The impact of agricultural development in sub-Saharan Africa on greenhouse gas emissions and interactive effects with climate change on air quality

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Abstract:

With the advent of an African Green Revolution, inputs of nitrogen (N) to agricultural soils in sub-Saharan Africa are expected to increase by an order of magnitude by mid-century. Nitrogen additions to soils cause increases in the microbially-mediated production of nitric oxide (NO), a precursor to the formation of ozone pollution in the troposphere. Because tropospheric ozone is typically limited by concentrations of NO_x (NO and nitrogen dioxide), increased NO emissions may have ramifications for public health and crop productivity in the region.

In order to expand our understanding of N additions and trace N gas emissions, and ultimately to understand how ozone formation in East Africa may be driven by interactions between changing NO emissions and climate change, we will conduct a controlled experiment in Maseno, Kenya starting with the beginning of the 2011 growing season in February. We will use a randomized complete block design to estimate yield, NO, and N_2O response functions across different levels of fertilizer addition. Measurements of nitric oxide will be made using an LMA-3D analyzer, and we will test cavity ring-down spectroscopy, a novel technology that makes dynamic analysis of N_2O fluxes possible in the field, bypassing measurement errors associated with sample storage, transport, and analysis under traditional static chamber techniques. By coupling the results of the field NO measurements to the GEOS-Chem chemical transport model, we can investigate how changes in NO emissions will interact with climate to affect ozone dynamics in sub-Saharan Africa.