



HAL
open science

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

Ari Setyan, Pascal Flament, Nadine Locoge, Karine Deboudt, Véronique Riffault, Laurent Alleman, Coralie Schoemaeker, Jovanna Arndt, Patrick Augustin, Fabrice Cazier, et al.

► To cite this version:

Ari Setyan, Pascal Flament, Nadine Locoge, Karine Deboudt, Véronique Riffault, et al.. Characterization of fine particles in the near-field of a metallurgy plant: Overview of the NANO-INDUS project. European Aerosol Conference (EAC), Sep 2013, Prague, Czech Republic. <hal-02335009>

HAL Id: hal-02335009

<https://lilloa.hal.science/hal-02335009v1>

Submitted on 23 Oct 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC 4.0 - Attribution - Non-commercial use - International License

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

A. Setyan^{1,2} (ari.setyan@gmail.com), P. Flament^{1,2}, N. Locoge^{1,3}, K. Deboudt^{1,2}, V. Riffault^{1,3}, L.Y. Alleman^{1,3}, C. Schoemaeker^{1,4}, J. Arndt⁵, P. Augustin^{1,2}, F. Blond⁶, A. Blondel^{1,2}, F. Cazier^{1,7}, H. Delbarre^{1,2}, D. Dewaele^{1,7}, P. Dewalle^{1,4}, M. Fourmentin^{1,2}, P. Genevray^{1,7}, R.M. Healy⁵, P. Le Louer⁸, T. Leonardi^{1,3}, H. Marris^{1,2}, S. Mbengue^{1,3}, J. Wenger⁵

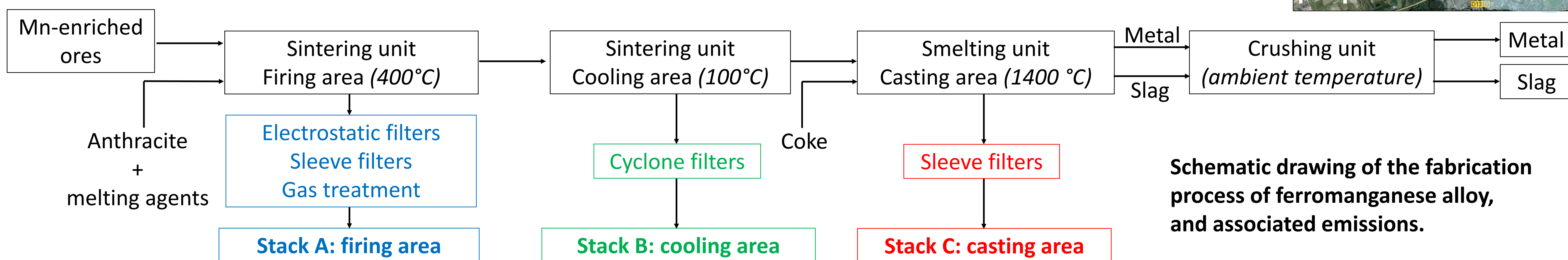
¹Université Lille Nord de France ²Université du Littoral Côte d'Opale (LPCA) ³Ecole des Mines de Douai ⁴Université des Sciences et Technologies Lille 1 ⁵University College Cork ⁶Glencore Manganèse France SAS ⁷Université du Littoral Côte d'Opale (CCM) ⁸LECES

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).

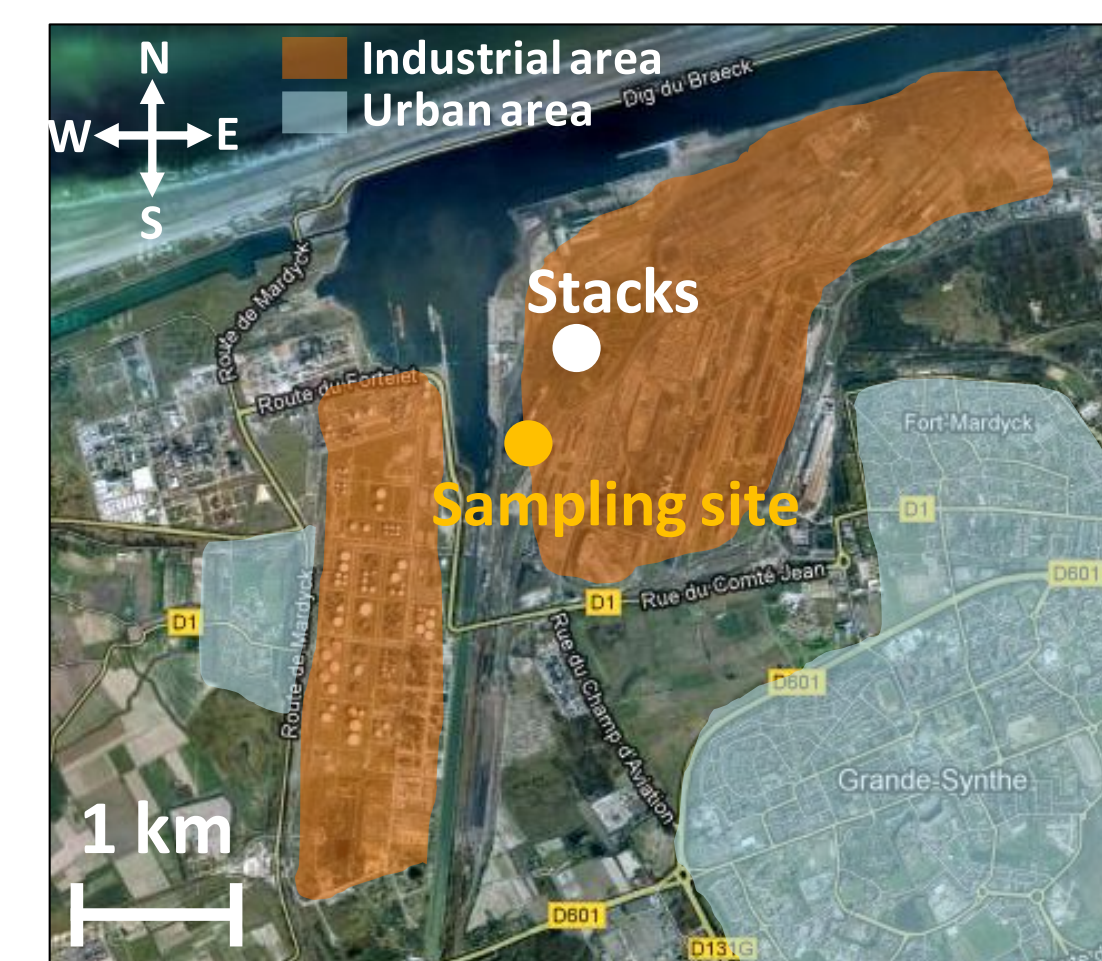


Schematic drawing of the fabrication process of ferromanganese alloy, and associated emissions.

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.



Results and discussion

Near-field intensive campaign

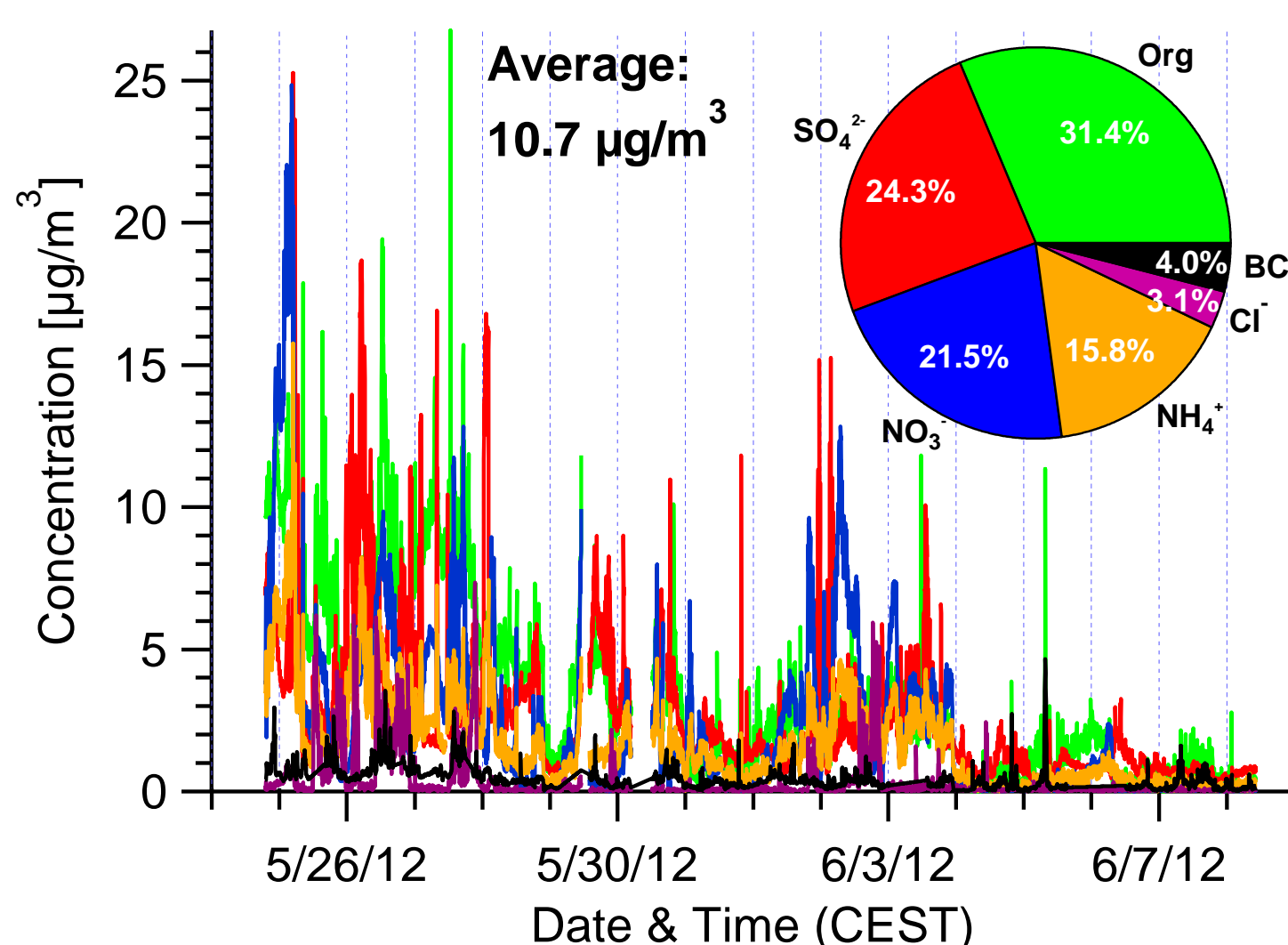
Air mass comparison:

- 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

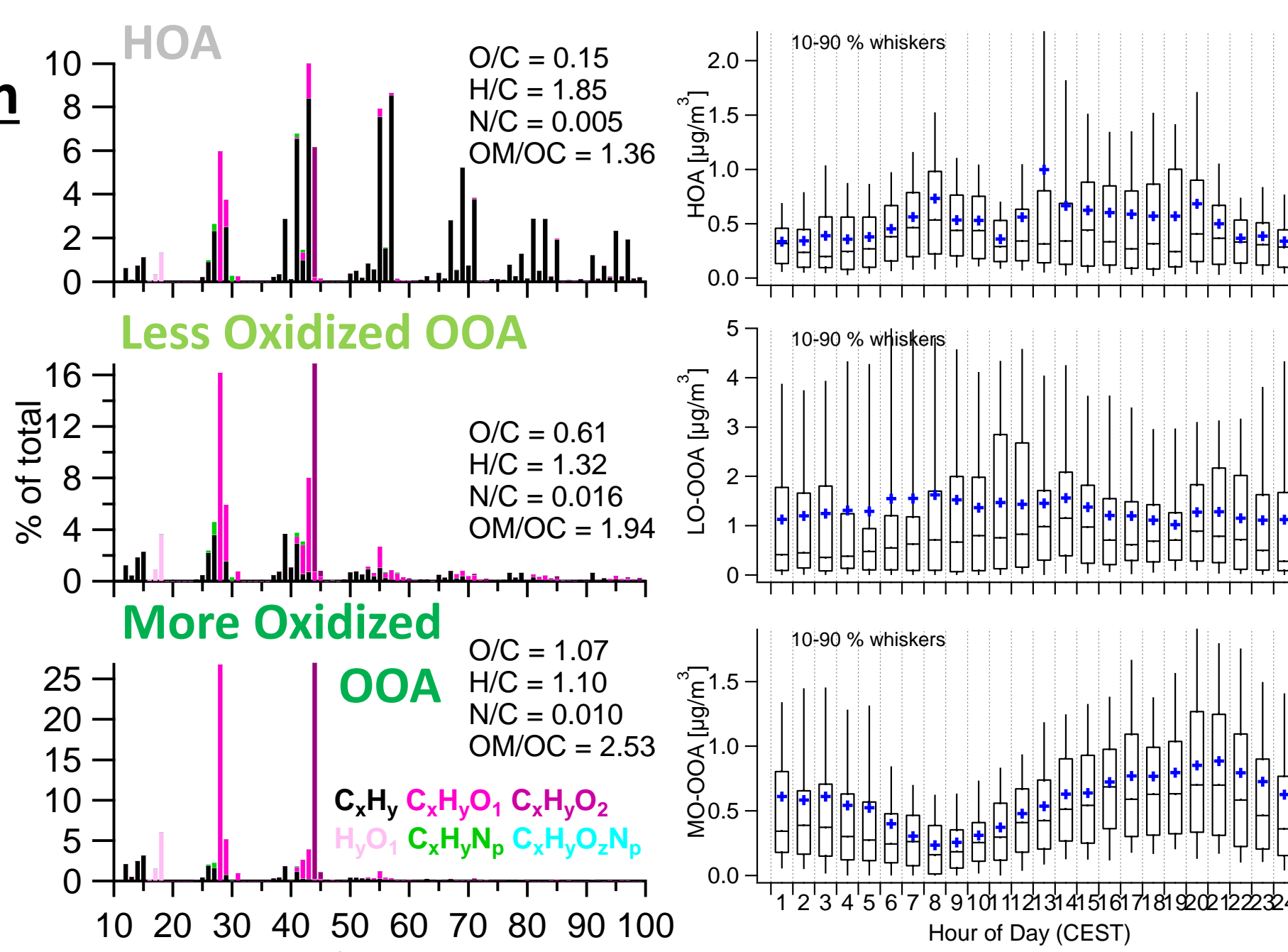
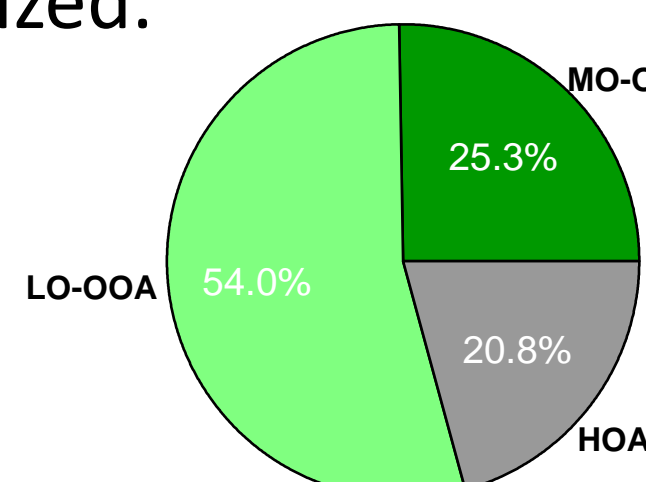
Concentration and chemical composition of non-refractory submicron particles (NR-PM₁) (HR-ToF-AMS):

- Dynamic variation of the particle concentration and chemical composition.
- NR-PM₁ dominated by inorganics (2/3 of the total mass).



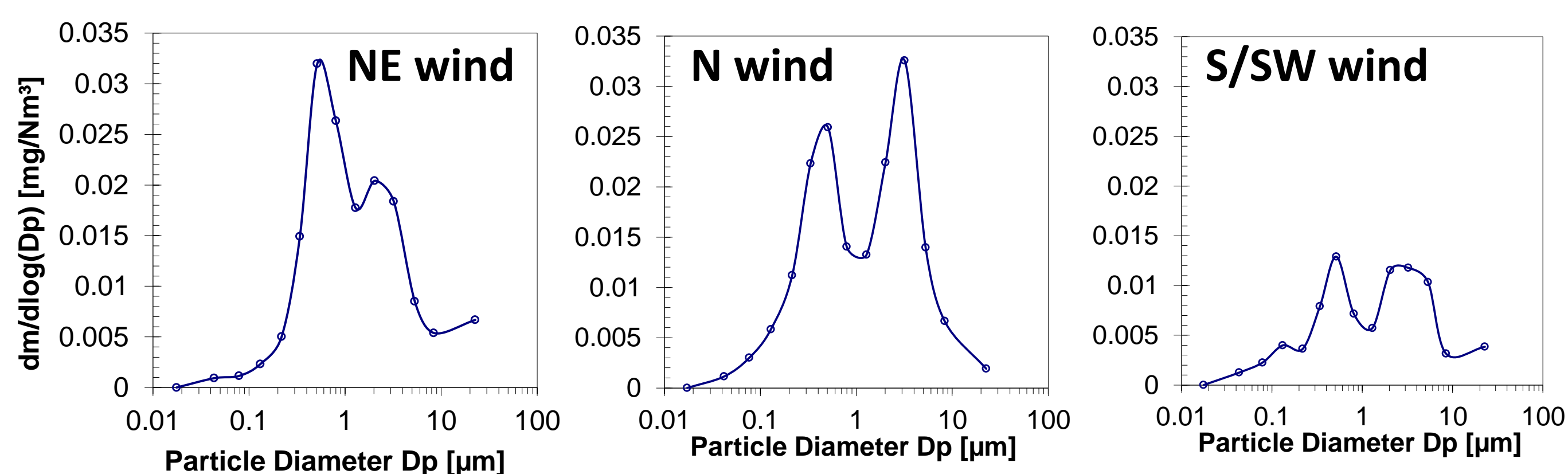
Positive matrix factorization of organics (HR-ToF-AMS):

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



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.

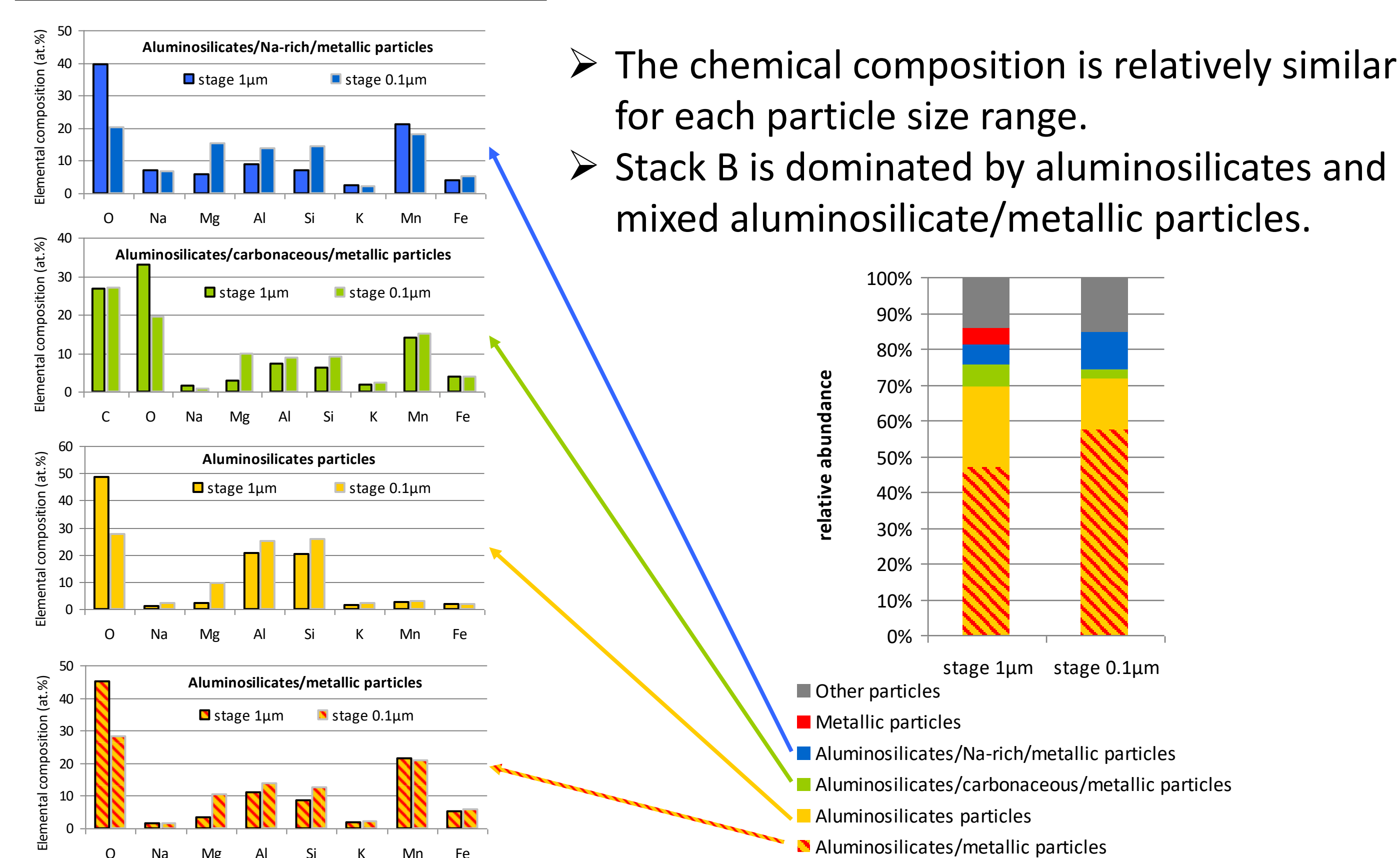


Sampling at the stacks

Major atmospheric emissions come from the sintering unit:

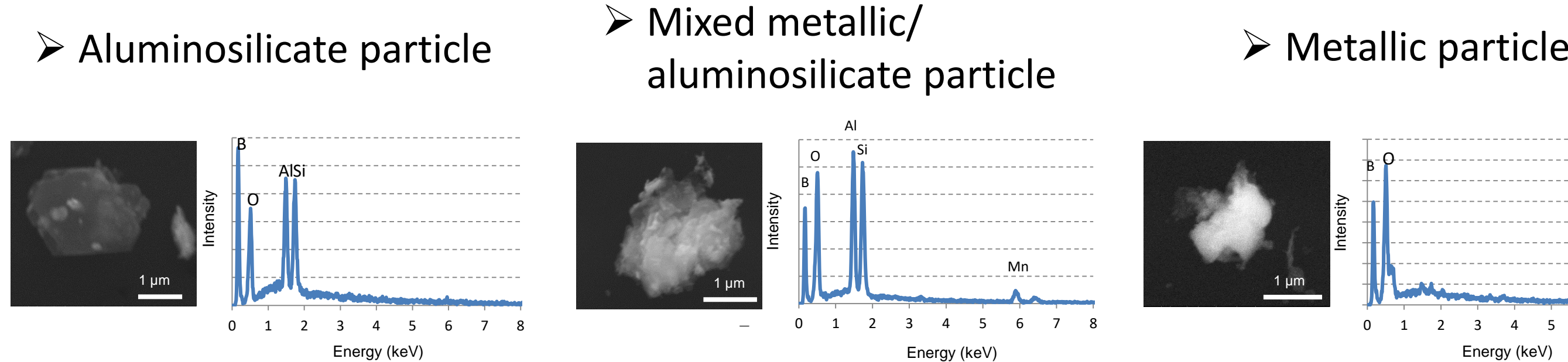
- Stack A (firing area) for gaseous species, with essentially CO, NO_x and SO₂.
- Stack B (cooling area) for particulate matter with about 30t/yr.

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:



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).