Committee on Earth Observation Satellites

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

Hank Margolis (HQ)
Jaime Nickeson (SSAI/NASA Goddard)
Laura Duncanson (Univ. Maryland)
Andrew Mitchell (GSFC)
David Crisp (JPL)
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
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 (https://lpvs.gsfc.nasa.gov/documents.html). Note: the AGB protocol is also available from other sites that we do not track.
NASA CEOS Carbon Update: Biomass

Laura Duncanson, Univ. Maryland
CEOS Plenary (Virtual Meeting)
1-4 November 2021
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.
A Forest Biomass Reference System from Tree-by-Tree Inventory Data


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.
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).
   - 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**.
# CARB-17, CARB-19, CARB-20: Biomass Harmonization Activity for the UNFCCC GST

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

**Past Products**

**Inputs to Biomass Harmonization Activity**
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.
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.
Carbon Update: Working Group on Information Systems and Services (WGISS)

Andy Mitchell (GSFC)
CEOS Plenary (Virtual Meeting)
1-4 November 2021
**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.
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
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.
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.
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):
  \[
  \text{NCE} = \text{FF} + \text{River}_{\text{lateral}} + \text{Crop} + \text{Wood}_{\text{lateral}} + \Delta C
  \]
- ΔC can be compared with bottom-up estimates of carbon stock changes.

Plots by Brendan Byrne (NASA/JPL) and the OCO-2 Flux MIP.
Satellite based top-down observations can resolve CH$_4$ 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)
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 CO$_2$ 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
Status of Products

• Preliminary regional to national scale GHG products and documentation delivered for review by CEOS GST Stakeholders
  o 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