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A Trend Analysis of Aerosol Related Parameters and their Relation to Precipitation Variability in Arizona

Krista Rasmussen (1) and Hesham El-Askary ()

(1) Chapman University, Orange, California, United States (rasmu113@mail.chapman.edu), (2) Chapman University, Orange, California, United States (elaskary@chapman.edu)

The Objective of our research was to investigate if there is a correlation between haboob outbreaks, resulting in large dust storms over Arizona, and the precipitation patterns over the region. We also examined the extent of this correlation over the last ten years using satellite daily observations to highlight the possibility of better forecasts for precipitation events, such as monsoon thunderstorms. Our research indicates that haboobs increase precipitation in the Sonoran desert of Arizona because the dust particles are large enough to act as cloud condensation nuclei (CCN). The dust particles absorb moisture from the air, causing larger storms to occur when these swollen particles of dust mix with the rain of the monsoons. Data was collected from five locations spread out over the state of Arizona for the years of 2002-2012. The method we utilized was data oriented and required a quantitative analytical approach, where aerosol optical depth (AOD) data from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra satellite was collected and analyzed. Other parameters, namely Angstrom Exponent and Water Vapor Cloud (WVC), were used to identify different types of aerosols with different sizes in the atmosphere. It was found that high AOD values associated with slowly moving air masses were generally accompanied by higher precipitable water vapor. Precipitable water vapor is a measure of the water vapor content of the air. It is one of the most important greenhouse gases of the atmosphere, participating in a major way in the energy cycle (latent heat). Moreover, it regulates the planetary temperatures through absorption and radiation emission, most significantly in the thermal infrared (the greenhouse effect). However, the indirect forcing involving the interactions between aerosols and clouds, impacting climate, has large uncertainties and requires further investigation. Knowledge of the haboobs seasonal patterns can be combined with the aerosol Angstrom exponent analysis to achieve an approximate differentiation of the aerosols' origins. On the other hand rainfall data from NASA's Tropical Rainfall Measuring Mission (TRMM) satellite was collected and analyzed in coherence with the aerosol data. By manipulating this data into a time-series form, we determined the direct correlation between dust and precipitation events. It was found that increased dusty events increased precipitation with an average of two months lag time. This can be attributed to the fact that dust can remain high up in the atmosphere for months after a haboob occurs, thus influencing precipitation for up to two months following a dust storm. The data from the five locations was decomposed and cross-correlated in order to determine the nature of the relationship between the dust and rain. Each location indicated that a strong correlation does exist between the AOD, Angstrom exponent, and precipitation data, indicating that the there are complex interactions occurring between dust and precipitation in Arizona at a microphysical level.