Extinction characteristics of SOA formed following the photolysis of 2-nitrophenol: A broadband study in the near-ultraviolet

E. M. Wilson[1, 2], J.C.Wenger[1, 2], D. S. Venables[1, 2]

[1] Department of Chemistry, University College Cork, Cork, Ireland
[2] Environmental Research Institute, University College Cork, Cork, Ireland

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Presenting author email: eoin.wilson@umail.ucc.ie

The contribution of atmospheric aerosols is a large source of uncertainty in our understanding of radiative forcing. Although scattering of light by particles is well known, recent research has shown that particulate absorption can be important in the near-UV (Jacobsen 1998). There have been few studies of the optical properties of secondary organic aerosol (SOA) in the near-UV region. The aim of this study is to characterise the aerosol optical properties of SOA formed from the photolysis of 2-nitrophenol.

Nitrophenols are an important class of aromatic hydrocarbons that are of concern because of their carcinogenic and phytotoxic properties (Harrison et al, 2005). The largest sources of these compounds are anthropogenic and they have been found in air, cloud, soil, fog and snow samples. 2-nitrophenol is a particularly important nitrophenol compound in the troposphere. It is a gas phase precursor of nitrous acid, HONO, and thus an indirect source of the atmospheric oxidant OH.

We have recently developed and demonstrated an incoherent broadband cavity enhanced absorption spectroscopy (IBBCEAS) system for studying the near-UV optical properties of aerosols (Chen et al., 2011; Wilson et al, 2012). The system is connected across a 4 m^3 atmospheric simulation chamber in the Centre for Research into Atmospheric Chemistry at University College Cork. Uniquely, the system gives real time, in situ measurements of the aerosol extinction across a continuous spectral region from 320-405 nm.

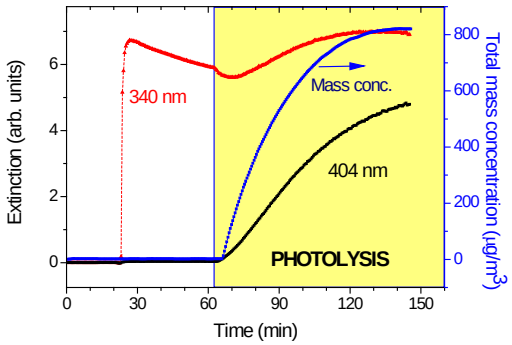

Figure 1. Time profile of aerosol mass concentration (blue) and sample extinction at 340 nm (red) and 404 nm (black) during SOA formation. Gas phase 2-nitrophenol was introduced at 22 minutes and photolysis began at 62 minutes.

In a series of experiments, gas phase 2-nitrophenol was introduced into the chamber and subsequently photolysed. SOA was formed promptly and in high yields upon illuminating the chamber. The extinction across the chamber increased rapidly when the chamber lights were on and coincided with aerosol formation (Fig. 1). Off-line filter samples were taken to study the absorption characteristics of the particles in solution, allowing us to compare on-line and off-line techniques. The extinction due to aerosol was investigated under a variety of different experimental conditions. These included the presence of an OH scavenger, changes in relative humidity, and the presence of ammonium sulphate seed particles. The influence of NO_2 on suppressing the aerosol particle yield was also studied. An analysis of the extinction spectra is used to propose a possible mechanistic pathway for the photolysis of 2-nitrophenol.

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