

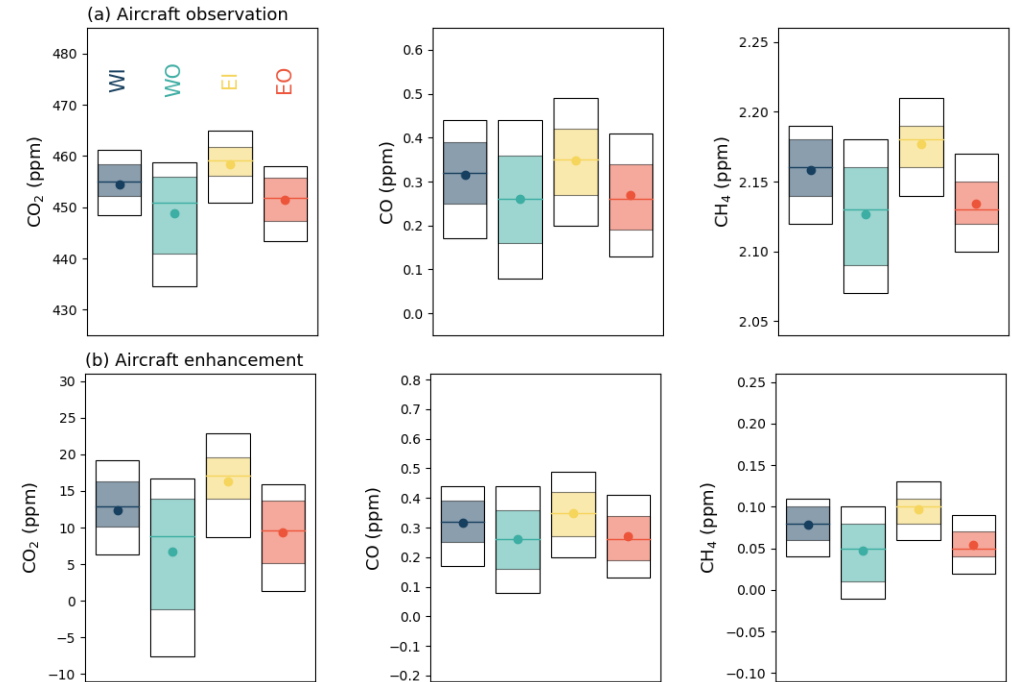
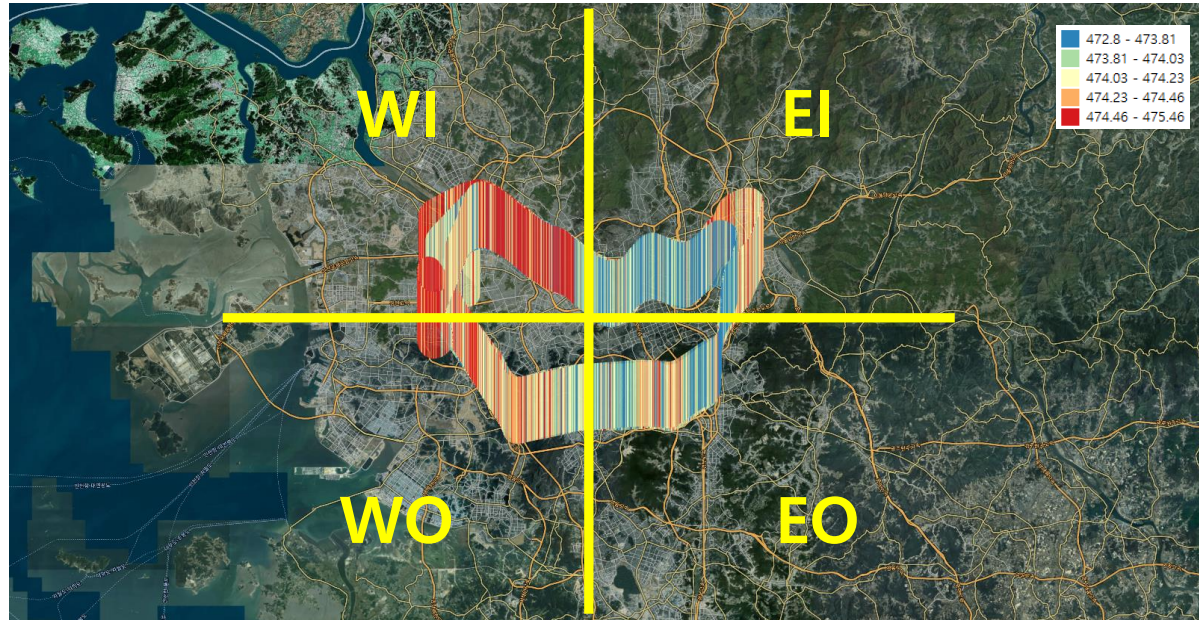
Urban greenhouse gas observations of Seoul using measurements from ground to space

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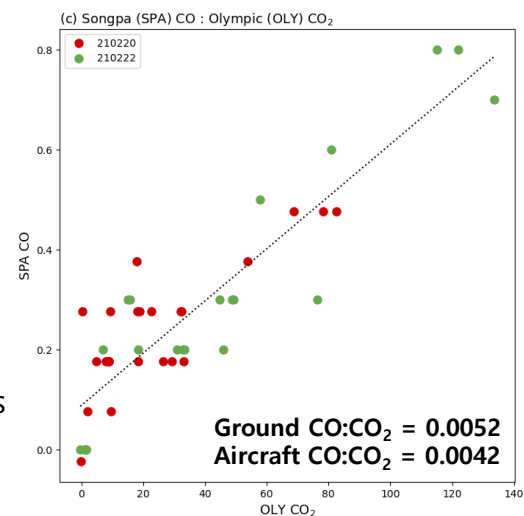
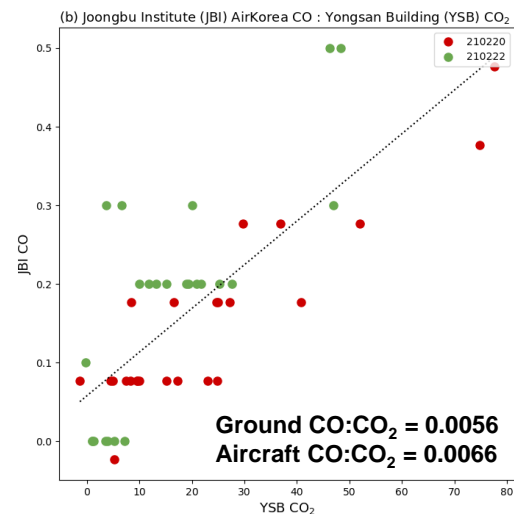
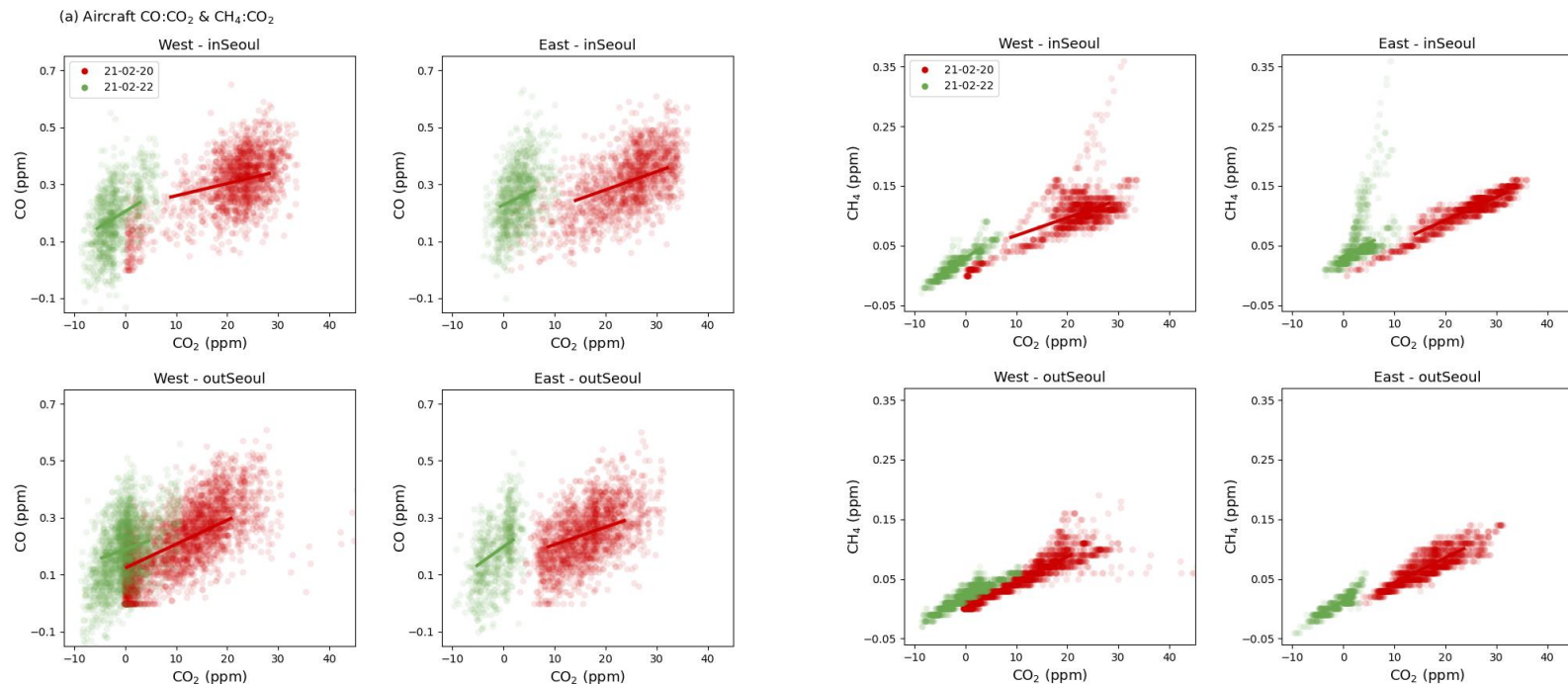
Aircraft CO₂ observation route (21-02-20)



- Seoul is a megacity with high emissions of both anthropogenic greenhouse gases and air pollutants. We introduce the current greenhouse gas monitoring efforts that are being made in Seoul using both ground, aircraft, and space-based measurements.
- The aircraft observation campaign in cooperation with NIER was carried out on 19 Feb. 2021 ~ 22 Feb. 2021.
- Data from two days of the campaign (21-02-20 & 21-02-22) were used in this study.
- Enhancements are calculated by differencing the daily first percentile concentration from each observation data.
- We divided the aircraft track into 4 sectors: West-inSeoul (WI), West-outSeoul (WO), East-inSeoul (EI), East-outSeoul (EO).
- Measurements made within Seoul (WI & EI) show average concentrations that are around 1.4%, 25%, and 1.8% higher for CO₂, CO, and CH₄, respectively, compared to measurements made outside Seoul (WO & EO).

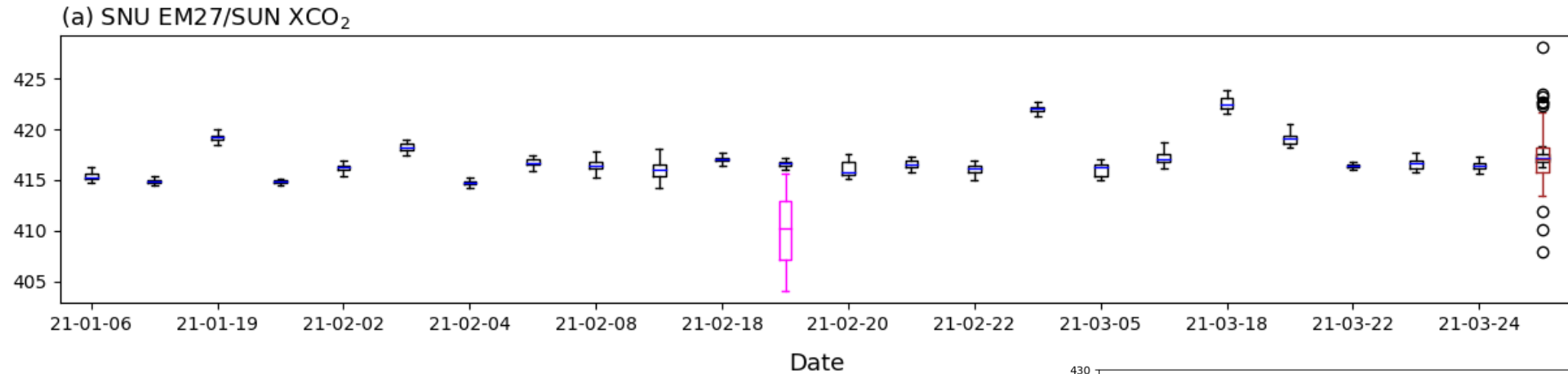
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Ground CO:CO₂ vs Aircraft CO:CO₂

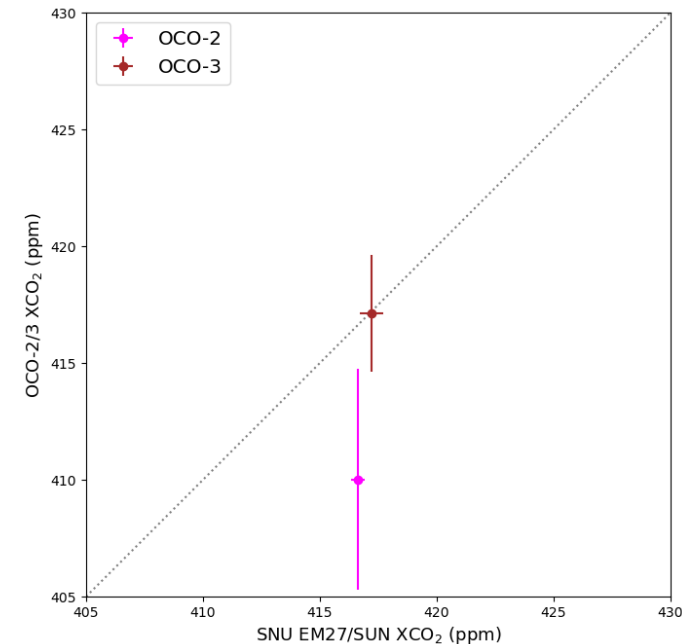


- Aircraft measurements of CO:CO₂ & CH₄:CO₂ enhancements can be used to characterize the combustion source characteristics within Seoul.
- The positive linear relationship of CO:CO₂ shown in both aircraft and ground measurements indicate that air quality deteriorates with the increase of CO₂. Much of the CO are emitted from heavy amounts of traffic within Seoul.
- Especially, the high correlation of CH₄:CO₂ from aircraft measurements imply that they are emitted from similar sources.
- The CH₄:CO₂ ratio could mostly be affected by the public buses in Seoul which have been running 100% on CNG fuel since 2007, as well as the newly built Seoul Power Station in the WI sector that produces liquid natural gas, which emits large amounts of both CH₄ and CO₂.
- Ground measurements of CO:CO₂ in both WI (Fig. b) and EI (Fig. c) sectors show high correlations. There are no CH₄ measurements currently available in the ground monitoring network.
- Aircraft and ground observations show a consistent CO:CO₂ ratio despite ground measurements being situated in one area while aircraft measurements move across Seoul.

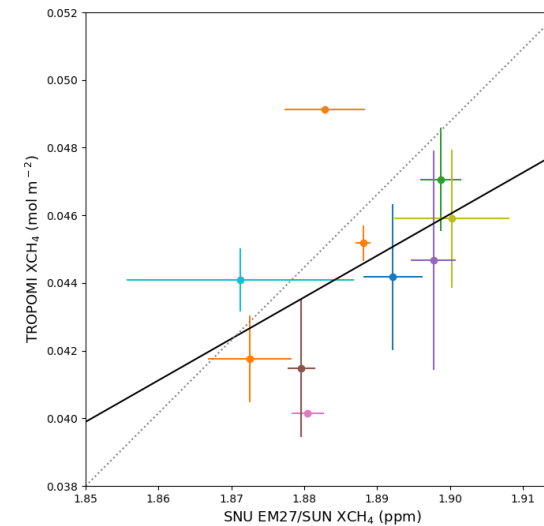
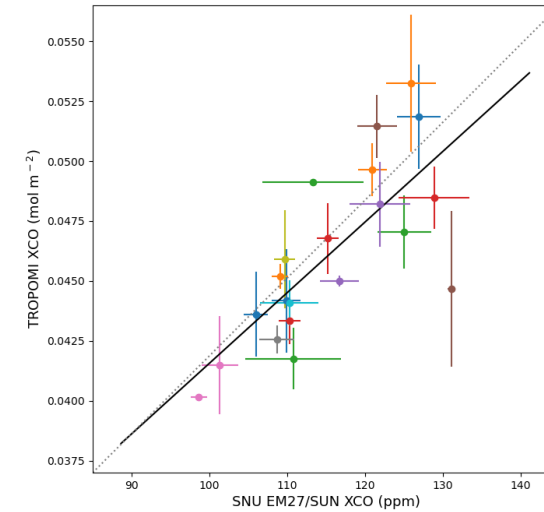
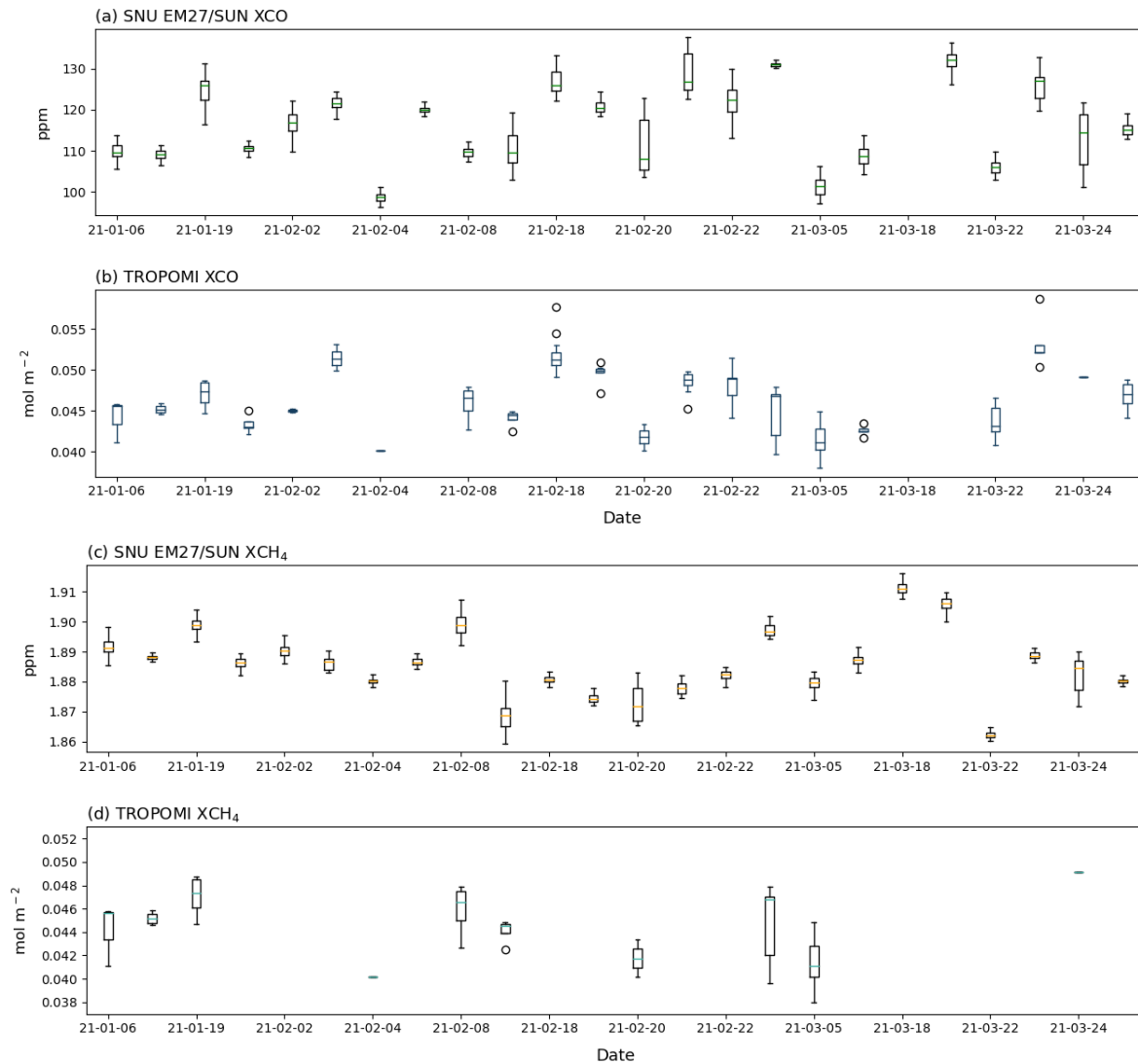
OCO-2/3 XCO₂ vs. SNU EM27/SUN XCO₂



- Ground-based EM27/SUN comparisons are made with satellite measurements of OCO-2, OCO-3, and TROPOMI.
- Measurements of CO₂, CO, and CH₄ have been made on clear days with the EM27/SUN at SNU starting from January of 2021.
- We are currently making measurements in tandem with OCO-2 target and nadir measurements and OCO-3 SAM measurements.
- The OCO-2 observation made on 21-02-19 did not have enough measurements within Seoul (mostly made outside Seoul).
- More OCO-2 and OCO-3 data need to be collected for future comparisons.



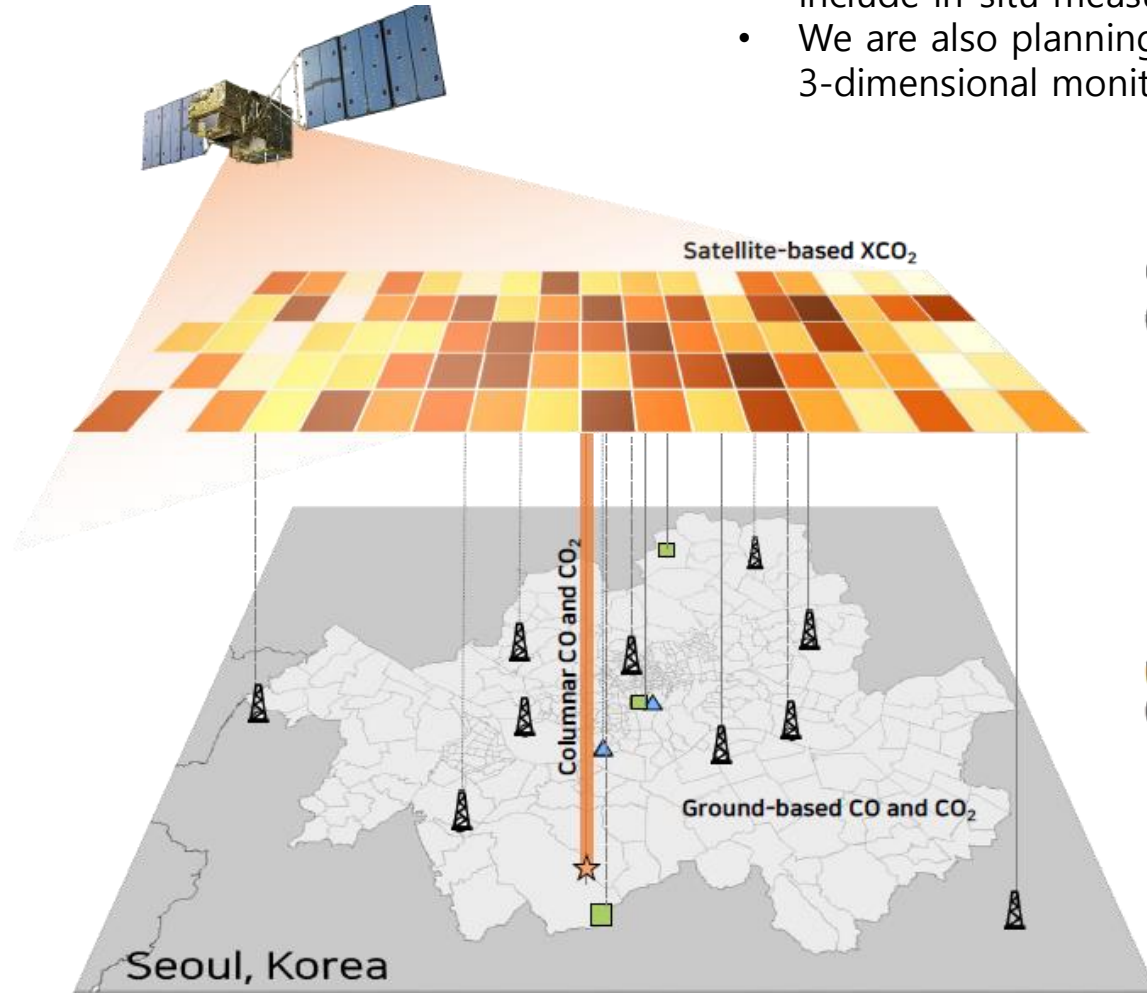
TROPOMI XCO & XCH₄ vs. SNU EM27/SUN XCO & XCH₄



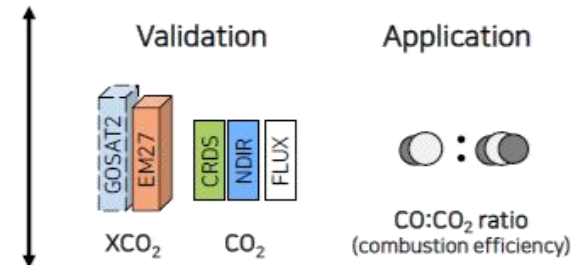
- SNU EM27/SUN measurement comparisons with TROPOMI measurements show a agreeable trend for XCO and XCH₄; however, XCH₄ compariosns show a weaker agreement compared to XCO comparisons.

Ongoing Research at SNU

- With the PI as Sujong Jeong, the SNU team is currently part of the 2nd GOSAT RA and is monitoring GHG-AQ in Seoul using urban monitoring networks across Seoul which include in-situ measurements, EM27/SUNs, and flux towers.
- We are also planning to use multiple satellite synergies and inverse modelling for a 3-dimensional monitoring of greenhouse gases in Seoul.



GOSAT-2, OCO-2, OCO-3, TROPOMI, GEMS (XCO and XCO₂)



Urban monitoring network (CO₂, CO, XCO, and XCO₂)

- ★ EM27 (FTIR)
- PICARRO (CRDS)
- ▲ LI-COR-850A (NDIR)
- ⚙ Urban flux tower network
(urban 8 sites, peri-urban 6 sites)

