OCO-2: A progress report at the end of the prime mission

David Crisp (Jet Propulsion Laboratory, California Institute of Technology) for the OCO-2 Team

6 June 2017

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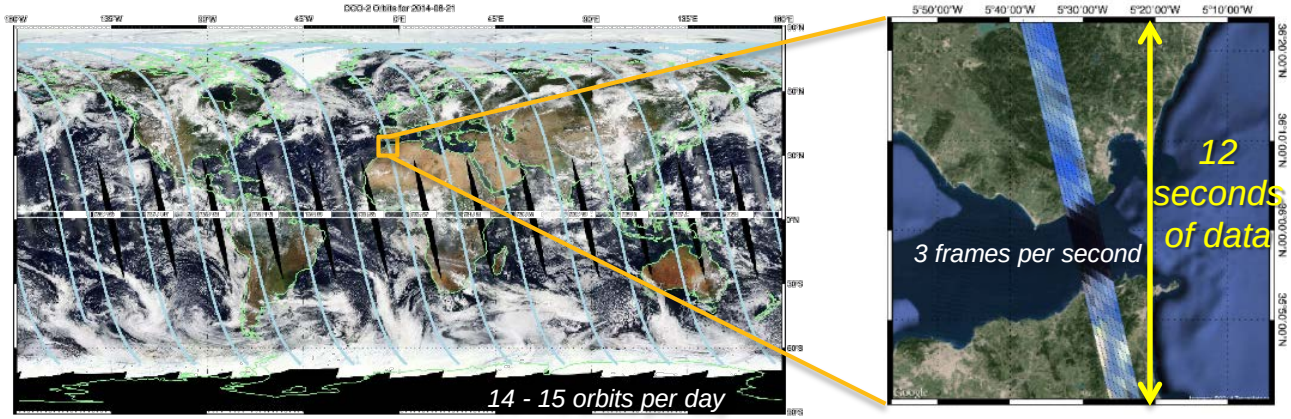
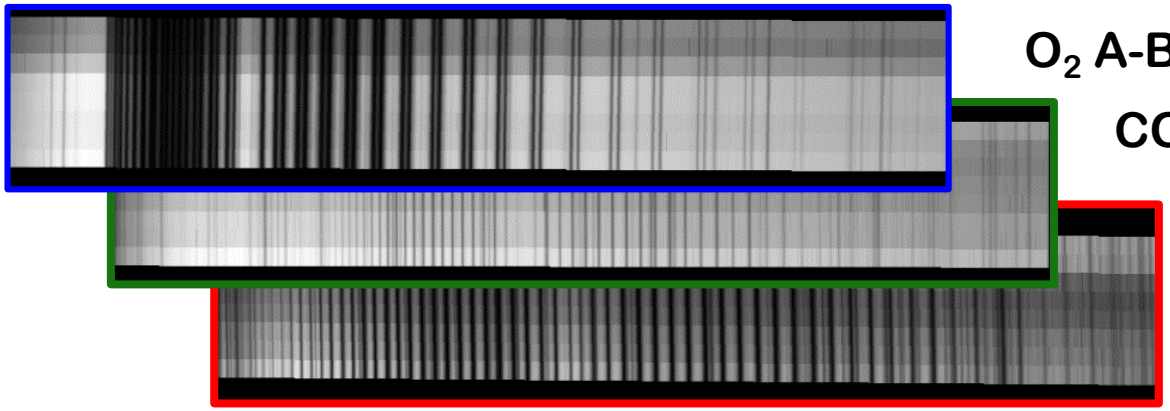
Government sponsorship acknowledged.

OCO-2 Sampling Approach





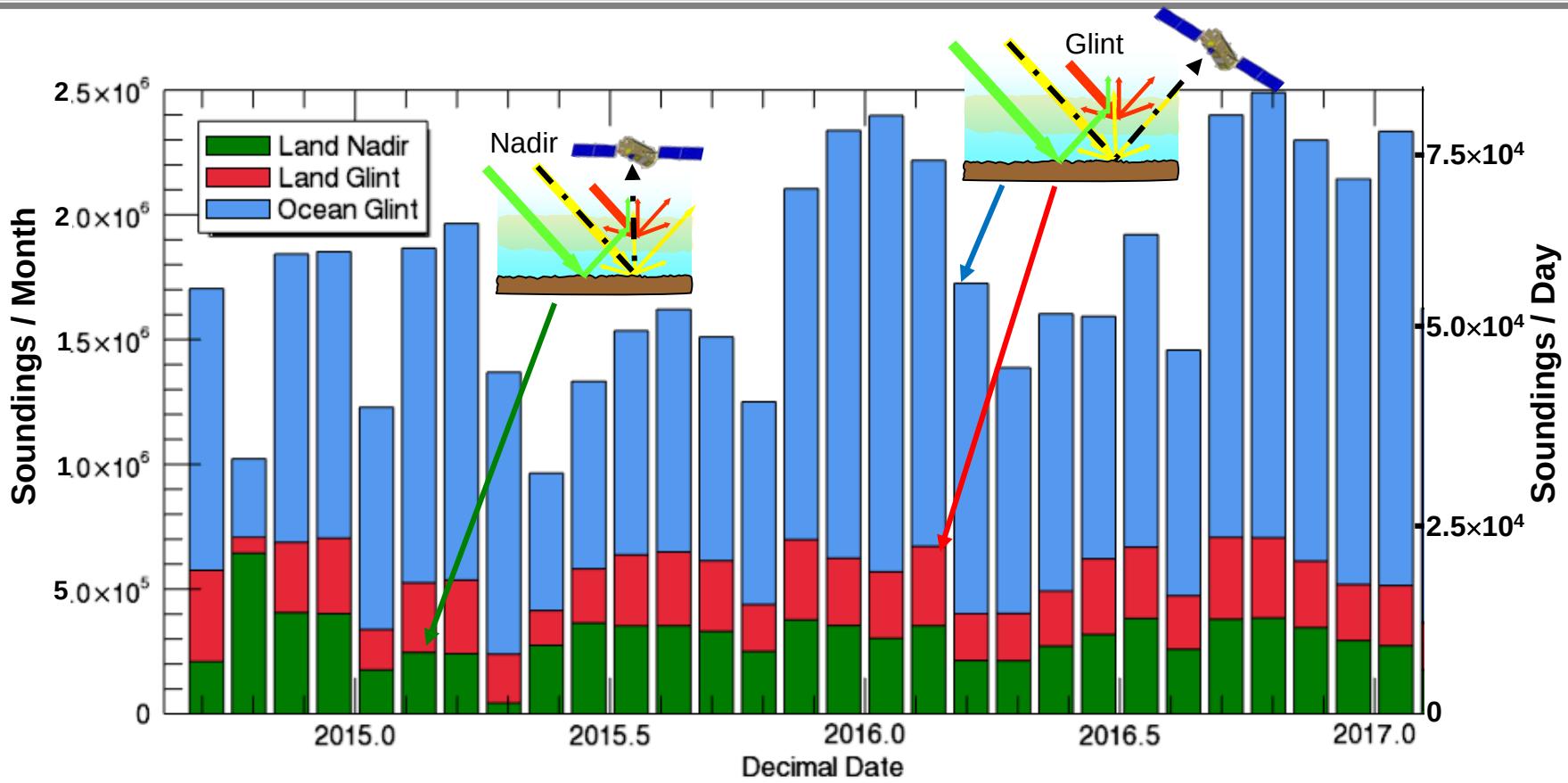
O_2 A-Band

CO_2 1.61 μm Band

CO_2 2.06 μm Band

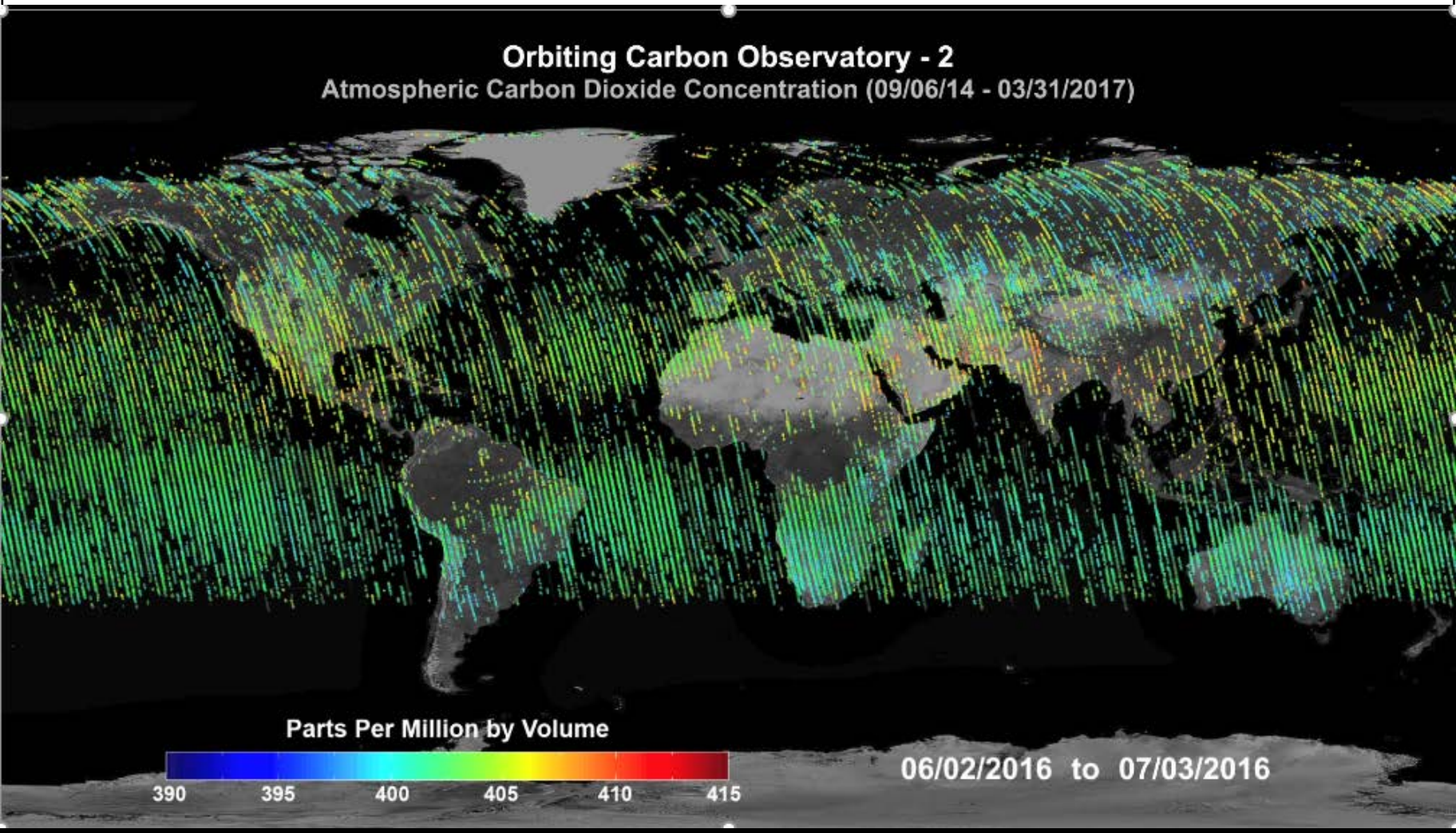
The OCO-2 instrument collects 24 soundings each second as it flies over the sunlit hemisphere of the Earth, yielding almost 1 million soundings each day

OCO-2 Collects Many Cloud-free X_{CO2} Soundings Each Day

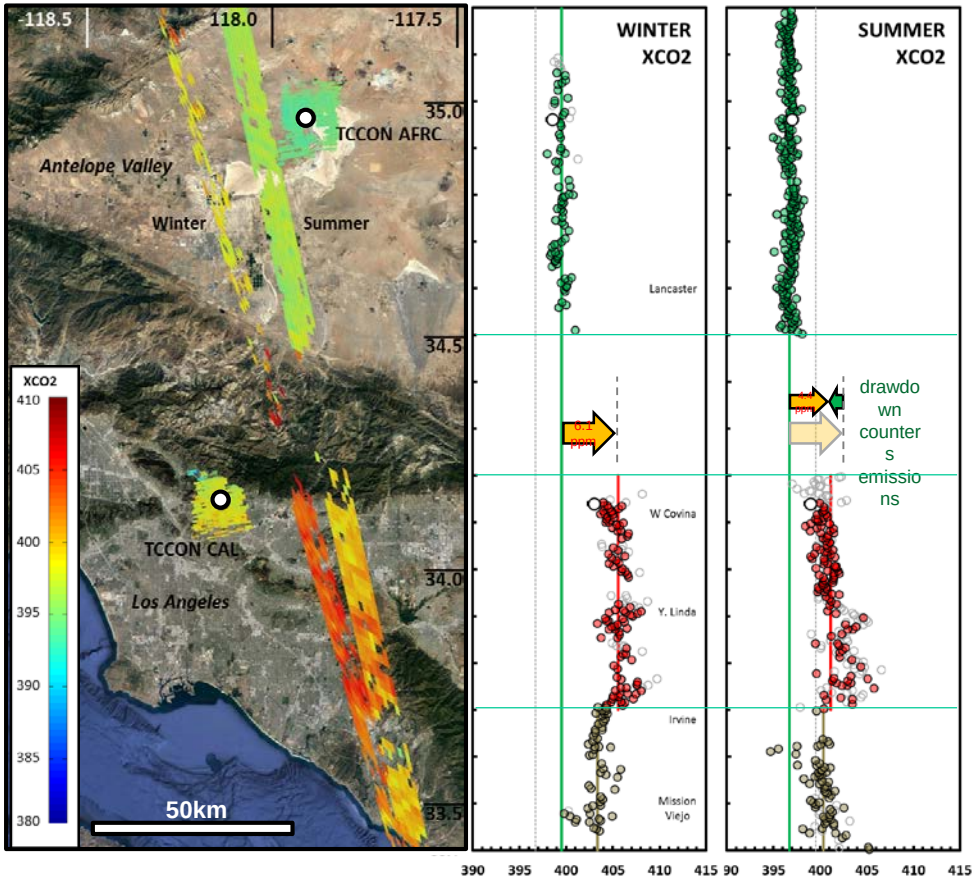


The glint/nadir observations strategy has been refined to maximize the number of full-column X_{CO2} retrievals. The "optimal" viewing strategy, implemented in November 2015 acquires ocean glint on all orbits predominately over the Atlantic or Pacific Oceans.

A Quick Look at the OCO-2 Prime Mission

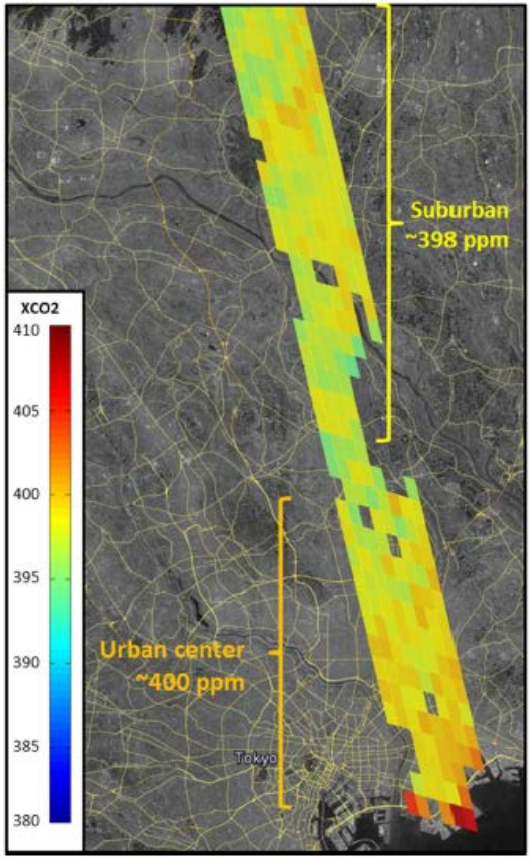


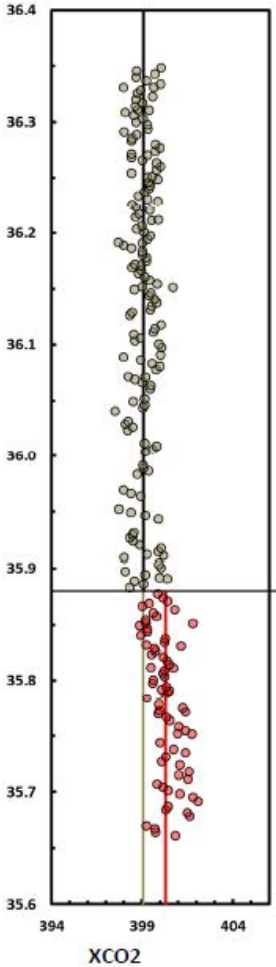
Localized Sources Urban Centers



Los Angeles Basin

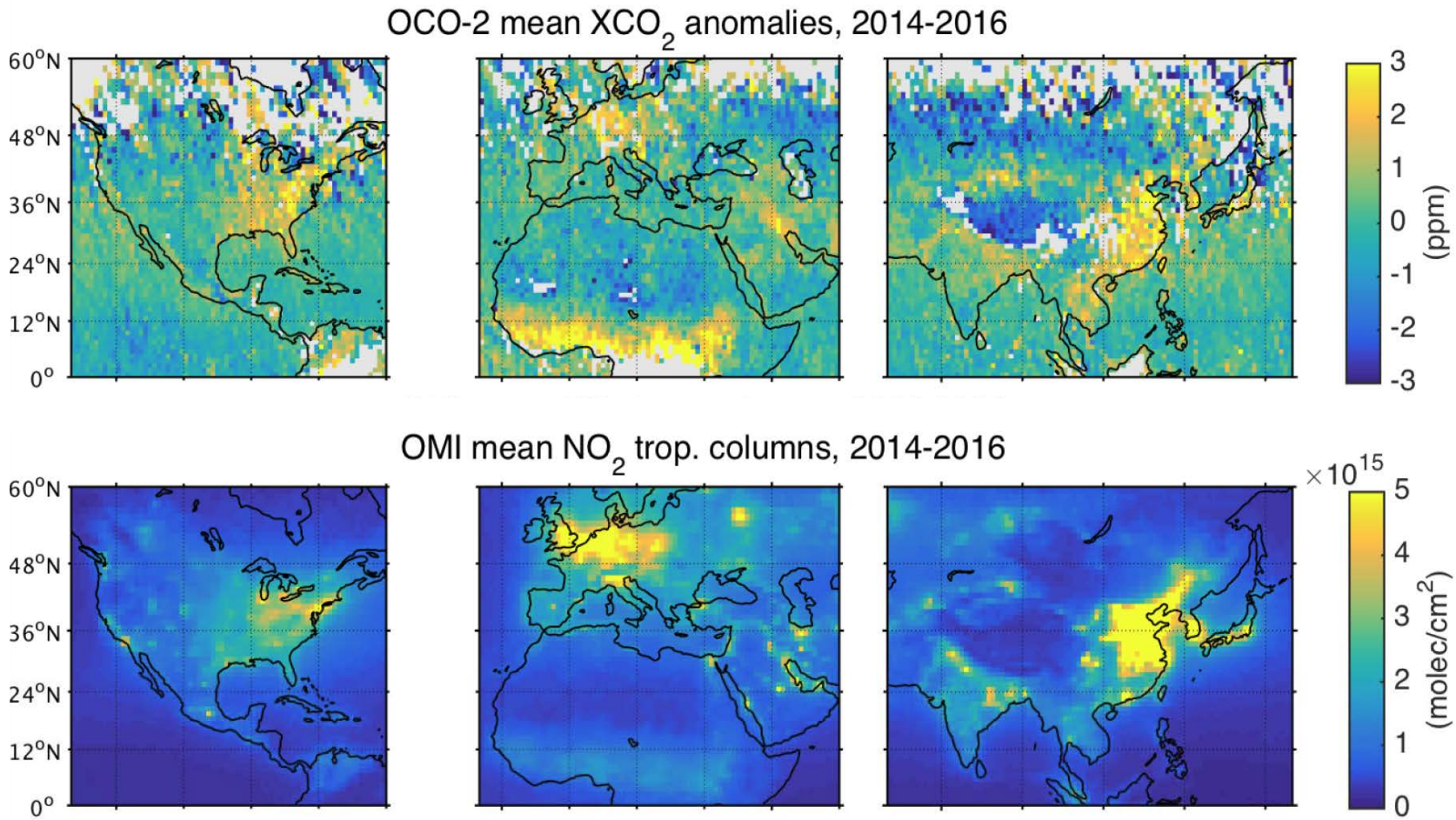
Tokyo





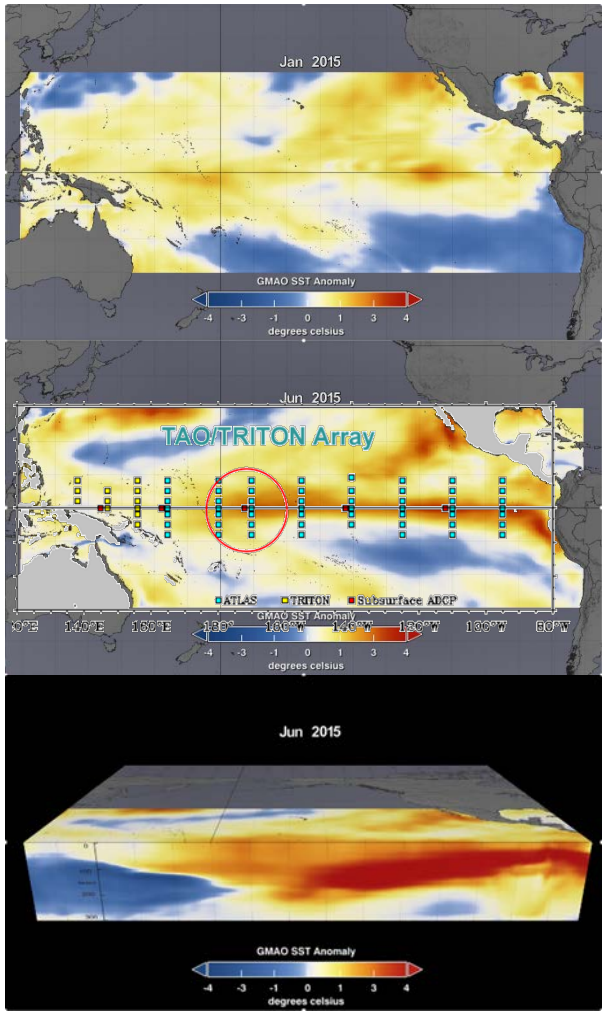
Florian Schwandner et al.(Submitted)

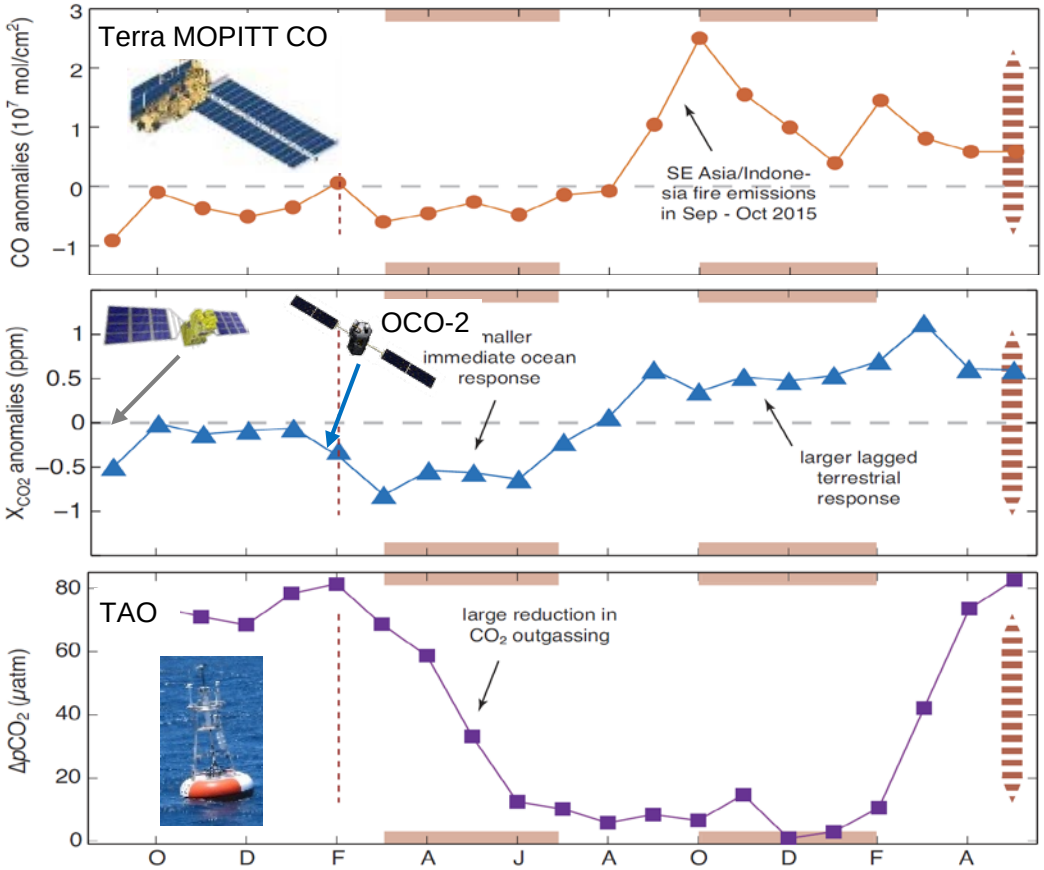
Anthropogenic Emissions



Janne Hakkarainen et al. GRL (2016)

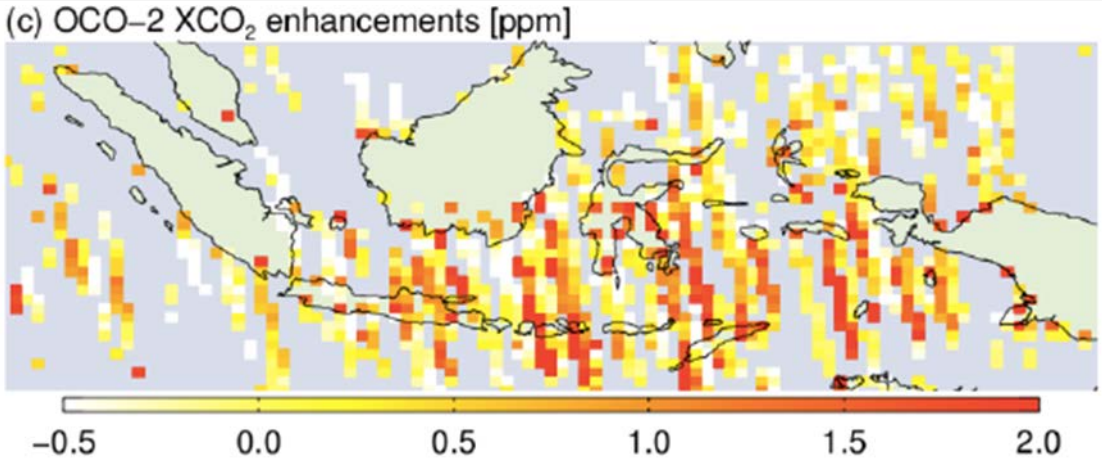
2015-2016 El Niño: Ocean Response



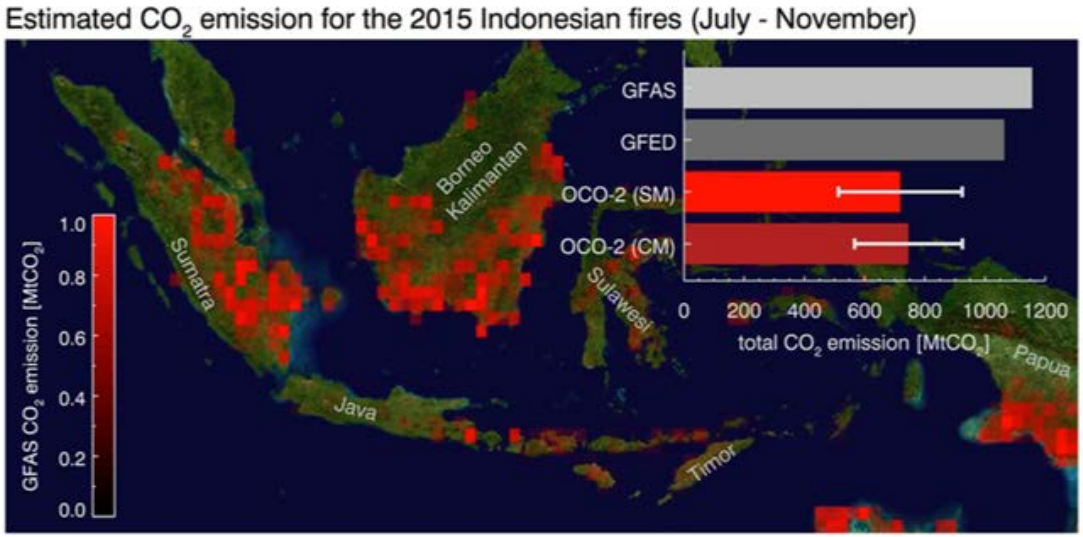


Chatterjee et al. (submitted to Science)

2015-2016 El Niño: Fires



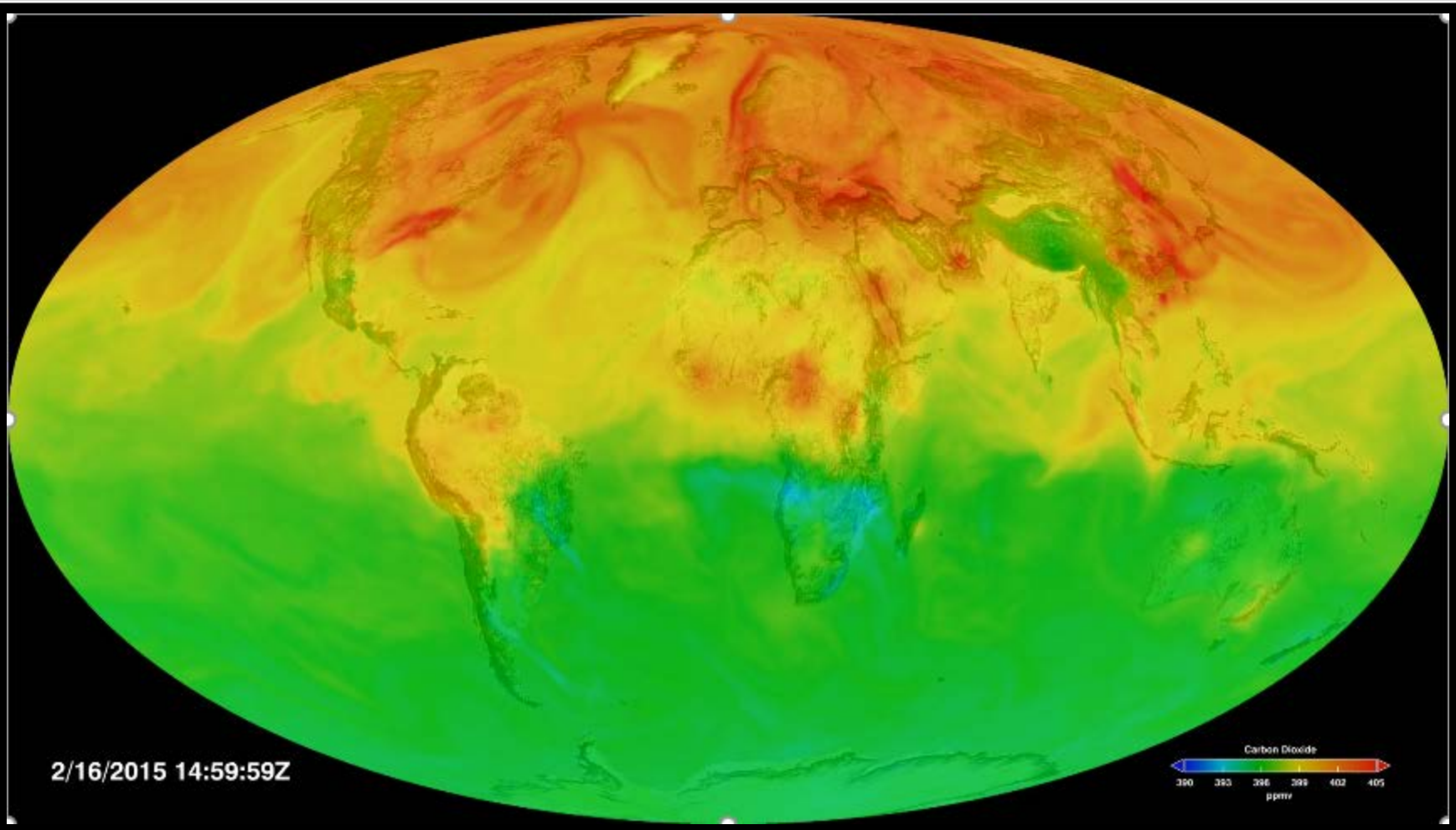
X_{CO2} enhancements over Indonesia observed by OCO-2 between July and November 2015.



Fire emissions inferred from OCO-2 X_{CO2} estimates have been compared to the GFAS and GFED fire inventories. The OCO-2 estimates are less than 70% as large as those in the inventories.

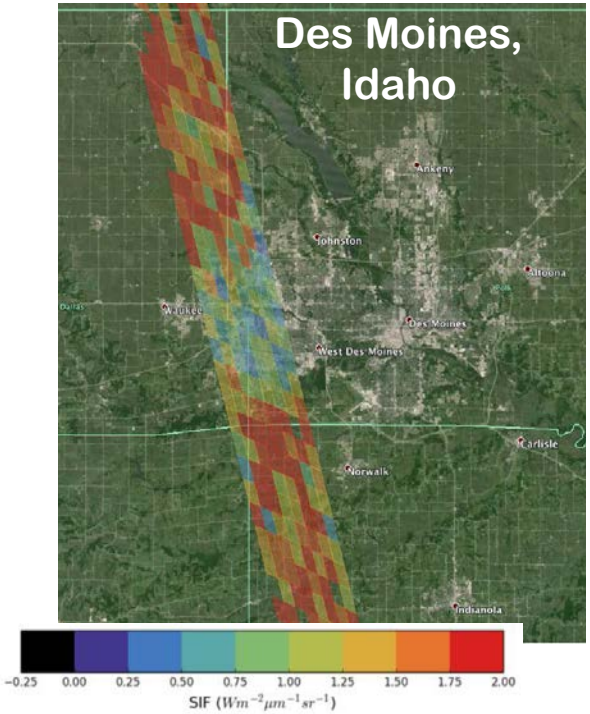
Jenns Heymann et al. (GRL, 2017)

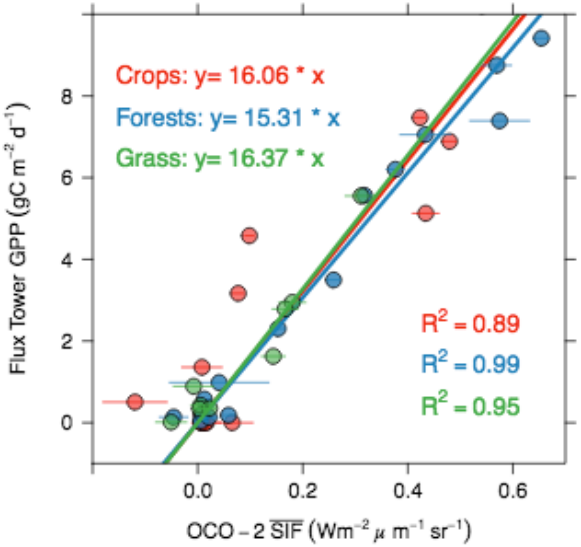
Assimilation of OCO-2 X_{CO2}



Brad Weir et al. GSFC GMAO

Solar Induced Chlorophyll Fluorescence (SIF)

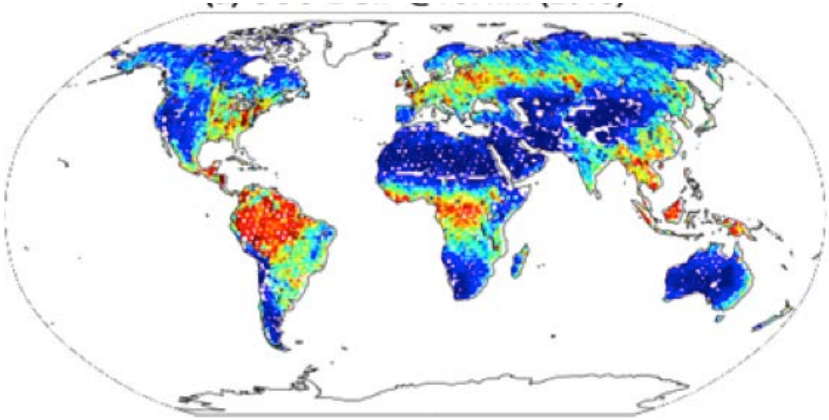




- OCO-2 SIF linearly related to GPP *across biome types!*
- Outperforms MODIS and upscaled GPP.

OCO-2 SIF Observations are providing useful information about CO2 uptake by land plants

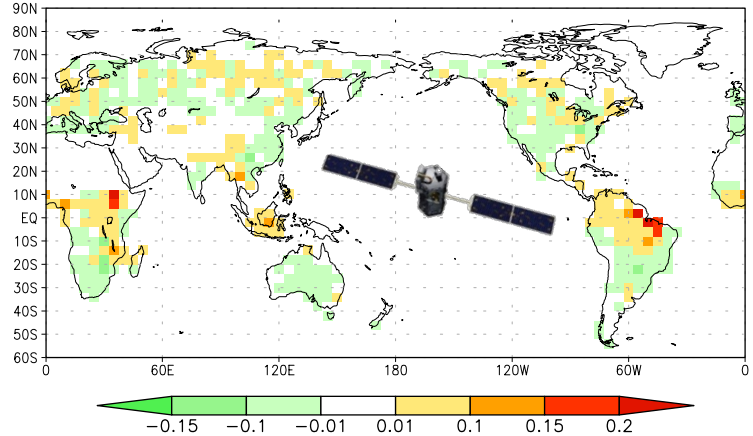
Ying Sun et al. (submitted 2017)



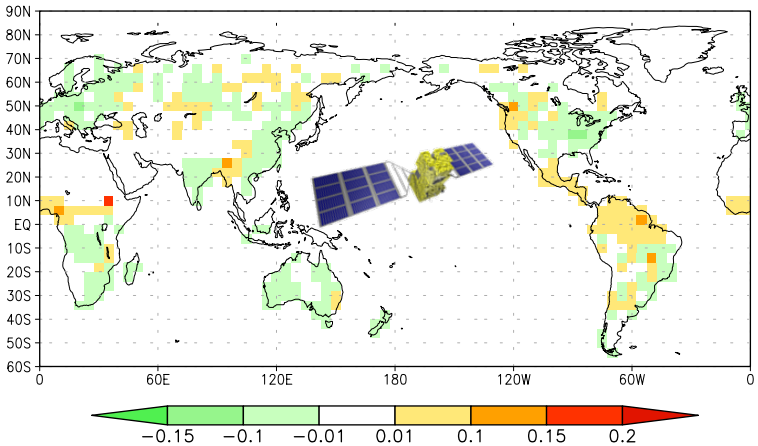
OCO-2 SIF 2015

2015 El Niño and 2011 La Niña annual biosphere fluxes and their differences

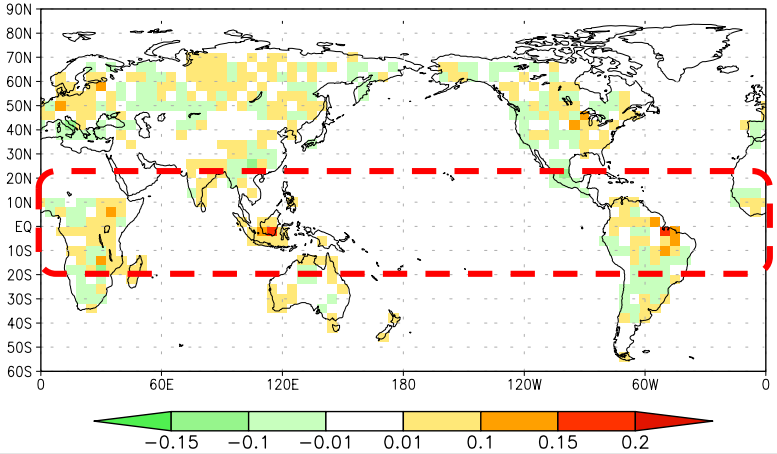
2015 (GtC/yr)



2011 (GtC/yr)



2015- 2011 (GtC/yr)



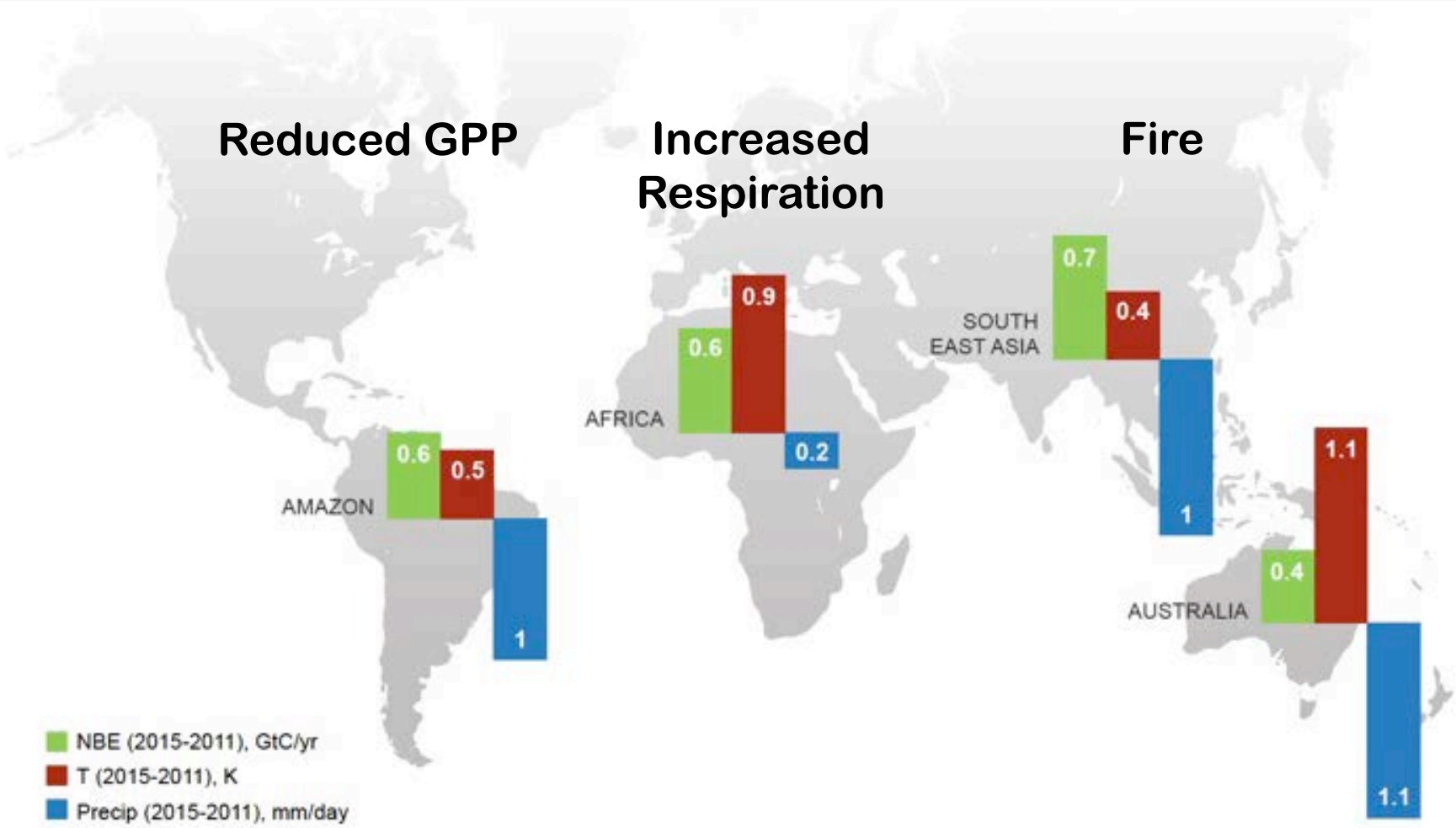
Red: release CO_2 into atmosphere

Green: absorb CO_2 from atmosphere

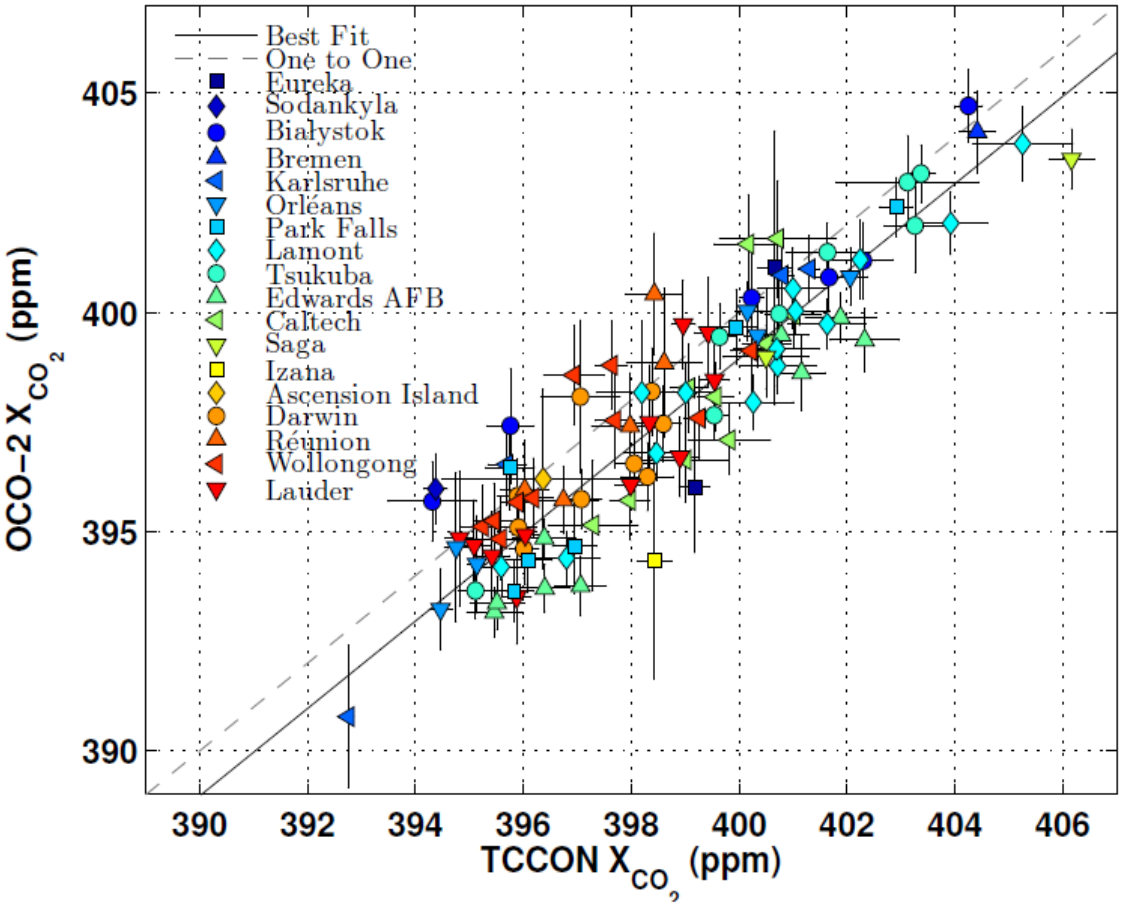
- **The most significant impact of 2015 El Niño on biosphere carbon fluxes is the increase of CO_2 release from the tropics**

Liu et al. (Submitted to Science 2017)

2015-2016 El Niño: 3 Continents, 3 Stories



Comparison of TCCON and OCO-2 X_{CO2}



Comparisons with the Total Carbon Column Observing Network (TCCON) stations are being used to identify and correct biases in X_{CO2} estimates.

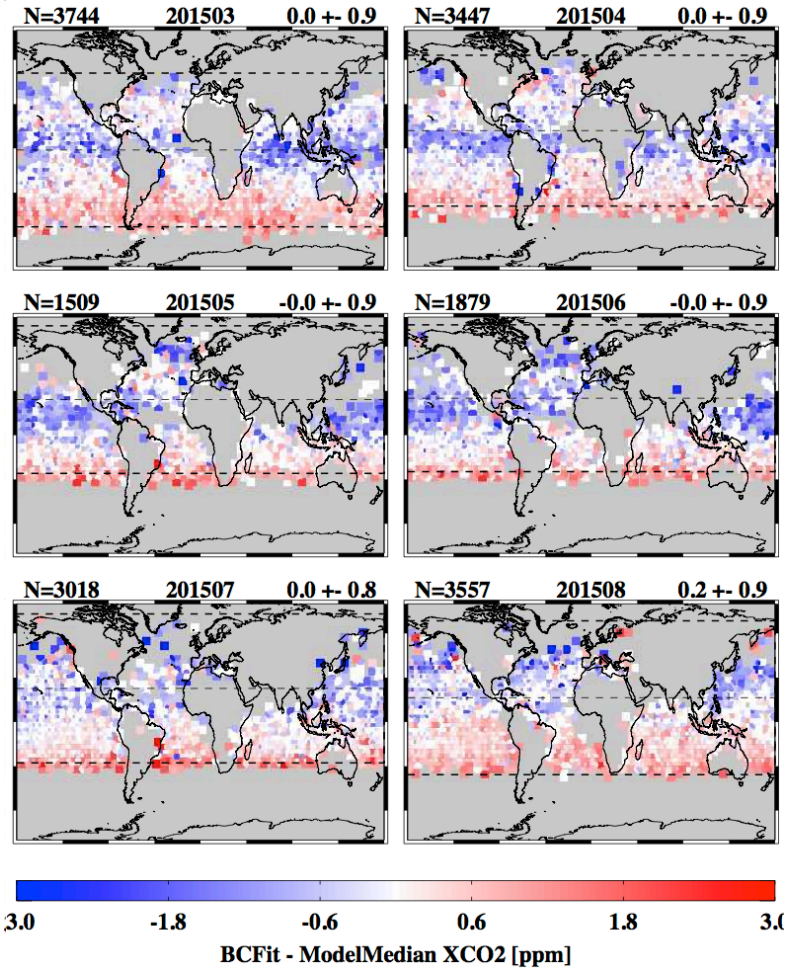
After applying a bias correction

- Global bias is reduced to < 0.4 ppm
- Station-to-station biases reduced to ~1.5 ppm

Wunch et al. (2017)

Known Issues and Coming Attractions: The OCO-2 Version 8 Data Product

With Strat Aerosols



- Optically-thin stratospheric aerosol layers can introduce biases in the OCO-2 X_{CO2} products
  - The largest effects are seen at high latitudes over the ocean
  - Volcanic activity and fires that enhance stratospheric aerosols can introduce large errors
- More subtle biases are introduced by limitations in the instrument calibration, gas absorption cross sections, cloud screening and surface reflection model
- These issues and others are addressed in the OCO-2 Version 8 data Product, which will be produced later this summer

See presentation by O'Dell et al.

Summary

- OCO-2 completed its 2-year prime mission on October 16, 2016 and began its first extended mission.
  - OCO-2 has been returning 25000 to 75000 full-column measurements of X_{CO2} each day for 2.6 years
  - The Version 7/7r X_{CO2} data product has single-sounding random errors near 0.5 ppm at solar zenith angles as large as 70°
  - Comparisons to TCCON show that OCO-2 X_{CO2} estimates have a global bias of 0.4 ppm and station-to-station biases of 1.5 ppm
  - Larger biases are seen in glint data at mid-to-high latitudes due to the neglect of stratospheric aerosols
  - The Version 8 data product is under development to address these and other issues, and will be available later this summer
- OCO-2 products can be obtained from the GES-DISC

http://disc.sci.gsfc.nasa.gov/OCO-2

Thank You for Your Attention

Questions?