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Where and why do extreme carbon events occur; the importance of marginal lands

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Extreme carbon events account for a large portion of global variations and may provide information on future responses to climate change. Here we investigate when and why annual extreme gross primary production (GPP), net ecosystem exchange (NEE) and leaf area index (LAI) events occur in up-scaled flux tower measurements and satellite based remote sensing products, and compare spatial locations and drivers of the events with independent results from a dynamic global vegetation model.

We attribute climatic drivers by ranking ecosystem events and extract percentiles along with their climatological co-variates, and attribute each percentile to climatic anomalies in the 2-dimensional temperature and precipitation anomaly space, i.e. wet and cold, wet and warm, dry and cold and dry and warm. We construct new "annual" climatic drivers by accounting for time lags (previous 12 months) and influence of different seasons on inter-annual variations of GPP, LAI and NEE. Thereby, removing variations in drivers that do not influence variations in the ecosystem variables, and allowing for analysis on time-lags of drivers.

Overall we find robust patterns between the model and the independent datasets in terms of the drivers of positive and negative extremes. Comparing the ecosystem model and the observational based datasets in terms of which of the four main climatic conditions (warm and wet, warm and dry, etc) co-occur with the 5th and 95th percentiles reveals an agreement of more than 50% of gridcells for GPP, LAI and NEE.

The largest GPP and NEE extremes occur mainly in tropical and sub-tropical marginal lands; savanna and shrub lands mainly driven by precipitation. A feature common to the ecosystem model and the observational based data-products.