Air pollution monitoring through the integration of the space and ground data

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Air pollution

- Primary (directly emitted from the sources) and secondary air pollutants (generated in the atmosphere through a series of chemical reactions)

- Ambient air pollution can affect respiratory, pulmonary, heart disease, stroke and lung cancer

- Mortality rate attributed to household and ambient air pollution, age-standardized (per 100,000 population)
Monitoring air pollution

Ground-based measurements
Pandora spectrometer (NO\textsubscript{2} and O\textsubscript{3})
Data source: https://www.pandonia-global-network.org

Satellite Remote sensing
Modis Terra aerosol optical depth at 550nm 2007 to 2011 average
Data source: http://daac.gsfc.nasa.gov/giovanni

- Ground-based in-situ and remote sensing instrument can be measured at only a few sites in global
- Satellite can provide global distribution of air pollutants
• GEMS, onboard the GEO-KOMPSAT2B (Geostationary Korea Multi-Purpose Satellite), is a geostationary scanning ultraviolet-visible spectrometer.

• It is designed to monitor trans-boundary pollution events for the Korean peninsula and the Asia-Pacific region.
A multi-output random forest (MORF) model for estimation of hourly concentrations of PM$_{2.5}$, PM$_{10}$, O$_3$, NO$_2$, CO, and SO$_2$

Using GEMS observations, ERA5 reanalysis datasets, in-situ observations (China National Environmental Monitoring Center)

Spatial distribution of annual mean concentrations for six air pollutants

[Yang et al., 2023]
Application (1)

Surface concentration estimation

- The ozone pollution in Guangdong on April 30, 2021
- The dust storm in North China on March 15, 2021

[Yang et al., 2023]
Comparison NO$_2$ from GEMS and Pandora

- The comparison and validation of satellite-based NO$_2$ VCD retrievals are essential because of their non-negligible error sources

[Kim et al., 2023]
The average correlations using MAX-DOAS and CNEMC data were 0.81 and 0.57 → a high level of accuracy

Transport flux of NO$_2$ could increase by over 500% within 1 h, making a significant contribution to local NO$_2$ concentrations
Further suggestions (previous study)

Trend analysis on air quality changes in East Asia

- Climatological and trend (a) GOCI AOD at 550nm, (b) OMI SO$_2$, (c) OMI tropospheric NO$_2$, and (d) IASI ammonia from MAR 2011 to FEB 2019
- Observations = Meteorological (Multiple linear regression model) + Meteorology-corrected (residual)
- Residual can be interpreted as emission

[Ahn et al., in revision]
Further suggestions (previous study)

Trend analysis on air quality changes in East Asia

- Decreased SO$_2$ and NO$_2$ reduces the production of ammonium sulfate ((NH$_4$)$_2$SO$_4$) and ammonium nitrate ((NH$_4$)NO$_3$), which results in the increased atmospheric NH$_3$
- The effective implementation of the emission control for the certain species can cause the unintended increasing of air pollutant

[Ahn et al., in revision]
Thank you!