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Effects of aerosol optical properties and temporal variations on radiative forcing: focus on the National Capital Region

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ABSTRACT

EFFECTS OF AEROSOL OPTICAL PROPERTIES AND TEMPORAL VARIATIONS ON RADIATIVE FORCING: FOCUS ON THE NATIONAL CAPITAL REGION

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Atmospheric aerosols are widely known to have detrimental health and climate impacts and this issue is a serious concern in the National Capital Region (NCR), the most densely populated region in the Philippines, since it affects the welfare of 12.9 million residents in the region. However, the aerosol patterns in the region is not yet investigated extensively and the effect on climate is yet to be studied. To better understand their optical evolution, temporal variation and radiative forcing effects, MODIS Terra and Aqua aerosol datasets from 2003 to 2017 were studied for trends in aerosol optical depth (AOD), angstrom exponent (AE) and single scattering albedo (SSA), to be used as input in radiative forcing calculations. From the retrieved AOD, it was found out that aerosol loading in NCR is higher during the wet season (May to October) than the dry season (November to April). Higher relative humidity was found to increase AOD due to their effect on the hygroscopic growth of aerosols. The high amount of water vapor in the region greatly affects the optical property of these atmospheric aerosols as revealed by the very high SSA values (above 0.9). The presence of anthropogenic aerosols in the morning is confirmed by the higher AE and lower SSA values compared to afternoon. From the Mann-Kendall trend test, there is a significant decrease in mean afternoon dry season AOD from 2004 to 2017, with a rate

of -0.0042/year, and this is faster than the reported global negative trend. The decrease in dry season AOD coincided with the decreasing black carbon, nitrogen oxides and sulfur dioxide in recent years. From the Tropospheric ultraviolet (TUV) radiative transfer model, the computed aerosol radiative forcing (ARF) values were all negative indicating that aerosols in the region tends to cool the climate, and this is due to the highly scattering nature of the particles. Among the input variables in the model, sensitivity analysis revealed that AOD has the biggest impact on radiative forcing. From the long-term seasonal ARF time series, the mean dry season ARFs are becoming less and less negative through the years and in particular, the afternoon dry season ARFs in the blue and red region of the spectrum have significant trends as revealed by the Mann-Kendall trend test. Even though these aerosols are highly scattering in nature, their depletion in recent years is causing them to have weaker cooling effect on the climate of NCR.