Multiple Controls on Soil Respiration along the Coastal Plains Forests of North Carolina

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Soil respiration ($R_s$) is the crystallization of multiple biogeochemical processes including decomposition of soil microbes, root and rhizosphere respiration and modulated by photosynthesis and meteorological forcing at different temporal resolution. Despite these complex interactions, exponential temperature response function has been traditionally used to quantify $R_s$. Against the backdrop of increased anthropogenic perturbations including climate and land use change, this can lead to uncertainty in the estimation of carbon budget of different ecosystems. This will be especially relevant for the coastal plain forests. Despite high organic content, carbon dynamics across this ecosystem remains relatively understudied compared to other ecosystems.

To address these issues, we have used time series modelling techniques to unravel the impact on $R_s$ variability by different biotic and abiotic factors at various temporal scales. The different land types incorporated in the study include intensively managed loblolly pine stands (Ameriflux site codes – US NC1 & US NC2). Error analysis of the residual of a $Q_{10}$ model fit to $R_s$ data using wavelet transformation reflected significant ($p < 0.05$) peaks at the daily, synoptic and monthly time scales. Cross-wavelet transformation (CWT) highlighted significant ($p < 0.05$) correlation between photosynthesis (represented by photosynthetically active radiation (PAR)) and $R_s$ at the diurnal scale with PAR leading $R_s$ on the order of 1 – 3 hours. Based on phase diagrams, we also detected a temperature independent component of $R_s$ at the diurnal scale. CWT analysis also found soil moisture to induce $R_s$ at the synoptic scale.

Overall, we found strong evidence of multiple controlling factors regulating soil respiration across coastal plain forests. Our work reflects the necessity to move beyond temperature and incorporate different biotic and abiotic factors to develop a mechanistic model of soil respiration.