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Integrating simultaneous aerosol, cloud and water vapor profiles for climate studies

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Aerosols in the troposphere have broad impact ranging from human health effects to global climate change. These effects are poorly quantified and represent the greatest uncertainty in our understanding of the climate system. Moreover, aerosols, in indirect way, tinker with size, shape and location of clouds. Pollution aerosols act as cloud condensation nuclei, making the clouds brighter, denser, long-lived, and more extensive, thus reflecting more sunlight back into space and partially mitigating global warming. Although chemical composition of aerosol particles is crucial to its ability to nucleate new droplets, it is less important than the size in determining their ability to nucleate clouds. The interacting pathways between clouds and aerosols are very complex because clouds remove aerosols, but aerosol may also be produced and enhanced within the clouds through chemical and physical processes. Thus, the significant role of atmospheric aerosols in modulating tropical clouds has far reaching consequences on weather and climate. Atmospheric water vapor also plays a vital role in bridging aerosol and cloud processes. At high relative humidity aerosols often expand (thereby size, shape, polarization and chemistry) by absorbing water, and make the cloud drop nucleating ability more complex. Albeit, satellites provide large scale coverage of the column measurements of aerosols, clouds and water vapor, vertical profiles are essential for better understanding of their climatic influences. With an aim to obtain such vertical distributions of aerosols, clouds and water vapor, an ultra-high space (7.5 m)-time (less than a minute) resolution pulsed Raman lidar has been installed recently, for the first time in the country, at the Indian Institute of Tropical Meteorology (IITM), Pune, India. This lidar utilizes Nd:YAG laser with its fundamental (1064 nm) and harmonic (355 nm) radiation, and a Cassegrain telescope with multi-channel transient recorder receives back-scatter signal at these wavelengths in addition to the Raman shifted lines at 387nm and 408nm for determining water vapor mixing ratio. This lidar also has the capability to observe cloud profiles through multiple scattering phenomenon. This paper purports simultaneously obtained aerosol and cloud extinction and water vapor mixing ratio profiles and their interplay. Added, the boundary layer and cirrus cloud structures and their association with concurrent structures observed with NIR Doppler Wind Lidar and GPS Radiosonde will be discussed.