The Impact of Elevated CO_2 on Plant Production Responses to Drought: A Model-Data Comparison at Four US FACE Sites.

Anthony Walker, Lynn Fenstermaker, Martin De Kauwe, Belinda Medlyn, Elise Pendall, Sönke Zaehle, Rich Norby, and the FACE-MDS team.

Plants respond to increasing atmospheric CO[2] (eCO2) by reducing stomatal apertures which, coupled with increased assimilations rates, increases plant water use efficiency (WUE). In some environments, increased WUE allows for water savings that can prolong the onset of detrimental drought effects on plants.

Ecosystem observations from four long-term Free-Air CO[2] Enrichment (FACE) experiments—the evergreen needleleaf Duke Forest FACE experiment (NC), the deciduous broadleaf Oak Ridge FACE experiment (TN), the prairie heating and FACE experiment (WY), and the Nevada desert FACE experiment—were used to evaluate the assumptions of a suite of terrestrial ecosystem models.

All sites experienced at least one dry year which coincided with below average annual net primary production (NPP). At all but the driest site (NV), eCO2 alleviated the effect of the dry year on NPP, the extent of which increased with how mesic the site was in general. Many models were able to capture this response across sites though there substantial differences in model behaviour. Model assumptions that were important in determining the under eCO2 mediated recovery of NPP during the dry year were: The soil water content at which soil water becomes limiting to plants; whether soil water limitation affects stomatal conductance, photosynthetic parameters, or both; and the shape of the soil water limitation curve.