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Effects of temperature and moisture variability on soil CO_2 emissions in European land ecosystems

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Soil respiration is one of the largest terrestrial fluxes of carbon dioxide (CO_2) to the atmosphere. Hence, small changes in soil respiration rates could have large effects on atmospheric CO_2. In order to assess CO_2 emissions from diverse European soils under different land use and climate (soil moisture and temperature) we conducted a laboratory incubation experiment.

Therefore, we incubated soil cores (Ø 7 cm; height 7 cm) from nine European sites which are spread all over Europe; from the United Kingdom (west) to the Ukraine (east) and Italy (south) to Finland (north). In addition these sites can be clearly distinguished between their land use into forests, arable lands, grasslands and one peat land. Soil cores were incubated in a two-factorial experimental design at 5 different temperatures (5, 10, 15, 20, and 25˚C) and 6 different moisture contents (5, 20, 40, 60, 80, and 100 % water filled pore space (WFPS)). An automated laboratory incubation measurement system was used to measure CO_2 emissions.

Results show that highest CO_2 emissions occurred with intermediate moisture content (40% to 60%) over all sites. We found that the relationship between CO_2 emissions and temperature could be well described by the equation

(R^2 ranges from 0.98 to 1) over all sites. In general CO_2 emissions were strongly related with both variables temperature and moisture. However, temperature sensitivity of soil respiration was strongly declined under very dry and very wet conditions (5 and $>$80 % WFPS moisture content). Moisture sensitivity of CO_2 emissions was positive related to temperature, although at low temperatures (5-10˚ C) moisture content had almost no effect on CO_2 emissions.

In summary our results indicate that the variability in soil temperature and moisture decisively controls soil CO_2 emissions, while land use had only a minor impact and describe the effect and dependencies of temperature and moisture on the development of CO_2 emissions.