climate change initiative

BIOMASS

Supporting Global Estimation of Past, Current and Future Vegetation Above Ground Biomass

Professor Richard Lucas & Frank Martin Seifert

biomass cci

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high resolution land cover cci

land surface temperature cci

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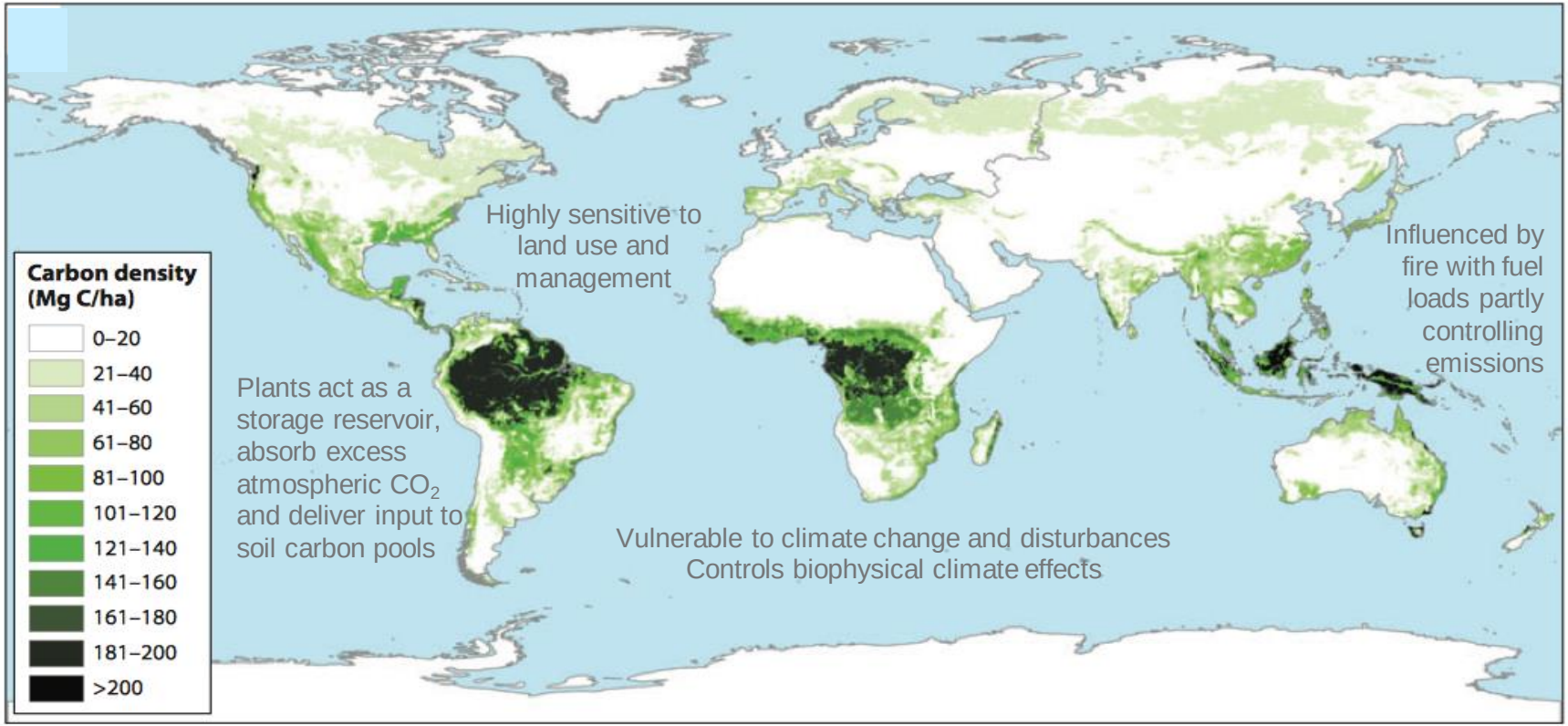
CCI+

Biomass: An Essential Variable in the Earth Climate System



Fate of Anthropogenic Emissions (2005-2015)

Sources

E_{FF} = 34.1 ± 1.7 $GtCO_2$ yr^{-1} (91 %)

E_{LUC} = 3.5 ± 1.8 $GtCO_2$ yr^{-1} (9 %)

Partitioning

G_{ATM} = 16.4 ± 0.4 Gt CO_2 yr^{-1} (44 %)

S_{OCEAN} = 9.7 ± 1.8 Gt CO_2 yr^{-1} (26 %)

S_{LAND} = 11.5 ± 3.1 Gt CO_2 yr^{-1} (30 %)

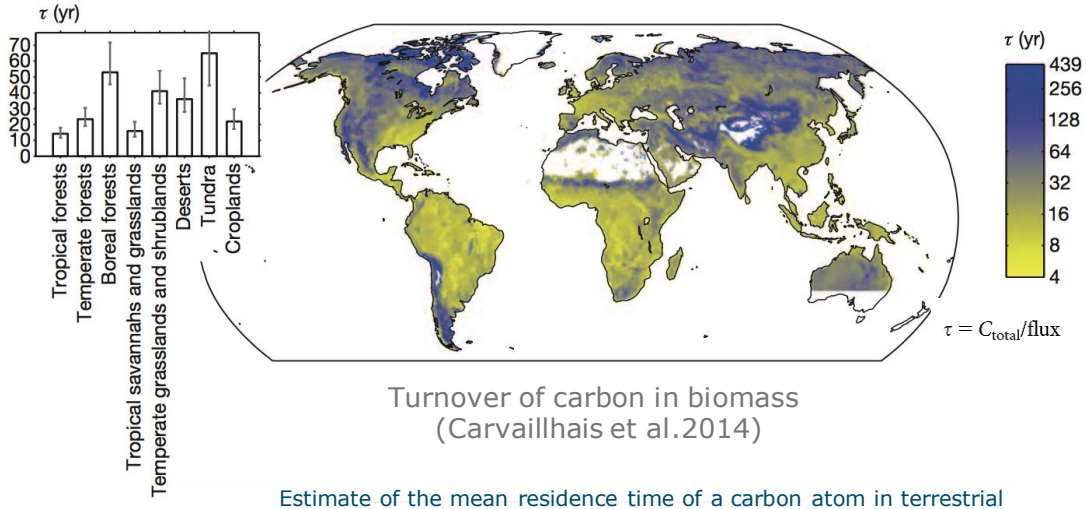
$E_{FF} + E_{LUC} = G_{ATM} + S_{OCEAN} + S_{LAND}$

S_{LAND} - Not adequately measured

CO_2 sinks include response of land and ocean to elevated CO_2 & changes in climate and other environmental conditions

Relevance to Climate Science and Models

- Emerging relationships between biomass and climate allow process-oriented evaluations of Earth System Models
- Provides information on carbon residence time and facilitates model initiation and validation.
- Increased recognition of biomass dynamics and influence of disturbance regimes on emissions.
- Direct retrieval of biomass changes constrain carbon budgets (e.g., as relevant to the Paris Agreement process)



Turnover of carbon in biomass
(Carvaillhais et al.2014)

Estimate of the mean residence time of a carbon atom in terrestrial ecosystems from its initial fixation by photosynthesis until its respiratory (including autotrophic respiration) or non-respiratory loss.

C_{total} = kgC m^{-2}

Flux = kgC m^{-2} yr^{-1}

Policy Requirements for Biomass Change

Biomass & biomass change are key quantities in UN mechanisms for slowing down global warming:

- Robust and transparent reporting to the UNFCCC
- Reduction of Emissions from Deforestation and Degradation (REDD+)
- National Determined Commitments under the Paris agreement and its 5-year cycle of global stock-taking

Earth Observation Data for the Global AGB Algorithm

Epoch

Mid 1990s

2002-2011

2016-2018

2019 onwards

Biomass Change

Radar

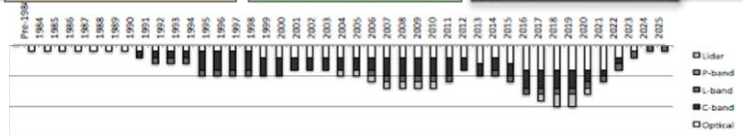
- JERS SAR
- ERS SAR
- ALOS PALSAR (25 m mosaics)
- ENVISAT ASAR
- ALOS-2 PALSAR-2 (25 m mosaics)
- Sentinel-1
- SAOCOM
- NISAR
- BIOMASS
- NOVASAR
- TANDEM-X

Optical

- Landsat
- MODIS
- Sentinel-2

Lidar

- ICESAT GLAS
- GEDI
- MOLI
- ICESAT-2



GLOBAL CORE ALGORITHM

(C-band SAR)
L-band SAR HH and HV
Canopy cover (optical)

Segmentation

Machine learning classification of EO data

Assignment of LIDAR profiles and height to segments

Classification of forest extent and structural type (inc. trees/shrubs; based on height and cover)

Determination of C- and L-band transmissivity

BIOMASAR-C | BIOMASAR-L

GSV and AGB maps

Merging to generate AGB map

GSV and AGB map

Biome and Forest Types (Specific improvements)

- Tropical/subtropical closed forests
- Woodlands and savannas
- Boreal and temperate forests
- Mangroves
- Freshwater inundated forests

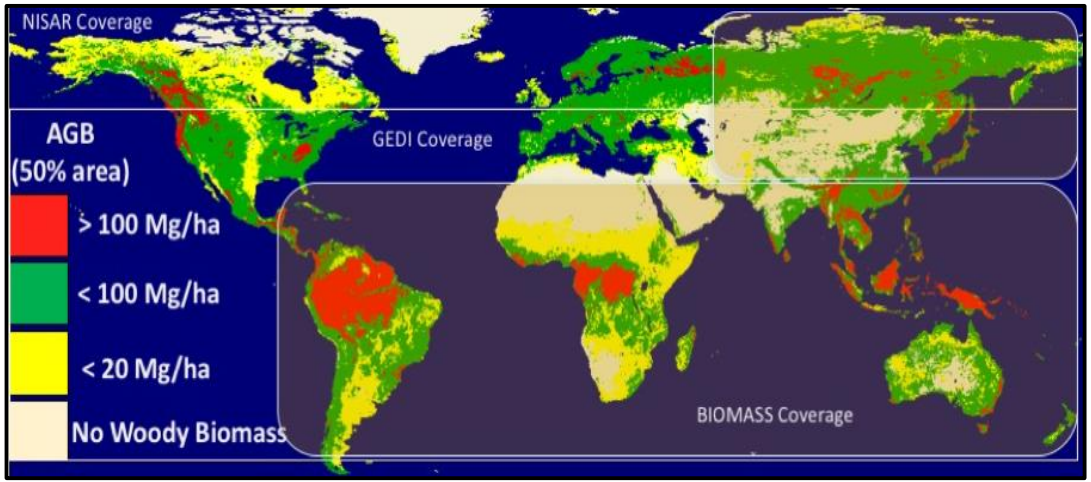
In situ data

Algorithm refinement by biome, forest type and sensor(s)

- Existing databases
- Timely delivery
- Airborne and ground

Validation and Uncertainty Assessment

Observational motivation: 3 New Missions Devoted to Forest Structure and Biomass



CCI Biomass: User groups

Main target is climate and carbon cycle modellers.

Current use of biomass by modellers is limited by focus on carbon fluxes, not stocks, but key groups exploiting biomass in models are Edinburgh, LSCE (Paris) & Max Planck (Jena).

The REDD+ community has secondary priority for CCI Biomass. For them the value of biomass data (and for land management) crucially depends on:

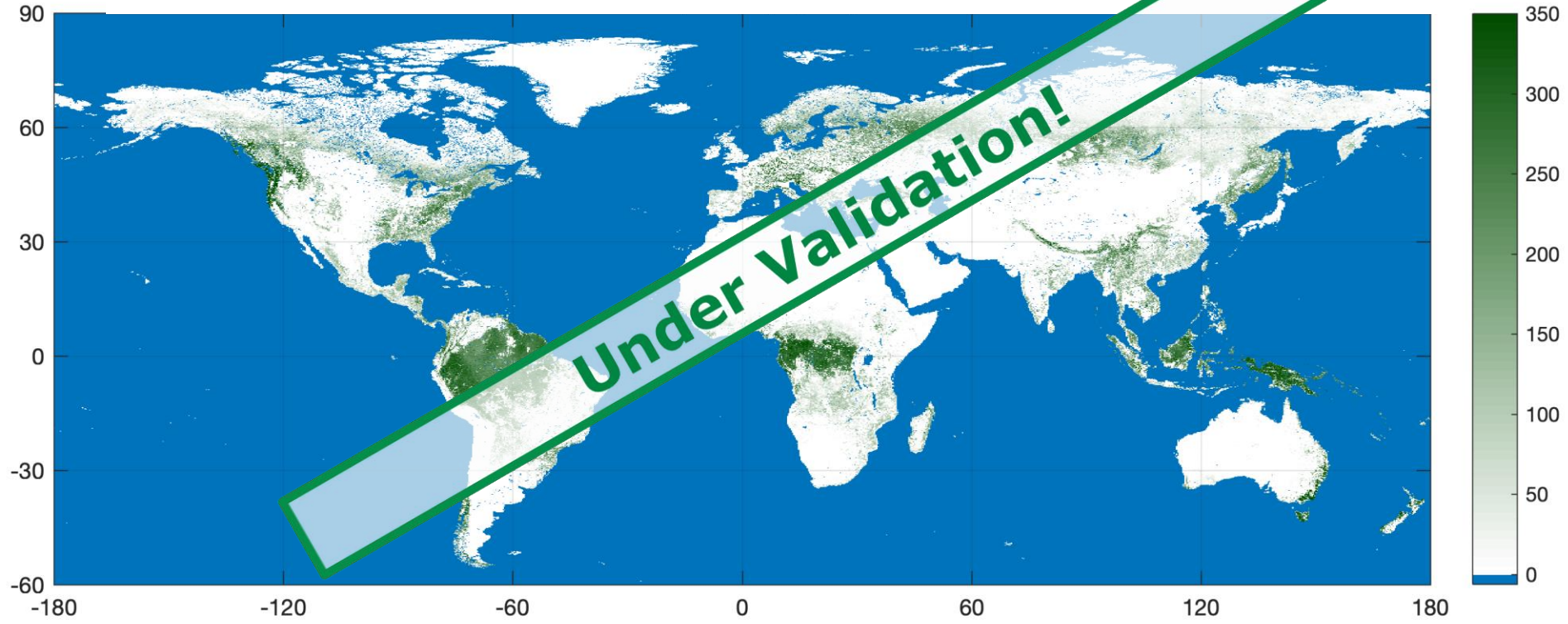
- Resolution
- Accuracy
- IPCC acceptance

CCI Biomass products

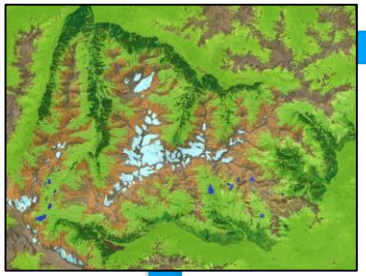
Products	Maps of forest AGB Maps of forest growing stock volume Maps of precision for both products Maps of AGB change between periods
Spatial Coverage	Global
Grid spacing	1 km x 1 km (target 100 m x 100 m)
Temporal Extent	2007-2010, 2017-2018 and 2018-2019
Accuracy	Unbiased, accuracy better than existing maps

CCI Biomass 2017

Epoch 2017, AGB (Mg/ha) @ 100m

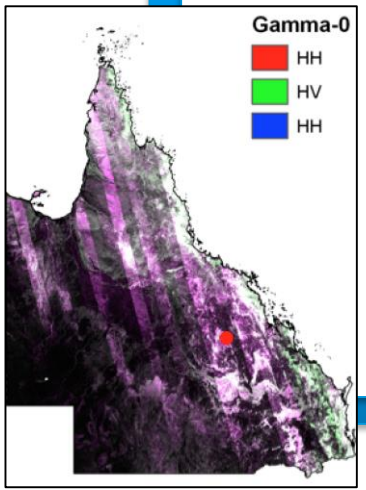


Linking with other ESA CCI Projects



land cover cci

Inputs to land cover descriptions



snow cover cci

soil moisture cci

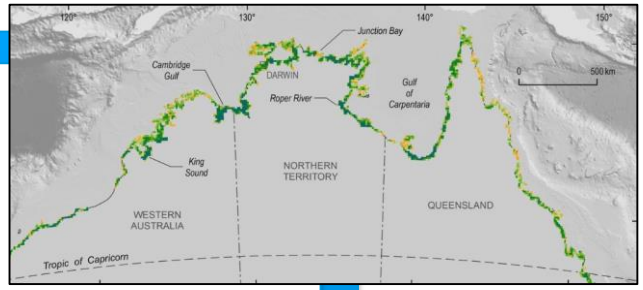
Impact on biomass retrieval algorithms

ghg cci

Contributions to GHG emissions

sea level cci

Sea level impacts on mangrove biomass



fire cci

Fire impacts on biomass

CCI Biomass - Conclusions

Biomass is an Essential Climate Variable

- Considerable uncertainty at the global level
- Temporal retrieval from EO data for quantifying biomass change is problematic

CCI Biomass focuses on the above ground biomass of woody vegetation

- Using combinations of radar, optical and lidar data for retrieval.
- Refining/modifying the GlobBiomass algorithm but considering other options.
- Considering influences of other environmental variables on EO data (e.g., soil moisture, water inundation)
- AGB and AGB change estimates: establishing links with other ECVs (e.g., fire, snow, soil moisture, sea level rise).

Uncertainty assessment

- Requires *in situ* data that are high quality (for algorithm development and validation) but also representing a wide range of environments.
- Introducing capacity to support enhancement of existing repositories and timely collection of ground data.

Links with climate science

- Benchmarking land-surface models
- Understanding carbon processes (e.g., allocation)
- Constraining regional C-budgets
- Quantifying emissions and sinks associated with the land use change and forestry sectors.

For further information visit:
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