Air quality trends and perspectives in South Korea inferred from GEMS and LEO satellites during 2015–2023

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1. Motivation

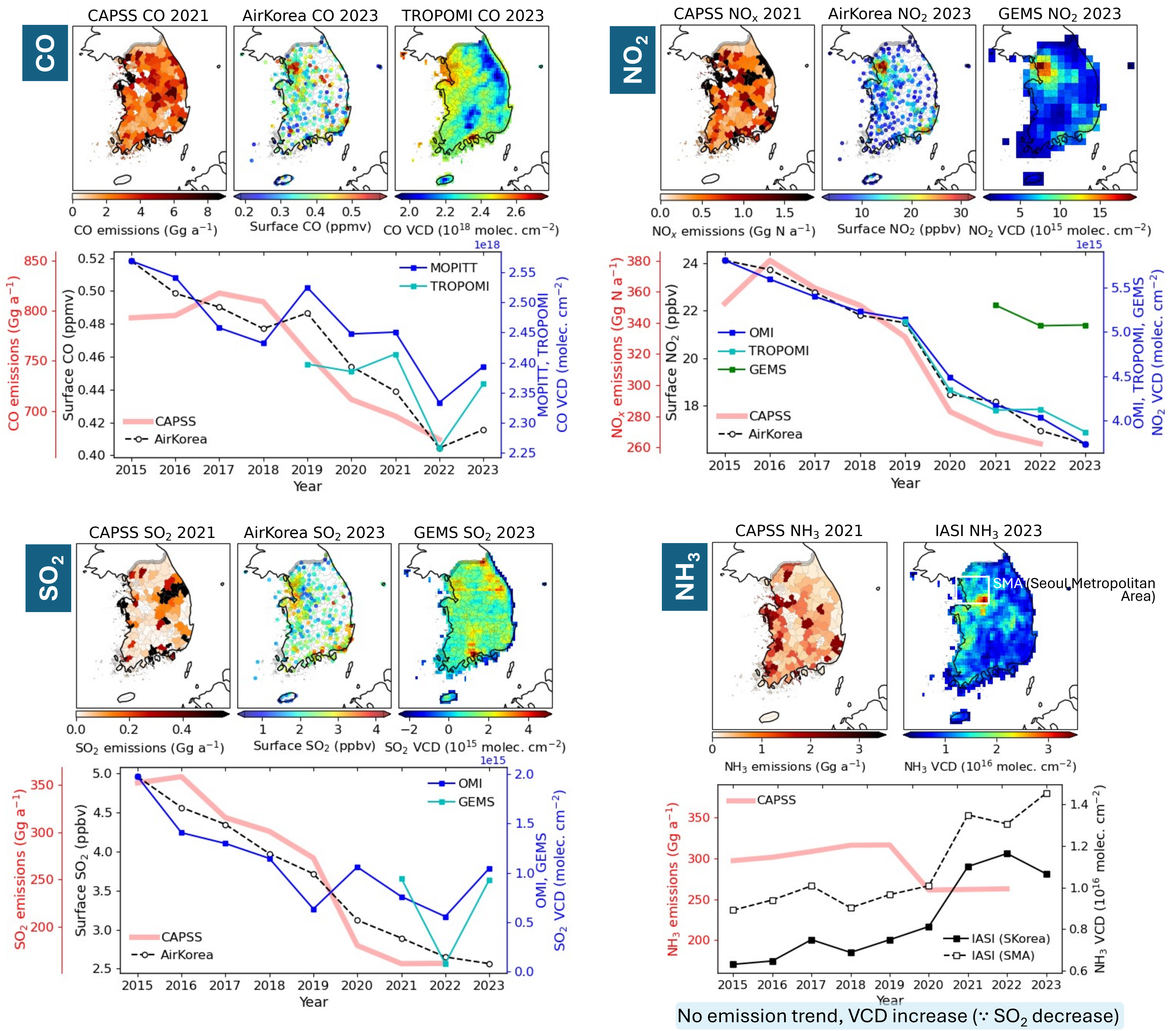
- 30,000 premature deaths per year are presently attributed to air pollution in South Korea.[1]
- **CO**, **SO_2**, and **NO_2** have decreased continuously, achieving >**99% attainment**.
- Surface **O_3** and **$PM_{2.5}$ exceed** air quality standards, and O_3 is **increasing** (0.4 ppbv a^{-1}).
- **Satellite observations** offer a new resource for monitoring air pollutants and trends.
- We **analyze recent (2015–2023) trends** and demonstrate the synergy between surface and satellite observations.
- We **diagnose O_3 and PM nitrate (NO_3^-) sensitivities** to guide control strategies.[2,3]

2. Data

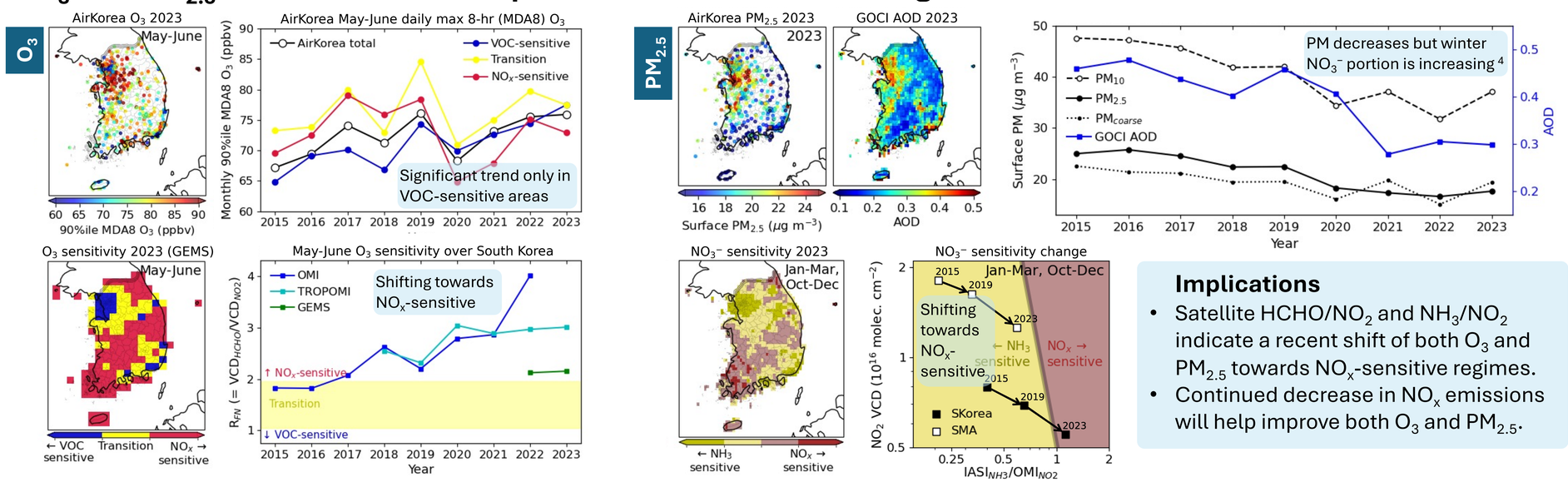
- Emissions: Clean Air Policy Support System (CAPSS)
- Surface: AirKorea ground network
- Satellites: LEO and geostationary instruments

Instrument	Operation	Observations
Low Earth Orbit (LEO)		
MOPITT	1999–	CO vertical column density (VCD)
OMI	2004–	SO_2, NO_2, HCHO VCDs
TROPOMI	2017–	CO, NO_2, HCHO VCDs
IASI	2006–	NH_3 VCD
Geostationary Orbit		
GEMS	2020–	SO_2, NO_2, HCHO, CHOCHO VCDs
GOCI	2011–21	AOD (aerosol optical depth)
GOCI-II	2020–	AOD

3. Precursor distributions and national trends



4. O_3 and $PM_{2.5}$ sensitivities and implications for control strategies



Implications

- Satellite HCHO/NO_2 and NH_3/NO_2 indicate a recent shift of both O_3 and $PM_{2.5}$ towards NO_x-sensitive regimes.
- Continued decrease in NO_x emissions will help improve both O_3 and $PM_{2.5}$.

Reference

[1]Oak et al. (2023), [2]Duncan et al. (2010), [3]Dang et al. (2024), [4]Lee et al. (2024)

Acknowledgement

This work was supported by Samsung Advanced Institute of Technology.

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