Impacts of Anthropogenic Aerosols and Irrigation on the Dry Season Climate over North India

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Abstract

During the past decade, a significant declining trend in precipitation has been observed over North India in dry season (Oct-Dec). During the same period, this area also exhibits increasing anthropogenic aerosol loadings and more active irrigation activity. The present study aims to investigate the potential influences of anthropogenic aerosols and irrigation on North India dry season climate, using a set of idealized equilibrium global climate simulations with the NCAR CESM v1.0.3. All simulations are forced with sea surface temperature and greenhouse gas levels representing year 1850 and integrated for 30 years. The control run uses the year-1850 aerosol and precursor emission inventories and no irrigation effect is considered in land processes. In the high aerosol run the emission inventories are switched to year-2000 only over North India in the dry season. On a regional, seasonal mean basis relative to the control run, the increased aerosol emissions lead to an 8.31 W m$^{-2}$ decrease in downward solar radiation, a 0.28 °C surface cooling, and a 3 mm mon$^{-1}$ decrease in precipitation. The interior area around the Indus Valley shows the most severe precipitation decline, associated with regional circulation change and reduced moisture advection. In the irrigation run, in which irrigation effects are imposed during dry season over North India, the increased surface to atmosphere latent heat flux (6 W m$^{-2}$) caused a significant cooling (-0.42 °C) and precipitation decline (-4.16 mm mon$^{-1}$). The combined aerosol-irrigation simulation reveals their nonlinear effects on regional climate. The current results suggest that anthropogenic aerosols and irrigation can decrease dry season precipitation over North India by perturbing the surface energy budget and regional circulation.

Reference

Qui, J.H., 2003: Broadband extinction method to determine aerosol optical depth from accumulated direct solar radiation, J. of Appl Meteo., 42 (11), 1611–1625.


