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Impact of tropical cyclones on aerosol properties over urban region of Hyderabad, India

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Fierce tropical cyclones occur in India during the pre-monsoon (spring), early monsoon (early summer), or post-monsoon (fall) periods. Originating in both the Bay of Bengal and the Arabian Sea, tropical cyclones often attain velocities of more than 100 kmh-1 and are notorious for causing intense rain and tidal waves as they cross the Indian coast. Cyclones are associated with heavy rainfall, gusty winds, and sometimes, storm surges. In the present study, we have analyzed the changes in aerosol properties at Hyderabad, India, associated with very severe cyclonic storm "Mala" occurred during the last week of April, 2006 over the Central-Eastern part of the Bay of Bengal centered near Lat. 16.0 N and Long. 93.0 E, at 18:00 UTC on 28th April 2006, about 500 Km North of Portblair. This tropical cyclone, packing winds of 240 km/h, slammed into Myanmar on 28th April and 29th April destroying hundreds of houses, two beach resorts and at least five factories as per the reports of the Kyemon daily paper and the International Federation of the Red Cross. Cyclone "Mala" is described as the most severe cyclone in the Bay of Bengal after the 1999 Orissa Super Cyclone. The measurements for the case study were carried out in the premises of the National Remote Sensing Centre (NRSC) campus at Balanagar (17o.28' N and 78o.26' E) located within the Hyderabad urban center during cyclone period. Synchronous and continuous observations of columnar Aerosol Optical Depth (AOD) were carried out using a handheld multi-channel sun-photometer (Microtops-II, Solar Light Co., USA) at six wavelength bands centered around 380, 440, 500, 675, 870 and 1020 nm. Continuous measurements of particulate matter (PM) grain-size distribution were performed with the GRIMM aerosol spectrometer, model 1-108. The cyclone "Mala" over the Bay of Bengal occurred during 26-29 April, 2006, struck the coast of Myanmar with winds of 115 mph (185 kmh-1), causing severe damage and loss of human life on 29 April, 2006. Initially the depression was moving northwest and on 25 April it changed its direction and accelerated towards north and after northeast resulting in remarkable wind direction changes. As the cyclone moved towards the Myanmar coast on 29 and 30 April, the low-level convergence turned to northwesterly, pulling air from the northern Indian landscapes. This caused an increase in wind speed over the entire Bay of Bengal. The intensity of the cyclonic activity affected continental India on 28 and 29 April. On that day the wind field was dominated by a northwesterly flow from Indian continent towards the Bay of Bengal, which lifted a lot of mineral dust particles from the Indian arid landscapes. This is further confirmed from the analysis of Terra-MODIS image on 29 April, where the dust plumes over the Bay of Bengal can be clearly detected. The variation of the daily mean particulate-matter load measured by the GRIMM instrument showed nearly a two-fold increase in particulate-mass concentrations during the intense cyclone period (28th and 29th April). This is attributed to the increase in surface winds caused by the cyclonic activity, strongly associated with lifting of coarse-mode aerosols from the landscapes neighboring Hyderabad. Also, from the large standard deviations it is concluded that the diurnal pattern of the PMx concentrations are highly variable during the cyclonic activity, probably caused by the frequent and sharp changes in wind speed and direction accompanying it. The day-to-day variation of AOD500 and Ångström exponent were also analysed. Contrary to the PMx concentrations, the AOD500 values showed remarkable decrease during the cyclone period. This decrease can be as high as 44% between the pre and during cyclone days (25th and 28th April), respectively and 41% between 28 and 30 April. These large variations in aerosol load are mainly attributed to the changes in wind speed and direction as well as the air mass trajectories, bringing marine air masses over the

region on 28th April. Despite the uplifting of soil particles near the surface, the higher winds can act as a ventilation tool for the whole atmospheric column, thus resulting in lower AODs. Results are discussed in the paper.