Combining remote sensing earth observations and in situ networks: detection of extreme events and optimal network size and design

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Remote sensing observations provide important information about vegetation and carbon dynamics on large scales, flux towers in situ measurements at the plot scale. Events important for ecological processes, such as hydrometeorological extremes, often happen at spatiotemporal scales between those covered by these two data sources. We discuss the event detection rates of ecological in situ networks as a function of their size and design. Using extreme reductions of the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR), available from satellite missions, as a proxy for substantial losses in Gross Primary Productivity (GPP), we rank historical events according to their severity, and show how many would have been detected with a given number of randomly placed sites, discuss the problem of clustering of sites, and compare the theoretical results with the existing networks FLUXNET and NEON. The further spatio-temporal expansion of the ICOS network should carefully consider the size distribution of extreme events in order to be able to monitor their impacts on the terrestrial biosphere.