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Ozone Impacts on forest Growth: A Sensitivity Analysis for Norway spruce

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Ozone is one of the most important damaging air pollutants for forests in Austria. The mean atmospheric ozone concentration varies between 22.5 and 51.5 ppb (parts per billion) depending on altitude. Based on the emissions of the precursor substances (nitrous oxides and volatile hydrocarbons), the concentrations increase around 0.2 ppb per year and exceed the threshold for effects on plants. The light saturated rate of photosynthesis is sensible to ozone load. This corresponds to a reduction of the potentially possible CO2 fixation and can be regarded as a proof of the damage potential of ozone. The defence capacity vis-à-vis increased ozone increases with increasing elevation. At higher elevations the higher natural stress potential is accompanied by a higher defence potential against ozone damage. Based on these findings the following working hypotheses were formulated: (i) Under the acceptance that ozone uptake leads to a reduction of volume increment, model calculations on volume increment should exhibit a systematic bias versus the ozone dose. (ii) For locations unencumbered by ozone, the model should underestimate, for strongly burdened locations it should overestimate volume increment. (iii) Error patterns should change with increasing elevation, due to the increasing defence potential. Results demonstrated that at elevations above 800 m a.s.l. no ozone effect was detectable via trends in errors versus ozone dose. At elevations below 800 m, a significant trend in errors from plots with low ozone doses to plots with high ozone doses was evident. Although the model used in this study includes no explicit ozone reactions, we can be confident at the 95 % level that Norway spruce trees growing below 800 m a.s.l. react to an increase in ozone dose with a reduction in volume increment.
It is, however, important to emphasize that the evidence for increment reduction is qualitative evidence but does not allow the quantification of the ozone induced reduction in volume increment. A quantification of the reduction in volume increment requires the statistical validation of the dose-response relations on the basis of additional data series from sites with different ozone loads, elevations and site conditions.