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Inverse determination of soil heterotrophic respiration response to temperature and water content under field conditions

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Soil heterotrophic respiration is an important carbon flux within the global carbon cycle. Since this process is mainly controlled by soil temperature and soil moisture the exact knowledge of the response functions for these two parameters is crucial for a reliable prediction of soil carbon turnover and CO2 release to the atmosphere at different field sites. We inversely determined temperature and moisture response equations of soil heterotrophic respiration using a 1-dimensional CO2 transport and carbon turnover model. For the model inversion we used an hourly dataset of measured soil water contents, soil temperatures and CO2 fluxes for one year. Model carbon pools were initialised with measured soil carbon fractions. Best respiration flux prediction was obtained by an exponential soil water content response function with an optimum at an effective saturation of 0.62 and a temperature response which can be well approximated by the Arrhenius equation with an activation energy of 102 kJ mol-1 and a reference temperature of 15.5 °C for temperatures < 25°C. For higher temperatures the temperature response is rather uncertain due to the infrequent occurence of temperatures > 25 °C within the soil profile during observation. Inverse parameter estimation using numerical models is a promising tool for a reliable determination of the 'in situ' temperature and moisture response of heterotrophic soil respiration.