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Forest Disturbances Requirements of Biomass Datasets

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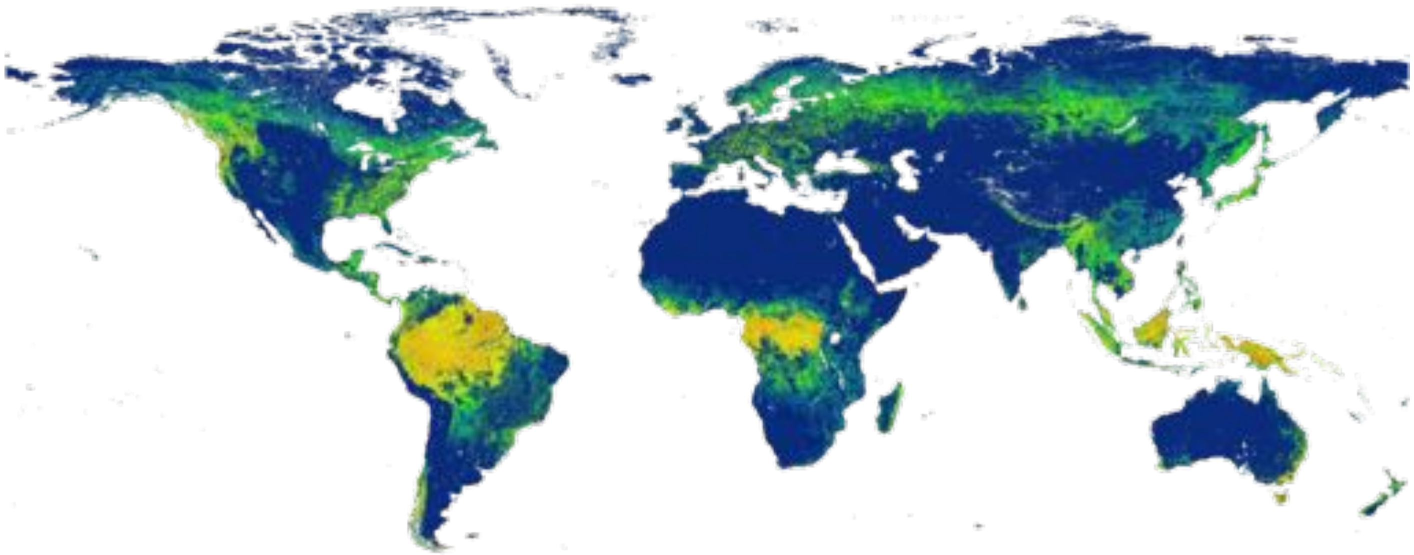
biomass cci

Biomass and Biomass Change

- Biomass and biomass change are of major relevance to mitigation and adaptation at global and national level
- Carbon stock changes occur faster than long-term climate change
- Their impacts need to be accounted for in climate modelling



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Types of disturbances

- Fire
- Insect damage
- Phytopathogens
- Windfall
- Extreme climate events, e.g. drought
- Damage by animals, e.g. elephants
- Selective logging

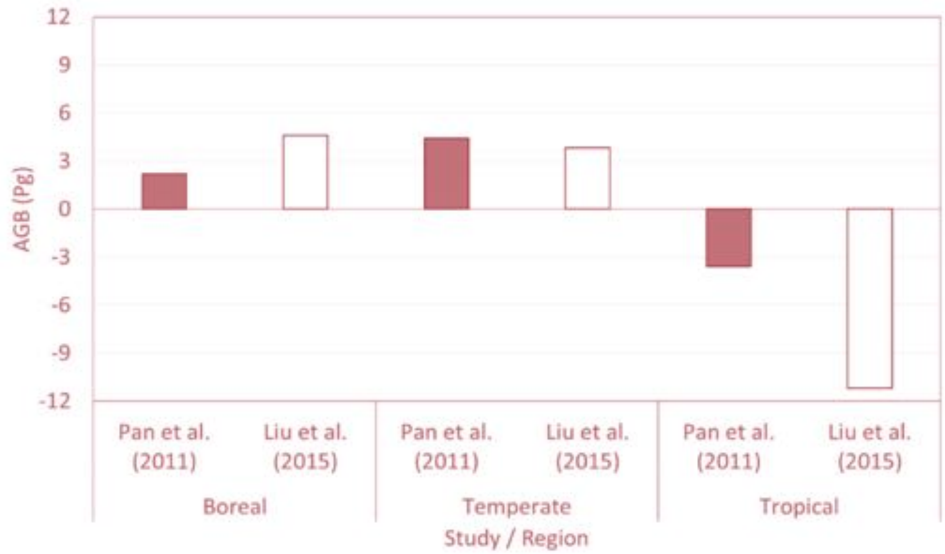
Fate of AGB

- Carbon emission
- Standing deadwood
- Fallen deadwood
- Removal of timber

Trends in global biomass

- Boreal and temperate biomes: Carbon trends (Liu et al. 2015) using Vegetation Optical Depth (VOD) are comparable to trends in ground observations for 2000-2007 (Pan et al. 2011)
- Tropical biome: The studies disagree in their estimates of AGB loss

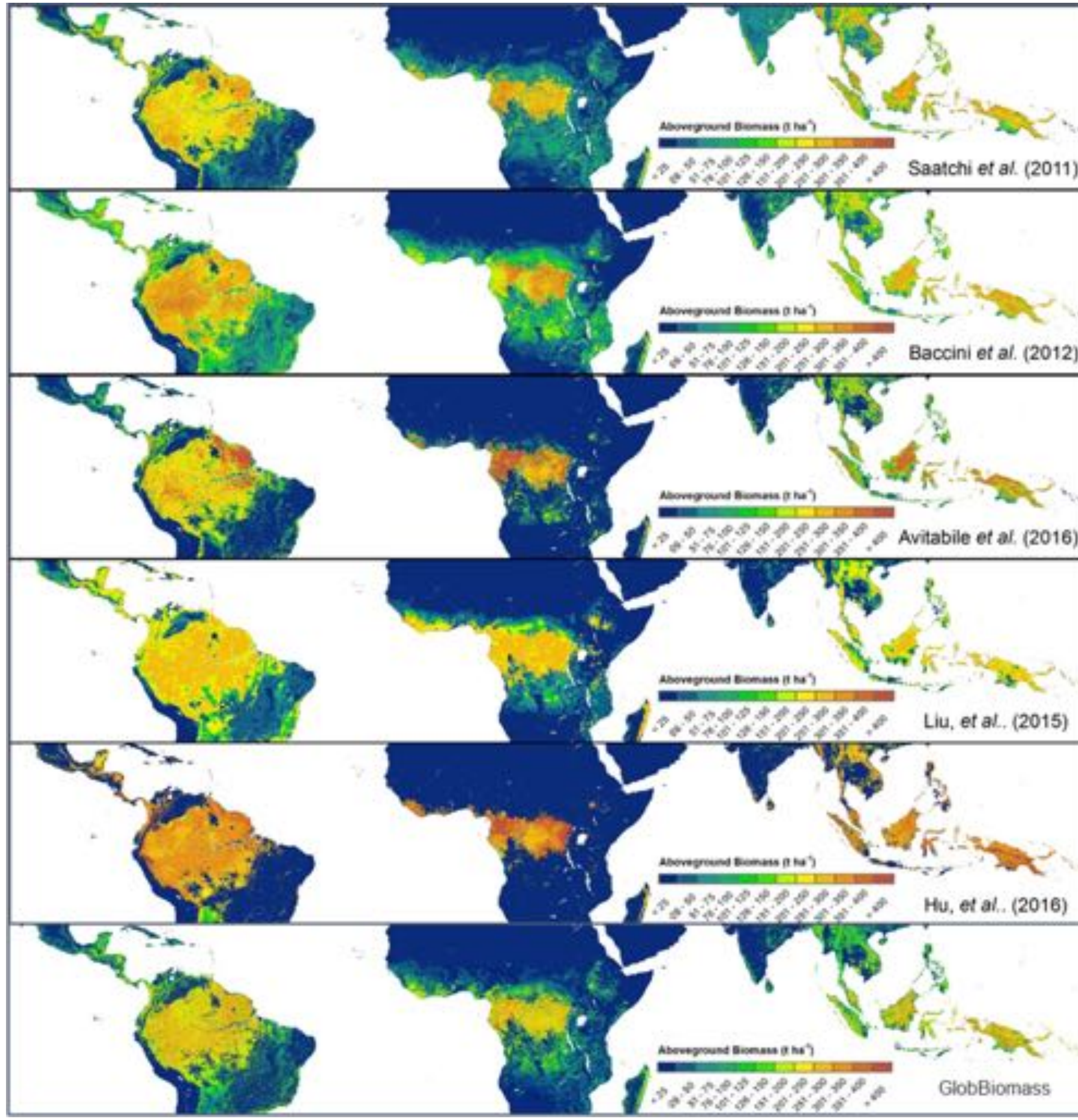
Comparison of AGB change in the period 2000 - 2007



Rodriguez-Veiga, P., Wheeler, J., Louis, V., Tansey, K. and Balzter, H., 2017. **Quantifying forest biomass carbon stocks from space.** *Current Forestry Reports*, *3*(1), pp.1-18.

Uncertainty of AGB retrievals in the tropics

Global and pan-tropical maps present divergent amounts and spatial distribution of AGB



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ESA CCI Biomass expected outcomes

- 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**
- Biomass change maps:
  - Annual change (2017-2018 vs. 2018-2019)
  - Decadal change (2007-2010 vs, 2017-2019)

Biomass user requirements

Item	Requirement
Spatial Resolution	500m-1km derived from 100-200 m observations
Temporal Resolution	Annual
Uncertainty	Acceptable error is < 20% for AGB > 50 t/ha, and < 10% for AGB ≤ 50 t/ha
Other C pools	Below-ground, soil organic and coarse woody debris.

Summary of relevant requirements by GCOS

Requirements for biomass change

- Identify the optimal stability and coverage periods for biomass map production and changes between two epochs.
- Establishing links with other ECVs. For example, exploring the drivers of AGB change, since these have different rate coefficients in terms of the associated emissions:
  - Shifting agriculture
  - Commodity driven
  - Fire
  - Forest management
  - Urbanization
- Better information on biomass increase due to forest growth
- Uncertainty characterization of the AGB change

Challenges for biomass change

- Noise and errors:
  - Random variation due to atmospheric conditions, system noise and radar speckle
  - Environmental changes that affect biomass estimates, e.g. rainfall
- Types of AGB change:
  - Sudden high-intensity change due to deforestation and fire
    - Almost complete loss of biomass. Requires an accurate estimate of biomass before the change event
  - Lower intensity, possibly progressive change caused by forest degradation
    - Harder to detect and measure. Few convincing studies that show this is possible with high enough precision and accuracy, particularly in moderate to high biomass forests
  - Biomass changes due to forest growth
    - Hard to estimate accurately except in low biomass areas with rapid regrowth (such as regenerating forest in the tropics or short cycle plantations)
- Availability of long-term in-situ measurements for validation

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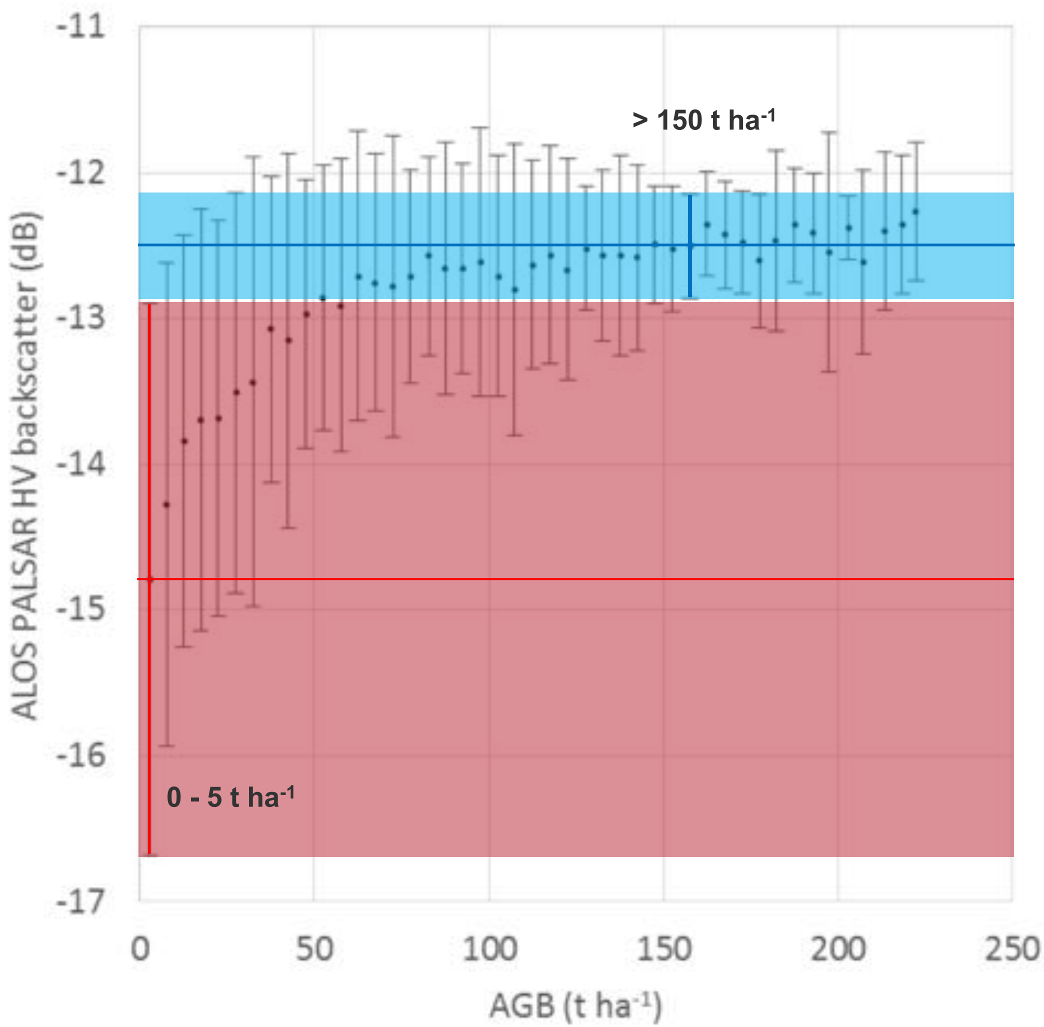
Challenges for biomass change

- Confidence intervals in AGB estimations are wide, making it difficult to detect AGB change with high confidence.
- Figure: Average ALOS PALSAR HV backscatter versus average reference AGB.
- Error bars indicate one standard deviation of the ALOS PALSAR HV backscatter per reference AGB range for the Yucatan peninsula, Mexico.



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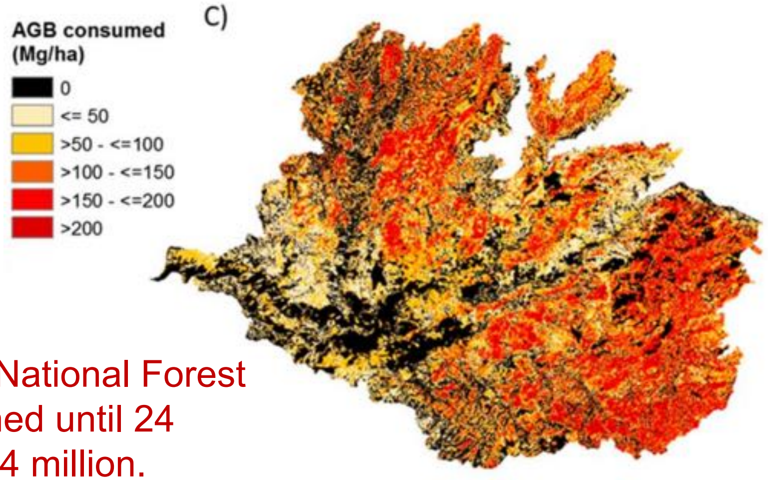
Fire disturbance and biomass change

- Biomass consumption and carbon release are critical to understanding the role of fires in the carbon cycle and vary between individual fires.
- Methods exist to estimate the consumed biomass, e.g. by integrating postfire airborne LiDAR and multitemporal Landsat OLI imagery (Garcia et al. 2017).
- Estimated AGB had an R^2 = 0.82 and RMSE = 60 t/ha.
- The California Rim Fire alone released 12.06 ± 0.06 Tg CO_2e to the atmosphere, equivalent to the annual emissions of 2.57 million cars.



The Rim Fire was started by an illegal campfire in Stanislaus National Forest in California on 17 August 2013. It burned 1,041 km² and burned until 24 October 2014, causing 10 non-fatal injuries and costing $127.4 million.

Garcia, M., Saatchi, S., Casas, A., Koltunov, A., Ustin, S., Ramirez, C., Garcia-Gutierrez, J. and Balzter, H., 2017. **Quantifying biomass consumption and carbon release from the California Rim fire by integrating airborne LiDAR and Landsat OLI data.** *Journal of Geophysical Research: Biogeosciences*, *122*(2), pp.340-353.

Fire and biomass change

- Biomass change is required to quantify the role of fires in the carbon cycle:
  - Carbon build-up before the fire (fuel load, related to fire risk)
  - Carbon release during the fire (direct emissions)
  - Carbon fluxes after the fire (post-disturbance fluxes), incl. soil carbon fluxes, tree die-back and regrowth

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Conclusions

- Biomass change is required for understanding the impacts of forest disturbances.
- Estimating AGB change is very challenging due to wide confidence intervals in AGB maps
- User requirements have to be realistic and achievable
- Strong potential for links to other ECVs (particularly Fire CCI)

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Merci!
Thanks!

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