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Air pollution modeling over the Ganges basin and north-west Bay of Bengal in the early post-monsoon season using the NASA GEOS-5 model

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The Ganges basin is characterized by a significant population growth accompanied by developing industry, agriculture, and increasing transportation. This has resulted in increased anthropogenic emissions and declining air quality. The NASA GEOS-5 model was used to extend the MERRA reanalysis with five atmospheric aerosol components (sulfates, organic carbon, black carbon, desert dust, and sea-salt). The model includes assimilation of bias-corrected Aerosol Optical Thickness (AOT) from the MODIS sensor on both Terra and Aqua satellites. The obtained eight-year (2002 – 2009) MERRA-driven aerosol dataset (MERRAero) was applied to study AOT and its trends over the Ganges basin and north-west Bay of Bengal (BoB) in the early post-monsoon season. This season is characterized by aerosol transport from the Ganges basin to north-west BoB by prevailing winds; lower cloud fraction compared to the monsoon season; and still significant rainfall of over 150 mm/month. In the early post-monsoon season (October), modeled data showed that AOT was lower over the east of the Ganges basin than over the north-west of the Ganges basin: this was despite the fact that the east of the Ganges basin should have produced higher anthropogenic aerosol emissions due to higher population density, increased industrial output and transportation. This is evidence that higher aerosol emissions do not always correspond to higher AOT over the areas where the effects of meteorological factors on AOT dominate those of aerosol emissions. MODIS AOT assimilation was essential for correcting modeled AOT mainly over the north-west of the Ganges basin, where AOT increments were maximal. Over the east of the Ganges basin and north-west BoB, AOT increments were low and MODIS AOT assimilation did not contribute significantly to modeled AOT. Our analysis showed that increasing AOT trends over north-west BoB (exceeding those over the east of the Ganges basin) were reproduced by GEOS-5, not because of MODIS AOT assimilation, but mainly because of the model capability of reproducing meteorological factors contributing to AOT trends. Air pollution modeling allowed us to determine aerosol species responsible for the increasing AOT trends over north-west BoB: aerosols were dominated by anthropogenic air pollution, such as sulfates and carbon aerosols. In October 2009, the vertically integrated aerosol mass flux over north-west BoB was maximal, while monthly mean wind was minimal. This indicates accumulating aerosol particles over north-west BoB. The wind convergence over north-west BoB was also maximal in October 2009. Therefore, vertically integrated aerosol mass flux is sensitive to wind convergence causing aerosol accumulation.