Introduction to ESA's CCI Biomass

Frank Martin Seifert
The objective of the CCI programme is to realise the full potential of the long-term global EO archives that ESA together with its Member States have established over the last 30 years, as a significant and timely contribution to the EU's databases required by the UNFCCC.
Overview of ESA's CCI Biomass and Purpose of the 1st CCI Biomass User Workshop

Professor Richard Lucas
Fate of Anthropogenic Emissions (2005-2015)

Sources

\[ E_{\text{FF}} = 34.1 \pm 1.7 \text{ Gt CO}_2 \text{ yr}^{-1} \ (91\%) \]

\[ E_{\text{LUC}} = 3.5 \pm 1.8 \text{ Gt CO}_2 \text{ yr}^{-1} \ (9\%) \]

Partitioning

\[ G_{\text{ATM}} = 16.4 \pm 0.4 \text{ Gt CO}_2 \text{ yr}^{-1} \ (44\%) \]

\[ S_{\text{LAND}} = 11.5 \pm 3.1 \text{ Gt CO}_2 \text{ yr}^{-1} \ (30\%) \]

\[ S_{\text{OCEAN}} = 9.7 \pm 1.8 \text{ Gt CO}_2 \text{ yr}^{-1} \ (26\%) \]

\[ E_{\text{FF}} + E_{\text{LUC}} = G_{\text{ATM}} + S_{\text{OCEAN}} + S_{\text{LAND}} \]

\[ S_{\text{LAND}} \text{ - Not adequately measured} \]

CO\textsubscript{2} sinks include response of land and ocean to elevated CO\textsubscript{2} & changes in climate and other environmental conditions
Biomass: An Essential Variable in the Earth Climate System

Plants act as a storage reservoir, absorb excess atmospheric CO₂ and deliver input to soil carbon pools.

Highly sensitive to land use and management.

Influenced by fire with fuel loads partly controlling emissions.

Vulnerable to climate change and disturbances.

Controls biophysical climate effects.
CCI Biomass Aims

CCI Biomass is a three year project that aims to:

a) Generate global maps of above-ground biomass (Mg ha\(^{-1}\)) for four epochs (mid 1990s, 2007-2010, 2017/2018 and 2018/2019), with these being capable of supporting quantification of biomass change between epochs.

b) Provide information that is relevant for climate and has the potential to be exploited by global carbon cycle and climate models as they develop.

Fully supportive of global efforts and collaborative
Earth Observation Data for Retrieving Global Forest Biomass and Understanding Climatic Contributions

Sensors relevant to biomass:

- JERS SAR
- ERS SAR
- ALOS PALSAR (25 m mosaics)
- ENVISAT ASAR
- ALOS-2 PALSAR-2 (25 m mosaics)
- Sentinel-1
- SAOCOM
- NISAR
- BIOMASS
- NOVASAR
- TANDEM-X
- ICESAT GLAS
- GEDI
- MOLI
- ICESAT-2
- MODIS
- Landsat
- Japanese L-band SAR (1996-2018)

Biomass Change:
- Trunks
- Branches
- Leaves
Integrating Sensors for Improved Biomass Retrieval

Landsat–derived Cover (Red)
ALOS PALSAR~ L-band HH (Green)
and L-band HV (Blue)

Peninsular Malaysia
Gabon
Wales, UK
Sweden
Central America

ICESAT GLAS coloured by height, Injune, Queensland

Structural classification
Supportive Data Layers for Refining Biomass Estimates

- LIDAR profiles
- Forest Structure
- Water Inundation
- Rocky Ground
- Urban Areas
- Mangroves

Global Layers
The Structural Development of Forests

Global Forest structural classification

Based on canopy height (Simard et al. 2011; Biogeosciences) and cover (Hansen et al. 2013; Science)

Africa
The Structural Development of Forests

Forest Biomass And Change

Height

Cover

Mangroves, Northern Australia

Global Mangroves

Mangrove Height Malaysia (Tandem-X)

1996 (JERS-1 SAR)
2007-9 (ALOS PALSAR)
2010 (ALOS PALSAR & Landsat)
2015-16 (ALOS-2 PALSAR)
Factors Influencing Biomass Retrieval

Mangrove Height
Malaysia (Tandem-X)

Pekel et al. (2016; Nature)

SEDAC (2018)
Uncertainty in Biomass Retrieval

Water Occurrence

Pekel et al. (2016; Nature)

SEDAC (2018)
Integrating Environmental Variables into Land Cover and Change Classifications

**Land Cover Classifications** Generated from Environmental Variables according to the Food and Agriculture Organization (FAO) Land Cover Classification System (LCCS) and derived from Environmental Variables with unit quantities (e.g., m, %, days)

Trees closed canopy (>70-60%) tall (14-30 m) continuous broadleaved evergreen with 2nd layer supporting open canopy 7-3 m in height; Above Ground Biomass of 210 Mg ha⁻¹; dominated by *Pinus sylvestris*

Lucas and Mitchell (2017)
Linking with other ESA CCIs

- **Inputs to land cover descriptions**
- **Sea level impacts on mangrove biomass**
- **Impact on biomass retrieval algorithms**
- **Fire impacts on biomass**
- **Contributions to GHG emissions**
CCI Biomass: Global Plant Biomass Facility

Mobile Data Collection

Land cover and environmental variables (including tree to stand level biomass) consistently captured in near real time

Existing Biomass Databases (e.g., FOS)
ESA’s Climate Change Initiative: User Requirements – Climate Modelling

Tuesday 25th September - Session 1. Agenda

- Introduction and Welcome
  - F. M. Seifert (ESA)
- Overview of ESA's CCI Biomass and Purpose of the 1st CCI Biomass User Workshop
  - R. Lucas (AU)/P. Calais (LCSE)
- ESA's GlobBiomass Project and Datasets
  - M. Santoro (GAMMA)
- Review of Experiences and User Requirements for Biomass Mapping
  - M. Herold (WUR)
- NASA GEDI Update and potential collaboration
  - J. Armston (UMD)
- Biomass estimation GEDI and OBI-WAN
  - S. Healey (NSFS)
- The NISAR mission and Forest Characterization NASA's Arctic Boreal Vulnerability Experiment (ABoVE)
  - P. Siqueira (UMASS)
- The ESA NASA Joint Platform
  - F. Seifert (ESA)
- Break