Characterizing Tropical Forest Representativeness for Optimizing Sampling Network Coverage

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Tropical forests exchange more carbon and water with the atmosphere than any other biome on Earth, and they play important roles in the planetary energy balance. Intact tropical forests are believed to be a major sink for atmospheric CO_2, accounting for up to 50% of terrestrial carbon uptake. Yet, in the coming decades the tropics are predicted to experience exceptional changes in temperature, atmospheric CO_2 levels, and in the timing and amount of precipitation. New research efforts focused on quantifying ecosystem responses to such changes require a systematic approach for maximizing sampling coverage while objectively representing environmental variability at appropriate spatial and temporal scales. We have developed a quantitative methodology for stratifying sampling domains, informing site selection, and determining the representativeness of measurements and sampling sites and networks. This analytical approach employs multivariate spatiotemporal clustering (MSTC) and representativeness analysis with 4 km2 global bioclimate data to produce global maps of ecoregions at various levels of division and to identify representative locations for sampling the environmental conditions contained within them. We developed a representativeness metric and used it to generate maps quantifying the global and tropical representativeness of the Fluxnet, RAINFOR, and CTFS-ForestGEO sampling networks. These maps indicate how well each network represents tropical and global forests, and identify optimal locations for constructing additional sampling sites. By combining representativeness maps from multiple networks, we have produced a map that can be used to understand which combination of sites and networks best represent any given map location. This analysis provides useful insights into optimal sampling strategies, offers a framework for up-scaling measurements using remote sensing and other gridded data, and provides an approach for integration of models and measurements. These techniques can be applied at different spatial and temporal scales to meet the needs of individual measurement campaigns.

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