3.080 The natural aerosol diffuse radiation fertilisation effect on global plant productivity.

Presenting Author:
Alex Rap, School of Earth and Environment, University of Leeds, Leeds, United Kingdom, a.rap@leeds.ac.uk

Co-Authors:
Catherine Scott, University of Leeds, Leeds, United Kingdom
Carly Reddington, University of Leeds, Leeds, United Kingdom
Dominick Spracklen, University of Leeds, Leeds, United Kingdom
Lina Mercado, University of Exeter, Exeter, UK

Abstract:

Atmospheric aerosol from natural sources include primary emissions of biomass burning, sea-salt, and desert dust along with aerosol precursors from vegetation, ocean biology, and volcanoes that can subsequently form particles in the atmosphere. All these aerosol particles play an important role in the climate system through their direct and indirect radiative effects. In addition, through scattering of solar radiation these particles increase the fraction of diffuse radiation and the efficiency of photosynthesis. Here we quantify the impact of natural aerosol (e.g. biomass burning, secondary organic aerosol, volcanic aerosol) on plant photosynthesis via the diffuse radiation fertilisation effect. We use a methodology based on combining three models: (i) the Global Model of Aerosol Processes (GLOMAP), (ii) the SOCRATES radiation model, and (iii) the JULES land-surface scheme. Our results show how natural aerosol reduces the amount of total radiation reaching the surface, while increasing diffuse surface radiation. This leads to substantial enhancements of net primary productivity (NPP) over large tropical areas of the globe such as the Amazon and central Africa. We show for example that secondary organic aerosol (SOA) from biogenic volatile organic compounds (BVOC) emissions lead to a global NPP enhancement of ~1.2 Pg C a^{-1}, which is twice the mass of BVOC emissions causing it. Hence, our simulations indicate that there is a strong positive ecosystem feedback between plant emissions and plant productivity. We also show that Amazon fires lead to an NPP increase in the Amazon basin equivalent to ~50% of the annual regional carbon emissions from biomass burning. While this NPP increase occurs primarily during the dry season, it actually counteracts some of the observed effect of drought on tropical production. Finally, we find that current levels of anthropogenic pollution aerosol suppress some of the natural aerosol diffuse radiation fertilisation effect.