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Estimating biomass compartments and surface fuel loads by integrating various satellite products with a data-model fusion approach

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What we need…

What we have …

Dynamic:

- Leaf area index

Static:

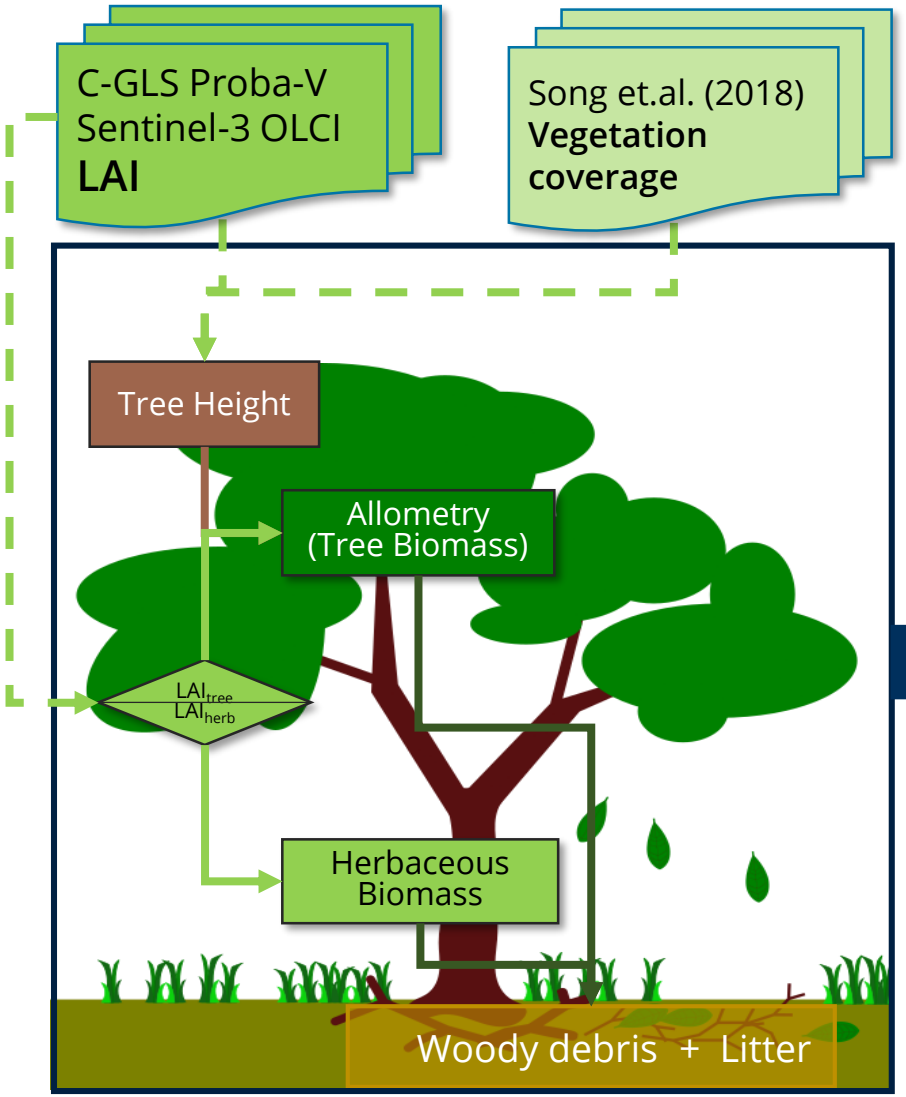
- Above ground biomass
- Forest canopy height

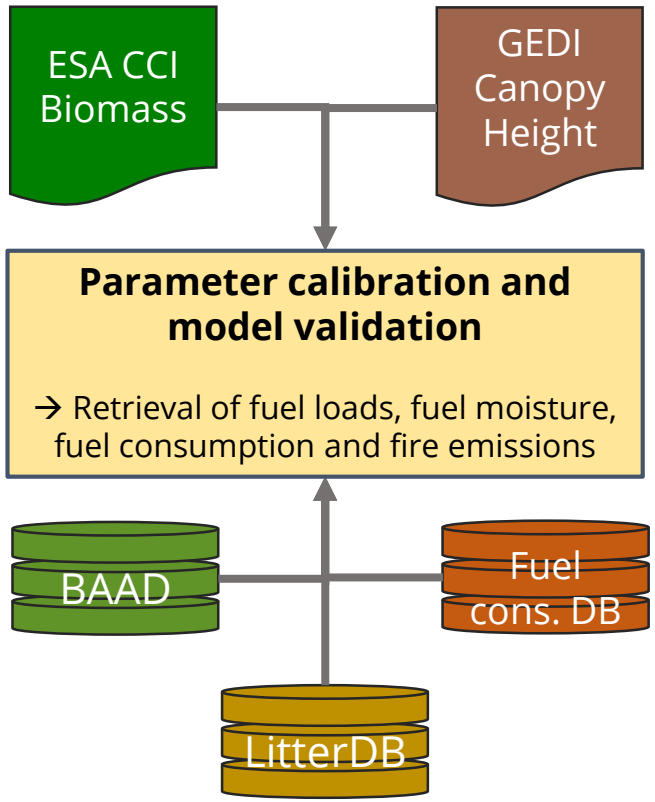
Annual:

- Land cover

- Global fuelbed database (static, no spatial variability)

S4F Fuel Data-Model Fusion Approach





Tree Biomass

$$BM_{stem} = a1 \times H^{\frac{1}{a2}}$$

$$BM_{branches} = a3 \times BM_{stem}^{\frac{1}{a4}}$$

$$BM_{leaf} = a5 \times BM_{stem}^{\frac{1}{a6}} \times fcover$$

Dynamic Loads

$$L_t = L_{t-1} + T_{\boldsymbol{leaf},t} + T_{herb,t} - D_{litter,t}$$

$$FWD_t = FWD_{t-1} + T_{br,t} \times f_{sb} - D_{fwd,t}$$

$$CWD_t = CWD_{t-1} + T_{\boldsymbol{br},t} \times (1 - f_{sb}) + T_{stem,t} - D_{cwd,t}$$

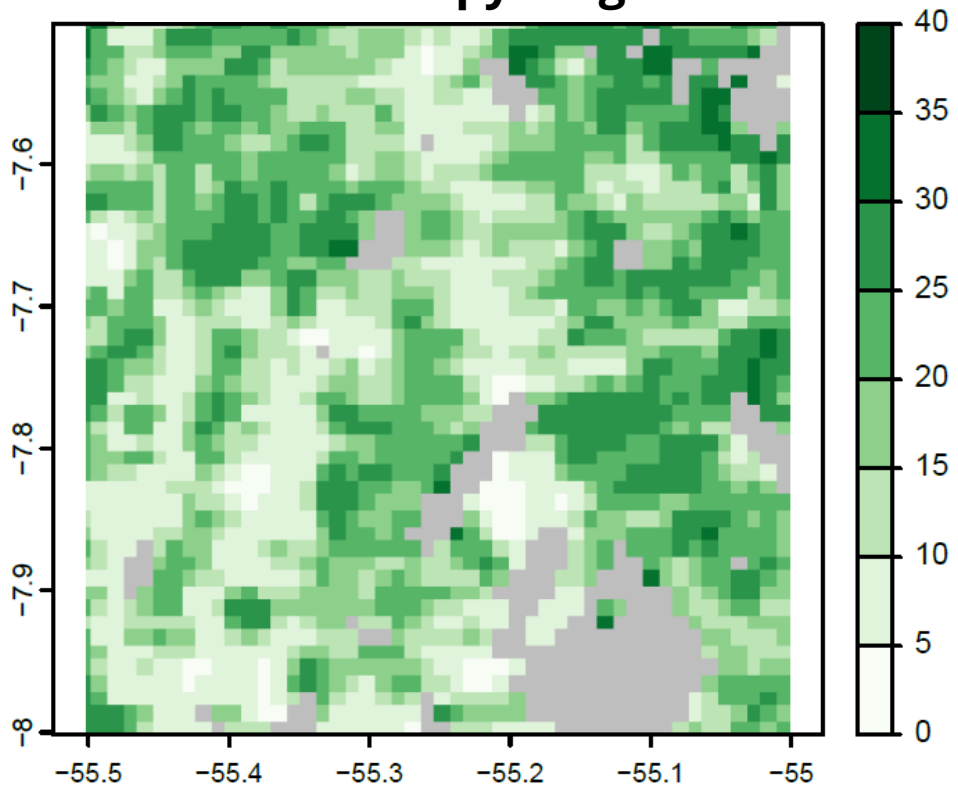
Decomposition*

$$D_{i,t} = S_{i,t} \times \left(1 - e^{-\frac{k_i}{tsy}}\right), with\ S_i \in \{L, FWD, CWD\}$$

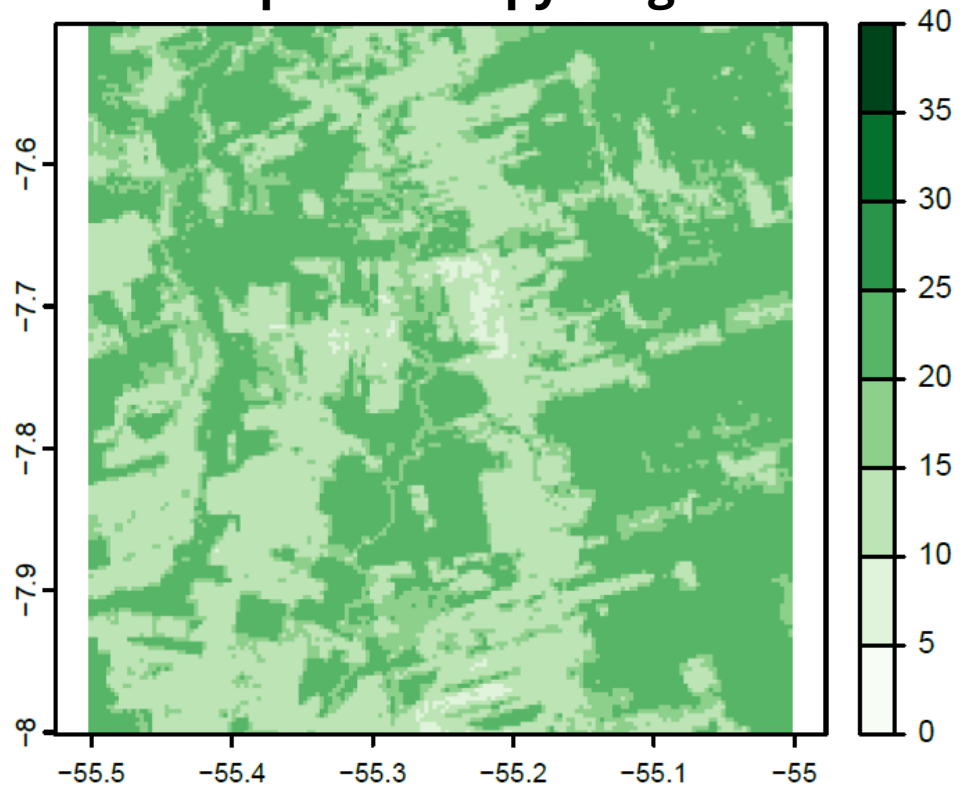
*decomposition rates based on (Harmon et al., 2020)

Pre-calibration of tree height

GEDI canopy height

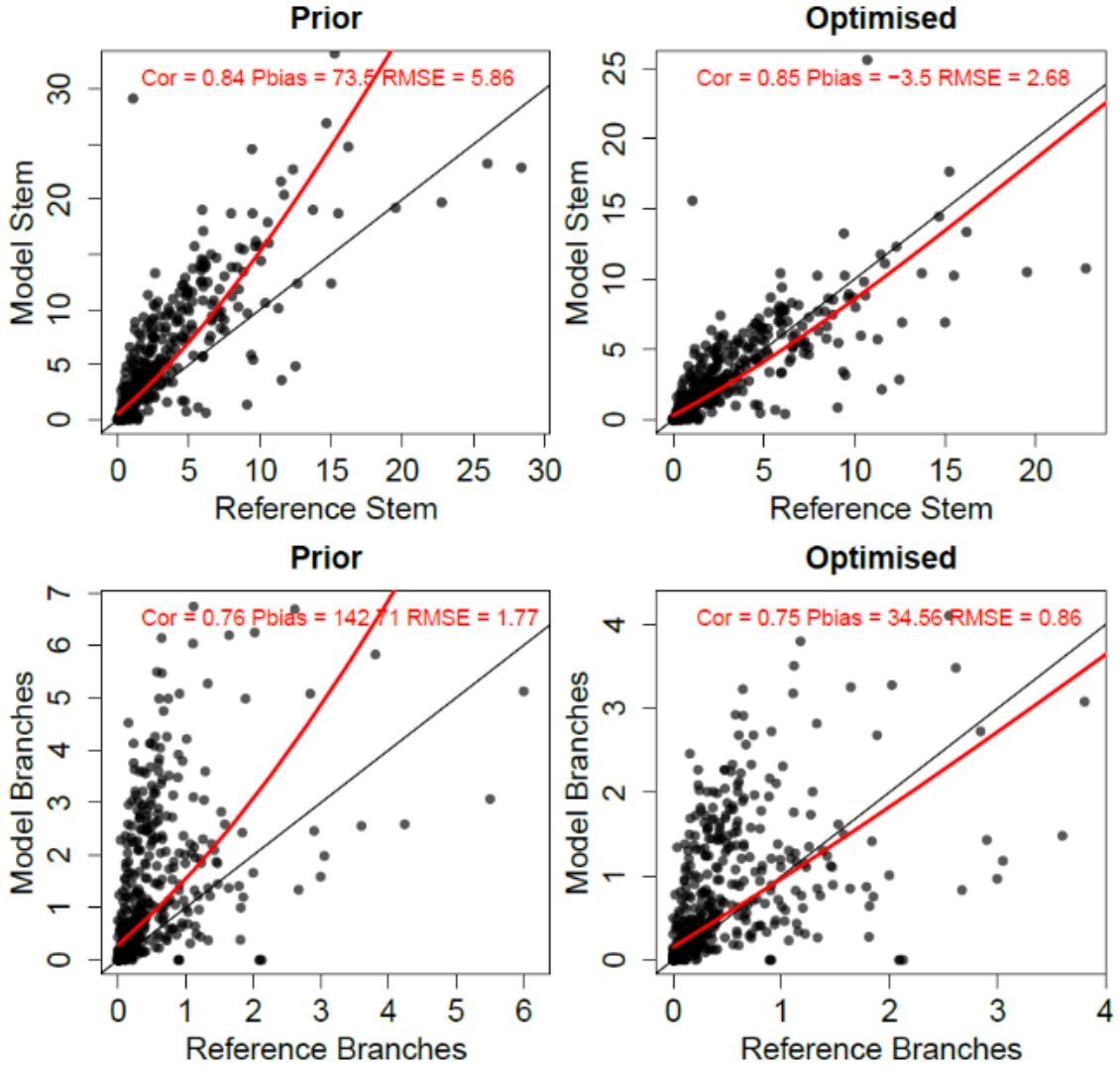


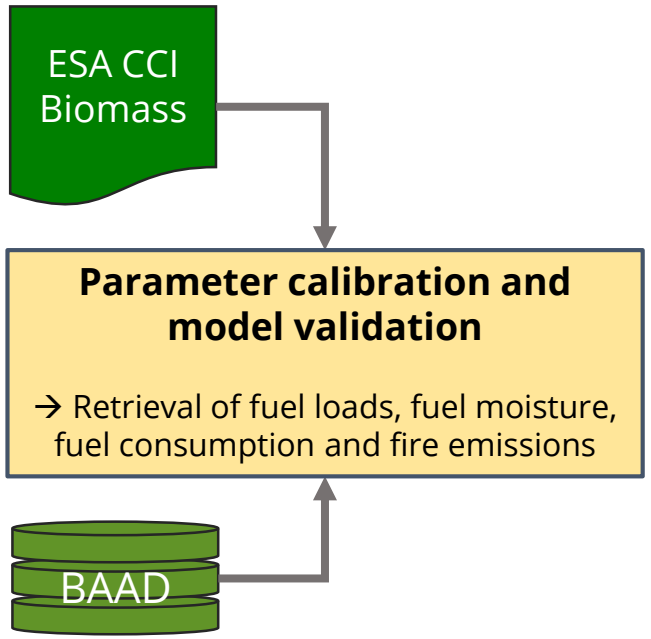
S4F prior canopy height



$$H = h1 \times LAI^{2}_{long-term} + h2 \times Treecover + h3$$

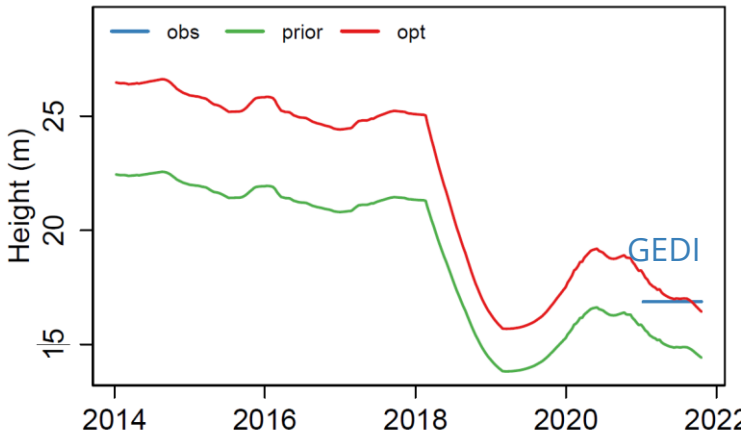
Pre-calibration of allometry module

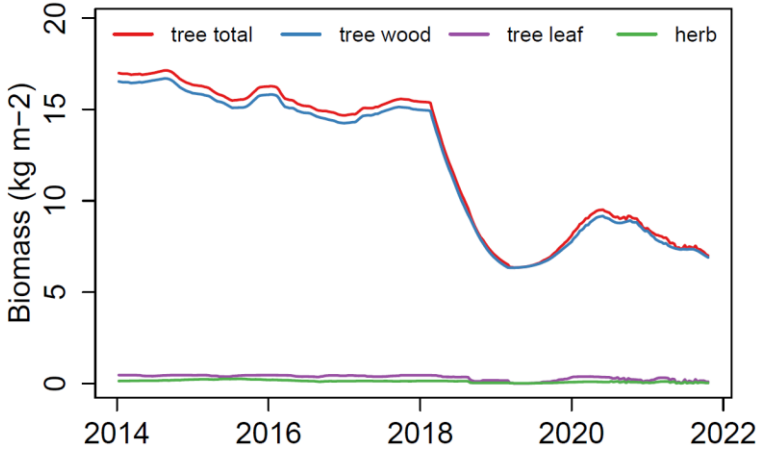


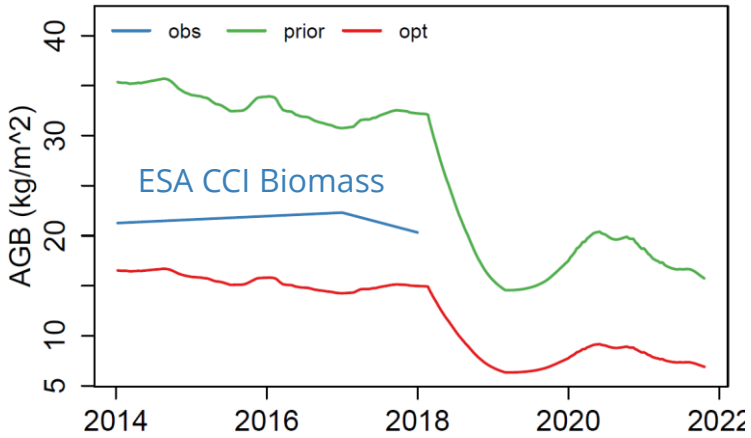


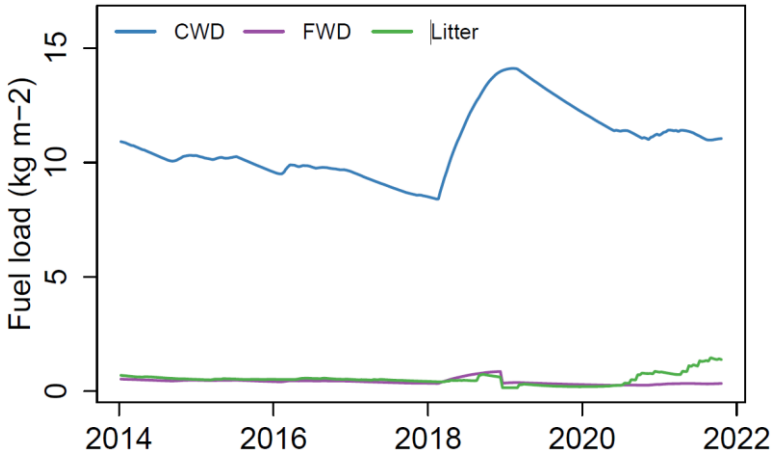
Joint calibration for single grid cells

Calibration with genetic optimization using Kling-Gupta efficiency as cost function



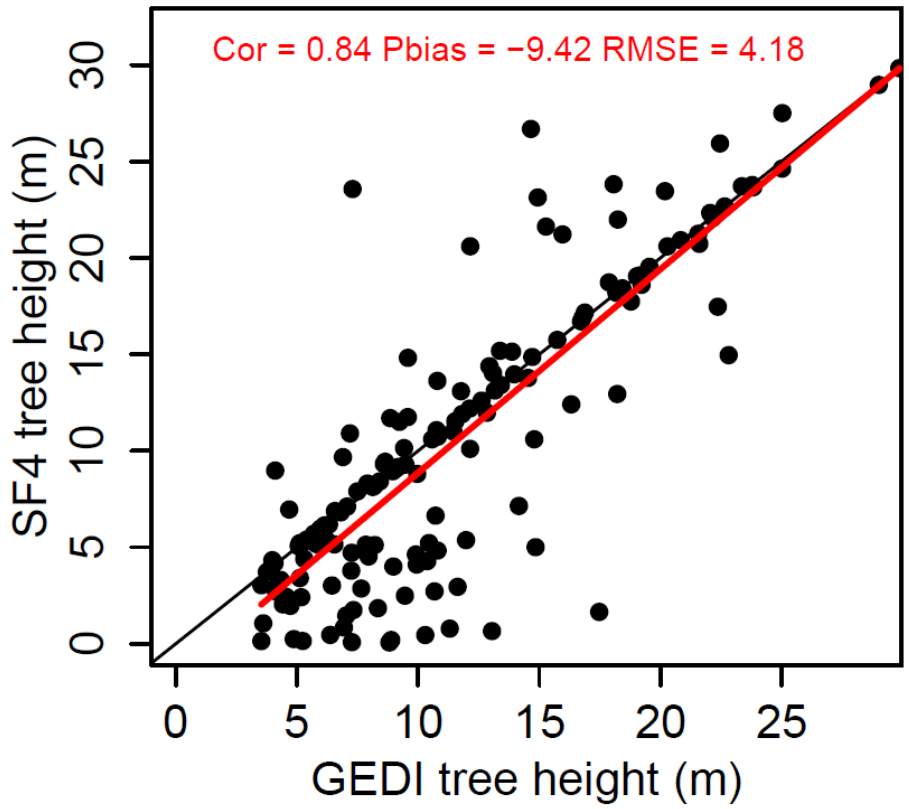


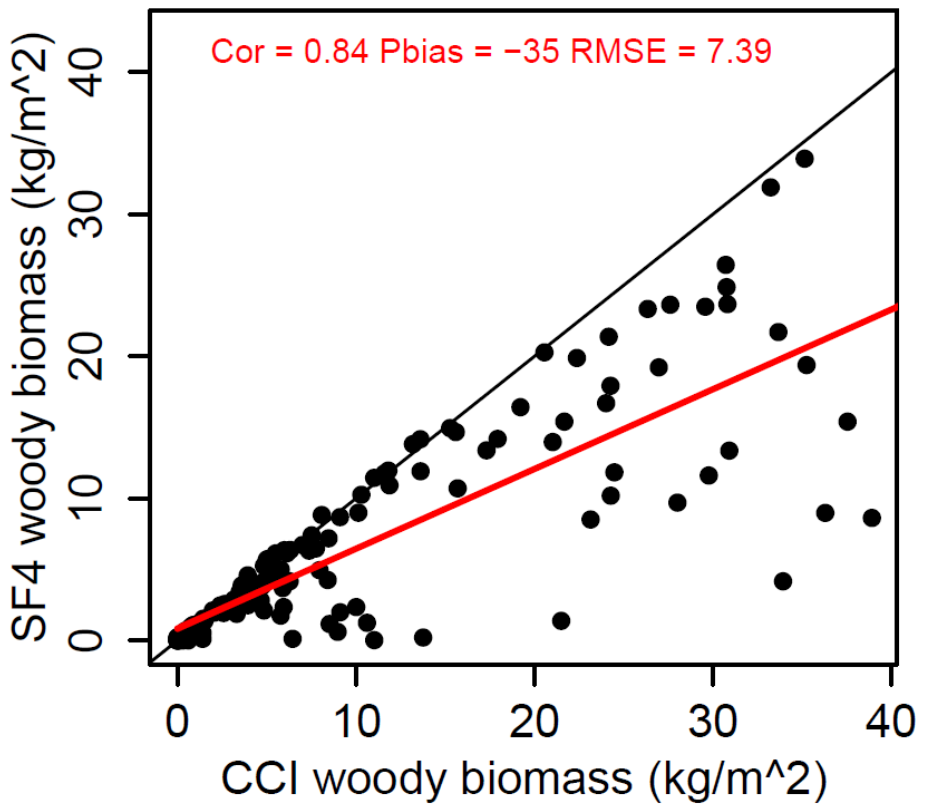




Results for one example grid cell in the Amazon

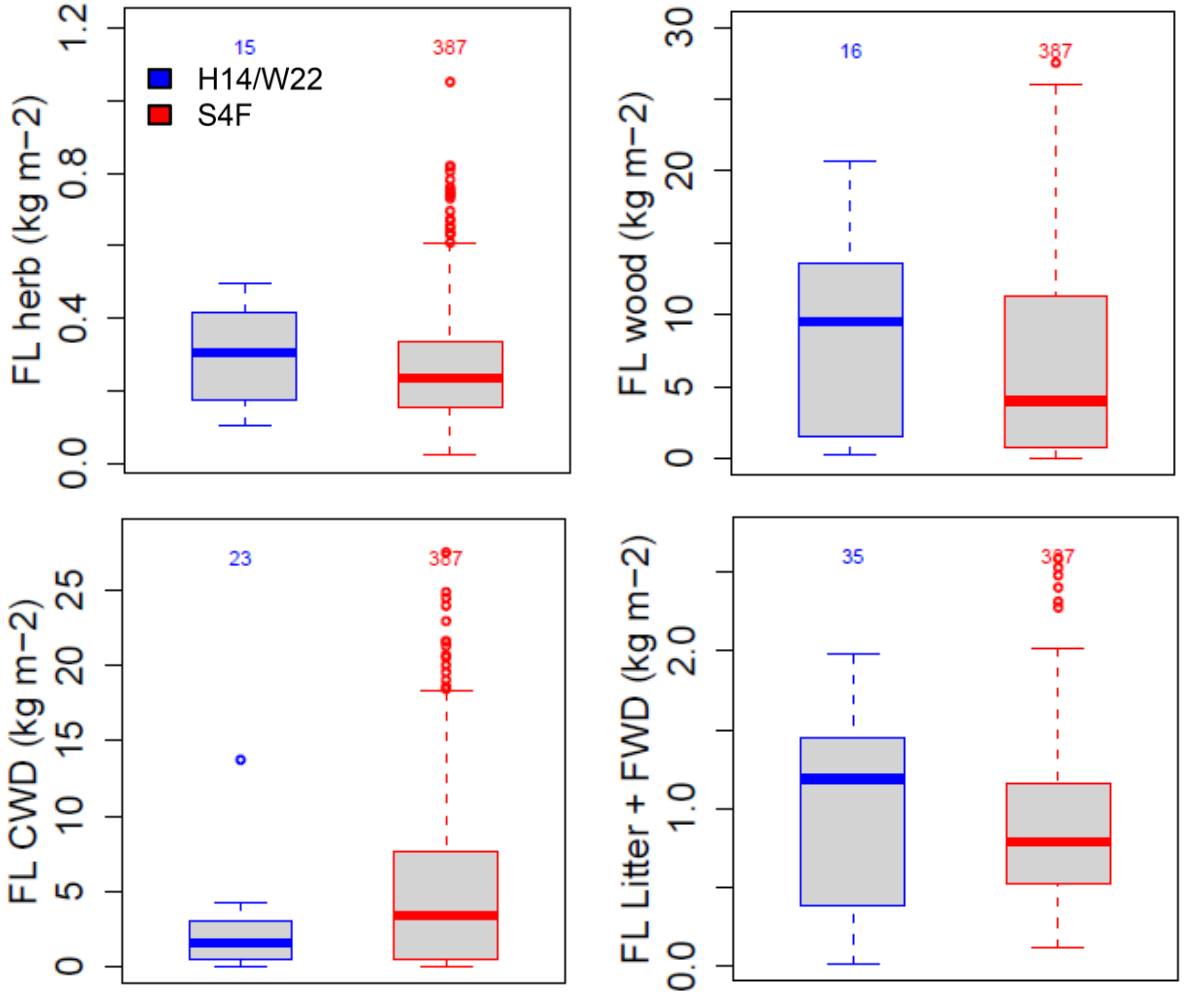
Joint calibration for single grid cells





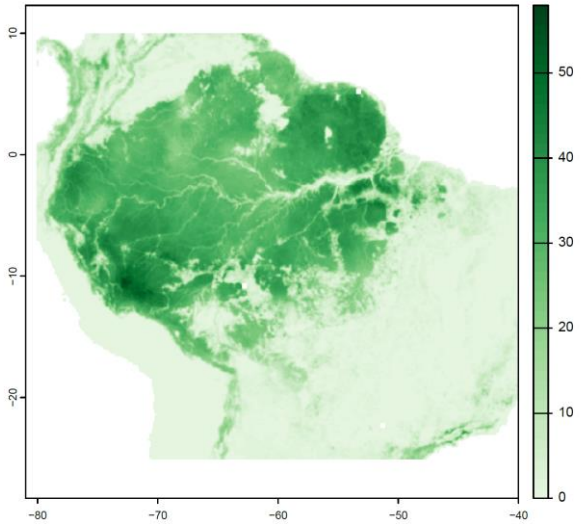
Validation of fuel loads

Validation against measurements from the global database of litter fall mass and litter pool sizes (Holland et al. 2014) and fuel consumption database (van Wees et al. 2022)

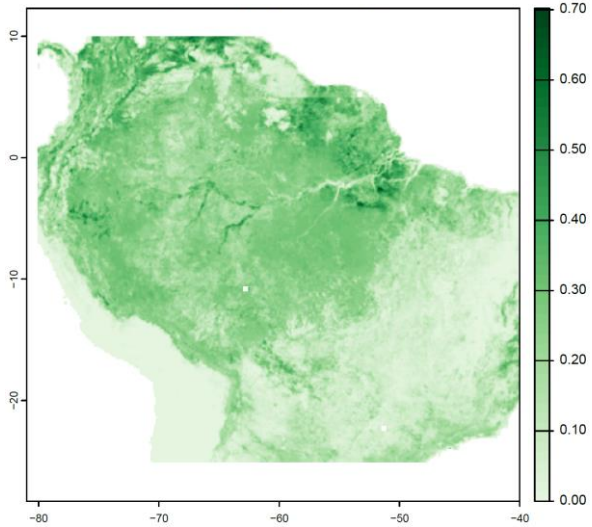


Results

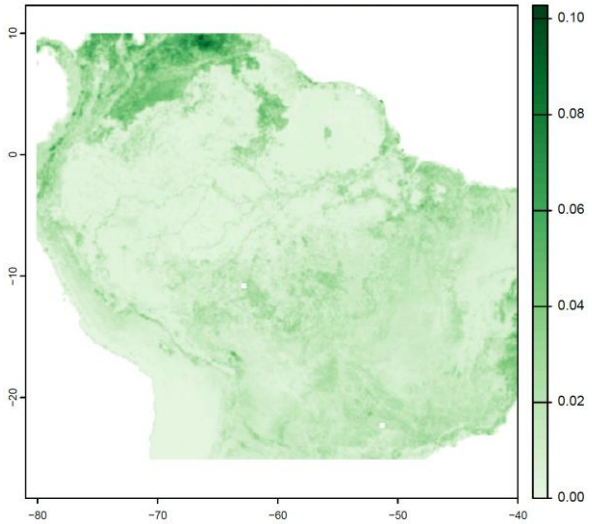
Woody biomass



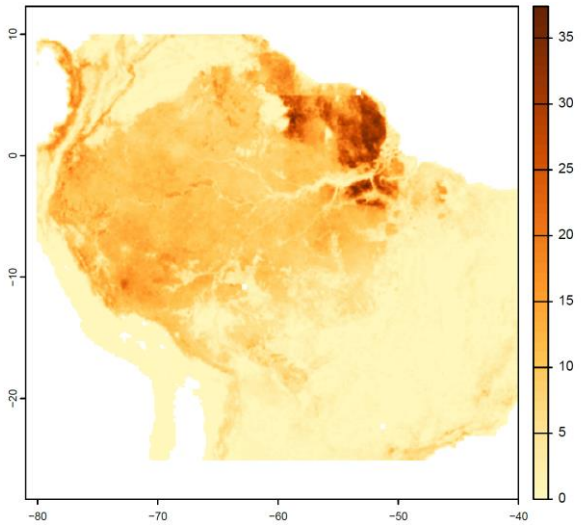
Leaf biomass



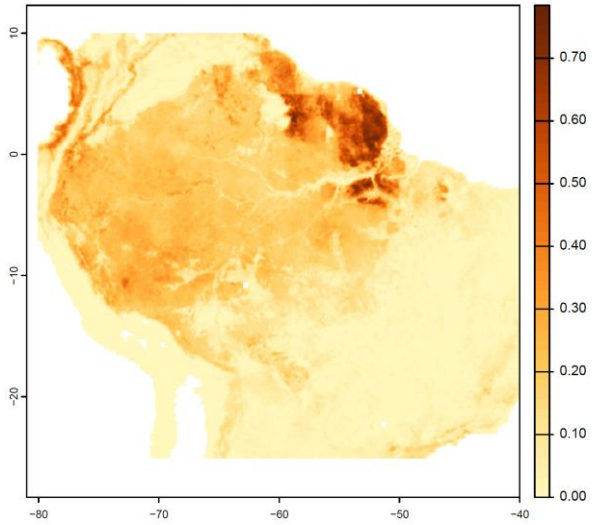
Herbaceous biomass



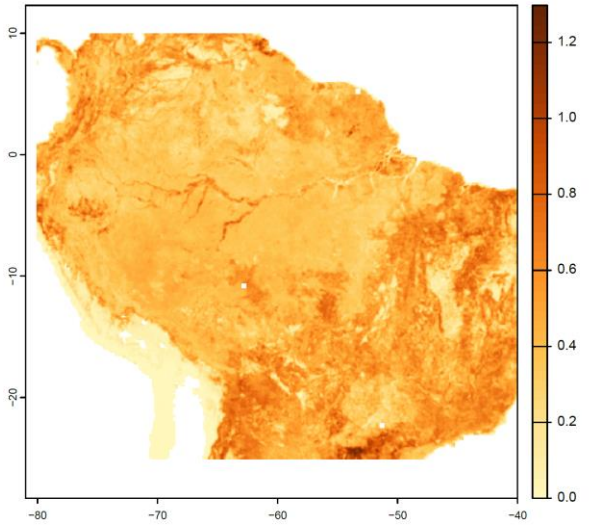
Coarse woody debris



Fine woody debris



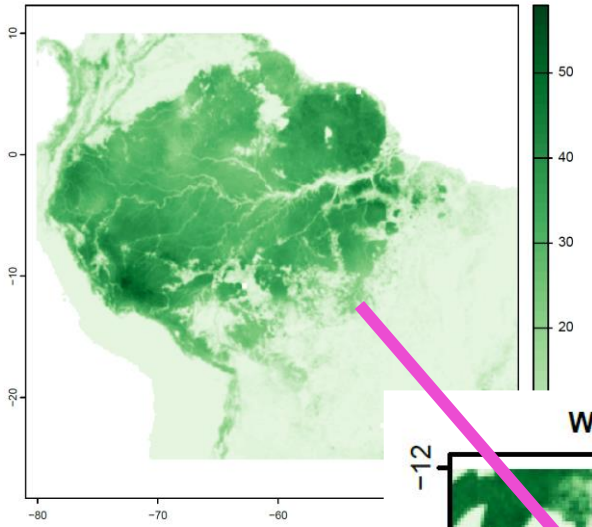
Litter



(kg/m²)

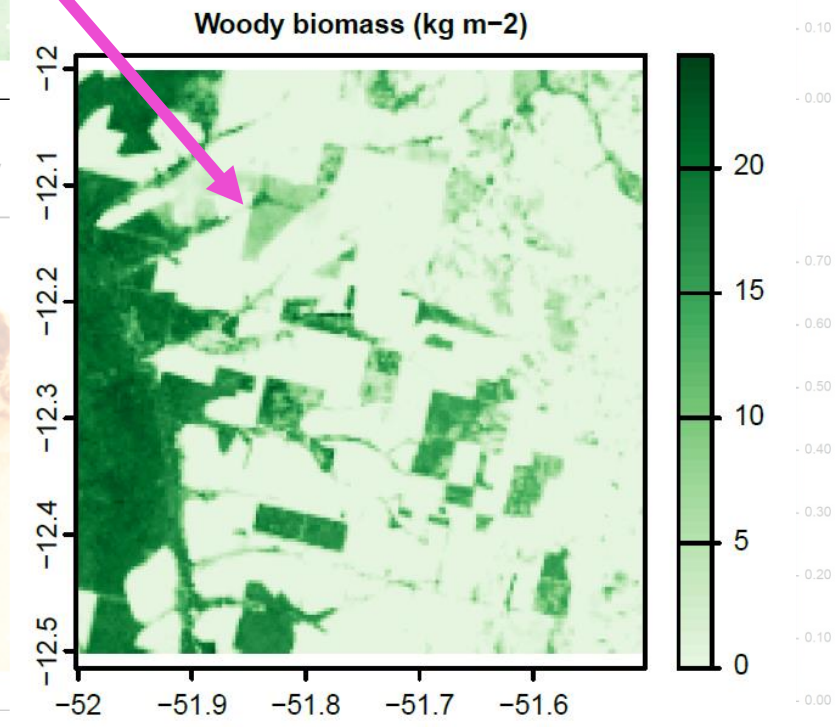
Results

Woody biomass

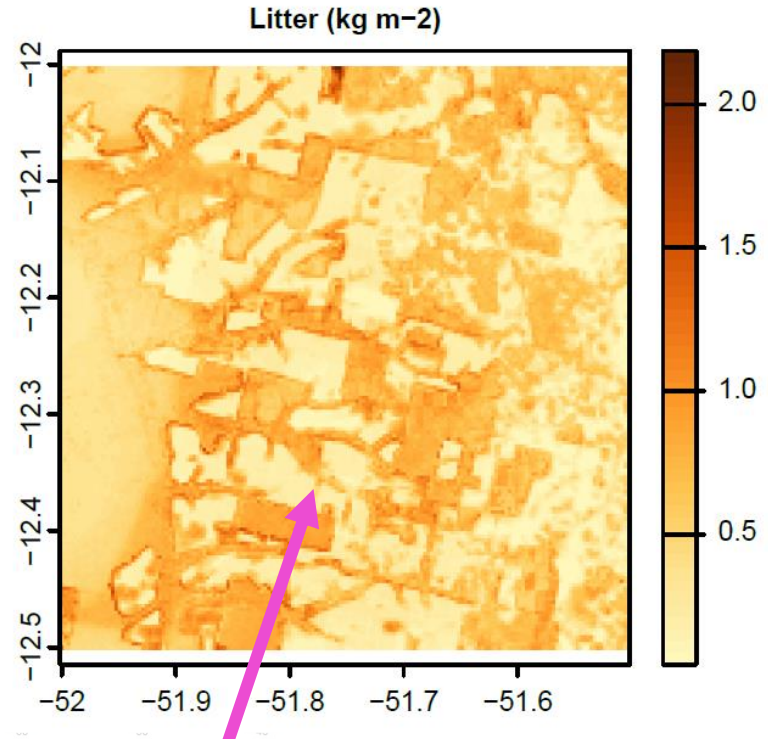


Leaf biomass

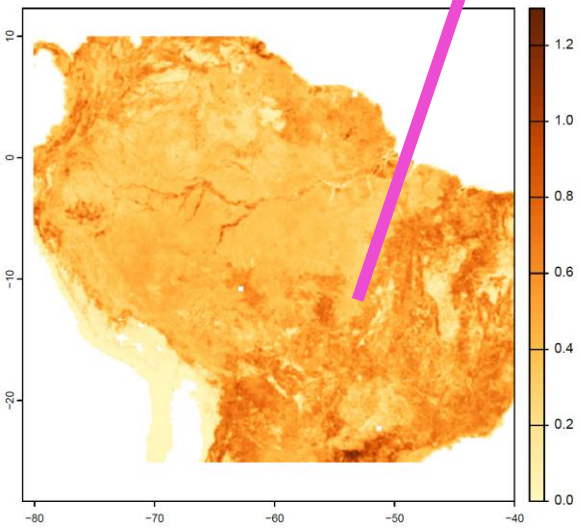
Herbaceo



Coarse woody



Litter



(kg/m²)

Conclusions

- Combining several satellite datasets in a data-fusion approach to estimate fuel loads at 300 m spatial resolution and 10-daily time steps
- Finding an optimum between four inconsistent datasets is challenging …
- Nevertheless, we obtain plausible distributions and temporal dynamics of fuel loads
- We „burn“ the fuels in Sense4Fire to obtain fire emission estimates

- Database of surface fuel loads will be available in May at: **sense4fire.eu**

  → Feedback and test users welcome