# RELATIONSHIP BETWEEN THE CHEMICAL CHARACTERISTICS OF AEROSOLS AND THE TRANSPORT OF AIR MASSES IN THE MAGELLAN REGION DURING 2019

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**Abstract:** This work studies the chemical characterization of atmospheric aerosols in the region of south-western Patagonia, during May-November 2019, and their relationship with atmospheric indexes: Antarctic Oscillation (AAO), the South Pacific Subtropical Anticyclone (SPSA) and the South Atlantic Subtropical Anticyclone (SASA), which affect the contribution-distribution of different sources and the transport of aerosols.

Samples of wet and dry deposition were collected at two selected sites. Their chemical, statistical and back trajectory analysis showed good air quality at the study sites, influenced by marine sources and secondarily by anthropogenic and crustal sources.

Ski Resort, Monte Fenton (left) and Universidad de Magallanes (right)

Sampling sites in South America: Monte Fenton (MF, -53°16'S, -, 620 AMSL) and Punta Arena71°05'Ws (PA, -53°14'S, -70°88'W, 10 AMSL, 178.362 inhabitants)


## Methodology:

The concentration of major ions ($Ca^{+2}$, $Cl^-$, $K^+$, $Mg^{+2}$, $Na^+$, $NH_4^+$, $NO_3^-$, $SO_4^{-2}$) (mg $L^{-1}$) was measured at MF and PA, and trace elements (Al, Br, Ca, Cl, Cr, Fe, K, Mg, Mn, Na, Ni, P, Pb, S, Se, Si, Ti, V, Zn) (x$10^{-8}$ mg $L^{-1}$) at MF, by ion chromatography and energy dispersive X-ray fluorescence respectively.

Results were used to obtain non-crustal and non-sea-salt elemental fractions as well as enrichment factors, and then studied by Principal Component Analysis (PCA), and modelling of air mass back trajectory using HYSPLIT. This to establish aerosol sources and transport paths.

Atmospheric patterns were studied using daily indexes of AAO, SPSA and SASA, which were compared with the daily wind distribution (from meteorological stations at MF and PA) using Pearson correlation coefficients. HYSPLIT modelling allowed estimation of a source cluster for each sampling.

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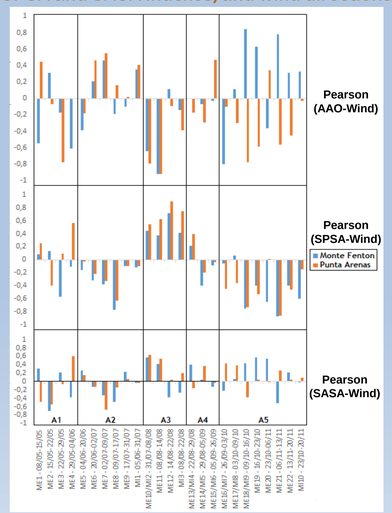
## Results:

### Pearson correlation coeficient between AAO, SPSA and SASA indexes, and wind directions



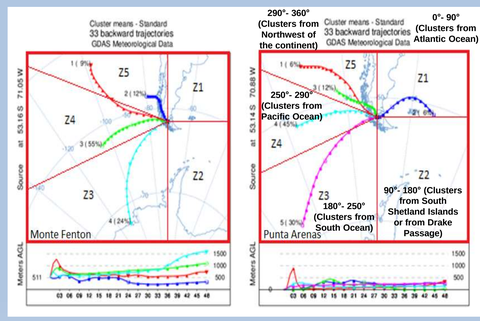

ME = Muestreo Elemental (Elemental Sampling); MI = Muestreo Iónico (Ionic Sampling)

Pearson coefficients data was divided in five "Atmospheric periods" (A1-5) according to similar atmospheric patterns behaviors.

The A3 and A4 periods were characterized by anticyclones presence around Patagonia, led by a positive AAO. It was observed significant enrichments in $Ca^{+2}$, $K^+$, $nssSO_4^{-2}$ and K, Na, P.

The A1, A2 and A5 periods presented standard air transport from west, led by a negative AAO. The A5 period also presented east wind from Patagonia to PA, possibly by SASA activity at high-latitudes..

### Back Trajectory Analysis in Monte Fenton (MF) and Punta Arenas (PA) [case study (31/07-08/08]

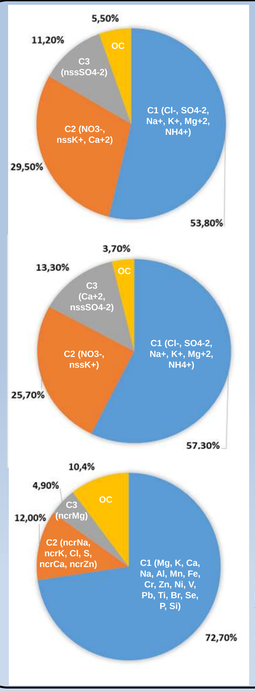



Back trajectory analysis revealed an Antarctic-Pacific origin for the air masses. Each map from HYSPLIT was divided into five zones, to understand cluster transport before arriving at the study sites.

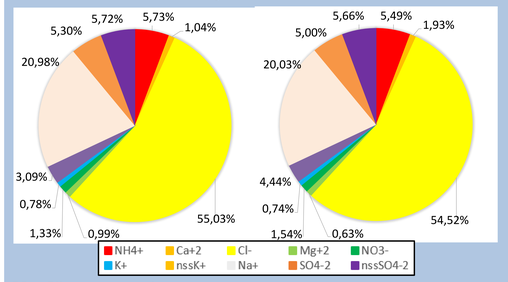
Analyses and wind distribution for the last 48 h showed that atmospheric pattern variability might cause air circulation (from north or east) over continental areas, before arriving at the study sites. This behavior together with local activities led to the increase in the enrichment of Ca, Cr, Fe, K and Mg aerosols, as a consequence of the increase in the fractions of these elements coming from the ocean and crust.

### Wind distribution from meteorological stations for case study (31/07-08/08)

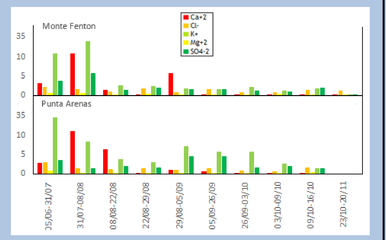
| Wind direction | Hourly distribution MF (last 48 h) | Hourly distribution PA (last 48 h) | Hourly distribution MF (total sampling) | Hourly distribution PA (total sampling) |
|---|---|---|---|---|
| North(N) | 0 (0,0'%) | 0 (0,0'%) | 10 (4,6%) | 23 (10,7%) |
| Northeast (NE) | 0 (0,0'%) | 0 (0,0'%) | 16 (7,4%) | 13 (6,0%) |
| East (E) | 0 (0,0'%) | 1 (2,1'%) | 0 (0,0%) | 10 (4,6%) |
| Southeast (SE) | 0 (0,0'%) | 1 (2,1'%) | 4 (1,9%) | 5 (2,3%) |
| South (S) | 0 (0,0'%) | 0 (0,0'%) | 12 (5,6%) | 2 (0,9%) |
| Southwest (SW) | 7 (14,6'%) | 22 (45,8%) | 11 (5,1%) | 42 (19,4%) |
| West (W) | 12 (25,0'%) | 17 (35,4%) | 53 (24,5%) | 75 (34,8%) |
| Northwest (NW) | 29 (60,4'%) | 7 (14,6%) | 110 (50,9%) | 40 (18,5%) |
| Calms (Without direction) | 0 (0,0'%) | 0,0 (0%) | 0 (0,0%) | 6 (2,8%) |




Ions distribution (%). It was very similar at both sites, MF (left) and PA (right), with $Cl^-$, $Na^+$ and $nssSO_4^{-2}$ as the most abundant ions.

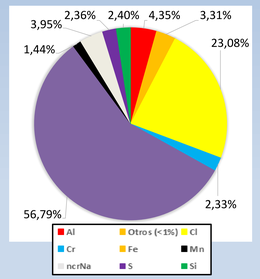



Ion enrichment factors [EF(X/Na+)] from MF (up) and PA (bottom). MI = Muestreo Iónico (Ionic Sampling). The Case study (31/07-08/08) included high enrichment for $Ca^{+2}$ and $nssK^+$ .




OC: Other components. PCA, using ionic concentration from MF (up) and PA (down) shows a marine (Component 1, C1), biological and crustal (Component 2, C2) and anthropogenic origin, such as construction works and heat-electricity generation (Component 3, C3).

Trace element distribution (%) at MF. Otros: other elements, Br, Ca, ncrCa, K, ncrK, Mg, ncrMg, Na, Ni, P, Pb, Se, Ti, V, Zn and ncrZn, below 1%. .




OC: Other components. PCA, using trace elements from MF shows a crustal (Component 1, C1), marine (Component 2, C2) and anthropogenic origin such as vehicle transport (Component 3, C3).

Element enrichment factors [EF(X/Al)] from MF. ME = Muestreo Elemental (Elemental Sampling). The Case study (31/07-08/08) included significant ncrK enrichment.