In-door Measurements of Ozone, Ions Concentration, Microclimate Variables in the Monastero of San Vincenzo's Church (Bassano Romano - Italy)

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Abstract

Ozone and ion concentrations were monitored along with micrometeorological parameters in order to understand the impact on cultural heritage of the "Monastero Benedettino of San Vincenzo". It is placed between Viterbo and Rome in the Sabatini mountains range. The importance of the site is established by the presence of many art treasures, like 3 frescos of 600 and by a marble statue of Jesus ("The Jesus cross carrying") which is recently attributed to Michelangelo (It is the original one) and abandoned by him after he discovered a black track in the marble of the face.

Introduction

Any artefact is influenced by the surrounding environment, in terms of stress produced by physical factors such as temperature, light irradiation and humidity, and, in a more general sense, by the microclimate resulting from the synergy of all these factors and by the presence of chemicals which can interact each others and, driven by local micrometeorological conditions, giving rise to damages to the in-door cultural heritage.

The action of the climate is continuous, and its effects usually appear in the long run, since they are caused by the succession of the characteristic stages of the system, such as the alternation of night and day and the sequence of the seasons. These changes may produce direct actions due to thermal, radiative and hygrometric stress on the surface, both through the simple phenomena of evaporation and condensation, and through more complex physical and chemical phenomena such as the activation of chemical reactions due to incident radiation. On the one hand, the continuous action of the local microclimate produces a deterioration in the long run, but on the other hand a sudden change in the local microclimate (changes in rainfall, in the wind regime, or in the maximum and minimum temperatures) produces effects on a shorter time scale [1].

Synoptic meteorological conditions can strongly enhance the synergic effects of physical quantities and chemicals concentration: i.e., thunderstorms increase the ionic content of the air masses as well as the ozone concentration and both have strong capabilities to alter the surface properties of materials and consequently to promote the degradation of artefacts.

The case of in-door ionic contents is of particular interest because it is not only linked to the meteo - climatic conditions but it is also related to the geological properties of the investigated area: the natural radioactivity is the major source of air ionization in absence of lighting.

To study the concurrent damaging effects of two 'philosophical' separate mechanisms of the 'real world' interaction on the in-door monumental heritage, an experimental campaign was carried out in summer period, in order to characterize the in-door concentration levels during the greater occurrence of atmospheric situations favourable to formation of high ozone at the "Monastero Benedettino of San Vincenzo". This church is also particularly interesting because is still active in officiating to local population and visitors: because of this the buildings undergoes to the influence of the external conditions only at given hours leading to a precise control of air-mass movements.

Materials & Methods

The main objective of the study was to understand the relative importance of ionization and ozone concentration levels induced by thunderstorms and those ones originated by the local environmental characteristics of the site (mean ozone concentration and radioactivity levels).

To meet this target two experimental campaigns were planned: the first one, with the aim to characterise the micrometeorological patterns of the church and the mean in-door ozone concentration, to be performed during the summer (results here reported); the second one, mainly devoted to the comparison of radioactive and lightning ionic productions planned for the late spring.

The experimental set-up of the first campaign was composed by an ozone concentration analyser Dasibi 1003, two air temperature sensors and a relative humidity sensor. All data were collected on a Campbell CR10X data-logger every minute and average every 10'.

The planned second campaign set-up will be prepared employing a meteorological station, to be placed out-door. In-door characteristics of turbulence and exchange fluxes will be monitored by a sonic anemometer placed within the church. The ozone concentration will be measured by the Dasibi 1003 and the natural radioactivity by high quality Geiger counters (gamma, beta); the air will be monitored by temperatures sensors, humidity sensors, electric field sensor; walls temperature will be also measured (contact sensors).

Results

First results are obviously preliminary results. The church of Monastero of San Vincenzo and in particular the chapel of The Jesus Cross Carrying, was recently restored (windows in particular).

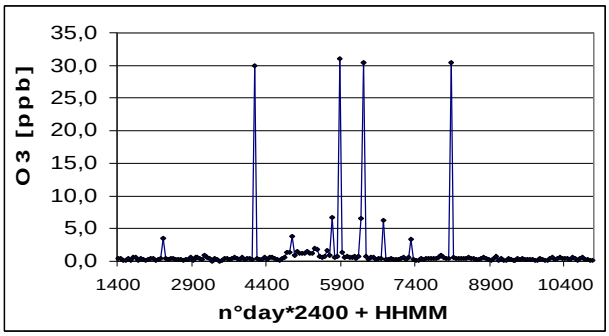

Fig. 1; In-door Air Temperature 10' average.

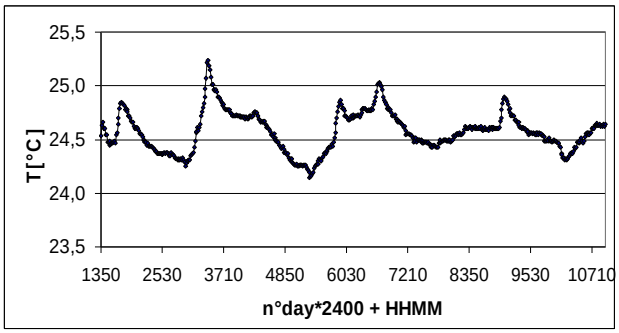

Fig. 2; Peaks in the Ozone concentration 30'avg
X axis: TIME (example of 4 days)

So measurements first show the good "separation" with outdoor environment, i.e. ozone, temperature and humidity forcing. That means the temperature is almost stable around 24.5°C, with smoothed and periodic oscillations in correspondence with those of outside temperature (fig. 1). Ozone concentrations [ppb] are very low for a rural environment (fig. 2) like one the church is settled, except for those cases during which a thunderstorm or a different ventilation occurred (open windows, open doors, long religious ceremonies, air mass changes).

Conclusions

The case of San Vincenzo and its precious marble statue and frescos represents a really interesting preliminary experiment to understand the air behaviour inside the church with this multi "variable" approach. Necessary a second experimental step in order to describe completely the turbulent fluxes inside, the electrical field's changing, ions concentrations and their contemporary effects on artefacts surfaces.

References

1) C. Cacace, G, Caneva, F. Gallo, T. Georgiadis, O. Maggi, P.Valenti, *Measurement of environmental physical parameters*, Chap. 3 in Cultural heritage and aerobiology, P. Mandrioli, G. Caneva, C. Sabbioni Eds., Kluwer Acad. Pub., (2004) pp 47-79, ISBN: 1-4020-1622-0.