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Aerosol Radiative Forcing over North India during Pre-Monsoon Season using WRF-Chem

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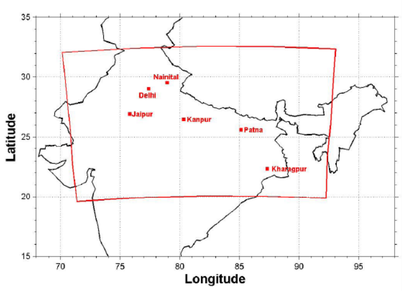
Rationale

Radiative forcing estimates based on model results provide a means to estimate the contribution from individual aerosol species to the overall radiative forcing. Using model data to compute aerosol optical properties also helps in a detailed understanding of various processes in interaction of aerosols with solar radiation.



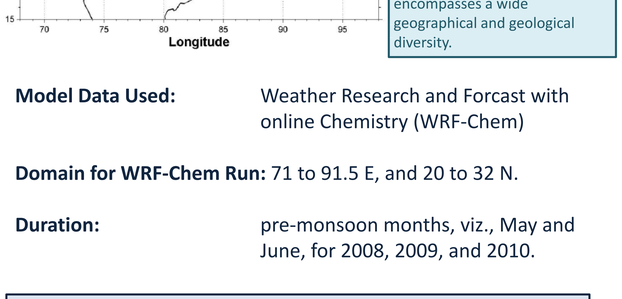
Study Region

The Indo-Gangetic Basin (IGB) is a vast extent of land mass in north India. It is a well-irrigated agricultural region, and has several cities of high economic activity. Besides the IGB, the study also considers the desert region in Rajasthan (west India), and central plateau region of Madhya Pradesh. The region encompasses a wide geographical and geological diversity.

Model Data Used: Weather Research and Forcast with online Chemistry (WRF-Chem)

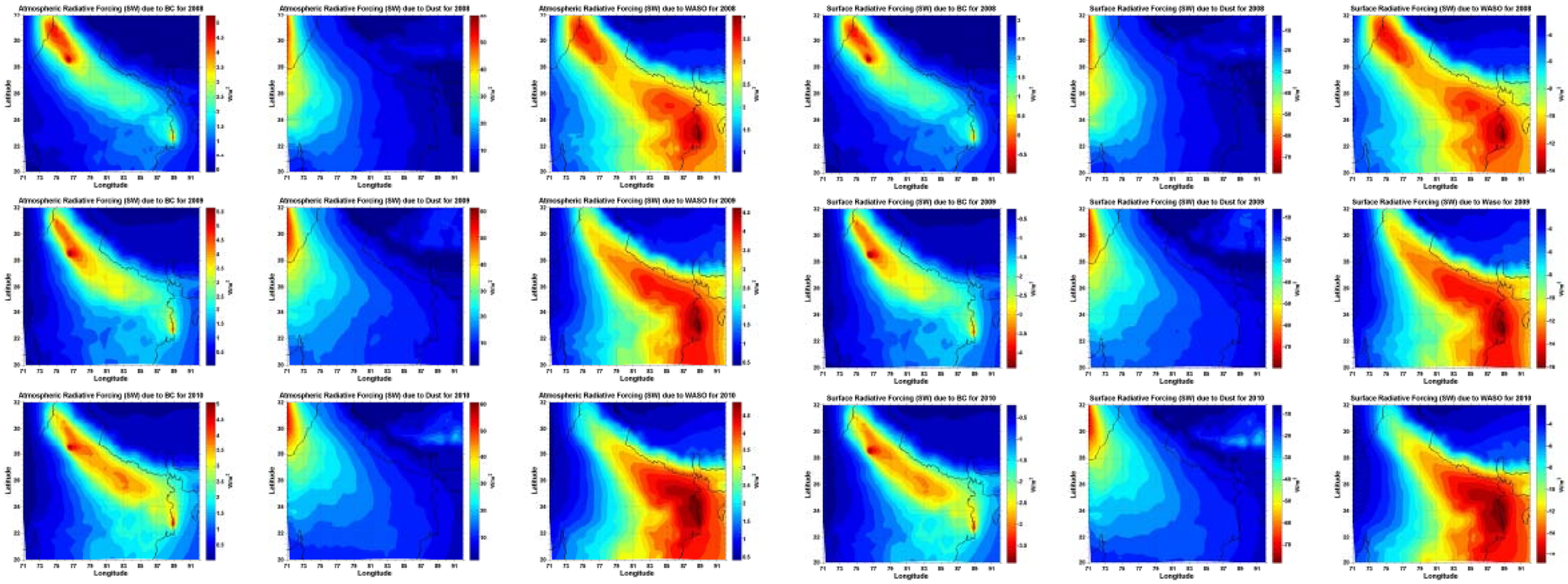
Domain for WRF-Chem Run: 71 to 91.5 E, and 20 to 32 N.

Duration: pre-monsoon months, viz., May and June, for 2008, 2009, and 2010.



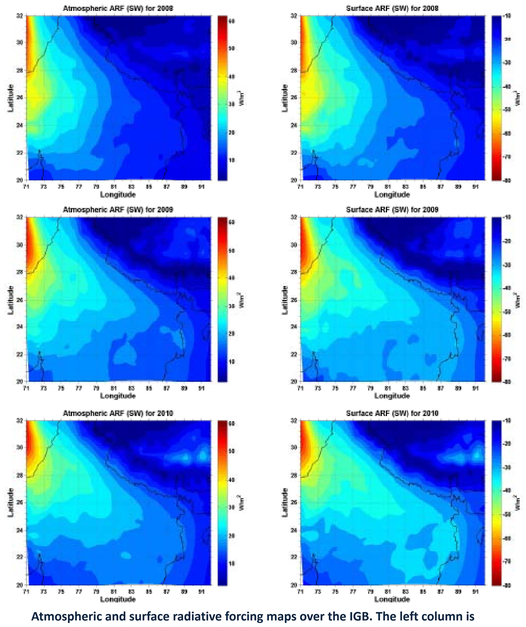
Methodology

WRF-Chem derived mass concentrations are converted to number concentrations using standard procedure. Optical Properties of Aerosol and Cloud (OPAC) software package is used to compute extinction and scattering coefficients, and asymmetry parameter. Computations are performed at different altitudes and the obtained values are integrated to get the column optical properties. Santa Barbara Discrete Ordinate Radiative Transfer (SBDART) model is used to calculate the radiative forcing at surface and top-of-atmosphere.

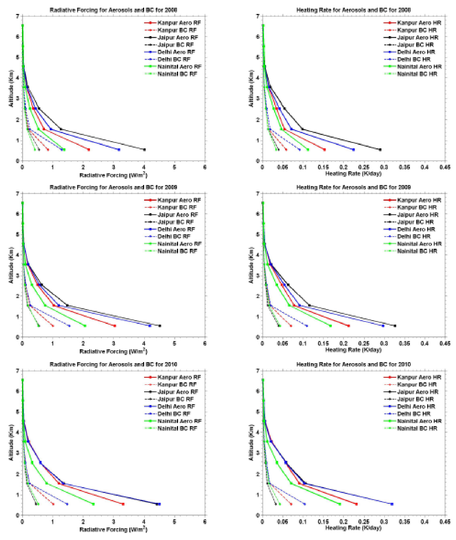


Atmospheric radiative forcing due to individual species. Left column is BC, middle column is dust, and right column is water-soluble aerosols. The various rows are in the order 2008, 2009, and 2010.

Surface radiative forcing due to individual species. Left column is BC, middle column is dust, and right column is water-soluble aerosols. The various rows are in the order 2008, 2009, and 2010.



Atmospheric and surface radiative forcing maps over the IGB. The left column is atmospheric radiative forcing, and right column is surface radiative forcing. The top, middle, and bottom rows are 2008, 2009, and 2010, respectively.



Radiative forcing and heating rate profiles due to aerosols, and only due to BC. The left column shows radiative forcing profiles, and right column shows heating rate profiles. The top, middle, and bottom rows are for 2008, 2009, and 2010, respectively.

Results

- Higher values of aerosol radiative forcing are observed over desert region in western Indian state of Rajasthan, and Punjab of Pakistan.
- Dust radiative forcing is high over western India.
- Radiative forcing due to BC and water-soluble (WASO) aerosols are higher over north-west Indian states of Punjab and Haryana, and the Indo-Gangetic Basin.
- A pool of high WASO optical depth and radiative forcing is observed over the Indo-Bangladesh border.
- Heating rate profiles due to total aerosols and only due to BC, evaluated at selected stations in north India, show variation between various stations and seasons.

References

- M Hess, P Koepke, and I Schult (1998), Optical properties of aerosols and clouds: the software package OPAC, *Bull. Amer. Meteor. Soc.*, 79(5), 831–844.
- Ricchiazzi, P., Yang, S., Gautier, C., & Sowle, D. (1998). SBDART: A research and teaching software tool for plane-parallel radiative transfer in the Earth's atmosphere, *Bull. Amer. Meteor. Soc.*, *79*(10), 2101-2114.
- Grell, G. A., Peckham, S. E., Schmitz, R., McKeen, S. A., Frost, G., Skamarock, W. C., & Eder, B. (2005). Fully coupled "online" chemistry within the WRF model. *Atmospheric Environment*, *39*(37), 6957-6975.