Size-resolved aerosol composition and source apportionment in Morocco: Contrasting urban and remote sites

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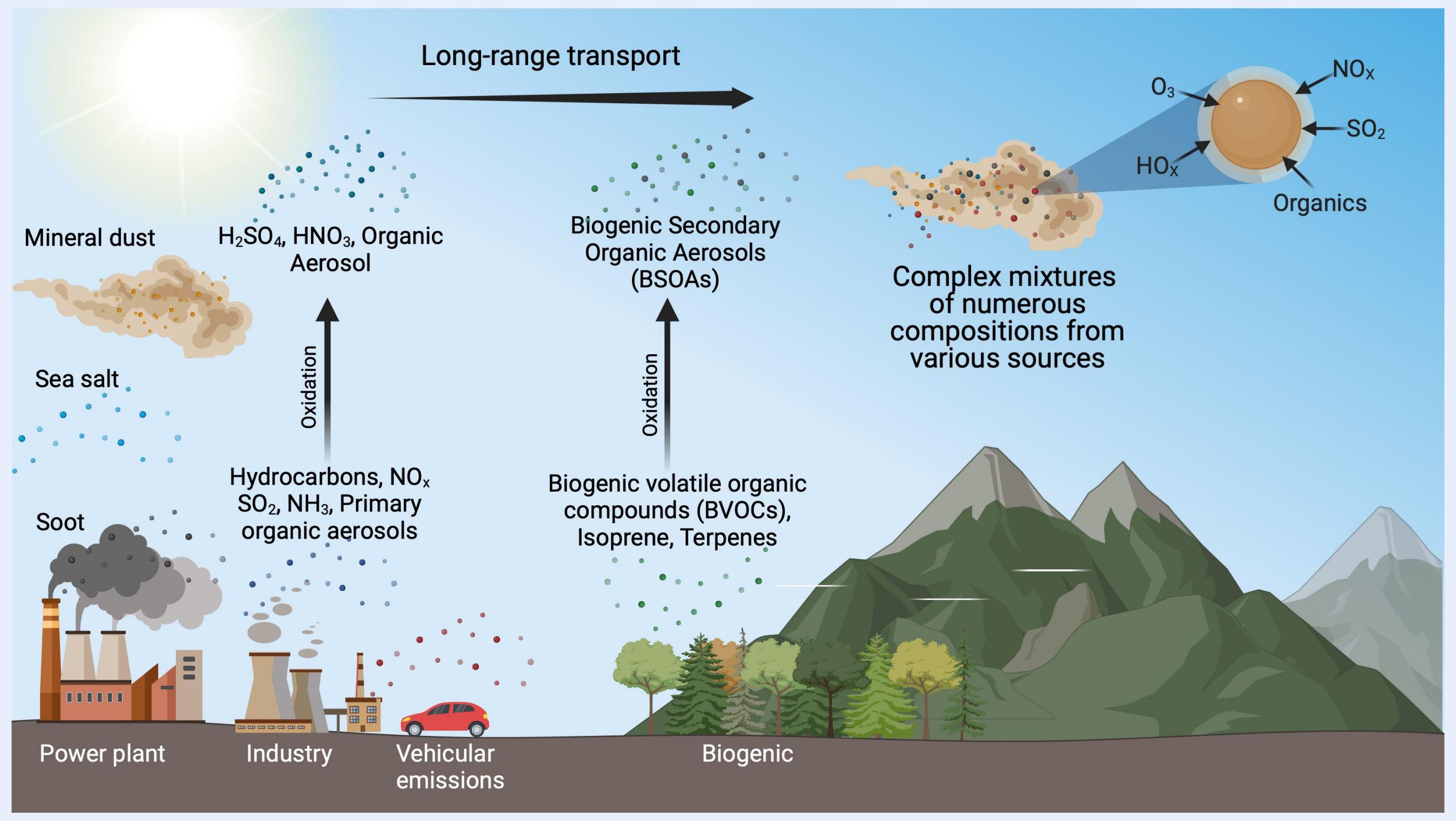
Motivation

- Understanding particulate matter (PM) is vital for air quality, climate, and health.
- Detailed research on PM composition and sources remains poorly understood in the North African region.
- A study in Morocco examined the chemical composition and source contributions of PM across various particle sizes, contrasting urban and remote regions of North Africa.



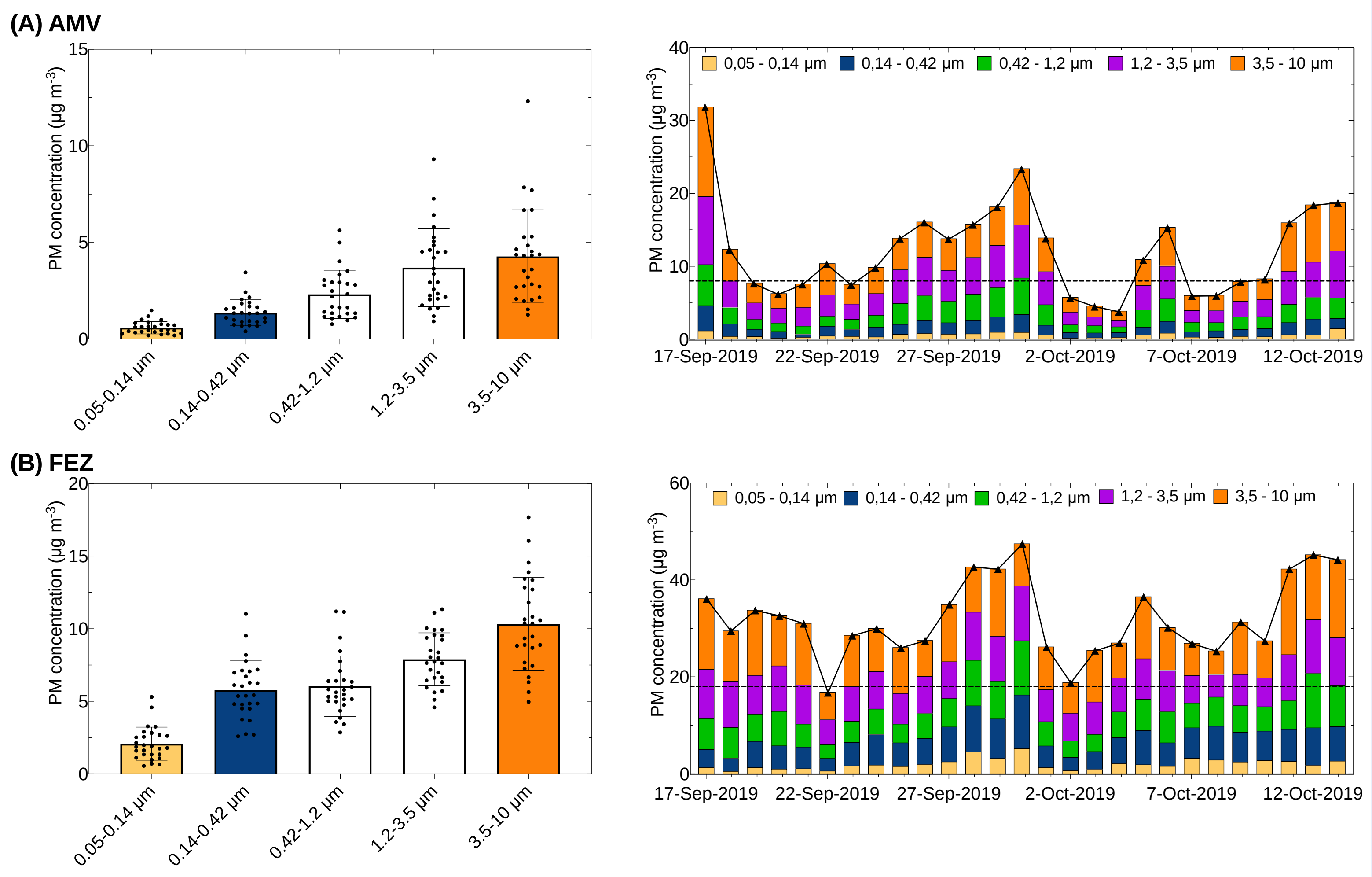
Methods

- An intensive sampling campaign was conducted in Sep-Oct 2019 at two distinct sites in Morocco:
  - **Atlas Mohammed V (AMV)** – remote high altitude.
  - City of **FEZ** – urban.
- A 5-stage Berner impactor was used to collect PM samples, followed by various laboratory analyses including mass, organic carbon (OC), elemental carbon (EC), water-soluble ions, trace metals, and organics such as alkanes and polycyclic aromatic hydrocarbons (PAHs) .

Results

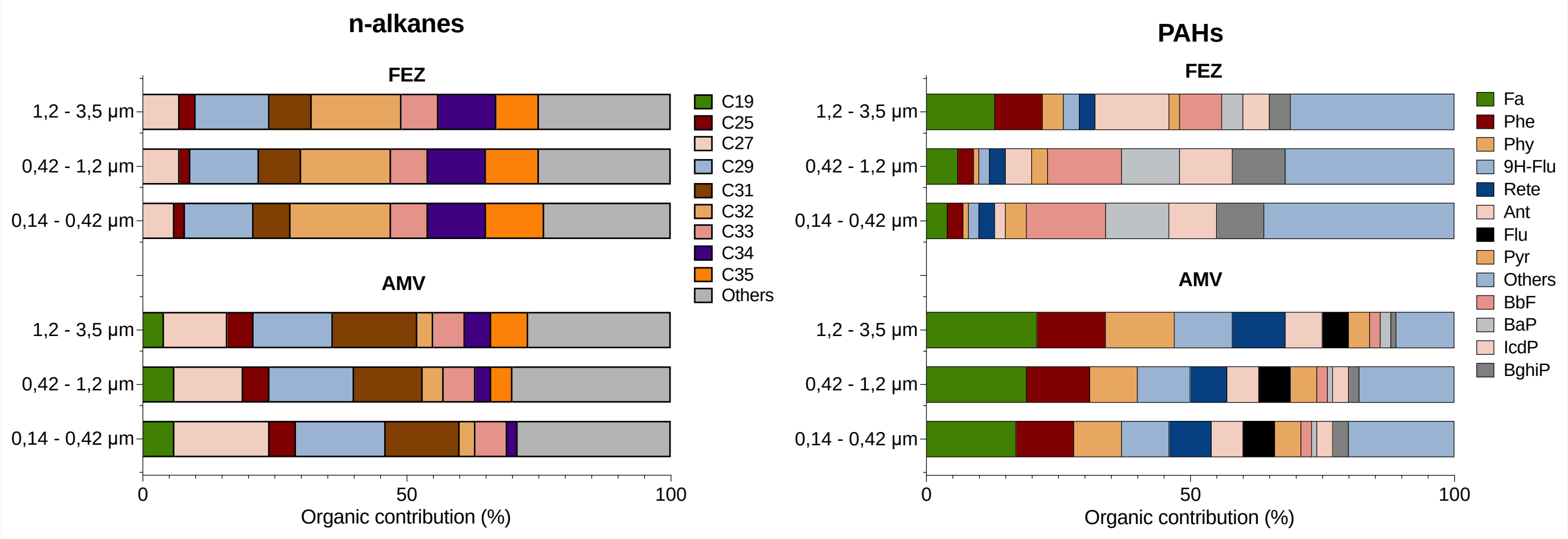
Overview of PM mass at urban and remote sites

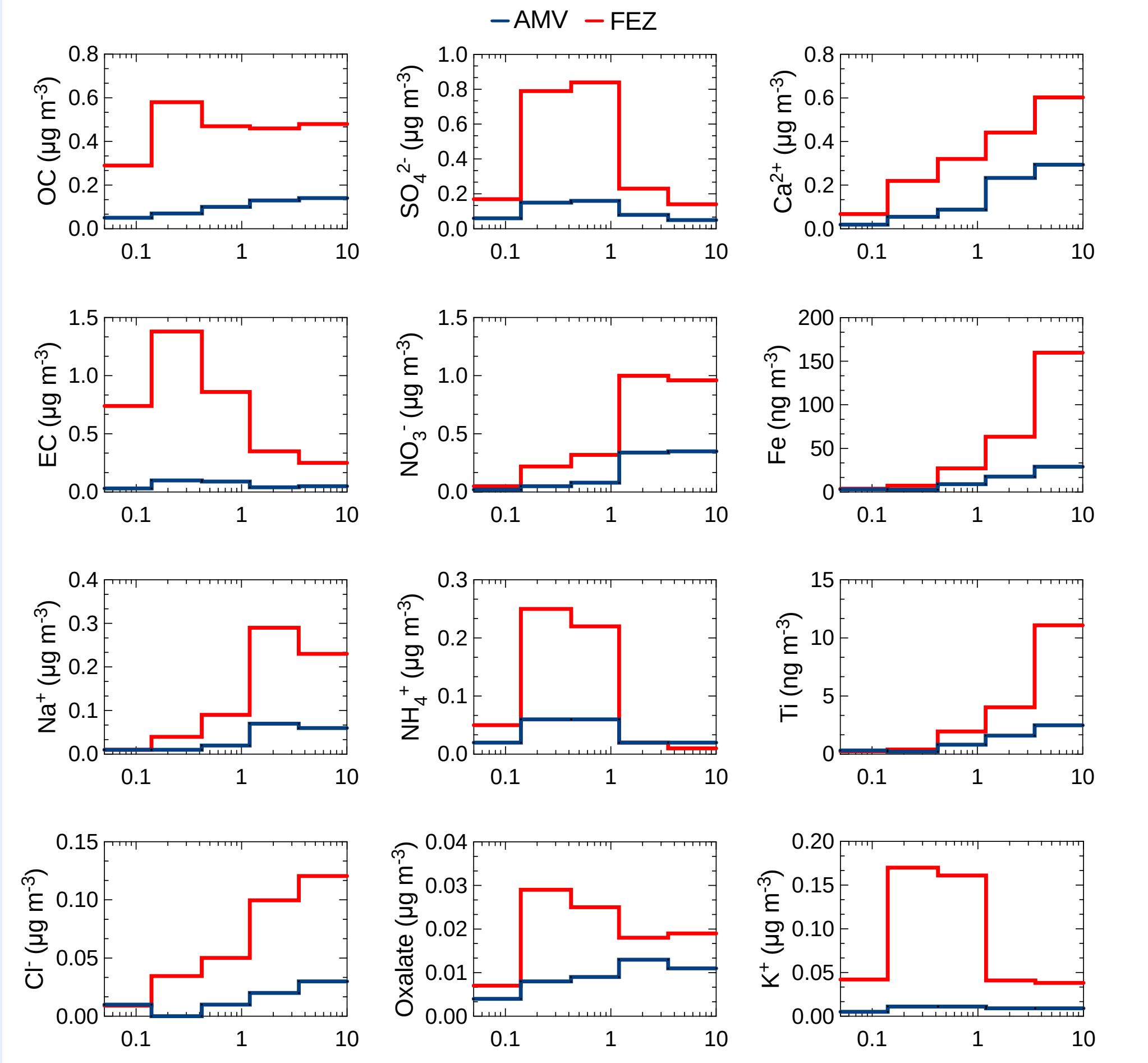
- FEZ site shows 2-4 times higher fine particle concentrations than AMV, likely due to urban sources, while AMV's coarse particles are predominantly due to mineral dust.
- Comparable $PM_{1.2}/PM_{10}$ ratios at both sites indicate the presence of fine anthropogenic particles with a more pronounced impact at FEZ.
- Meteorological factors, such as humidity and wind, affect the accumulation and dispersion of particles at both sites, with higher particle accumulations in dry conditions at FEZ.



Results

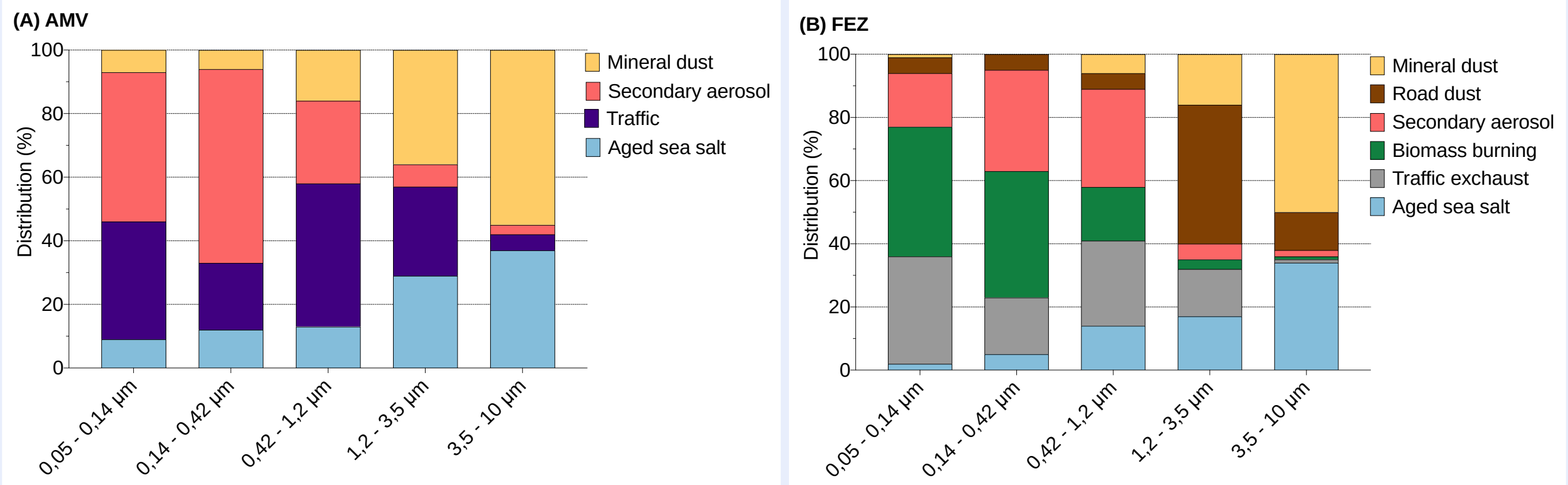
Size distribution and composition of chemical species

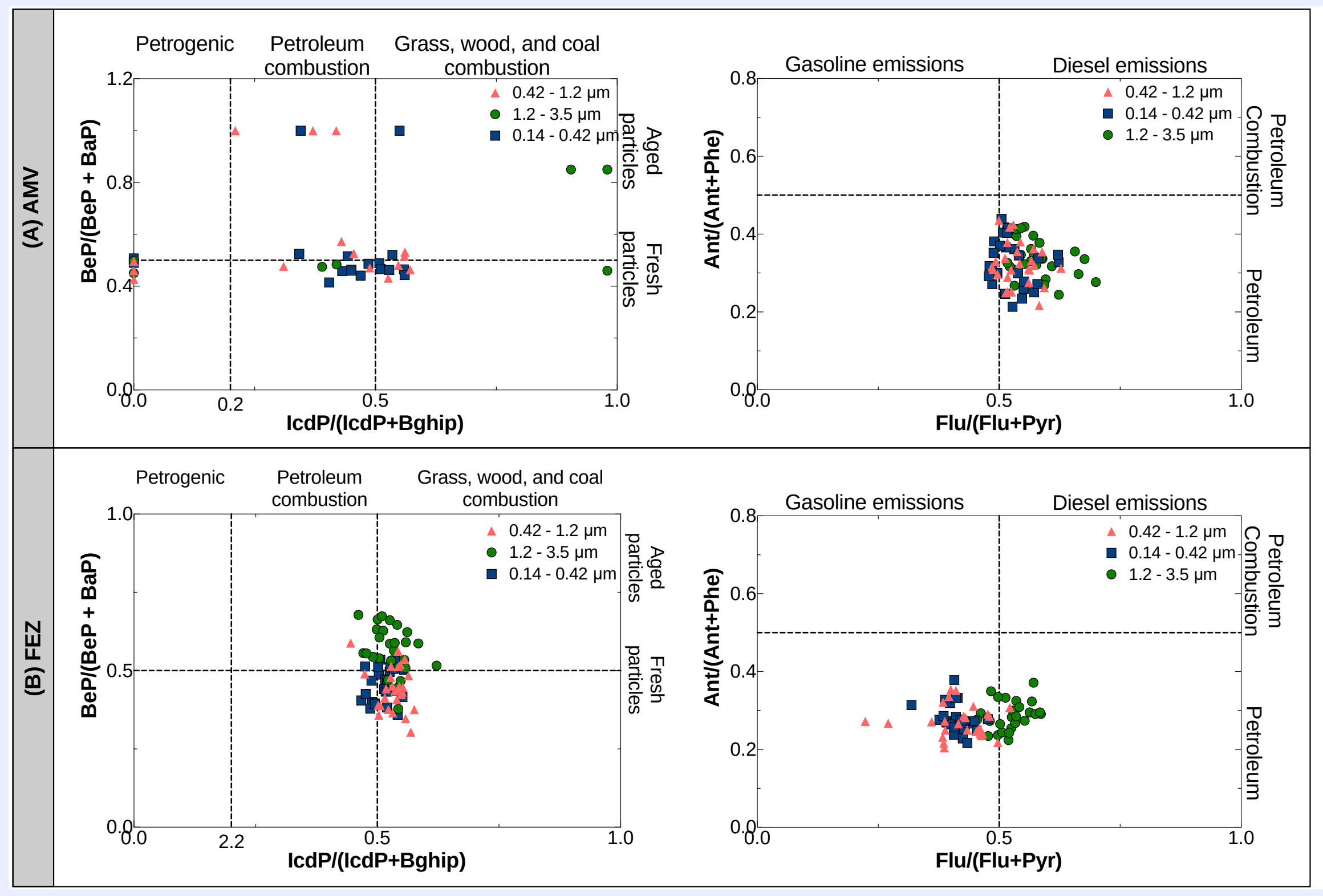




- Fine mode OC peaks at urban FEZ and coarse mode at remote AMV.
- Both sites show coarse mode peak for Na$^+$ and Cl$^-$, suggesting a sea salt origin.
- SO_4^{2-}, NO_3^-, and NH_4^+ appear in fine mode, indicating secondary aerosol formation, with differing mechanisms at each site.

Source apportionment





- The Positive Matrix Factorization (PMF) model identified four and six PM sources at AMV and FEZ, respectively.
- Mixed anthropogenic emissions and secondary aerosols at AMV significantly impacted ultra-fine and fine modes.
- Traffic exhaust and biomass burning dominated the fine mode at FEZ site.
- Mineral dust dominated the coarse mode at both sites, with FEZ's fine particles significantly impacted by local road dust.
- Diagnostic ratios of PAHs indicated fresh and aged particles at AMV from petroleum and combustion sources.
- FEZ showed a predominance of fresh emissions with traffic-related sources affecting all particle sizes.

Conclusion

- FEZ experiencing twice the PM mass concentrations of AMV, attributed to local traffic and biomass burning.
- Mixed anthropogenic emissions, secondary aerosols, and long-range transport of marine and desert dust at AMV.
- PM chemical composition and source apportionment highlights the need for targeted air pollution mitigation strategies in Morocco, offering crucial insights for future research and policy-making.