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Towards quantifying and understanding global spatio-temporal variability of ecosystem-atmosphere exchange with the world-wide FLUXNET network

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The eddy covariance technique has become the most prominent method to continuously estimate ecosystem-atmosphere carbon dioxide, water, and sensible energy exchange. Within the last two years a coherent data set from 246 sites including almost one thousand years of data and various forest, grassland and cropland types from boreal to tropical climates Here we give an overview over the characteristics of this new source for global observation-based analysis of the terrestrial Earth system and its interactions with the atmosphere. In particular, with such a large data set, we are able to separate spatial from diurnal to inter-annual variability of carbon, water and energy fluxes and their controlling climatic and biological factors. Key findings include: 1) Gross primary production (GPP) and ecosystem respiration (TER) are strongly related, both temporally and spatially, 2) in most cases variability in net carbon flux (NEE) is more strongly related to GPP than to TER, but with notable exceptions, such as highly disturbed and low productivity systems, 3) water-carbon interactions are of critical importance and act via biophysical and ecophysiological feedback, 4) climate factors that are important at a short time-scale (e.g. diurnal or synoptic) may become irrelevant at longer time scales (e.g. inter-annual). We conclude with a first up-scaling of those patterns with data-oriented methods, such as the Artificial Neural Network approach to generate FLUXNET derived global fields of carbon and water fluxes and their variability.