Geophysical Research Abstracts
Vol. 19, EGU2017-1171, 2017
EGU General Assembly 2017

Projection of ambient PM2.5 exposure in India and associated health burden

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Ambient particulate matter with diameter < 2.5 μm (PM2.5) is the major criteria pollutant for health assessments of air quality. (WHO, 2006). Exposure to PM2.5 has potential health risks due to cardiovascular and respiratory diseases leading to premature mortality. The annual premature mortality burden from ambient PM2.5 exposure in India is large ($\sim$0.6-0.8 million). It is important to understand how the ambient PM2.5 concentration will change in future under the warming climate and how it translates into premature mortality, when the population distribution exposed to the pollution and baseline mortality are expected to change in response to changes in socio-economic condition to adapt to climate change impacts. We estimate ambient PM2.5 future (up to 2100) by adopting 2 approaches. In the first approach, PM2.5 is estimated as a product of AOD from the CMIP5 models (under both RCP4.5 and RCP8.5 scenarios) and the present day conversion factor estimated by the Geos-CHEM model as a function of present day meteorological conditions and emission. The second approach involves adding up all the PM2.5 components (SO4, NH4, BC, SOA, POA, a fraction of sea salt and dust) available from 13 CMIP5 models under the RCP4.5 and RCP8.5 climate change scenarios. The change is represented in relative terms with respect to the baseline period PM2.5 exposure (2001-2005), when satellite data are available and the CMIP5 models are run in historical mode. The difference between these two approaches implies the role of meteorology in modulating PM2.5 exposure for future due to climate change. We present the decadal statistics and separate the role of meteorology from the combined role of meteorology and emission in modulating PM2.5 variability. We project premature mortality for future using population for future, projected under 5 SSP (Shared Socioeconomic Pathways) scenarios (definitions of these scenarios are provided in Table 1) developed by IIASA. The population under these five scenarios have varying capability to adapt and mitigate to cope up with the changing climate. We estimate premature mortality for two cases, (i) assuming BM to remain constant as of the present day, and (ii) modifying the BM as a function of gross development product. Relative risk is estimated using the IER function. Hence we develop customized scenarios for estimating premature death by linking projected PM2.5 under 2 RCP scenarios with population and baseline mortality from 5 SSP scenarios for each decade up to 2100, creating a total of 10 combined scenarios for each decade. We project that if baseline mortality remains as of present day (WHO 2011) then premature mortality increases up to the middle of the century and then decreases, but never decreases below the present day premature mortality, whereas if we assume that baseline mortality varies as a exponentially decaying function of GDP, premature mortality for future decades are projected to decrease below the present day estimate of premature mortality as GDP is projected to increase in all the 5 SSP scenarios. We further separate the effect of future meteorology, epidemiological changes and demographic changes in future on projected premature mortality. This study can help in the government in developing policies for future in order to avert the projected mortality and follow all the requirements that the best case scenario deserves in order to mitigate the effect of PM2.5 on mortality.