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RADI

Comparing carbon dioxide enhancement from anthropogenic emissions observed by GOSAT and OCO-2

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Outline

- Background-APEC Blue
- CO_2 enhancements from regional anthropogenic emissions
- Sensitivity of satellite retrievals to emission variations
- Discussion

Before 2014 Beijing APEC

Oct 15th to 31th

During 2014 Beijing APEC

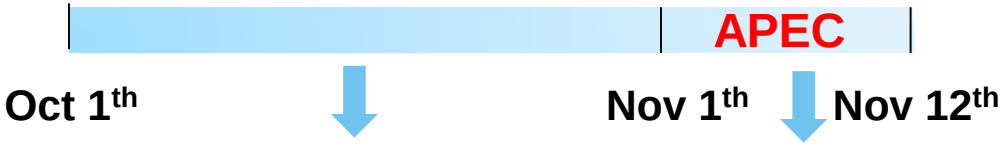
Nov 1th to 12th

What causes such a difference?

➢ Emission controls

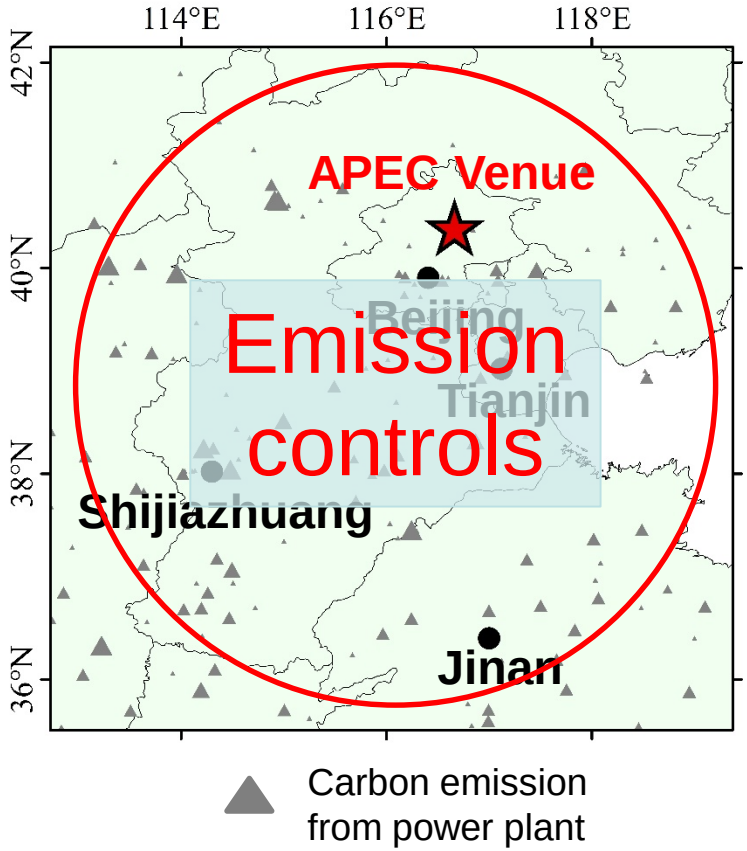
- To ensure good air quality during 2014 APEC summit, strict emission controls were implemented in Beijing and surrounding regions.

-Restrictions on the number of vehicles in operation, factory operation, construction activities.
-Offering vacations to local citizens.
-Free bus.



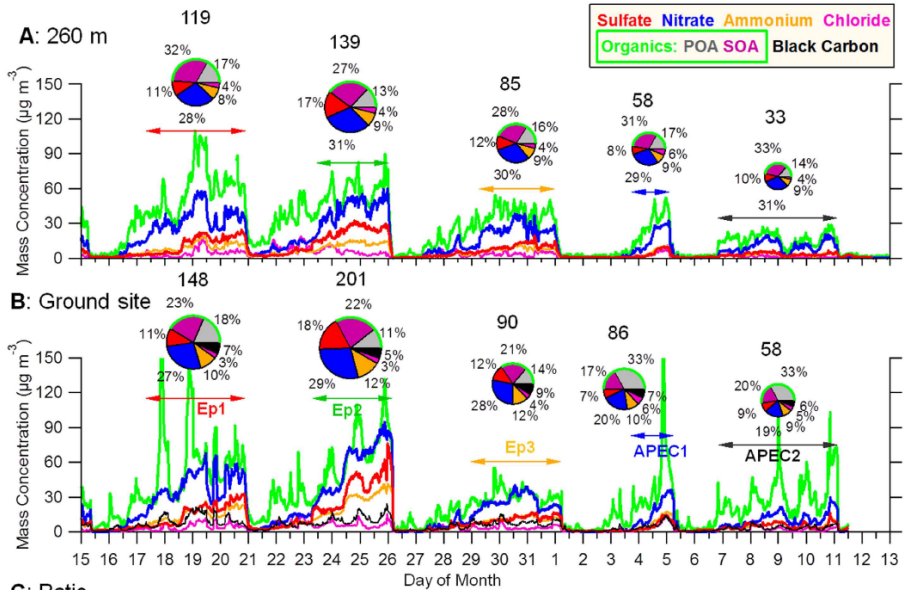
Factories don't meet the pollutant discharge standards has been disclosed.

All the factories near APEC venue was closed temporarily.



➢ Effectiveness of emission controls: APEC Blue

- The total amount of pollutant emission reductions in Beijing exceeded 40% during 2014 APEC summit (From government report).



(Sun et al., Sci Rep, 2016)

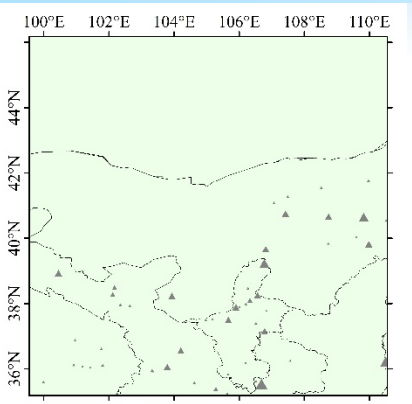
- **Reductions during APEC**

Type	At 260 height	On ground
SIA	60%	50%
SOA	55%	37%

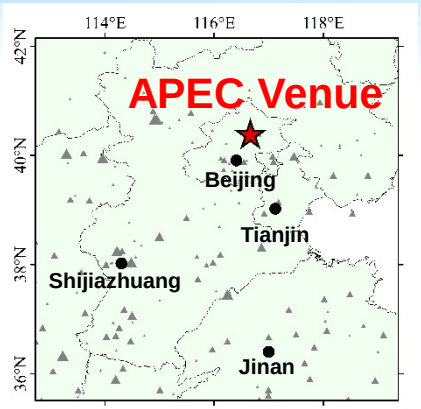
Whether the effect of emission controls can be detected by GOSAT and OCO-2?

Methods

➢Study area



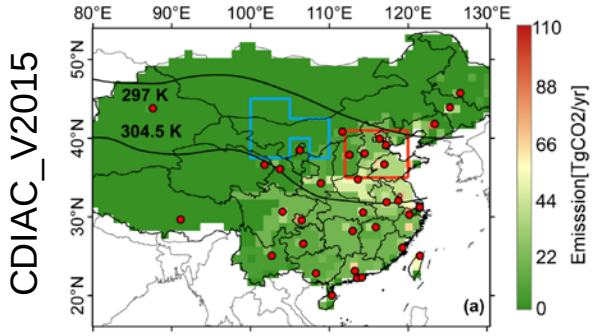
VS



Background region
Inner Mongolia grasslands

Emission region
Beijing-Tianjin-Hebei area in northern China

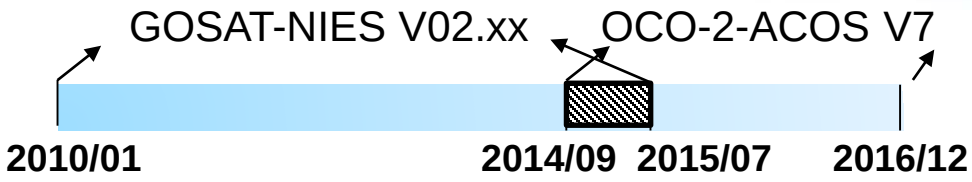
Potential temperature from NCEP

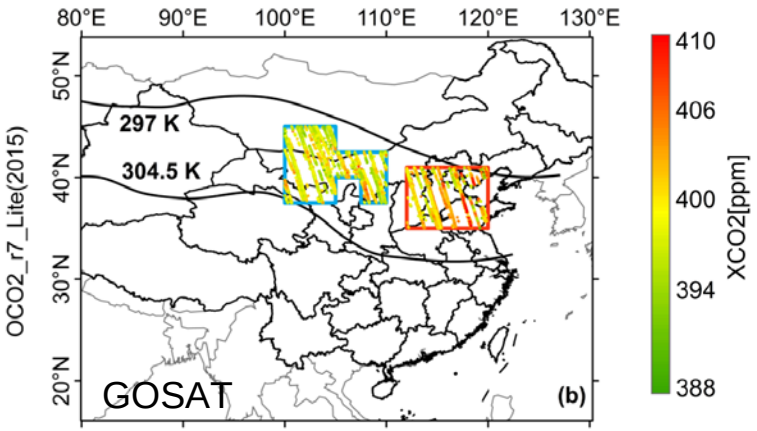


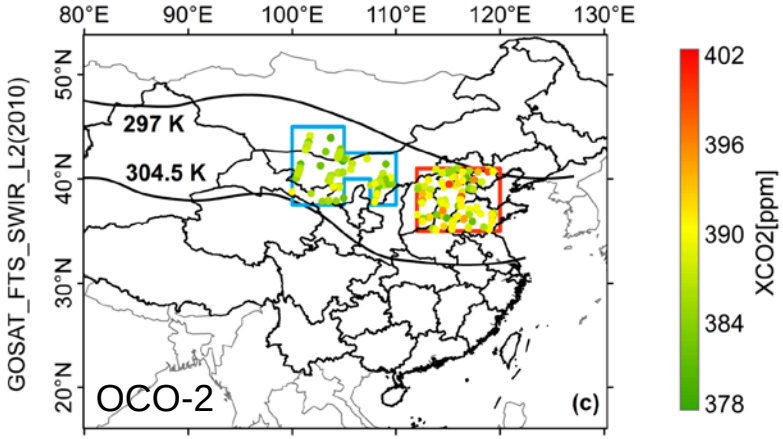
- Two regions are settled under the same meteorological conditions.

Methods

➢Used datasets







- Calculating CO_2 enhancements between emission and background region.

  Enhancement：$\triangle XCO2=XCO2^{Emission}-XCO2^{Background}$

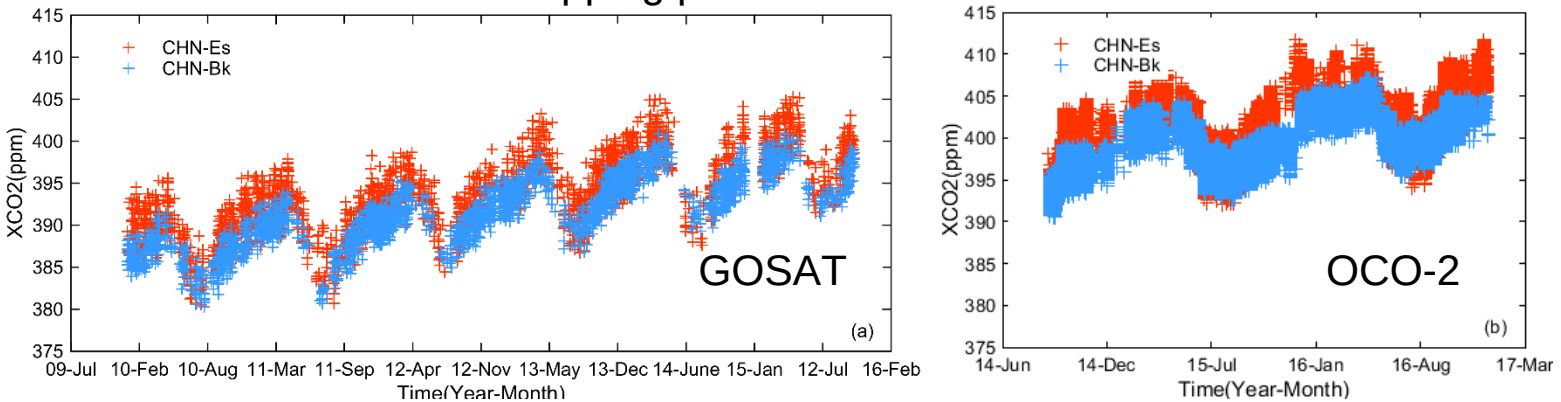
- Comparing CO_2 enhancements from GOSAT and OCO-2.

Results

➢ CO_2 enhancements from regional anthropogenic emissions

Enhancement：$\triangle XCO2 = XCO2^{Emission} - XCO2^{Background}$

Overlapping period of GOSAT and OCO-2 2014/09-2015/07



+ Emission region + Background region

	GOSAT	OCO-2
Averaged △XCO2 in overlapping period	2.48 ppm	2.21 ppm

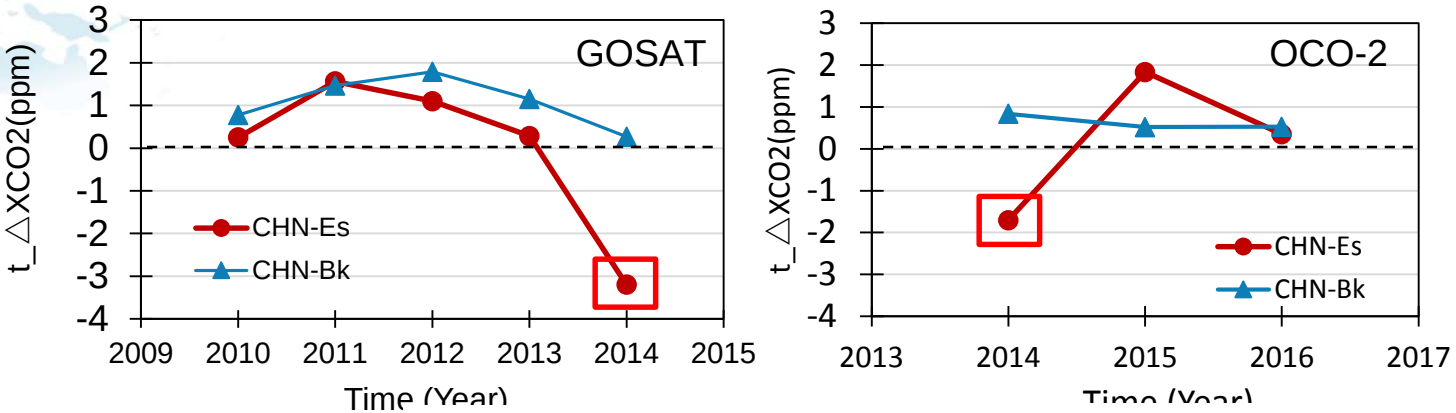
Regionally elevated CO_2 originating from anthropogenic emissions in urban intensive areas, about 2 ppm detected from GOSAT and OCO-2.

Results

➢ Sensitivity of satellite retrievals to emission variations

$$T\_\triangle XCO2 = XCO2_{inAPEC} - XCO2_{preAPEC}$$

（Oct 15th to 31th）　（Nov 1th to 12th）



--Normal--

$XCO2_{inAPEC} > XCO2_{preAPEC}$

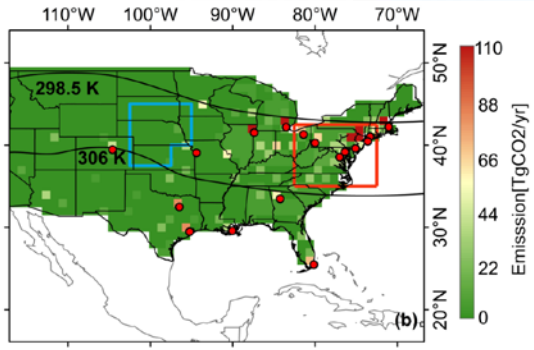
--Anomaly in 2014--

$XCO2_{inAPEC} < XCO2_{preAPEC}$

abnormal decline of 3 ppm in emission region

XCO_2 retrieved from GOSAT and OCO-2 can capture the effect of emission controls under strict mitigation measures.

Discussion ➢ Variations of XCO_2 in America

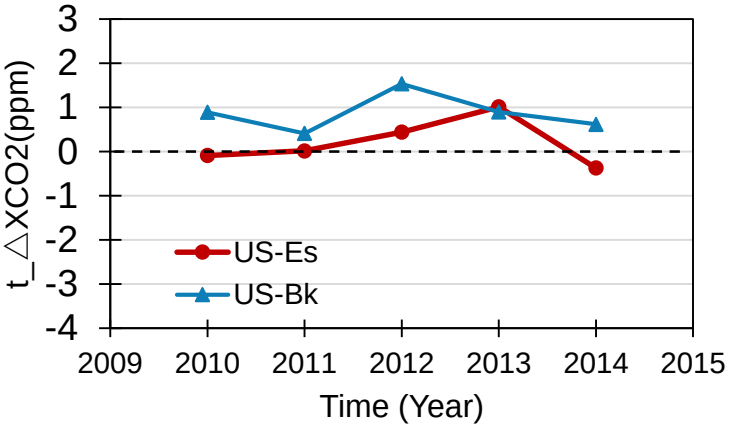


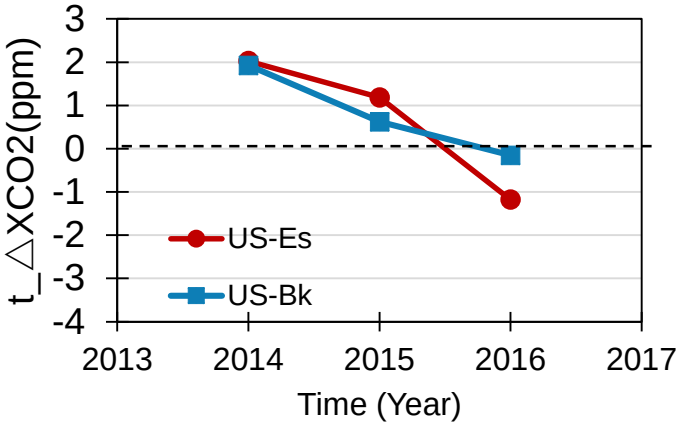
Background region
Dakota, Nebraska and Kansas

Emission region
Urban agglomeration in eastern USA

$T\_\triangle XCO2 = XCO2_{inAPEC} - XCO2_{preAPEC}$

（Oct 15th to 31th） （Nov 1th to 12th）



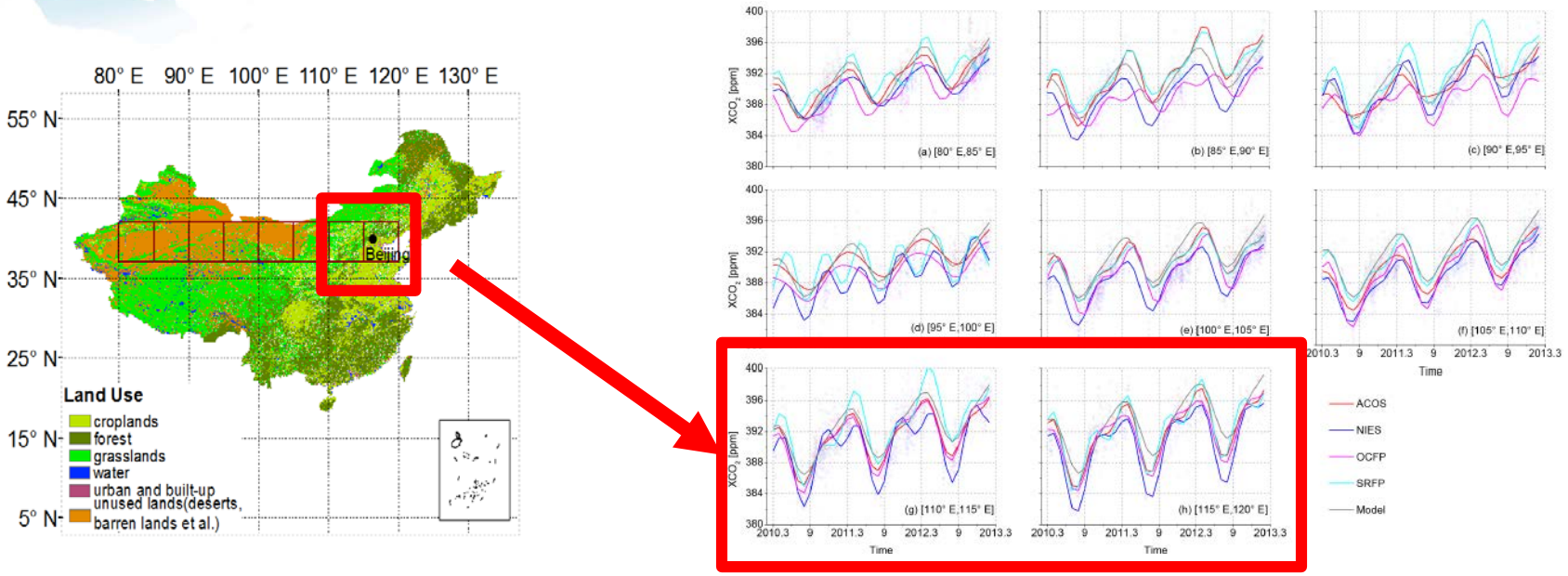


The anomaly of XCO_2 in 2014, which induced by regional emission reductions, hasn't been found in America.

Discussion

➢ Uncertainty of XCO_2 in emission region

- Difference of XCO_2 retrievals from the four algorithms (ACOS、NIES、OCFP、SRFP) and simulated XCO_2 from GEOS-Chem model in the emission region.



(Bie et al., AMT, 2018)

Inconsistency presents smallest in the eastern regions where the megacity of Beijing is located and anthropogenic CO_2 emissions are largely concentrated.

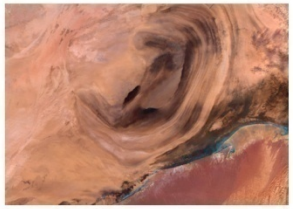
Conclusions

- Verified in further that regionally enhanced CO_2 originating from anthropogenic emissions in urban intensive areas can be detected both from GOSAT and OCO-2.

- Our results, detecting the XCO_2 reduction induced by emission control (APEC Blue), indicates that the regional enhanced XCO_2 induced by anthropogenic emission is likely maximum up to 3 ppm even in the strong emission region.

Thank you!



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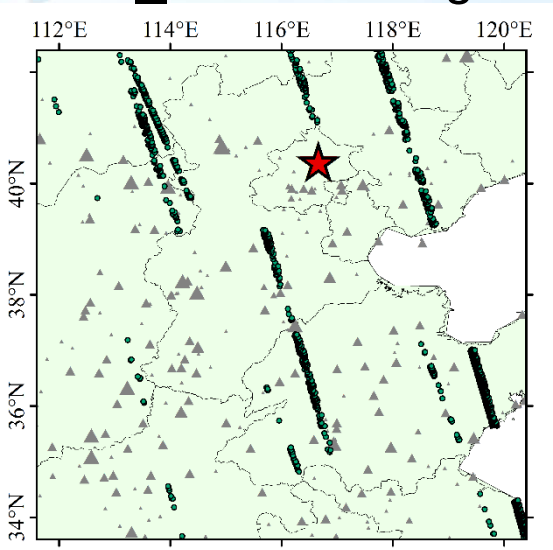
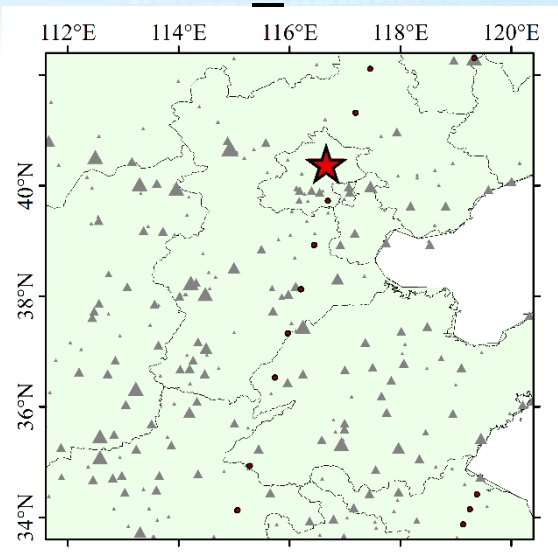
Samples of GOSAT footprints in Nov 2014

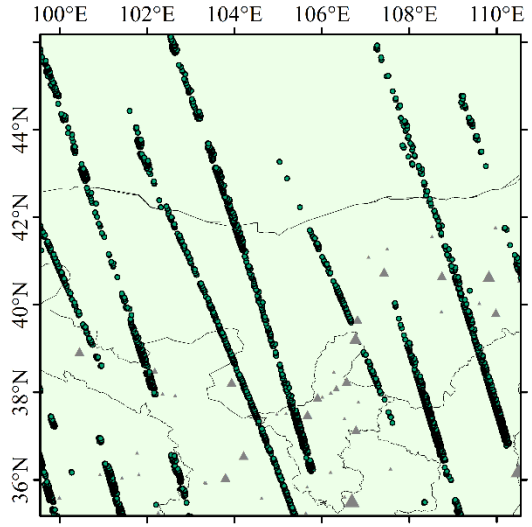
- OCO2_Emission region



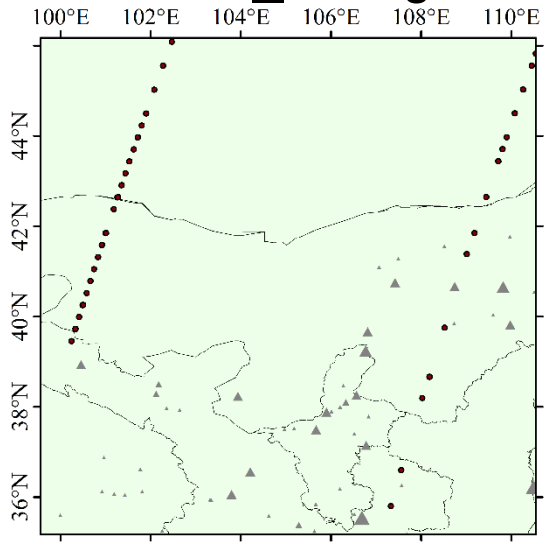
- GOSAT_Emission region



- OCO2_Background region



- GOSAT_Background region



APEC Venue

XCO2 footprints

Carbon emission from power plant