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The Impact of Atmospheric Aerosols on the Fraction of absorbed Photosynthetically Active Radiation

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Abstract

Aerosol pollution attracts a growing interest from atmospheric scientists with regard to their impact on health, the global climate and vegetation stress. A hypothesis, less investigated, is whether atmospheric aerosol interactions in the solar radiation field affect the amount of radiation absorbed by vegetation canopies and hence terrestrial vegetation productivity.

Typically, aerosols affect vegetation canopy radiation absorption efficiency by altering the physical characteristics of solar radiation incoming on for example a forest canopy. It has been illustrated, that increasing mixing ratio's of atmospheric particulate matter lead to a higher fraction of diffuse sunlight as opposed to direct sunlight. It can be demonstrated, based on the application of atmospheric (MODTRAN) and leaf/canopy radiative transfer (LIBERTY/SPRINT) models, that radiation absorption efficiency in the PAR band of Picea like forests increases with increasing levels of diffuse radiation. It can be documented - on a theoretical basis - as well, that increasing aerosol loads in the atmosphere, induce and increased canopy PAR absorption efficiency. In this paper it is suggested, that atmospheric aerosols have to be taken into account when estimating vegetation gross primary productivity (GPP).

The results suggest that Northern hemisphere vegetation CO2 uptake magnitude may increase with increasing atmospheric aerosol loads. Many climate impact scenario's related to vegetation productivity estimates, do not take this phenomenon into account. Boldly speaking, the results suggest a larger sink function for terrestrial vegetation than generally accepted.

Keywords: Aerosols, vegetation, fAPAR, CO2 uptake, diffuse radiation.