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Giant aerosol observations with cloud radar: methodology and effects

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Giant aerosol particles can act as Giant Cloud Condensation Nuclei (GCCN), and determine
the droplet concentration at the cloud formation, the clouds albedo and lifetime, and the precipitation formation. In addition, depending on their composition, they can also act as IN. It is not yet clear if they can also expedite rain processes.
The main techniques used nowadays in measuring aerosols, which are lidar and sun photometer, cannot retrieve aerosol microphysical properties for particles bigger than a few microns, which means that they do not account for giant aerosols. Therefore, the distribution and impact in the atmosphere and climate of these particles is not well known and the aerosol transport models largely underestimate them.
Recent studies have demonstrated that cloud radars are able to detect ultragiant volcanic aerosols also at a large distance from the source.
In this study, an innovative methodology for the observation of giant aerosols using the millimeter wavelength radar has been developed and applied to 6 years of measurements carried out at CNR-IMAA Atmospheric Observatory (CIAO), in Potenza, South Italy, finding more than 40 giant aerosol events per year and a good agreement with the aerosol climatologic data.
Besides, the effects of giant aerosols in the local and regional meteorology have been studied by correlating several atmospheric
variables in the time period following the observation of giant particles. The meteorological situation has been assessed through the data classification into cases characterized by different pressure vertical velocities at the upper atmosphere (400 hPa), Giant aerosols are correlated to lower values of the Cloud Optical Depth (COD) in presence of stable or unstable atmospheric conditions while higher values are found for an intermediate stability. The giant aerosols effects on the Liquid Water Path (LWP) are closely linked to those in the Aerosol Optical Thickness (AOD). The highest increases in the LWP occurs together with the increases of AOD.
Finally, the effects of giant aerosols on precipitation at a regional scale have been studied. The observation of giant aerosols can be correlated to an enhancement of the accumulated precipitation, which is quite relevant in the first 12 hours after their observation, as well as of the maximum rain rate in presence of the unstable atmospheric conditions. The increase in the maximum rain rate is instead more remarkable in correlation with stable atmospheric conditions and mainly during the first 6 hours after their observations.