

NASA Carbon Update for the CEOS Plenary (Virtual Meeting) 1-4 November 2021

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Context within the CEOS Working Group on Calibration & Validation – Land Product Validation Subgroup

Jaime Nickeson (SSAI / GSFC) CEOS Plenary (Virtual Meeting) 1-4 November 2021



CARB-19: Continuous Development of Good Practice Protocols



mass

The Land Product Validation Subgroup continues to develop validation Good Practices protocols for global land satellite products within their focus areas.

The table at the right shows a total of nearly 1900 downloads of these protocols from the LPV web site. All of the documents have DOIs and are available via the LPV Documents web page (<u>https://lpvs.gsfc.nasa.gov/documents.html</u>). Note: the AGB protocol is also available from other sites that we do not track.

Summary - Annual Downloads									
Year	AGB	SM	Albedo	LST	LAI*				
2016					53				
2017				17	58				
2018				104	142				
2019			126	79	95				
2020		102	122	106	134				
2021	396	103	76	64	108				
Totals	396	205	324	370	590				

* missing download stats from Aug2014-Jun2016



NASA CEOS Carbon Update: Biomass

Laura Duncanson, Univ. Maryland CEOS Plenary (Virtual Meeting) 1-4 November 2021





5

CARB-17: Coordinated Cal/Val Strategy Across Biomass Missions



A multi-mission working group between NASA's GEDI, ICESat-2, NASA/ISRO's NISAR, JAXA's ALOS and MOLI, ESA's BIOMASS and plot network leads continues to function ad-hoc, coordinated through LPV's biomass focus area. This group finalized **the CEOS WGCV LPV biomass protocol that was endorsed by CEOS Principals at SIT-36 (March 2021).** The biomass focus area now shifts to implementing this protocol through CEOS LSI AFOLU GEO.



CARB-17: Biomass Reference Network GEO-TREES



A Forest Biomass Reference System from Tree-by-Tree Inventory Data

Updated Reference Data Are Critically Important for Improved Biomass Mapping. GEO-TREES supports collection of new highquality **reference measurement**s for validation of biomass products.

We encourage **CEOS agency cooperation and funding support** of data collection for biomass validation following recommendations from the biomass protocol (open field and airborne data). There is an opportunity for lasting contributions to forest carbon monitoring.





CARB-17: Biomass Reference Network GEO-TREES



1. Activity accepted in March 2021 for the 2021-2022 GEO Work Programme

2. People behind GEO-TREES:

- Jerome Chave (Laboratoire Evolution et Diversité Biologique, France)
- Stuart Davies (Smithsonian Tropical Research Institute, USA)
- Mat Disney (University College London, UK)
- Laura Duncanson (University of Maryland, USA)
- Martin Herold (Wageningen University, NL)
- Nicolas Labrière (Laboratoire Evolution et Diversité Biologique, France)
- Oliver Phillips (University of Leeds, UK)
- Shaun Quegan (University of Sheffield, UK)
- Sassan Saatchi (Jet Propulsion Laboratory, USA)
- Plinio Sist (CIRAD, FR)
- Dmitry Schepaschenko (International Institute of Applied System Analysis, Austria)
- Klaus Scipal (European Space Agency, Italy)

3. First Achievements

- CNES committed to fund a project office for two years
- ESA ForestScan activity was kicked off to set up three reference sites (French Guiana, Gabon, Malaysia).
- NASA acquired 2021 airborne lidar (LVIS) over French Guiana.
- Discussions are under way with ISRO, World Bank (Mozambique pilot), others.





New biomass products are being released (e.g., GEDI, August 2021). Intercomparison, validation and harmonization of these products to increase product improvement and uptake. Open science activity using new 2020 products and available reference data.



Product	Data Type	Missions	Years represented	Spatial Resolution	Spatial Domain	Availability
GLOBIOMASS	SAR, lidar	ALOS, ENVISAT, ICESat GLAS	2010	100-m	Global	Available now
GEOCARBON	Fusion of other products	Inputs to other products (lidar, SAR, Optical)	~2010	0.01°	Global	Available now
NASA JPL	Lidar, SAR	GLAS, ALOS	2015	10-km	Global	Available now
CCI Biomass	SAR and Optical	ALOS, Sentinel-1	2017, 2018	100-m	Global	Available now
NASA JPL	Lidar, SAR and optical	GEDI, ALOS-2	2020	10-km	Global	Available Q4 2021
NCEO Africa	Lidar, SAR, Optical	GEDI, ALOS-2, Landsat	2007 - 2017	100-m	Africa	Available now
CCI Biomass	Lidar, SAR and Optical	ALOS, Sentinel-1, GEDI, ICESat-2	2020	100-m	Global	Available Q4 2021
NASA GEDI mission Product	Lidar	GEDI	2019-2021	1-km	+/- ~51.6° latitude	Available Q4 2021
NASA ICESat-2 boreal product	Lidar	ICESat-2, Landsat	2019-2021	30-m	Boreal (50-75° N)	Available Q4 2021

Past Products

Inputs to Biomass Harmonization Activity



ESA (+EU/UK Researchers):

- Clement Albinet
- Martin Herold
- Heather Kay
- Richard Lucas
- Joana Melo
- Erik Næsset
- Kostas Papathanassiou
- Klaus Scipal
- Frank-Martin Seifert
- Pedro Rodriguez Veiga

- NASA (+US Researchers):
- John Armston
- Ralph Dubayah
- Laura Duncanson
- David Minor
- Sean Healey
- Ron McRoberts
- Sassan Saatchi
 - Sylvia Wilson

Products are being assessed following the WGCV biomass protocol using available reference data in pilot USGS Silvacarbon countries.

- 2020 biomass maps are now available for the team, and will be presented at COP26.
- Harmonization framework is still in discussion; harmonized product is expected 2022
- Country case studies developed for Paraguay, Peru, Solomon Islands, Japan, and Wales.

JAXA:

- Osamu Ochiai
- Ake Rosenqvist
- Takeo Tadono
- Masato Hayashi





About

Feedback

EARTHDATA MAAP Dashboard BETA

Canopy Height (m) 🛈 🕓 🧲

Max Normalized ... 🛈 🕓

Topographic Sola... (i) 🕓 🔵

Taiga-Tundra Eco... 🛈 🕓 🚺

🖸 mapbox

EXPLORE

Areas

Global

Boreal

Taiga Ecotone

< **BIOMASS PRODUCT SHARING**

Welcome

MAAP User Working Group (UWG) members are developing a biomass product using covariates from Landsat 8, ICESat-2 Canopy Heights, and Copernicus DEM for the boreal region. This region is 50 - 75 degrees North, encompasing parts of North America and Eurasia. The MAAP makes it possible for UWG members to collaborate virtually and scale their science using the MAAP Algorithm Development Environment (ADE) and Data Processing System (DPS).

Explore ~

Inputs: Pictured are the inputs to the final biomass product as well as the final product itself. Landsat8 Covariates are a UWG-generated product. ICESat-2 ATL08 is included as a dependent variable in the model and is shown here with color categories based on canopy height.

The MAAP will enable international scientific collaboration on biomass mapping. Later this year, MAAP scientists will use the platform to share and request other groups' biomass products to enable harmonization of those different products.

ATL08 informationCanopy height measurements taken with ICESat2 sensor are used determine tree heights across the region of interest.

Landsat Covariates14 different variables derived from

In collaboration with Development Seed and the MAAP team the biomass harmonization activity is working on a web-based dashboard to allow exploration of the new biomass products, and associated story telling by product teams and data users (e.g., Paraguay, Peru, Wales, Japan). The dashboard is planned for release in advance of COP26.



Committee on Earth Observation Satellites

Carbon Update: Working Group on Information Systems and Services (WGISS)

Andy Mitchell (GSFC) CEOS Plenary (Virtual Meeting) 1-4 November 2021



WGISS – Working Group on Information Systems and Services



Objective: Implement a carbon data portal to facilitate the discoverability and accessibility of Essential Climate Variables (ECV) products and space-borne Climate Data Records (CDRs). The portal seamlessly accesses data both in CWIC and FedEO systems to provide necessary data and services to the carbon science community of both CEOS and GEOSS.

WGISS Carbon Portal prototype work has come to a successful conclusion!!

- Enables interoperability with Open Data Cube (ODC) to support CEOS Chair forest carbon initiative.
- CWIC server is operational and the API is publicly available for querying.
- Agencies are now free to build and sustain their own data access portals/clients using the CWIC APIs.
- Provides pre-defined topics/datasets: Atmospheric Carbon, Ecosystem Carbon, Ocean Carbon, and Mixed-Theme Carbon.
- Allows searching of ECV and CDRs.



Next steps: Enhances the portal to support new requirements from CEOS, GEOSS, and Global Carbon Project; Enhance interoperation with Open Data Cube; Explores support to other CEOS Initiatives.



Committee on Earth Observation Satellites

Carbon Update: Working Group on Climate, Greenhouse Gas Task Team

David Crisp, NASA/JPL/Caltech CEOS AC-VC, GHG Task Team CEOS Plenary (Virtual Meeting) 1-4 November 2021





Greenhouse Gas Inventories for the UNFCCC Global Stocktake



- To support the 2023 Global Stocktake (GST), Parties to the Paris Agreement are compiling inventories of greenhouse gas (GHG) emissions and removals to assess progress toward their Nationally Determined Contributions (NDCs) to emission reductions.
 - These inventories are based on bottom-up methods that estimate annual emissions and removals of GHGs from the sectors specified in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
- GHG emissions and removals can also be estimated from spatially and temporally -resolved measurements of their concentrations using atmospheric inverse methods.
- The top -down atmospheric inventories derived from these fluxes
 - are not as process-specific as bottom -up inventories,
 - complement those methods by providing a transparent, integrated constraint on fluxes from all processes on spatial scales spanning large power plants or urban areas to nations or the entire globe.



Primary Objective – Starting a Conversation



The primary objective of these pilot top -down GHG products is to start a conversation with stakeholders and users to establish the utility and best practices for combining bottom -up and top -down products to enable a more complete Global Stocktake



Carbon Stock Changes from CO₂ Emissions/Removals by Sector/Country



2015-2018 median \pm standard deviation of fossil fuel (FF), River_{lateral}, Crop_{lateral}+Wood_{lateral}, Δ C, and NCE for 28 countries for inversions using in situ (IS) or OCO-2 Land Nadir and Land Glint (LNLG) data.



In situ (IS) and OCO-2 (LNLG) CO₂ data inform the **Net Carbon Exchange (NCE)** between surface and atmosphere.

• NCE can be further subdivided into fossil fuel emissions (FF), lateral carbon fluxes due to rivers, crop, and wood, and changes in land carbon (ΔC):

 $NCE = FF + River_{lateral} + Crop + Wood_{lateral} + \Delta C$

 C can be compared with bottom -up estimates of carbon stock changes







- Satellite based top-down observations can resolve CH₄ emissions by sector AND Country: Can resolve total emissions for about 58 countries
- Top 5 emitting countries emit about half of all anthropogenic CH ₄ emissions (consistent with inventory data)
- Most emissions are from the agricultural sector, primarily livestock
- Caveat: Because we cannot easily quantify transport model error, these estimates should be treated cautiously and as a starting point for future investigations



AWF = Agriculture, Waste, and Fires

FF = Fossil fuels (coal, oil, gas)

N = Natural (Wetlands and seeps)

Plots by John Worden and the CMS-Flux Team (NASA/JPL)

CE

Tracking Emissions from Localized Hot Spots



Pilot products are also being developed to track emissions from localized sources including large urban areas, power plants and oil fields

- GOSAT team accelerated the development of an upper/lower tropospheric product to track effects of COVID-19 lockdowns on emissions from large urban areas
- OCO-2 and TROPOMI teams are tracking CO₂ emissions from individual powerplants and large urban areas
- TROPOMI team is tracking methane emissions from fossil fuel extraction, and collaborating with the GHGSat team to locate intense plumes



OCO-2 XCO_2 and TROPOMI NO₂ combined to quantify CO_2 emission by large South African power Plants



Zehner et al. (IWGGMS-16, 2020)



Status of Products

- Preliminary regional to national scale GHG products and documentation delivered for review by CEOS GST Stakeholders
 SIT, GHG TT, AFOLU TT, AGVC, WGCV, WGCapD ...
- Examples of space -based estimates of local sources (power plants, large urban areas, fossil fuel extractions sites) under development
- Inputs to CEOS GST website in preparation for submission by 30 Sep
- Updates to pilot inventories, documentation and capacity building activities continuing through October in preparation for COP -26

COP-26 Plans

- Pilot top -down GHG products featured in CEOS Report to SBSTA
- Prepare posters to support the 2021 Earth Information Day (Nov 2)
- Side Events proposed