# Tropical vegetation in global vegetation models: plant functional types and other simplifications

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Tropical vegetation canopies host a bewildering array of plant existence strategies ranging from grassland and savanna vegetation to wetland low forest types, upper montane krummholz and the soaring stature of lowland tropical forests. The models used to represent these ecosystems on a global scale, however, almost universally make use of a very restricted set of Plant Functional Types (PFTs) such as 'broadleaf tree' and 'C4 grass' to represent vast swathes of structurally diverse tropical ecosystems. Additionally, canopy structure is generally represented in a very basic way, usually as a green sheet of zero thickness covering the land surface. Photosynthesis is usually represented, arguably, in too much detail, whereas spatial processes such as gap formation, seed dispersal and pollination are are usually not represented at all. Whether the reasons for these simplifications are practical (e.g. limited computational capacity), human (e.g. individual expertise on tropical diversity and software engineering seldom coinciding) or theoretical (e.g. legitimate interpretations of functional niche theory in the case of PFTs), their widespread use appears unlikely to change soon. Therefore, it makes sense to ask how far we can really go with current modelling structures. In 1987 Box said "all models are wrong; the practical question is how wrong do they have to be to not be useful". Borrowing from results of the Role of Biodiversity in Climate Change Mitigation project (ROBIN) and results from runs using the Joint UK land Environment Simulator (JULES), we explore whether vegetation models are still so wrong that they are not at all useful, or do we perhaps dismiss them out of hand because of their seemingly-flawed approaches?

**Keywords:** Tropical vegetation model simplification PFT

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# Remote sensing detection of the Amazon phenology

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**Background:** The Amazon, Earth's largest tropical rainforest, has a critical role on the seasonality of carbon and water cycles. However, swings of both cycles depend on the phenology of Amazonian canopies. Understanding biome scale phenological cycles is not trivial, but is critical for mechanistically quantify the effects of climate change on Amazon forest functioning and its feedbacks. Therefore, the aim of this study was to understand the links between phenological cycles and remote sensing data to evaluate the drivers of phenology and connect phenology with photosynthetic capacity of Amazon canopies. **Methods:** We used multi-level remote sensing data on vegetation indices, sun induced fluorescence and climate data to evaluate the functioning of Amazon canopies. Result - We found that Amazon trees have variable phenological cycles depending on their resistance to water limitation. The enhanced vegetation index is a coherent proxy of leaf flush in Amazonia. However, does not follow the patterns of photosynthesis. The best indicator of canopy photosynthesis is the information on sun induced chlorophyll fluorescence. Our analysis indicates that leaf flushing in most of the Amazon respond to light instead of water. Interestingly, despite leaf flush occurring in the end of dry season, the maximum values of sun induced chlorophyll fluorescence are observed during the wet season. Therefore, the peak of leaf flushing and the maximum photosynthetic capacity of Amazon forest canopies occur with a lag that is related to the maturation of new leaves. **Conclusion:** We conclude that we now have a much better understanding about the representation of phenological cycles by remote sensing data. With this knowledge, the main processes driving large scale canopy phenology can be studied and process based models can be improved. Our data not only showed the main variables limiting the phenological cycles, but also the locations where light overcomes the influence of water in determining the seasonal cycles and vice-versa. The lag between leaf flush and maximum photosynthetic capacity is also a key finding for accurately model the seasonality of carbon and water cycle in Amazonia.

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