# Seasonal dynamics and molecular effects of city and sea spray aerosols on A549 human alveolar epithelial cells

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Epidemiological studies indicate that residing in coastal areas promotes health. Benefits are often attributed to psychological pathways and increased physical activity, but these factors alone cannot fully explain the sustained physiological advantages. This implies the involvement of additional environmental factors, such as exposure to marine aerosols. These aerosols contain biological components from diverse environmental sources, including viruses, bacteria, marine-derived toxins from algae, spores and pollen, which can interact with our biological systems.

Coastal environments are a source of microbial and chemical biodiversity. The proposed mechanisms for their health benefits include immunoregulatory effects and the 'biogenics' hypothesis. The 'biogenics' hypothesis states that airborne biogenic compounds in rural and coastal environments interact with specific cell signalling pathways to exert pleiotropic health benefits, by targeting the PI3K/Akt/mTORC1, NF-kB, and PTEN pathways and autophagy.

Although marine biodiversity may impact the extent of the health benefits, its biological effects remain poorly characterized. To address this gap, aerosol samples were taken both in the city of Ghent and at the coast in Ostend during a one-year sampling campaign. The aerosol samples were analysed to measure the chemical diversity, while the biological activity was assessed through in vitro testing with the human lung cell line A549. Transcriptomics were used to develop a mechanistic understanding of molecular and cellular action of the biogenic chemicals.

The results revealed a strong seasonal effect, with minimal biological activity in winter and peak effects in spring and early summer. During the latter season, enriched hallmark gene sets include KRAS signaling, E2F targets, TNFa signaling via NF-kB, G2M checkpoint, MYC targets and the P53 pathway. Within the spring and early summer season, the SSA samples induced more differential gene expression than the city samples. Additionally, coastal aerosols exhibited the highest chemical diversity, strongly correlated with their Na+ content, indicating a significant marine origin and supporting the 'biogenics' hypothesis.

**Keywords**
Sea Spray Aerosols; Biogenics; Transcriptomics