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Effects of solar dimming and brightening on the terrestrial carbon sink

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Plant photosynthesis increases with solar radiation. Recent studies have shown that photosynthesis is more efficient under diffuse light conditions (Gu et al., 2003, Niyogi et al., 2004, Oliveira et al., 2007, Roderick et al., 2001). Changes in cloud cover and atmospheric aerosol loadings from either volcanic and anthropogenic sources, modify the total radiation reaching the surface and the fraction of this radiation which is diffuse, with uncertain overall effects on plant productivity and the global land carbon sink.

A decrease in total solar radiation (Liepert, 2002, Stanhill and Cohen, 2001, Wild et al., 2005) has been observed at the Earth surface over the 1950-1990 period, called solar dimming. Such dimming gradually started to transform into brightening in some regions of the world since the late 1980s (Wild et al. 2005). The effect of these changes in total solar radiation and associated changes in diffuse radiation and diffuse fraction on the land biosphere has not yet been accounted for in global carbon cycle simulations because such models lack the mechanism that includes the diffuse irradiance effects on photosynthesis

In this study we estimate the total impact of variations in clouds and atmospheric aerosols on the land carbon sink using a global land carbon cycle model modified to account for the effects of variations in both direct and diffuse radiation on canopy photosynthesis (Mercado et al., 2007) during the global dimming and brightening period.

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