GCM simulation of black carbon's impact on large scale precipitation

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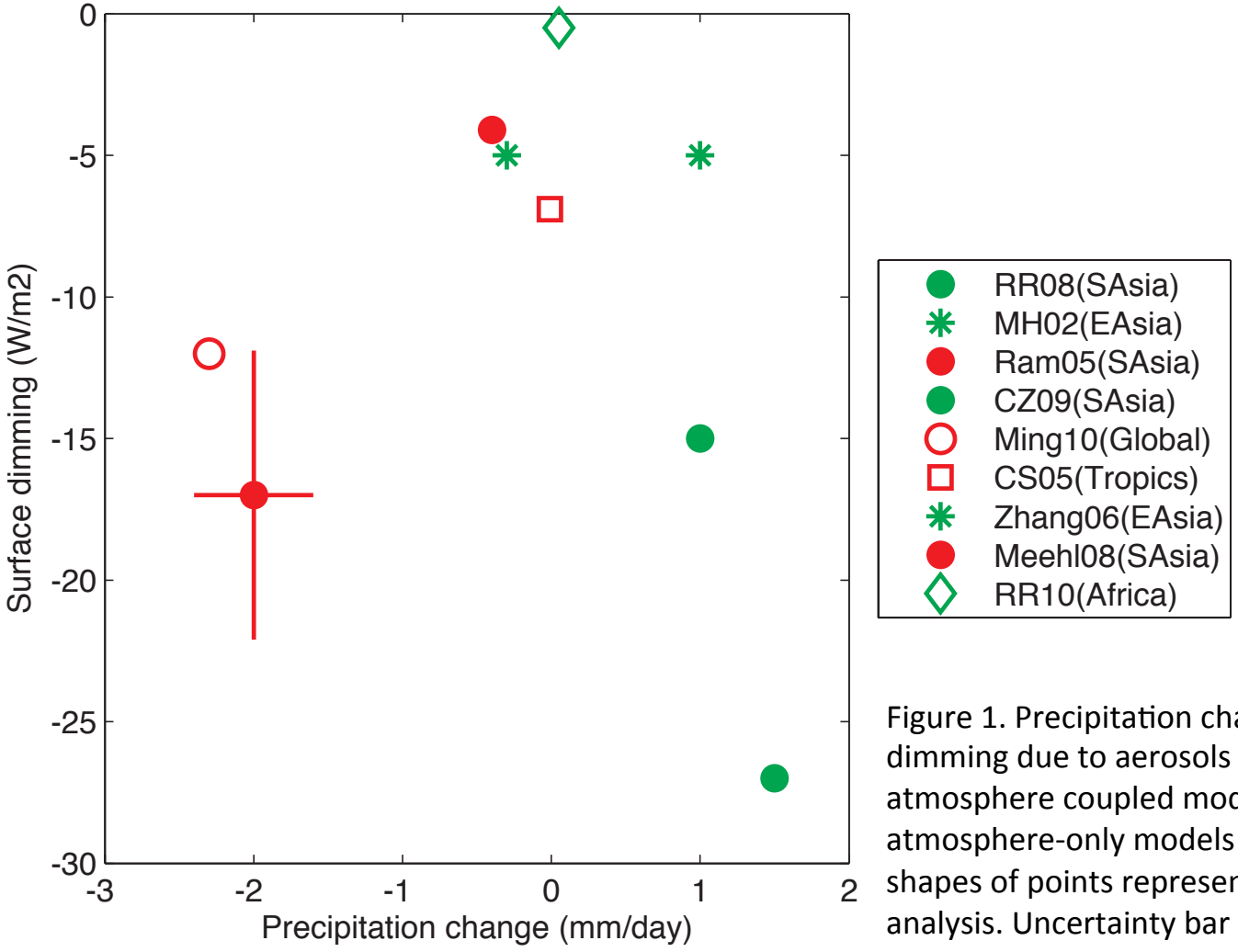

Figure 1. Precipitation change (mm/day) and surface dimming due to aerosols from GCM simulations. Ocean-atmosphere coupled models are shown in red, and atmosphere-only models are shown in green. Different shapes of points represent different geographical domain of analysis. Uncertainty bar is shown for one model simulation.

Authors & Year	Short title	Model & Domain	Main points
Randles and Ramaswamy 2008	Absorbing aerosols over Asia: model response to aerosol optical depth and aerosol absorption	GFDL South Asia	At higher-extinction optical depths, low-level convergence and increases in vertical velocity overcome the stabilizing effects of absorbing aerosols and enhance the monsoonal circulation and precipitation in northwestern India
Menon and Hansen 2002	Climate Effects of Black Carbon Aerosols in China and India	GISS East Asia	A tendency toward increased summer floods in south China, increased drought in north China, and moderate cooling can only be simulated when the aerosols included a large proportion of absorbing black carbon
Ramanathan et al. 2005	Atmospheric brown clouds: Impacts on South Asian climate and hydrological cycle.	NCAR_CAM3_coupled South Asia	Ensemble of coupled ocean-atmosphere simulations from 1930 to 2000 show decreases in surface solar radiation, changes in surface and atmospheric temperatures over land and sea, and decreases in monsoon rainfall, similar to the observed trends.
Collier and Zhang 2009	Aerosol direct forcing of the summer Indian monsoon	NCAR_CAM3 South Asia	Results indicate that the inclusion of aerosols results in drops in surface temperature and increases in precipitation over central India during the pre-monsoon months of March, April, and May. The presence of aerosols induces tropospheric shortwave heating which destabilizes the atmosphere for enhanced convection and precipitation.
Ming et al. 2010	Two opposing effects of absorbing aerosols on global-mean precipitation	GFDL_coupled Global	Damping effect of atmospheric heating can outweigh the enhancing effect of surface warming, resulting in a net decrease in precipitation.
Chung and Seinfeld 2005	Climate response of direct radiative forcing of anthropogenic black carbon	GISS_coupled Tropics	Direct radiative forcing of anthropogenic BC is also predicted to lead to a change of precipitation patterns in the tropics; precipitation is predicted to increase between 0 and 20N and decrease between 0 and 20S, shifting the inter-tropical convergence zone northward.
Zhang et al. 2006	A Modeling Study of the Effects of Direct Radiative Forcing Due to Carbonaceous Aerosol on the Climate in East Asia	NCAR_CAM3 E Asia	Carbonaceous aerosol could also induce summer precipitation to decrease in southern China but increase in northern China.
Meehl et al. 2008	Effects of Black Carbon Aerosols on the Indian Monsoon	NCAR_CAM3_coupled South Asia	In summer monsoon season, the model experiments show that BC aerosols have likely contributed to observed decreasing precipitation trends over parts of India,
Randles and Ramaswamy 2010	Direct and semi-direct impacts of absorbing biomass burning aerosol on the climate of southern Africa	GFDL southern Africa	Biomass burning aerosol increase cloud and precipitation; hypothetical loading of scattering aerosol will serve to suppress hydrological cycle.
Huang et al. 2009	Black Carbon and West African Monsoon precipitation	NCAR Africa	In boreal cold seasons anomalously high African aerosols are associated with significant reductions in cloud amount and surface precipitation (sub-grid convection)