

The impact of particulate matter on the precipitation in Athens, Greece

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Aim of the study

The objective of this study is to investigate the short-term relationship between particulate matter concentrations and daily precipitation features in Athens, Greece, during the period 2001-2009. The mean daily surface mass concentrations of particulate matters with a diameter less than 10 μm (PM_{10}) or less than 2.5 μm ($\text{PM}_{2.5}$), were acquired from the air pollution-monitoring network of 7 monitoring stations of the Greek Ministry of Environment Energy and Climatic Change (GMEECC). Besides, daily precipitation totals (mm) and duration (h) from the National Observatory of Athens (NOA) and satellite observations of cloud properties (such as cloud effective radius, cloud optical depth, cloud top pressure) from MODIS Terra and Aqua Daily Level-3 Data, were used in the analysis.

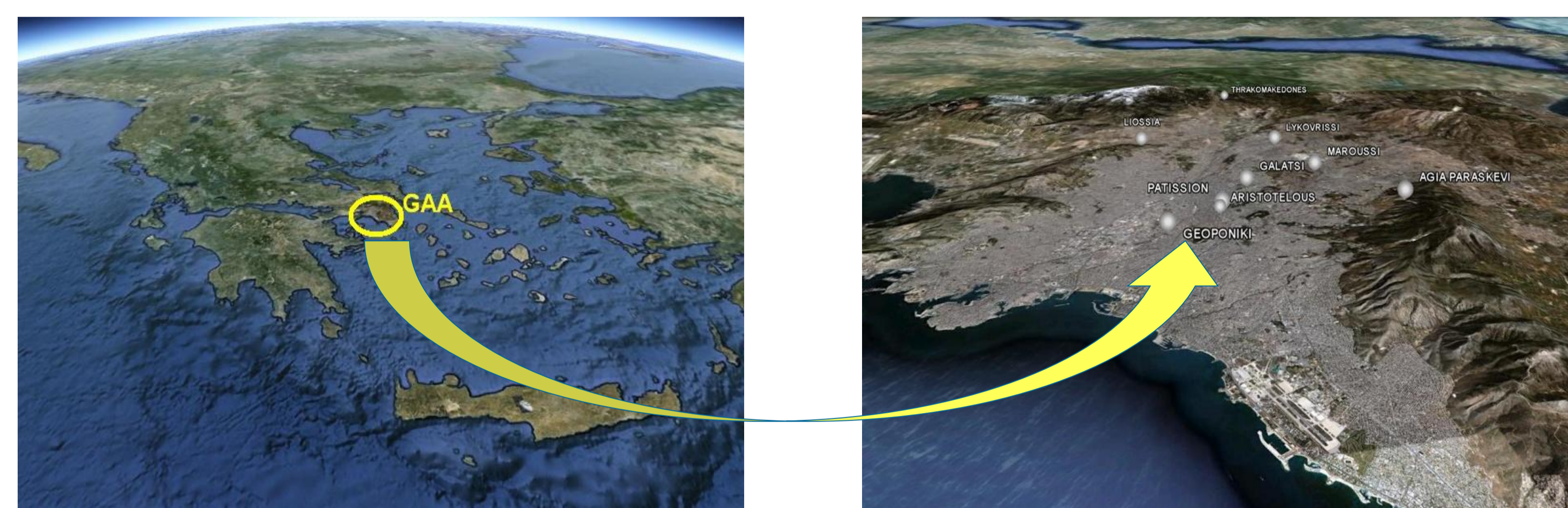


Figure 1. Map of Greece (left graph) and the air pollution-monitoring network of the GMEECC within GAA (right graph).

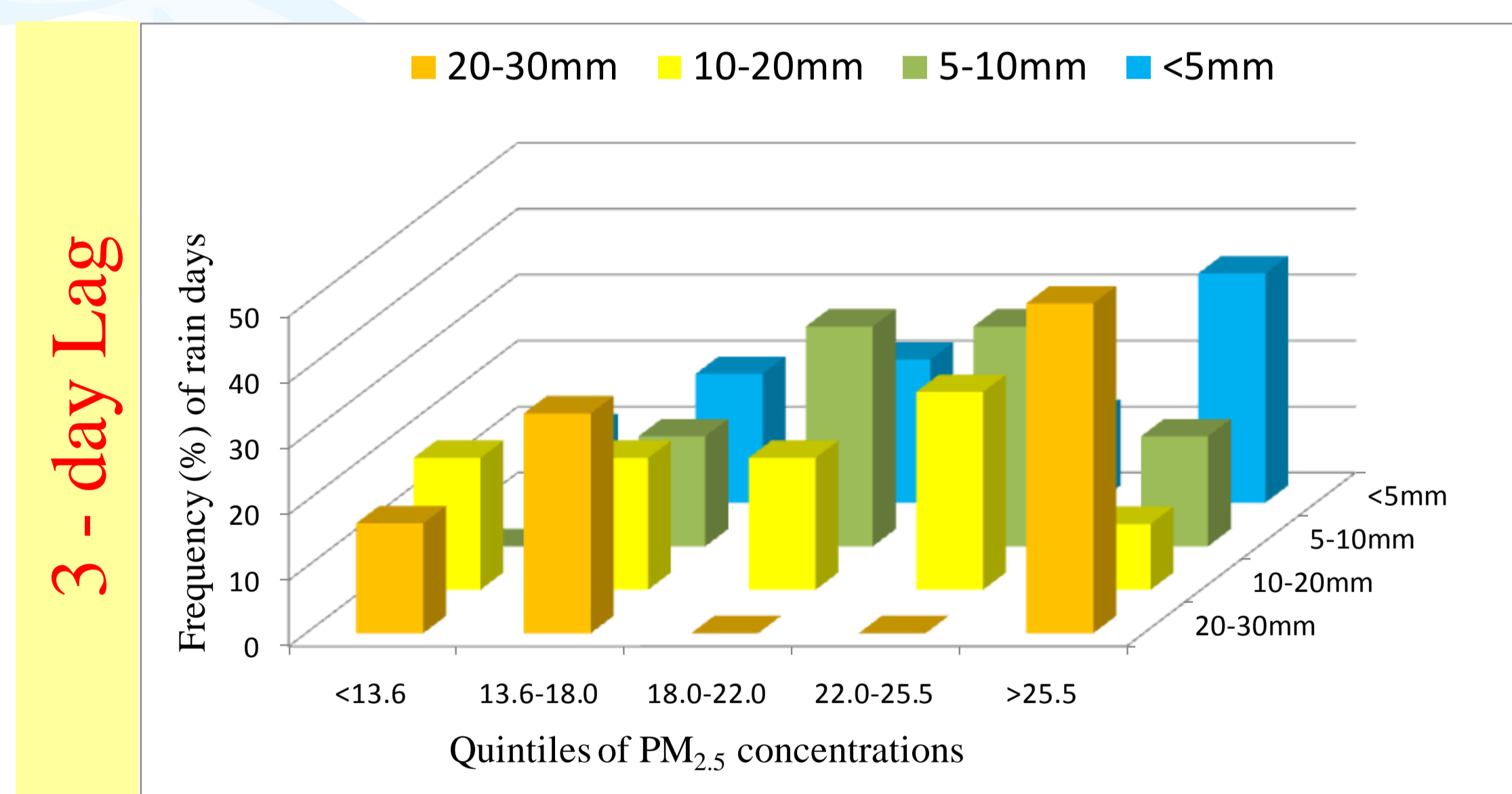
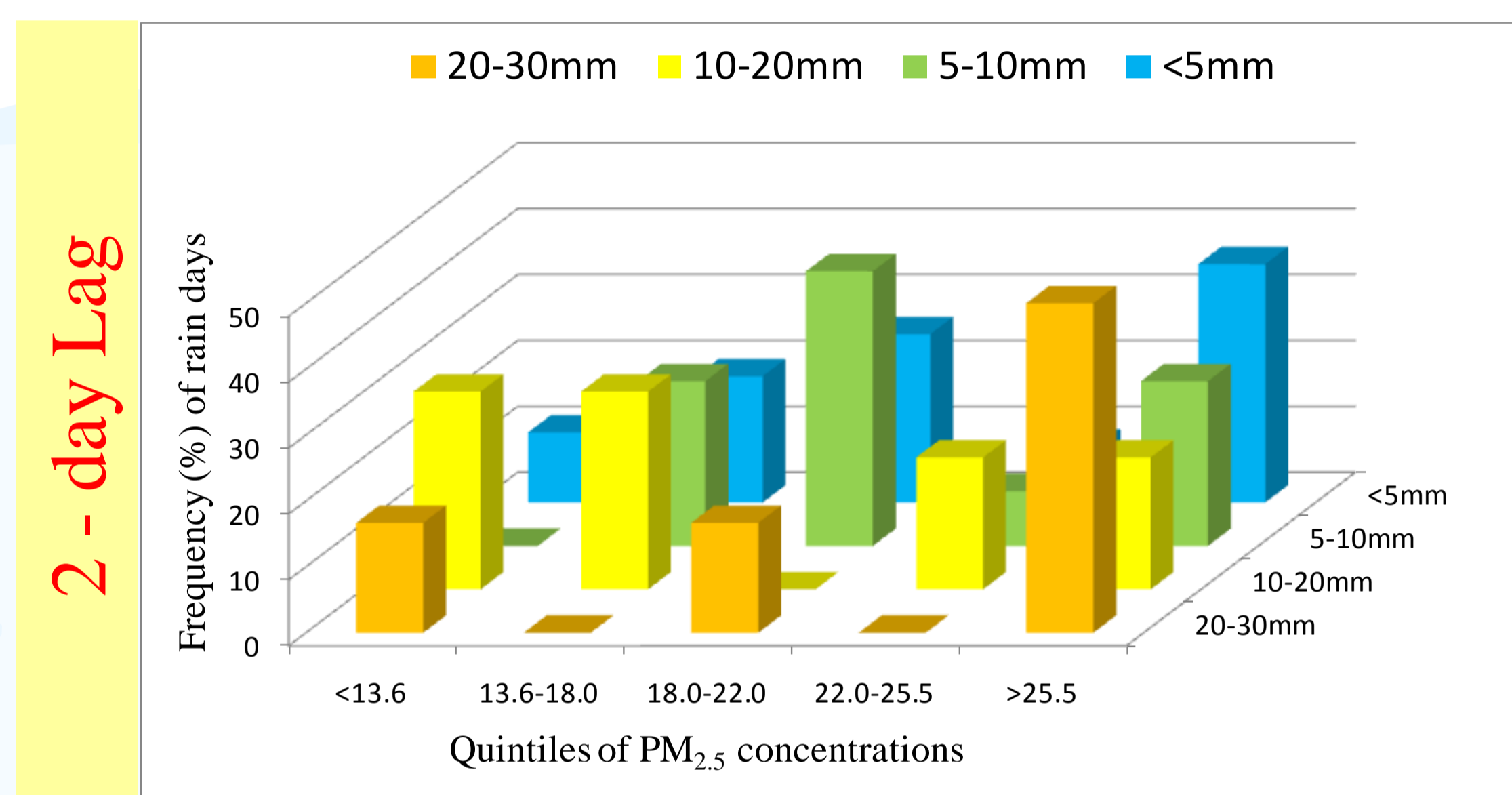
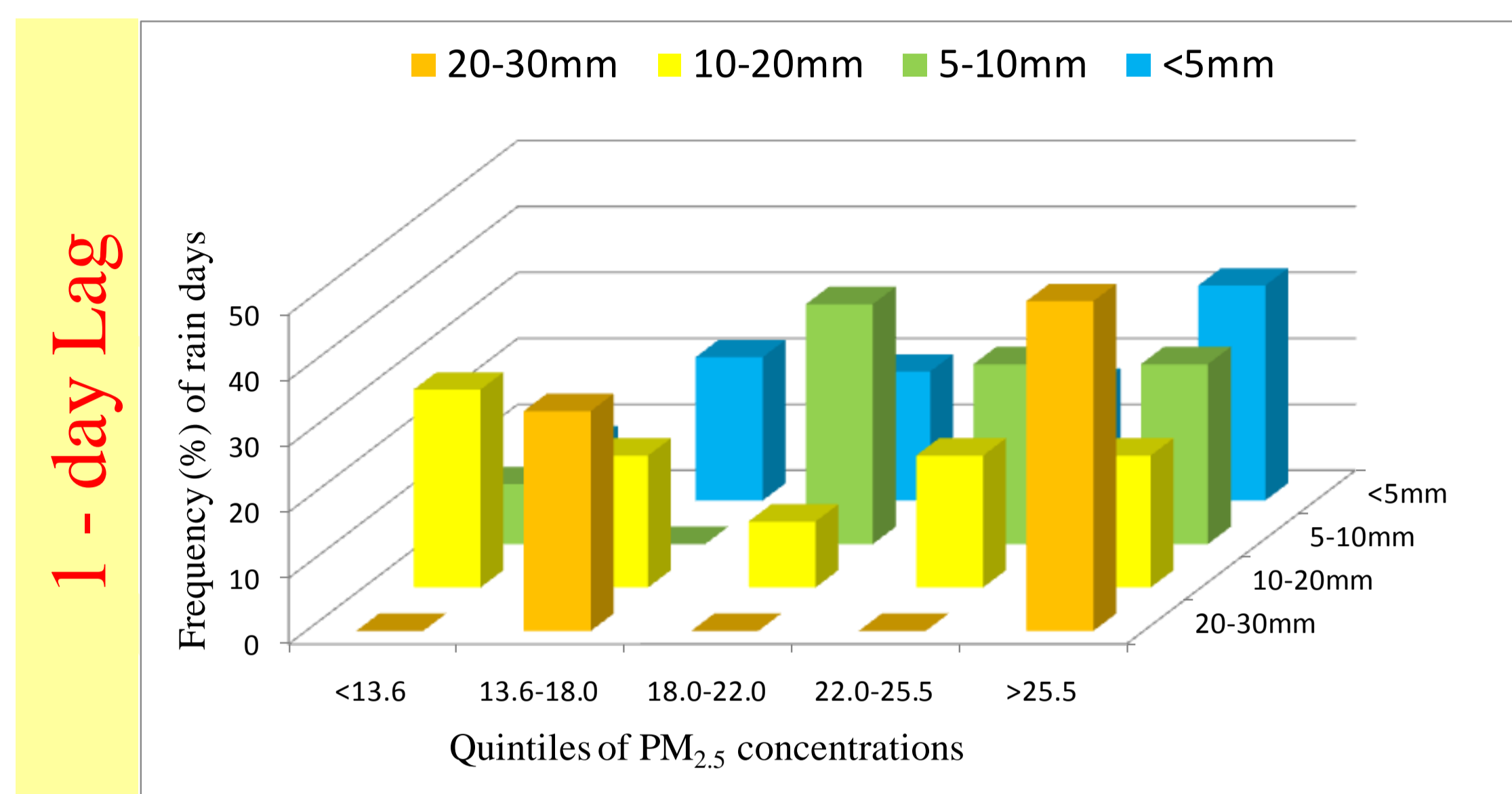


Figure 3. Frequency of rain days (%) with rain < 5 mm, 5-10 mm, 10-20 mm, 20-30 mm and > 30 mm for each quintile of mean daily $\text{PM}_{2.5}$ concentrations within greater Athens area, for the entire year.

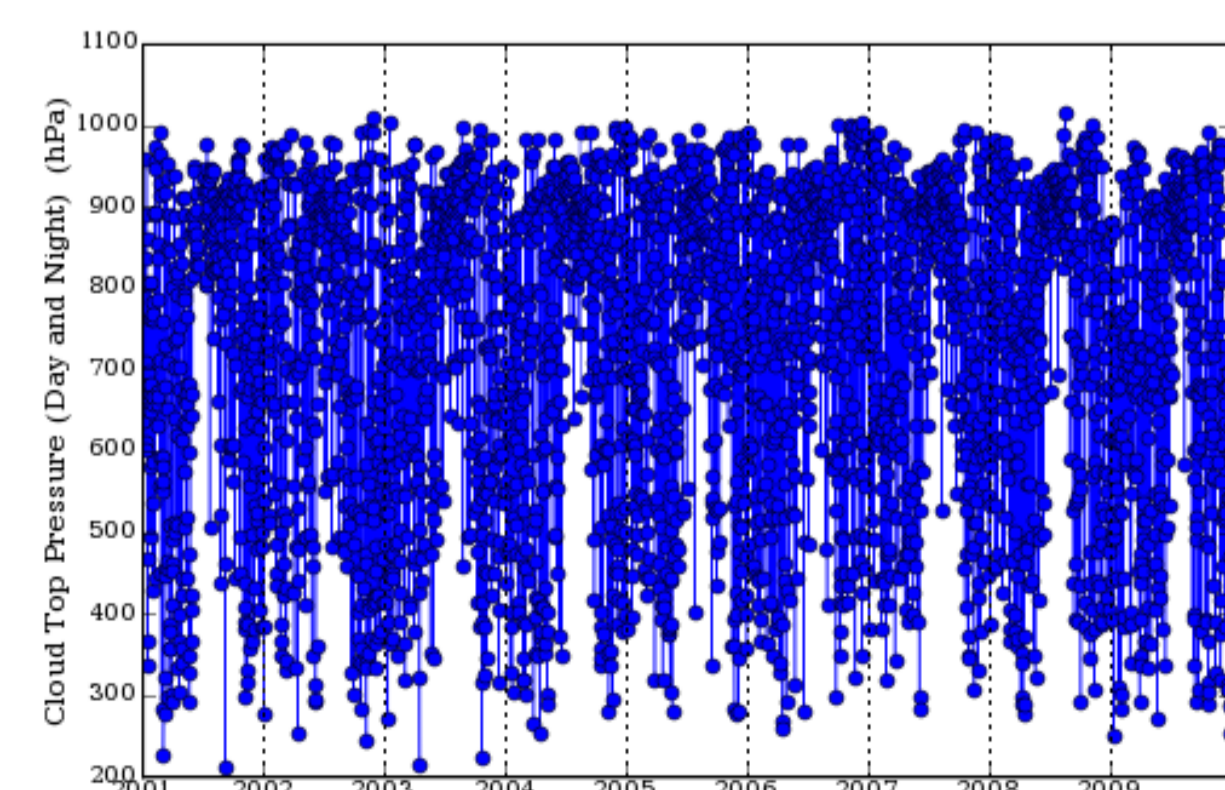


Figure 6. Time series of area average of cloud top pressure from Modis Terra.

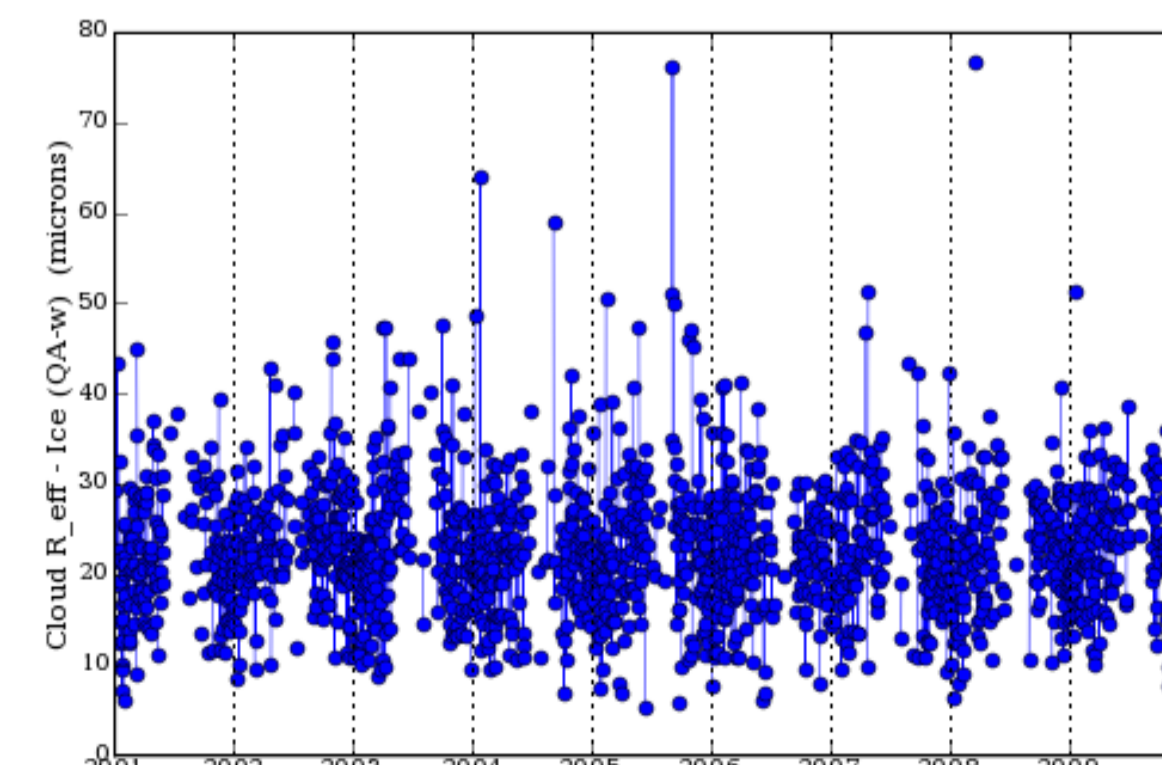
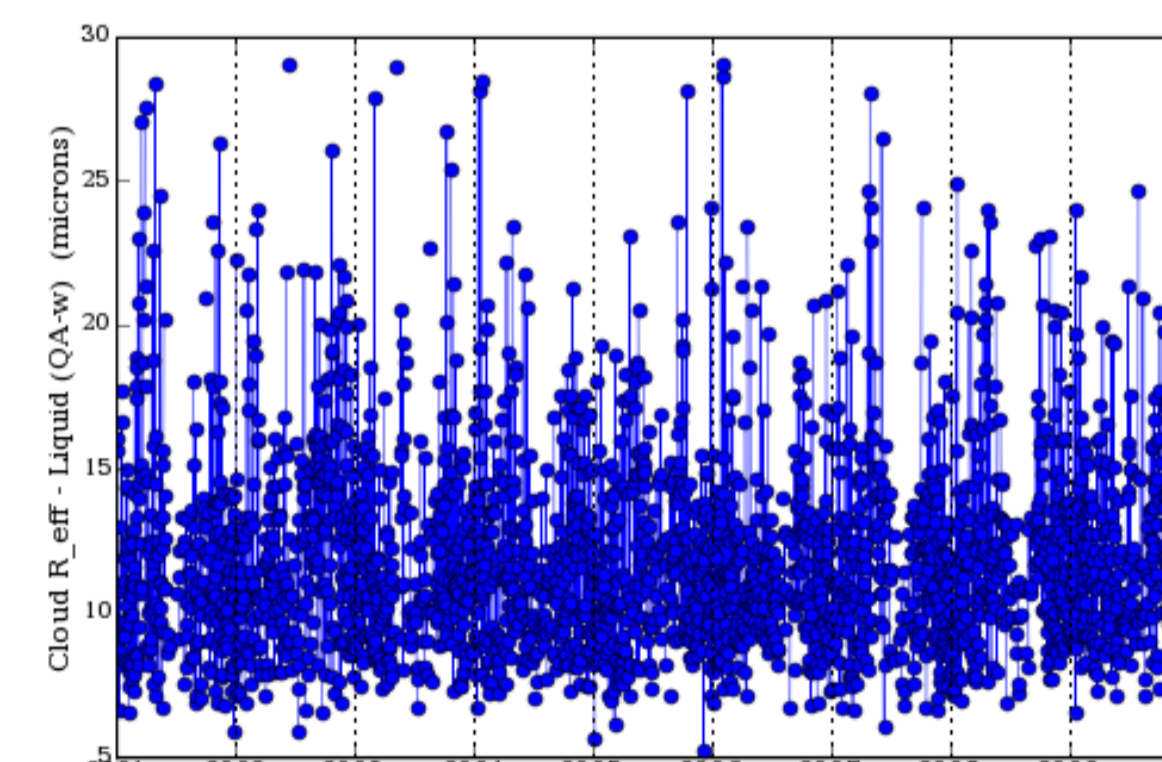
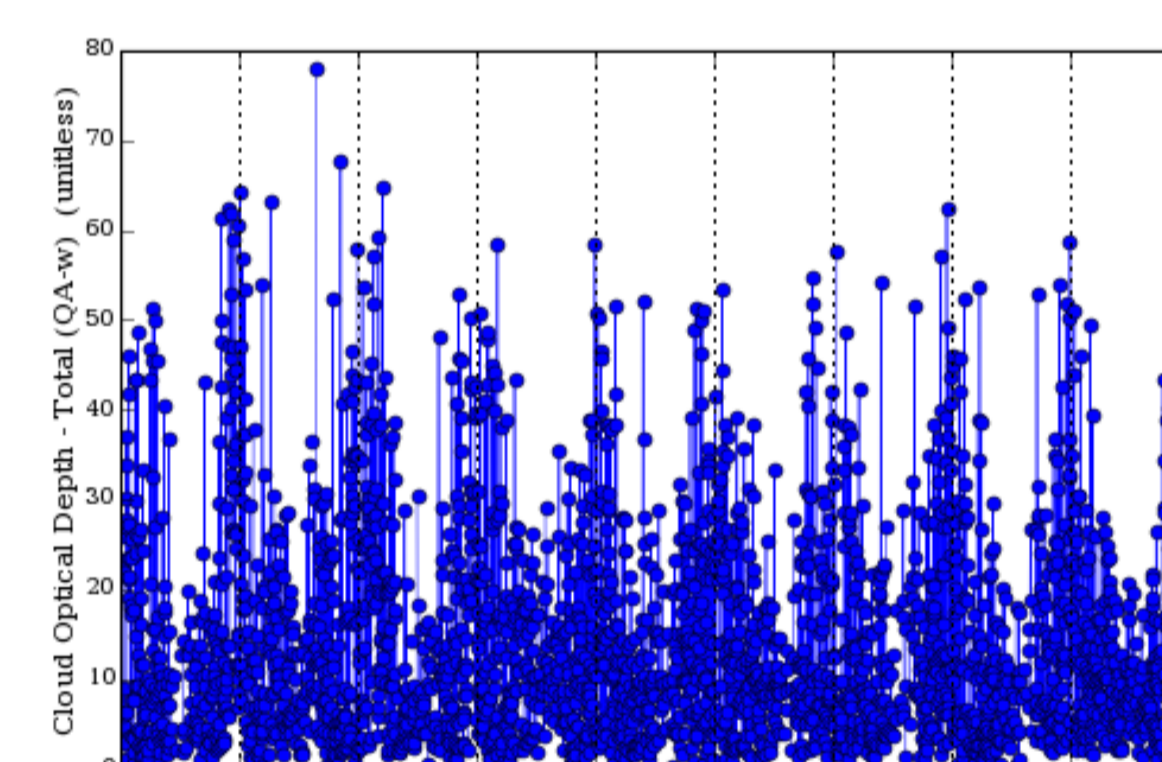


Figure 5. Time series of area average of cloud effective radius for ice (lower graph), liquid (middle graph) and total cloud optical depth (upper graph), from Modis Terra.

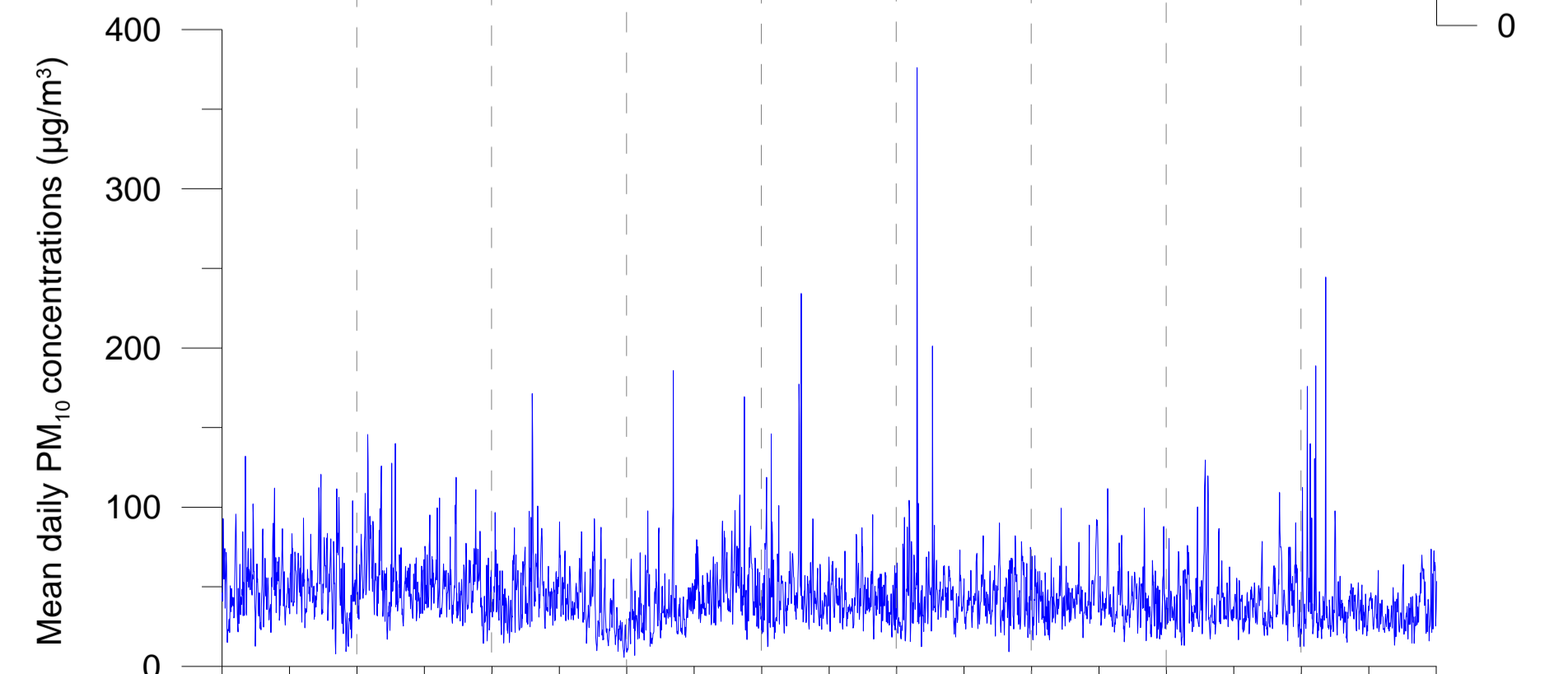
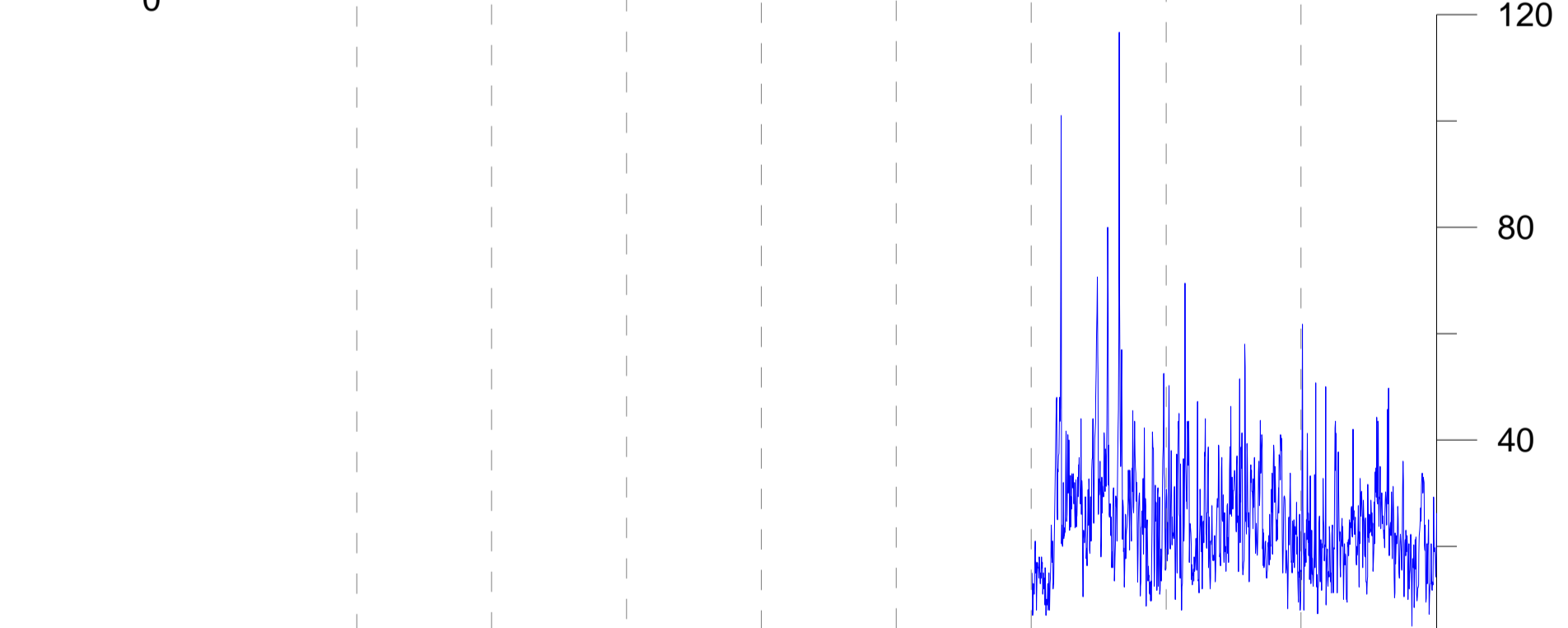
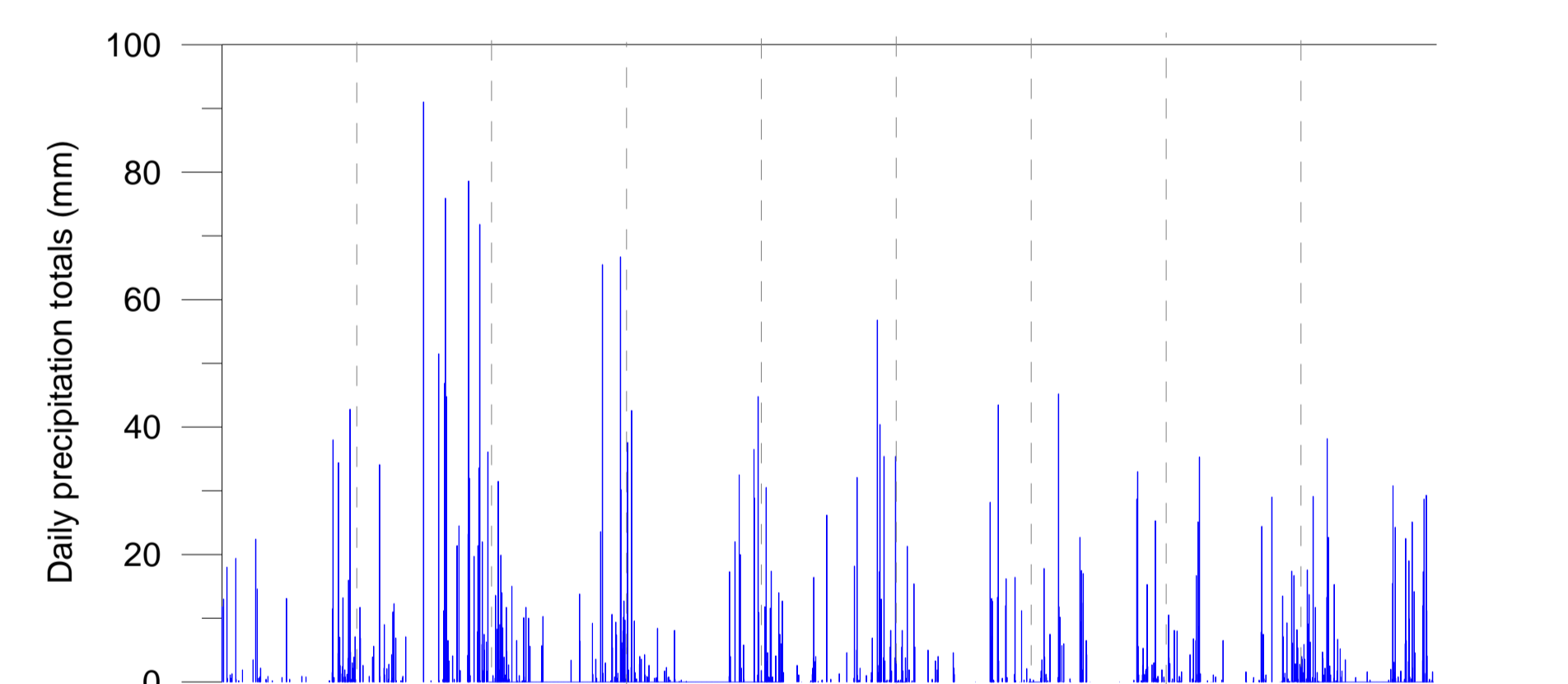


Figure 4. Time series of mean daily PM_{10} concentrations (lower graph), mean daily $\text{PM}_{2.5}$ concentrations (middle graph) and daily precipitation totals (upper graph) within greater Athens area, during the period 2001-2009.

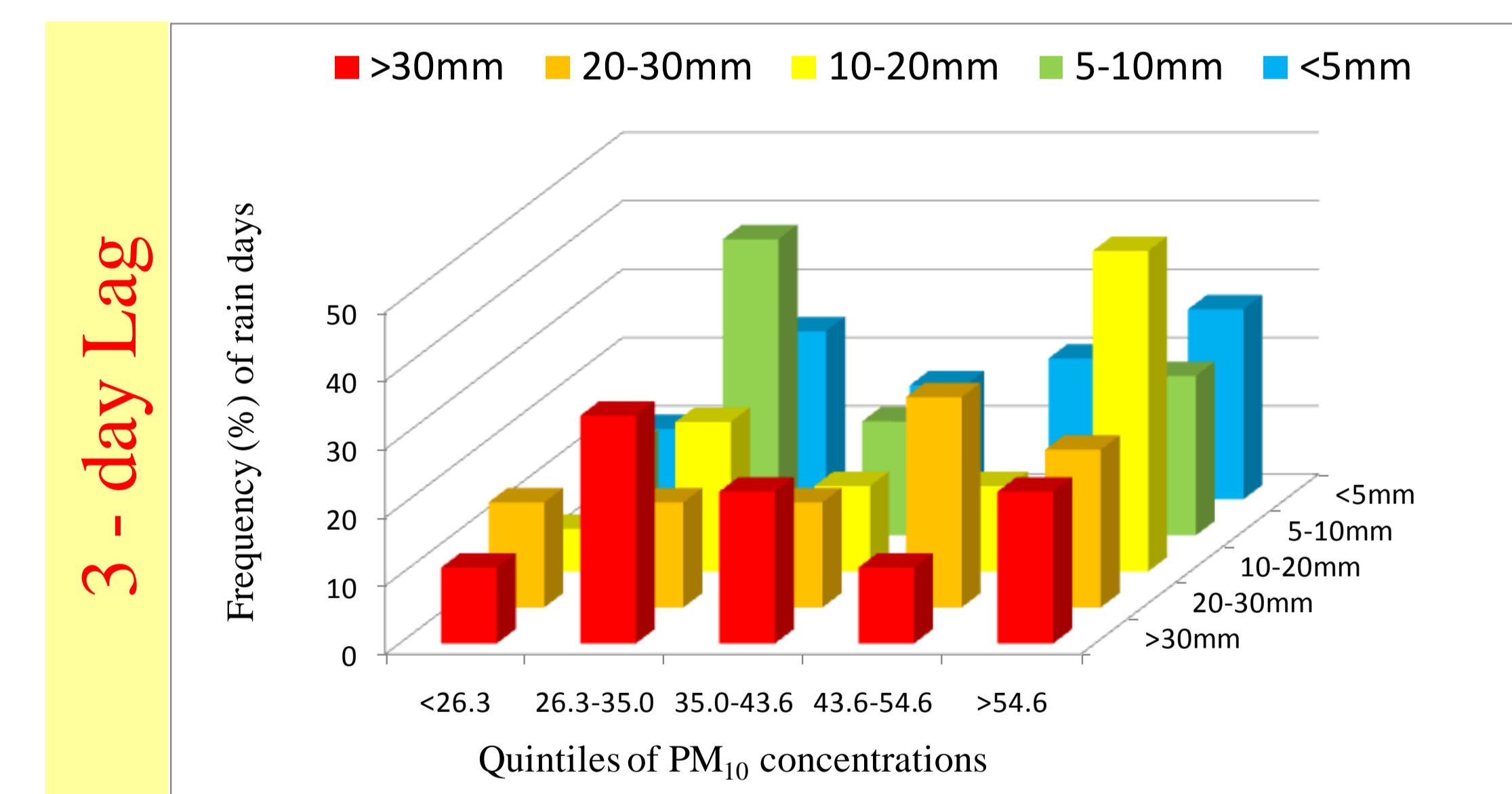
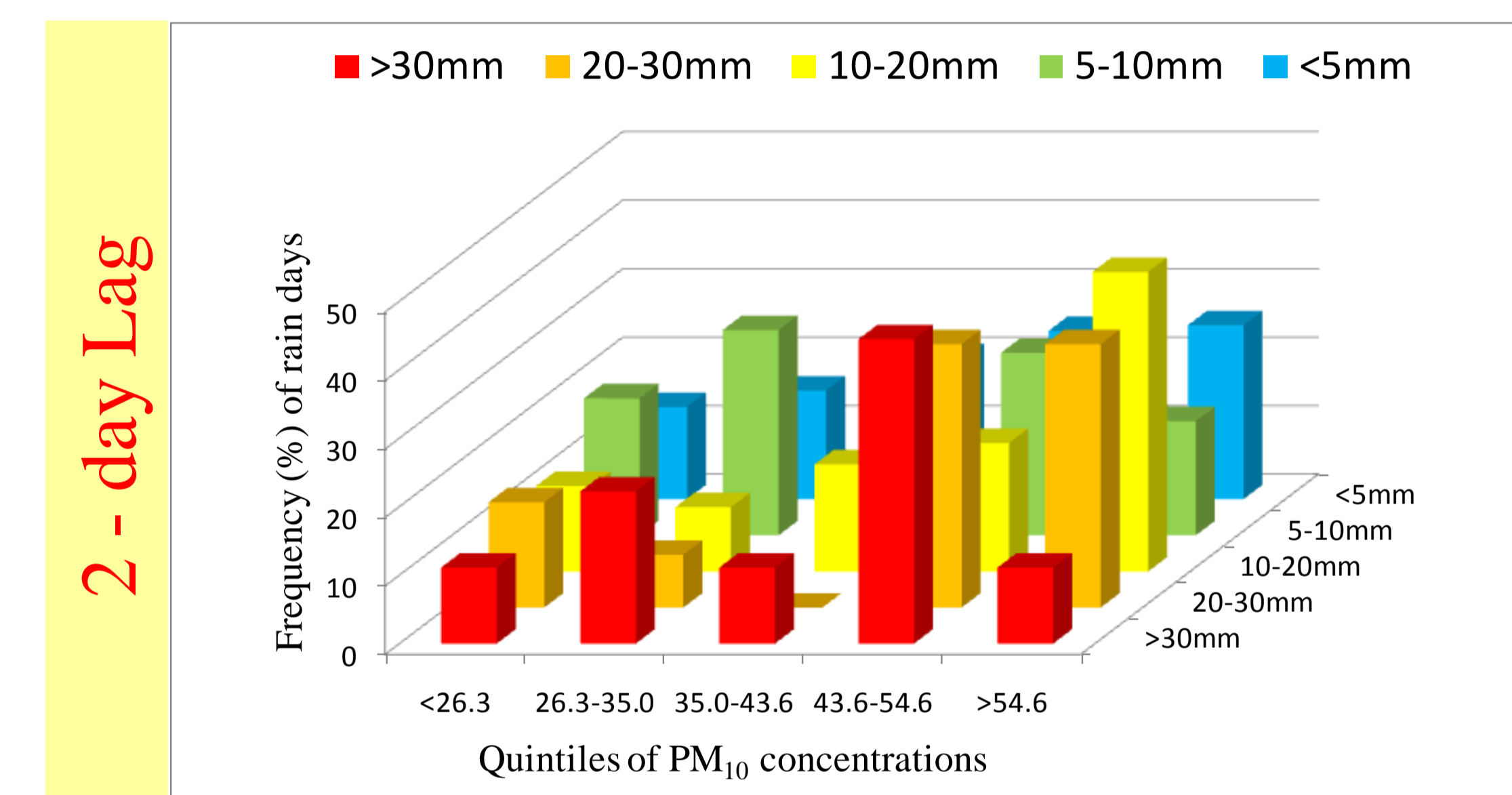
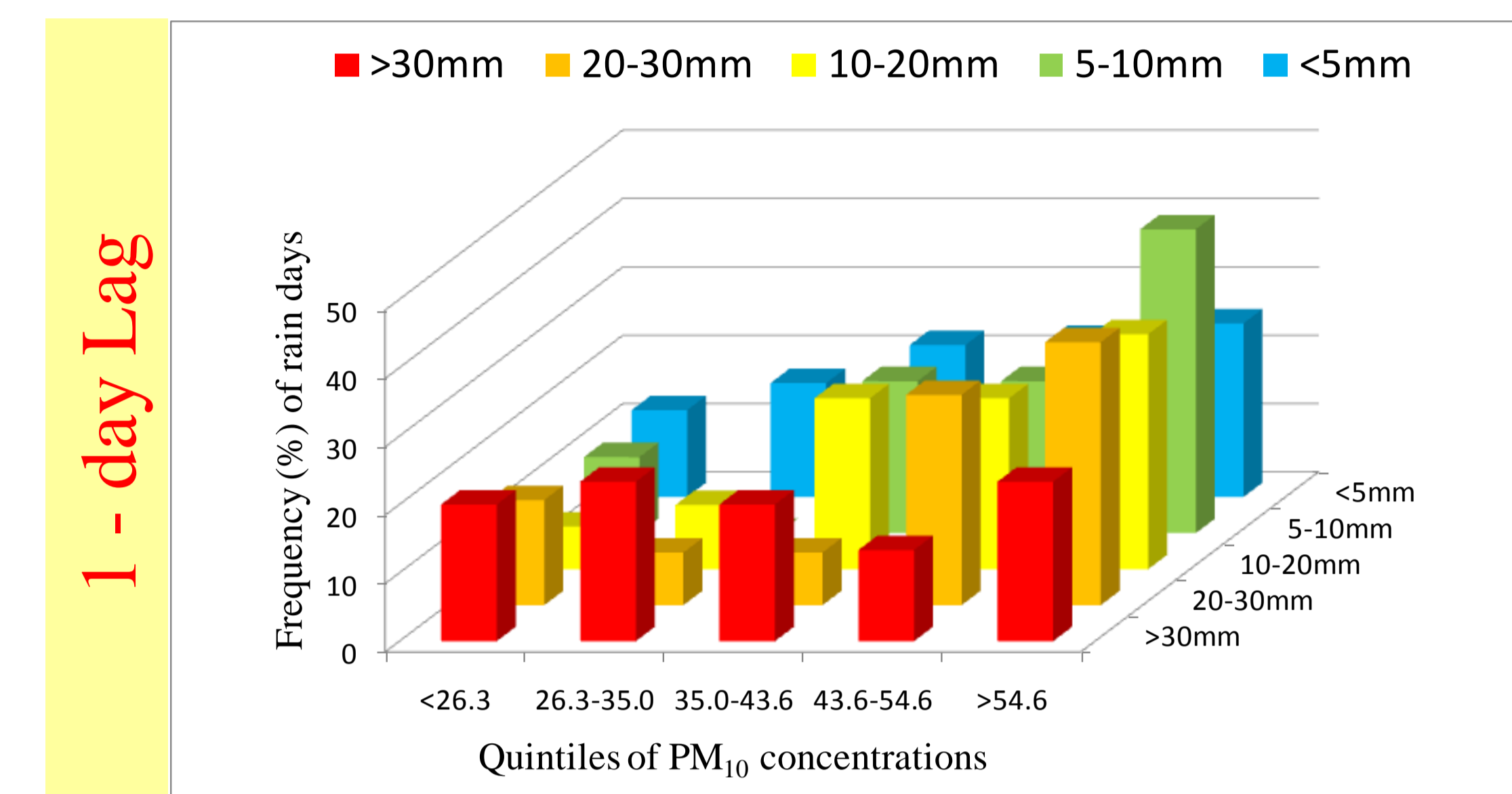


Figure 2. Frequency of rain days (%) with rain < 5 mm, 5-10 mm, 10-20 mm, 20-30 mm and > 30 mm for each quintile of mean daily PM_{10} concentrations within greater Athens area, for the entire year.

Conclusions

The results showed that, PM_{10} and $\text{PM}_{2.5}$ concentrations are positively correlated with the frequency of light (<5 mm day⁻¹ and 5-10 mm day⁻¹) and moderate precipitation (10-20 mm day⁻¹) days against no relationship with the frequency of very heavy precipitation (>30 mm day⁻¹) days. Using superposed epoch analysis, it was found that high PM_{10} concentrations existed few days before the occurrence of moderate precipitation. Satellite observations of cloud properties show that higher aerosol concentrations are positively correlated with the increase in cloud effective radius, cloud optical depth, and cloud-top heights. Based on the examined period, it is likely that, the increase in aerosol concentration results in the increase of precipitation frequency in Athens via enhanced coarse nucleation in the middle troposphere.

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