7.10 AN EXPERIENCE IN THE CONTINUOUS LAGRANGIAN MODELLING OF THE IMPACT OF A SOLID WASTE INCINERATOR ON AIR QUALITY IN A SLOW WIND AREA

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INTRODUCTION

This paper shortly presents experience gathered in the Lagrangian modelling of the impact of a solid waste incinerator on air quality in the area of Milan, representative of most Pianura Padana, along with problems encountered and solutions devised.

The system, designed to support a complex monitoring programme aimed among others to the collection of particulate concentrations to detect heavy metals and polycyclic hydrocarbons (PAH), is composed by an advanced meteorological data collection station, a meteorological processing system, and a Lagrangian model.

Given the stack tip is at 120m above ground, the collection of vertical meteorological profiles has been considered an important design requirement, essential to confer realism to the monitoring and modelling system.

THE METEOROLOGICAL DATA COLLECTION AND PROCESSING SYSTEM

The meteorological data collection system consists of an "advanced" meteorological station, installed in the Pero water treatment plant at 1km from the monitored AMSA Milan Silla2 incinerator site, with the following instrument composition:

- A PCS2000 SODAR/RASS (Metek GmbH);
- an USA-1 ultrasonic anemometer (Metek GmbH);
- an NR-Lite net radiometer (Kipp & Zonen);
- two CM3 global radiometers (Kipp & Zonen), one of which sampling radiation from downwards; the upwards-looking radiometer provides the global solar radiation measurement the two radiometers jointly operate as one albedometer;
- an HFP01 ground heat flux plate (Hukseflux);
- a ground temperature profile sensor (by Servizi Territorio srl), consisting in three Pt-100 small-size thermometers sampling temperature at 5, 10 and 50cm below ground surface;
- one Hygroclip thermo-hygrometer (Rotronics);
- one PLUV-02 pluviometer with 500cm^2 (by Micros srl).

The data are subject to a post-acquisition data processing occurring at the station site. Ultrasonic anemometer data are elaborated in real-time by eddy-covariance using the Meteoflux system (by Servizi Territorio srl).

Preliminarily processed data is collected through GSM cellular modem in parallel at two sites, aimed at direct monitoring of the meteorological conditions (c/o AMSA Central Direction site in Milan) and at further data processing and dispersion modelling (c/o Servizi Territorio's in Cinisello Balsamo) respectively. Of these data processing sites, the latter and more complex is equipped with:

- The SARA data gathering and archiving software (by Servizi Territorio);
- the Grafik SODAR/RASS data visualization package (by Metek);
- the PBL_MET-based meteorological processor (by Servizi Territorio);
- the Scipuff non-stationary Lagrangian puff dispersion model;
- a post-processor, used to compute high-resolution concentrations from the puff file (by Servizi Territorio).

The main station's peculiarity is the placement of the wind measurement point on a 12m mast, allowing measurement to be taken at 8m above current plant canopy; according to plant grow rate by species at the site, no intervention on vegetation is scheduled for the next two years. Other differences exist between the station and a typical WMO measurement site: being the station aimed at measuring micro-meteorological variables in the first instance, WMO requirements have been intentionally departed from when necessary. The instrument set is redundant, so that in lack of one measurement, the latter can be reconstructed by estimation.


Figure 11. The Pero advanced meteorological station

THE DATA COLLECTED AND THEIR USEABILITY TO FEED A LAGRANGIAN MODEL

The advanced SODAR/RASS meteorological station has been officially tested on March 2004. Data collection is progressing since the stations' installation, during November 2003.

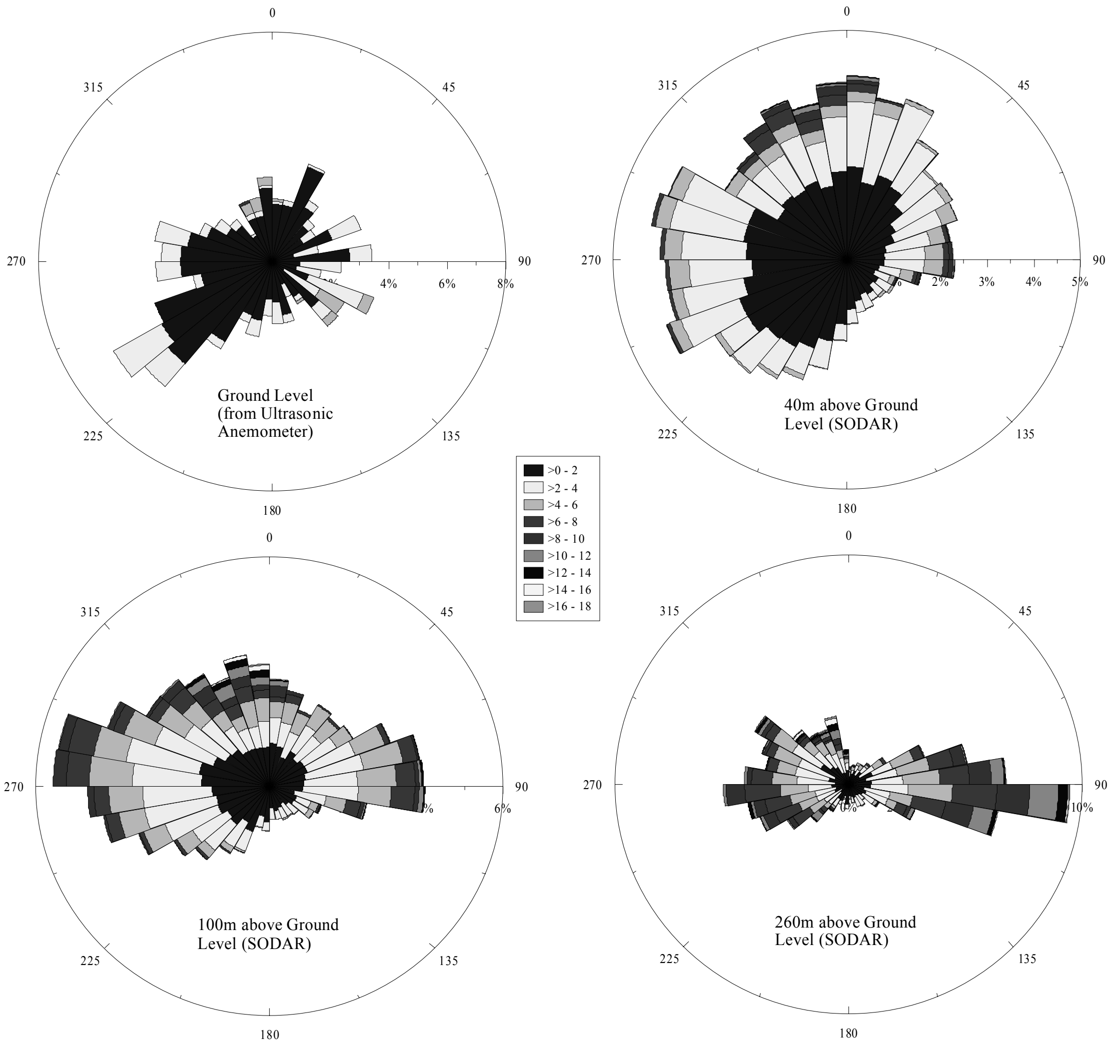

Figure 2. Wind roses at various heights above ground at Pero

As it is apparent from figure 2, wind statistics change with height. As height above ground increases, the prevailing south-western winds tend to be replaced by an East-West very strong component.

It can be often observed during winter time, and more generally under stable conditions, that the ratio of backscattered signal to external noise tends to decrease when the SODAR pulses cross atmospheric layers characterized by a very low turbulence. An indicator of the likelihood to find low turbulence data is the data availability profile shown in figure 3.

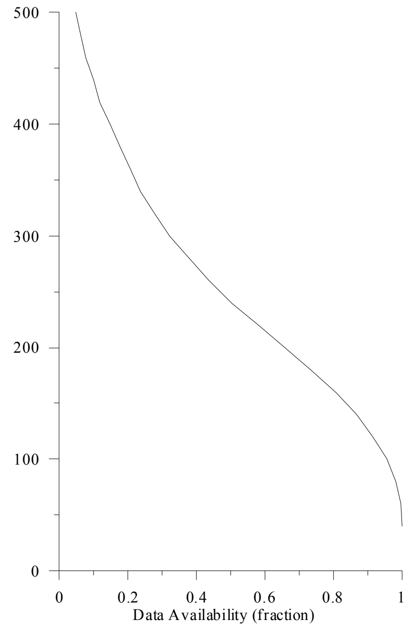

Figure 2. Relative data availability profile

PROBLEMS WITH THE SIMULATION OF ATMOSPHERIC POLLUTANT GROUND CONCENTRATION

Before SODAR/RASS profiles can be fed to an atmospheric pollutant dispersion model, meteorological processing is required, with the following objectives:

- Smoothing;
- Vertical gaps filling;
- Data input format conversion.

Whatever the algorithm used, however, the smoothing and vertical gap filling process will not alter the substantial shape of wind and turbulence, which often departing from the framework depicted by similarity relations. A case frequently observed in Pero is the occurrence of a strong wind shear, as depicted in figure 4. In order to use the information coming from the knowledge of the experimental vertical profiles, it is sensible to adopt a *non-stationary Lagrangian* model.

In addition to the meteorological processing objective listed for general models, using non-stationary Lagrangian models requires continuous meteorological data files, so that *time gaps* should be avoided.

These requirements are not simple to satisfy univocally and convincingly. While vertical data smoothing and gap filling may be accomplished by using well-known and robust algorithms, like for example spline approximants, no simple way is devisable to fill vertical profile time gaps *a posterior*, in real-time. The situation is somewhat better for surface data, where the current degree of instrument redundancy allows to fill time gaps by either estimation using similarity considerations or spectrum-preserving signal completion.

In the case specifically analysed, this inconvenient has been mitigated as much as possible, by requiring a higher-than-usual dependability on the SODAR/RASS and ultrasonic anemometer's data acquisition systems.

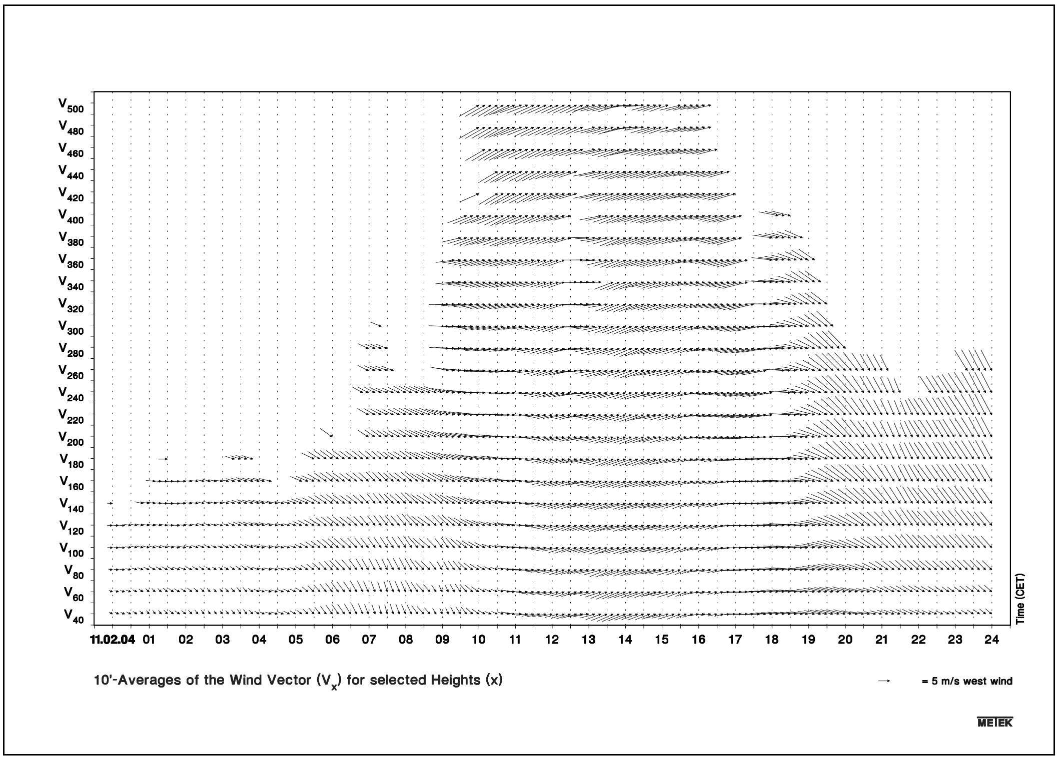

Figure 3. Sample of wind vector data

The actual impossibility to assure the vertical profile time series has no gaps demands using a model which can tolerate missing vertical profiles (provided surface data are available).

EVALUATION OF RESULTS

A very common claim about Pianura Padana is its hourly wind to be of low intensity, which, combined to strong capping inversions, often conspire to the development of high levels of atmospheric pollution.

The measurements available, on the other side, suggest a much more complex picture, in which significant deviations from simple expected profiles may occur, under some circumstances. These complexities, in turn, may affect to a point evaluations made using “simple” atmospheric pollutant dispersion models.

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