Photosynthetic responses of 13 grassland species across 11 years of free-air CO₂ enrichment is modest, consistent and independent of N supply

TALI D. LEE*, SUSAN H. BARROTT and FERDIE REICH
Department of Forest Resources, University of Minnesota, 1530 Cleveland Ave. N., St. Paul, MN 55108, USA

Abstract
If long-term responses of photosynthesis and leaf diffusive conductance to rising atmospheric carbon dioxide (CO₂) levels are similar or predictably different among species, functional types, and ecosystem types, general global models of elevated CO₂ effects can effectively be developed. To address this issue we measured gas exchange rates of 13 perennial grassland species from four functional groups across 11 years of long-term free-air CO₂ enrichment (CO₂)-induced enhancement of productivity, it is concluded likely to slow down climate warming by constraining the future size and persistence of elevated CO₂ effects on terrestrial ecosystems in response to rising CO₂ levels.

Introduction
Given the regulatory role of leaf photosynthesis and stomatal conductance in plant responses to atmospheric carbon dioxide (CO₂) concentrations, it is important to characterize the long-term consequences of rising CO₂ in these fundamental processes (Ainsworth & Rogers, 2007) and to determine the influence of other environmental factors on photosynthesis and CO₂ effects on these processes (e.g. Campbell & Berry, 1988). The relatively small response of photosynthesis to rising CO₂ levels is consistent with a great deal of caution.

Photosynthetic Responses of 13 Grassland Species across 11 Years of Free-Air CO₂ Enrichment is Modest, Consistent and Independent of N Supply

Global Change Biology, 2011

Plant responses to atmospheric carbon dioxide (CO₂) are fundamentally mediated by photosynthesis. Therefore, understanding how photosynthesis responds to rising CO₂ levels is required to develop accurate global change models. To address this issue we measured 13 perennial grassland species across 11 years of CO₂ enrichment. This long-term elevated CO₂ produced consistent but modest increases in photosynthetic rates of 10% compared to plants grown at ambient CO₂, which is much less than that found across similar studies. Therefore, models that assume and thereby simulate stronger elevated CO₂ stimulation of photosynthesis across Earth’s ecosystems should be viewed with a great deal of caution.

Tali Lee
Associate Professor, Department of Biology