Master Thesis Project: Application of tree species distribution for forest carbon stock mapping in Europe

Supervisors

Martin Thurner, Christian Beer (ACES Biogeochemistry Unit)

Background

Forests take up CO_2 from the atmosphere through photosynthesis and release it again through respiration, litterfall, or mortality. By a net uptake of atmospheric CO_2, forests can mitigate global warming (Bonan, 2008). It is thus important to monitor the forest carbon stock, i.e. the amount of carbon stored in forests.

Satellite data have recently enabled spatially extensive mapping (resolution 0.01°) of forest carbon stock in northern hemisphere boreal and temperate forests (Thurner et al., 2014). The signal (microwave radar), which is actively sent from the satellite and backscattered from the earth surface, is related to the volume of tree stems (Santoro et al., 2015). In a subsequent step, information on wood density, proportions of stem biomass to other tree compartments (branch biomass, root biomass, foliage biomass), and the vegetation carbon content have been used to convert stem volume to total forest carbon stock (Thurner et al., 2014).

Since consistent information on tree species distribution is lacking at global scale, the conversion algorithm could only divide between different leaf types, i.e. broadleaf, needleleaf deciduous and needleleaf evergreen forest. Unfortunately, the variance in wood density and biomass proportions is relatively high within leaf types, leading to a relatively high uncertainty in the final carbon stock map. For instance, the wood density is usually much higher in oak (*Quercus*) than in birch (*Betula*) or other broadleaf trees, resulting in a very high variance when summarized to the wood density of broadleaf trees (Fig. 1).

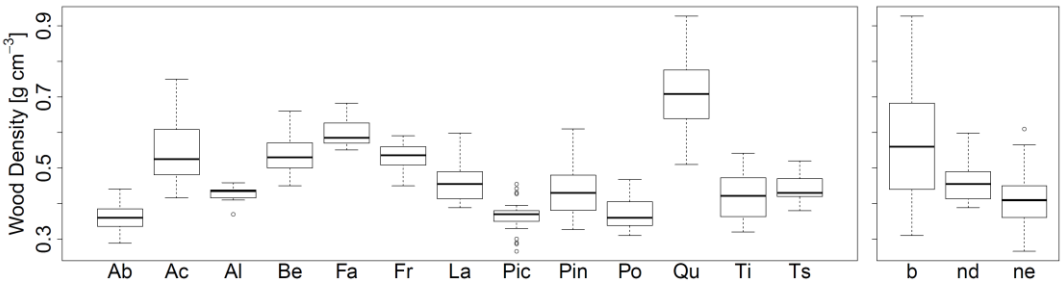

Fig. 1: Variance in wood density (g cm^{-3}) measurements across tree genera (left: Ab, Abies; Ac, Acer; Al, Alnus; Be, Betula; Fa, Fagus; Fr, Fraxinus; La, Larix; Pic, Picea; Pin, Pinus; Po, Populus; Qu, Quercus; Ti, Tilia; Ts, Tsuga) and leaf types (right: b, broadleaf; nd, needleleaf deciduous; ne, needleleaf evergreen) (Thurner et al., 2014)

Research idea

Although consistent global tree species maps are still lacking, such information is available for Europe (for instance Brus et al., 2012; http://www.efi.int/portal/virtual_library/information_services/mapping_services/tree_species_maps_for_european_forests/). Based on tree species distribution maps, wood density and biomass proportions can be applied for individual tree genera instead of leaf types only. This will lead to estimates of European forest carbon stock with higher accuracy and reduced uncertainty.

Requirements

- Basic programming skills, ideally basic experience in statistical computing and visualization with R, MATLAB or similar
- Interest to work with large spatial datasets, applied statistics and regression models
- Interest to write a thesis in English

Literature

Bonan, 2008: http://science.sciencemag.org/content/320/5882/1444

Thurner et al., 2014: http://onlinelibrary.wiley.com/doi/10.1111/geb.12125/full

Santoro et al., 2015: http://www.sciencedirect.com/science/article/pii/S003442571530064X

Brus et al., 2012: https://link.springer.com/content/pdf/10.1007/s10342-011-0513-5.pdf

Contact

Martin Thurner: martin.thurner@aces.su.se

Christian Beer: christian.beer@aces.su.se