The Research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 262584, JERICO

TNA PROJECT REPORT

3nd Call of Proposals

19 September – 25 November, 2013

A) General Information

Proposal reference number	CALL_3_2
Project Acronym (ID)	MAPOM
Title of the project	Marine Aerosols Properties Over the Mediterranean
Host Research Infrastructure	CNR ACQUA ALTA
Starting date - End date	5 May 2014 – 26 September 2014
Name of Principal Investigator **Home Laboratory** **E-mail address** **Telephone**	Dr. Jacques Piazzola University of Toulon, Mediterranean Institute of Oceanography (MIO) BP 56, 83162 La Valette du var cedex France piazzola@univ-tln.fr + 33.494.142.082
Additional users	Gilles Tedeschi, Tathy Missamou - MIO, University of Toulon, France

B) Project objectives (max. 250 words)

The aim of the present project is to advance the knowledge of the general cycle of aerosols in the atmosphere as a contribution to the meteorological scenarios in a climate change perspective. The specific activity is proposed as part of a 3 years French project dedicated to the development of a multi-scale approach using grid-nesting models for the atmospheric fate of the marine aerosol over the Mediterranean including its interaction with anthropogenic pollutant, impacting the radiative properties and effects on the meteorological processes. Aerosol data acquired in the targeted site and data from other locations in France will contribute to validate coupled (physics of weather and chemistry) models and to implement an accurate primary and secondary sea-spray source formulation using aerosol concentrations in the 0.01-50 µm size range.

C) Main achievements and difficulties encountered (max. 250 words)

Three experimental campaigns of seven days were made from May to September 2014. In addition supplementary data were acquired using remote acquisition of our aerosol probes installed on board in the period from April to the first days of June. The experiments allowed acquisition of about 500 aerosol size distributions and also chemical samplings using a Dekati collector. No particular difficulty was encountered expect some problems of an aerosol probe which fails during July. This problem has limited the remote acquisition of the summer.

D) Dissemination of the results

Analysis of the data is still in progress, but it is clear that they will be published soon. In particular, a paper should be written on the comparison of the data acquired on the ACQUA ALTA platform and those already recorded in the northern Mediterranean. In particular, the question is to what extent the sea-spray source function implemented in the model of aerosol transport as MACMod is relevant in the Adriatic Sea.

E) Use of the Infrastructure/Installation

	In situ	By remote
Nr. of Users involved	2	2
Access units (days/months/etc)	days	days
In situ stay day / Remote Access duration	21 5-12 May 2014 13-20 June 2014 22-26 Sept 2014	8 12 May - 07 July 2014

F) User project scientific field

Main field	Earth Sciences & Environment
Scientific description	Other – Environment

H) Technical and Scientific preliminary Outcomes (max. 2 pages)

Introduction

Although atmospheric aerosols are recognized to be a crucial agent of climate change (Intergovernmental Panel on Climate Change (IPCC), 2013), the estimation of their impact on climate remains an important scientific challenge. This is due to the heterogeneous spatial and temporal distribution of tropospheric aerosol particles, their different origins (natural, anthropogenic and mixing), their physical and chemical behaviour in the free troposphere, which makes accurate estimation of their climatic impact at regional or global scale difficult. In coastal areas, aerosol concentrations result from complex mixing between particles produced by natural processes of both continental and marine origins and particles of anthropogenic origin issued from urban and industrial activities. Sea salts generated at the air-sea interface by wave breaking represent a major component of the natural aerosol mass (Jaenicke, 1984; Andreae, 1995; Yoon et al. 2007; Piazzola et al., 2009) and therefore are important in the Earth radiative budget (Laskin et al., 2003; Mallet et al., 2003; Mulcahy et al., 2008). In addition, they have a significant influence on the coastal urban air quality (Knipping and Dabdub, 2003) through their ability to have chemical and physical interactions with other aerosol species and with gases and to transport a large variety of organic matter to ecosystems of estuaries (Paerl et al., 2002). The size of sea salt particles can vary over a wide range (0.02-

50 µm diameter). Moreover, they are also very soluble and hygroscopic, and their size can be doubled at high relative humidity compared to dry state. Sea salt is made primarily of sodium chloride (NaCl) and small amounts of other salts such as sulphate, calcium and potassium, but they can also contain significant amounts of organic carbon.

The aim of the present project is to advance the knowledge of the general cycle of aerosols in the atmosphere as a contribution to the meteorological scenarios in a climate change perspective. The specific activity is proposed as part of a 3 years French project dedicated to the development of a multi-scale approach using grid-nesting models for the atmospheric fate of the marine aerosol over the Mediterranean including its interaction with anthropogenic pollutant, impacting the radiative properties and effects on the meteorological processes. Aerosol data acquired in the targeted site and data from other locations in France will contribute to validate coupled (physics of weather and chemistry) models and to implement an accurate primary and secondary sea-spray source formulation using aerosol concentrations in the 0.01-50 µm size range. The present report deals with the experiments which took place in the ACQUA ALTA platform anchored near the coast of Venice and which allowed acquisition of a large number of aerosol size distributions in the size interval covering 0.1 to 40 µm. Three experimental campaigns of seven days were made from May to September 2014. In addition supplementary data were acquired using remote acquisition of our aerosol probes installed on board in the period from April to the first days of June. The experiments allowed acquisition of about 500 aerosol size distributions and also chemical samplings using a Dekati collector. These chemical analysis have been made to better understand the anthropogenic impact on the Adriatic. The analysis is still in progress, but the first results show that the sea-spray concentrations (acquired during long fetch conditions) seems to be slightly lower in the Adriatic compared to the ones measured in the northern Mediterranean. This would mean that the dispersion models have to be specifically implemented on the Adriatic.

1. Field site and experiments

Measurements of aerosol properties took place in the Acqua Alta platform. The oceanographic tower Acqua Alta (Figure 1) is located in the Northern Adriatic Sea, 15 km off the coast of the Venice lagoon, where the local sea depth is about 16 m (Fig. 2). The tower, which has been operational since the early ‘70s, is managed by the Institute of Marine Sciences - National Research Council (ISMAR-CNR) and commonly hosts a very large variety of meteorological, oceanographic, physical and chemical instruments. The tower allows both long term deployment of automatic instruments, connected in real time with the control ashore station, and extended stay of people on board for devoted campaigns. Multiple power sources, which can be controlled on board or ashore, are available. The main structure is a quadratic template jacket steel structure with four 0.60-m diameter main legs fixed to inserted steel pipes driven 22 m into the sea bed (Cavaleri, 2000). The first floor at +4.3 m above mean sea level (MSL)

is too close to the sea surface to be of any particular use, as it is often smashed by waves. The second floor, at +6.5 m above MSL, contains two power generators, batteries, and a small workshop. Besides a peripheral catwalk, there is a 5.5 x 4.0 m platform. At the third floor, +9.3 m above MSL, the 5.0 x 7.0 m hut hosts the living quarters, including indoor rooms for instruments. A peripheral catwalk makes access from all sides possible. Up to five persons can stay on board for several days. The 70 m^2 top terrace, at level +12.3 m above MSL, in addition to non-permanent instrumentation, contains a water tank, a meteorological mast at the south corner, a wind generator at the north corner. The instruments to measure sea spray in the framework of the JERICO project where mounted on platform at the second floor (Figure 1).

Fig. 1: The AQUA ALTA platform

Fig. 2: The study area in the Adriatic Sea. V denotes Venice and T is the tower location.

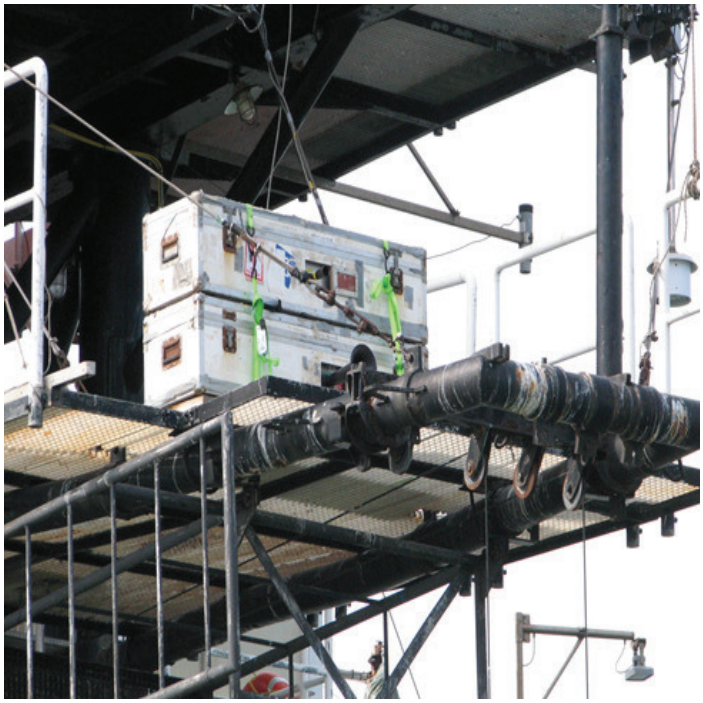

Fig. 3: the aerosol probes

The aerosol data were acquired at the second stairs of the platform (Fig. 3) in the 0.1-95 µm size ranges using two particle measuring systems (PMS): the active scattering spectrometer probe (ASASP) and the classical scattering spectrometer probe (CSASP) . At the top of the hills, at the four points located at 200 m, 160 m, 85 m and 82 m respectively, we used two ASASP instruments that cover the 0.1-47 µm size range. The data accumulation period was 1 min for the four probes, and the data were stored as the average over a 4-min interval. It should be noted that the PMS probes use an isokinetic sampling inlet to reduce losses. The transport efficiency is considered optimal for the aerosol sizes below 15 µm (Brockmann1993), which is the range of interest for the present study. Prior to the experiments, the probes had been calibrated with latex particles of known sizes. About the uncertainty of such optical probes, a minimum of a factor of 3 is expected between the aerosol concentration data simultaneously measured using two probes of the same type at the same location (Reid et al. 2006; Cohen, pers. comm, 2007).

For chemical characterization, aerosols were sampled with a low pressure cascade impactor (Dekati) from the 18th of June to the 20th of June 2014 and from the 23th of September to the 25th of September 2014. The impactors were sampling directly in the atmosphere. The impactor was a 20 lpm 13-stages low pressure cascade impactor which cut-off aerodynamic diameters were 0.03, 0.06, 0.108, 0.17, 0.26, 0.4, 0.65, 1, 1.6, 2.5, 4.4, 6.8 and 9.97 µm for subsequent IC analysis. The collection plates are custom-made out of aluminium foil for IC

analysis and quartz Whatman for the OC/EC analysis.

2. Campaign overview.

In Fig. 4 the wind speed and direction recorded during the measurements period are reported. We can see that the wind speed was rather low all along the period. This induces very few periods of sea-surface production at the air-sea interface.

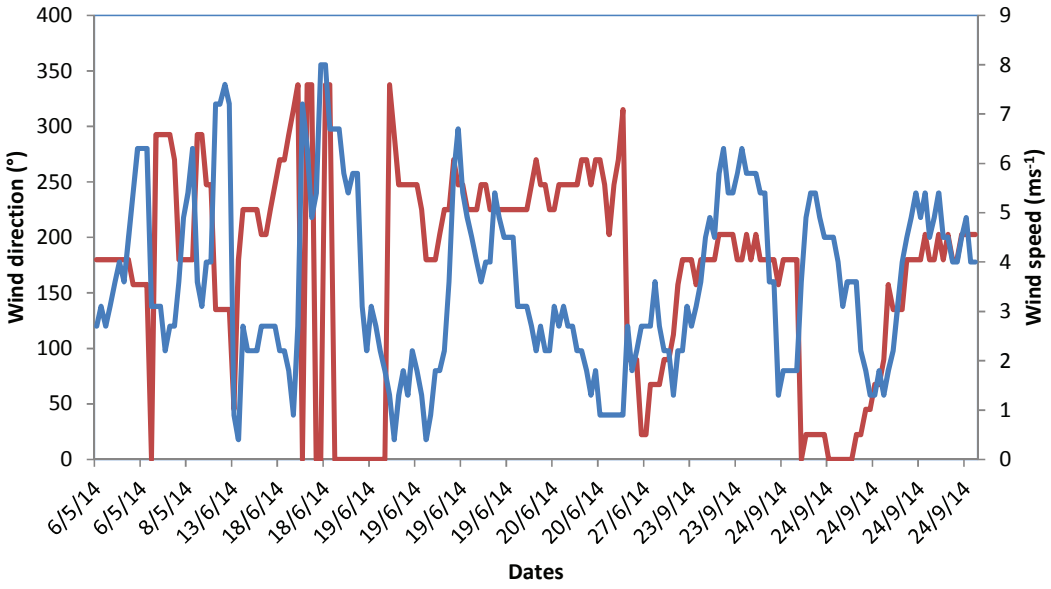

Fig. 4: The wind speed (blue line) and direction (the red one) recorded during the measurements period.

2. The aerosol size distributions

This section deals with the aerosol size distributions measured during the three periods on the Aqua Alta platform. First of all, Fig. 4 shows averaged aerosol size distribution recorded for two different wind directions which occur in the study area during the campaign and for a wind speed of about 6 ms^{-1}. The first aerosol size distribution deals with Bora conditions, which corresponds to a fetch of about 80 km and the second one was acquired for northwest direction, i.e., for a fetch of about 13 km.

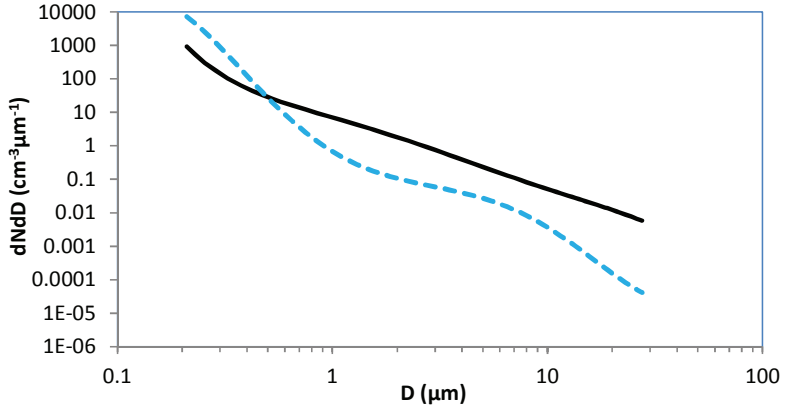

Fig. 5: Aerosol size distributions measured for two different wind directions, i.e., the Bora (the black curve) and a northwest direction (the dashed blue line) for a wind speed of 6 ms^{-1}.

We can note in Fig. 5 a net distinction between the concentrations of both the submicrometer and supermicrometer particles which clearly indicates the respective contribution of continental and marine sources of the measured aerosols. In particular, the concentrations submicronic particles decrease as the fetch increase whereas the concentrations of the larger ones increases with increasing fetch. For the very short fetch conditions investigated (i.e., Northwest direction in the study area), the shape of the aerosol size distributions are quite constant with time, as shown in Fig. 6.

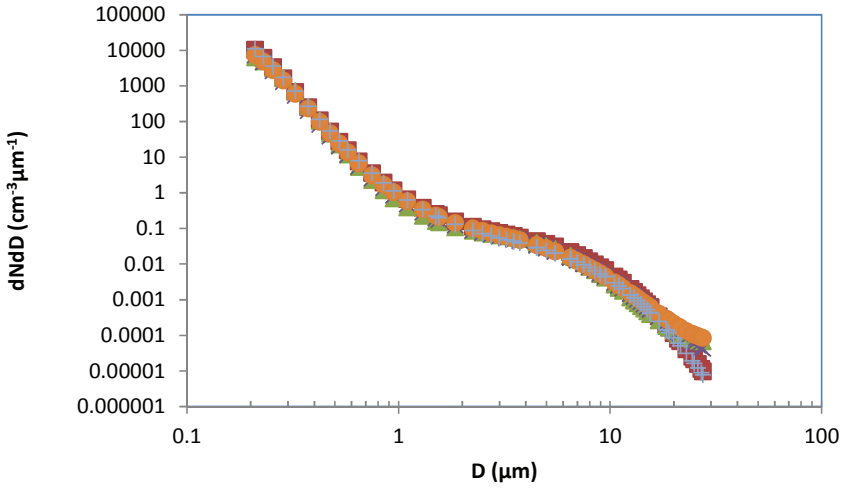

Fig. 6: Typical aerosol size distribution measured for northwest direction in the Adriatic at wind speeds between 6 and 8 ms^{-1}.

For short fetch, Fig. 7 shows a comparison between the mean aerosol size distribution measured in the northern Mediterranean for a fetch of 80 km (e.g., Piazzola et al., 2003) and the one recorded during northwest direction in the Adriatic Sea, the both for a wind speed of a 7 ms^{-1}. We can note that the concentrations are smaller in the Adriatic for the smaller sizes, whereas the concentrations of supermicronic particles are larger in the Adriatic Sea than those measured in the northern Mediterranean. This shows that the marine contribution measured in the Adriatic is more important. It should be noted that most of the aerosol size distributions for such a fetch was recorded during moderate wind speed conditions in the Mediterranean in winter at the end of strong wind episode, while the aerosol size spectrum in the Adriatic Sea was acquired in May on the Aqua Alta platform which could correspond to period of phytoplankton bloom with possible increase of the marine primary production..

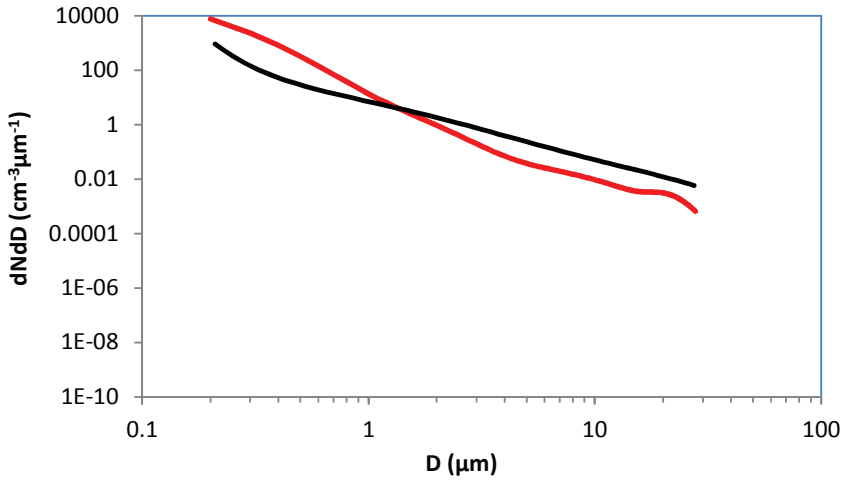

Fig. 7: Comparison of the typical aerosol size distribution measured for a fetch of 80 km in the northern Mediterranean (the red curve) and in the Adriatic (the black one) at a wind speed of 7 ms^{-1}.

3. Chemical analysis

The experimental measurements made on the paltform on the island of Porquerolles should allow for a survey of different anthropogenic and natural compounds of atmospheric aerosols of the Adriatic coastal area.

Conclusion

The aim of the present project was to analyze the aerosol size distributions in the Adriatic Sea. Three experimental campaigns of seven days were made from May to September 2014. In addition supplementary data were acquired using remote acquisition of our aerosol probes installed on board in the period from April to the first days of June. The experiments allowed

acquisition of about 500 aerosol size distributions and also chemical samplings using a Dekati collector. No particular difficulty was encountered except some problems of an aerosol probe which fails during July. This problem has limited the remote acquisition. Both the physical and the chemical analysis are still in progress.

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