A NEW DATA ANALYSIS METHOD IDENTIFIES TRUE TEMPERATURE SENSITIVITY OF SOIL RESPIRATION

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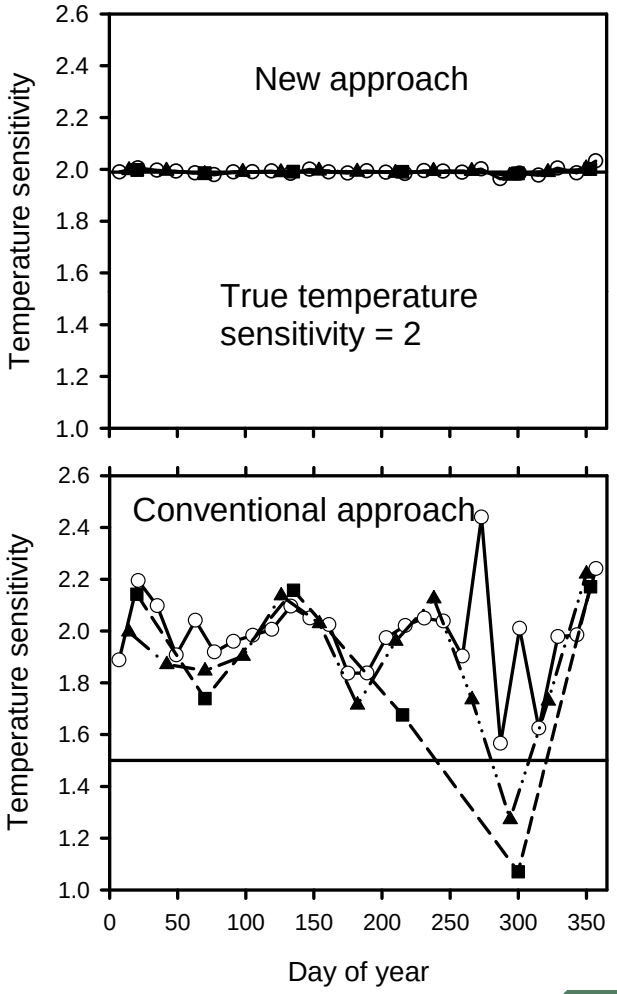
DOE/Office of Science/Biological & Environmental Research

- The temperature sensitivity of soil respiration is one of the most important processes in the terrestrial carbon cycling and carbon – climate interactions.
- But so far it has been difficult to estimate sensitivity parameters from measurements, leading to uncertainties in coupled carbon-climate simulations
- A new approach called the 'localized ratio Fitting' (LRF) has been developed and shown to be able to isolate and remove confounding effects and thus accurately estimate the 'true' temperature sensitivity
- A serendipitous finding is that the commonly reported seasonal pattern of temperature sensitivity (low in summer and high in winter) may be an artifact of an inappropriate method of data analysis instead of a consequence of temperature acclimation of soil respiration



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We propose a novel approach, called the "localized ratio fitting" (LRF), to estimating the true temperature sensitivity from soil respiration measurements, a task crucial to modeling terrestrial carbon cycle and climate but so far hindered by the inadequate conventional regression approach. LRF takes advantage of the different timescales of the pool dynamics–induced and environmental variation–induced changes in soil CO_2 efflux. It first transforms the expression for soil respiration into a form suppressing the influence of soil carbon pool dynamics and then uses the transformed expression to infer the parameters of environmental sensitivities. LRF works best for high-frequency soil respiration measurements and thus is particularly suitable for analyzing time series produced by automated soil chambers and from soil incubation experiments. We evaluated the validity of LRF with both simulated (with a multipool soil organic carbon model driven by realistic plant litter input scenarios) and measured (with automated soil chambers) time series of soil respiration. LRF accurately retrieved the true temperature sensitivity from the simulated heterotrophic soil respiration while the conventional approach failed to do so. The simulation also revealed that LRF performed better than the conventional approach when a direct photosynthetic signal existed in the time series of soil respiration although even LRF could not completely eliminate the interference of photosynthetic contribution for estimating the true temperature sensitivity. Importantly, the simulation on the photosynthetic influence reproduced a typical seasonal pattern of apparent temperature sensitivity reported in the literature: higher sensitivity in winter (dormant season) and lower sensitivity in summer (growing season). Such pattern has been interpreted as an indication of temperature acclimation of soil respiration by previous studies. Our simulation now indicated that that interpretation may be incorrect. The validation with actual soil chamber data showed that the use of LRF led to more consistent estimates of temperature and moisture sensitivities from observations, indicating its better robustness against compounding effects of parallel processes on soil respiration. It was demonstrated that once the true environmental controls were properly accounted for, soil respiration measurements could be used to infer effects of biological processes on soil respiration.

Gu L, Hanson PJ, Post WM, Liu Q (2008) A novel approach for identifying the true temperature sensitivity from soil respiration measurements. *Global Biogeochemical Cycles* 22, GB4009, doi:10.1029/2007GB003164.