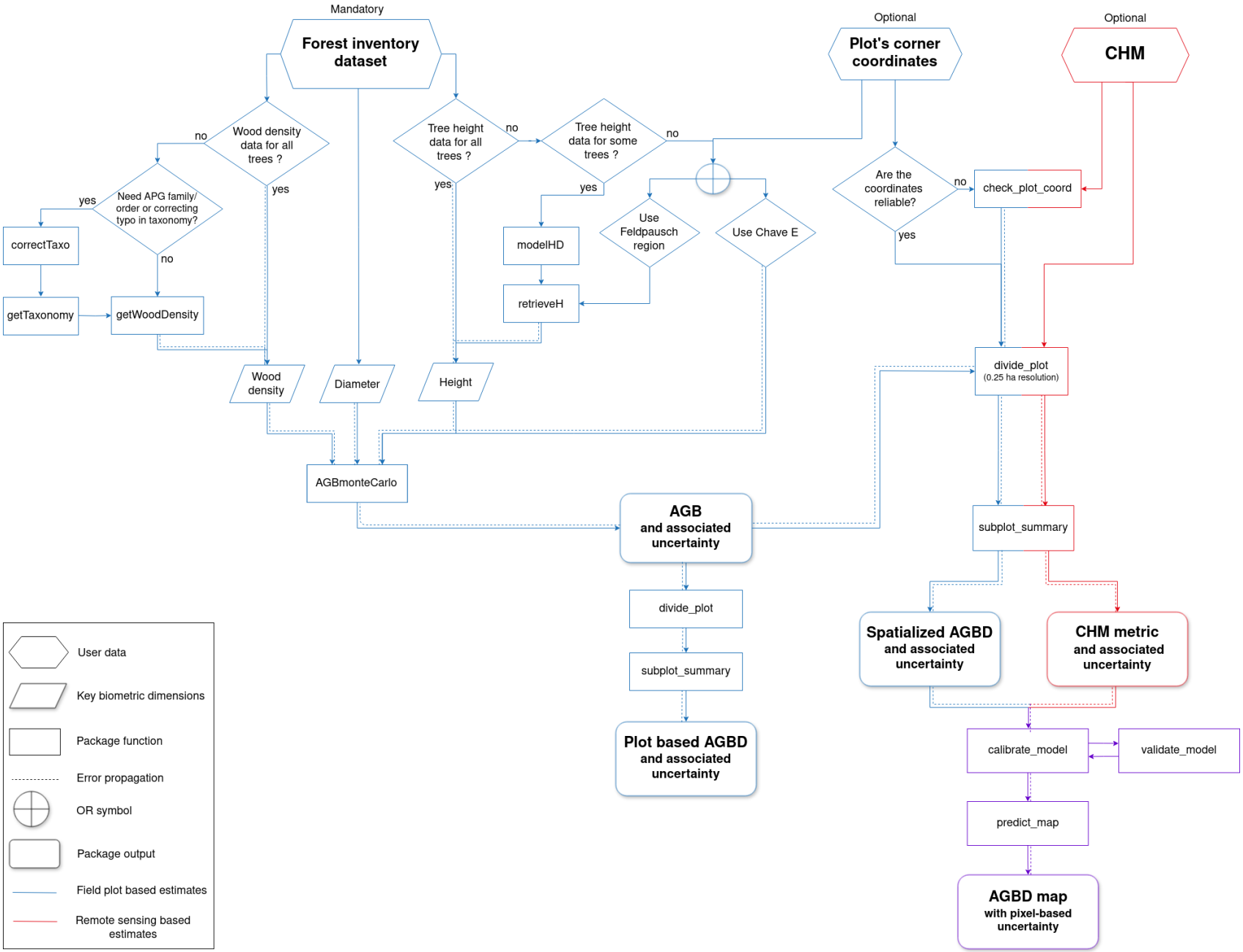
FRM4BIOMASS midterm meeting
WP2 - BIOMASS R package

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

UMR AMAP, IRD

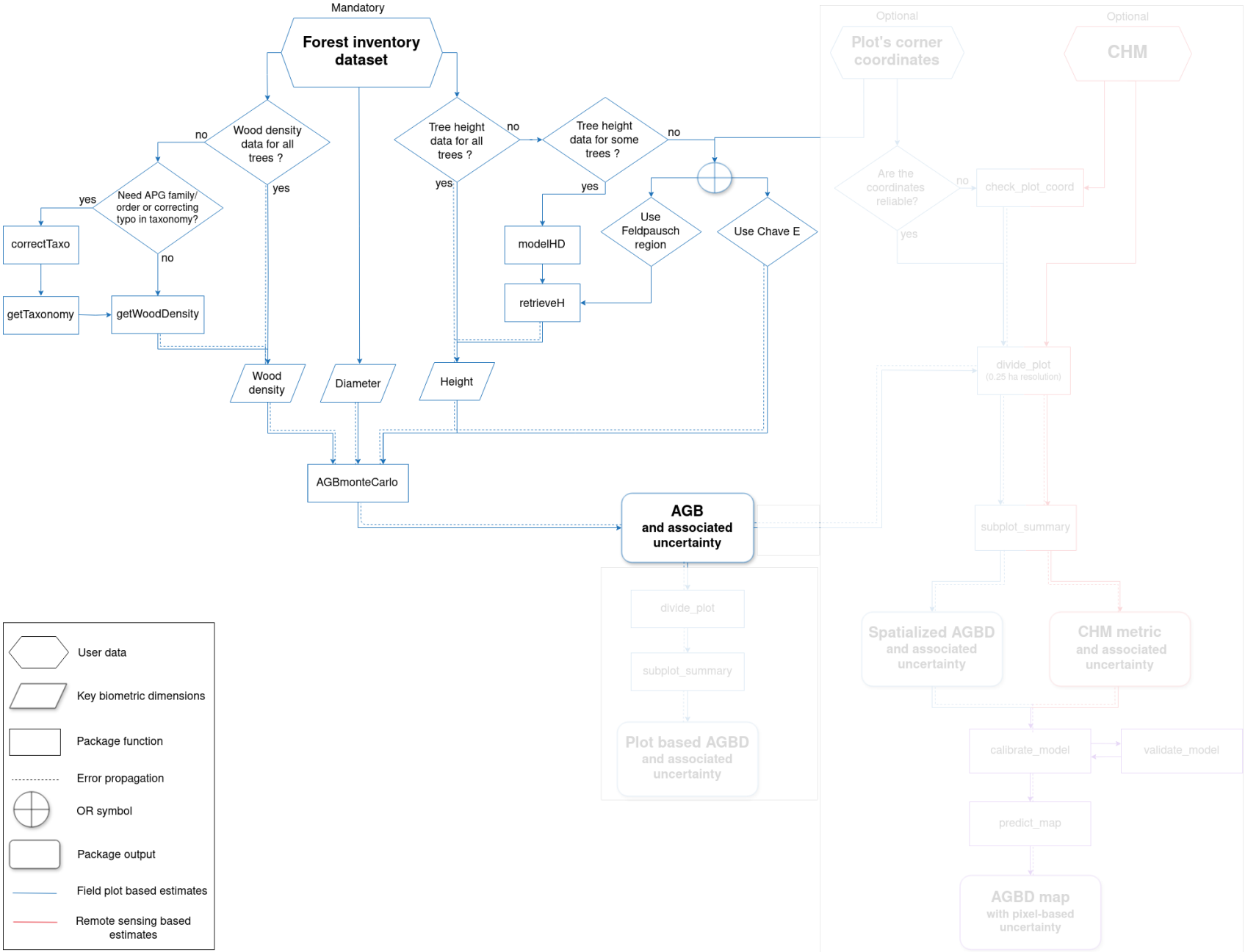
2025-06-23

Workflow

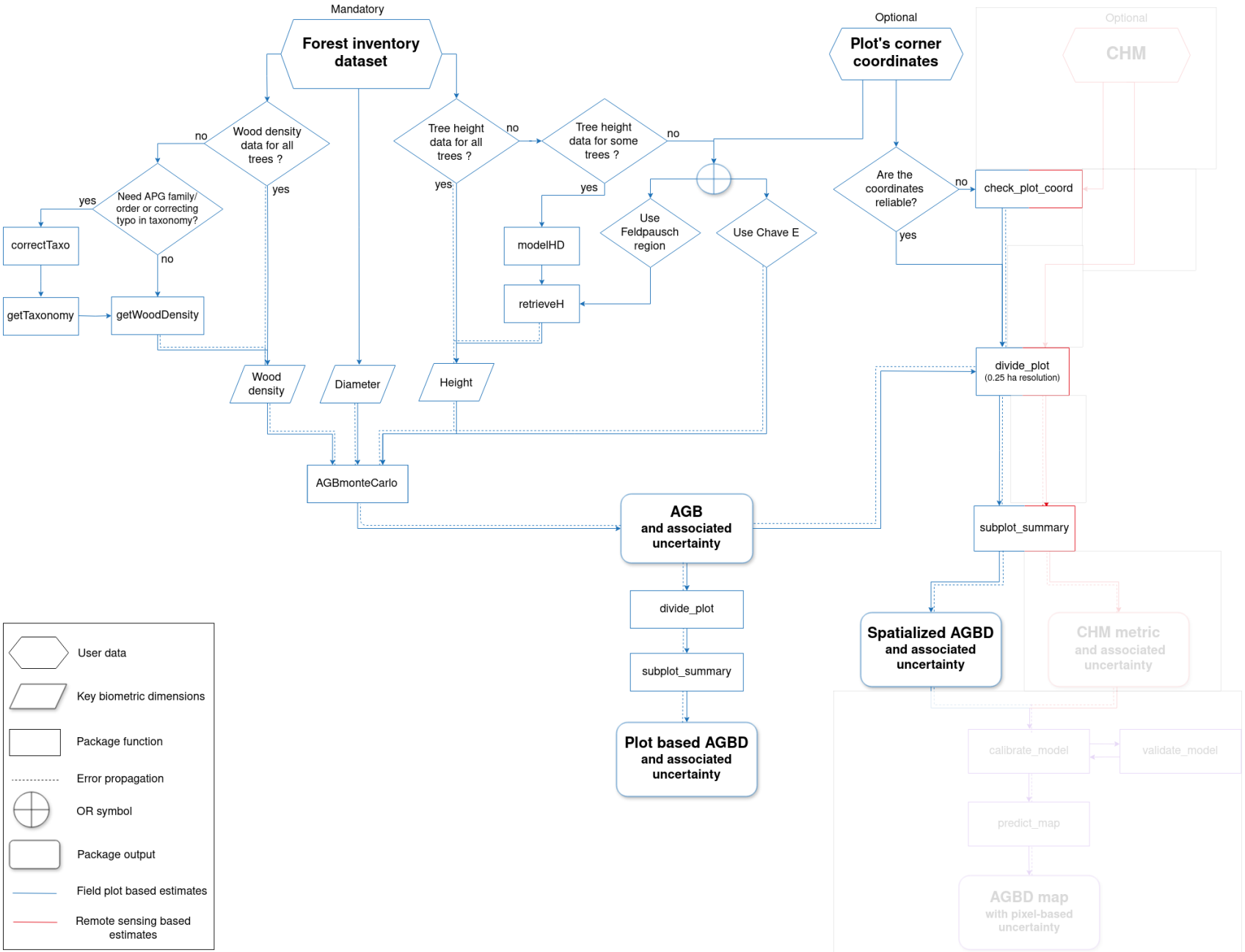

Mandatory
Forest inventory dataset
Optional
Plot's corner coordinates
Optional
CHM
Wood density data for all trees ?
no
yes
Need APG family/ order or correcting typo in taxonomy?
yes
no
correctTaxo
getTaxonomy
getWoodDensity
Tree height data for all trees ?
no
yes
Tree height data for some trees ?
no
yes
modelHD
retrieveH
Use Feldpausch region
Use Chave E
Are the coordinates reliable?
no
yes
check_plot_coord
Wood density
Diameter
Height
AGBmonteCarlo
AGB and associated uncertainty
divide_plot
subplot_summary
Plot based AGBD and associated uncertainty
divide_plot (0.25 ha resolution)
subplot_summary
Spatialized AGBD and associated uncertainty
CHM metric and associated uncertainty
calibrate_model
validate_model
predict_map
AGBD map with pixel-based uncertainty
User data
Key biometric dimensions
Package function
Error propagation
OR symbol
Package output
Field plot based estimates
Remote sensing based estimates

FRM4BIOMASS: what has been done & ongoing work

Shiny app for BIOMASS



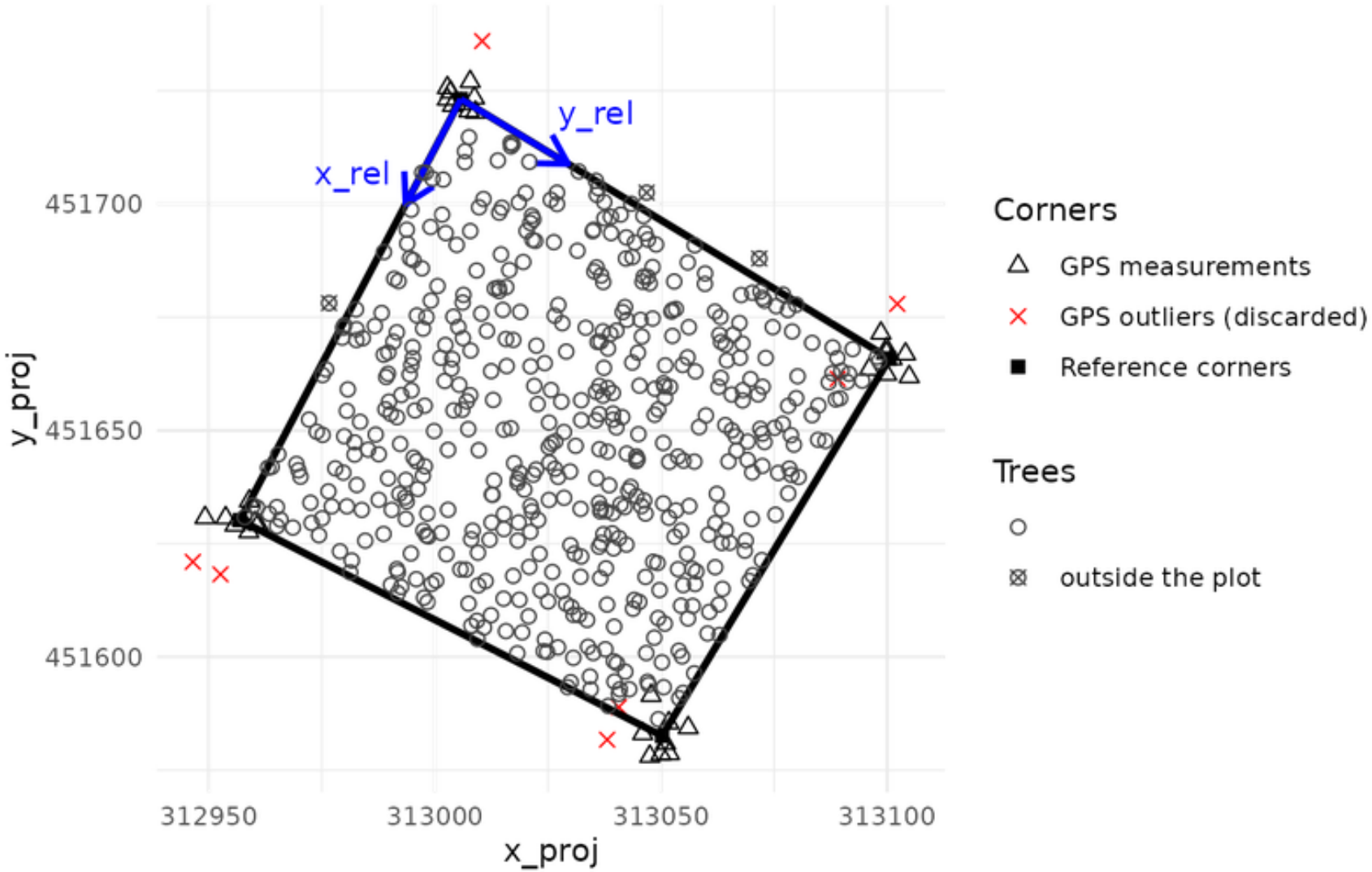
Spatialization (V2.2)



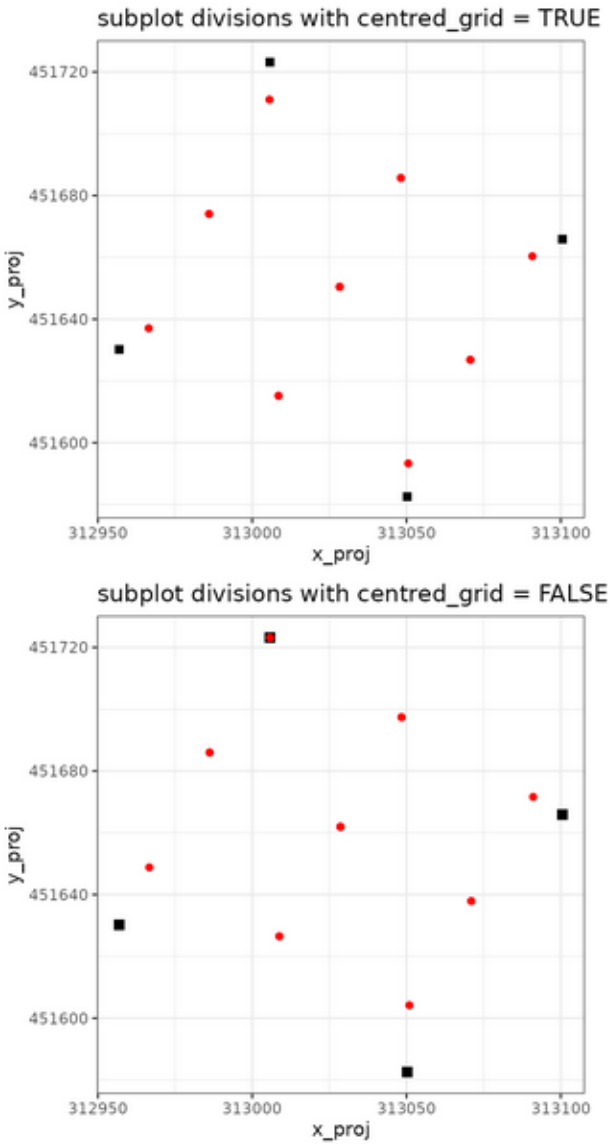
Spatialization (V2.2.4, CRAN release March 2025)

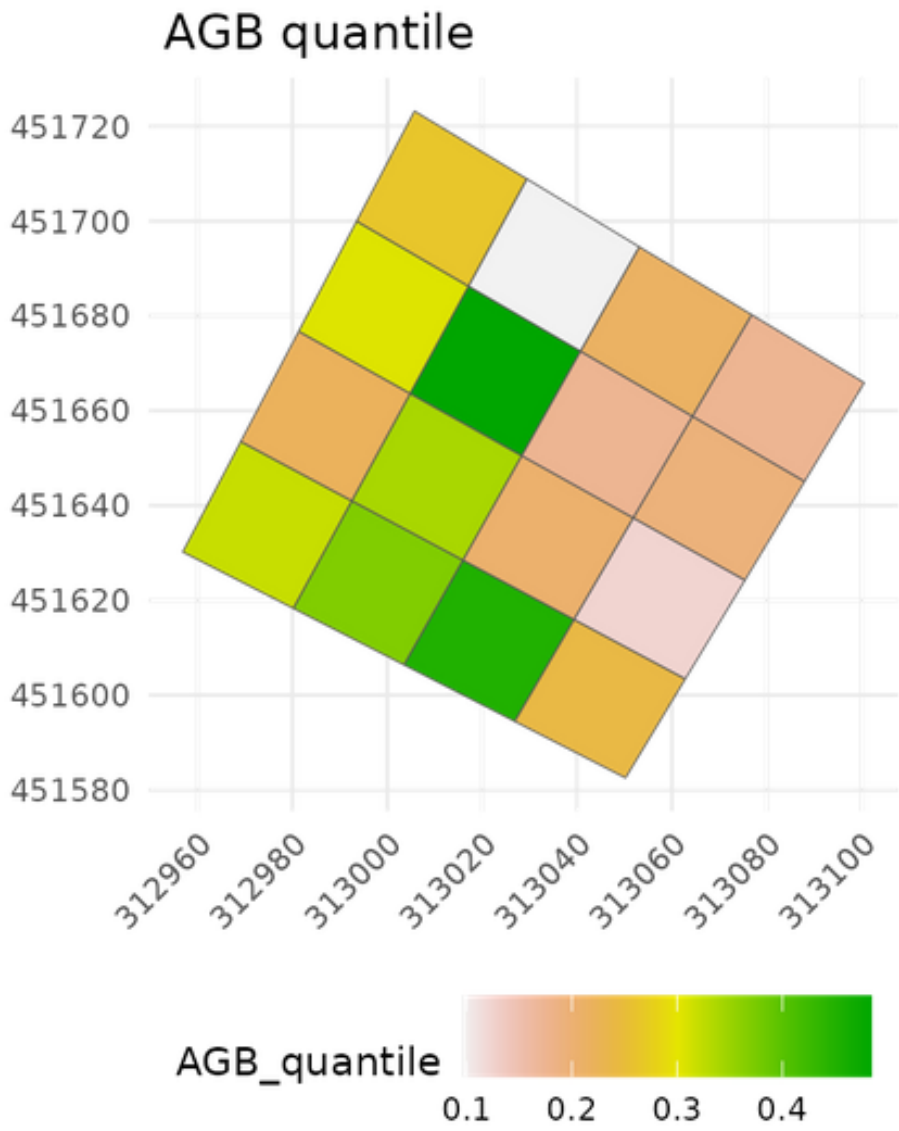
- check plot coordinates
- spatialized AGB (*ie* AGBD) products

Spatialization (V2.2.4, CRAN release March 2025)

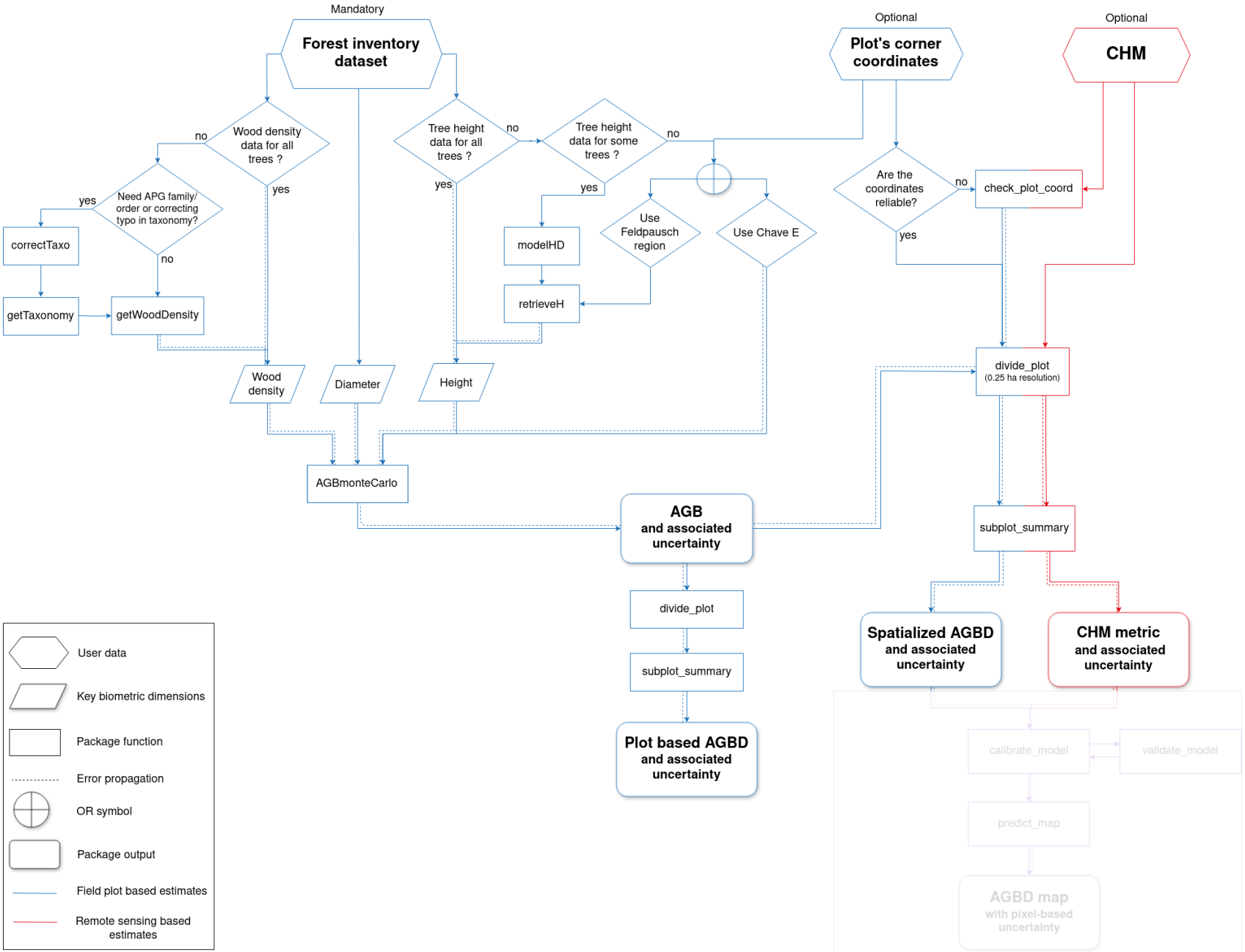


Spatialization (V2.2.4, CRAN release March 2025)

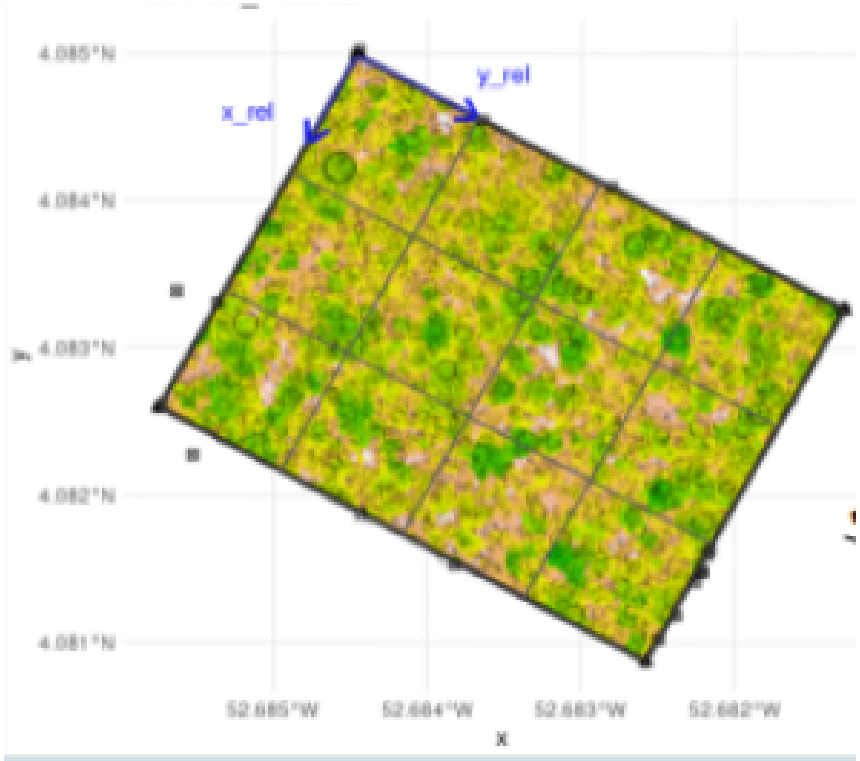


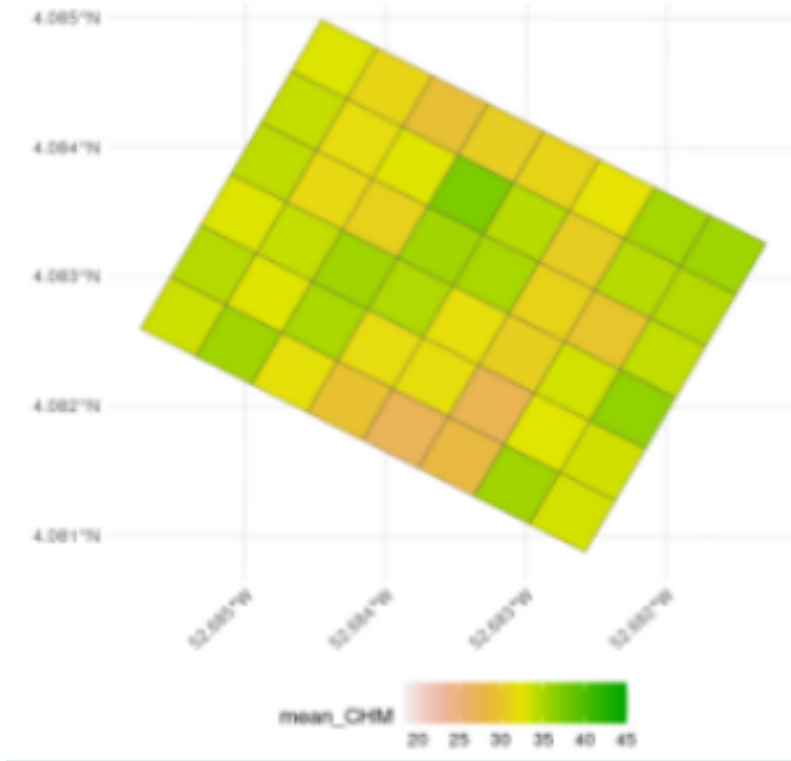


CHM management (V3)

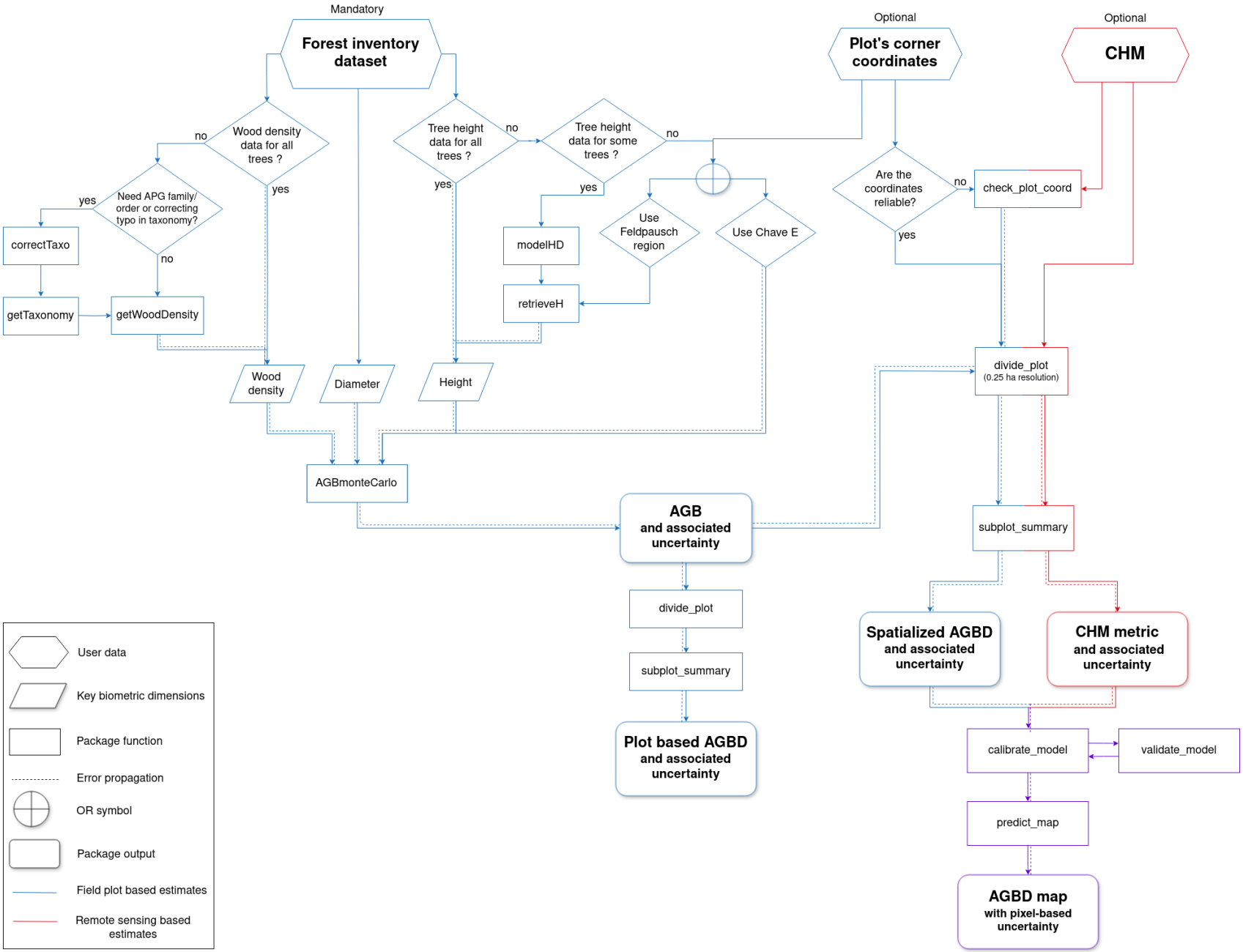


CHM management (V3, implemented but not released yet)



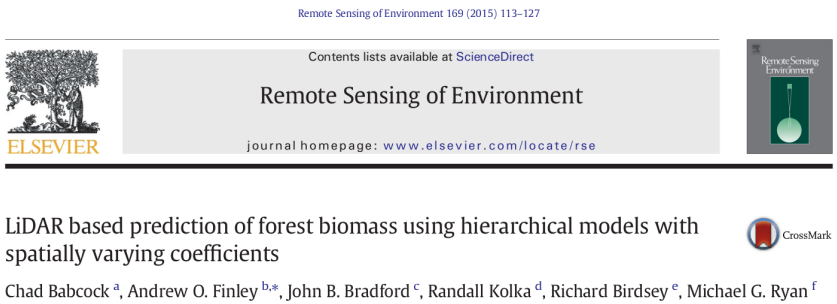


CHM-AGBD model calibration (V3)



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 $\tilde{\alpha}(s_1), ..., \tilde{\alpha}(s_n) \sim MVN(0, C_\alpha(s_i, s_j))$
- references


Remote Sensing of Environment 169 (2015) 113–127

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

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]


Remote Sensing of Environment 318 (2025) 114557

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

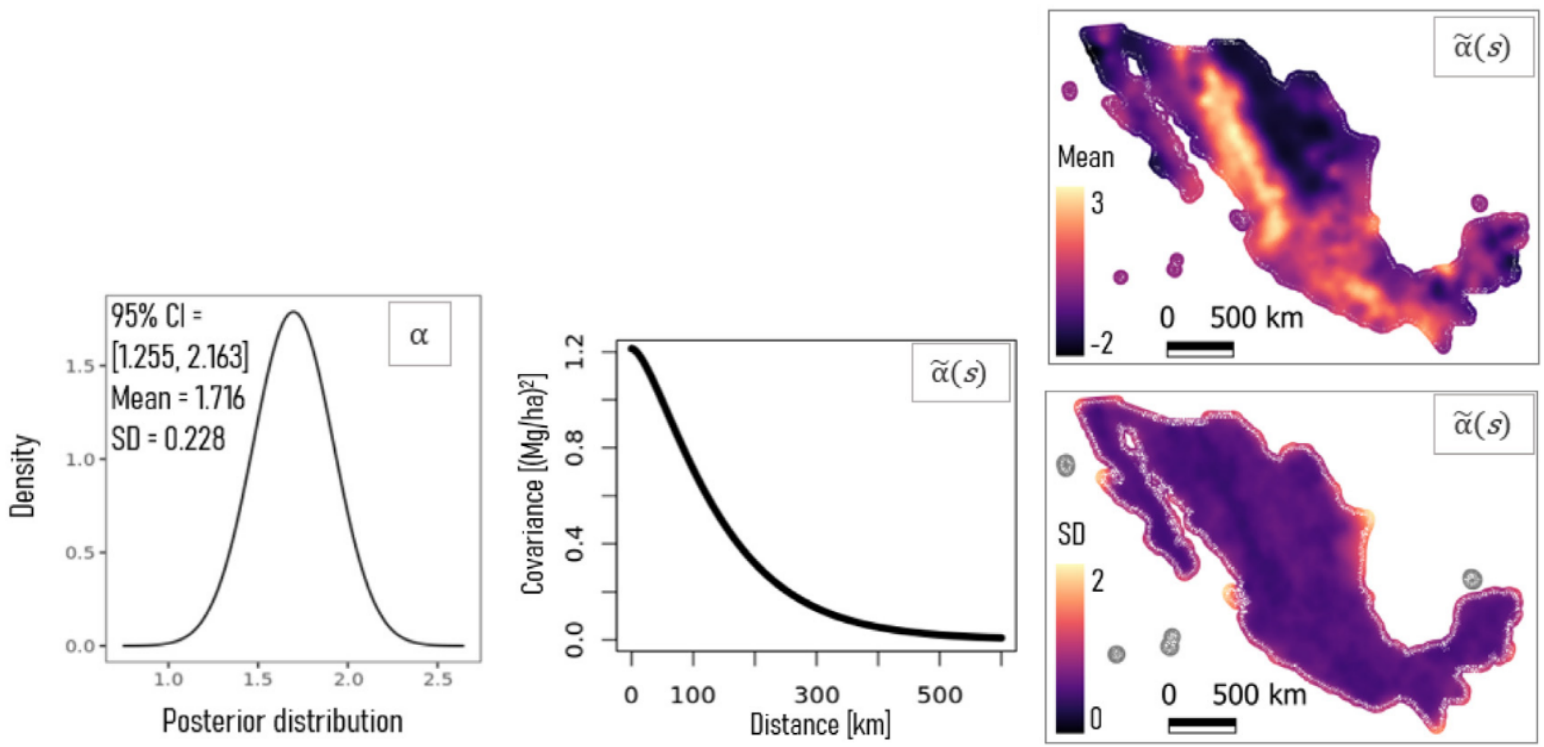
A geostatistical approach to enhancing national forest biomass assessments with Earth Observation to aid climate policy needs

Neha Hunka [a,*], Paul May [b], Chad Babcock [c], José Armando Alanís de la Rosa [d], Maria de los Ángeles 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]

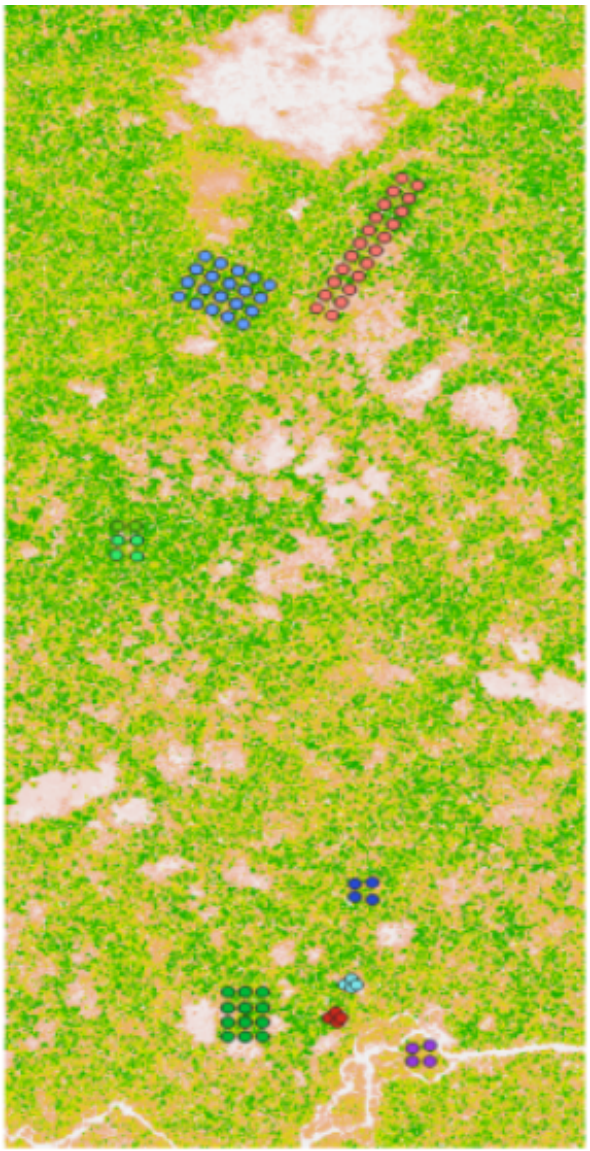
CHM-AGBD model calibration: proposed statistical framework

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

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



CHM-AGBD model calibration: example with Nouragues data



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)

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

- Initiation d'un companion paper sur la V3
- à l'heure actuelle on sous estime l'incertitude associée au modèle hauteur diamètre car on ne propage pas l'incertitude sur les paramètres d'allométrie -> propagation de toute l'incertitude associée à la hauteur via brms
- Update de la wood density database -> en attente de Fabian, ce qui nous permettrait d'adopter une approche de propagation d'incertitude plus intégrée
- Update de la correction taxo -> en attente de Renato : on ne gère pas les synonymes, ce qui est fait par Renato. Par contre tant que le pkg n'est pas sur le CRAN on ne l'intégrera pas
- Détection d'erreurs dans BIOMASS: outliers du diamètre, hauteur et WD (plus court terme single date)

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