MINUTES & ACTIONS

CEOS Space Data Coordination Group for GFOI
Biomass Day Workshop

v1-0

26 March 2019, Hampton, VA, USA

Main discussion points and outcomes from the 15th SDCG Meeting Biomass Day Workshop

CEOS agencies are investing more than $US4Bn in satellite missions for launch between 2018 and 2024 for estimation of above-ground biomass. The data from these missions is of significant value for a range of user communities and uses, including as inputs to essential climate variables, and for operational national forest monitoring systems and reporting.

As noted in the recent paper *'The Role and Need for Space-Based Forest Biomass-Related Measurements in Environmental Management and Policy'* (Herold et al, 2019):

- Further effort is required to stimulate uptake of biomass data by key stakeholders...there has been little progress in demonstrating how biomass mapping from space can be integrated in national forest monitoring and national GHG inventories efforts...,CEOS should stimulate and implement demonstration activities that then can lead to experiences and improved guidance, training materials, and capacity building efforts;

- Biomass maps should be developed as a co-creation of both producers and users. Particular focus is needed to match estimates from biomass maps produced using space data with field-based biomass estimates and to harmonize these biomass estimates based on national definitions;

- There is a need for international forest monitoring and data coordination groups (GFOI, GOFC-GOLD, and CEOS) to represent the needs of the data users and encourage data providers to work collaboratively to provide complementary, relevant, transparent, and validated biomass data and information;

- The key challenge is to avoid a widening gap between what is evolving and demonstrated in research and in the context of space-based missions, and the diverse demands of users, particularly in terms of the need for operational systems. This can only be achieved through a long-term collaborative effort among producers and users.

SDCG's first *Biomass Day* took the opportunity to convene representatives from space data providers, from CEOS WGCV LPV (undertaking technical work on the Biomass Protocol), and from the GFOI Capacity Building component (World Bank - as Co-Lead) to debate these challenges and to see where CEOS might be able to step up to them - particularly for the needs presented by GFOI countries, and in collaboration with the Capacity Building Component. The hope is to identify new tasks that might be addressed within the CEOS Work Plan and areas that might benefit from high level support from being identified as important within the incoming SIT Chair's *Carbon and Biomass* activity.

The meeting noted the substantial coordination activity between NASA and ESA, including on the MAAP platform and through the Multi-Mission Group telcons. JAXA has asked to join this collaboration and to bring the benefits from its ALOS series and MOLI mission.

The CEOS Biomass Protocol will be published in Q3 2019 and will subsequently be applied to the development of several sensor biomass datasets, including first from IceSat-2 and GEDI. WGCV LPV and the related bilateral coordination efforts represent the most significant work underway on calibration, validation and results inter-comparison - that will be extremely vital for data uptake given the diversity of data and measurement approaches. ESA's GLOBBIOMASS and BIOMASS CCI, and NASA's CMS programmes will all provide data of value to GFOI countries and biomass data users.

A number of areas were highlighted where SDCG and/or CEOS SIT might support and complement the work of LPV on the Biomass Protocol:

- provision of user-led tools for national product validation (World Bank suggested that these focus on Google Earth Engine platform);

- CEOS Principal support for the necessary CEOS-led validation through active super-sites;

- adaptation of the Protocol as a module for the updated version of the GFOI Methods and Guidance Documentation (MGD) and REDDCompass tool envisioned in 2019; CEOS MGD authors are ready to support review of the draft Biomass Protocol when ready;

- provision of training and education materials to support the Capacity Building component in developing understanding and demand for the new data, through the work of World Bank, SilvaCarbon and FAO; World Bank is interested in funding pilot activities and training under its readiness programme saying that materials are needed now; World Bank can help develop an understanding as to the ability of countries to apply biomass datasets (and noted Mexico, Colombia, and Ghana as likely early candidates);

- an overview of the CEOS data, its availability schedule, format and access for ease of understanding by GFOI countries; LIDAR products and some form of standardisation might be especially helpful to reduce complexity;

- sample GEDI data (eg) would be useful to support investigation of suitable tools for GEE and Open Data Cube.

Identification of supporting activities for inclusion in the SIT Chair Prospectus for 2020-21 should be provided in time for the SIT TW (Sep 2019) and with some indication of cost level. At the working level, SDCG sees value in developing a coordination axis between the GFOI Data Component and the Capacity Building Component to develop education and training efforts that will ***'serve to accelerate the policy relevance of the CEOS agency biomass mission data'*** with GFOI countries and beyond. SDCG will explore mutual interests directly with the Capacity Building Component Co-Leads (WB, SilvaCarbon and FAO, as well as with the GFOI Leads Team.

The meeting noted the intention of SIT Chair and the EC to further develop CEOS engagement with environmental conventions and to be proactive in pursuing the case for application of EO data. Some biomass datasets may be available for inclusion in 2023 Global Stocktake activities for the Paris agreement. EC aims to convene a meeting in 2020 to develop this engagement - spanning greenhouse gases and the land activity sectors.

Pending clarification of the nature of the SDCG Work Plan tasks in relation to biomass, it was noted that it would be valuable to have continued representation in SDCG from relevant agencies - and NASA in particular given their increased investment in missions like GEDI and NISAR of significant importance to GFOI objectives.

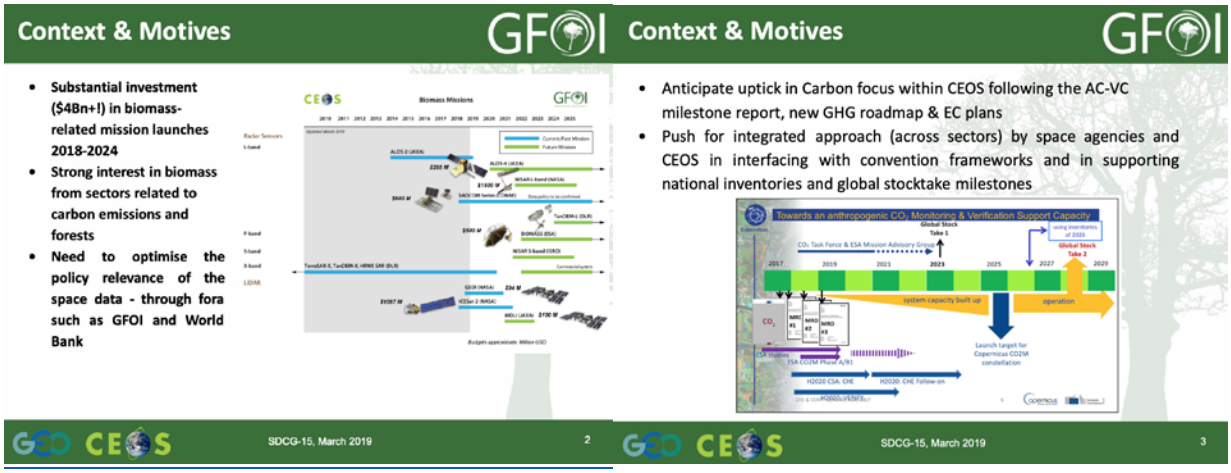
It was agreed that the topic of biomass measurements from CEOS agencies would benefit from greater exposure beyond the technical level attention in the WGCV subgroup LPV. SDCG will seek to ensure inclusion of pertinent objectives in the SIT Chair planning for 2020-21, and to help develop a strong coordination axis with the GFOI Capacity Building component on the training and education aspects in particular for GFOI countries.

Intro and Welcome

Stephen Ward (SDCG Secretariat) welcomed participants to the Biomass Day workshop and outlined the objectives for the day, including the emergence of a number of biomass missions, a CEOS priority around

biomass set by incoming SIT Chair, and links with GFOI (especially through the Capacity Building Component).

- There are a number of opportunities for CEOS to help promote the policy relevance of biomass datasets, including an action to prepare related inputs to CEOS reporting to SBSTA.



Kathy Hibbard (NASA) noted that the US is sensitive to commitments relating to the Paris agreement.

NASA

Hank Margolis reported:

- Work has been undertaken to compare the GEDI data with airborne data from Gabon, and the match is good.
- Preliminary results from ICESat-2 are looking promising, despite some doubts based on the underlying technology.
- There was good coordination between NASA, ESA, and DLR on logistics for airborne campaign over Gabon.

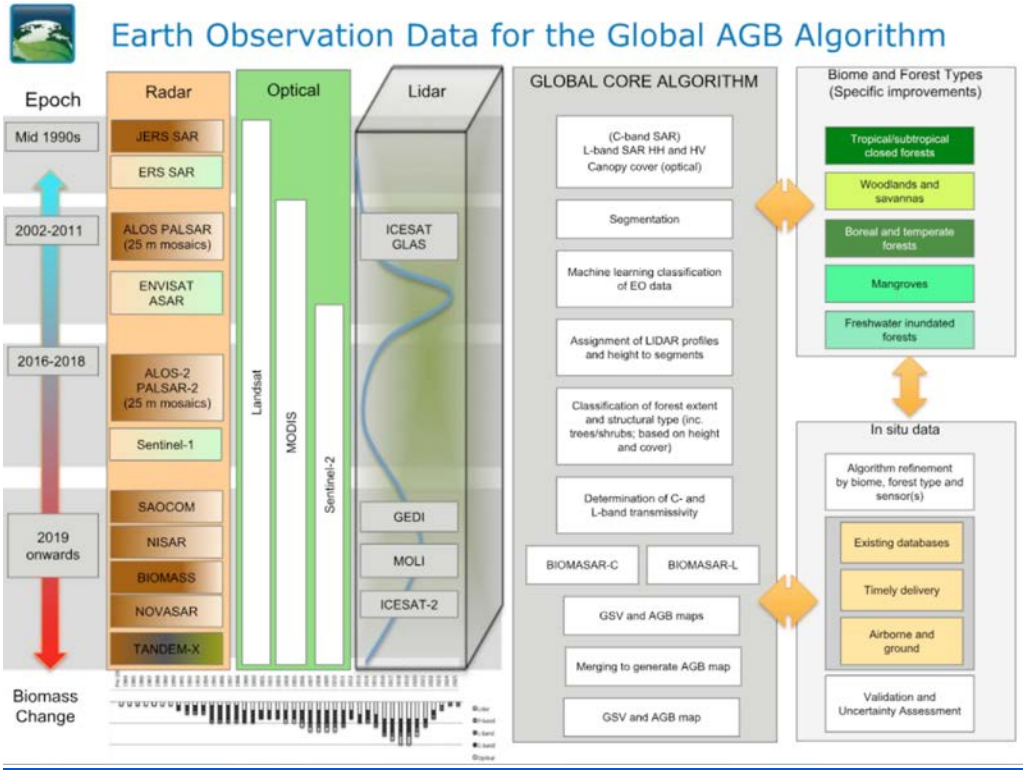
A brief discussion followed.

- Hank noted that a biomass analysis platform is being designed for the science user community, though a more end-user / country-focused platform could follow naturally.
- SDC (Surface Deformation and Change - from decadal survey concepts) is likely the continuity option for NISAR.
- NASA is focused on partnership (with other agencies, industry, etc.) and this presents an opportunity.

ESA

Steven Hosford presented on behalf of ESA (Frank Martin Seifert, and ESA colleagues):

- GLOBBIOMASS uses Envisat, IceSat and Landsat data for a forests AGB global dataset at 100m resolution;
- Biomass is one of the ESA CCI ECVs added in 2018; Richard Lucas and Shaun Quegan are leading the CCI Biomass contract; the product schema is illustrated below;

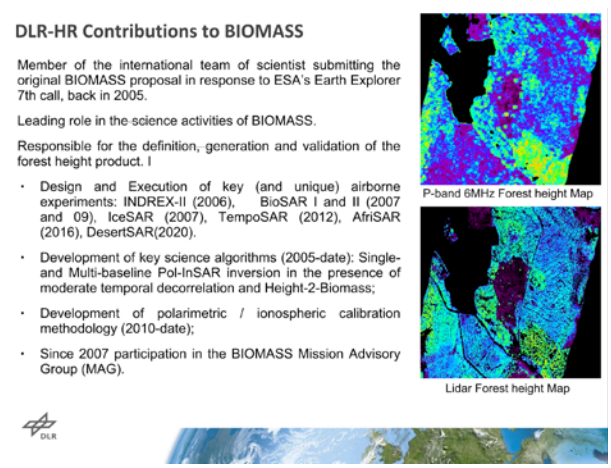


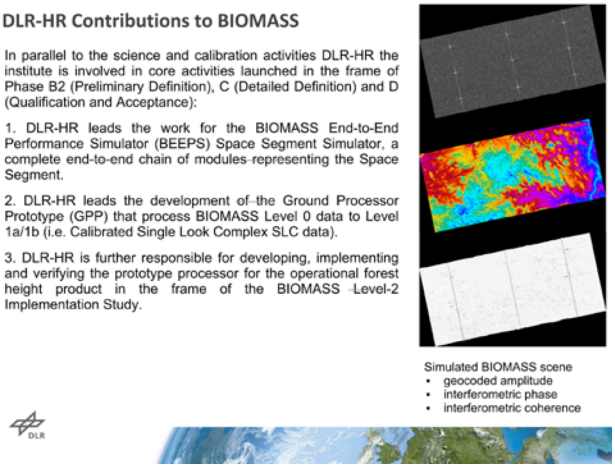
- BIOMASS is ESA's 7th Earth Explorer mission for launch in 2022 (see details here);
- The Forest Observation System is an international in-situ forest biomass database cooperation. FOS data is publicly available. Provides well curated biomass plot data in a unified format.
- ForestScan contract being defined to: establish new technologies such as terrestrial lidar scanning and drones to collect forest height and AGB data for EO product validation; collect data for three supersites (S-America, SE-Asia and Africa); in collaboration with the CEOS biomass cal/val team establish a measurement protocol for these new techniques.

The multiple parties involved often makes collaboration complicated (e.g. establishment of MOUs with each PI is untenable). Open data policies are not the norm, often driven by the need to publish.

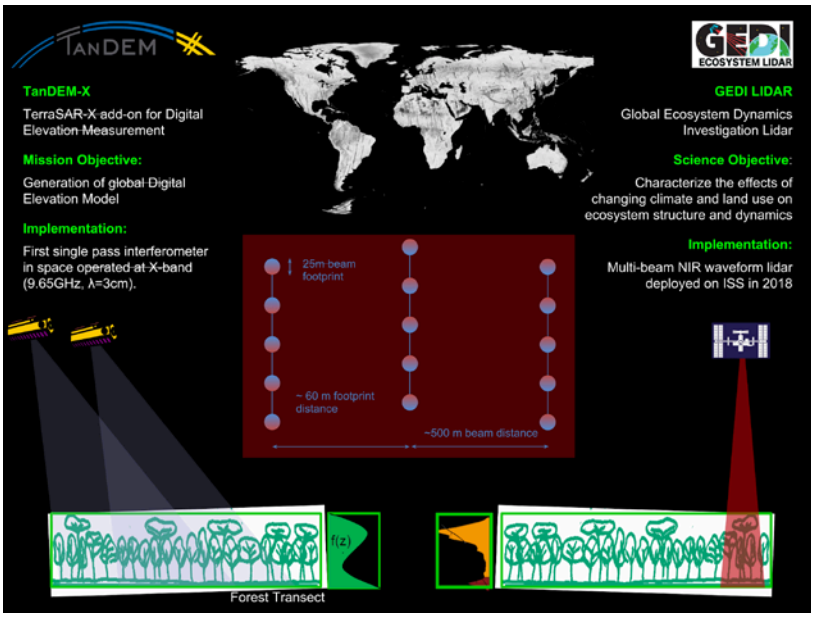
DLR

Michael Bock presented (remote) on DLR-HR Contributions to BIOMASS:





Michael presented on TanDEM-X – GEDI Fusion for Global Vegetation Mapping:



Michael presented on the global TanDEM-X Forest/Non-Forest Map and the Tandem-L Mission Proposal:

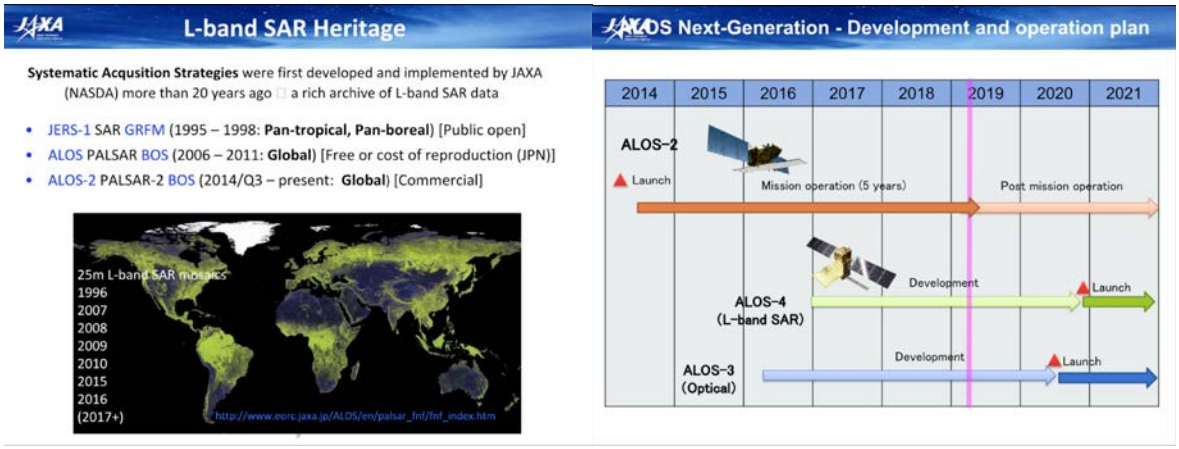
- The global Forest/Non-Forest dataset will have a resolution of 50x50 meters, provide binary Forest/Non-Forest data, and should be available within next weeks - **freely available for scientific and non-commercial purposes**.

Laura noted there's an ongoing collaboration between GEDI and TanDEM-L facilitating data exchange and intercomparison. In policy fora, the definition of what constitutes a forest remains *up to each country*.

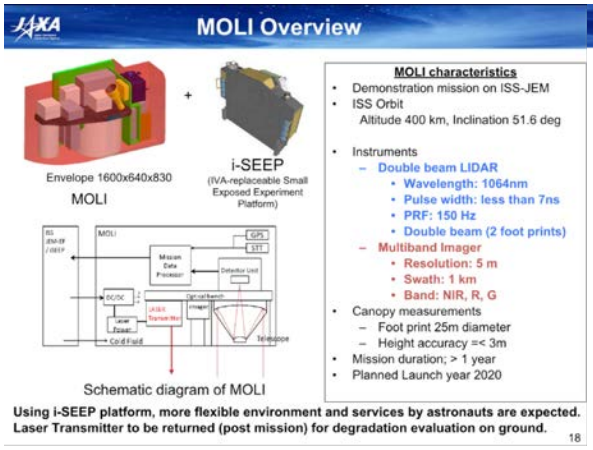
JAXA

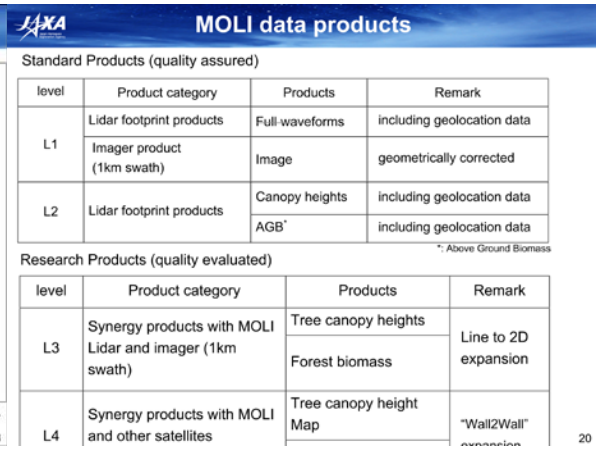
Osamu Ochiai presented (remotely) on heritage and plans for **JAXA L-band (ALOS)** activities and heritage:

- JAXA welcomes the opportunity to work with other agencies, and the *in-situ* community in order to improve overall observations.
- Biomass is addressed under continuous missions and new applications in the ALOS-4 Mission Objectives.

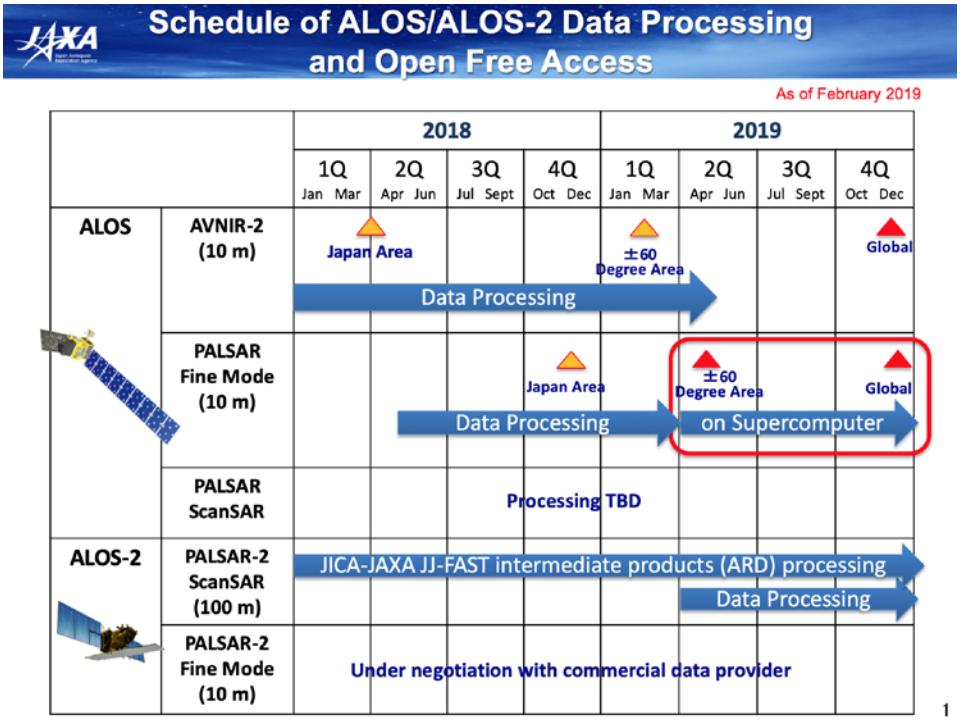


Osamu presented a summary of the **Multi-footprint Observation LIDAR and Imager (MOLI)** instrument, with operations expected from around 2020.





- **ALOS data policy** is evolving, and the expectation is that all ALOS data will be open from the end of 2019. Negotiations for the opening of ALOS-2 ScanSAR data (100m) currently underway; 10m discussions would follow, and this data is currently available under research terms (e.g. proposal).

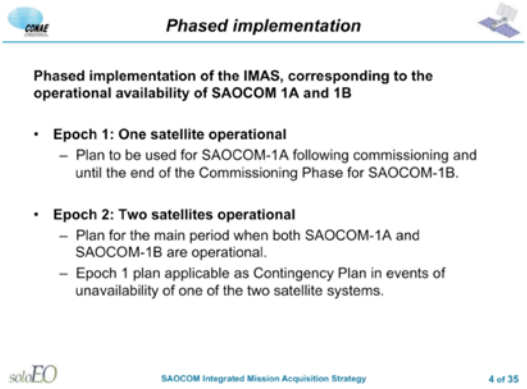


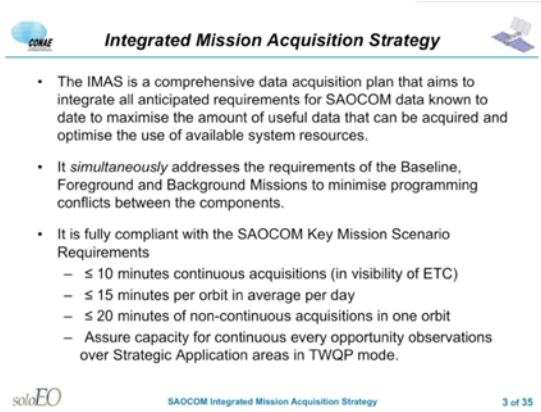
Brian asked about the ALOS-2 ScanSAR data, and whether the full archive up to current would be available. Osamu confirmed this is the plan, though computing resources are currently being discussed.

CONAE

Ake presented on **SAOCOM** status:

- The main driver for SAOCOM is soil moisture monitoring in the Pampas, though biomass is partially addressed by the global background mission (GBM); and,
- Forest and biomass change is a thematic driver for the GBM, in part driven by inputs from SDCG.





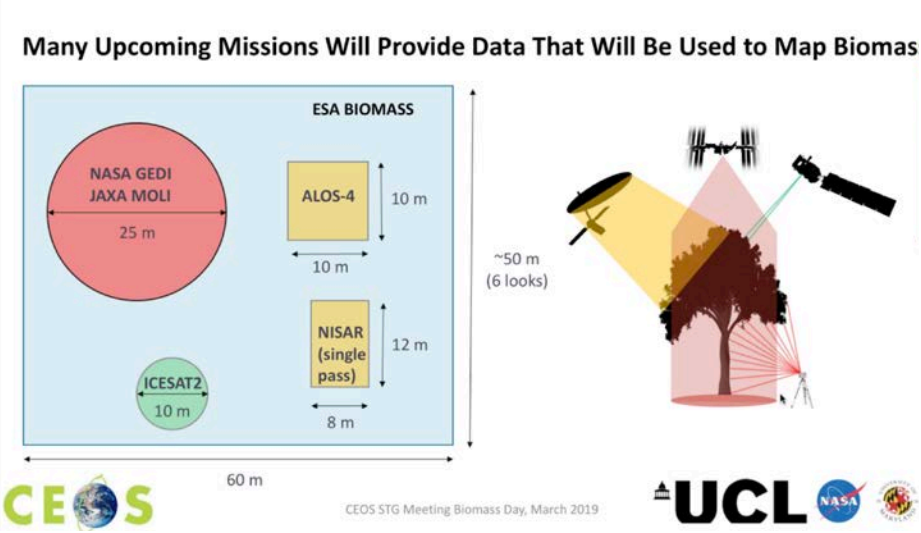
Relevant Commercial Missions

Stephen Ward reported on the UrtheCast OptiSAR constellation and some work by Planet on biomass estimation. NASA is working on a data buy agreement for NASA researchers, and this is expected to include Planet data.

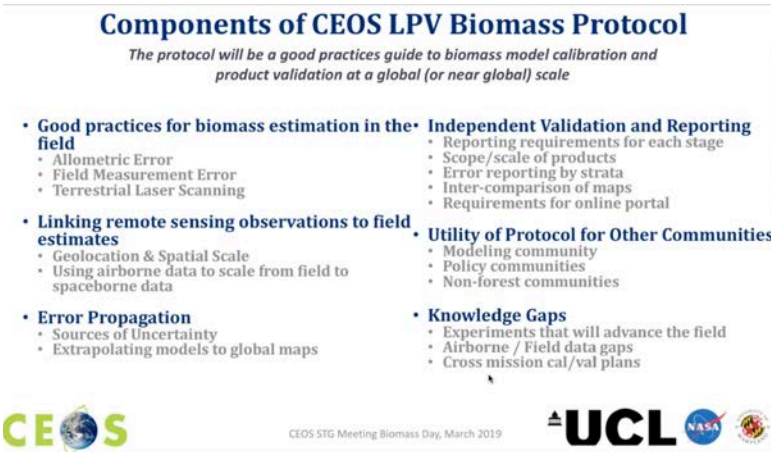
CEOS Biomass Protocol

Laura Duncanson reported:

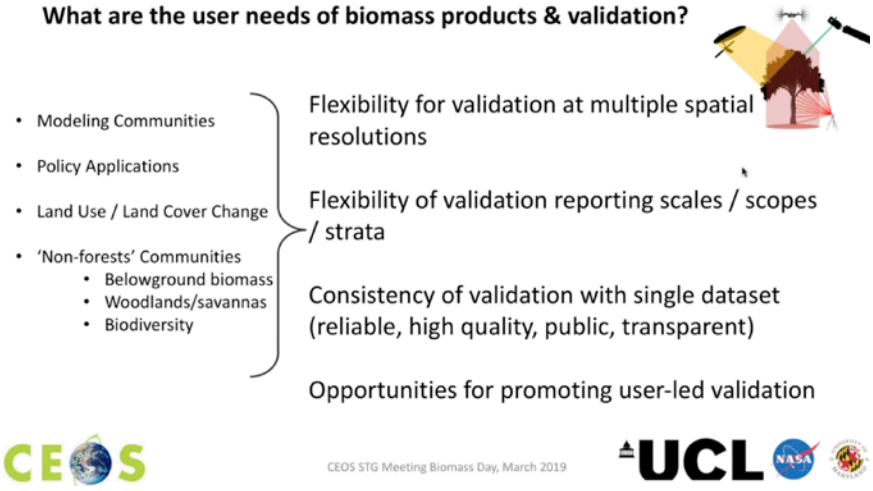
- LPV Biomass focus has been going for 3 years based on the 'explosion' of biomass data we have been discussing; Fernando Camacho (U. Valencia) is the LPV lead.
- Accuracy requirements for the missions are quite variable in both range and description, which is a likely blocker for uptake by the broader community; this is in part due to the diversity of technologies being employed; addressing this issue is one of the key drivers for the Biomass Protocol.



- The CEOS LPV Biomass Protocol provides a good practice guide for biomass model calibration and product validation at a global scale.

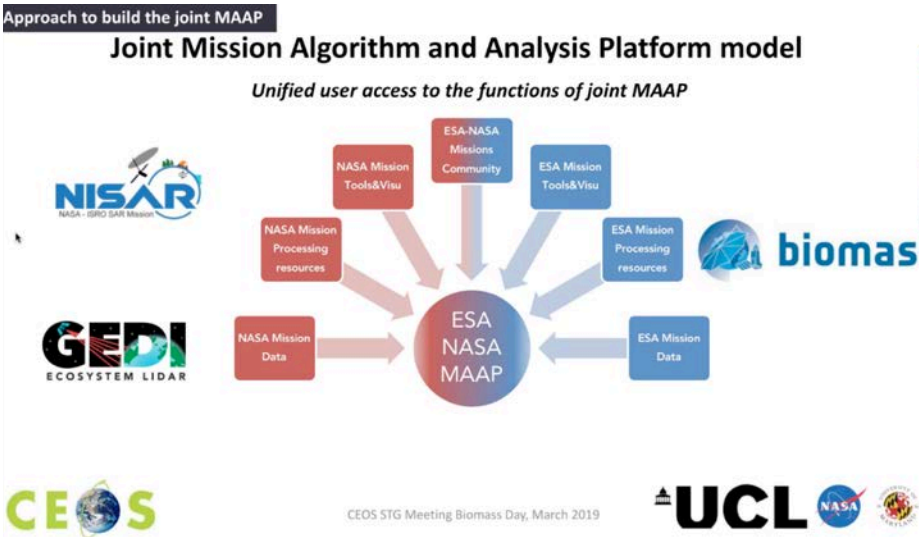


- Terrestrial observations (TLS) have emerged as a useful technology in measuring woody volumes, and refitting allometries; wherever TLS is available, it is expected that error will be greatly reduced; free tools and automation are greatly increasing uptake; in certain forests (open canopy) UAV approaches can also be powerful.
- The GFOI R&D meeting last year stressed the importance of country validation of new biomass products for them to have confidence in new data sources.



- Key validation approaches are: use of super-sites (LPV-led); user-led validation - one area where GFOI/SDCG may be able to help (Collect Earth, National Forest Inventory data).
- **Aiming for Q3 2019 for publication of the Protocol**, and application to the GEDI and ICESat-2 datasets. For success of the Protocol they need: updated reference datasets; and validation tools.
- Multi-Mission Biomass CalVal Group has had monthly telcons (GEDI, ICESAT-2, BIOMASS, NISAR, plus plot network people like FOS, ForestPlots, ForestGEO) for data sharing, campaign planning, priority setting etc.
- **To date, MOLI has not been represented in the Multi-Mission Biomass Cal/Val Group, but this is something the group would like to address; ALOS-4 representation may also be useful. ACTION: JAXA to follow up representation in the Multi-Mission Biomass Cal/Val Group.**

- Collaboration on workflow harmonisation (e.g. between ESA-NASA), is very helpful on joint planning activities. The framing in (e.g.) LPV and GFOI helps to present this work in the broader context.
- It likely makes sense to establish agreement and collaboration in multi-lateral forums such as CEOS, rather than pursue many bi-lateral approaches. GEDI, ICESat-2, NISAR and BIOMASS teams are working on coordinated cal-val.
- There is a set of proposed biomass validation supersites. A subset of data rich multi-mission sites that serve all missions. There is a need to keep these sites up to date in order to be used with the new generation of missions; mission-specific efforts are underway for the likes of GEDI and Biomass, but these are generally focused on mission objectives, **and CEOS/SDCG may be able to support by helping to fill the gaps.**
- Through the NASA commercial data buy, a potential role for high temporal revisit data from Planet is being explored - including to confirm the currency of old cal-val sites and field data.
- MAAP will host NISAR, GEDI, BIOMASS data and algorithms. Access is TBD. Initial focus is for agencies themselves and close to the mission operations. Hank suggested it would be open to researchers from around 2021.



- **User-led product validation is maybe the area where GFOI/SDCG can help the most, and this could be captured in a future iteration of the GFOI MGD and accompanying REDDCompass online resource.**

Next Steps and Areas for Collaboration

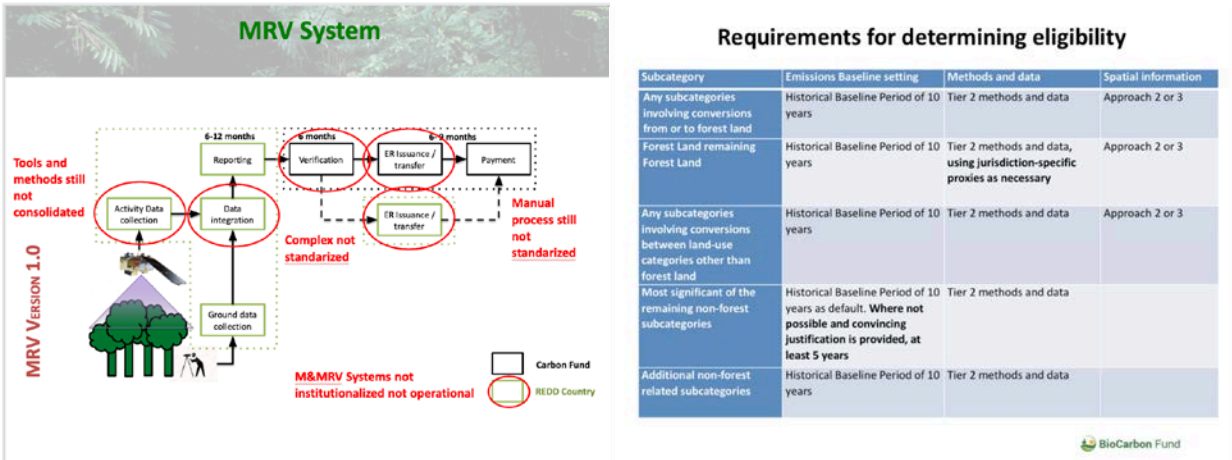
- Add a chapter on biomass *change* validation
- Collection of new field, TLS and airborne lidar over biomass super-sites
  - And/or establishment of new biomass super-sites
- Develop tools for CEOS-led validation
- Develop a tool for user-led validation

CEOS STG Meeting Biomass Day, March 2019

World Bank view on need for biomass datasets

Julian Gonzalo presented biomass datasets needs from the perspective of Emission Reduction Programs.

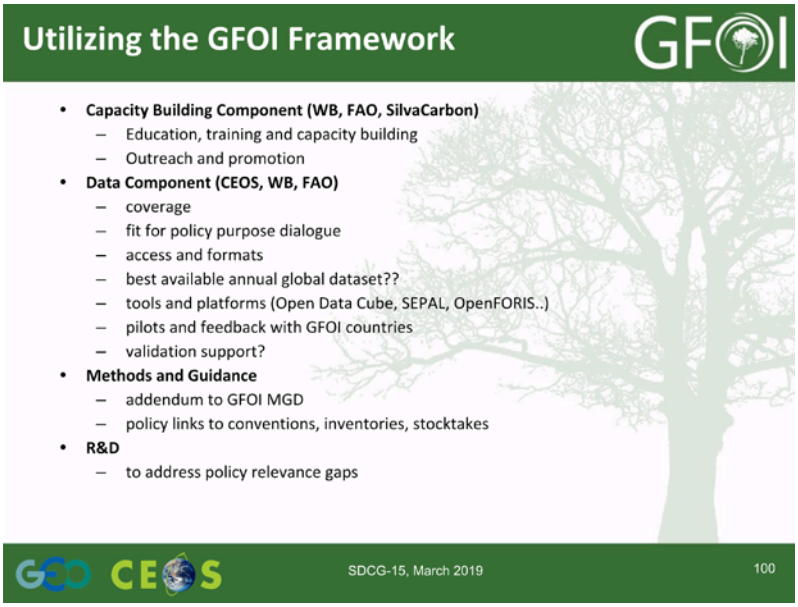
- Efforts are underway to address gaps in a typical MRV system, including activity data collection (e.g. from EO satellites). Also under consideration are potential future iterations of national MRV systems.



- Comparability and error propagation will be key considerations for countries considering picking up the next generation of data collection tools (e.g. EO satellites) and methods.

Discussion Topic 3: Utilizing the GFOI Framework to best effect

Stephen opened a discussion on how best to utilise the GFOI framework and its various components to promote the uptake of biomass data.



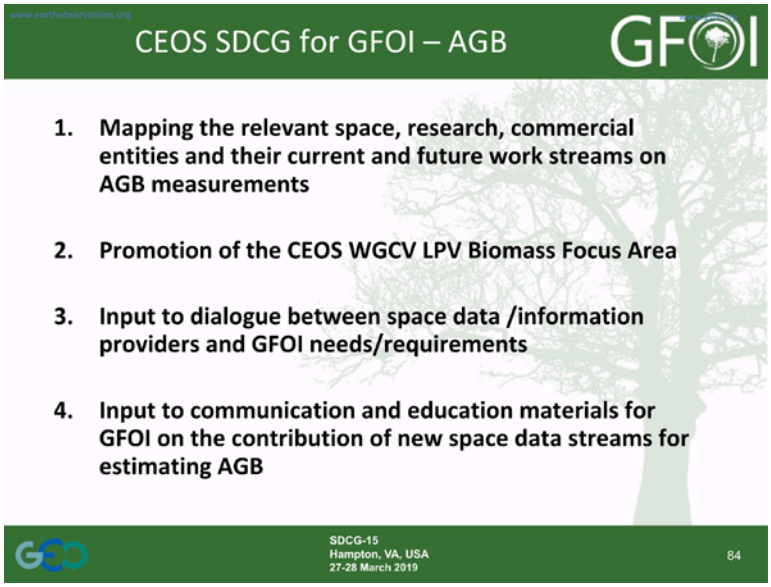
- The form, activities, and funding for the GFOI R&D component is uncertain which will make it challenging to engage with that component in the short term.
- Ake noted that the MGD is currently one single document, as well as the online REDDCompass - but there is an update planned this year (last was 2016), and this will likely include the creation of online modules. **This may be an opportunity to include information and links to the CEOS Biomass Protocol**, though there may be a mismatch between the MGD's operational focus and the Protocol's research focus.
- **There may be potential for a LiDAR flavour of ARD**, and Laura noted these discussions are already taking place, though the fundamental nature of LiDAR data sets may present challenges. There may also be biomass-related products that move beyond the standard ARD products.
- For airborne LiDAR data, the point clouds are dense are enough to make a raster product (e.g. biomass map). L0-L4 products from GEDI will be distributed via the DAC; these will be in the form of GEDI point data pulled from the lower-level products.
- **Having a standard table of LiDAR data products (e.g. from L0 to L4) would be a helpful coordination reference**. To date, the work being done has largely been at the prototype stage, but as these products move towards operational, this kind of standardisation may develop.
- **A format optimised for country uptake should be considered,** in particular how to ensure these products are developed from the outset with this optimisation in mind.

- The World Bank's approach is to build awareness and capacity, then work with users on tools, application development, and data handling. Some of this tool development will be done in cooperation with the private sector. **WB would especially welcome scripts and tools in Google Earth Engine** to be compatible with many existing GFOI activities.
- **OBI-WAN will port GEDI data onto Google Earth Engine, and also on to AWS for data cube development.** First GEDI data is available in about 6 months, with gridded products likely following approximately two years later.
- Julian said that there will be a mix of interest in making own country biomass maps along with some happy to accept pre-cooked maps. Global products may be welcome by countries with lower capacity to generate their own products. **It would be useful to have an overview of what data is available when and in what format.**
- **Considering how to pitch biomass data in the policy space is a key question**, and Julian noted that there will be a phased approach with the deadline extending to 2030, and so for countries still working to establish their baselines, new biomass products could be employed. For other countries who have already established their baselines, they could use biomass products to compare with their inputs, but not as a part of the baseline. **In any case, training materials for countries would need to be developed now. These could be developed (e.g.) with SilvaCarbon**, though the forest-aid training space is complicated and generally not well coordinated - generally because of a diversity of approaches and products.
- **A draft initial information paper on biomass observations for GFOI users has been initiated, however inputs from mission teams, and the CEOS Biomass Protocol would be quite useful. Laura noted that the missions are creating mission handbooks which could be useful.**
- **Julian noted that they could consider providing funding for pilots and specific training under their readiness budget.** Space data and platforms will be presented at the upcoming GFOI Plenary, along with Open Data Cube (Digital Earth Africa) and how it could support.
- The incorporation of GEDI data into data cubes for countries like Ghana where Brian has built a Data Cube may enable countries to start to explore the potential.
- GEDI's non-repeating orbit means that the sampling is random, and it's not well suited for change detection.
- The first global biomass map (gridded product) is expected after two years of mission operations. As more samples are added, uncertainty will be reduced, and the uncertainty requirement for the mission will only be met after two years.
- **WB says countries will need help in working with lidar point data.**
- **GEE would be the best first place to provide biomass data based on the country interaction that the WB is working with.**
- It would be useful to have some initial GEDI data to start incorporating data into Open Data Cube - it may be possible to start working with simulated data, e.g. simulation of the recent overflights in Ghana.
- **ACTION: Follow-up with Julian/WB on training materials for the country MRV and lidar data handling and processing activities.**

- Julian noted that **Colombia** could be an interesting pilot country to work with - good system developed with US and Hansen support and have made their own in-country adjustments, and IDEAM has a good independent institutional basis, and they have a clear driver with recent forest changes (e.g. livestock and land price drivers); **Mexico** could also be a potential candidate based on existing forest plots and have worked with AWS; in Africa - **Ghana**; countries could feed back to support validation;
- **ACTION: To follow-up with Julian on sharing a list of countries and their potential (maturity) for uptake of biomass data**

Discussion Topic 1: Multi-Mission Collaboration

Joanne Nightingale presented a brief set of discussion points regarding inter-agency collaboration.

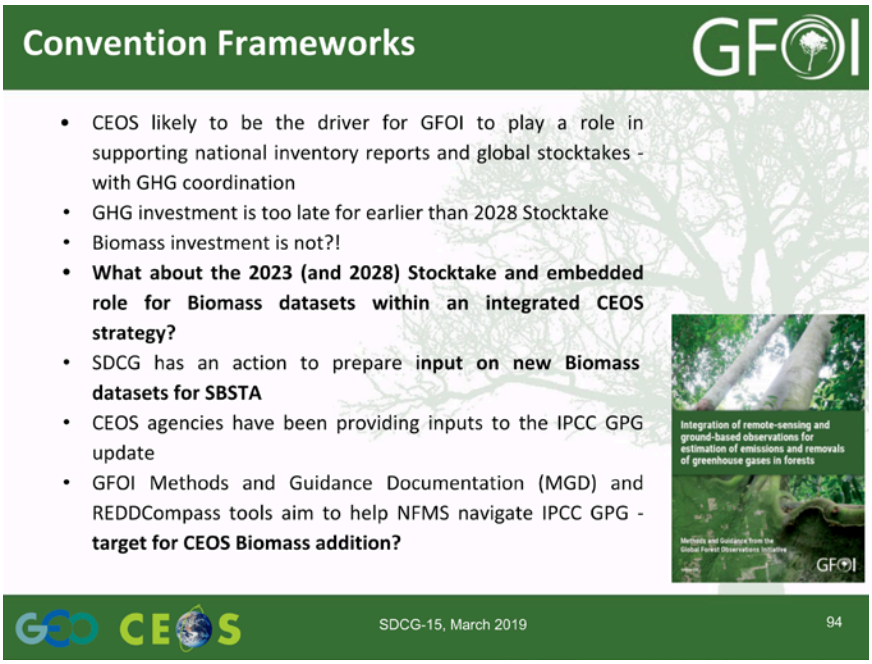


- **The concept of a CEOS VC for biomass could be considered.**
- Broadening participation through CEOS could also be considered, rather than working bilaterally.
- The dialogue between space data/information providers and GFOI needs/requirements is important, in particular in addressing gaps between user needs and the research domain. It's not likely that these methods will be introduced operationally soon, but they could be used in fact checking exercises.
- Merging these new approaches into what countries are doing now is one of the key challenges, and this translation piece could be a role for this group to play. There is a need to manage expectations for these new datasets, and keep them realistic.
- Matt Hansen is going to use the baseline GEDI data to project back into the past using the Landsat time series.
- Mission teams are focused on their products, however how the user communities use the data can be expected to vary a lot.
- Tom - the line between data providers and users is evolving.
- Trust will be a core question, and is an area where space agencies as data providers need to assure that trust - the GFOI community can play a role in advising on the required types of data sets.

- The development of communication and education materials is a role that SDCG and/or GFOI should play - need to be clear on the capabilities of the new EO data sets.
- **ACTION Joanne to share the list of validation / accuracy criteria with Laura.**
- Two potential approaches to validation - automation of empirical validation; and, a user data driven validation approach.
- MGD could advise on the collection of *in situ* information in support of (e.g.) current airborne campaigns in anticipation of future satellite data flows.

Discussion Topic 2: SIT Chair Contribution

Stephen Ward opened a discussion on potential roles for CEOS SIT Chair, noting that the SIT Chair Term 2020-2021 highlights Carbon & Biomass as a priority.



- By 2023, GEDI mission will be completed and we can anticipate having the complete set of products in support of inputs to the Stocktake process.
- There is also a need to view the mix of upcoming carbon related missions synergistically, e.g. to consider how the integrated mix of missions can be used to yield more than than sum of their parts. This is something that WGClimate is considering for next year in the form of a workshop at JRC.
- **ACTION: Follow-up with Laura on the update of the GFOI MGD and how the biomass (protocol) could be codified in this document. Laura suggested that a few of the MGD reviewers (e.g. Ake) to review the protocol - Ake happy to be the contact.**
- The gap between the country-focused MGD, and the more research-focused biomass protocol needs to be considered before we propose how it might be incorporated in the MGD.

- **ACTION: To follow-up on CEOS input to SBSTA on developments in biomass, and some of this content could be drawn from the biomass protocol and mission handbooks - deadline likely Oct 2019.**
- The question of a user-facing resource for MAPP is something that may evolve and grow naturally.
- From the multi-mission perspective, the main need is contemporaneous field/*in-situ* data and analysis of the data along with satellite observations.
- There is a need to have a two-year end state for each of the SIT Chair priorities, including biomass - it could be that elements of the work of the multi-mission group would be a good focus for these targets for biomass, with the opportunity to put the case for resources to Principals at SIT.
- **ACTION: Brian to follow-up with Laura on suggestion that maybe the COVE tool could help out - is GEDI in there…? can you add a plane mode…? Brian to provide background information on COVE to Laura - Laura suggested the NISAR team may be interested.**

Discussion Topic 4: Organisational aspects and roles

Steven Hosford introduced a discussion on potential changes in the CEOS organisation to help improve the impact and visibility of activities.

- **ACTION: Need to consider what kind of representation NASA should have in SDCG based on the coming investment in forest-related missions - the ideal rep would represent these missions. Ideally SDCG would have clear biomass-related work plan tasks first to support the discussion.**
- There is a particular emphasis on hyperspectral for the characterisation of forest systems - this may provide an other element of the package of forest-related observations - (US decadal SBG mission concept - Surface Biology and Geology), which is one of the higher probability missions to follow through -
- **Increasing visibility of these activities within CEOS could be important to the progression overall.**

Wrap up

- Ake recall that Osamu Ochiai had asked if SDCG should only be focused on GFOI, and Stephen noted that if merged into LSI-VC the naming is suggested to be 'Forests & Biomass Team' which is more general.
- We should consider ESA CCI Biomass as a potential interface/contributor;
- SERVIR plans training work for LiDAR data familiarisation;
- **GEDI has no outreach budget and this will limit the ability to promote the data to GFOI and beyond; SDCG can certainly help here.**
- The CEOS Biomass Protocol scope is limited to forest and not agriculture.
- **Next steps for SDCG will be driven by inputs to the SIT Chair plans and the development of the new 3 year Work Plan.**
- **ACTION: SDCG EXEC to come back to the group with a list of items to put in the SIT initiative for the next two years.** We should consider the list of possible implementation options, ideally with $ cost estimates attached

List of Participants

Organization	Participant
DLR	Michael Bock*
DLR	Kostas Papathanassiou*
ESA and CEOS CEO	Steven Hosford
JAXA	Ake Rosenqvist
JAXA	Osamu Ochiai*
NASA	Brian Killough
NASA	Hank Margolis
NASA	Kathy Hibbard
NASA	Mike Falkowski
NASA	Hank Margolis
WGCV-LPV	Laura Duncanson
UKSA	Joanne Nightingale
USGS	Tom Maiersperger
SDCG Secretariat	Stephen Ward
SDCG Secretariat	George Dyke
World Bank	Julian Gonzalo Jimenez

** - joined via GoToMeeting*

Record of Actions SDCG-15-Biomass Day

No.	Actionee	Action	Due date
SDCG-BMD-01	JAXA	**JAXA to follow up representation in the Multi-Mission Biomass Cal/Val Group.**	Jun 2019
	Rationale: Currently not represented		
SDCG-BMD-02	SDCG EXEC	**Follow-up with Julian/WB on training materials for the country MRV and lidar data handling and processing activities**	Apr 2019
	Rationale: Need for biomass data understanding in countries		
SDCG-BMD-03	SDCG EXEC	**Follow-up with Julian on sharing a list of countries and their potential (maturity) for uptake of biomass data**	Apr 2019
	Rationale: Need to begin to develop understanding of requirements		
SDCG-BMD-04	SDCG EXEC	**Joanne to share the list of validation/accuracy criteria (from Copernicus?)with Laura**	May 2019
	Rationale:		
SDCG-BMD-05	SDCG EXEC	**Follow-up with Laura on the update of the GFOI MGD and how the biomass (protocol) could be codified in this document. Laura suggested that a few of the MGD reviewers (e.g. Ake) to review the protocol - Ake happy to be the contact.**	May 2019
	Rationale: MGD is a key tool for promoting good practice in GFOI		
SDCG-BMD-06	SDCG EXEC	**To follow-up on CEOS input to SBSTA on developments in biomass, and some of this content could be drawn from the biomass protocol and mission handbooks**	Oct 2019
	Rationale: Existing CEOS action needs to be addressed		
SDCG-BMD-07	Brian Killough	**Follow-up with Laura on suggestion that maybe the COVE tool could help out - is GEDI in there…? can you add a plane mode…? Laura suggested the NISAR team may be interested.**	Apr 2019
	Rationale: SEO wants COVE to be comprehensive		
SDCG-BMD-08	SDCG and NASA CEOS reps	**Consider what kind of representation NASA should have in SDCG based on the coming investment in forest-related missions - the ideal rep would represent these missions. Ideally SDCG**	Jun 2019

		would have clear biomass-related work plan tasks first to support the discussion.	
	Rationale: SDCG membership must reflect the key missions		