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Response of the Mediterranean-type Ecosystems of California to Varying Levels of Atmospheric Carbon Dioxide and Varying Climate: Potential implications for Europe

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Three decades of research on climate change in the chaparral, a Mediterranean-type climate ecosystem, at San Diego State University's Sky Oaks Biological Field Station, has provided information and insights that are useful to understanding climate change impacts for other regions including Europe. Explored have been impacts of preindustrial and projected future carbon dioxide levels on ecosystem structure and function. Also explored is the impact of stand age, fire, and variation in key environmental variables on net ecosystem exchange, soil respiration, and carbon sequestration.

Results from these atmospheric carbon dioxide manipulations shows that long-term stimulation of NEE, carbon sequestration, leaf area, fuel accumulation, and VOC production occur and that ecosystem composition, species reproduction, soil microbial composition, and plant-animal interactions, are affected by increased atmospheric carbon dioxide levels. Suggested is the fact that at least these water stressed ecosystems see increased water use efficiency and increased NPP over the long-term from elevated atmospheric carbon dioxide.

More than a decade of measurement of net ecosystem exchange by eddy covariance demonstrates the long term pattern of carbon exchange with stand age, and the short term impacts of variation in climate, especially precipitation, on stand water use and NEE. Annual variability in rainfall has profound affects on NEE, the impact of variation in annual rainfall on NEE lasts more than one year. Punctuated periods of drought have longer-term effects on species composition than on NEE. The functioning of this ecosystem adjusts more quickly than does the composition of the ecosystem. Similarly, the sink strength of NEE following fire recovers more quickly than does community composition and percent above ground cover.
The combined impacts of anticipated changes in atmospheric carbon dioxide and climate suggests changes in species composition and NPP. Fire intensity and/or frequency are anticipated to increase due to increases in weather conditions conducive to fire and increases in fuel accumulation due to higher atmospheric carbon dioxide levels.

These data suggest that the functioning of ecosystems adjusts to and compensates for changes in ecosystem structure and species composition and can be important. These data also suggest structure, function, and composition of warm-temperate, water-limited, ecosystems in Europe may be quite sensitive to increases in atmospheric carbon dioxide and to both episodic and secular drought.