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The end of the anthropogenic aerosol era?

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The Earth's climate is rapidly changing. Over the past century, aerosols, via their ability to absorb or scatter solar radiation and alter clouds, played an important role in counterbalancing some of the greenhouse gas (GHG) caused global warming. This, over a century-long anthropogenic aerosol cooling effect, prevented present day climate to have yet reached even higher surface air temperatures and subsequent more dramatic climate change impacts. Trends in aerosol concentrations and optical depth show that in many formerly highly polluted regions such as Europe and the United States of America aerosol precursor emissions have already decreased back to pollution levels of the 1950s. More recent polluting countries such as China may have reached a turning point in recent years as well, while India keeps still following an upward trend. Here we study aerosol trends in the CMIP6 simulations of the GISS ModelE climate model using a fully coupled atmosphere composition configuration, including interactive gas phase chemistry, and either an aerosol microphysical (MATRIX) or a mass based (OMA) aerosol module. Results show that the question if we are already at a period where aerosol radiative forcing continuously declines globally depends on the aerosol scheme used. Using the aerosol microphysical scheme, where the aerosol system reacts stronger to the trend in sulfur dioxide (SO_2) emissions, global peak direct aerosol forcing was reached in the 1980's, whereas the mass-based scheme simulates peak direct aerosol forcing around 2010. The models are tested again ice core records, satellite and surface network datasets. An evaluation with satellite data between 2001 and 2014 demonstrates that the model that better reproduces the satellite retrieved trends has reached maximal aerosol direct forcing in the 1980s, and is since on a decreasing global forcing trajectory. As a consequence, we expect that the recently observed global warming which is primarily driven by greenhouse gases has been augmented by the effect of a decreasing aerosol cooling effect on the global scale.