Competing Influences Of Greenhouse Warming And Aerosols On Asian Monsoon Climate Change

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In this lecture, results are presented, based on CMIP5 multi-model historical simulations, illustrating the competing influences on the global and regional drivers of the Asian monsoon under global greenhouse warming (GHG) and aerosol forcing. A steady increase in the GHG-induced warm-ocean-warmer-land (WOWL) has been in effect since the 1950's in connection with increased anthropogenic GHG emissions, substantially increasing moisture transport from adjacent ocean, and enhancing rainfall over the Asian monsoon regions. However, under GHG warming, atmospheric stability is increased due to strong reduction in mid-tropospheric and near surface relative humidity, in conjunction with a strengthened the Deep Tropical Squeeze (DTS, Lau and Kim 2015). During the boreal summer, the DTS strongly suppresses monsoon convection and rainfall over subtropical and extratropical land, leading to a weakening of the Asian monsoon meridional circulation under GHG-only forcing. The inclusion of aerosol emission changes strongly masks WOWL and the DTS, up to 60% over the northern hemisphere, negating to a large extent the rainfall increase due to GHG warming, and leading to a further weakening of the monsoon circulation, through increasing most static energy, associated with aerosol solar dimming and semi-direct effects. Overall, we find that GHG exerts stronger positive rainfall sensitivity, but less negative circulation sensitivity in SASM compared to EASM. In contrast, aerosols exert stronger negative impacts on rainfall, but less negative impacts on circulation in EASM compared to SASM.