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Patterns of aboveground biomass allocation of mature beech forests change in response to water availability - a transect study in Northern Germany

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Recent climate change scenarios are predicting increased exposure to droughts for many temperate forests in the 21st century which might decrease productivity. While decreasing timber yield with reduced precipitation has often been reported from managed forests, the dependence of forest net primary production (NPP) on precipitation is not well understood. In a transect study in 12 mature beech forests (Fagus sylvatica) along a precipitation gradient (820 to 540 mm yr-1), we measured all aboveground NPP components (NPPa; stem wood, leaf mass, flower and fruit production) in years with dry or moist summers for testing the hypotheses that (1) reduced precipitation decreases leaf area index, stem wood production and also NPPa, and (2) these reductions are stronger in dry summers. While stem wood production showed the expected close positive correlation to precipitation ($p < 0.01$, $R2 = 0.57$) in the dry summer, a precipitation effect was absent in the moist summer. Surprisingly, NPPa remained invariant across the precipitation gradient in both the dry and wet years. The strong reduction in wood production along the precipitation gradient in the dry year was primarily a consequence of a large increase in fruit production of beech toward the drier stands, accompanied by a reduction in LAI by about 25 %. We conclude that beech NPPa seems to be remarkably insensitive to a 30-percent precipitation reduction; its main effects were a large C allocation shift from stem and leaf biomass production to fruit production and probably a reduced NPPa in the subsequent year.