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Main and interactive effects of multiple global-change factors on soil respiration and its components: a meta-analysis

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Global change usually involves simultaneous changes in multiple environmental factors, which may considerably affect ecosystem structure and functioning and alter ecosystem services to human society. With increased awareness of their potential interactions, some multi-factorial studies have been conducted to investigate their main and interactive effects on carbon (C) cycling in terrestrial ecosystem. However, how multiple global-change factors affected soil respiration (Rs) and its components (i.e. autotrophic (Ra) and heterotrophic respiration (Rh)) remains controversial among individual studies. In this study, we conducted a meta-analysis to examine the main and possible 2- or 3-factor interactive effects with warming (W), elevated CO_2 (E), nitrogen addition (N), increased precipitation (I) and drought (D) on Rs and its components from 150 published papers. Our results show that E, W, I and N significantly stimulated Rs by 29.23%, 7.19%, 22.95%, and 16.90% ($p<0.05$), respectively, while I depressed it by 16.90% ($p<0.01$). E consistently induced a significant positive effect on both Ra and Rh, while I affected them with an opposite trend. Among nine two-way interactive effects on Rs, synergistic interaction (i.e. the effect of combined treatment > the additive effects of single two main factors) occurred in E×N, E×W, I×N, and D×W, while neutral interaction (i.e. the effect of combined treatment ≈ the additive one) and antagonistic interaction (i.e. the effect of combined treatment < the additive one)was rare, only in I×W for neutral one and in N×W and I×E for the latter. In addition, E×W and E×N displayed synergistic interactions on Rh. The more dominance of synergistic interactions in two-way interactive effects on Rs and Rh may determine a central positive tendency of Rs in future, and affect the feedback of terrestrial C cycle to the climate system correspondingly.