Corso di Dottorato Nazionale in Polar Sciences, Università Ca' Foscari di Venezia

Ciclo XXXVIIII

Chemical characterization of atmospheric aerosols in Antarctica

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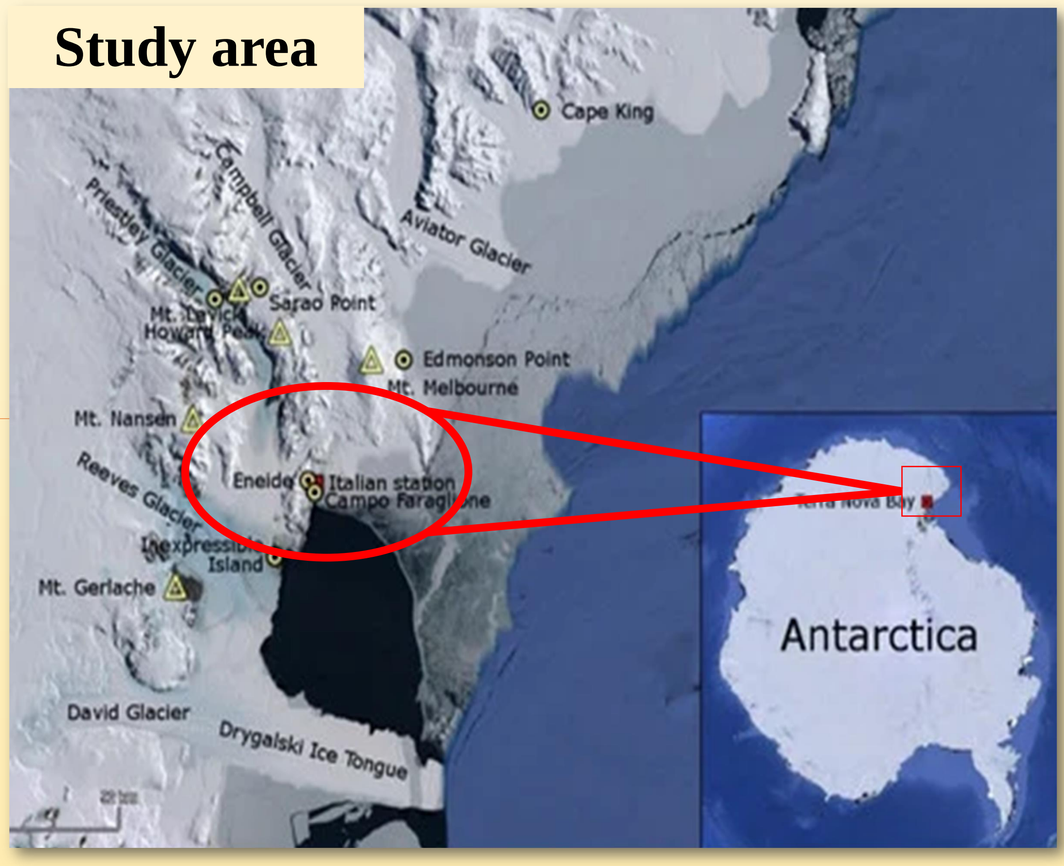
Introduction

Studying atmospheric aerosols is a great of concern to understand the distribution of organic and inorganic contaminants in both marine and terrestrial ecosystems and is becoming increasingly relevant to air quality and threats related to human health.

Polar regions are not exempt to the negative effects of human activities, in fact Particulate Matter released in the atmosphere, affects the solar radiation transfer, influences climate change, interacts with cloud formation and controls the optical, electric, and radiative properties of the atmosphere[1].

Chemical characterization of atmospheric aerosol is widely recognized to understand sources of contaminants and the status of the Polar environments[2], Regions considered traps for PM transported from other locations[3] through long-range atmospheric transport[4].

Study area



Project Timeline

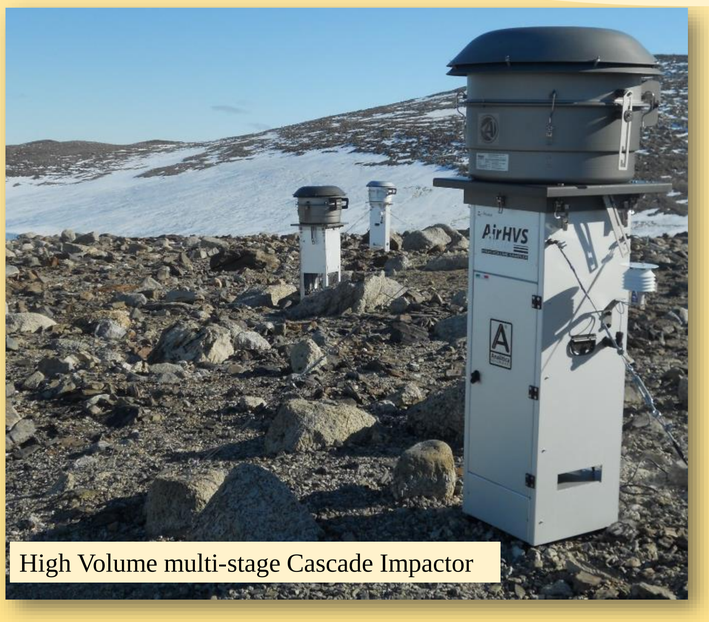
Activities	First Year - 2023/2024												Second Year - 2024/2025												Third Year - 2025/2026											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Bibliography research																																				
Analytical measurement																																				
Element analysis																																				
Nanoparticle analysis																																				
Data Processing																																				
Chemometric analysis of data																																				
Source apportionem																																				
Data processing																																				
Air-mass-back trajectories evaluation																																				
Conclusion - Final Thesis																																				
Conference participation																																				
Paper submission																																				

Aim of the Project

- Characterization of the size-resolved atmospheric Particulate Matter in terms of trace metal(loid)s, TMs (As, Cd, Cr, Co, Hg, Pb, V, Zn), minor and major constituents (Al, Ca, Fe, Mn, Na, K)
- Chemical characterization and source apportionment of Particulate Matter, the Enrichment factors
- Optimization and set up of analytical procedures to measure nanoparticles and stable isotopes

Material and methods

Meteorological parameters: temperature, precipitations, relative humidity, pressure, wind speed, and wind direction



High Volume multi-stage Cascade Impactor

Field Sampling:

- Three Antarctic sampling campaigns:
  - Nov 10, 2017 to Jan 13, 2018
  - Nov 09, 2018 to Jan 26, 2019
  - Nov 12, 2019 to Jan 20, 2020
- PM10 high-volume sampler with a 5-stage high-volume cascade impactor (six subs fractions 10-7.2 µm; 7.2-3.0 µm; 3.0-1.5 µm; 1.5-0.95 µm; 0.95-0.49 µm; < 0.49 µm)
- Flow rate at 1.13 m^3 min^{-1}
- 10-days sampling strategy using PTFE fiber filters
- Three field blank samples were collected

→ PTFE fiber filters

Micro-wave acid digestion procedure: HNO_3/*HF*/ H_2O_2 mixture

DMA

Total PHg

ICP-MS

TMs
minor constituents
Nanoparticles
Isotopes

ICP-OES
Fano Marine Center

Major constituents

GF-AAS

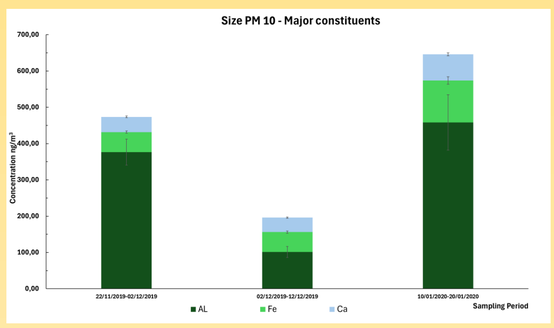
TMs

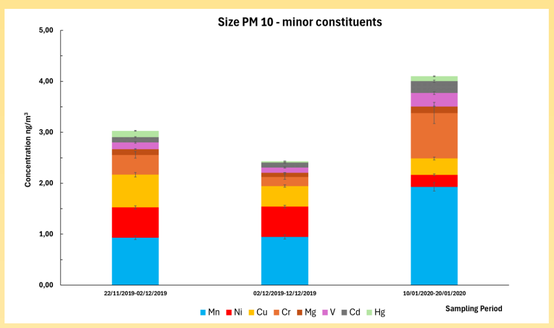
Expected Outcomes

1. A more complete scenario on any potential effects of long-distance transport, seasonal variation of environmental condition on polar areas and valuable information of the distribution of contaminants in Terra Nova Bay
2. Make a comparison with the Northern Pole to achieve a further estimation of the dramatic shifts in Polar regions and give a general overview of rapid changes
3. Use the results obtained to integrate the Antarctic Guidelines

Preliminary Results

Austral Summer 2019-2020

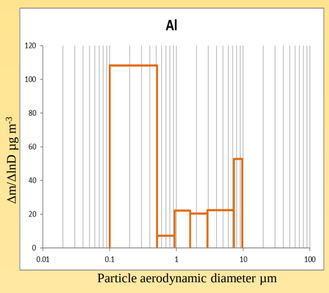




Size distribution of elements, three groups are defined:

- GROUP I Bimodal distribution Al; Ca; Cu; Mg; Ni;
  - Accumulation mode ACM (0.1µm < Dp < 1.0 µm)
  - Coarse mode , CM (2.5 µm < Dp < 10 µm)

  CM is mainly associated with crustal sources
  ACM could be connected with antrophogenic sources
- GROUP II Trimodal distribution Cd; Cr; V;
  - Accumulation mode ACM (0.1µm < Dp < 1.0 µm)
  - First coarse mode , CM1 (1.0 µm < Dp < 2.5 µm)
  - Second coarse mode, CM2 (2.5 µm < Dp < 10 µm)
- GROUP III Unimodal distribution:
  - Coarse mode, CM (Dp < 10 µm) Fe; Mg;
  - Fine mode, FM (D_p < 2,5 µm) : Hg;



Further studies on the chemical composition of aerosol are necessary → As Co Pb Zn K Na

References

1. Noone, Kevin. Physics Today 51.10 (1998)
2. Bargagli, Roberto. Science of the total environment 400.1-3. (2008)
3. Bargagli, R., 2016. Chemosphere 163, 202–208. Baroni, M., Bard, E., P
4. Barbaro, Elena, et al. Environmental Chemistry 13.5 (2016)