Chapter 4: Effects of Elevated CO2 and Temperature Stress on Ecosystem Processes

Stanley D. Smith, Dean N. Jordan and Erik P. Hamerlynck

Introduction
In this chapter, we examine the effects of temperature stress and elevated CO2 on ecosystem processes, including primary production, nutrient cycling, and landscape water and energy balance. Although we examine the interplay between changing CO2 and rising temperature on ecosystem processes, an important focus of this book is on the effects of environmental stress in concert with elevated CO2 on biological systems. Environmental stress has been defined in many ways, and often varies depending on whether it is applied to a cultivated production system or to an ecosystem. In its broadest sense, environmental stress is any environmental factor that lowers primary production below its optimum (Osmond et al., 1987). In this context, any nonoptimum temperature can be considered stressful. However, a more narrow view of environmental stress would require that an environmental condition (e.g., freezing/chilling temperatures, heat stress) cause some type of damage to the plant in question. Severe damage to plants, causing either mortality or an irreversible loss in productivity, can be seen to have clear impacts on ecosystem processes. However, there are very few elevated-CO2 studies that have examined this important type of temperature response in plants. Also of interest from an ecosystem perspective is recurring environmental stress, which can result in either physiological hardening in plants (which may be irreversible within a given growing season) or genetic responses of populations over time, such that the ecosystem equilibrates to nonoptimum conditions through a loss of productivity.