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Aerosol loading impact on Asian monsoon precipitation patterns

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Solar light absorption by aerosols such as black carbon and dust assume a key role in driving the precipitation patterns in the Indian subcontinent. The aerosols stack up against the foothills of the Himalayas in the pre-monsoon season and several studies have already demonstrated that this can cause precipitation anomalies during summer. Despite its great significance in climate change studies, the link between absorbing aerosols loading and precipitation patterns remains highly uncertain.

The main challenge for this kind of studies is to find consistent and reliable datasets. Several aerosol time series are available from satellite and ground based instruments and some precipitation datasets from satellite sensors, but they all have different time/spatial resolution and they use different assumptions for estimating the parameter of interest.

We have used the aerosol estimations from the Ozone Monitoring Instrument (OMI), the Along-Track Scanning Radiometer (AATSR) and the MODerate resolution Imaging Spectroradiometer (MODIS) and validated them against the Aerosol Robotic Network (AERONET) measurements in the Indian area. The precipitation has been analyzed by using the Tropical Rainfall Measuring Mission (TRMM) estimations and the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2).

From our results it is evident the discrepancy between the aerosol loading on the area of interest from the OMI, AATSR, and MODIS, but even between 3 different algorithms applied to the MODIS data. This uncertainty does not allow to clearly distinguishing high aerosol loading years from low aerosol loading years except in a couple of cases where all the estimations agree. Similar issues are also present in the precipitation estimations from TRMM and MERRA-2.

However, all the aerosol datasets agree in defining couples of consecutive years with a large gradient of aerosol loading. Based on this assumption we have compared the precipitation anomalies and found typical patterns characterizing different Indian regions in late summer. Analyzing the AERONET data we have also separated the black carbon and dust contribution to the total aerosol loading based on aerosol spectral optical properties for investigating the link between different aerosol types and precipitation patterns.