Analysis on the spatiotemporal distribution of OCO-2 XCO_2 over South Korea

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NOAA GMD Annual Meeting 23-24, May, 2017

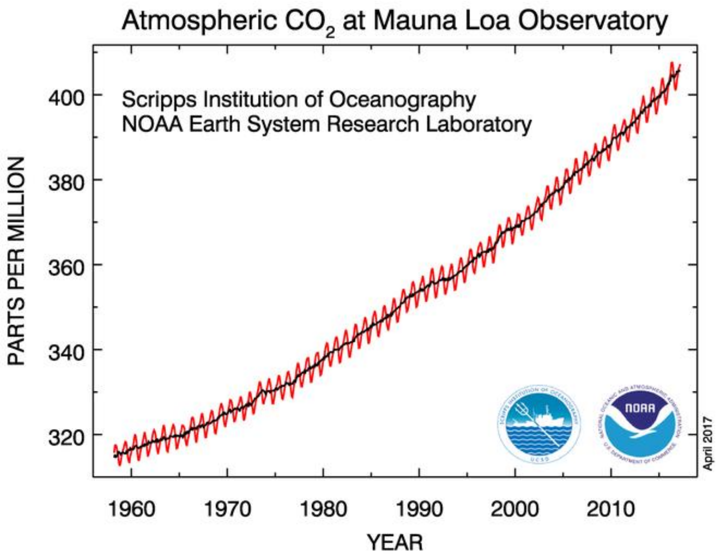
1. Introduction

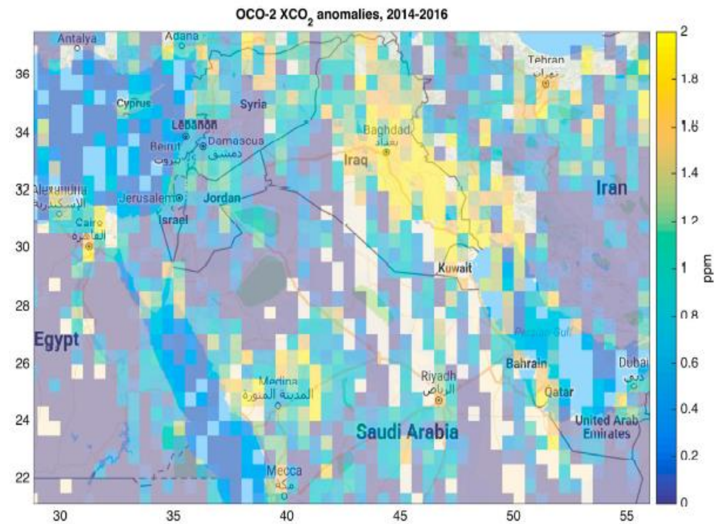
- CO₂ is one of major greenhouse gases and has been increased since the beginning of the industrial revolution. (IPCC, 2014)

- CO_2 observation using satellite

  - Local CO_2 sources were detected through the satellite observation in previous studies.

    (Bovensmann et al.(2010), Hakkarainen et al.(2016), Kort et al.(2012), Schneising et al.(2013))





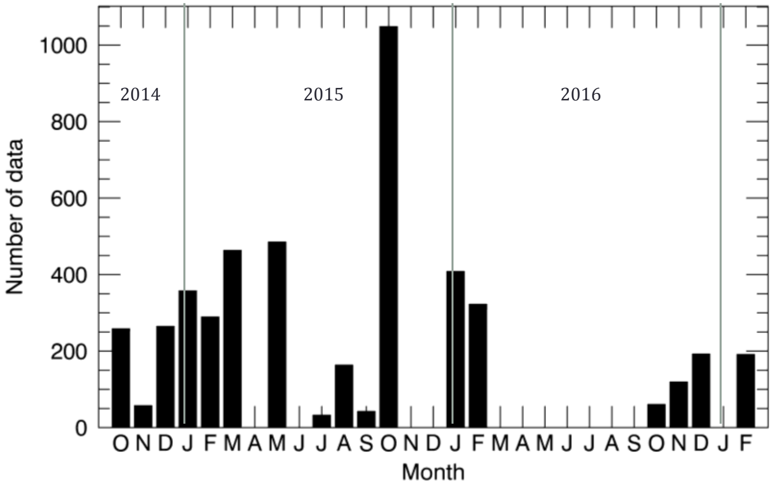
Hakkarainen et al.(2016)

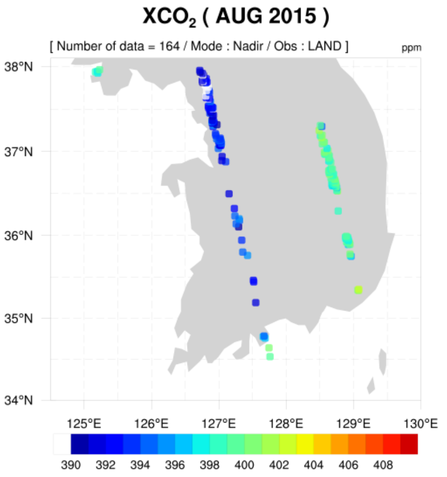
- In this study
  - Spatiotemporal distribution of OCO-2 XCO_2 over Korea domain(34-38°N, 124-130°E) during October 2014 – February 2017 is analyzed.

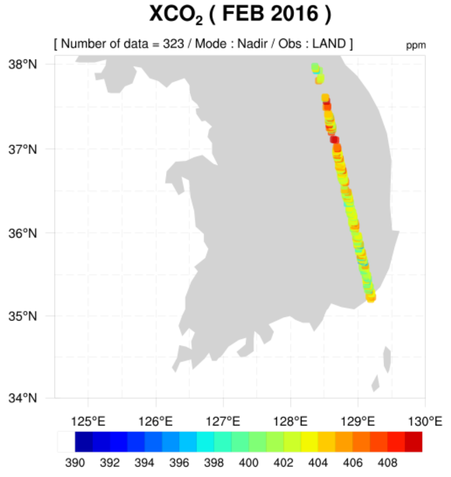
2. Data

- OCO-2
  - Passes over Korea domain at 13-14KST.
  - Spatial resolution : 1.29km X 2.25km (in Nadir mode)
- Research area : Korea domain(34-38°N, 124-130°E)
- Research period : October 2014 – February 2017
- Only land data observed in nadir mode(7Br Lv.2) and error < 1ppm were used in this study.

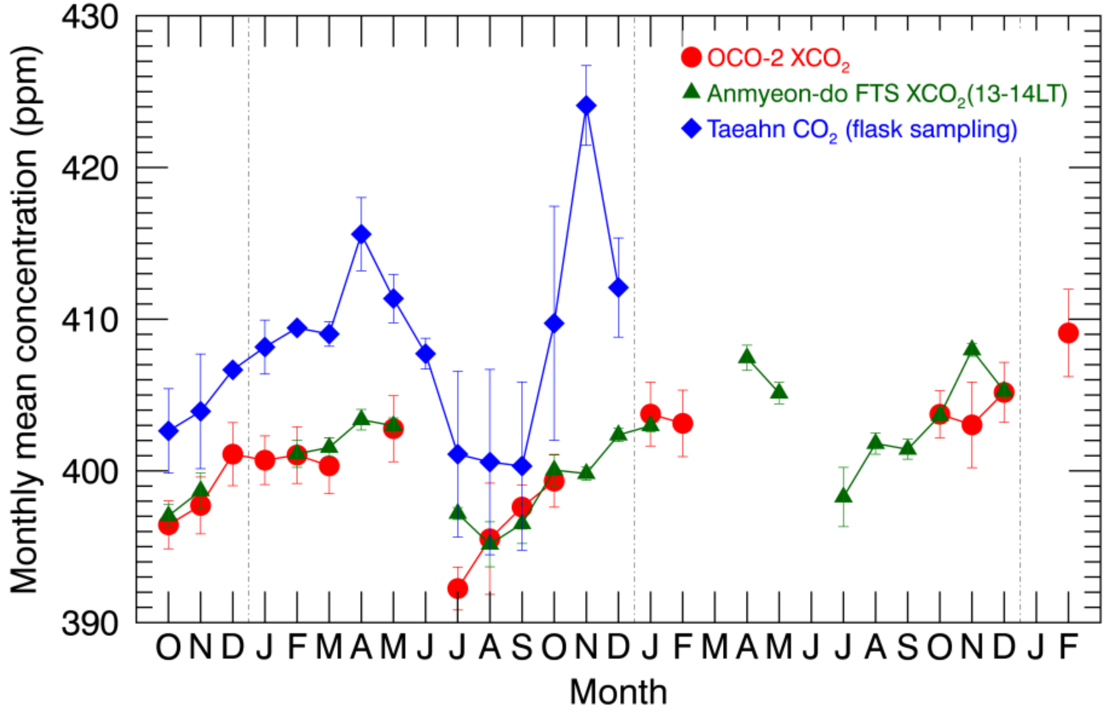
$$[\ XCO2 = 0.2095 \times \frac{Column\ CO_2}{Column\ O_2}\ ]$$





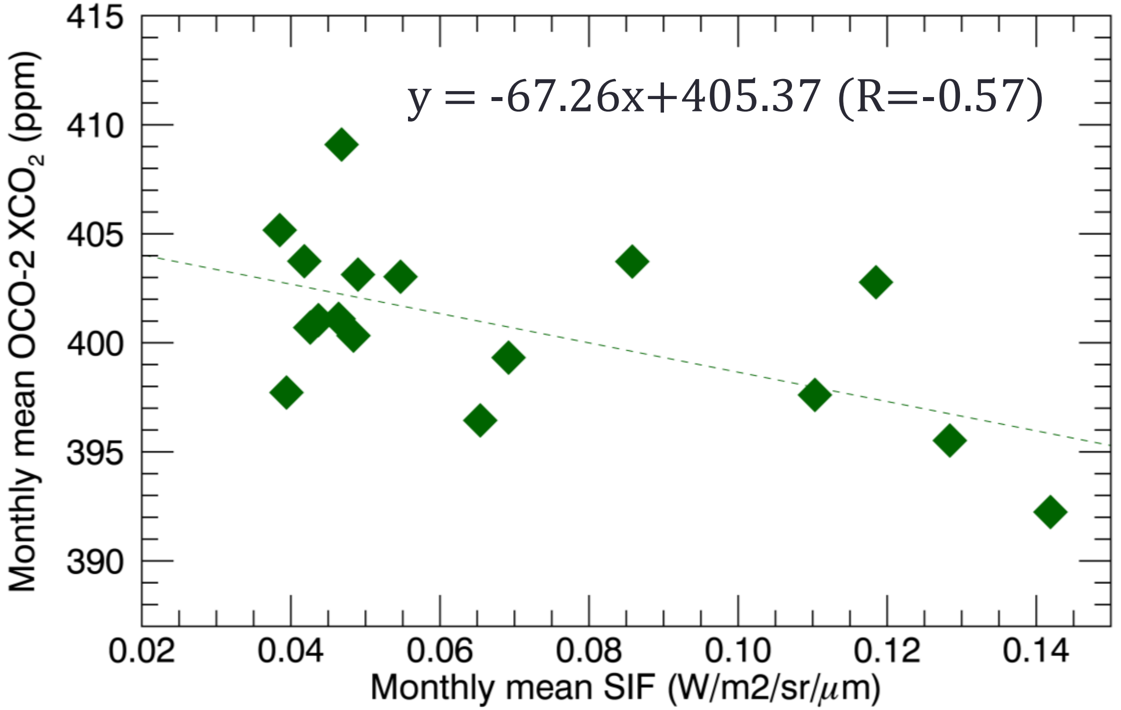


3. Seasonal Variation of Korea OCO-2 XCO_2



- Monthly mean Korea OCO-2 XCO_2
  - Only for the months has more than 30 data points.
  - Presents similar variation tendency to monthly mean of Anmyeon-do (AMY) FTS XCO_2 ($R = 0.87$) and CO_2 at Tae-Ahn peninsula (TAP) site ($R = 0.85$).
  - TAP CO_2 is higher and larger in amplitude of variation than other two observations because it represents the surface CO_2 concentration.

3. Seasonal Variation of Korea OCO-2 XCO_2



- Negative correlation between monthly mean OCO-2 XCO_2 and OCO-2 Solar Induced Fluorescence (SIF)

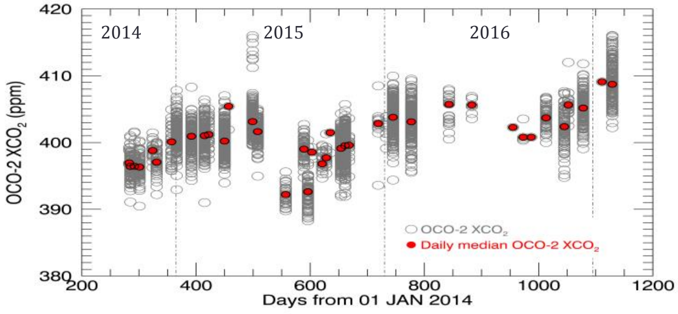
4. Spatial distribution of Korea OCO-2 XCO_2

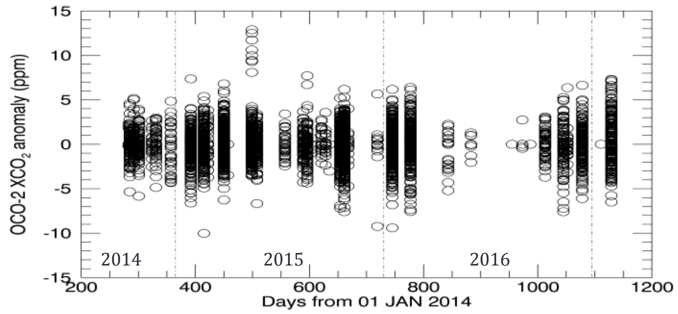
- Method

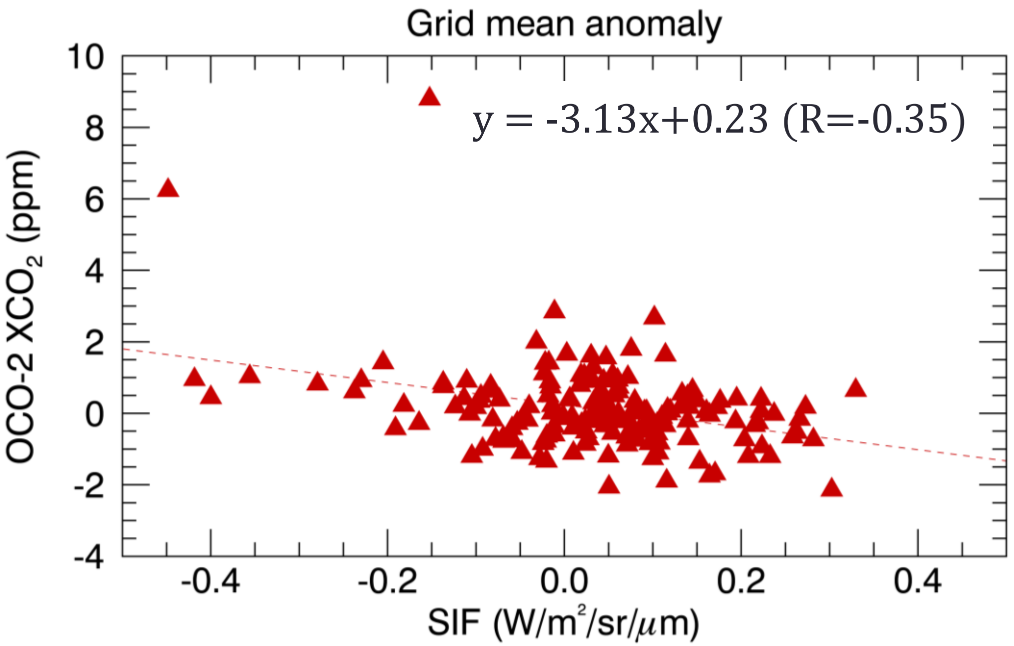
  - 0.1°X0.1° Grid mean Korea OCO-2 XCO_2 anomalies were computed by following equation to remove a seasonal variation.

$$XCO_2 \text{ anomaly} = XCO_2 - \text{daily median of } XCO_2$$ (Hakkarainen et al.(2016))

  - The effect of spatial distribution of vegetation is removed by using the correlation between grid mean OCO-2 XCO_2 anomalies and grid mean OCO-2 SIF anomalies.



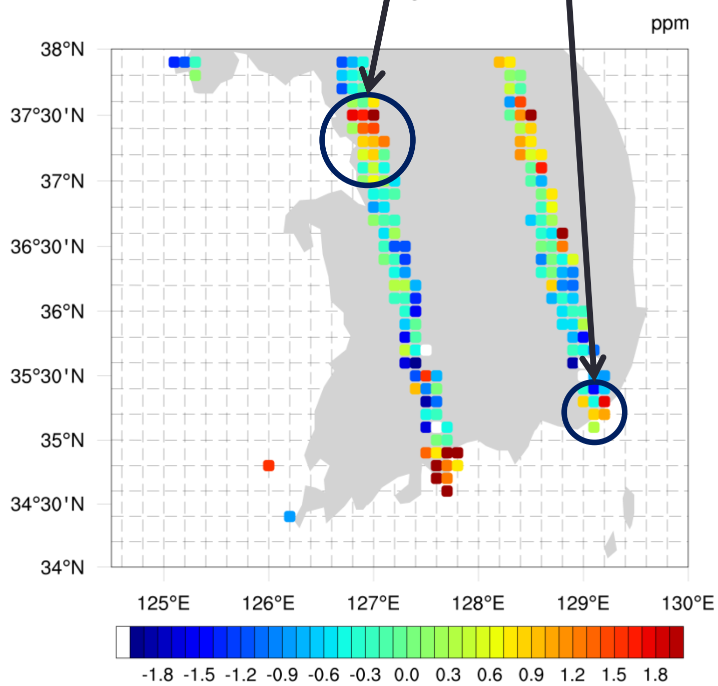




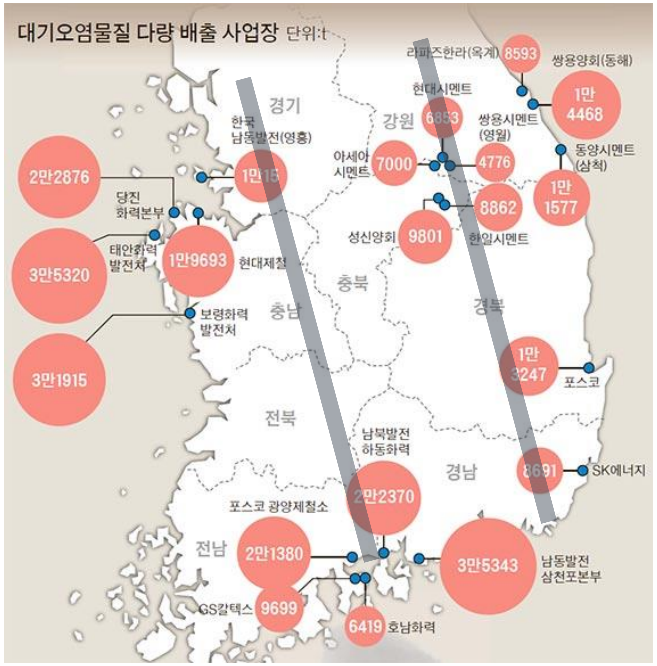
4. Spatial distribution of Korea OCO-2 XCO_2

- Positive anomalies
  1. Near the big cities (Seoul, Pusan…)
  2. Industrial regions (Gwangyang, Youngwol)

XCO_2 anomaly (0.1°X0.1°)



Top 20 CO_2 sources(industry) in Korea



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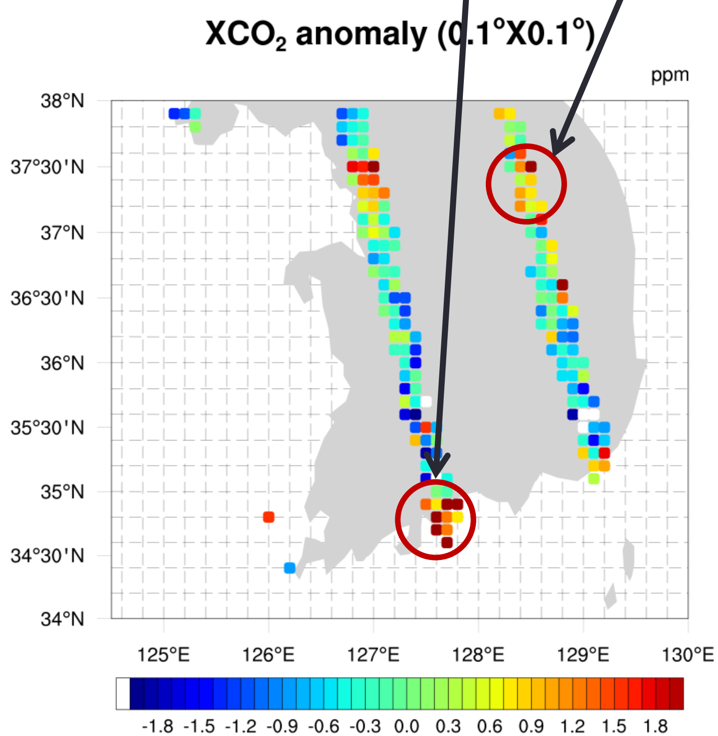

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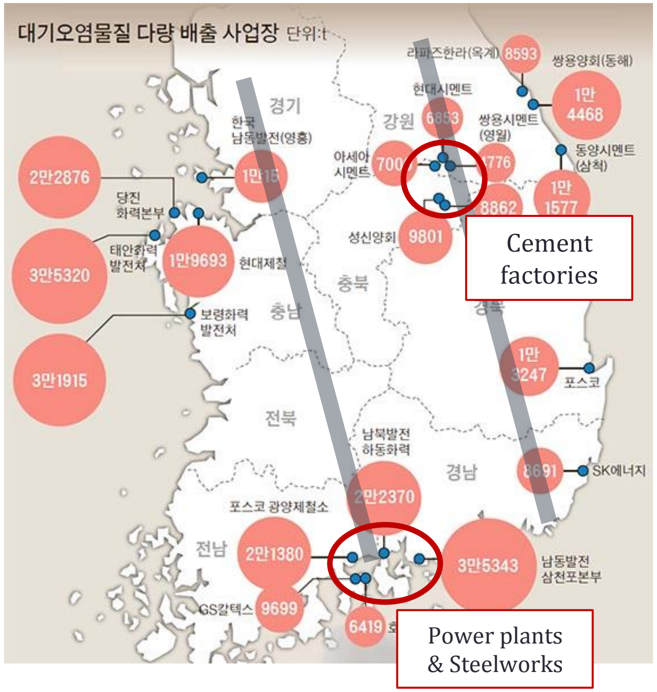

4. Spatial distribution of Korea OCO-2 XCO_2

- Positive anomalies
  1. Near the big cities (Seoul, Pusan…)
  2. Industrial regions (Gwangyang , Youngwol)
- Aura OMI NO_2 over Korea domain shows high positive anomalies near the regions where those of OCO-2 XCO_2 are located in.

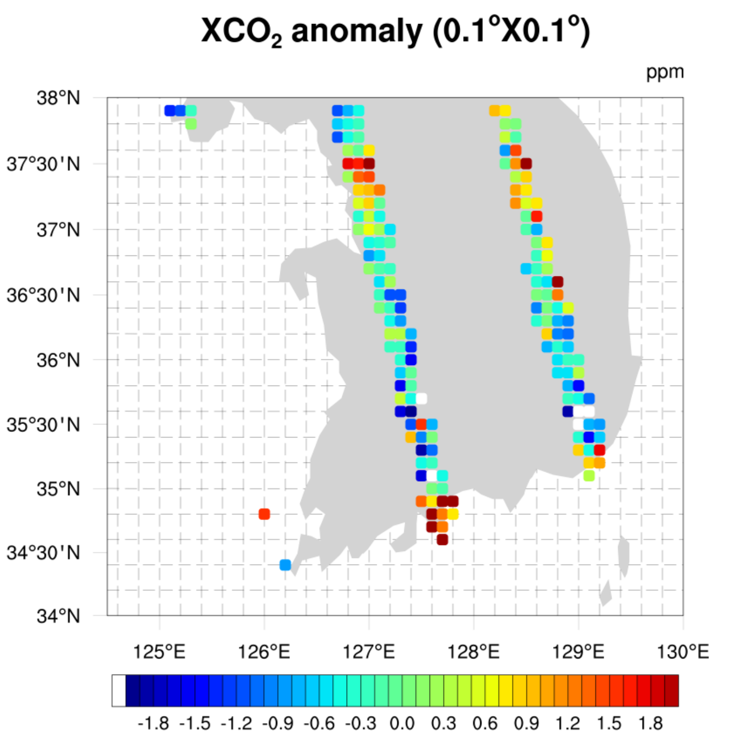

Figure 8. Vegetation effect removed 0.1°X0.1° Grid mean Korea OCO-2 XCO_2 anomalies.

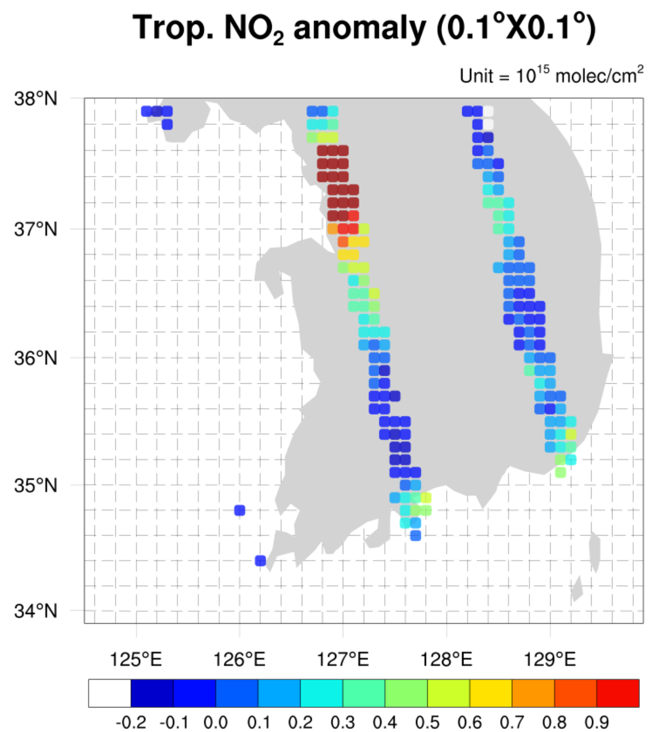

Figure 10. 0.1°X0.1° Grid mean Korea NO_2 anomalies observed by Ozone Monitoring Instrument (OMI).

5. Special case - August 2015

- High XCO_2 concentration over whole Korea domain are observed in 07 August 2015.
  - Corresponds to AMY FTS observation and CT2016.

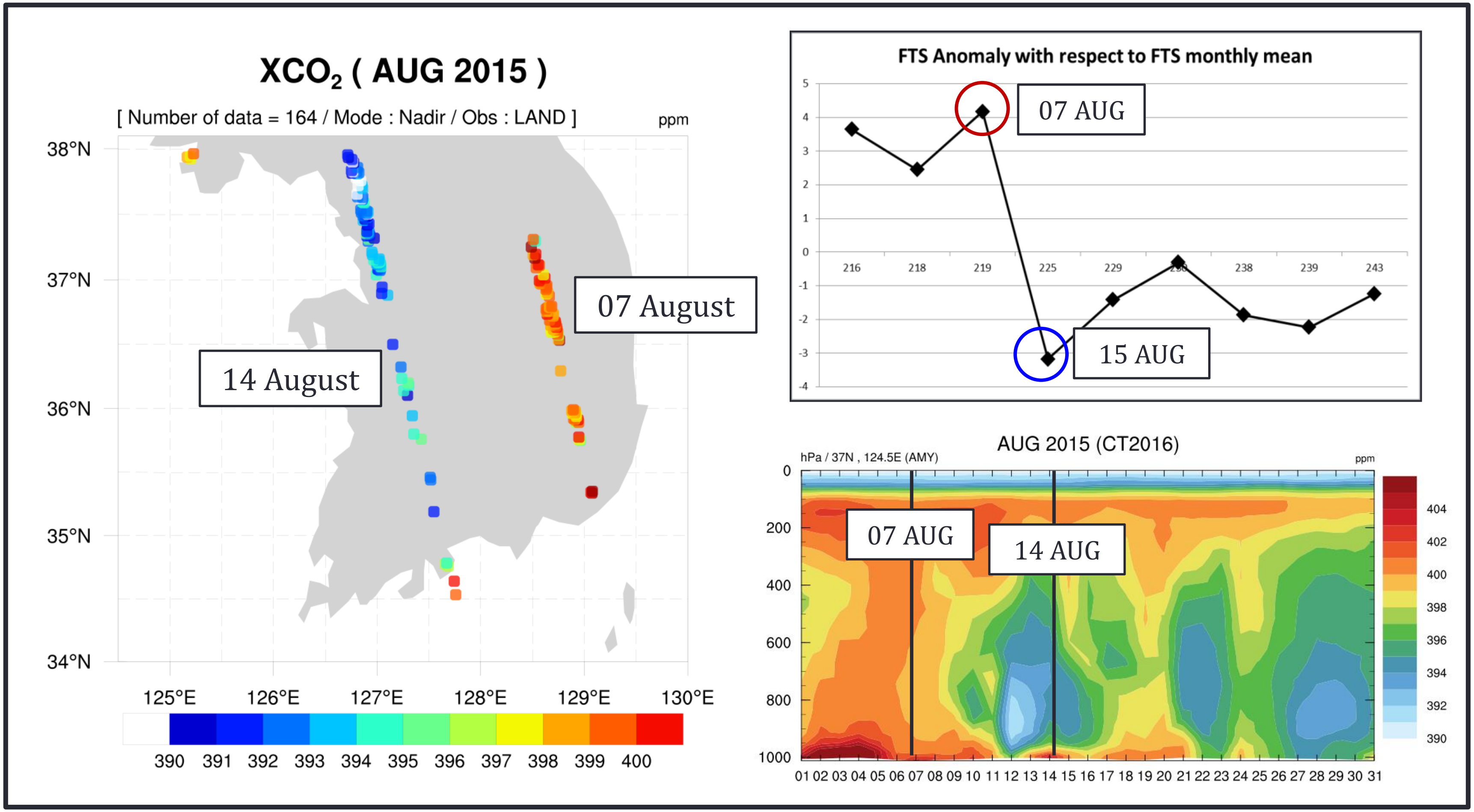

Figure 11. Concentrations of OCO-2 XCO_2, AMY FTS XCO_2 and CT2016 CO_2 in August 2015.

6. Summary

- Seasonal variation of Korea OCO-2 XCO_2
  - Monthly mean Korea OCO- XCO_2 tend to be higher in winter and lower in summer.
  - Present good correlation with monthly mean Anmyeondo FTS XCO_2 and TAP CO_2.
  - Negative correlation with OCO-2 SIF.

- Spatial distribution of Korea OCO-2 XCO_2
  - Vegetation effect removed 0.1°X0.1° grid mean XCO_2 anomalies were analyzed.
  - Most of positive anomalies are found near the large cities and industrial area.

- Systematic changes of XCO_2 over whole Korea domain occurred in August 2015.

- OCO-2 observes spatiotemporal variation of Korea XCO_2 well but further study about the other factors which can cause change in CO_2 concentration is needed and on-going now.