

FRM4BIOMASS midterm meeting

WP2 - BIOMASS R package

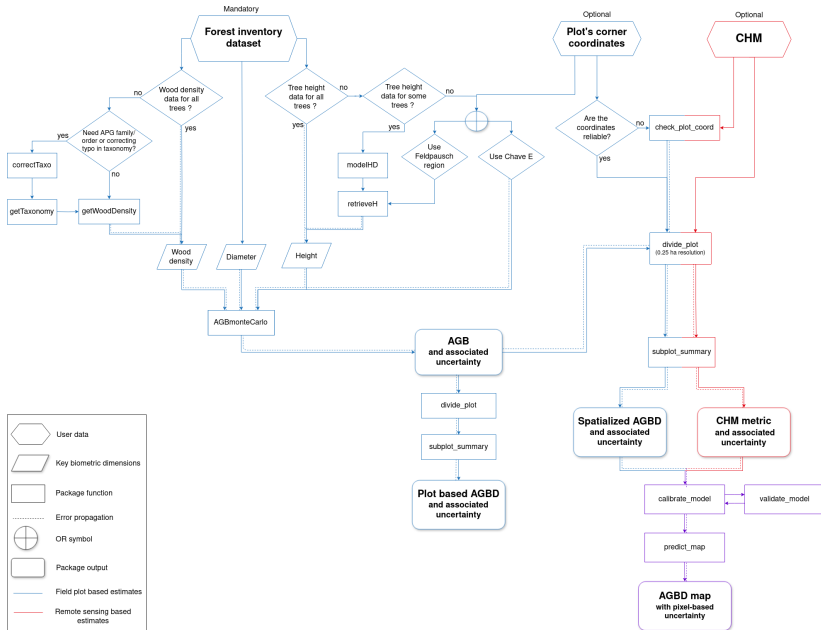
A. Bailly, D. Lamonica, M. Réjou-Méchain

UMR AMAP, IRD

2025-06-23

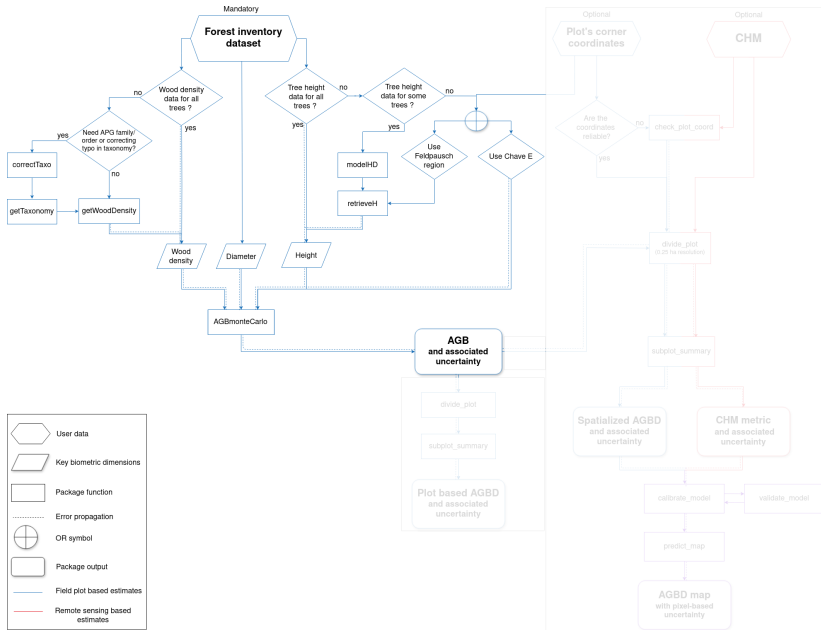


Workflow

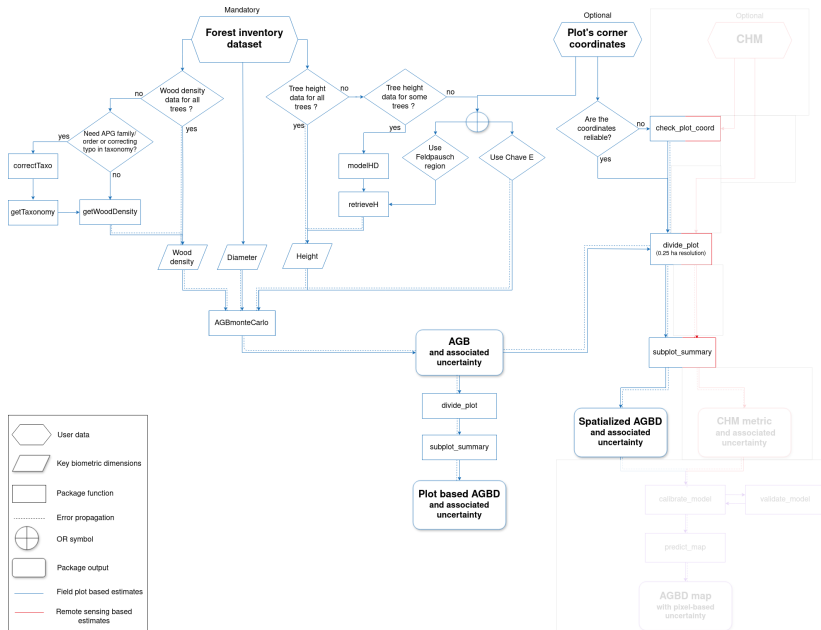


FRM4BIOMASS: what has been done & ongoing work

Shiny app for BIOMASS



Spatialization (V2.2)



Spatialization (V2.2.4, CRAN release March 2025)

- ▶ check plot coordinates
- ▶ divide plot into subplots
- ▶ spatialized AGB (*ie* AGBD) products at subplot level

BIOMASS 2.2.4 Articles ▾ Reference

Spatialize trees and forest stand metrics with BIOMASS

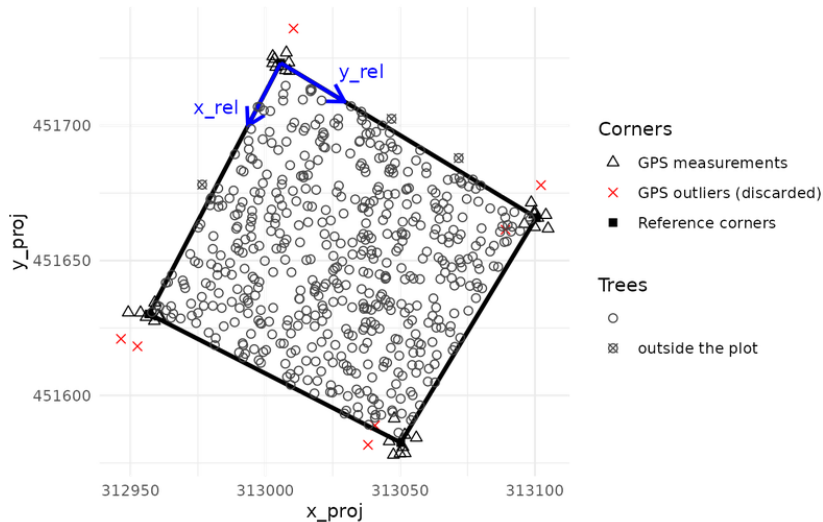
Arthur Bailly

2025-05-22

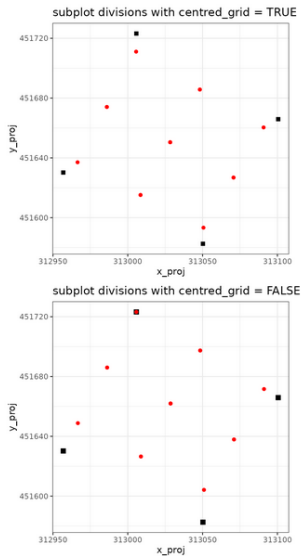
Source: [vignettes/Vignette_spatialized_trees_and_forest_stand_metrics.Rmd](#)



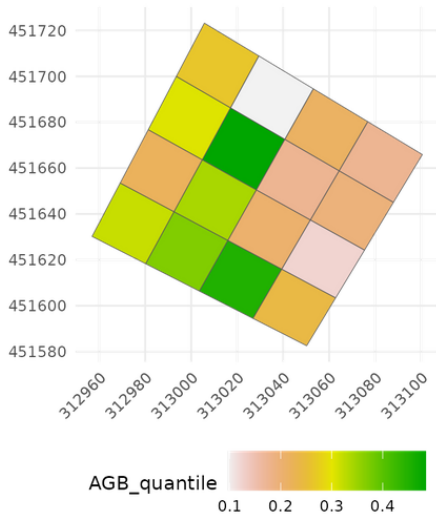
Spatialization (V2.2.4, CRAN release March 2025)



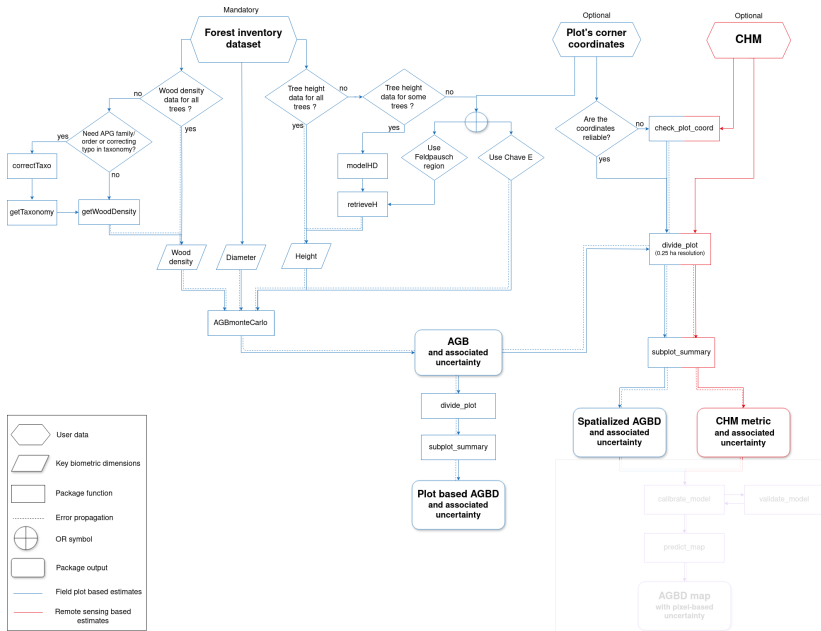
Spatialization (V2.2.4, CRAN release March 2025)



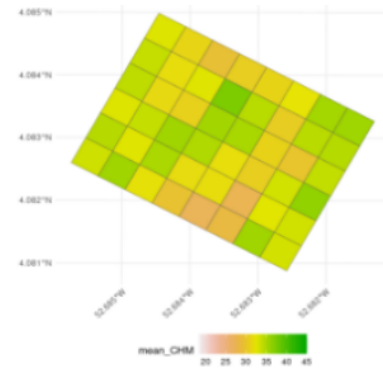
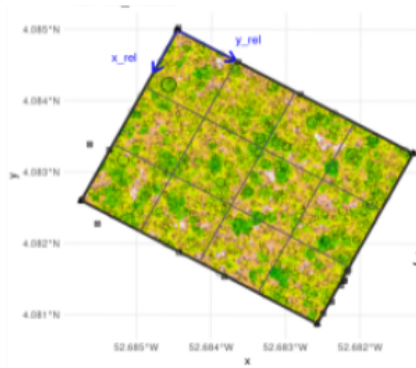
AGB quantile



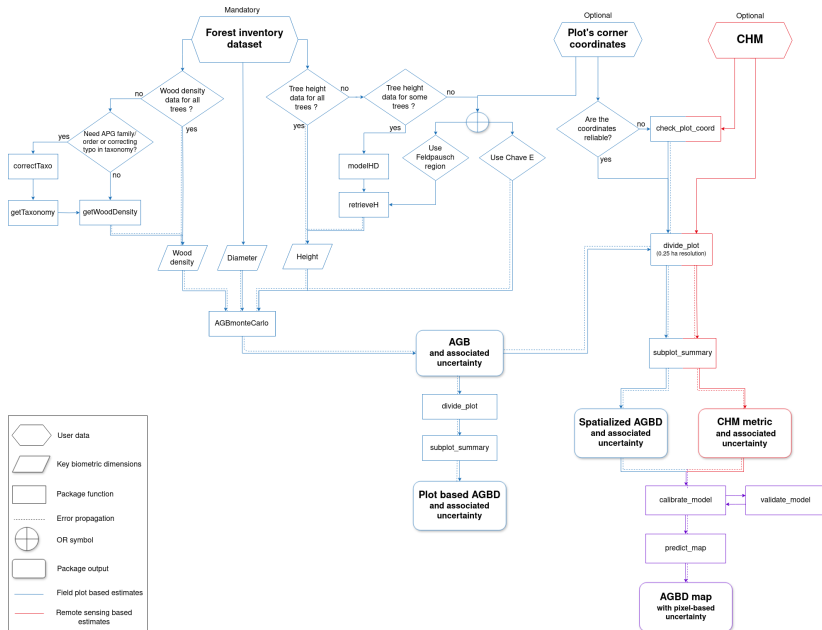
CHM management (V3)



CHM management (V3, implemented but not released yet)



CHM-AGBD model calibration (V3)



CHM-AGBD model calibration: proposed statistical framework

- ▶ geostatistical model with SPV-I/C (SPatially Varying Intercept/Coefficients) to integrate spatial correlation:
- ▶ $y(s) = (\alpha + \tilde{\alpha}(s)) + (\beta + \tilde{\beta}(s)) \times x(s) + \epsilon(s)$
with $\tilde{\alpha}(s_1), \dots, \tilde{\alpha}(s_n) \sim MVN(0, C_{\alpha}(s_i, s_j))$
- ▶ references



LiDAR based prediction of forest biomass using hierarchical models with spatially varying coefficients

Chad Babcock ^a, Andrew O. Finley ^{b,*}, John B. Bradford ^c, Randall Kolka ^d, Richard Birdsey ^e, Michael G. Ryan ^f



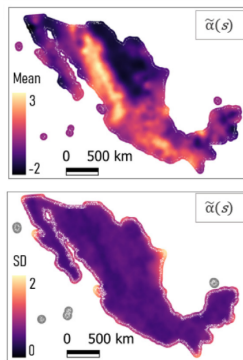
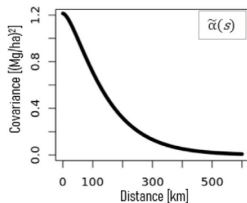
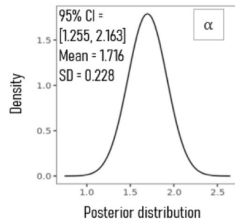
A geostatistical approach to enhancing national forest biomass assessments with Earth Observation to aid climate policy needs

Neha Hunka ^{a,*}, Paul May ^b, Chad Babcock ^c, José Armando Alanís de la Rosa ^d, Maria de los Angeles Soriano-Luna ^d, Rafael Mayorga Saucedo ^d, John Armston ^a, Maurizio Santoro ^e, Daniela Requena Suarez ^f, Martin Herold ^f, Natalia Málaga ^f, Sean P. Healey ^g, Robert E. Kennedy ^h, Andrew T. Hudak ⁱ, Laura Duncanson ^a

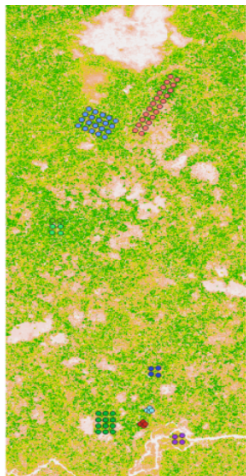
CHM-AGBD model calibration: proposed statistical framework

$$y(s) = (\alpha + \tilde{\alpha}(s)) + (\beta + \tilde{\beta}(s)) \times x(s) + \epsilon(s)$$

with $\tilde{\alpha}(s_1), \dots, \tilde{\alpha}(s_n) \sim MVN(0, C_{\alpha}(s_i, s_j))$

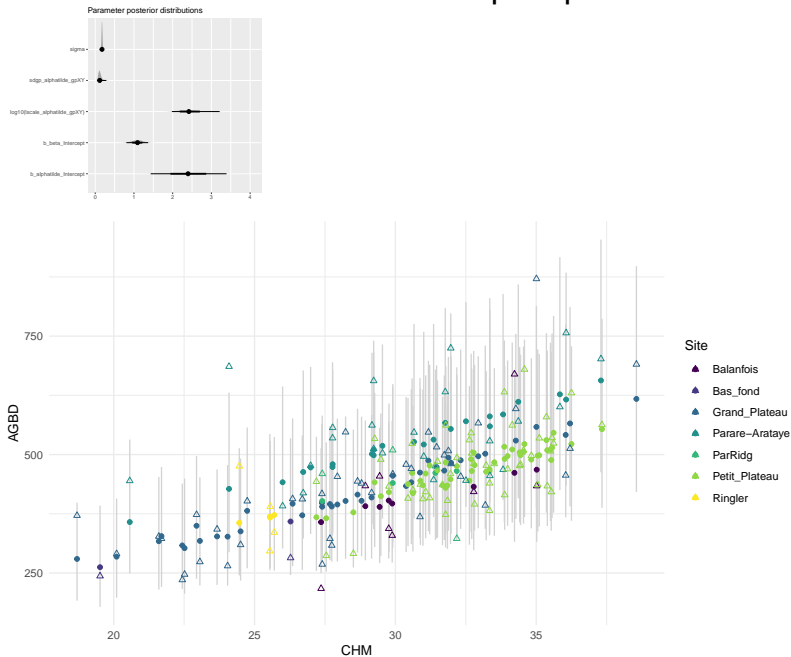


CHM-AGBD model calibration: example with Nouragues data

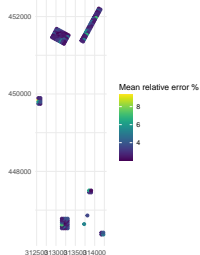


- SPV-I model $AGBD(s) = (\alpha + \tilde{\alpha}(s)) + \beta \times CHM(s) + \epsilon(s)$
with
 $\tilde{\alpha}(s_1), \dots, \tilde{\alpha}(s_n) \sim MVN(0, C_{\alpha}(s_i, s_j))$

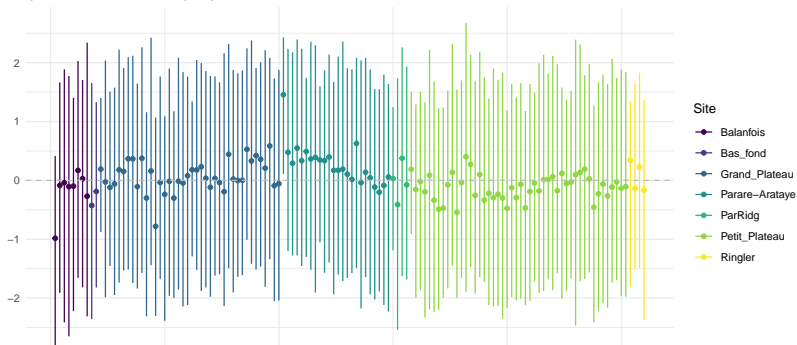
CHM-AGBD model estimates and plot prediction



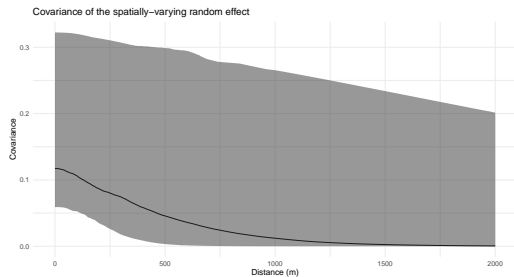
CHM-AGBD model errors: plots



Spatially-varying random effect
posterior distributions per plot



CHM-AGBD model landscape predictions



(ça arrive)

CHM-AGBD model calibration: implementation possibilities & difficulties

- ▶ brms package, STAN, geostat module in JAGS
- ▶ how to propagate AGBD uncertainties, computation wise (eg Monte Carlo procedure, or directly into the model ?)
- ▶ future statistical development to use all the CHM spatial structure: better use of available information for a more robust & precise full spatial AGBD prediction (for a next major version)

CHM-AGBD model validation

- ▶ proposed framework: Ploton et al. (QUEL PAPIER?)
- ▶ to be further discussed

Final product: uncertainty sources & how to deal with them

- ▶ wood density, height, diameter
- ▶ plot based AGB prediction: allometric relationship with Monte Carlo procedure
- ▶ plot based AGB density & CHM computation: spatial error with Monte Carlo procedure
- ▶ plot based AGBD-CHM calibration: spatial structure with SPVI/C (Bayesian framework)
- ▶ full spatial AGBD prediction: plot based AGBD uncertainties with Monte Carlo procedure ?

Perspectives

Short term perspectives - with Arthur

- ▶ Companion paper for V3 BIOMASS R package
- ▶ Currently under estimation of uncertainties in HD model (only residual error, no parameter uncertainties propagation) → Bayesian inference & propagation (eg, using brms package)
- ▶ Update wood density database → en attente de Fabian, ce qui nous permettrait d'adopter une approche de propagation d'incertitude plus intégrée
- ▶ Update taxonomy correction, currently we do not deal with synonymy → en attente de Renato, but his package needs to be on CRAN
- ▶ Error detection: outliers (diameter, height, wood density)

Long term perspectives - with ?

Temporal BIOMASS

- ▶ propagation des erreurs conjointes sur différentes dates plots & lidar
- ▶ technique pkg implémentation + structure à revoir pour intégrer la dynamique temporelle
- ▶ choix de l'approche allométries/différences de CHM etc

Thank you for your attention