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Various dominant factors of temperature sensitivity of soil respiration across China

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As a crucial process of global carbon cycle, soil respiration (RS) is one of the largest out flux of carbon dioxide from terrestrial ecosystems to atmosphere. The temperature sensitivity of RS (Q_{10}) was considered as a benchmark in describing terrestrial soil carbon-climate responses. However, the spatiotemporal and dominant factors of Q_{10} were not explored well at regional scale. To bridge the knowledge gap, we derived a gridded dataset of Q_{10} from 1994 to 2016 across China (data-derived Q_{10}) by using a random forest (RF) model with the linkage of 515 field observations and environmental variables. The model efficiency of RF was 0.5 with root mean squared error (RMSE) of 0.62. Spatially, data-derived Q_{10} varied a lot from 1.54 to 4.17 with an average of 2.52, and were higher in cold regions. Temporally, the annual change of data-derived Q_{10} was not significant (p = 0.28). To investigate the dominant factors, we used partial correlation analysis to detect the relationships between data-derived Q_{10} and annual mean temperature (MAT), annual mean precipitation (MAP) and soil organic carbon (SOC). Generally, SOC was the most dominant factor which covered 46 % of land surface across China, followed by MAT (29 %) and MAP (25 %). However, there was a strong spatial heterogeneity of the proportions of dominant factors in different climatic zones, ecosystem types, and climatic conditions. Among different ecosystems, the percentage of areas dominated by MAT in grasslands (34 %) and wetlands (31 %) were higher than that of other ecosystem types (less than 25 %). Under different MAP gradients, it can be observed that the percentage of areas dominated by MAP was higher when MAP is extremely high (> 1600 mm) or extremely low (0 ~ 200 mm), which were 31 % and 29 %, respectively, higher than that at 800 ~ 1000 mm (16 %). In our results, percentage of areas dominated by MAT was higher in cold regions. As MAT increased, the percentage of areas dominated by MAT gradually decreased, and it was 33 % at MAT <-5℃, higher than when MAT at 15 ~ 20℃ (23 %). Similarly, this phenomenon was more intuitive along the Q_{10} gradient, the percentage of areas dominated by MAT gradually increased from 22 % (Q_{10} < 2) to 56 % (Q_{10} > 3.5). Also, this phenomenon could be observed across different climatic zones. Except for the smallest tropical regions, from subtropical to temperate to plateau regions, the local temperature gradually decreased while the percentage of areas dominated by MAT also gradually increased (from 24 % to 36 %). Our results showed that in colder regions, the temperature influenced Q_{10} more significantly, which may indicate that future Q_{10} variations in cold regions may be more notable than in warm regions in a warming climate.

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