Anomalies in Chinese CO_2 fluxes during 2015/2016 El Niño: Comparison between satellite and in-situ observation assimilation

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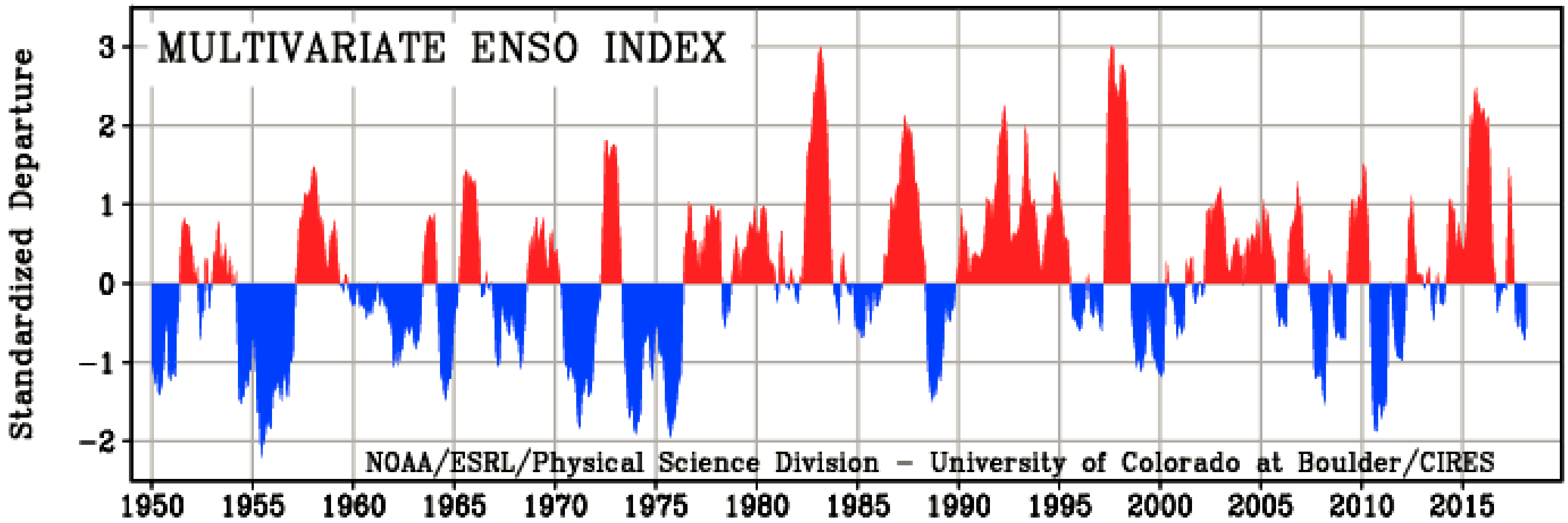
Outlines

- **Background**
- **Observations and model**
- **Results**

  comparison between in-situ and satellite inversions

  anomalies in 2015/2016
- **General conclusion**

2014-2016 ENSO event

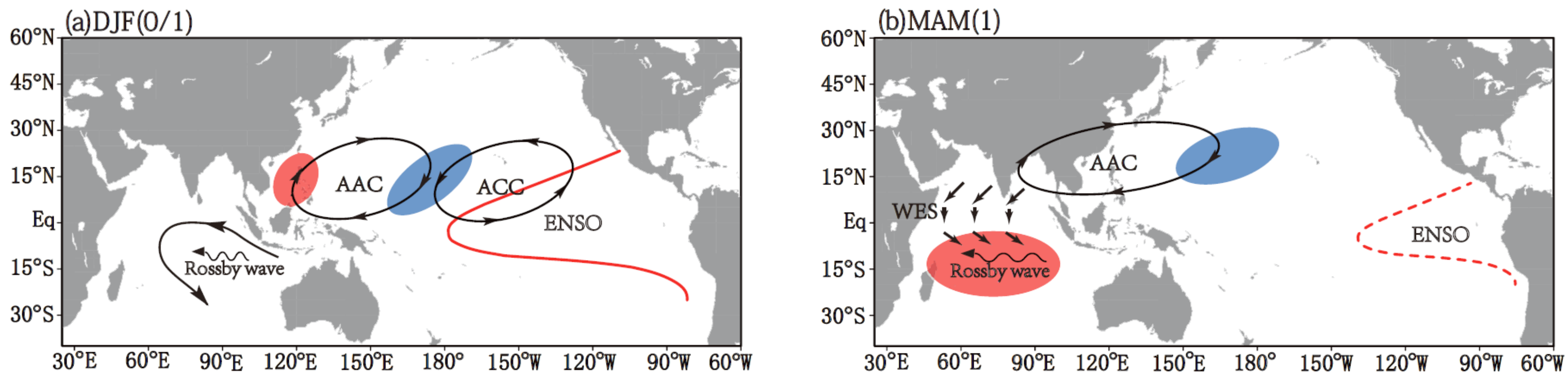


Onset from 2014 March to July
Peak from 2015 October to 2016 February
End in 2016 May

How can ENSO effect East Asian monsoon?

ENSO------------------------------Esat Asian monsoon-----climate of eatern China

(anomalous lower tropospheric anticycle)



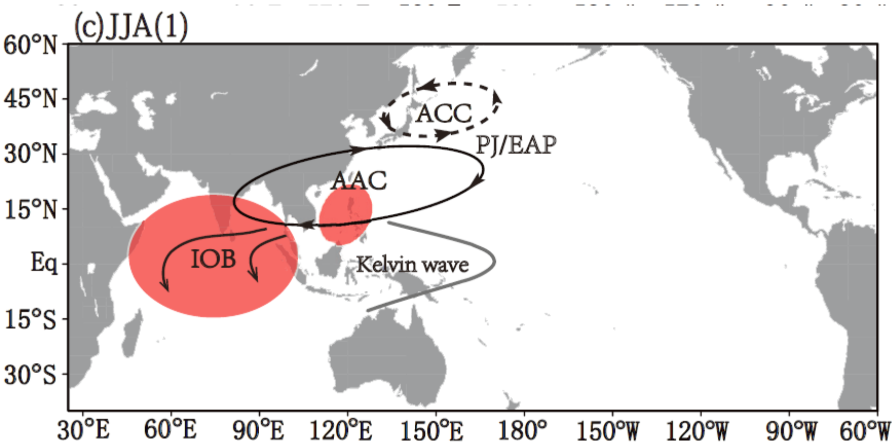


Fig. 3. Schematic representation of the major SST anomalies and atmospheric teleconnection over the Indo-Pacific oceans associated with El Niño events: (a) El Niño impacts on the South IO through westward Rossby waves during December–February; (b) Rossby waves inducing Southwest IO warming, which in turn induces an anti-symmetrical wind pattern over the tropical IO during March–May; (c) the second IO warming exciting a tropospheric Kelvin wave propagating into the western Pacific, forcing the AAC and PJ/EAP pattern to affect East Asia during the following summer.

AAC: A large-scale anomalous anticycle

ACC: Anomalous cyclonic circulation

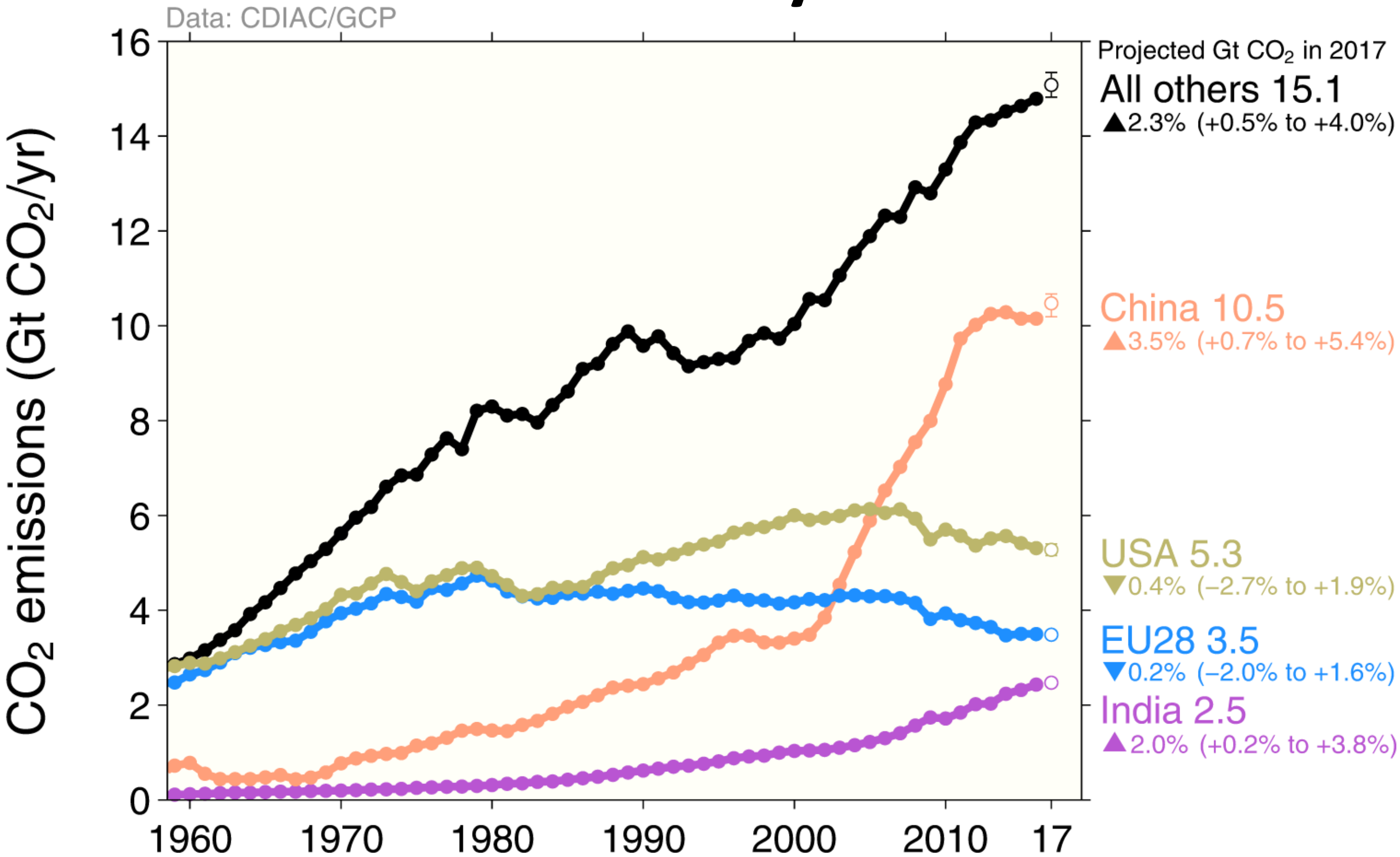
IOB: Indian Ocean Basin-wide

PJ:Pacific –Japan

EAP:East Asia-Pacific(EAP)

Ref: Xie.S et al., AAS,2016

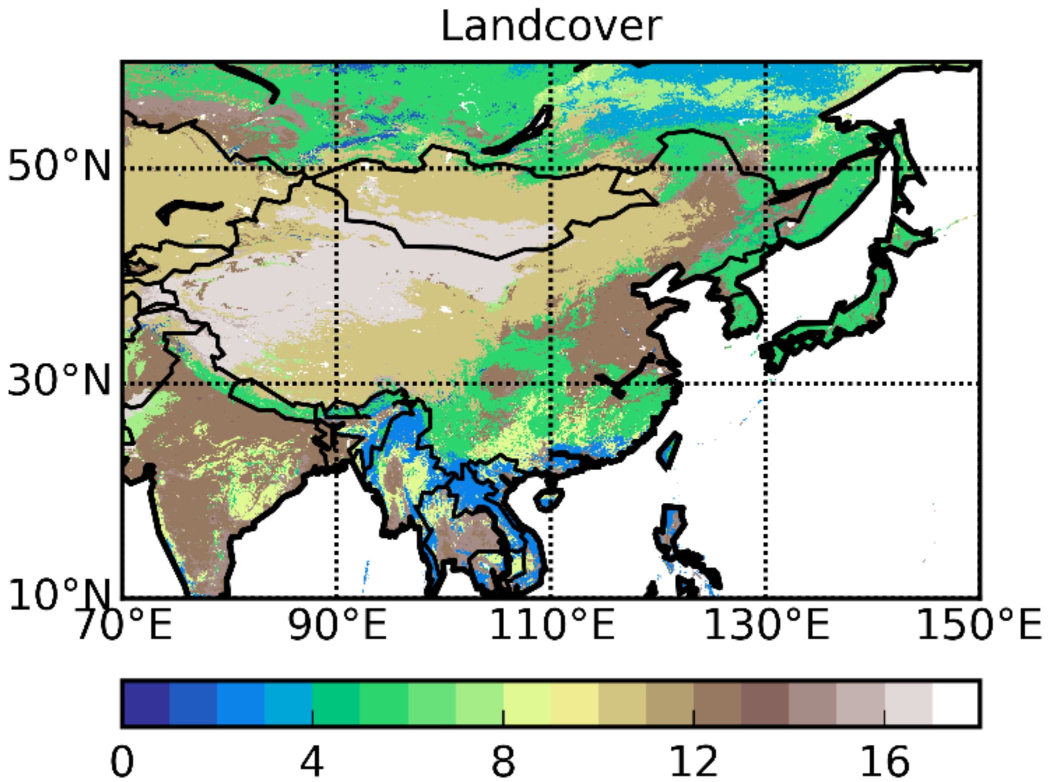
China is the top CO_2 emitter from fossil fuel and industry



GLOBAL CARBON PROJECT

China has been the first emitter since 2006. The top four emitters in 2016 covered 59% of global emissions. China(28%), United States(15%), EU28(10%), India(7%)

Land cover over China



0:WATER 1:Evergreen Needleleaf forest 2 Evergreen Broadleaf forest
3 Deciduous Needleleaf forest 4: Deciduous Broadleaf forest 5 Mixed forest
6 :Closed shrublands 7: Open shrublands 8;Woody savannas
9: Savannas 10:Grasslands 11:Permanentwetlands
12:Croplands 13: Urban and built-up
14:Cropland/Natural vegetration mosaic 15: Snow and ice
16:Bareen or sparsely vegetated 255:Fill Value/Unclassified

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Top-down Flux inversions

CTM:

Version: GEOS-Chem v9.02
Resolution : 4 (Lat) X 5 (Lon)/47 levels
Met Fields: ***GEOS-5 & GEOS-FP***

Prior fluxes:

- ✓ODIAC Fossil fuel emissions(2016).
- ✓3-hourly biospheric fluxes (CASA till 2015.12);
- ✓Monthly oceanic surface fluxes (Takahashi)
- ✓Weekly biomass burning emissions (GFED)

Time period:

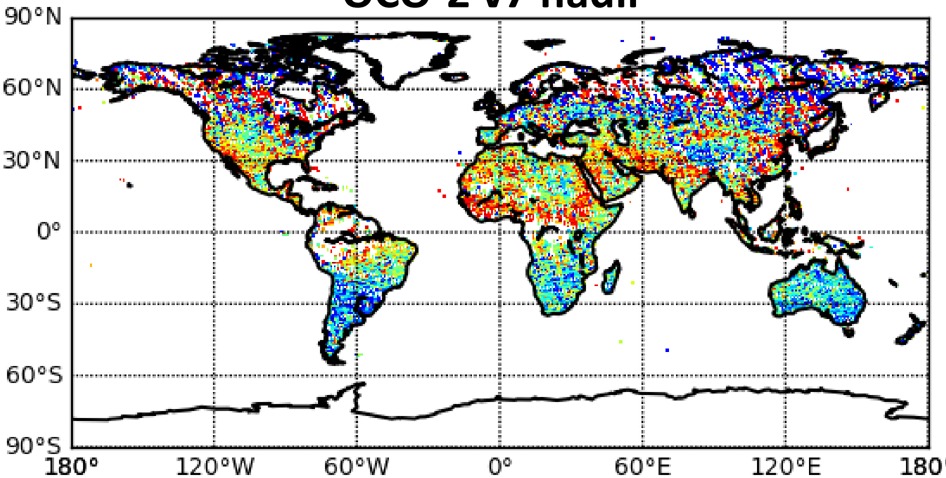
2009.01 to 2016.12

Observations:

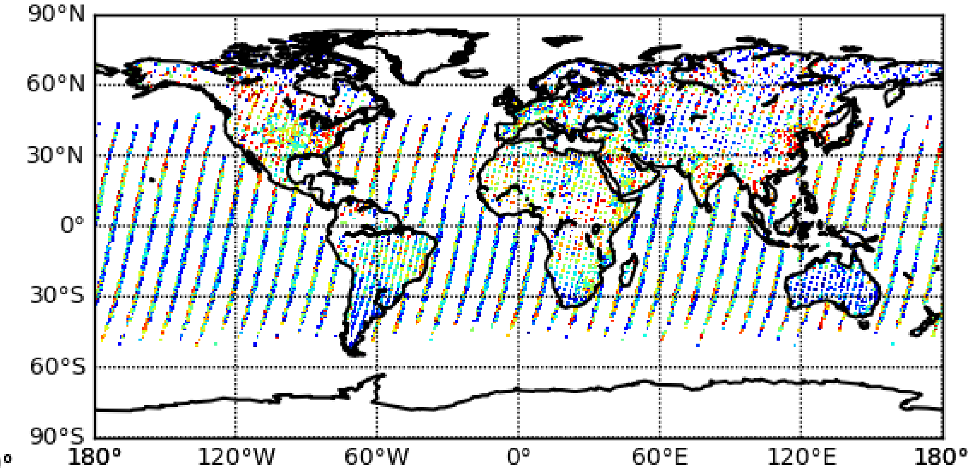
Insitu: In-situ observations (ObsPack: globalview v3.2)
OCO-2: Land **nadir** 10s XCO2 retrievals of v7 by JPL
ACOS-B7: GOSAT XCO2 retrievals by JPL (O'Dell el al.)
UOL-V7: GOSAT XCO2 retrievals by UoL (Parker et al.)

Observation coverage (satellite samplings in 2015)

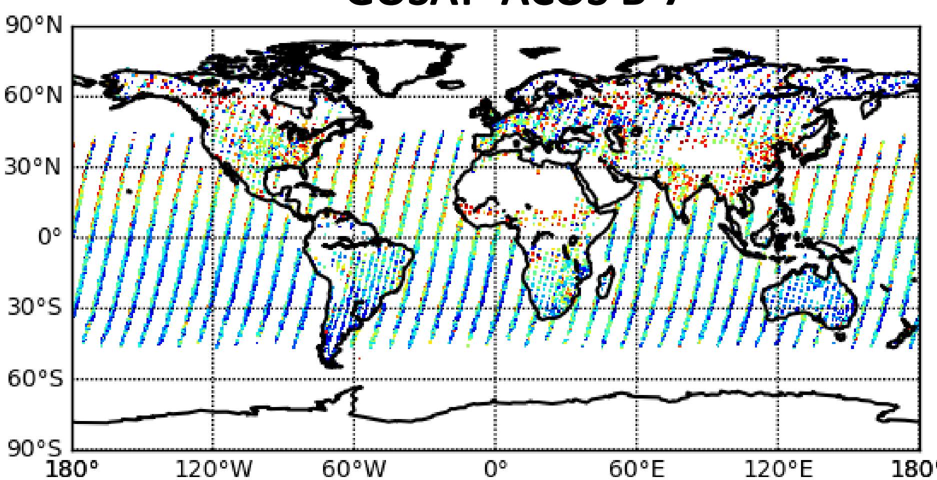
OCO-2 v7 nadir



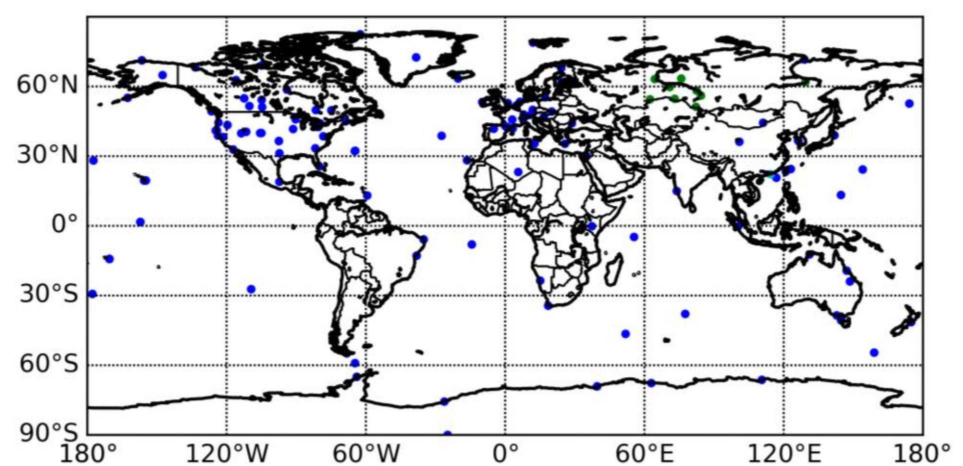
GOSAT UoL-V7

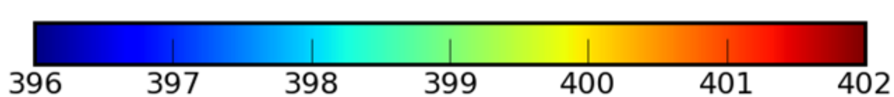


GOSAT ACOS B-7



In-situ sites





Obspack_co2_1_GLOBALVIEWplus_v3.2

JR-STATION sites

Hok Tsui(HKG) from WDCGG

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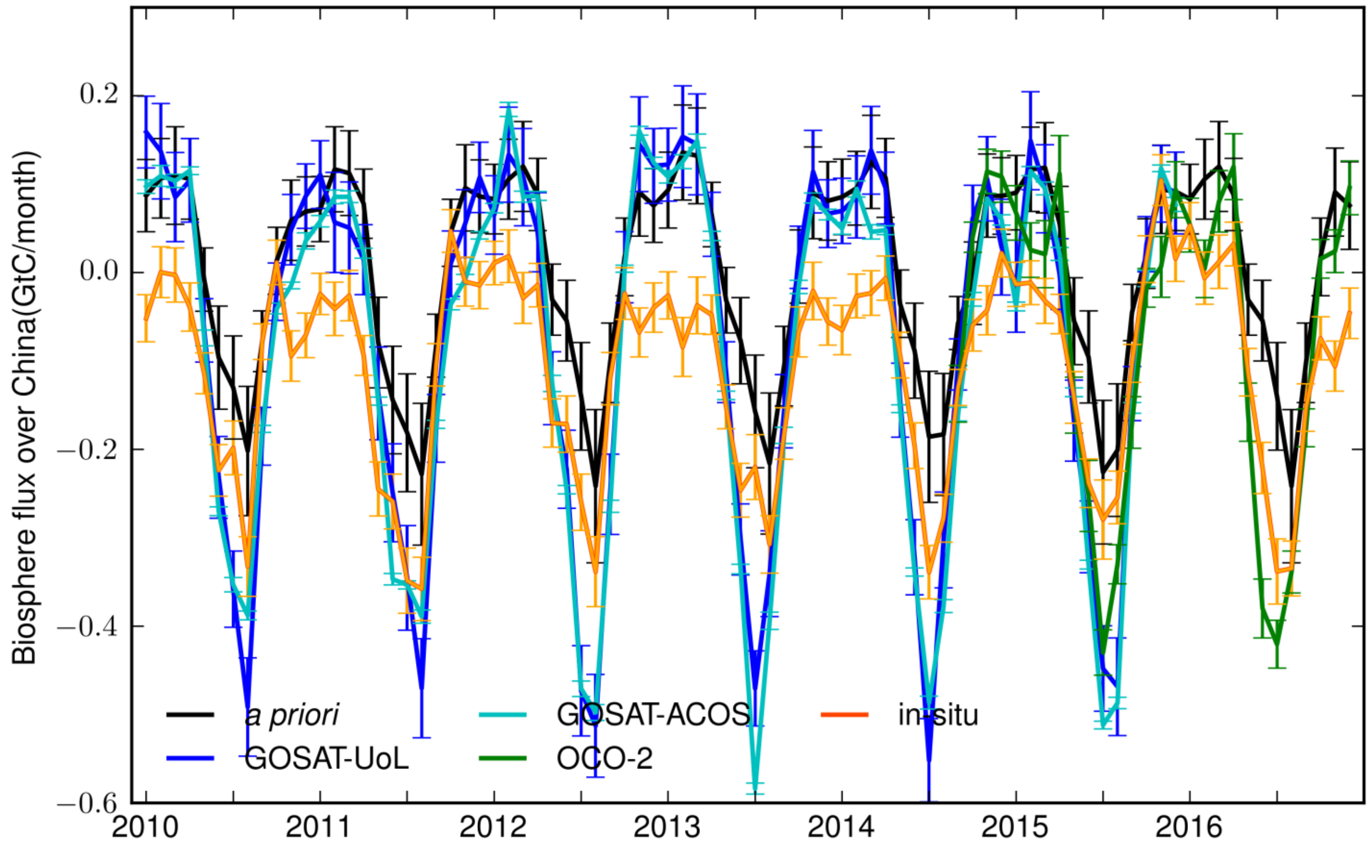
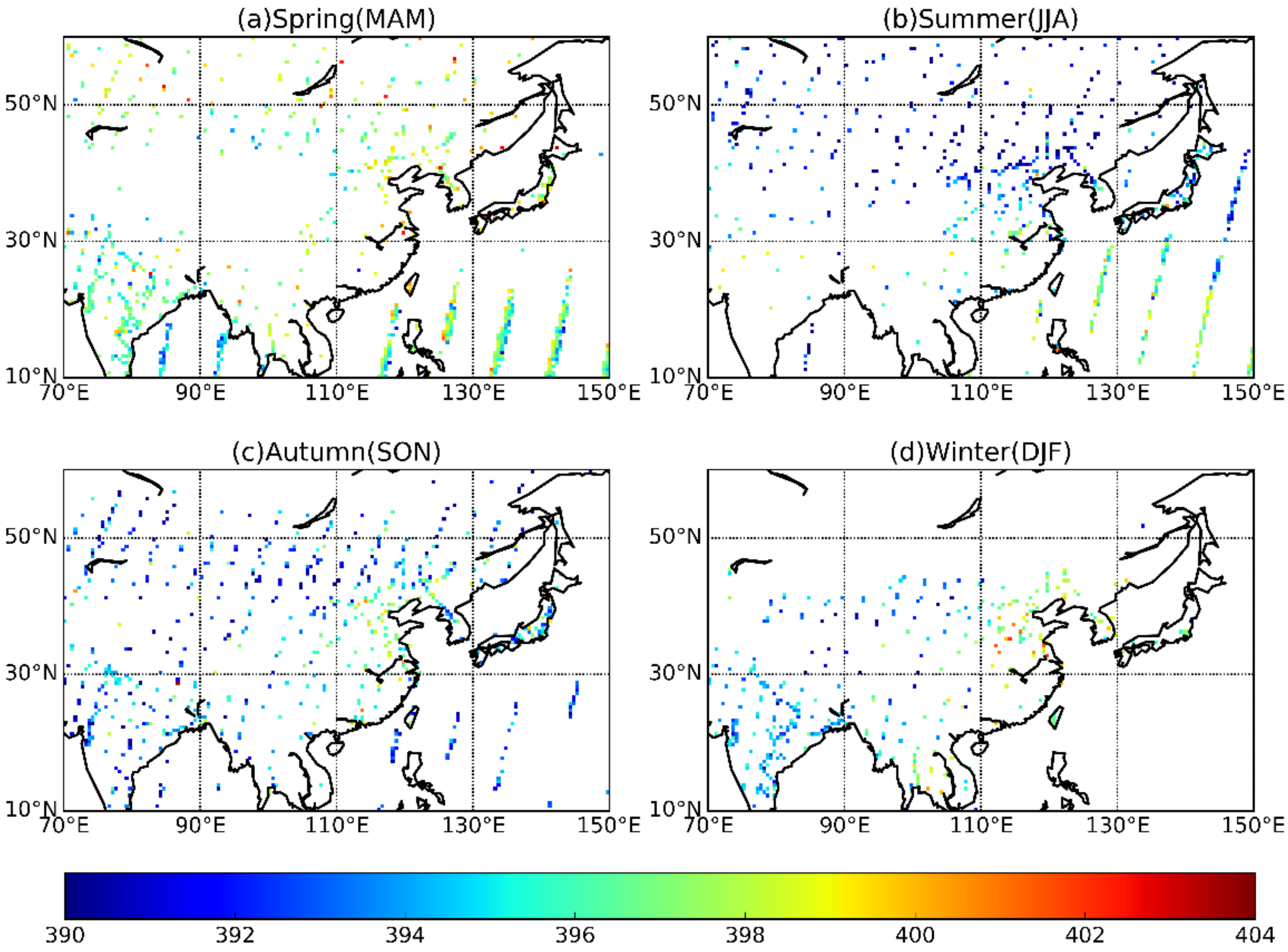
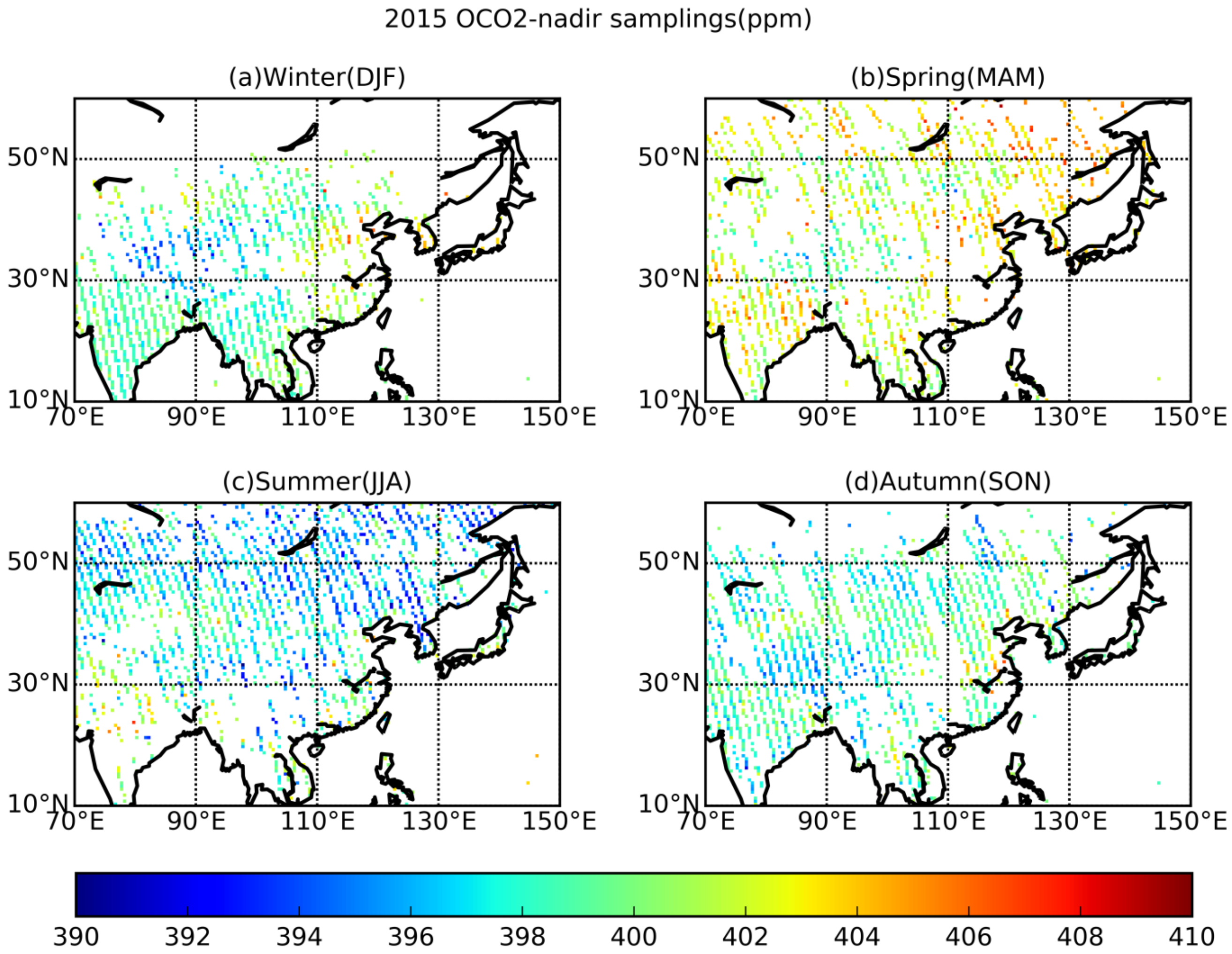
Monthly biosphere flux over China



Inversition results inferred from satellite measurements have larger seasonal amplitude than the the results inferred from in-situ results. The satellite results show more emission in winter and more upake in summer.

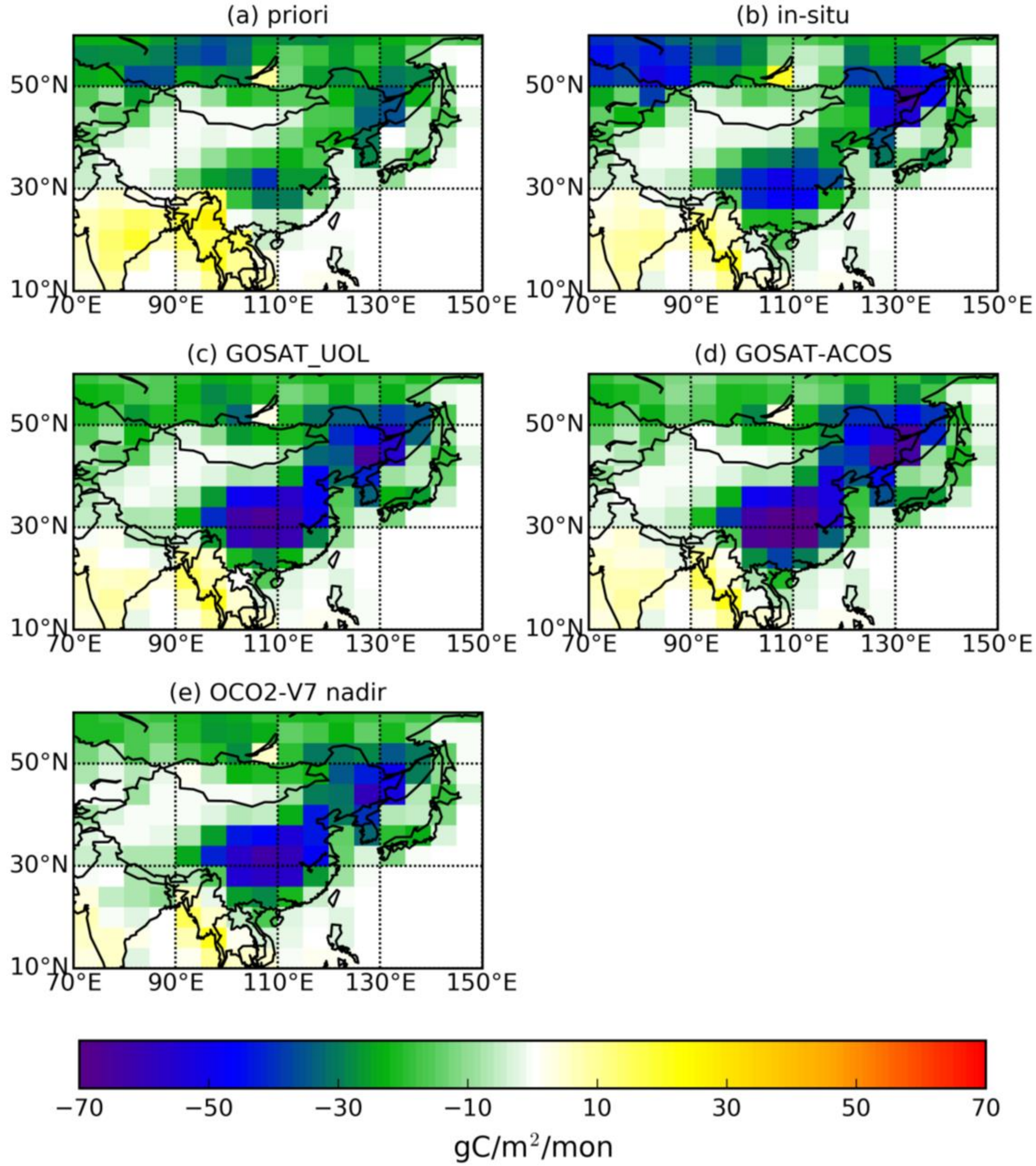
UoL samplings



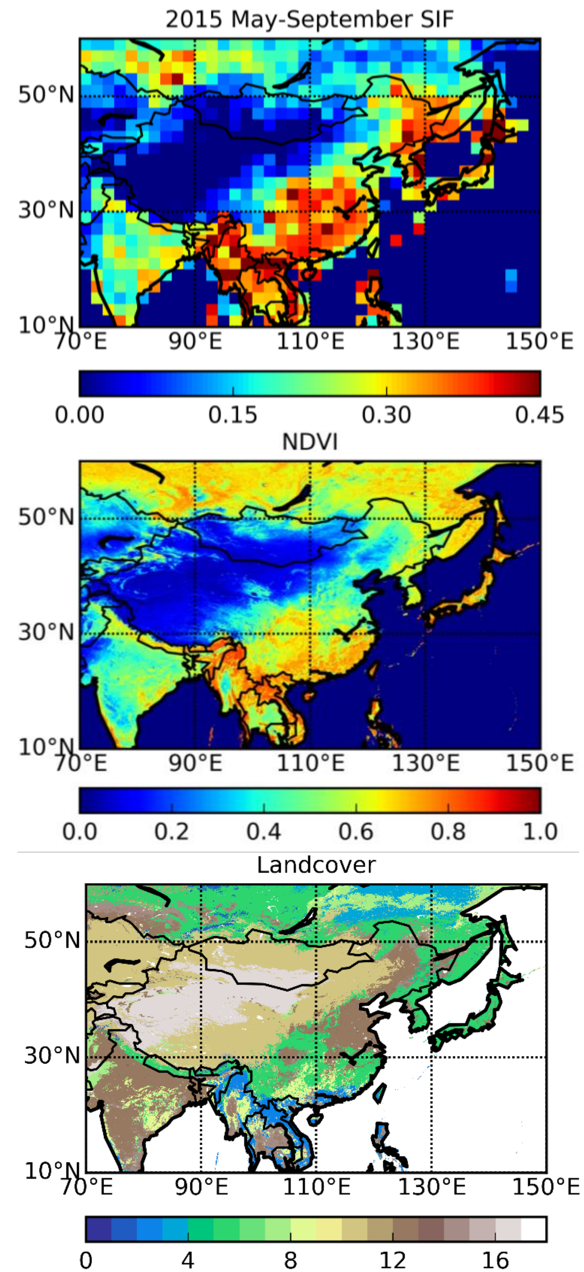


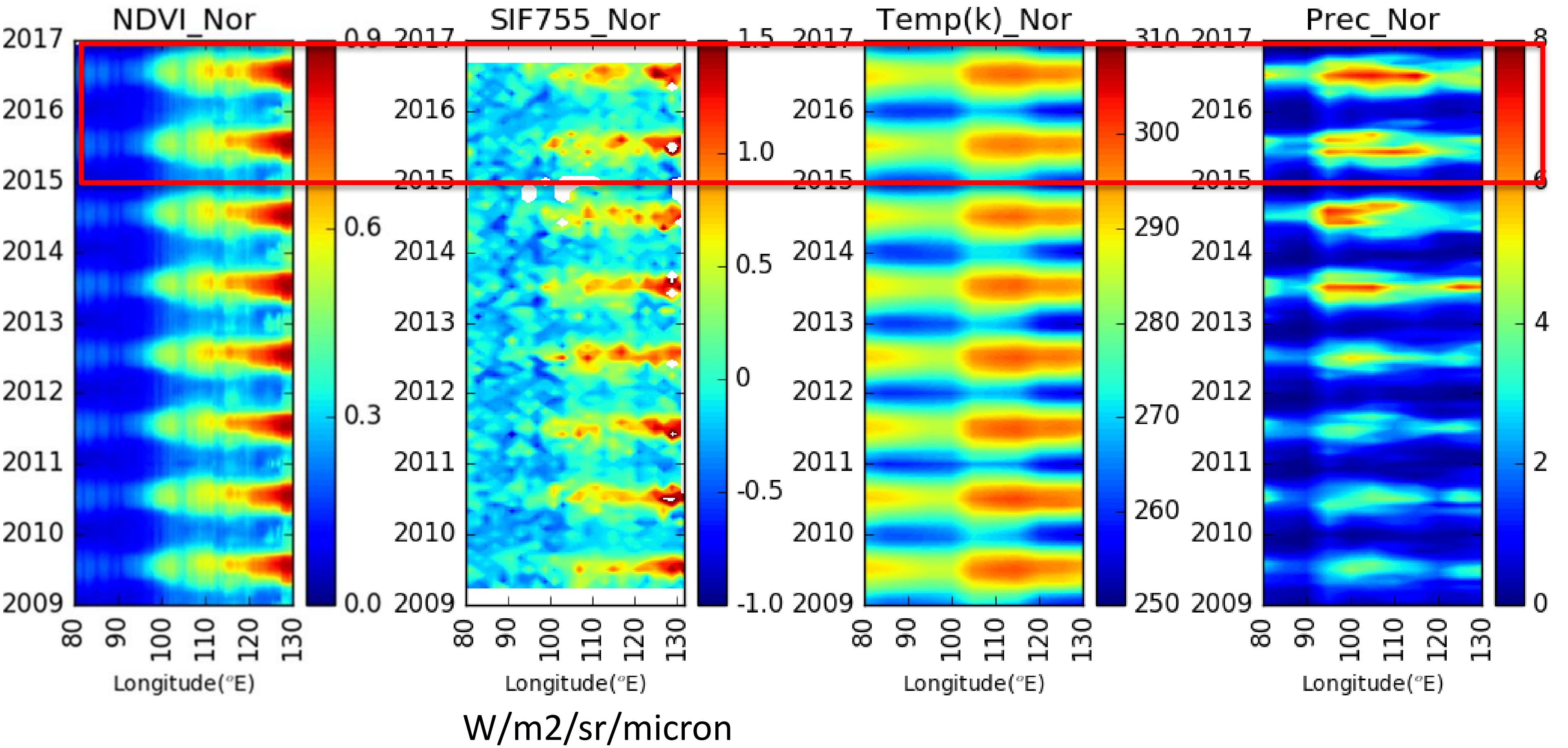
2015 OCO2-nadir samplings(ppm)
(a)Winter(DJF)
(b)Spring(MAM)
(c)Summer(JJA)
(d)Autumn(SON)
50°N
30°N
10°N
70°E
90°E
110°E
130°E
150°E
390
392
394
396
398
400
402
404
406
408
410

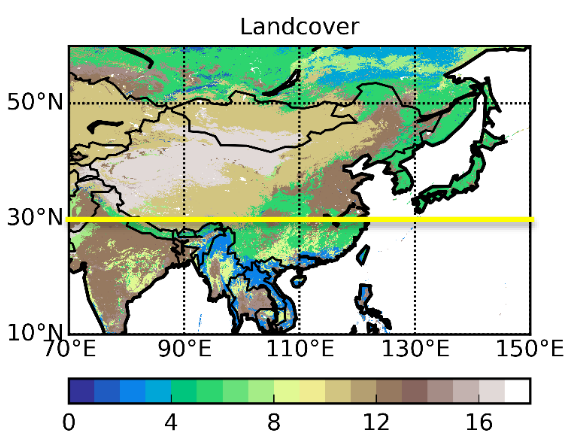
2015 May-September



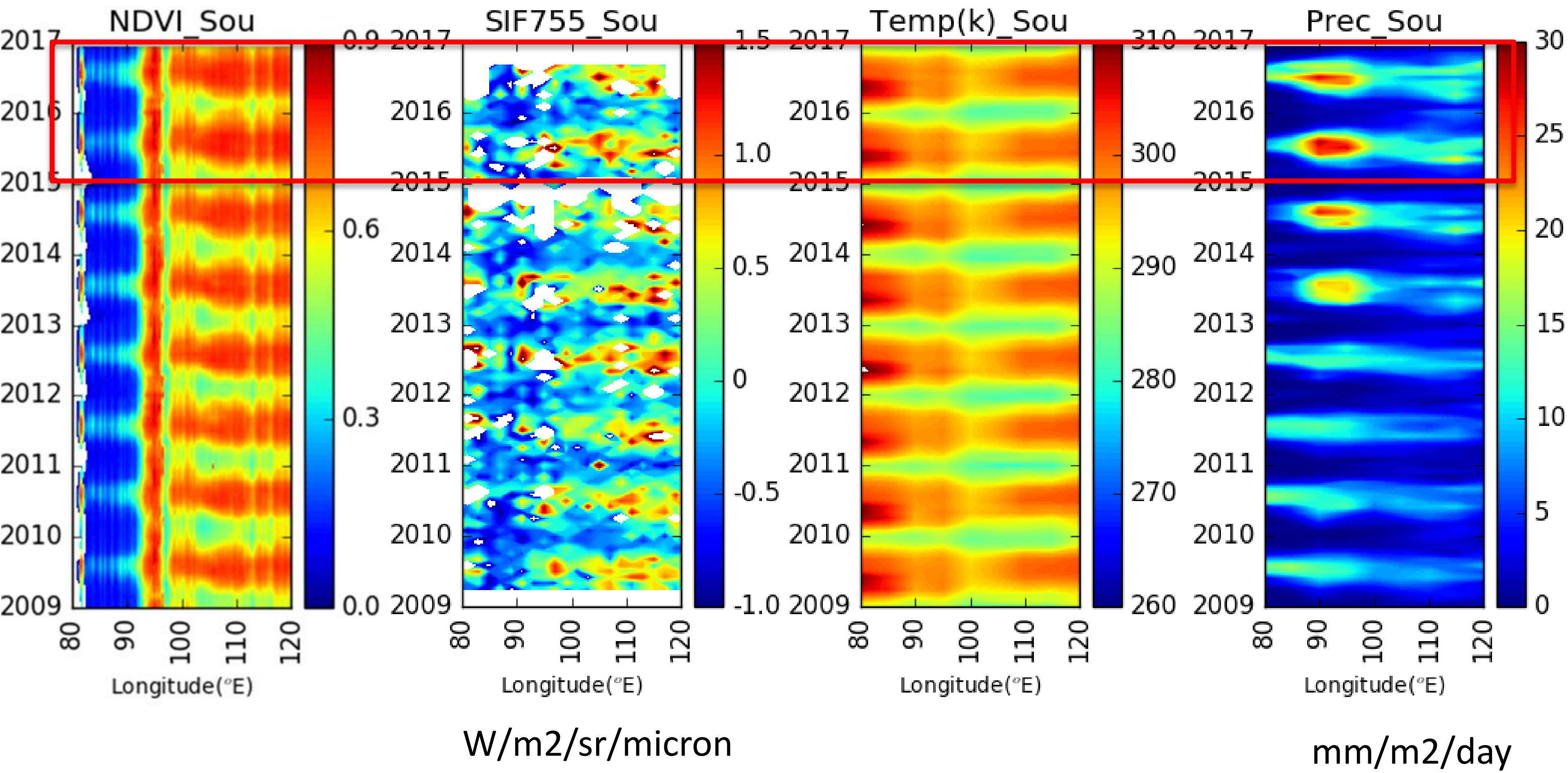
OCO-2 SIF 755nm





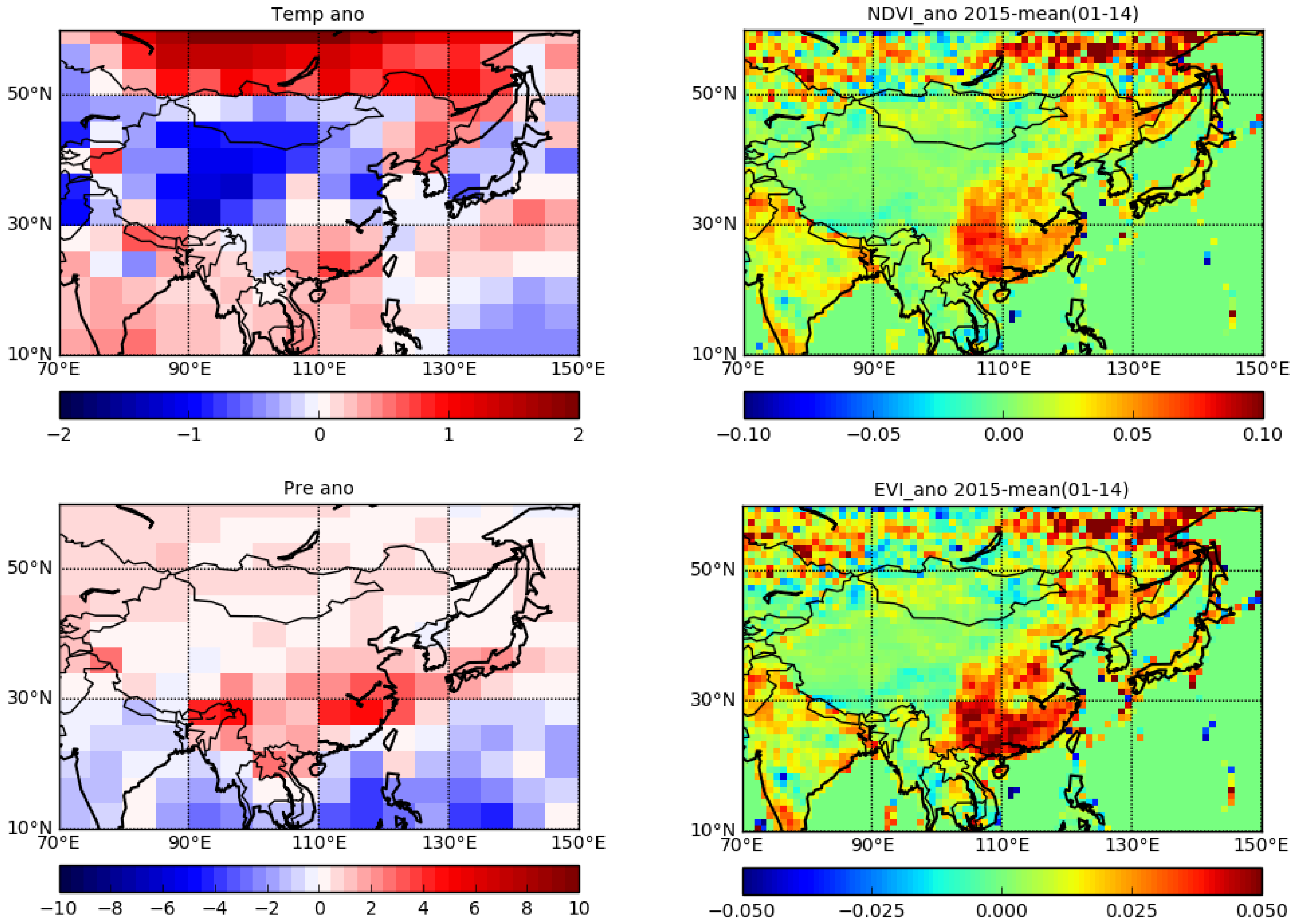


In northern China, especially in northeast of China, with the increase of temperature and precipitation, the NDVI increase, not only the maximum in summer, but also the values in spring and autumn, which means more biosphere activities in spring and autumn.

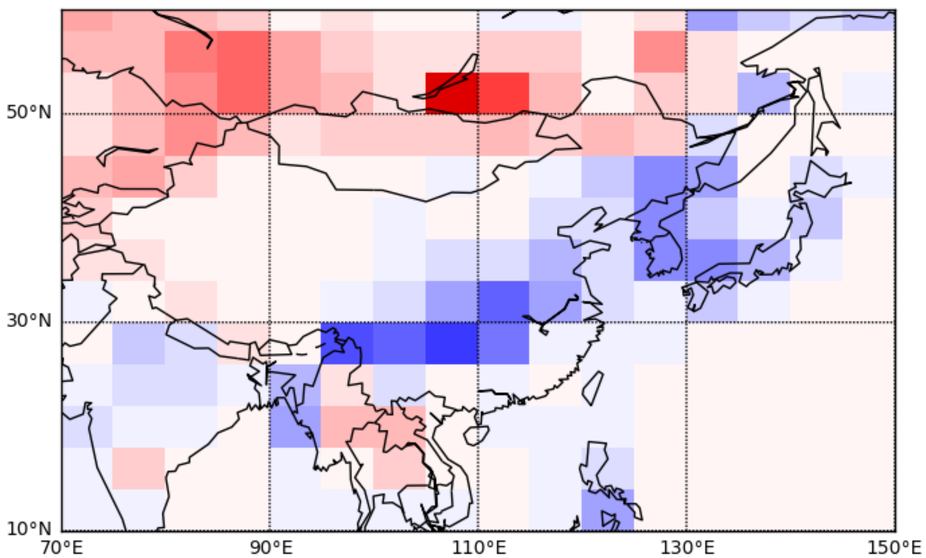


NDVI_Sou
SIF755_Sou
Temp(k)_Sou
Prec_Sou
2017
2016
2015
2014
2013
2012
2011
2010
2009
80
90
100
110
120
Longitude(°E)
0.9
0.6
0.3
0.0
1.5
1.0
0.5
0
-0.5
-1.0
310
300
290
280
270
260
30
25
20
15
10
5
0
W/m2/sr/micron
mm/m2/day

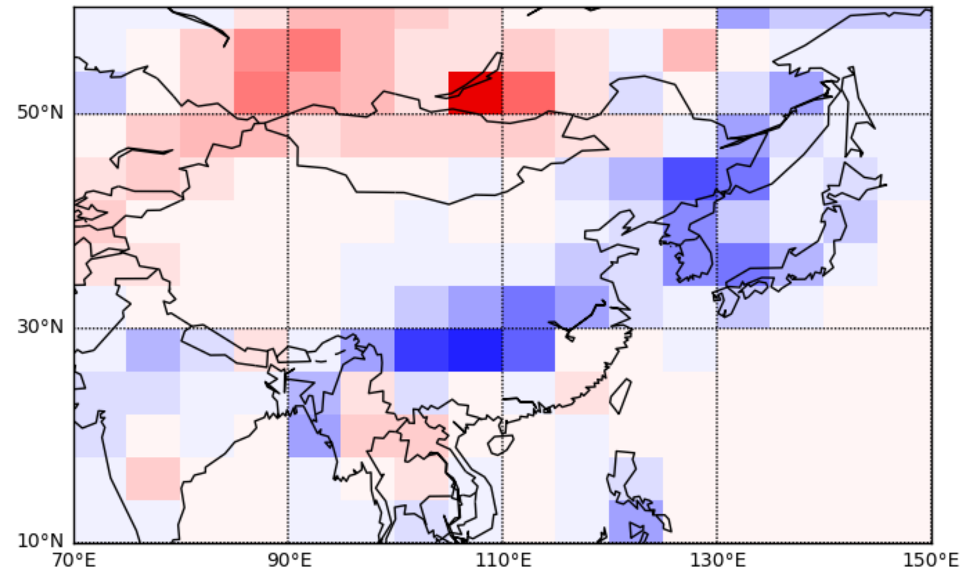
2015


Temp ano
NDVI_ano 2015-mean(01-14)
Pre ano
EVI_ano 2015-mean(01-14)
50°N
30°N
10°N
70°E
90°E
110°E
130°E
150°E
−2
−1
0
1
2
−0.10
−0.05
0.00
0.05
0.10
−10
−8
−6
−4
−2
0
2
4
6
8
10
−0.050
−0.025
0.000
0.025
0.050

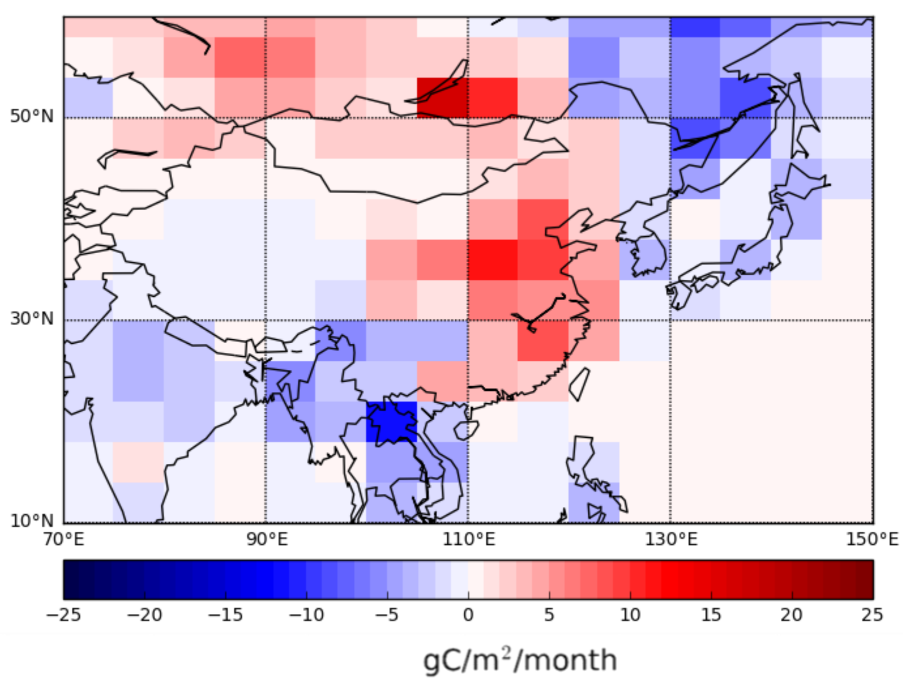
GOSAT UoL ano 2015



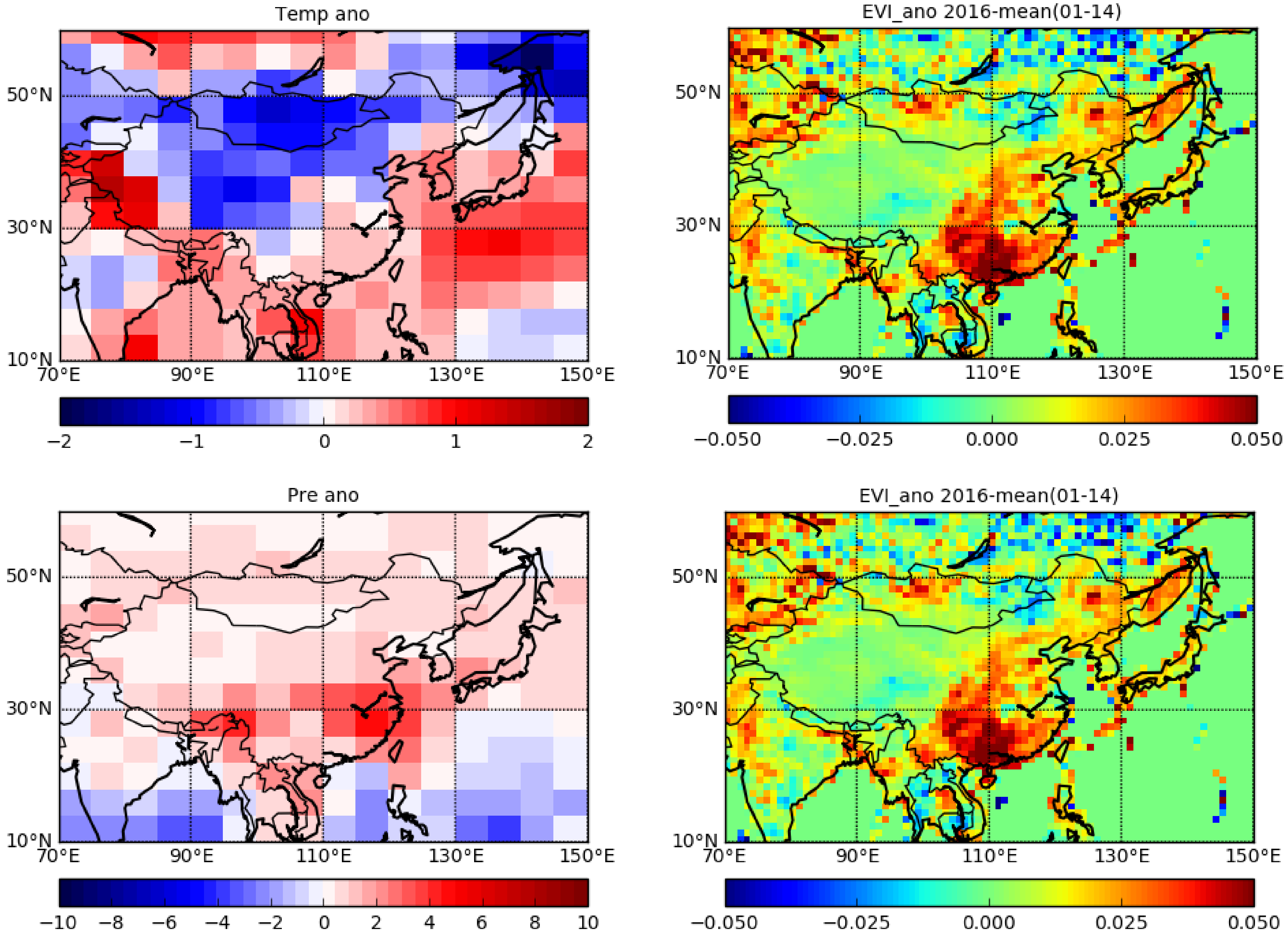
GOSAT ACOS ano 2015



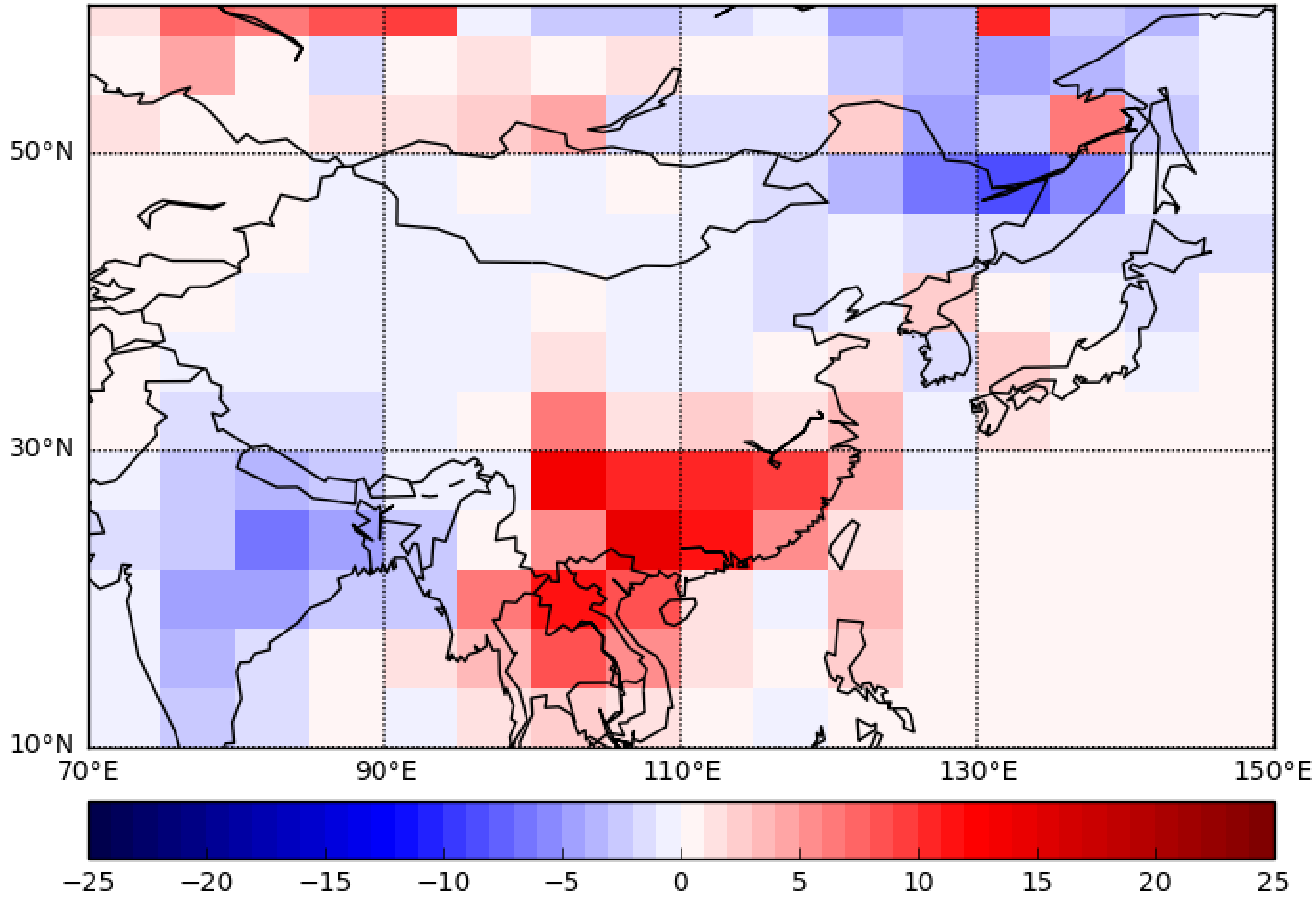
In-Situ ano 2015



Anomalies of satellite results in 2015 are more consistent with the vegetation index variations


Temp ano
EVI_ano 2016-mean(01-14)
Pre ano
EVI_ano 2016-mean(01-14)
50°N
30°N
10°N
70°E
90°E
110°E
130°E
150°E
−2
−1
0
1
2
−0.050
−0.025
0.000
0.025
0.050
−10
−8
−6
−4
−2
0
2
4
6
8
10

In-Situ ano 2016

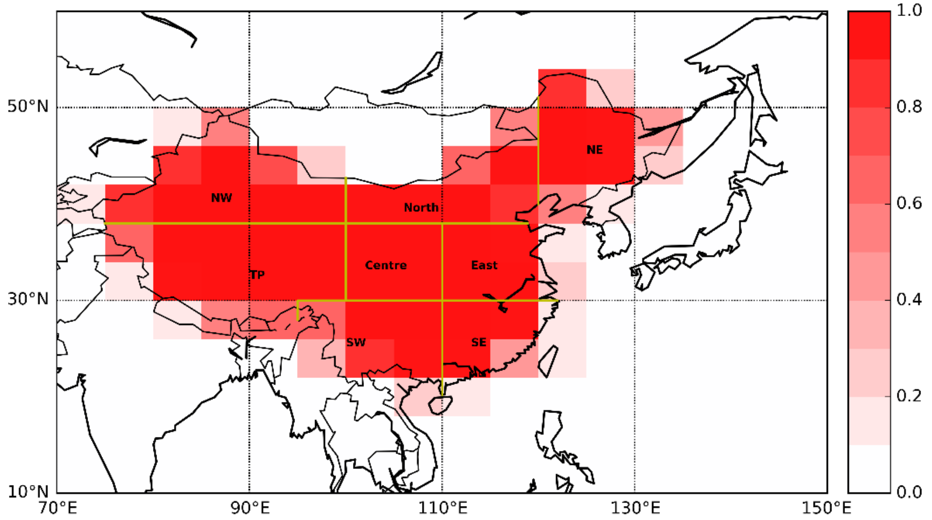


General conclusion

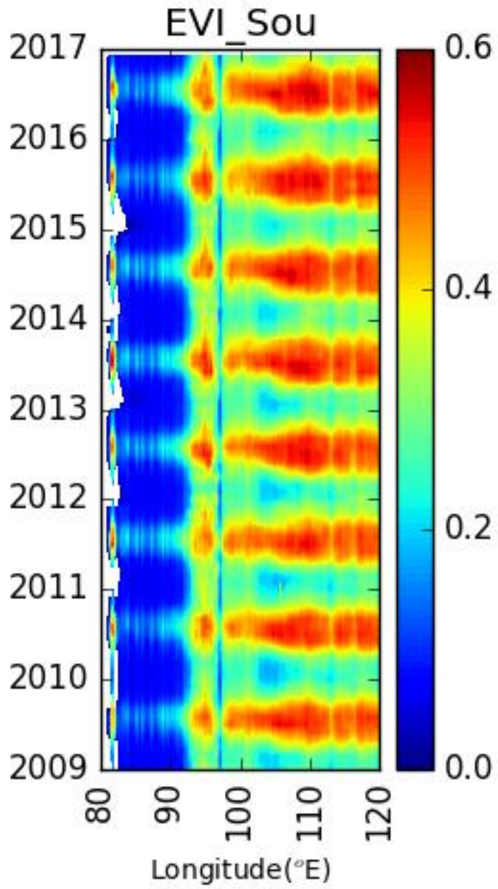
- The satellite inversions show larger seasonal amplitudes than the in-situ inversion.
- During the growing season. Both satellite and in-situ inversions shows a spatial pattern consistent with the forest distributions
- NDVI/EVI over northeast China increased in both 2015 and 2016, accompanied with higher temperature and an increase of precipitation. The change of NDVI and EVI in southern part is similar with the northern one, but maybe mainly due to the increased precipitations.
- The flux variations for satellite inversions are more consistent with the NDVI/EVI variations.

Acknowledgement

We really appreciate the ACOS team for providing the GOSAT ACOS products, the OCO-2 for providing the OCO-2 v7 products.
Thanks to the NASA LPDAAC t provide the NDVI, EVI, land cover products.
Thanks Japanese team for providing observations of JR-station sites.



Region	NW	North	NE	TP	CC	East	SW	SE
NW	1.0							
North	0.075	1.0						
NE	0.029	0.666	1.0					
TP	0.400	0.192	0.033	1.0				
CC	0.128	0.591	0.169	0.518	1.0			
East	0.058	0.784	0.325	0.277	0.775	1.0		
SW	0.079	0.441	0.095	0.491	0.871	0.686	1.0	
SE	0.037	0.504	0.141	0.293	0.733	0.777	0.845	1.0


EVI_Sou
2017
2016
2015
2014
2013
2012
2011
2010
2009
80
90
100
110
120
Longitude(°E)
0.6
0.4
0.2
0.0