Summer drought limits the positive effects of CO2 and heat on plant growth in future climate

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The large scale project CLIMAITE, led by Riso DTU, has published its first synthesis paper in the renowned journal *Global Change Biology,* and the conclusion is perhaps a little surprising that the predicted increase in plant growth, due to more CO2 in the atmosphere is noticeably limited when combined with higher temperatures - and especially summer droughts.

In contrast to the increased growth in plants that scientists have often seen in studies with elevated CO2, the first synthesis paper on the comprehensive CLIMAITE project shows that the combination of summer drought and potential plant growth-promoting factors such as higher temperatures and increased CO2 together limit the effect of CO2 increased plant growth significantly.

"When you've previously seen a significantly higher plant growth at elevated CO2 concentrations, it is typically because it has been controlled studies, where only the CO2 concentration was changed. We fundamentally had the theory that you have to look at the combination of the different climate variables, since the plants in the future will be exposed to multiple changes simultaneously, "explains Klaus Steenberg Larsen, who is a researcher in the Biosystems Division at Risø DTU and lead author on the scientific paper.

CLIMAITE is a Danish research center that investigates how climate

change, as they probably appear in 2075, affects biological processes and ecosystems in nature. Data from the first two years are underlying the scientific paper, and results clearly indicate that we will not get the predicted increase in plant growth in our latitudes in the future.

Out in the wild

The core of CLIMAITE's activities is a common field scale experiment, in contrast to many other experiments conducted in laboratories under controlled conditions. Climate manipulations are still conducted with both CO2, temperature and rainfall by for example using CO2 jets and curtains that keep the rain away.

"We have set up the experiment, so that there are plots that are exposed to either increased CO2, heat or summer drought alone, and plots that are exposed to all possible combinations of these three climate variables. In this way we can see how the ecosystem is affected by each climate variable, and what happens in the combinations, "explains Klaus Steenberg Larsen.

The world's largest set-up

The research area is located in the military training area near Jægerspris. Here CLIMAITE has built a facility where they can make experiments at field scale with elevated CO2 using the Free Air Carbon Enrichment (FACE) technique. The elevated temperature in the ground at approx. 1 degree is achieved by passive nighttime warming and altered rainfall or drought are obtained by means of roller blinds in periods of 4-6 weeks over the summer.

In total this gives 8 different set-ups in the total 48 plots. And thus CLIMAITE is one of the largest facilities of its kind.

"We measure things such as nitrogen in precipitation, plants, soil fauna, microbes and soil water. Nitrogen is often a limiting factor for plant growth, and absolutely essential for how ecosystems respond to climate change, "says Klaus Steenberg Larsen, and continues:

"The results in the paper cover the years 2006-2007, and the experiment will run until 2014. But it takes time to gather the results from the 20-30 people who interpret and analyze the results from the many types of equipment that are set up. However, we can clearly see that especially the drying of the soil has a significant negative effect on nitrogen production - and thus on the possible plant growth - even in those areas that are exposed to increased CO2 and warming."

Results from field trials as these are important for future policy decisions and actions to be taken to counteract or directly prevent climate change in the future. And the first step would be to have this knowledge built into global climate models. In this case, for example, on interactions between the different climate variables that is the result of the CLIMAITE experiment.

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