

Using OCO-2 column XCO₂ retrievals to rapidly detect and estimate extreme terrestrial biosphere carbon anomalies

Andrew Feldman^{1,2}, Zhen Zhang³, Yasuko Yoshida⁴, Abhishek Chatterjee⁵, Joanna Joiner¹, and Ben Poulter¹
 (1) NASA Goddard Space Flight Center, (2) NASA Postdoctoral Program, ORAU, (3) University of Maryland, (4) SSAI, (5) Jet Propulsion Lab



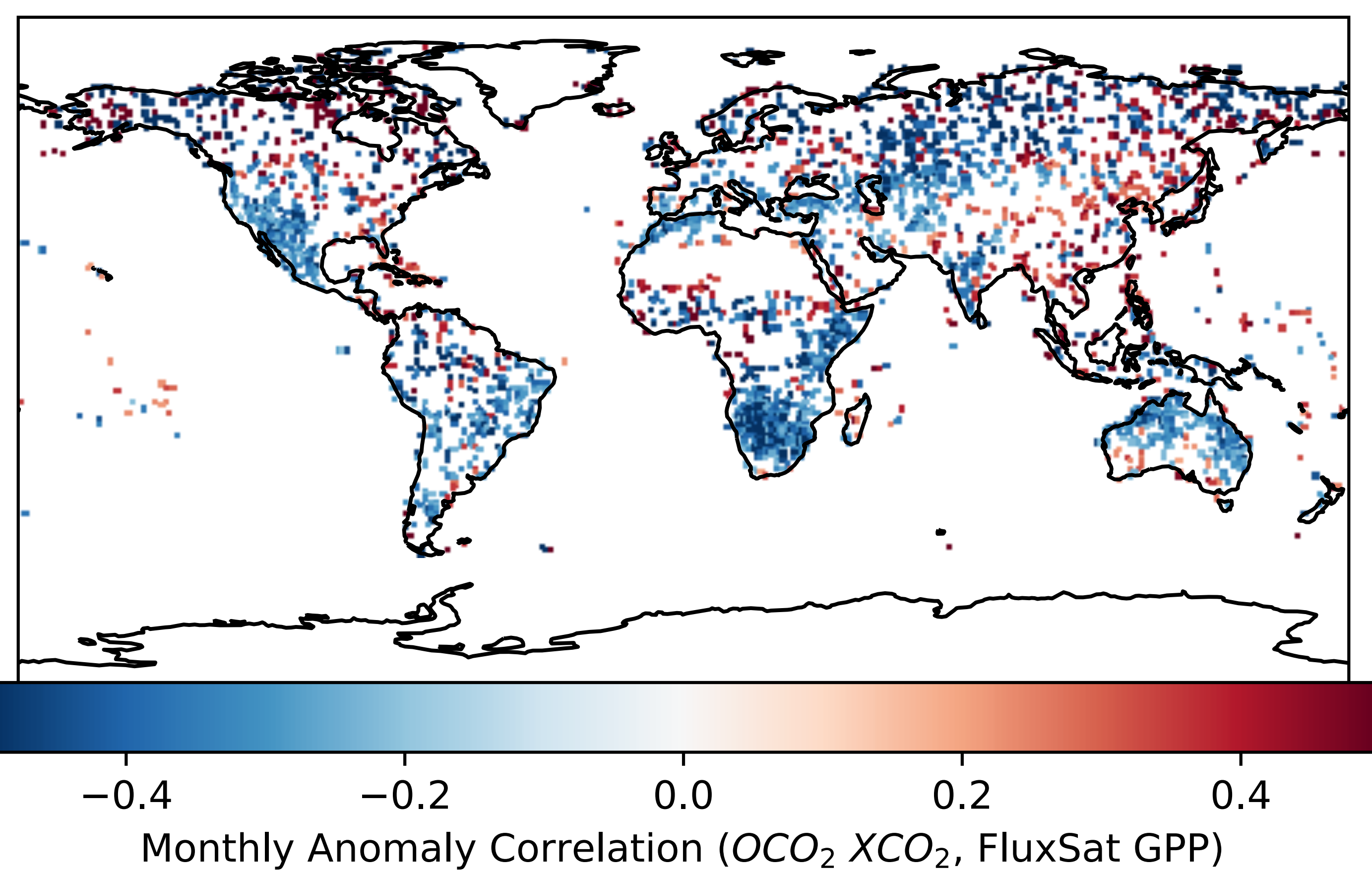
MOTIVATION

- Surface CO₂ flux information mainly available at high latency (i.e. models) which is less capable for rapid attribution of carbon-climate feedbacks
- OCO-2 XCO₂ is mainly used for constraint on seasonal to interannual carbon cycle, but provides opportunity for rapid attribution studies of sub-seasonal extreme events

RESEARCH QUESTIONS

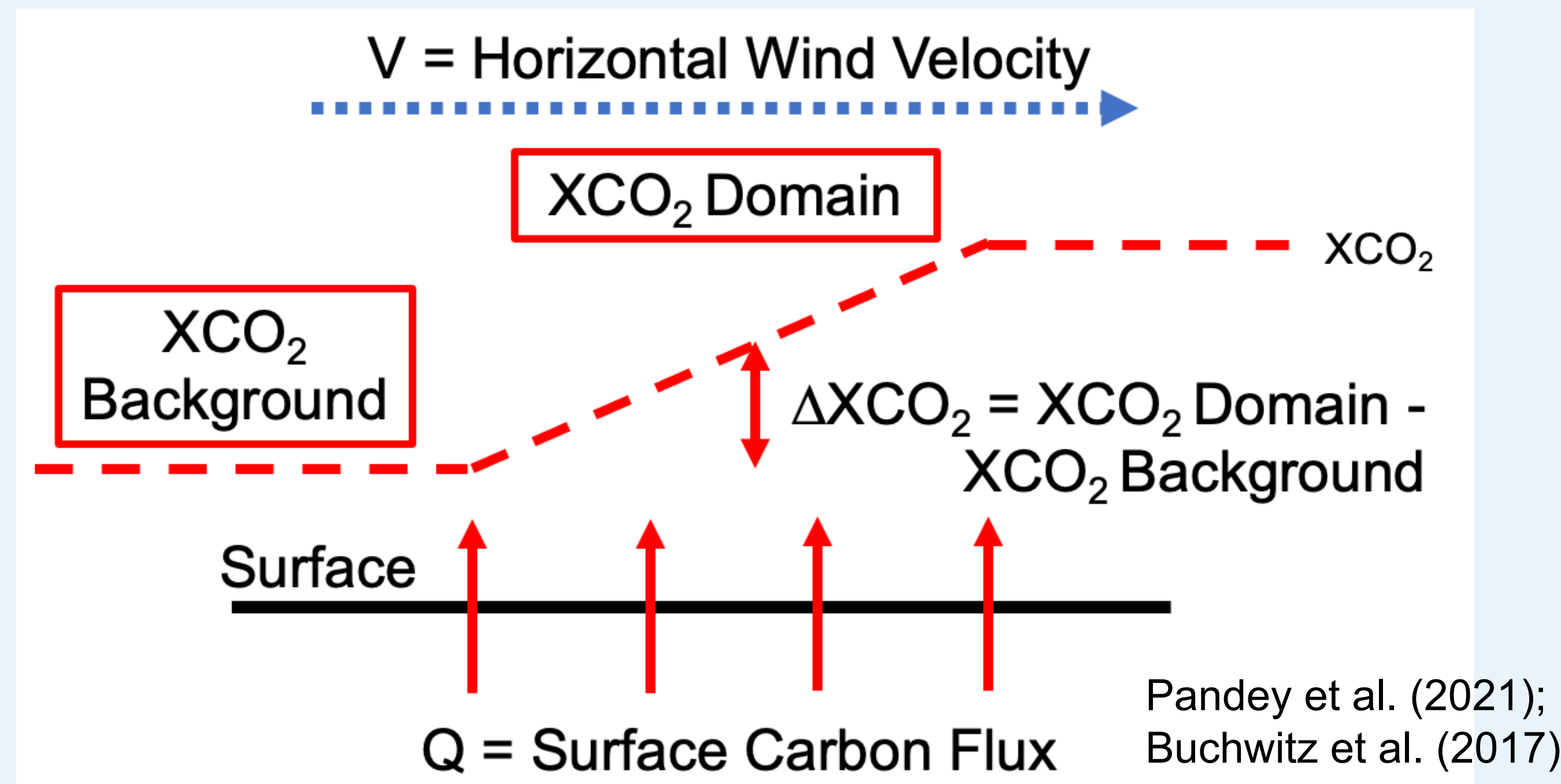
- Can satellite XCO₂ be used to directly monitor monthly surface CO₂ flux anomalies from the terrestrial biosphere?
- Where and under what conditions?

REGIONS WITH LAND-ATMOSPHERE CO₂ LINK



- **Blue** = regions where atmospheric carbon (XCO₂) is directly linked to plant CO₂ fluxes
- Regions like the Western US also have tractable wind conditions: consistent upwind source and low wind direction variance

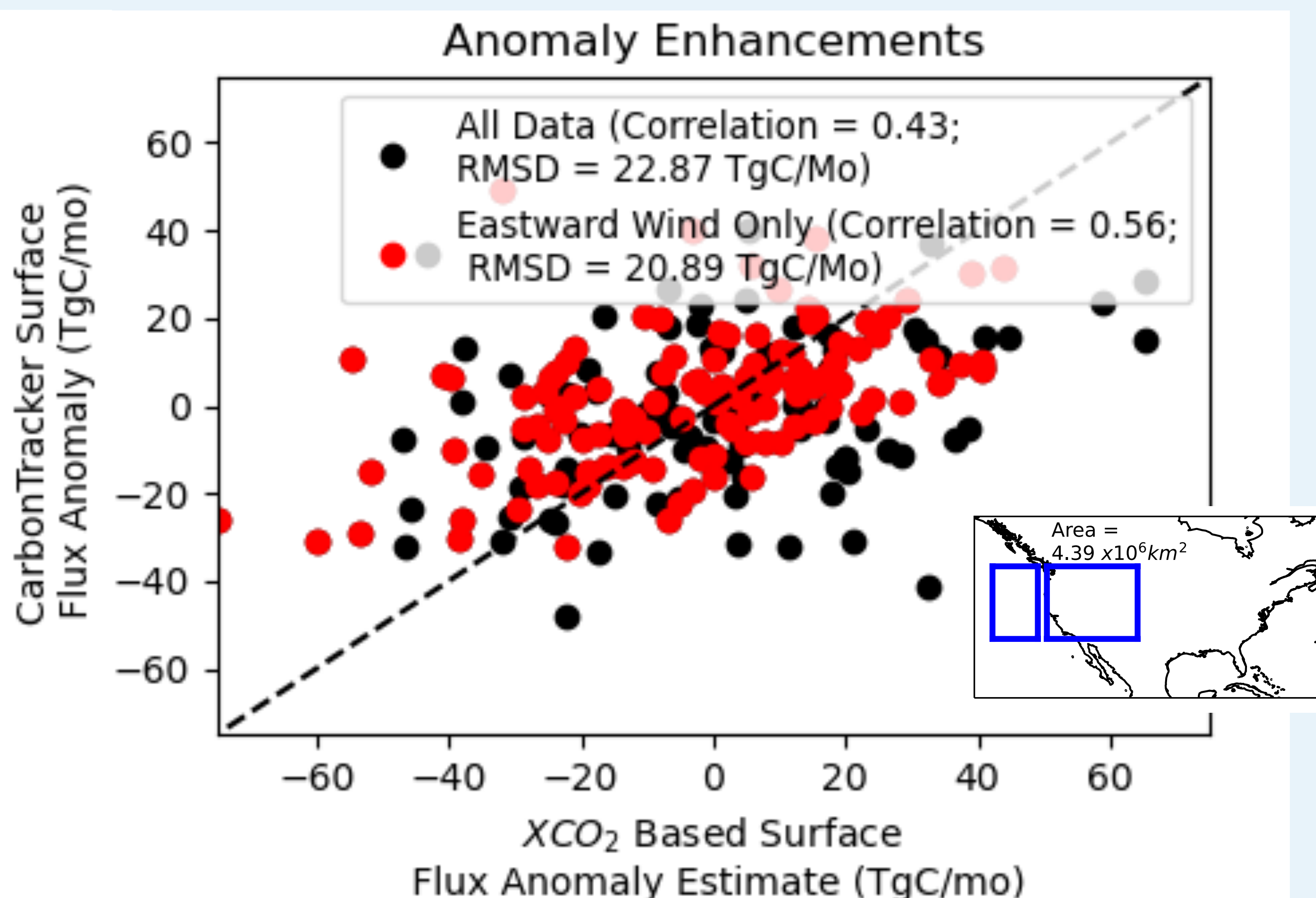
SIMPLE MASS BALANCE FLUX ESTIMATION



$$Q = (\Delta XCO_2)(V)(L)(C)(M_{exp})(M)$$

L = Effective region length scale
 C = 2 (assumption of linear increase of XCO₂ within domain)
 M = Conversion from carbon mixing ratio to total column mass
 M_{exp} = Ratio of atmospheric to surface pressure

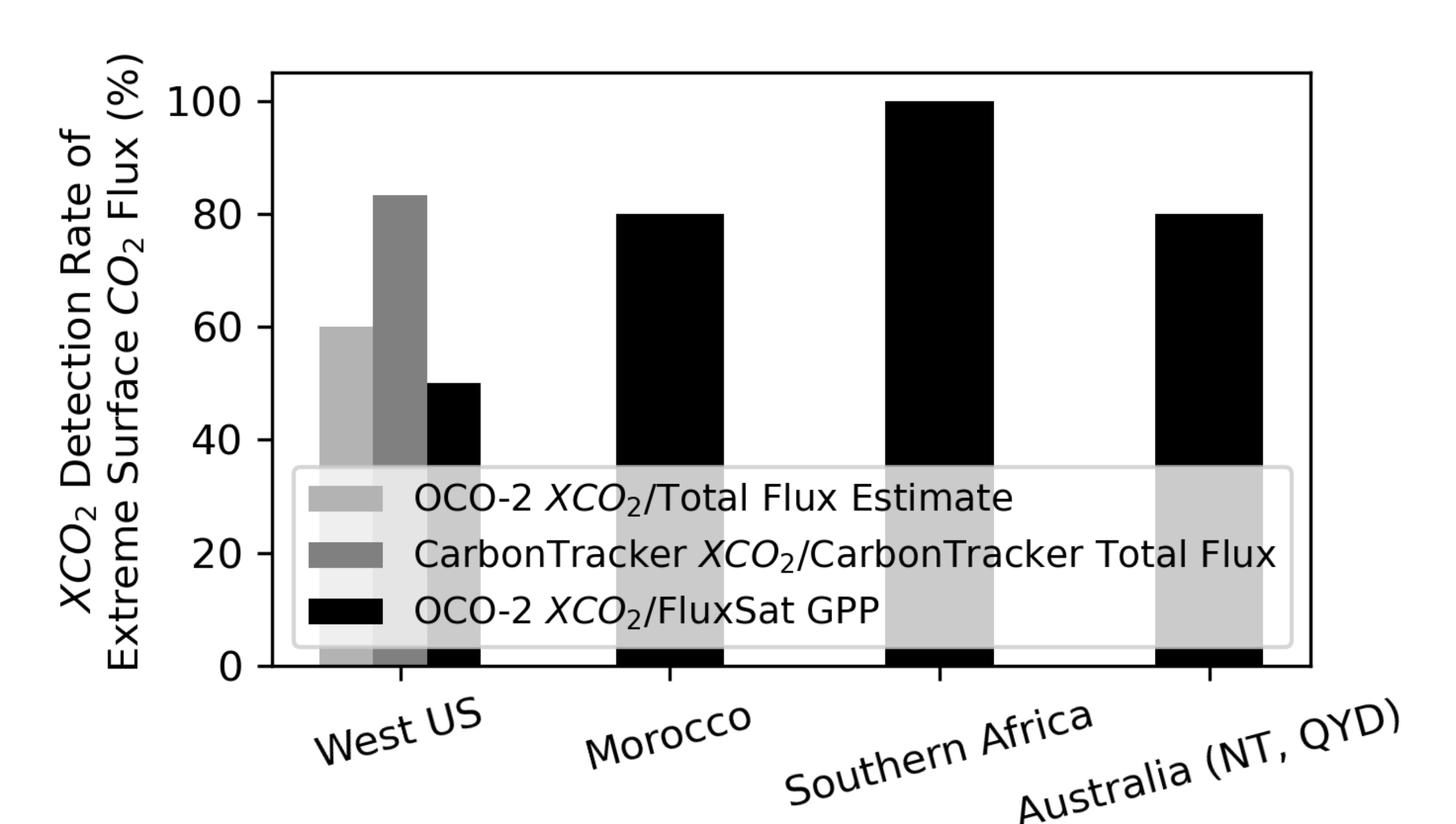
- Pixel source mass balance method can provide first order estimate of fluxes
- Requires large spatial area, consistent wind direction, and consistent background region
- However, OCO-2 observation noise hinders performance with nominal, smaller monthly fluxes



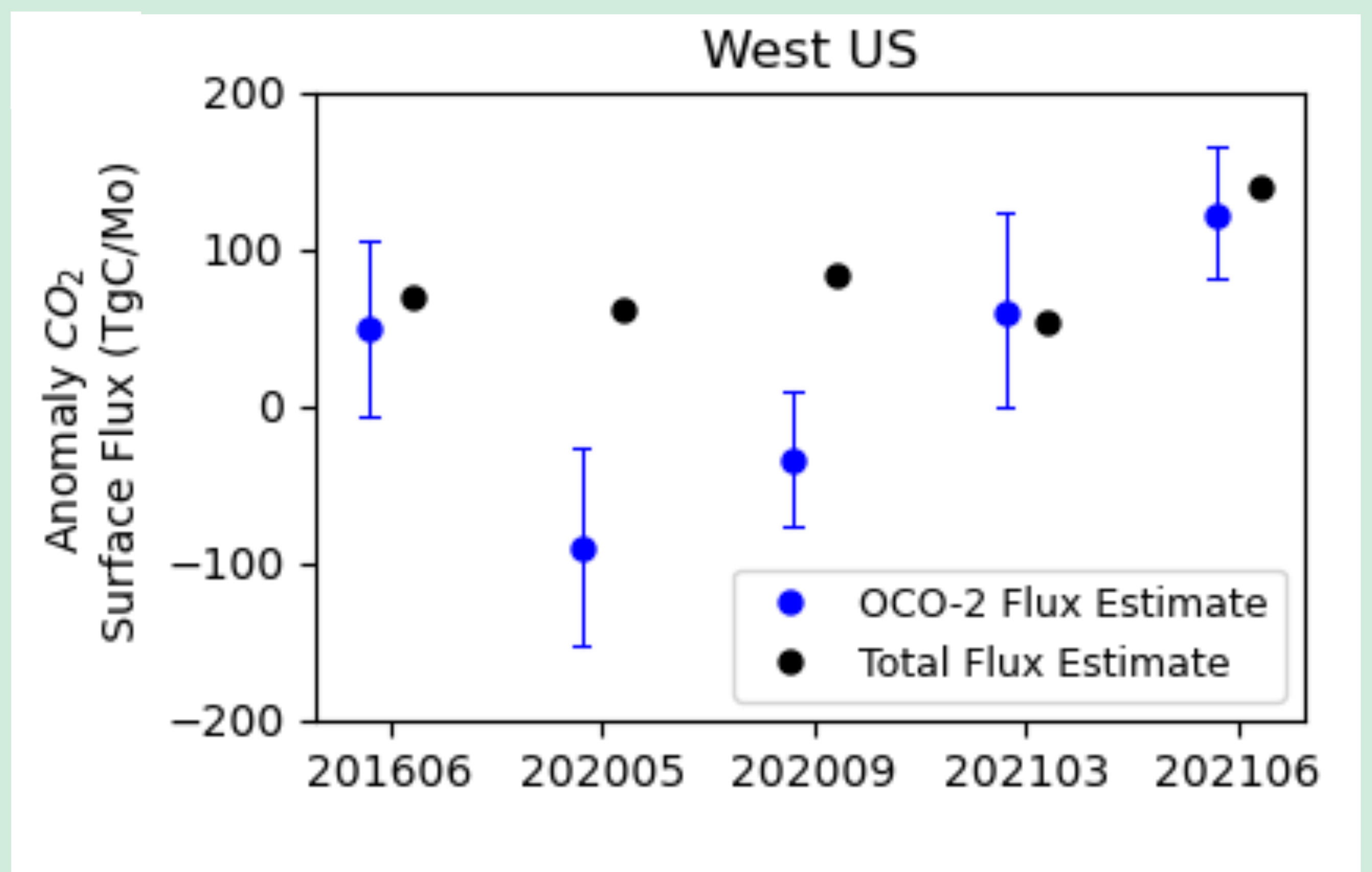
Using CarbonTracker reanalysis as testbed

EXTREME FLUX DETECTION AND ESTIMATION

OCO-2 anomalies can detect extreme surface fluxes, especially in regions where XCO₂ and surface CO₂ fluxes are tightly linked



OCO-2 XCO₂ flux estimates with the mass balance approach can commonly estimate the largest surface fluxes



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