Diurnal Cycles of Bioaerosols in NW Spain

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1. Motivation and Objectives

Atmospheric bioaerosols form a unique class of aerosol particles that are ubiquitous in nature, morphologically complex and are produced from a wide range of natural and anthropogenic sources. Laboratory and cloud chamber studies have identified some types of bioaerosols as potential cloud condensation nuclei (CCN) and ice nuclei (IN) and more recent airborne measurements have found organic material in cloud droplets and ice crystals associated with bioaerosols. The results from these studies suggest that bioaerosols may play an important role in cloud formation and evolution and hence an important factor also in climate change.

Ground based studies have linked the production of pollen and fungal spores to meteorological conditions. In particular, increased concentrations have been measured following rainfall, suggesting a link between elevated moisture and the release of pollen by plant life and fungal reproduction.

With the advent of instruments that can continuously measure bioaerosol concentrations using light induced fluorescence (LIF), the relationship between meteorology and pollen-spore production can be analyzed in much greater detail.

The objective of the current study is to use one of these LIF instruments, the Wideband Integrated Bioaerosol Spectrometer (WIBS) to evaluate the relationship between the properties of pollen and fungal spores and meteorological trends.

The measurements were made in the spring of 2015 on the campus of the University of Leon, Leon, Spain, from May 20 – June 6. Hourly samples (obtained from a spore trap Lanzoni, VPPS 2000) were made at the same time and analyzed for pollen concentrations.

2. Measurement Methodology

The Wideband Integrated Bioaerosol Sensor – WIBS (Fig. 1) measures the equivalent optical diameter (EOD) and the fluorescence of individual particles in three spectra bands when the particle is excited at two wavelengths: 280 nm and 370 nm. The EOD size range of the WIBS is from 0.5 µm to 20 µm.

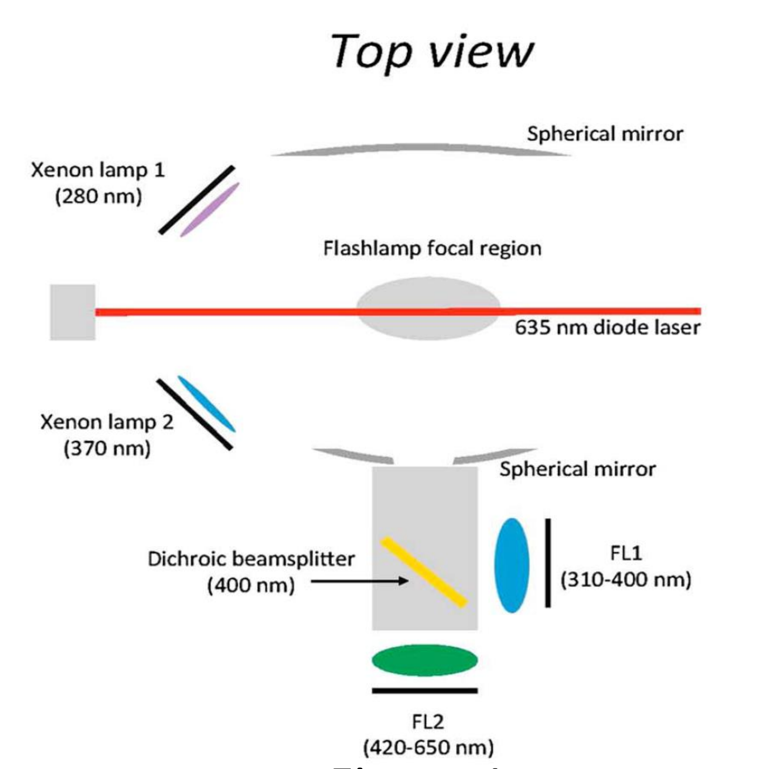

Figure 1

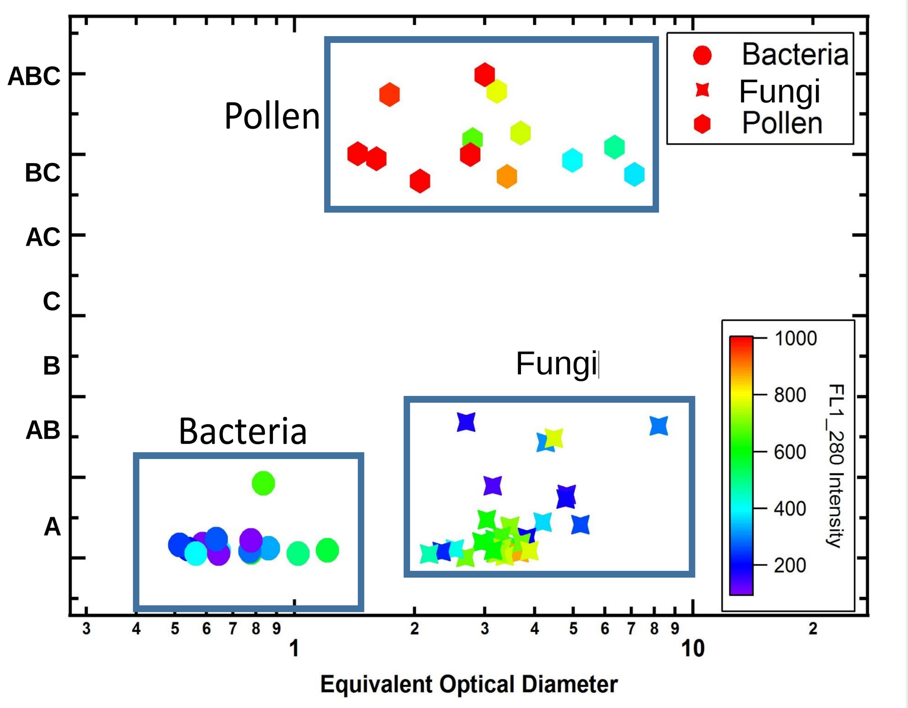

Figure 2

Fluorescing particles are classified into 7 types and compared with a laboratory generated library of bacteria, fungi and pollen (Fig. 2). Those particles that don't match library types are classified as "other".

3. Results

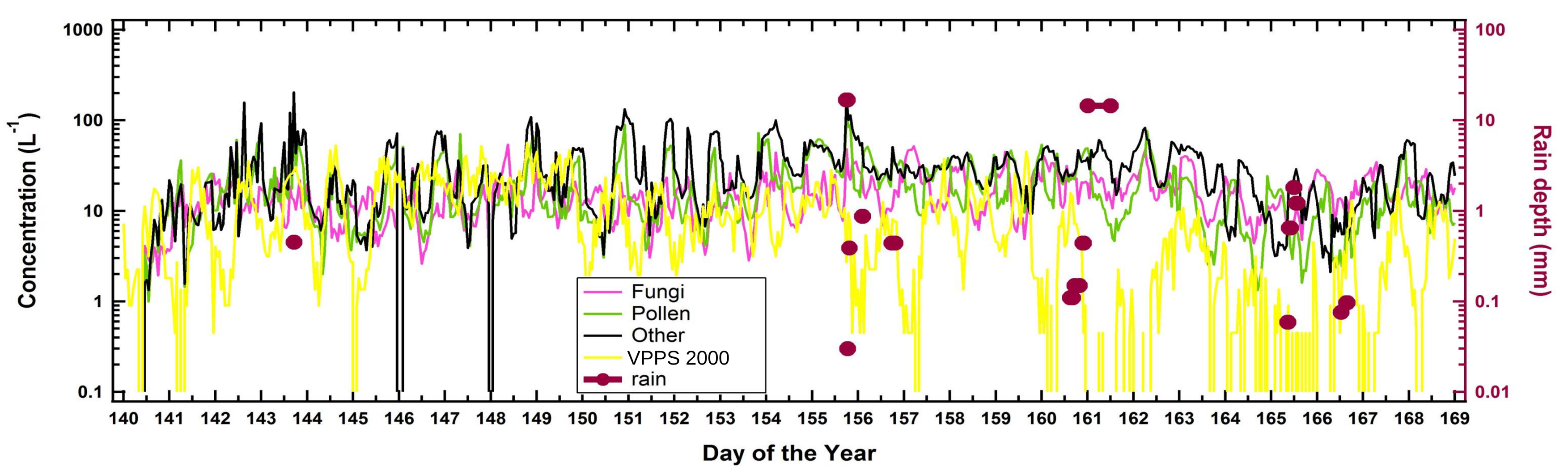

Figure 3 The time series of fungi, pollen and unidentified bioaerosol (other) measured by the WIBS show a daily oscillation in concentration, generally reaching maximum values at night time. The pollen concentration from VPPS 2000 is similar to measured by the WIBS but is more affected by rain than WIBS pollen.

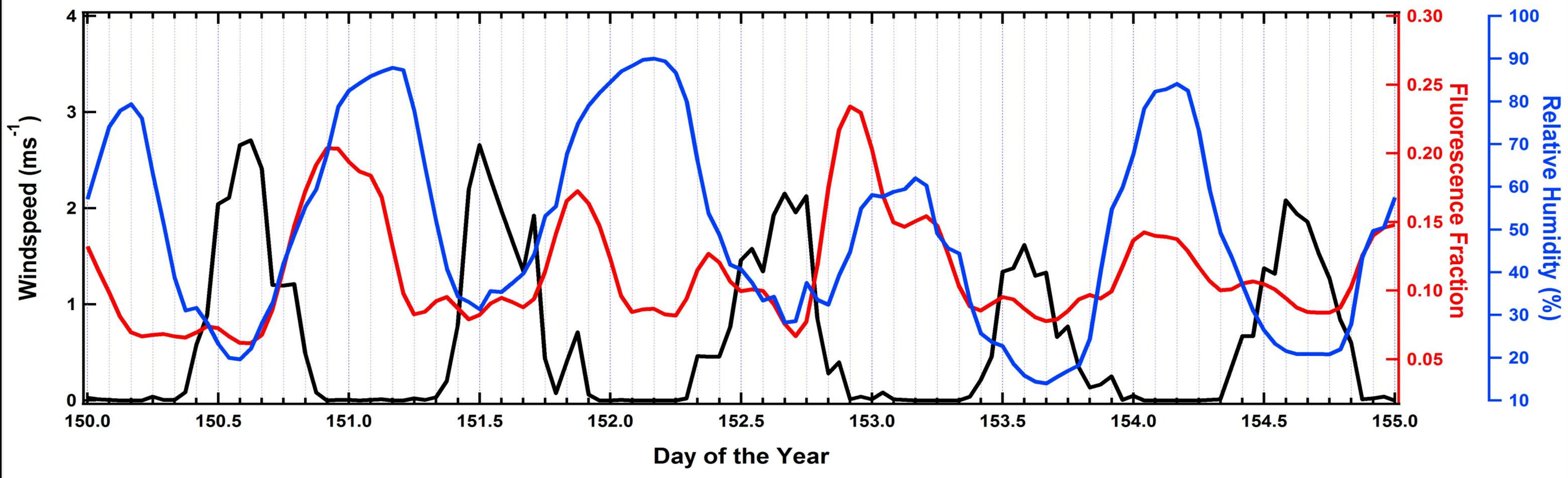

Figure 6 This expanded time series of wind speed, relative humidity (RH) and fluorescence fraction illustrates the diurnal cycle of all three parameters but out of phase with one another. The wind speed is at a minimum when the fluorescence fraction and RH maximize. The fluorescence fraction decreases before the RH.

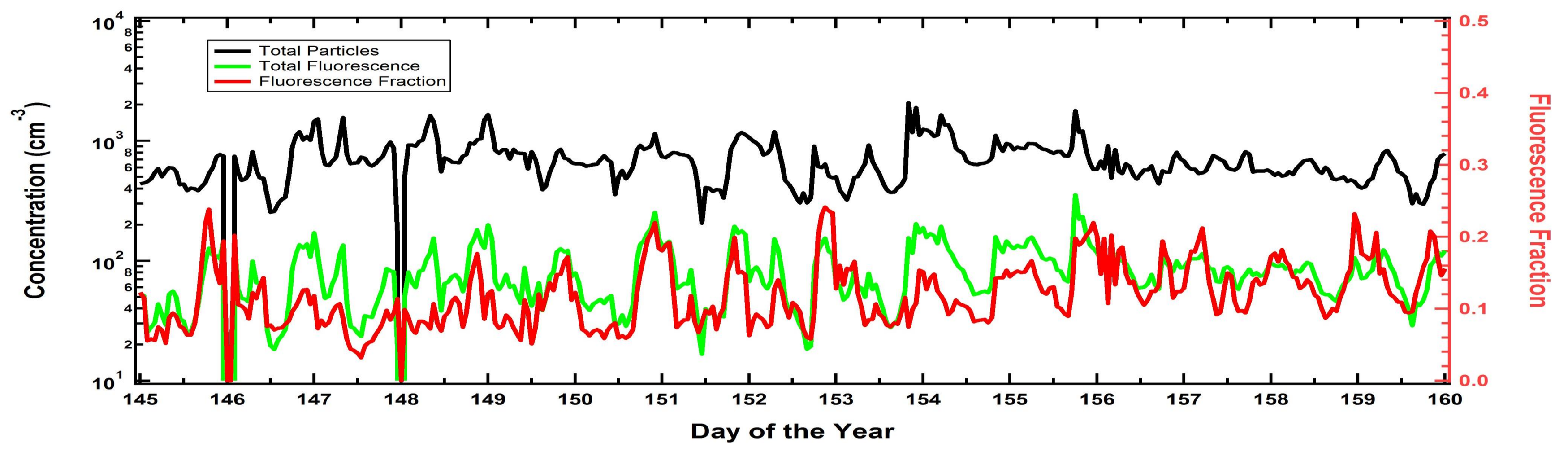

Figure 4 The concentration of all fluorescing particles is about 10% of the total particle concentration and follows the same daily cycle; however, as seen in the fluorescence fraction, the fluorescence oscillations are larger than the total particles, suggesting a different or additional source in the night time.

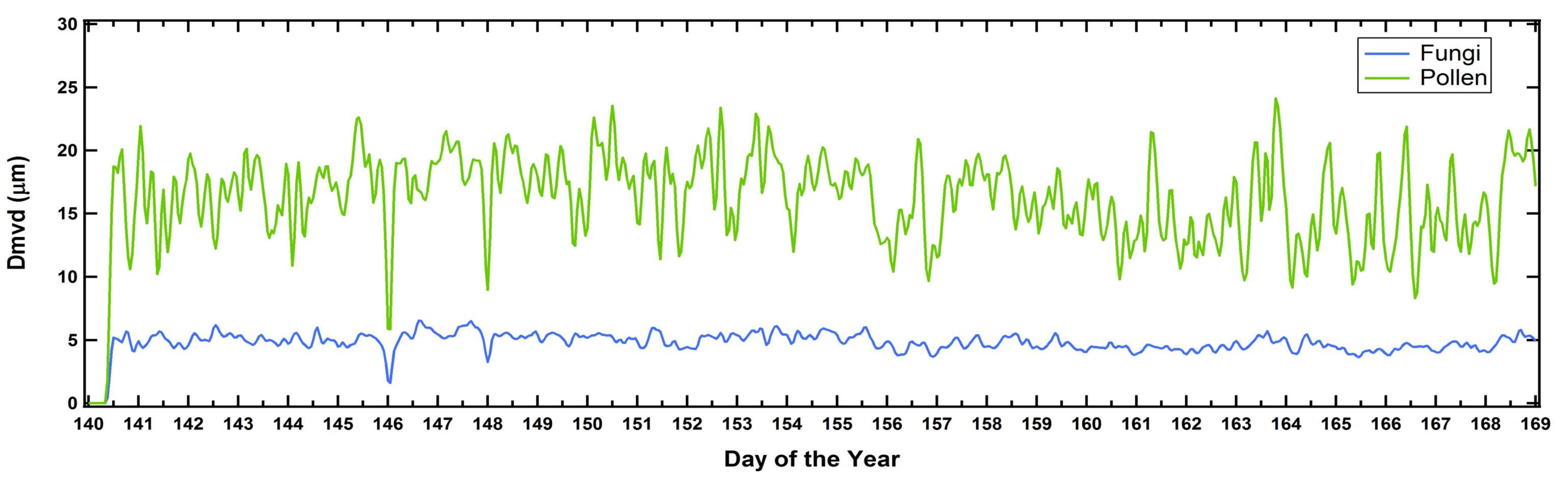

Figure 5 A comparison of the median volume diameters (Dmvd) of particles identified as pollen and fungi indicate that the pollen are generally twice as large as the fungi. In addition, the fungi Dmvd show no diurnal cycle whereas the pollen Dmvd has a variation of ±50%, not necessarily diurnal.

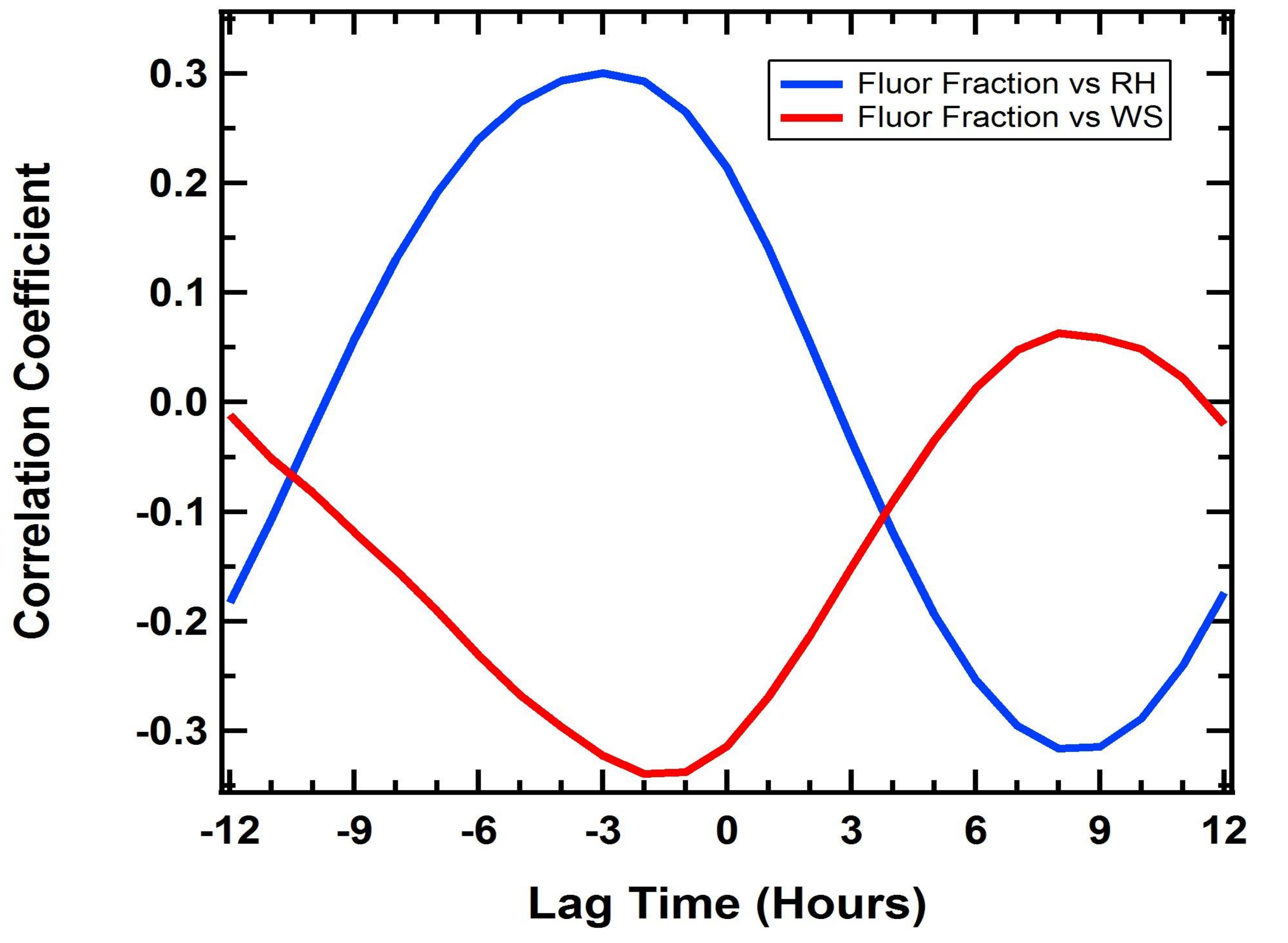

Figure 7 A cross correlational analysis of the wind speed and RH with the fluorescence fraction highlights the relative relationships between the diurnal cycles of these three parameters. The RH leads the fluorescence fraction by three hours while the wind speed lags by nine hours. This means that the fluorescence fraction begins increasing three hours after the RH. The minimum in wind speed correlation at 1.5 hours means that the fluorescence fraction maximizes 1.5 hours after the wind speed reaches its minimum.

Summary and Preliminary Conclusions

- The fluorescing particle population in general, and the pollen and fungi in particular, have a strong diurnal cycle with maximum concentrations near midnight.
- The diurnal fluctuations of the fluorescence particles are twice as large as those of the total aerosol population
- The diurnal cycle in fluorescence fraction is positively correlated with the relative humidity and negatively correlated with wind speed.
- The correlations suggest that the highest concentrations of bioaerosols occur under stagnant air conditions and high RH.

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