

Health effects and toxic potency of Saharan dust particles

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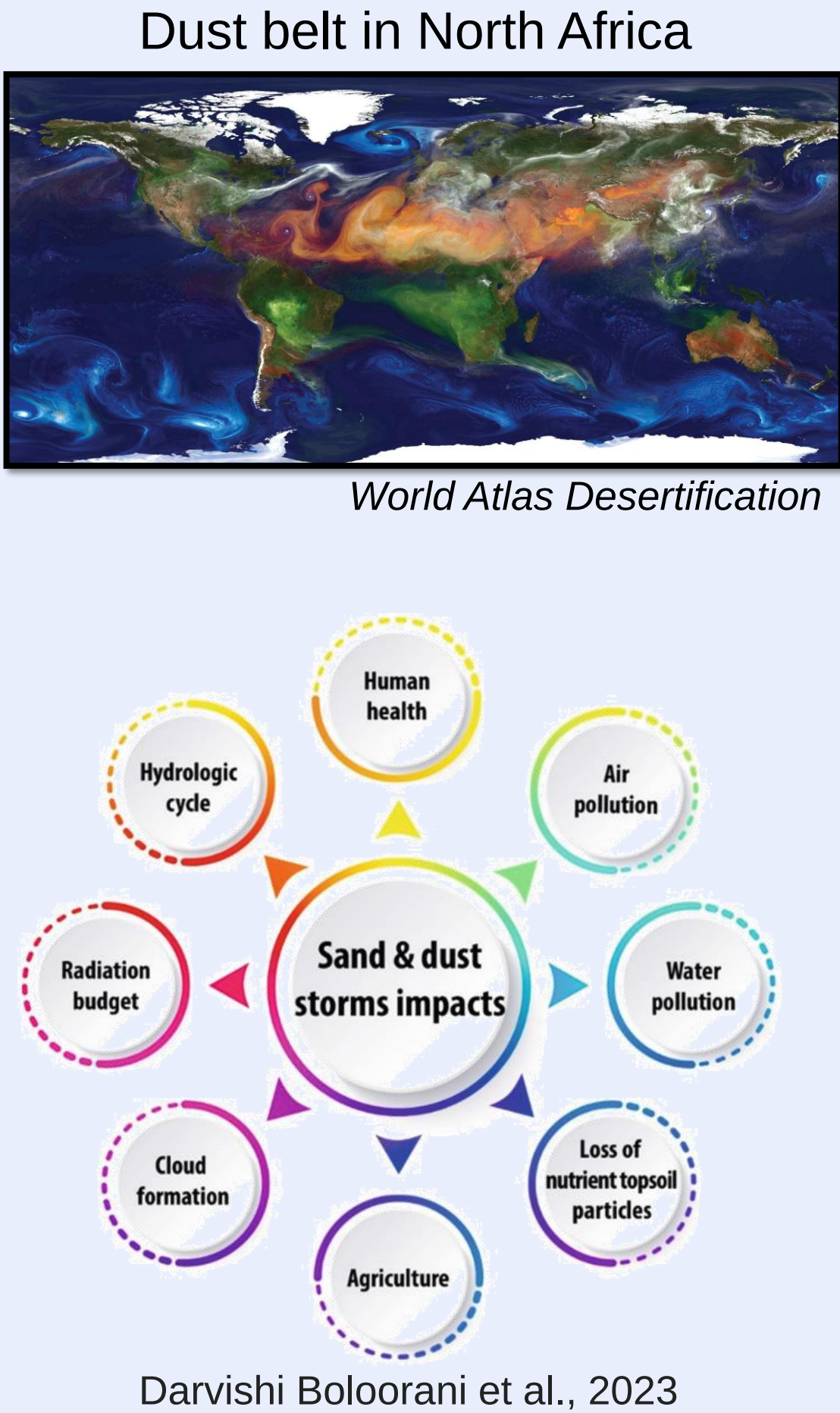
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DUSTRISK
HEALTH INDEX FOR DUST & ASSOCIATED MICROBES

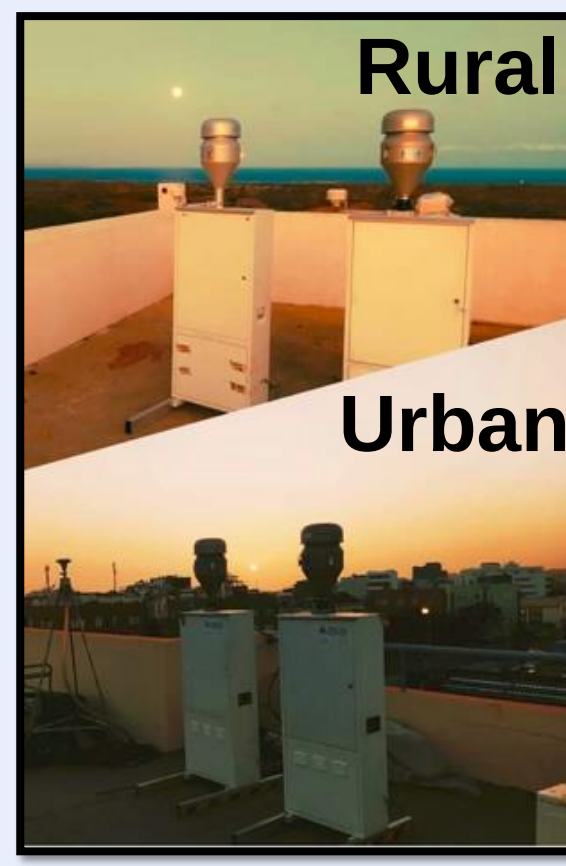
Motivation

- ❖ **Mineral dust pollution** has emerged as a **major global health concern**. This problem is anticipated to worsen due to climate change and the escalating release of crustal material into the atmosphere. ¹
- ❖ Existing studies have highlighted the scarcity of research focusing on the critical impacts of **sand and dust storms (SDS)** on water, soil, and the atmosphere. ²
- ❖ During **SDS events**, particles are carried **over long distances**, leading to **transboundary pollution** that impacts air quality in regions far from their **original sources**. ^{1,2}



Sampling and Methods

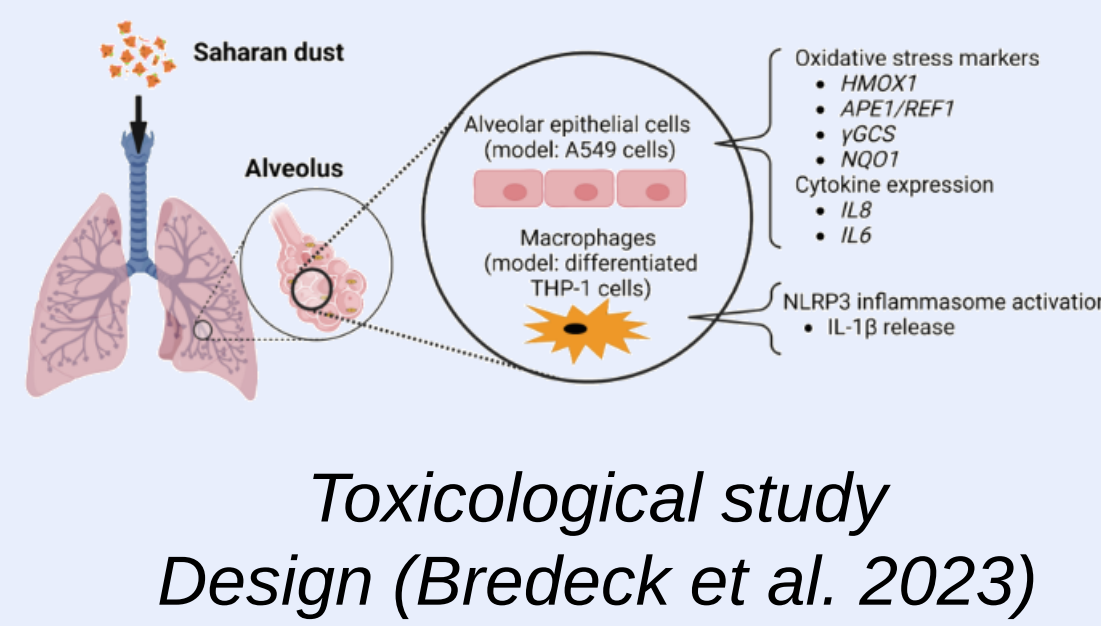
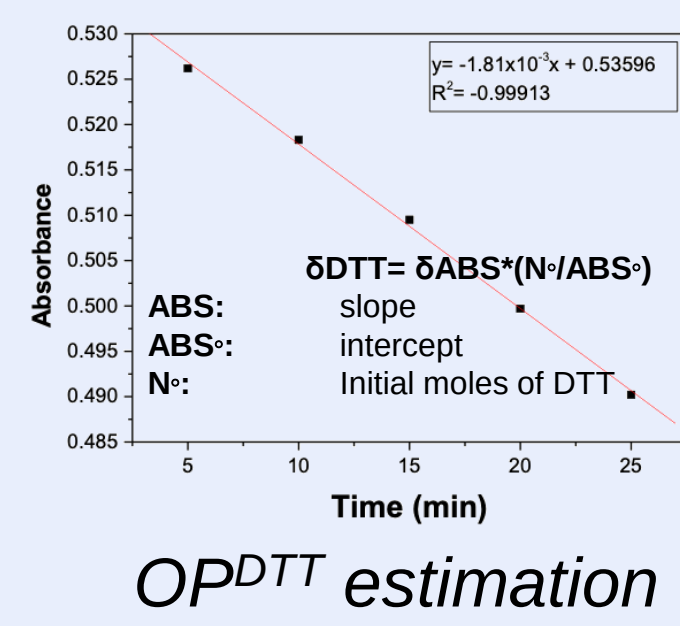
- ❖ **Dustrisk campaign:** (Jan. and Feb. of 2022) – Cape Verde Islands
- ❖ **PM10 and PM2.5** samples in rural and urban sites
- ❖ **Trace elements:** Total x-ray fluorescence (TXRF)
- ❖ **Ions:** Ion chromatography (IC)
- ❖ **Microbiology:** DNA extraction; quantitative PCR; amplification + sequencing of 16S rDNA.
- ❖ **Mercury determination:** Direct Mercury Analyser (DMA-80).
- ❖ **Oxidative Potential:** Dithiothreitol assay (OP^{DTT})
- ❖ **Toxicology:** A549 (alveolar epithelium)



Sampling sites



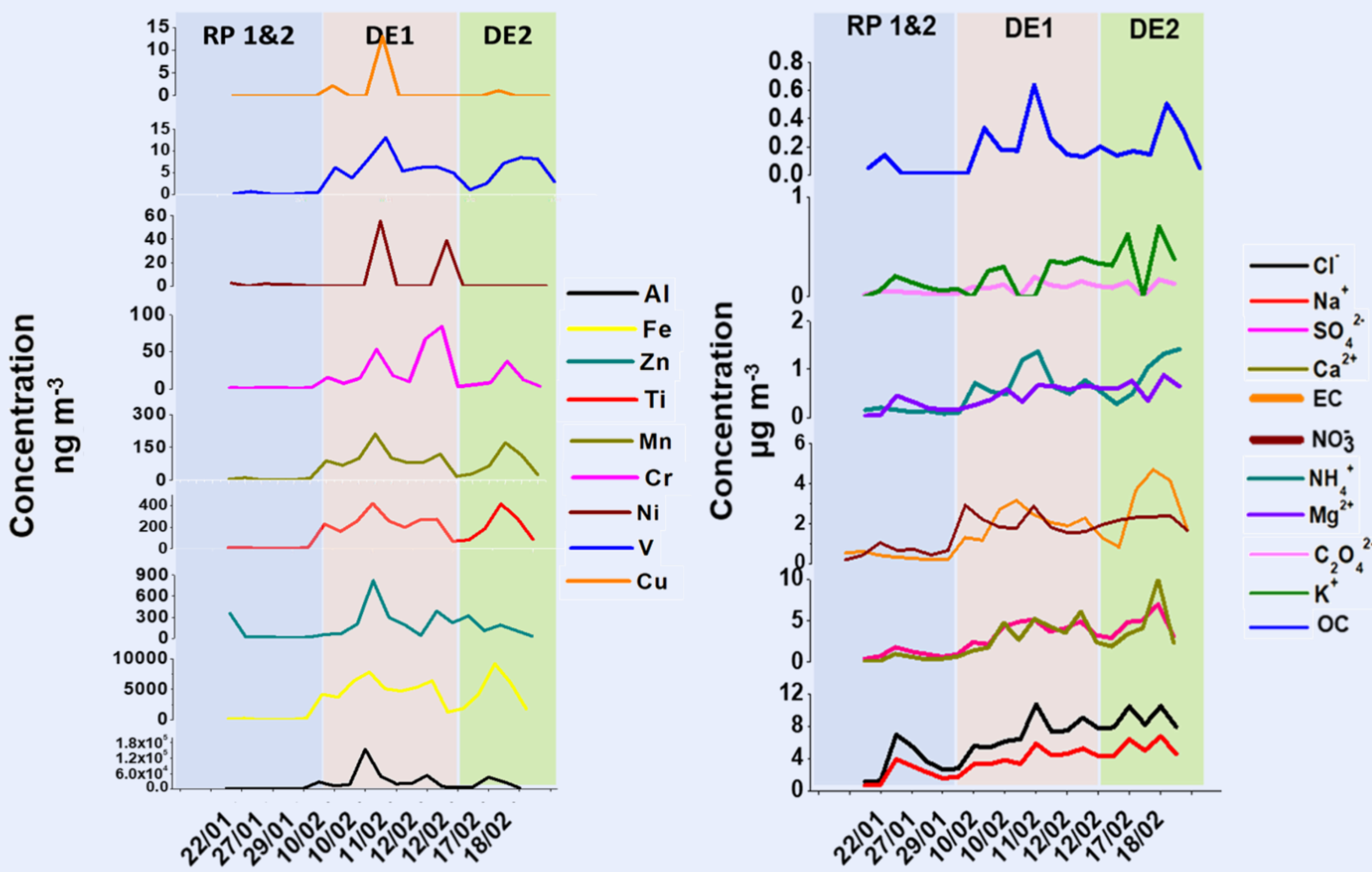
PM10 filters



Results and Discussion

Chemical composition

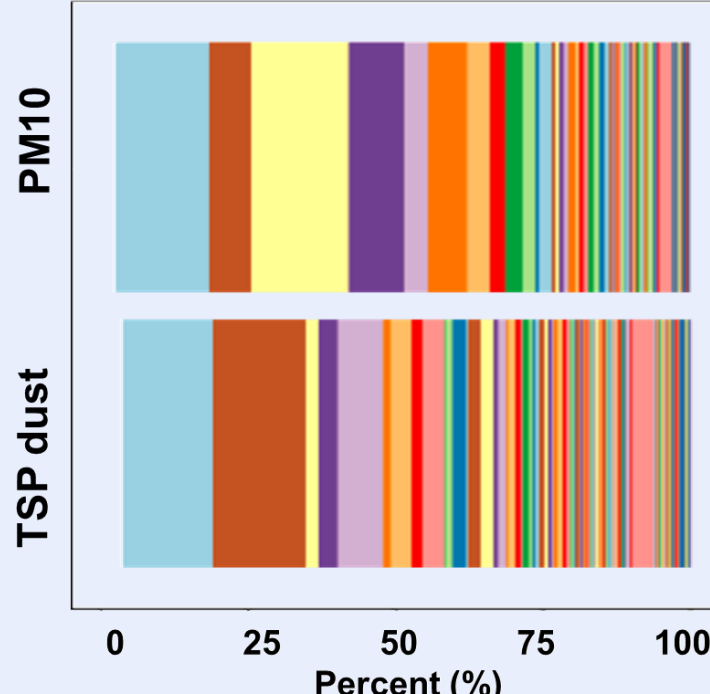
Trace elements, ions, elemental carbon (EC) and organic carbon (OC) during **reference period (RP)** and **dust events (DE1:10-12.02.2022; DE2: 15-18.02.2022)**



- ❖ Trace elements are **enriched about 15 times** during dust events; specially **Ti and Fe**, which are **23 and 31 times more concentrated** during dust events.
- ❖ During dust events, **ion concentrations are 2 (Cl⁻) to 10 (Ca²⁺) times higher** compared to non-dust periods.
- ❖ Both **OC and EC increase about 5 times** during dust events

Microbiology

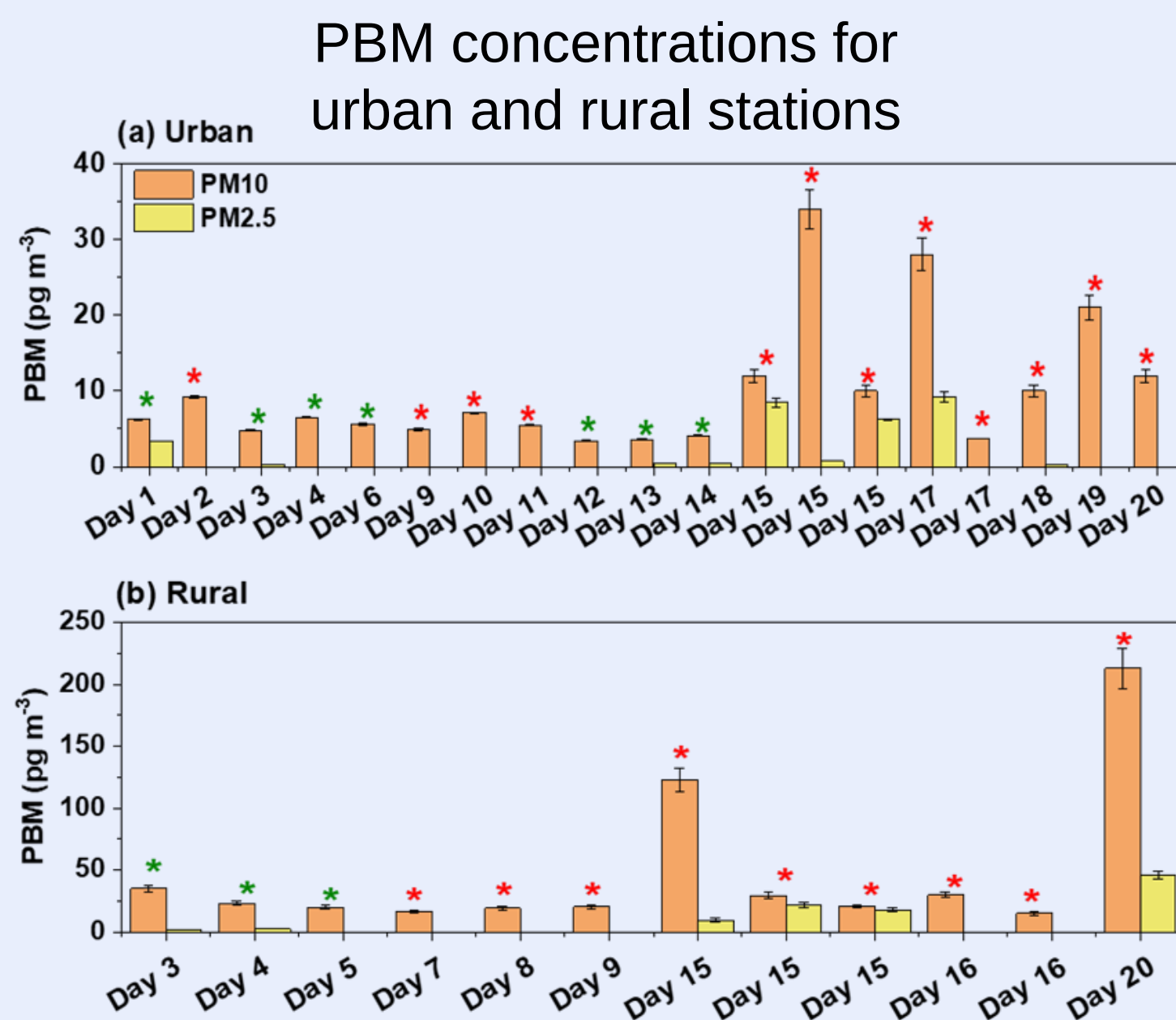
Dust microbes in total suspended particles (TSP) and PM10 samples



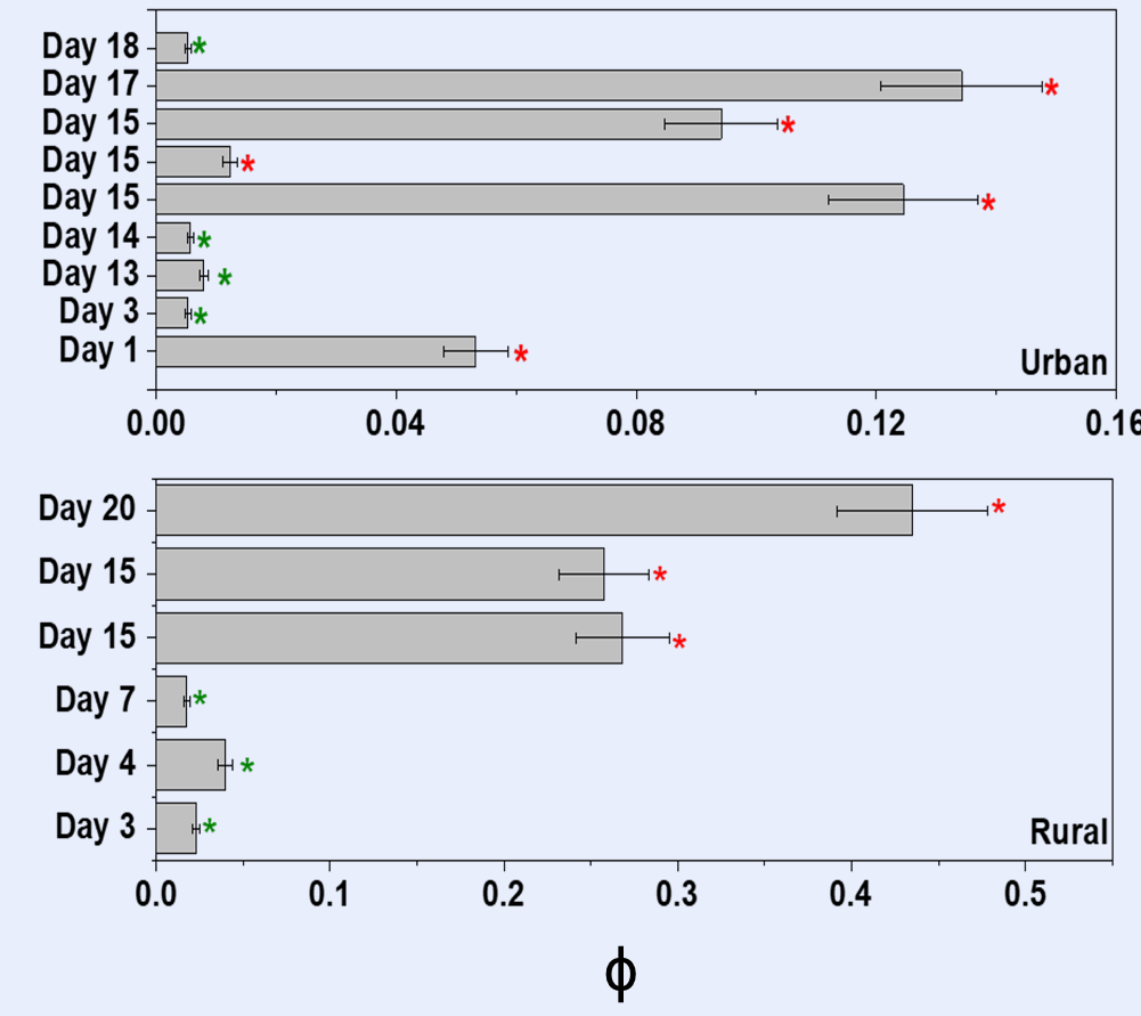
- ❖ **Planococcaceae** and **Bacillaceae** are highly abundant in filter samples and powder dust.
- ❖ Higher abundance of **Micrococcaceae** in PM10 particles compared to dust powder.
- ❖ Both **Bacillaceae** and **Paenibacillaceae** are more prevalent in dust powder samples.

Particle-bound Mercury (PBM)

Dust events (*; red) and non-dust events (*; green)

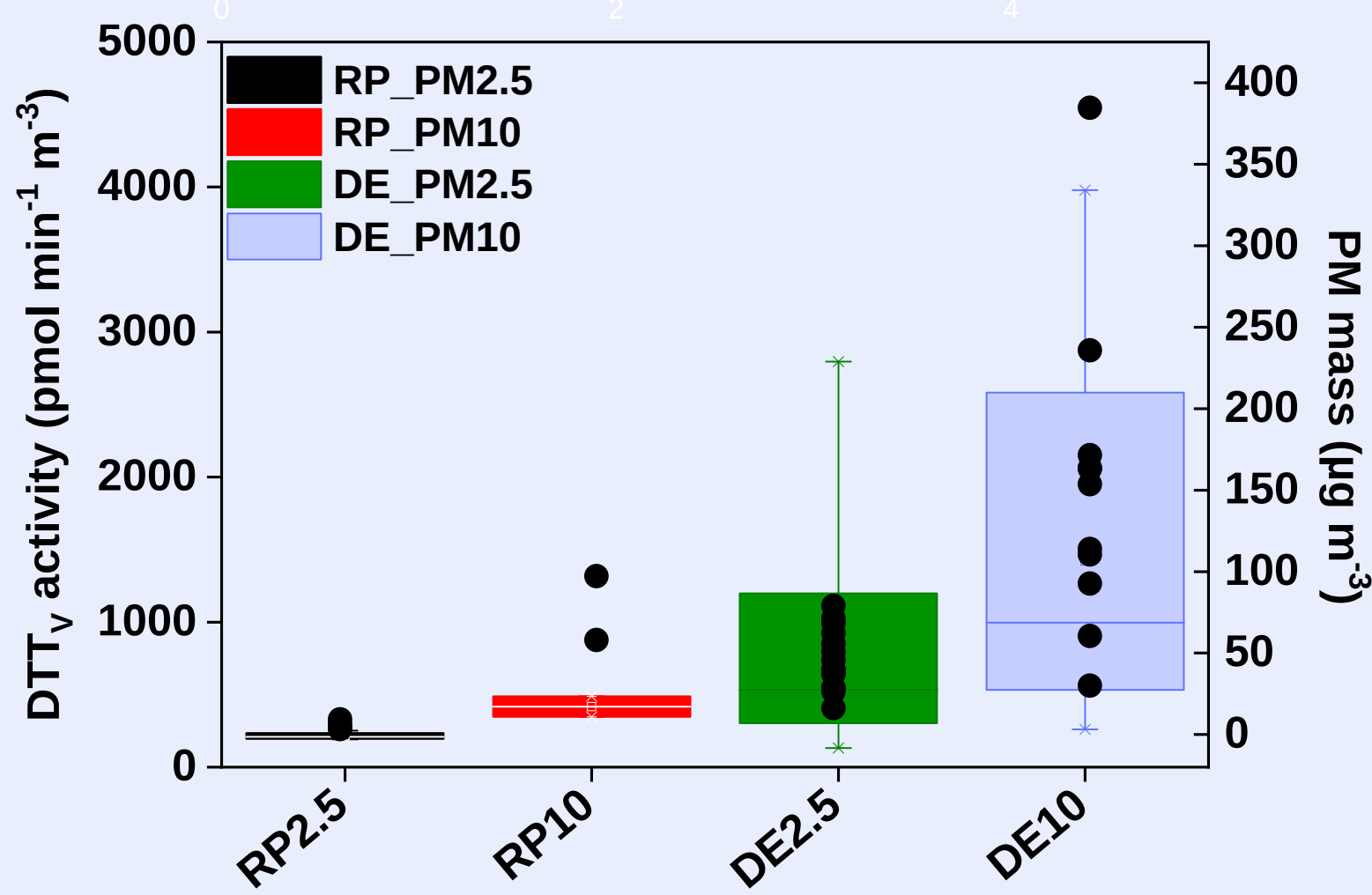


Gas-particle partitioning of atmospheric mercury (ϕ)



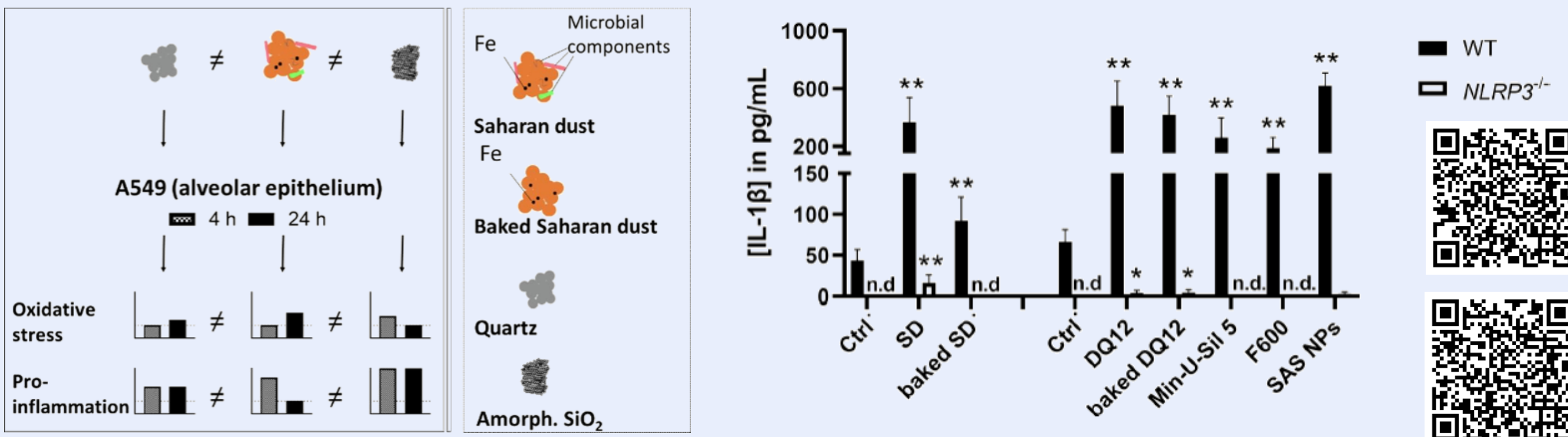
- ❖ **PBM concentrations in PM10 and PM2.5 increased 2.21- and 13.3-fold** during dust events, respectively, compared to non-dust events.
- ❖ The **PM10/PM2.5 PBM ratio was 2.18** during the **dust events** and **13.4** during the **non-dust events**, indicating that coarse particles containing significant PBM levels were a major contributor during the non-dust periods.

Dithiothreitol assay (OP^{DTT})



- ❖ **OP^{DTT} PM10 > OP^{DTT} PM2.5**
- ❖ Increased risk of exposure to **PM with high oxidative potential and enhanced toxic components of coarse particles** during dust events.

Toxicity studies



- ❖ Saharan dust shows strong toxic potency in comparison to Quartz and Amorphous Si, on lung alveolar epithelium cells, with a strong influence of the dust organic content.

References

1. Francis et al., *Atmos. Environ.* 2023
2. Panta et al., *ACP*. 2022
3. Darvishi Boloorani et al. *Dust and Health*. 2023.
4. Bredeck et al., *Environ. Intern.* 2023

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Conclusion

- ❖ Dust events in Cabo Verde contribute to a significant increase of aerosol chemical species including trace elements and ions.
- ❖ Saharan dust may act as an atmospheric carrier of Hg
- ❖ Exposure to particulate matter oxidative potential is higher during dust events and for PM10 compared to PM2.5.
- ❖ Saharan dust events activates the NLRP3 inflammasome, oxidative stress, and inflammatory cytokine release.