Max- Planck-Institut für Biogeochemie
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Beutenberg Campus Jena; Lecture Hall
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Institute Colloquium

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Highly Contrasting Effects of Different Climate Forcing Agents on Terrestrial Ecosystem Services

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The issue of human-induced climate change is becoming synonymous with increases in atmospheric CO_2, but there are many other atmospheric constituents that contribute to climate change. It is normal to compare the impacts of these different agents in terms of radiative forcing, which measures the impact on the planetary energy budget. However a number of recent studies have shown that many radiatively active constituents also have important direct impacts on the physiological functioning of ecosystems, and therefore on the "ecosystem services" that humankind relies upon. For example, carbon dioxide increases are believed to have positive impacts on plant growth, water use efficiency and river runoff (Gedney et al, 2006), whereas increases in near-surface ozone are very detrimental to plant health and productivity (Sitch et al, 2008). Here we demonstrate the total impact on global Net Primary Productivity (which is related to crop yield) and River Runoff (which is related to freshwater availability), of equivalent radiative forcings due to carbon dioxide, near surface ozone, and a reduction in sulphate aerosol. We compare this to the impacts of climate change alone, arising for example from a physiologically inactive agent such as methane. Contrary to the usual radiative forcing paradigm, we show that the total impacts of these different agents vary markedly, and in some cases differ in sign. In particular, current models suggest that the direct physiological impact of a CO_2 increase is strongly positive overall, overwhelming the negative impacts of climate change alone. Our analysis questions the conventional view that climate mitigation efforts should focus primarily on reductions in CO_2 emissions. Instead, from the context of terrestrial ecosystem services, the optimal future atmospheric composition may have higher CO_2 balanced by reductions in trace GHGs (such as ozone and methane) and perhaps even increases in reflecting aerosols through geoengineering.