Radiative and Physiological Effects of Increased CO_2: How does this Interaction affect Climate?

Abstract:
Several climate models indicate that in a $2xCO_2$ environment, temperature and precipitation would increase and runoff would increase faster than precipitation. These models, however, did not allow the vegetation to increase its leaf density as a response to the physiological effects of increased CO_2 and consequent changes in climate. Other assessments included these interactions but did not account for the vegetation down-regulation to reduce plant's photosynthetic activity and as such resulted in a weak vegetation negative response. When we combine these interactions in climate simulations with $2xCO_2$, the associated increase in precipitation contributes primarily to increase evapotranspiration rather than surface runoff, consistent with observations, and results in an additional cooling effect not fully accounted for in previous $2xCO_2$ simulations. By accelerating the water cycle, this feedback slows but does not alleviate the projected warming, reducing the land surface warming by $0.6^{o}C$. Compared to previous studies, these results imply that long term negative feedback from CO_2-induced increases in vegetation density could reduce temperature following a stabilization of CO_2 concentration.