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Synthesizing effects of precipitation manipulation on plant production and soil respiration - results and challenges

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We compiled a database containing data from over 70 experimental sites where precipitation was manipulated. These experiments cover different biomes (mainly tropical forests, temperate forests and grasslands, temperate and Mediterranean shrublands), but the majority of experiments was performed in the temperate zone. From these experiments, we collected (among others) available data for plant biomass and biomass production, leaf gas exchange, leaf and soil chemistry and soil respiration. Because experiments differed largely in the timing, duration and magnitude of the manipulation, our aim was to first quantify the manipulation and bring all experiments to a common denominator reflecting the (plant) available water. The data needed for such quantification of the manipulation are, however, available for very few experiments. Analyses that go beyond a meta-analytical approach (in which the magnitude of the manipulation is typically neglected) are therefore hampered.

In order to avoid problems related to the magnitude of the manipulation, we focussed the analyses of soil respiration (Rsoil) on within-experiment trends. We tested whether a simple temperature-soil moisture-model that fits well to the Rsoil measurements of the control plots can be used to predict the Rsoil measurements for the treatment plots. For several experiments we found that low predictability was not only related to extrapolation beyond the range of SWC in the control plots. Apparently, the manipulation had altered the response of Rsoil to temperature and/or SWC in the treatment plots to a degree which was not predictable from the controls.

Besides Rsoil, we also analyzed responses of ANPP to reduced precipitation. A mixed effects modelling approach (which accounts for clustering of observations from sites with multiple years of data and/or multiple manipulations) revealed that ANPP was mainly determined by the site mean annual precipitation (MAP). Additional variation was explained by actual annual precipitation (either natural or experimentally reduced). The effects of annual precipitation on ANPP did not vary across the studied range of MAP, and the database fails in providing evidence of differential effects of experimental drought across sites with contrasting precipitation regime.