CGMS should also seek to increase engagement with national inventory teams in the context of Earth Information Day. Building capacity in less developed regions will also be crucial, e.g. through activities like SilvaCarbon.

Discussion

- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) recognised COP-30 will be very important. Starting early, before the northern hemisphere summer, will be important to deliver effective, cohesive messaging from the remote sensing community.
- Albrecht von Barga (DLR) recalled the lack of structure around proposals and inputs for Earth Information Day. The submission dates for proposals should be made clear to Parties, as should the point of contact. DLR has had some contact in the past through IPCC in Germany.
- Patrick Gibson (UKSA) expressed support for the tiger team. It is important to understand what negotiators need from Earth Information Day, to inform discussions during the rest of the conference. At COP-29, there were breakout sessions run, but as they only lasted 45 minutes, no conclusions were reached and hence the outcomes couldn’t be brought to the table at the Plenary sessions.
- Jörg Schulz (EUMETSAT) highlighted the importance of connecting with WMO through the tiger team, as they have often had large representation at Earth Information Day.
- Yasjka Meijer (ESA) noted it is important to understand who we are creating information for. UNFCCC will react to whatever they receive from delegations. The tiger team should ensure multiple consistent proposals for Earth Information Day are submitted by different parties.

- Albrecht recalled feedback from delegations who noted the UNFCCC Secretariat must be careful not to drive the agenda and leave it up to the Parties.
- Yasjka suggested the tiger team also work to understand which agencies plan to have a pavilion, and who will participate in which events.
- Osamu Ochiai (JAXA, SIT Chair Team) noted that the SIT Chair and CEOS Chair Teams are planning a side meeting at SIT-40 focused on interactions between space agencies and their national negotiators. Other inputs from WGClimate are welcomed.
- Mélanie Juillard (CITEPA) noted that for COP-30, France is exploring the topic of water management, and is considering partnering with the International Office for Water.
- Mark Dowell (EC-JRC) recognised COP engagement is rarely solely focused on GHGs, and space agencies often contribute to other activities, such as water management. Water resource management is an emerging hot topic in Europe.
- The CEOS Chair is invited annually to SBSTA to make a statement on behalf of CEOS and CGMS members. WGClimate leads the drafting of this statement, where a first draft will be put together by summer. Ideas are welcome for this year’s statement.

WGClimate-22-24	<p>Vincent-Henri Peuch to lead the new UNFCCC COP Tiger Team, with the specific tasks to:</p> <ul style="list-style-type: none"> • Ensure consistent preparation for Earth Information Day • Enhancing coordination at key UNFCCC events throughout the year • Develop a comprehensive multi-year engagement strategy aligned with the phases of the GST process, including proactive preparation for party submissions. • Define key objectives for each COP and EID, ensuring that CEOS and CGMS efforts are strategic and aligned with broader climate goals. • Survey agencies to understand their level of participation at each COP (individuals and/or pavilions) <p>Vincent-Henri to reach out to all WGClimate members to call for participants in the Tiger Team. CEOS Chair Team and SIT Chair Team to be included.</p>	Due: 28 Feb 2025
WGClimate-22-25	<p>WGClimate members to contact UKSA CEOS Chair Team if they would like to provide inputs to the SIT-40 side meeting focused on the interactions of space agencies with their national delegations.</p>	Due: March 2025

8.2 - Expanding the Utility of ECV Inventory to Address Emerging Priorities

Mark Dowell (EC-JRC), Jörg Schulz (EUMETSAT) reported [[slides](#)]:

- The ECV Inventory has always been free and open, but was originally designed as an internal tool. The value for the external community has remained unclear.
- The focus has been on the production of Climate Data Records (CDRs) and its documentation with respect to GCOS guidelines and requirements. In the refresh of the inventory, it will now be called the ‘CDR Inventory’, to be more flexible in including data that are not ECVs nor are on typical ECV time scales.
- With the objective of enhancing discoverability and uptake by external users and stakeholders, a decision tree approach could be used to guide users to the right type of CDR.
- The suggested approach is to identify different application/stakeholder “groupings” and then map relevant ECV Inventory products onto these groupings. These groupings could be wide and varied, from science to Policy/Decision making.
- WGClimate members are requested to contribute to defining initial application/stakeholder typology categories, and also nominate for the role of category “champions” to map CDRs onto individual application/stakeholder “types”.

Discussion

- Jörg Schulz (EUMETSAT) noted funding for the Inventory has been secured until 2029, with contributions from the European Commission and EUMETSAT, and the new technical basis allows for the tagging and filtering of datasets. It would be good to have national inventory teams test the tagging of datasets.
- Wenying Su (NASA, WGClimate Chair) recalled the call to collaborate with the ESMO Working Group for Observations for Researching Climate, as well as the Global Goal for Adaptation indicator framework. The CDR Inventory could support these and many other different groups and typologies, with the right guidance on the types of data.
- Claire Macintosh (ESA) recognised ESMO has also been discussing with observation data experts, who would like a data discovery tool which can identify datasets which are fit for purpose. CMIP has an extensive user base which would be applicable for this type of work.
- Alexandra Nunes (EUMETSAT) recognised that either experts can manually pick what CDRs are useful for each application, or the inventory can be filtered based on

requirements. The latter would require the characterisation of additional information for each dataset.

- Mark Dowell (EC-JRC) recognised the translation of needs to requirements will require a lot of work, as some user categories are not capable of expressing their requirements as seamlessly as others.
- Jörg noted that about 300 records would need to be triaged at this stage. In the new inventory products will be published continuously, with about a 4 week turn around period. If the product is not verified by the agency, it will be published with an 'unverified' flag.
- Wenying suggested that the work flow be demonstrated in 2025 as a proof of concept.
- Heikki Pohjola (WMO) noted that WMO maintains the OSCAR Database, where a gap analysis can be performed for any measurement. The team is working on implementing a layer to perform gap analysis for ECVs.

WGClimate-22-26	WGClimate Chair to email WGClimate members, detailing the tasks around expanding the ECV Inventory, and requesting volunteers to contribute to defining initial application/stakeholder typology categories. Category "champions" will be chosen to map CDRs onto individual application/stakeholder "types". CMIP should be invited to join, and other external participants are also welcome.	Due: 28 Feb 2025
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8.3 - Roadmaps combined: comprehensive monitoring of the carbon budget

Vincent-Henri Peuch (ECMWF) reported [\[slides\]](#):

- CEOS now has three Carbon Roadmaps, either recently completed or in development: Greenhouse Gases (Issue 2 endorsed in October 2024), AFOLU (endorsed in November 2023) and Aquatic Carbon (in progress, scheduled to be completed by Q1 2026). Each roadmap looks at specific aspects where EO can constrain the carbon budget.
- There are a lot of specificities for each domain that justify three roadmaps. However, convergence is needed on activities of similar nature such as capacity building, stakeholder and user engagement, and interface activities.
- WGClimate, working with G3W, could explore basic inverse modelling capacities as an integrated tool to identify where key uncertainties lie.

- To date, the approach has been to look at use cases to understand the comparison between top-down and bottom-up approaches. Reconciling these approaches remains a challenge.
- Are there useful new activities that WGClimate could initiate or sponsor to ensure comprehensive monitoring of the carbon budget?

Discussion

- Mark Dowell (EC-JRC) recognised that, in developing the AFOLU Roadmap, the nature of the data assimilation systems was discussed. Should they become one system, or remain as parallel cross-talk systems? It was felt that the AFOLU community needed specific datasets, which wouldn't be produced by the integrated system.
- Richard Engelen (ECMWF) noted that each segment has a different way of looking at the carbon system, and hence it is unfeasible to bring everything together in one system. The managed biospheric emissions need to be properly accounted for as well. The interface between systems needs to be kept as close as possible to ensure the detailed information in global monitoring systems is available where needed.
- Dave Crisp (SIT Chair Team) noted that the three segments look at inverse modelling from different perspectives. In many cases, the land surface side wants the atmospheric community to provide as much information as possible, and hence facilitating communication between these communities would be very helpful.
- Wenying Su (NASA, WGClimate Chair) noted the G3W Modelling Task Team, and asked whether some of their work could be leveraged to progress these topics.
- Vincent-Henri Peuch (ECMWF, WGClimate Vice-Chair) recognised the actors in G3W are very similar to those in the CEOS/CGMS carbon roadmaps, and the connection with the climate sector is also very strong. To avoid duplication, the responsibilities of G3W versus WGClimate around these topics should be clarified.
- Yasjka Meijer (ESA, GHG-TT Lead) recognised the interfaces are more relevant for the GHG side. Inputs from the land and ocean sides are needed to better understand what is emitted into the atmosphere.
- Mélanie Juilliard (CITEPA) noted that blue carbon reporting is not currently included in the inventories. Within the inventory discussions, there are strong opinions as to whether or not it should be included.
- Dave noted that the AFOLU Roadmap is mostly focused on carbon stocks, while the GHG Roadmap looks more at fluxes. The Aquatic Carbon side is looking at ocean stocks to see whether there is inference for fluxes. Each segment has a different focus, but all

come together to form one carbon budget. With better interfaces between the segments, EO products can be made more valuable.

- Bottom-up and top-down reconciliation is a key area where the roadmaps need to converge on.
- Yasjka noted the need to understand ocean fluxes. Are there space-based tools which can assess the carbon fluxes in the ocean? Dave recognised that satellite instruments flown today can't quantify ocean fluxes at a meaningful level, as they have not been optimised for this application.
- Laura Lorenzoni (NASA, Aquatic Carbon Roadmap Team) noted that SOLACE is one project the team have been working with. One piece of these roadmaps is looking at how to improve the satellite observations of these interfaces.
- Ruediger Lang (EUMETSAT) recognised that CO2M data will be produced over the ocean, but the data yield remains uncertain. The accuracy CO2M will achieve will hopefully be the same or better than over land, however a factor of five better is unlikely. Validation networks should be extended over the ocean to improve accuracy.

8.4 - Capacity Development: EOTEC DevNet Climate Change Communities of Practice

Martyna Stelmaszczuk-Górska (University of Vienna) reported [[slides](#)]:

- Section on capacity building in Issue 2 of the GHG Roadmap highlighted the potential activities with EOTEC DevNet.
- EOTEC DevNet is a global forum that facilitates collaboration among EO capacity building providers and fosters the exchange of resources. Thematic focus is currently on disaster risk reduction, but there are plans to extend to climate adaptation and mitigation.
- EOTEC DevNet was initiated within CEOS WGCapD, and is partnered within the capacity development and education forums of UNOOSA, WMO, CGMS and GEO, among others.
- Five regional Communities of Practice (CoPs) have been established, to drive work and collaborate on guidance tools to make EO information more accessible. Over 1400 individuals have engaged in the Communities of Practice since their launch in April 2022.
- EOTEC DevNet has developed a flood tools tracker, with a drought tools tracker in development. This helps users find resources and initiatives which can help their specific use cases.

- The flood thematic working includes four regional groups to establish priorities for capacity building and identify gaps at the regional level. The drought working groups are still in the foundational phase.
- The climate adaptation and mitigation working groups could be expanded to represent WGClimate with support for connecting global and regional climate experts, and centralising climate adaptation and mitigation resources & training materials.
- EOTEC DevNet is looking forward to strengthening the collaboration with CEOS WGClimate & key stakeholders, to support WGClimate priorities.
- In Q4 2025, EOTEC DevNet will hold the first global consultation for the Climate Change Communities of Practice.
- Presented the following questions via Slido:
 - o Who are the critical partners & projects we should engage with?



- o What are the biggest capacity building gaps in climate adaptation and mitigation?

- Briony Turner (WCRP CMIP) recognised the need for observational and modelling interface champions. It may be worth WCRP collaborating with EOTEC DevNet to showcase champions and promote their activities.

WGClimate-22-27	WGClimate Chair to organise a virtual workshop between WGClimate and EOTEC DevNet to further the conversation, including on educating the public and communicating with media, as well as the concept of the Climate Mitigation and Adaptation Working Groups.	Due: Q2 2025
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8.5 - WIGOS 2050 Vision

Heikki Pohjola (WMO) reported [[slides](#)]:

- An effort has begun to update the WMO Integrated Global Observing System (WIGOS) vision for the 2050 timeframe, with a goal to finalise the document in 2026.
- The scope will include space- and surface-based components and will envision a global system to measure the Earth, and address WMO-relevant applications.
- There are many driving factors expected to influence this vision including technology evolution, applications/users needs, the future landscape of observing systems providers including non-traditional systems and commercial providers.
- The general goal of the vision is to present a likely scenario of how user requirements for observational data may evolve over the next 25 years, and an ambitious, but technically and economically feasible vision for an integrated observing system that will meet them. It provides high-level targets to guide the evolution of the WIGOS in the coming decades.
- The 2040 vision connected users of observations with observing system owners, helped application area owners prepare for future global observing systems, and served as a focal topic to facilitate international gap analyses.
- The updated 2050 vision aims to influence the evolution of global observing systems harmoniously between space and surface, facilitate discussions between operators and owners of applications, provide visibility of new technologies, and provide recommendations for enhanced interactions.

Discussion

- Osamu Ochiai (JAXA, SIT Chair Team) is the member of the expert team representing CEOS. The topic will also be presented at SIT-40, to discuss early feedback from CEOS.

- Heikki Pohjola (WMO) noted the needs of G3W are involved in the climate monitoring aspect.
- Jörg Schulz (EUMETSAT) recognised the expert team doesn't include any climate experts. The continuity needs of climate applications are critical, and WGClimate should provide some inputs.

WGClimate-22-28	WGClimate Chair and Vice-Chair to lead the drafting of some key climate points for consideration in the WIGOS 2050 Vision. WGClimate Chair to pass this information to Osamu Ochiai and Sean Burns, as the CEOS and CGMS representatives on the expert team.	Due: mid-April 2025
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Session 9: Other Business & Closing

9.1 - WGClimate Summary and Action Review

Libby Rose (WGClimate Secretariat) reviewed the actions recorded for WGClimate, which can be found in Appendix B.

9.2 - GHG Task Team Summary and Action Review

Libby Rose (WGClimate Secretariat) reviewed the actions recorded for GHG Task Team, which can be found in Appendix C.

9.4 - Closing remarks

Wenyang Su (NASA, WGClimate Chair) reported:

- The plan for WGClimate-23 is a virtual meeting in October. Based on the results of the poll distributed earlier, Friday 24 October, 2025 was chosen as the date.

WGClimate-22-29	WGClimate Secretariat to schedule WGClimate-23 for Friday 24 October, 2025.	Due: ASAP
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- The next in-person WGClimate meeting will be co-located with the GCOS Panel meeting in early February, 2026 with date and location to be confirmed.

Appendix A: List of Participants

In-person participants

Affiliation	Name
Citepa	Mélanie Juillard
Deutscher Wetterdienst	Andrea Kaiser-Weiss
DLR	Albrecht Von Bargaen
ECMWF	Richard Engelen
Environmental Defense Fund	Steven Hamburg
ESA	Claire Macintosh
ESA	Paul Fisher
ESA	Yasjka Meijer
ESA	Simon Pinnock
ESA	Susanne Mecklenburg
ESA	Clement Mathieu Jacques Albergel
EUMETSAT	Jörg Schulz
EUMETSAT	Robert Husband
EUMETSAT	Ruediger Lang
EUMETSAT	Simon Elliott
EUMETSAT	Alexandra Nunes
European Commission	Hugo Zunker
European Commission - JRC	Mark Dowell
GCOS	Caterina Tassone
GHGSat	Stephane Germain
GISTDA	Kanjana Kankodkurang
GISTDA	Pakorn Petchprayoon
JAXA	Hiroshi Suto
JAXA	Mariko Harada
JAXA	Osamu Ochiai
JAXA	Misako Kaichi
NCEO / STFC RAL Space	Gareth Thomas
NCEO / University of Edinburgh	Paul Palmer
NCEO / University of Leicester	John Remedios
NIES	Hiroshi Tanimoto
SIT Chair Team	David Crisp
STFC RAL Space	Dora Hegedus
UK NPL	Paul Green

Virtual Participants

Affiliation	Name
CEOS Executive Officer	Irena Drakopoulou
CICERO	Glen Peters
CMA	Lu Zhang
CNES	Carole Deniel
CSU	Chris O'Dell
CSA	Marcus Dejmek
Danish Meteorological Institute	Ole Krarup Leth
DKRZ	Fanny Adloff
DLR	Julia Marshall
ECMWF	Jean-Noel Thepaut
ECMWF	Vincent-Henri Peuch
ESA	Quentin Paletta
ESA / WGISS	Mirko Albani
ESA	Eduardo Pechorro
ESA	Frank Martin Seifert
ESA	Marie-Helene Rio
ESA	Christian Retscher
EUMETSAT	Stephan Bojinski
LSCE	Phillippe Ciais
NASA	Laura Lorenzoni
NASA	Lesley Ott
NASA	Wenyng Su
NASA	Ben Poulter
NASA JPL	Kevin Bowman
NC State University	Douglas Rao
NOAA	Jeff Privette
NOSA	Anja Sundal
Royal Belgian Institute for Space Aeronomy	Jean-Christopher Lambert
SIT Chair Team	Stephen Ward
UK Government / Energy Security	Onoriode Esegbue
UK Met Office	Amy Doherty
UNEP	Itziar Irakulis-Loitxate
UNFCCC	Maryam Navi
University of Exeter	Tim Lenton

UKSA	Beth Greenaway	University of Vienna	Martyna
UKSA	Patrick Gibson		Stelmaszczuk-Górska
UKSA	Harshbir Sangha	WMO	Heikki Pohjola
UNFCCC	Heather Nonhlanhla		
	Maseko-Msyale		
University of Leicester	Darren Ghent		
WCRP CMIP	Eleanor O'Rourke		
WCRP CMIP	Briony Turner		
WGClimate Secretariat	Harvey Jones		
WGClimate Secretariat	Libby Rose		
WMO	Gianpaolo Balsamo		

Appendix B: WGClimate-22 Actions

ACTION ID	DESCRIPTION	DUE
WGClimate-22-01	WGClimate Chair to share the call for members for the Earth System Modelling & Observations (ESMO) Working Group for Observations for Researching Climate (WGORC) (POC Claire Macintosh). Ensure GCOS also receives this invite and is represented in the Working Group.	Due: March/April 2025
WGClimate-22-02	WGClimate Chair and Vice-Chair to plan a joint 2-hr meeting with ESMO science steering group (POC Claire Macintosh). The recommendations presented (slide 19) should be discussed, and an action plan for the way forward agreed. GCOS should also be involved in these discussions.	Due: Q3 2025
WGClimate-22-03	ECV/CDR Inventory team to review the information available on the CEOS MIM Database, and consider establishing linkage with the CDR Inventory.	Due: June 2025
WGClimate-22-04	WGClimate Secretariat to publish the Gap Analysis Report on the CEOS Website.	Due: 21 Feb 2025
WGClimate-22-05	Jörg Schulz to provide the list of open actions from the Coordinated Action Plan for input into the CEOS Work Plan.	Due: 18 Feb 2025
WGClimate-22-06	EC-JRC (Mark Dowell) and ESA Climate Office (Susanne Mecklenberg) to discuss the potential for hosting the joint WGClimate-GCOS meeting in the first two weeks of February 2026. Let WGClimate Chair know of the decision reached.	Due: 28 Feb 2025
WGClimate-22-07	WGClimate Secretariat to connect GCOS with CEOS WGCV, to respond to action A31/1 from the GCOS Steering Committee: <i>GCOS to invite Space Agencies to enter a dialogue to establish permanent calibration/validation stations to make sure that the increasing amount of data that is being generated can be validated. Participate/do a presentation on GCOS (reference) networks in WGCV - WGClimate/CEOS Working Group on Cal/Val. GCOS Secretariat – Next WGClimate Meeting (February 2025).</i>	Due: 28 Feb 2025

WGClimate-22-08	WGClimate members to let WGISS know of any other datasets which may benefit from a global recovery effort.	Due: WGClimate-23
WGClimate-22-09	Jörg Schulz to meet with Mirko Albani regarding the EUMETSAT AVHRR collection, and potential to fill gaps over China and Mongolia. Connect with Misako Kachi regarding Mongolian contacts if necessary.	Due: Q2 2025
WGClimate-22-10	Jörg Schulz to establish a small team to review the CDR definition. If no progress is made in one year, consider concluding this activity. WGClimate members to contact Jörg if they would like to join these discussions.	Due: 28 Feb 2025
WGClimate-22-11	Vincent-Henri Peuch to connect with the UNFCCC Secretariat to plan the discussions for the Bonn Climate Conference in June. Other members interested in joining these discussions should contact Vincent-Henri.	Due: 28 Feb 2025
WGClimate-22-12	WGClimate members interested in engaging on the definition of the UNFCCC Global Goal on Adaptation (GGA) Indicators should contact Maryam Navi (UNFCCC) with their specific area of interest. Maryam will connect any interested members with the relevant experts.	Due: June 2025
WGClimate-22-13	WGClimate members and other community members to provide feedback on the GST Lessons Learned . Members are also invited to share the document with their national negotiators for review.	Due: 28 Feb 2025
WGClimate-22-14	WGClimate members interested in supporting the drafting of Issue 2 of the CEOS Global Stocktake Strategy to contact the SIT Chair Team.	Due: 28 Feb 2025
WGClimate-22-15	SIT Chair Team to share the draft GST Strategy with UNFCCC (Heather Maseko) once prepared.	Due: Sept 2025
WGClimate-22-16	WGClimate Chair to compose a letter from CEOS Chair and SIT Chair to WMO leadership regarding support for G3W. Share a draft at SIT-40.	Due: mid-March
WGClimate-22-17	Hiroshi Tanimoto, on behalf of AC-VC and WGCV ACSG, to invite WMO G3W and IMEO to their June meeting, in particular for a discussion around cal/val super sites.	Due: 28 Feb 2025

WGClimate-22-18	ESA to liaise with G3W in the context of the CARBONARA campaign.	Due: ASAP
WGClimate-22-19	Agencies interested in supporting post-doctoral researchers for RECCAP-3 to contact Ben Poulter.	Due: Q4 2025
WGClimate-22-20	WGClimate, with UNFCCC and IPCC TFI, to consider establishing regional satellite data experts to advise national inventory compilers.	Due: WGClimate-23
WGClimate-22-21	WGClimate to consider how best to provide capacity development resources around using satellite data for national inventories. This could be done as an expansion to the CEOS GST Portal .	Due: WGClimate-23
WGClimate-22-22	WGClimate Chair to invite WCRP representatives to WGClimate-24 (Feb 2026) to discuss their activities and opportunities for collaboration.	Due: Q4 2025
WGClimate-22-23	Richard Engelen to share the IG3IS guidelines document with WGClimate members.	Due: ASAP
WGClimate-22-24	<p>Vincent-Henri Peuch to lead the new UNFCCC COP Tiger Team, with the specific tasks to:</p> <ul style="list-style-type: none"> • Ensure consistent preparation for Earth Information Day • Enhancing coordination at key UNFCCC events throughout the year • Develop a comprehensive multi-year engagement strategy aligned with the phases of the GST process, including proactive preparation for party submissions. • Define key objectives for each COP and EID, ensuring that CEOS and CGMS efforts are strategic and aligned with broader climate goals. • Survey agencies to understand their level of participation at each COP (individuals and/or pavilions) <p>Vincent-Henri to reach out to all WGClimate members to call for participants in the Tiger Team. CEOS Chair Team and SIT Chair Team to be included.</p>	Due: 28 Feb 2025
WGClimate-22-25	WGClimate members to contact UKSA CEOS Chair Team if they would like to provide inputs to the SIT-40 side meeting focused on the interactions of space agencies with their	Due: March 2025

	national delegations.	
WGClimate-22-26	WGClimate Chair to email WGClimate members, detailing the tasks around expanding the ECV Inventory, and requesting volunteers to contribute to defining initial application/stakeholder typology categories. Category “champions” will be chosen to map CDRs onto individual application/stakeholder “types”. CMIP should be invited to join, and other external participants are also welcome.	Due: 28 Feb 2025
WGClimate-22-27	WGClimate Chair to organise a virtual workshop between WGClimate and EOTEC DevNet to further the conversation, including on educating the public and communicating with media, as well as the concept of the Climate Mitigation and Adaptation Working Groups.	Due: Q2 2025
WGClimate-22-28	WGClimate Chair and Vice-Chair to lead the drafting of some key climate points for consideration in the WIGOS 2050 Vision. WGClimate Chair to pass this information to Osamu Ochiai and Sean Burns, as the CEOS and CGMS representatives on the expert team.	Due: mid-April 2025
WGClimate-22-29	WGClimate Secretariat to schedule WGClimate-23 for Friday 24 October, 2025.	Due: ASAP

Appendix C: GHG-TT-05 Actions

ACTION ID	DESCRIPTION	DUE
GHG-TT-01	Yasjka Meijer to work with Simon Elliott to prepare a joint meeting between GHG-TT and CGMS Working Groups ahead of CGMS Plenary in June. G3W should be involved in this.	Due: June 2025
GHG-TT-02	GHG-TT members to review v0.2 of the Methane Best Practices.	Due: 28 Feb 2025
GHG-TT-03	Yasjka Meijer to arrange a side meeting at SIT Technical Workshop 2025 to discuss space-based ocean carbon measurements with GCOS.	Due: SIT-TW 2025
GHG-TT-04	Hiroshi Suto to coordinate a discussion on vicarious calibration campaigns for CO2M.	Due: Q4 2025
GHG-TT-05	Mark Dowell & Vincent-Henri Peuch to organise a dedicated virtual meeting between G3W and GHG-TT in mid-2025. The timing should consider the various G3W workshops.	Due: Q2 2025
GHG-TT-06	Members interested in joining the IMEO Use Cases Working Group should contact Yasjka Meijer. The group aims to meet in Q1 2025.	Due: ASAP
GHG-TT-07	John Worden to discuss with IMEO the establishment of a central database of controlled release experiments. Discuss whether this should be led by GHG-TT or IMEO.	Due: Q4 2025
GHG-TT-08	UKSA CEOS Chair Team to develop communications with IMEO regarding the methane best practices, to ensure consistent messaging around COP-30. Work with the Australian 2026 CEOS Chair Team, who will be CEOS Chair at the time of COP-30.	Due: COP-30
GHG-TT-09	Validation thematic lead (Dave Crisp) to add an action in Annex C of the GHG Roadmap for tracking needs & gaps in the validation system.	Due: 15 Mar 2025
GHG-TT-10	Jean-Christopher Lambert to share slides of last ACSG/WGCV presentation on tracking identified Cal/Val gaps.	Due: 28 Feb 2025
GHG-TT-11	Stakeholder thematic lead (Mark Dowell) to add an action in Annex C of the GHG Roadmap for collecting ideas for reaching	Due: 15 Mar 2025

	stakeholders to provide actionable information leading to mitigation.	
GHG-TT-12	Define a joint deliverable for the CEOS Work Plan between GHG-TT, WGCV ACSG, AC-VC to explore the concept of GHG cal/val super sites and understand gaps in the existing networks, in particular to support G3W and IMEO.	Due: 16 Feb 2025