Characterization of fine particles in the near-field of a metallurgy plant: Overview of the NANO-INDUS project

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Introduction

- The industrial area of Dunkirk (France) gathers factories releasing very large amounts of particles and pollutants, close to surrounding urban areas.
- Physico-chemical characteristics of fine particles (particles with an aerodynamic diameter < 2.5 µm) leaving industrial areas are not well known.

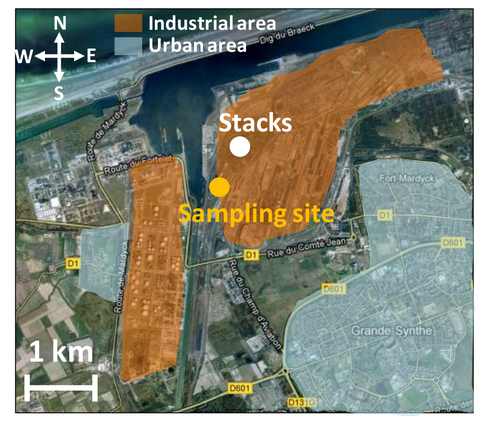
Aim of the project:

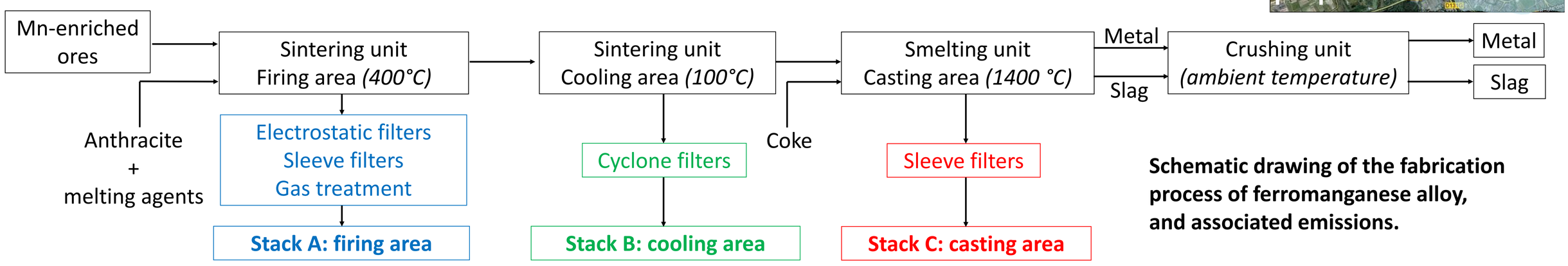
- **To study the evolution of physico-chemical properties of an industrial plume between the emission and a site located in the near-field (<1 km).**

Description of the NANO-INDUS project

Study performed at a ferromanganese alloy factory within the industrial area of Dunkirk in May/June 2012:

- Sampling of particles and measurement of gaseous compounds performed at the emission source (stacks of the factory).
- Intensive campaign performed in the near-field (<1 km) of the factory.





Schematic drawing of the fabrication process of ferromanganese alloy, and associated emissions.

Results and discussion

Near-field intensive campaign

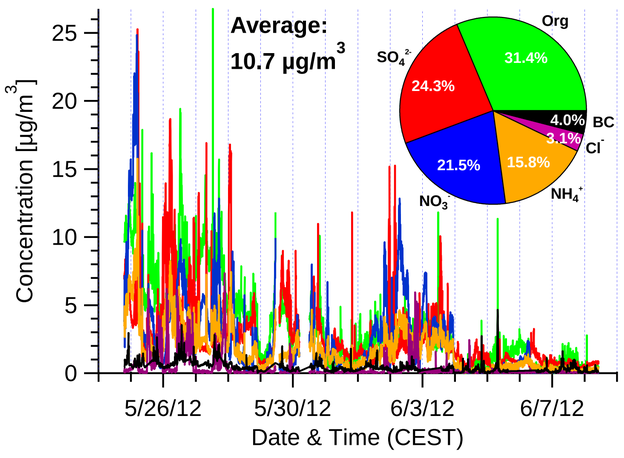
Air mass comparison:

- NE and E winds (under the influence of the industrial area): high concentrations of particles and pollutants.

	NE and E wind Industrial area	S and SW wind Urban area	N and NW wind Sea
Particle concentration	high	low	medium
Level of oxidation	medium	low	high
Size distribution (mode)	35 nm	15 nm	70 nm
CO	high	low	low
CO_2	high	medium	low
NO_x	high	low	medium
O_3	medium	medium	medium
SO_2	high	low	low

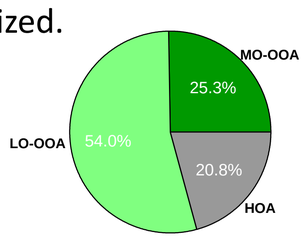
Concentration and chemical composition of non-refractory submicron particles (NR-PM_1) (HR-ToF-AMS):

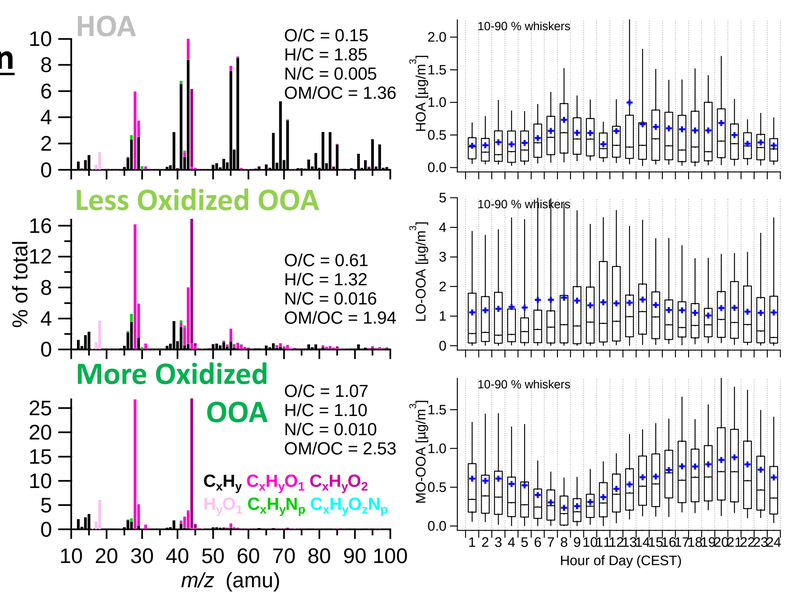
- Dynamic variation of the particle concentration and chemical composition.
- NR-PM_1 dominated by inorganics (2/3 of the total mass).



Positive matrix factorization of organics (HR-ToF-AMS):

- 3 factors identified: 2 oxygenated organic aerosols (OOA), 1 hydrocarbon-like organic aerosol (HOA).
- Organics are highly oxidized.



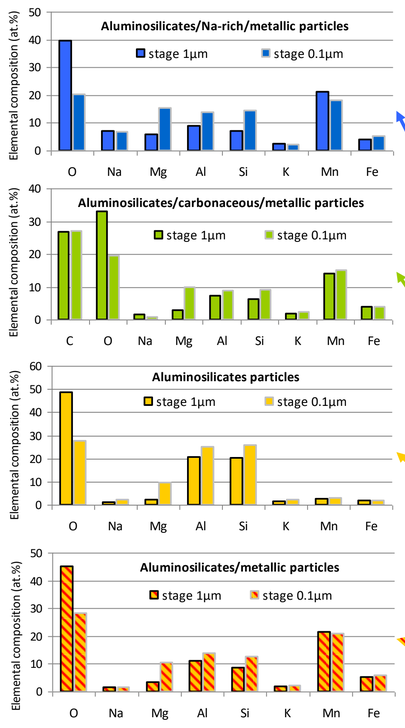


Sampling at the stacks

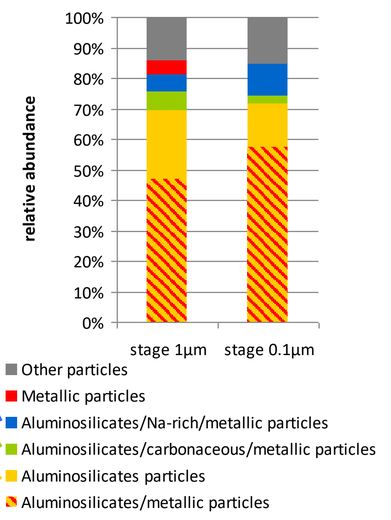
Major atmospheric emissions come from the sintering unit:

- Stack A (firing area) for gaseous species, with essentially CO, NO_x and SO_2.
- Stack B (cooling area) for particulate matter with about 30t/yr.

Relative abundance and elemental composition of particles sampled at the stack B (automated SEM/EDX):

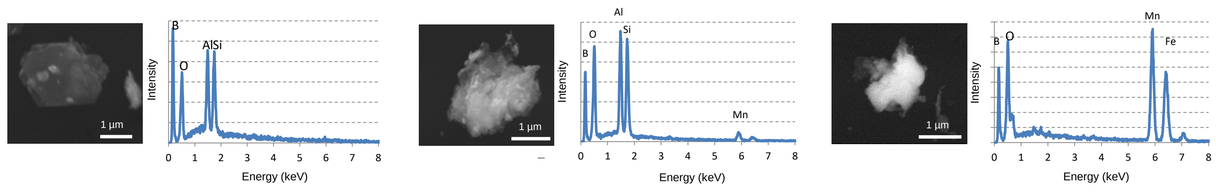


- The chemical composition is relatively similar for each particle size range.
- Stack B is dominated by aluminosilicates and mixed aluminosilicate/metallic particles.



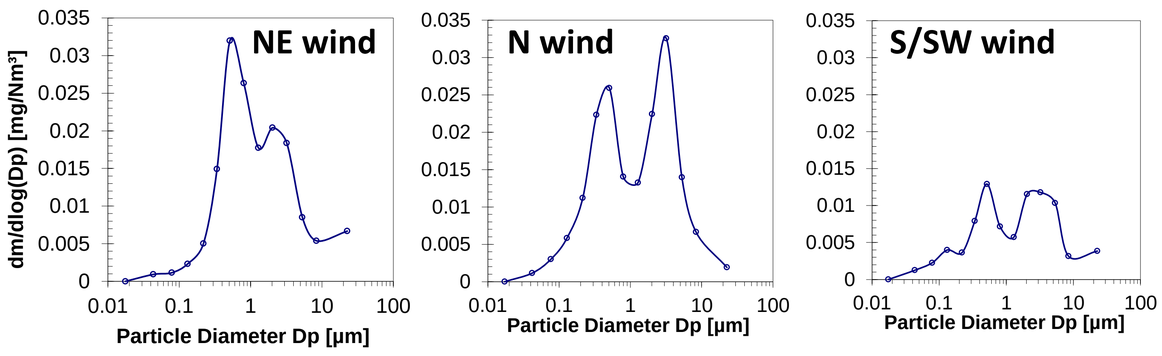
SEM pictures and EDX spectra of typical particles sampled at the stack B:

- Aluminosilicate particle
- Mixed metallic/ aluminosilicate particle
- Metallic particle



Particle mass size distribution as a function of air mass (Dekati 13-stage impactor):

- NE wind (air mass influenced by industrial emissions): 2 modes, particles mainly in submicron range.



Conclusion

- NE wind (under the influence of the factory and the industrial area): particle mass size distribution dominated by submicron particles.
- Dynamic variation of the particle concentration and chemical composition, even when the wind direction is constant. Possible reasons: atmospheric turbulence, variable emission rates from the stacks.
- Submicron particles are highly oxidized, which was unexpected at this site influenced by industrial and urban emissions.
- Fe and Mn are the dominant metals in particles released from the stacks (oxides or internally mixed with aluminosilicates).

Acknowledgements

- Financial support from ADEME (grant N° 11-81-C0089).