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Aerosol advection and sea salt events in Genoa, Italy, during the second half of 2005

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Abstract

Atmospheric aerosols in the PM_{10} fraction have been simultaneously sampled at three sites in the Genoa urban and suburban area during the second half of 2005, and information on the elemental composition has been gathered through energy dispersive X-ray fluorescence. Thanks to the simultaneous measurements and wind information, a few aerosol transport and transformation processes originated from the nearby sea and in the neighbouring Po Valley have been described. Sea salt concentrations at the three sites were well correlated and often related to Southern sector winds; moreover, by examining the Cl/Na ratio at two sites the time scale for Cl depletion in particulate matter has been estimated as 1–1.5 h for the Genoa atmosphere. During a Northerly gale, excess elemental Si concentrations (peaking more than 4 $\mu g\ m^{-3}$) were found at two sites, and were ascribed to an unknown local source. Finally, during an 11-day long 'heat wave' large concentrations for total PM_{10}, dust and secondary compounds have been found; these large concentrations lead to a number of exceedances of air quality standards, and have been ascribed to advection from the Po Valley.

Keywords: Sea salt; Soil dust; X-ray fluorescence; PM_{10}

1. Introduction

Tropospheric aerosols are a concern for health, with consequences for the respiratory tract (Maynard and Howard, 1999); moreover, they affect ecosystems by reducing photosynthetic activity, and manufactured items by contributing to corrosion (Singh, 1995). Aerosols also represent a climate issue (Houghton et al., 2001; Andreae et al., 2005), because they modify radiative forcing, heat distribution within the atmosphere (and thus atmospheric circulation), and cloud formation (and thus the hydrological cycle; Cruz and Pandis, 1997). For these reasons particulate matter is extensively sampled at urban and industrial areas, in compliance with air quality standards: such a monitoring activity is usually limited to publishing daily concentrations, with no distinction according to composition, origin, and meteorology. However, these pieces of information are essential if one wishes to recognize the natural and anthropogenic components, identify transport from different source regions, or understand the chemical processes occurring on aerosol particles.

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In this paper, results of PM_{10} sampling and elemental analysis at three sites in the Genoa urban and suburban area during the second part of year 2005 are discussed, together with meteorological patterns. Genoa is the most populated coastal city in Northwestern Italy (population: 650,000), and it is the chief seaport of the peninsula and one of the largest in the Mediterranean. Its industrial harbour has an extensive area and is located in the town centre, near residential neighbourhoods. The harbour has been rebuilt and greatly modernized after World War II, and the city has become a commercial and industrial centre. Manufacturing industries in town and the surrounding region include: iron and steel, chemicals, petroleum, airplanes, ships, locomotives, motor vehicles, and textiles. A variety of local aerosol emission sources are thus present: traffic, industries, ships, etc.

The city is influenced by a Mediterranean climate and is situated in complex terrain, with the Appenine Mountains near the shoreline reaching 1000 m-amsl altitude. Beside sources within the urban area, aerosol advection must be taken into account. Transport can originate at long distance, and for instance it is known that the Sahara desert has a non-negligible influence on aerosol concentration in the Mediterranean basin Schwikowski et al., 1995; Rodrıguez et al., 2001) and in Northern Italy (Braga Marcazzan et al., 1993; Van Dingenen et al., 2005; Marenco et al., 2006). But transport can also have a regional dimension; Genoa neighbouring source region candidates are the industrialized/polluted Po Valley and the sea.

This research is part of a large project carried out by the University and the Provincial Administration of Genoa

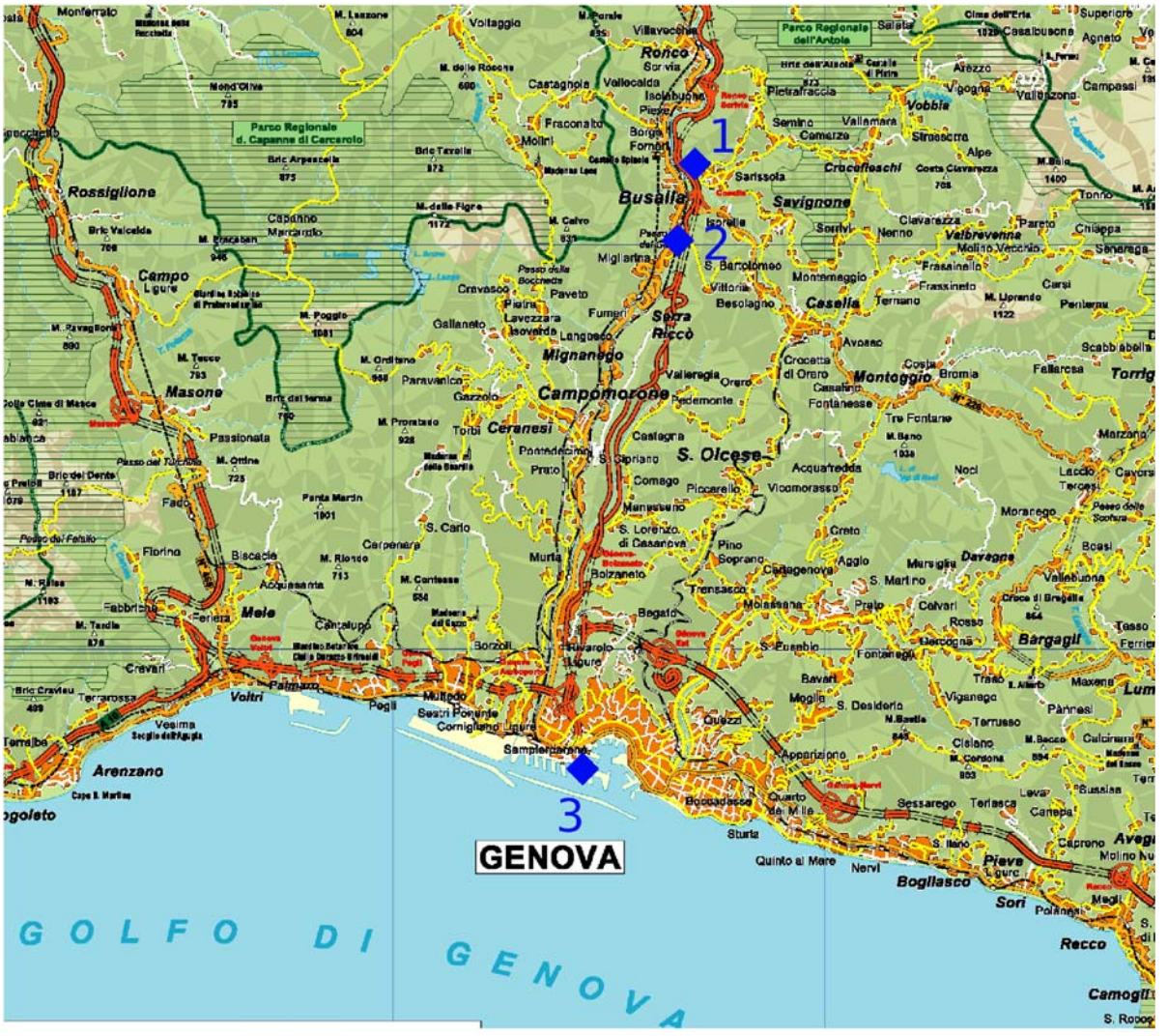

Fig. 1. Map displaying the position of sampling sites (#1 = Busalla; #2 = Passo dei Giovi; #3 = Lanterna).