Profiling of hygroscopic properties during the Po-Valley PEGASOS campaign 2012

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Aerosol particles influence the Earth's radiation budget by interacting with the incident sunlight. If they directly scatter or absorb the incoming solar radiation it is referred to as *aerosol direct effect*. The magnitude of this effect depends on several factors, including the chemical composition and size of the particles as well as their ability to take up water. If the particles are hygroscopic, this will itself lead to an increased size and change in index of refraction which will significantly vary their optical properties (Zieger et al., 2011). In addition, aerosols can exist in different mixing states that are usually described as internal and external mixtures. While an internal mixture implies that all particles of the same size have an identical chemical composition, an external mixture is composed by different substances that are chemically and physically independent. By analyzing the water uptake, the mixing state can be inferred. An internally mixed aerosol will grow uniformly with increasing relative humidity (RH), whereas the different species present in the external mixture will lead to a polymodal or broad size distribution. Since the chemical composition and ambient RH are known to change with altitude (Morgan et al., 2010), vertical profiles are important to quantify the actual optical properties and mixing states which particles have at different heights. This information is finally needed to e.g. determine the direct aerosol radiative forcing or to validate remote sensing with in-situ data.

Within the **P**an-**E**uropean **G**as-**A**ero**so**ls-climate interaction **S**tudy (PEGASOS) a Zeppelin is used to explore the planetary boundary layer. Two main measurement campaigns took place in the Netherlands and in the Po-Valley in Italy in 2012. As a new way to explore hygroscopic and optical properties on the platform, the white-light humidified optical particle spectrometer (WHOPS) was developed. Due to its ability to record data each second, it is highly suited for airborne measurements. The working principle can be explained as follows: First, the particles are dried and led through a differential mobility analyzer to select particles with a specific mobility diameter (d_{mob}). This monodisperse aerosol is then exposed to a defined high RH (typically 94%) and the new size is detected with a white-light optical particle spectrometer (WELAS). In this way, the hygroscopic growth factor can be determined. In addition, the humidification system is periodically bypassed. This allows retrieving information on the particle's effective refractive index by comparing the particle's dry mobility diameter with the optical response from the WELAS.

In this work we will present the hygroscopic growth and mixing state of aerosols, measured during the PEGASOS campaign in the Po-Valley in Italy in June 2012. Figure 1 shows an example for such a profile flown above San Pietro Capofiume (SPC), where the response of the WHOPS to dry, monodisperse particles (d_{mob}= 300 nm) is shown. The lower graph depicts the size distribution of the humidified particles and clearly shows a bimodal distribution with a more and a less hygroscopic mode. This is a clear indication of an externally mixed aerosol. Comparing the results for the two selected heights (i.e. 100 m and 700 m above ground), a similar behavior can be seen. Different results (i.e. non hygroscopic particles) were found for the larger sizes (d_{mob}= 500 nm) on days with Saharan dust intrusions.

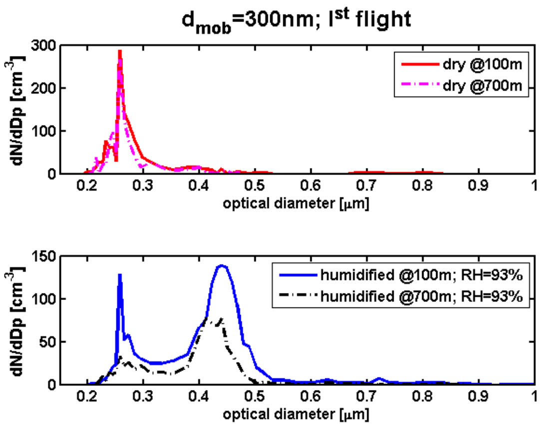

Figure 1: Data from a flight at SPC on the 20th of June 2012; for both plots a dry d_{mob} of 300 nm was selected; solid and dashed lines: flights at 100m and 700m above ground, respectively; the upper and lower graph show the dry and wet size distributions, respectively.

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