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Diagnosing temperature sensitivity of respiration at multiple spatial scale in the northern high-latitude regions

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Accurate estimation of the temperature sensitivity of respiration (Q_{10}) is important for understanding terrestrial ecosystem carbon cycle and its response to climate change, especially in the northern high-latitude regions (NHL). The conventional calculation of temperature sensitivity contain seasonal confounding effects on annual temporal scale. The scale-dependent parameter estimation (SCAPE) method which is based on singular spectral analysis could circumvent confounding effects. However, the process of screening a series of high frequency subsignals to identify the best intrinsic Q_{10} produce large error. In this study, we proposed the SCAPE-M method to improve the approach of screening high frequency subsignals. Three datasets were used to validate the SCAPE-M method in the NHL, namely FLUXNET2015 datasets, MsTMIP multi-model weighted average outputs, and ERA_interim reanalysis data. The main results were as follows: (1) On the site scale, the confounding effects in the forest ecosystems were less than grassland and cropland ecosystems in the NHL. The apparent Q_{10} derived from conventional approach differed among biomes in the NHL and increased with annual mean temperature. The mean apparent Q_{10} across 36 FLUXNET sites in the NHL was 2.71 ± 0.77. Contrary to the results of apparent Q_{10}, the intrinsic Q_{10} across 36 FLUXNET sites in the NHL were independent of annual mean temperature, and were confined to values around 1.54 ± 0.38. (2) On the grid scale, the apparent Q_{10} increased with annual mean temperature, with high values in the Western Europe and low values in the Mongolian Plateau. There were no significant changes of intrinsic Q_{10} in the spatial distribution. While the convergence value 1.01 ± 0.15 on the grid scale was smaller than the site scale. The results in this study indicated that the response of carbon cycle to climate warming in the NHL was less pronounced than suggested by most carbon cycle climate models.