Observing world cities from space: progress and challenges

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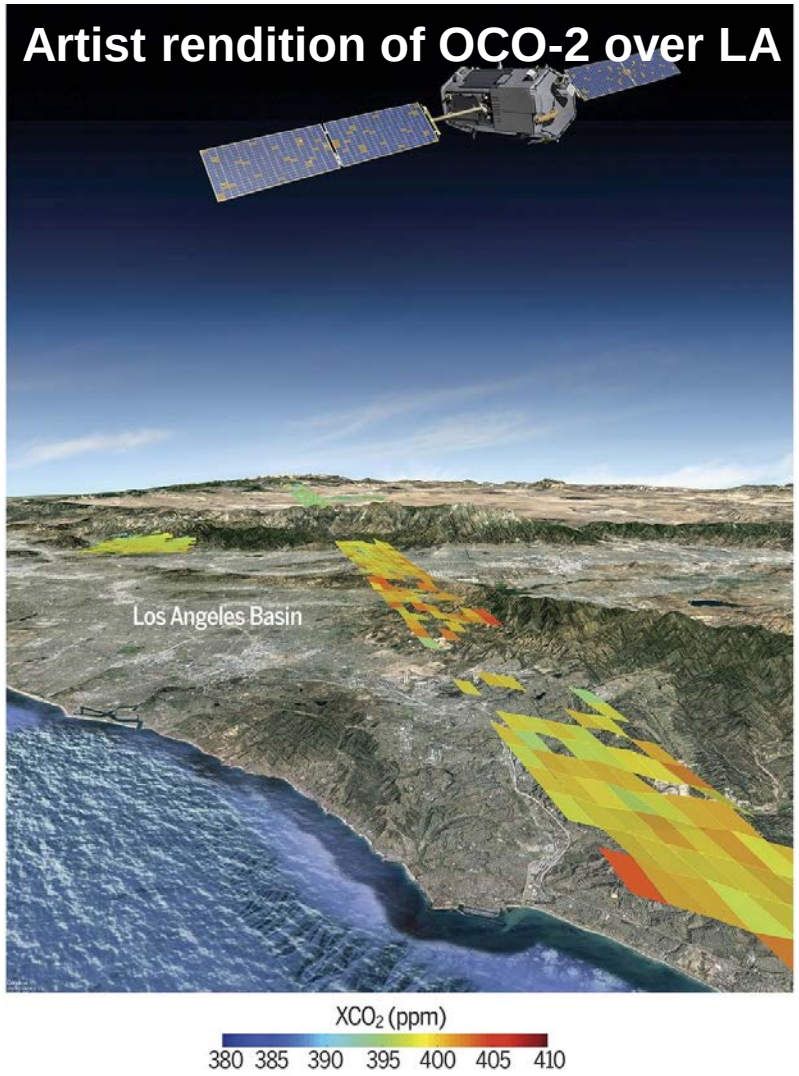
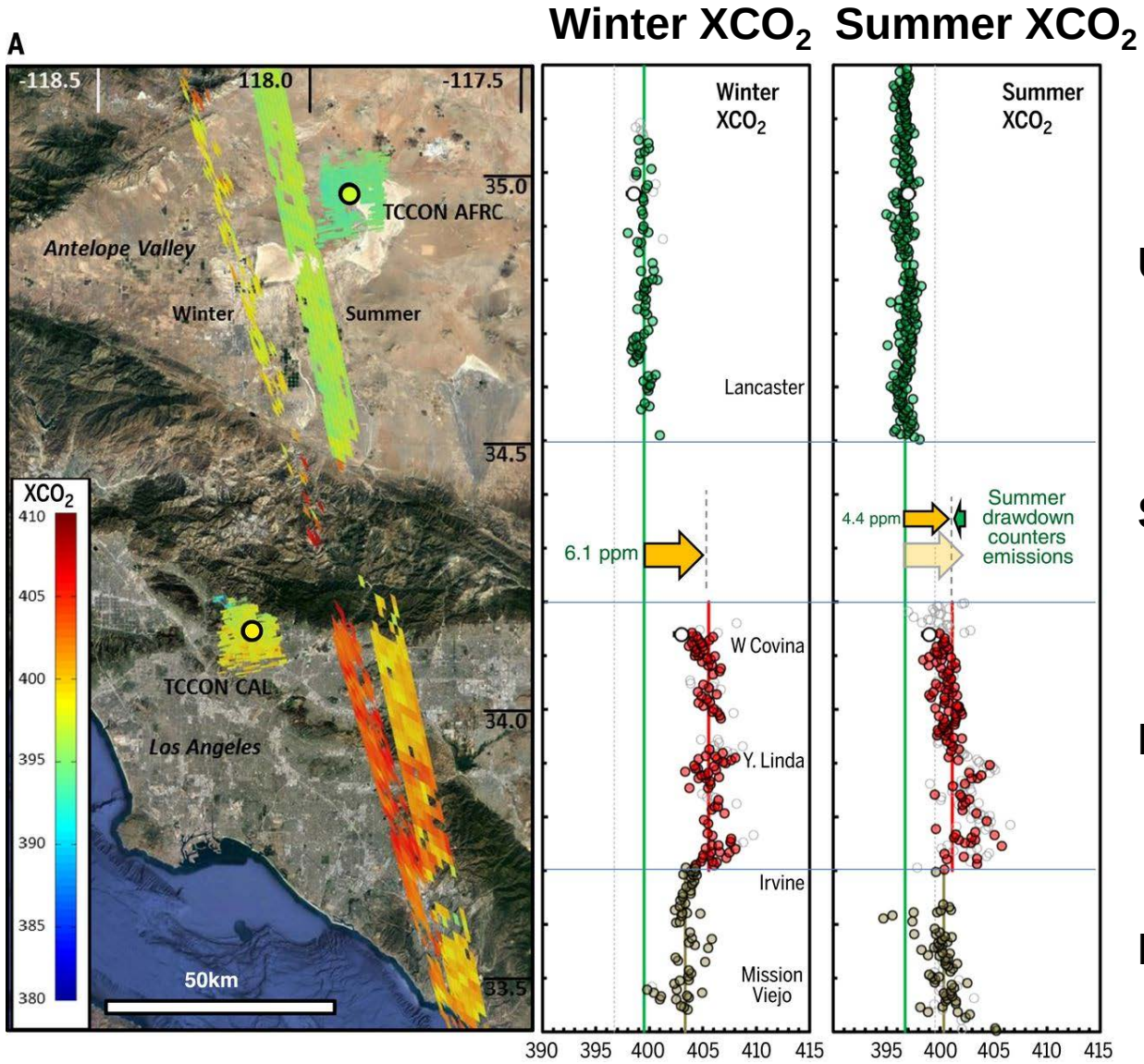
Great examples of viewing cities from space





Upwind of LA

San Gabriel Mtns

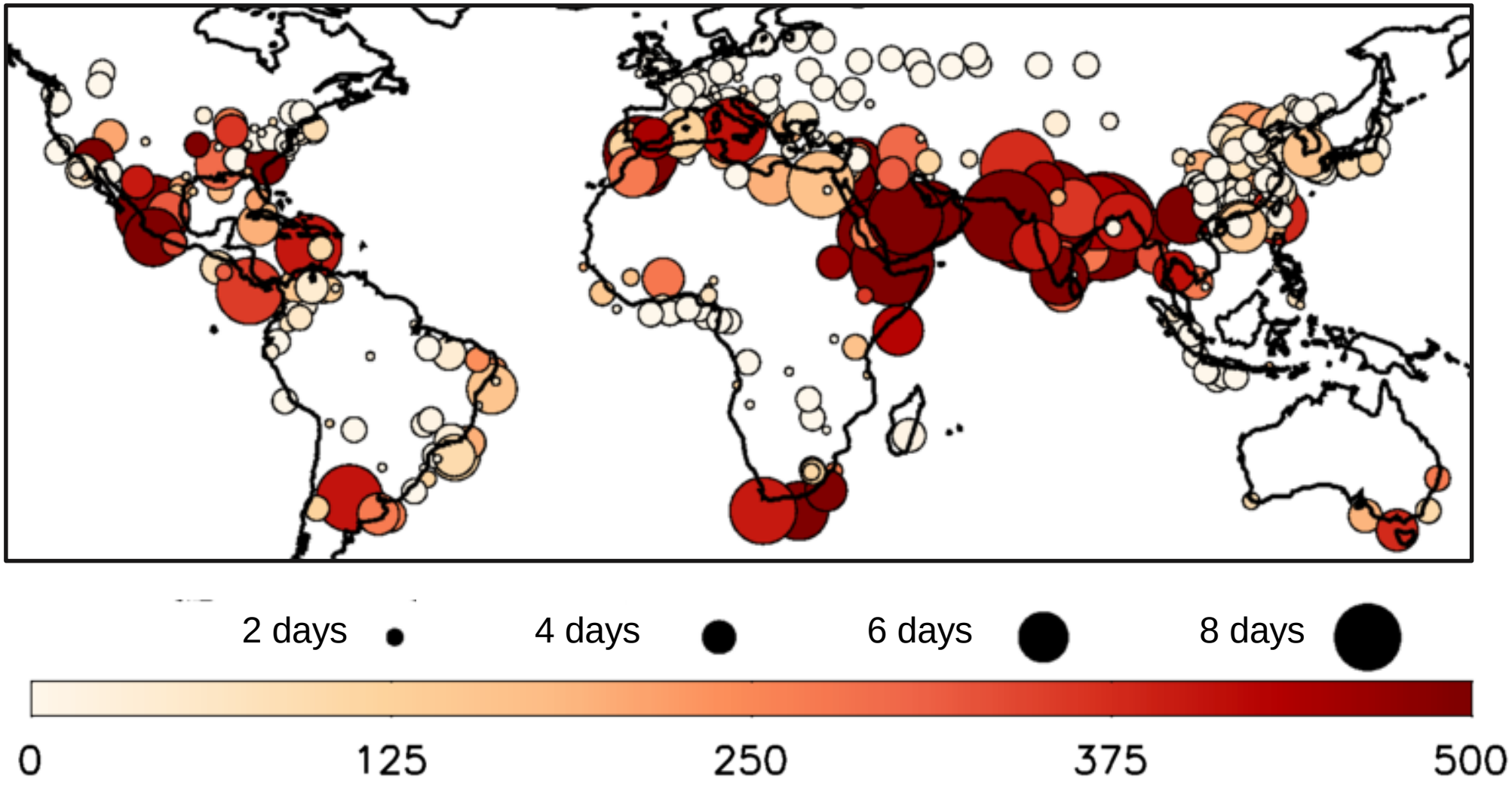
Interior LA

Downwind

Schwander et al., 2017

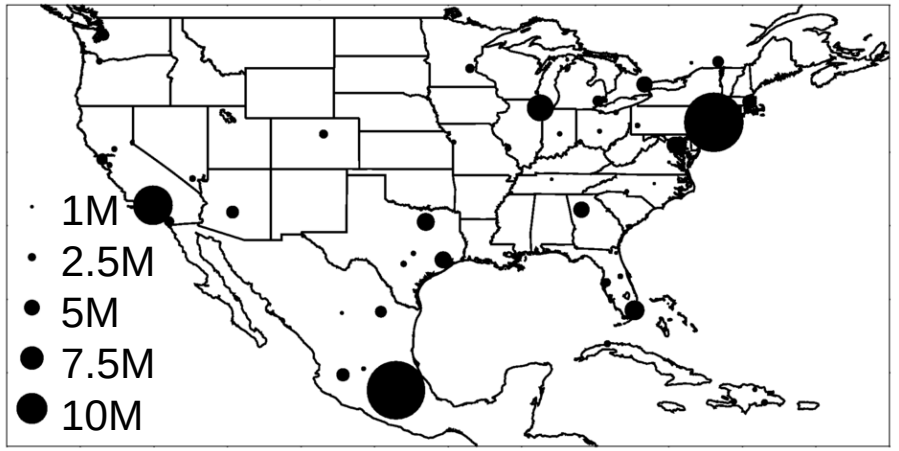
But how well do current satellites do over all cities?

OCO-2 Observations over World Cities - DJF, 2016-2018

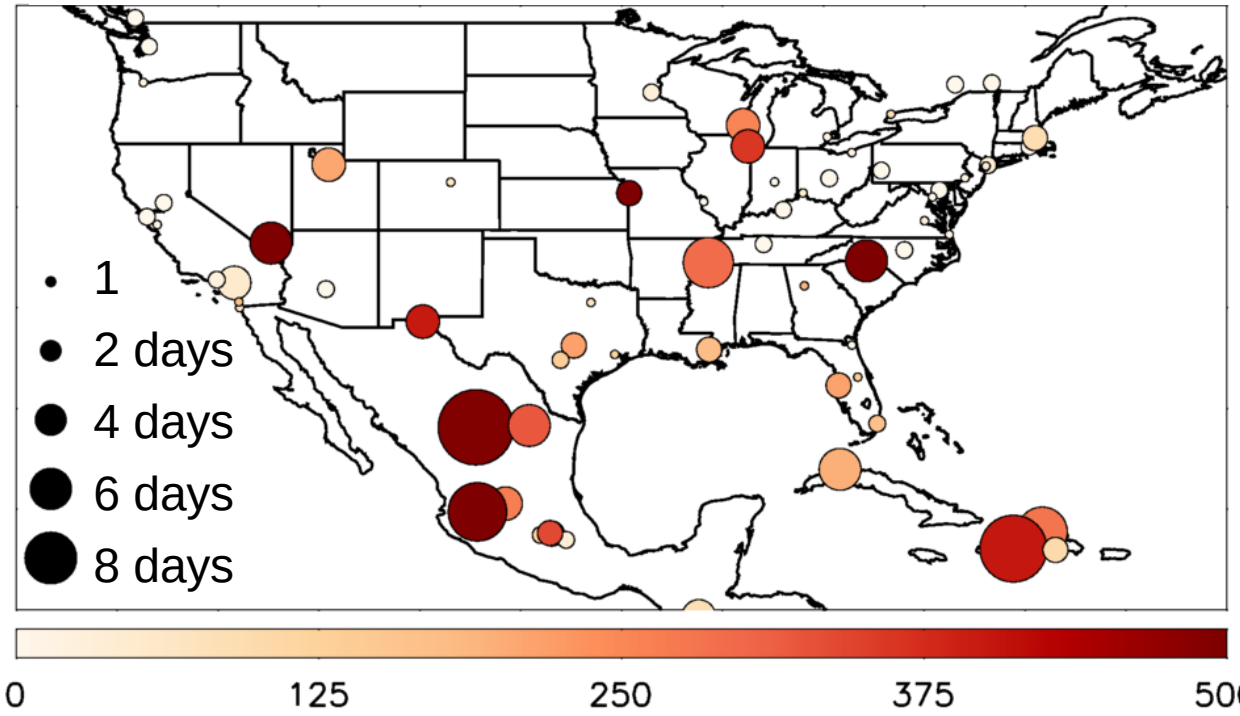


Seasonality matters – and we can't control when we get observations

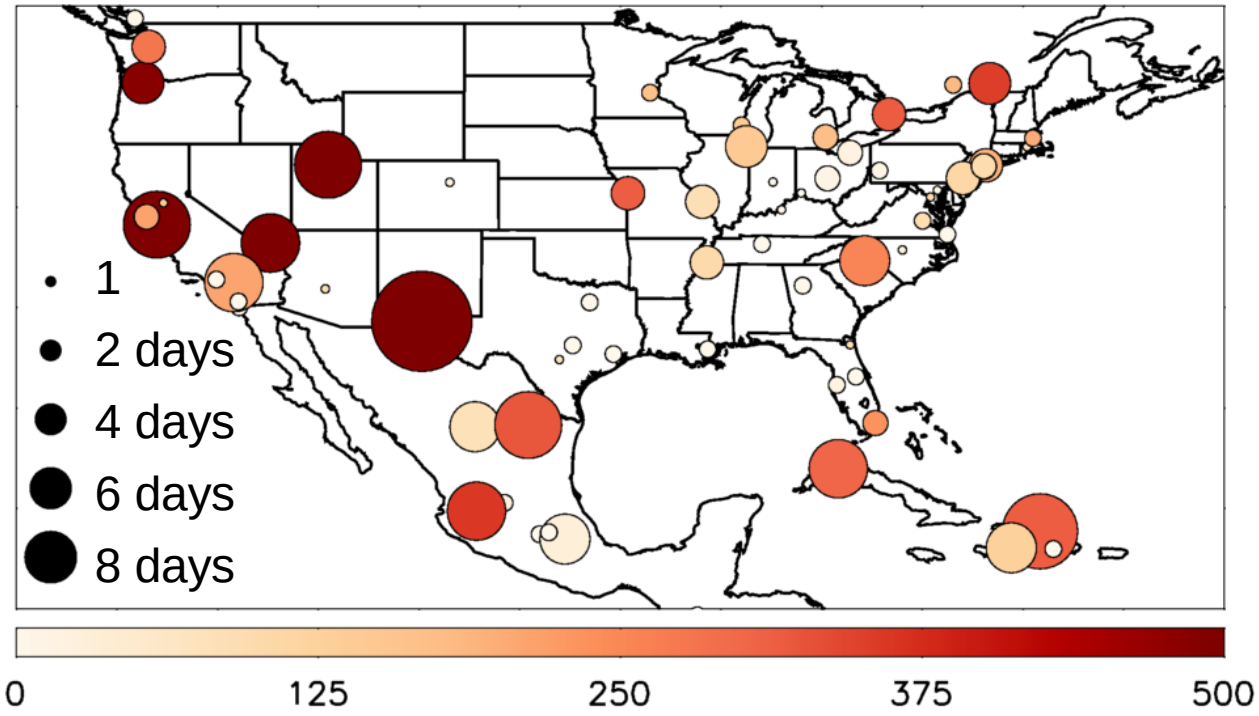
Population density



OCO-2 Observations over NA Cities - DJF, 2016-2018



OCO-2 Observations over NA Cities -JJA, 2016-2018

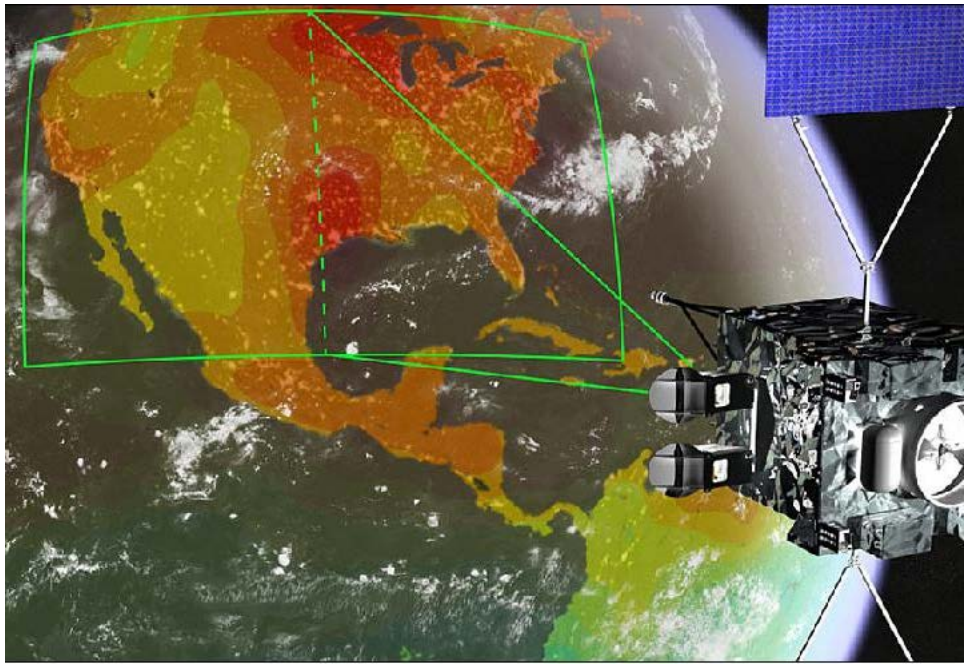


Future satellites will do better by having more chances to observe cities

OCO-3 – On ISS since May, 2019

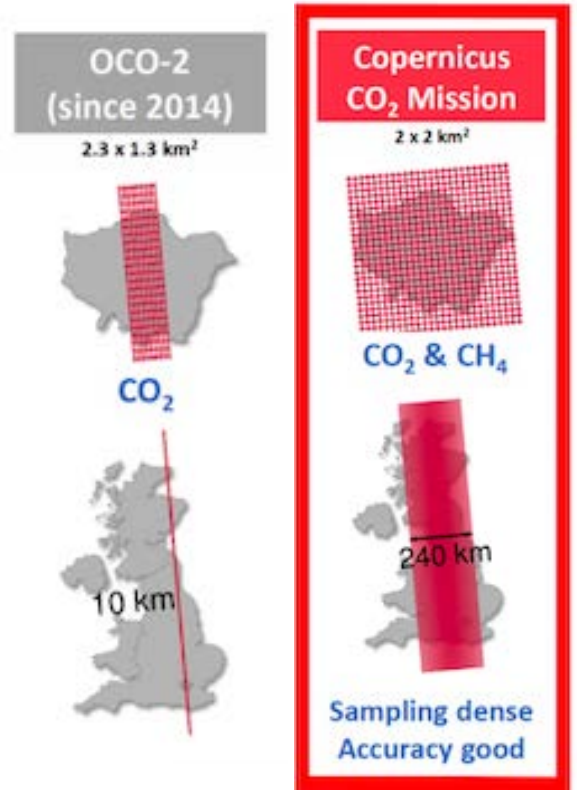
OCO-3's Snapshot Area Mode uses adaptive pointing to obtain denser observations over cities

GeoCarb – Planned launch in 2023



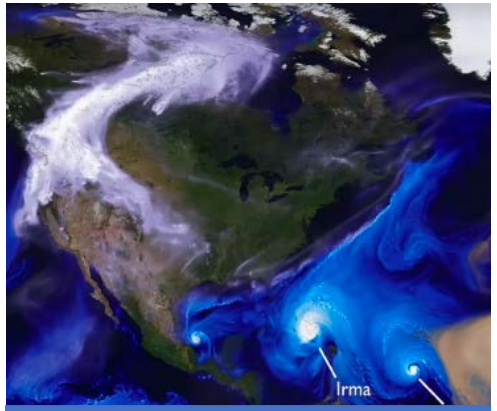
GeoCarb will be the world's first geostationary GHG satellite allowing daily scans over the America

ESA Sentinel 7 – First launch in 2025

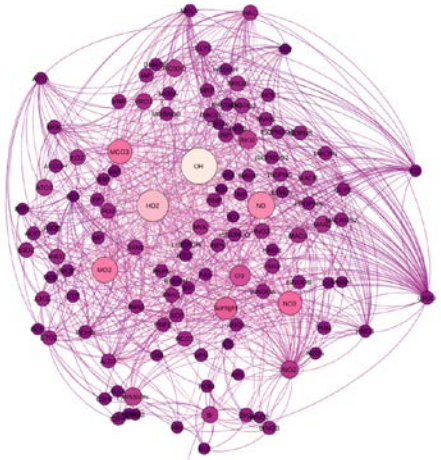


Sentinel 7 will include 3 spacecraft, increase swath width, full coverage every 2-3 days

The case for global models in cities

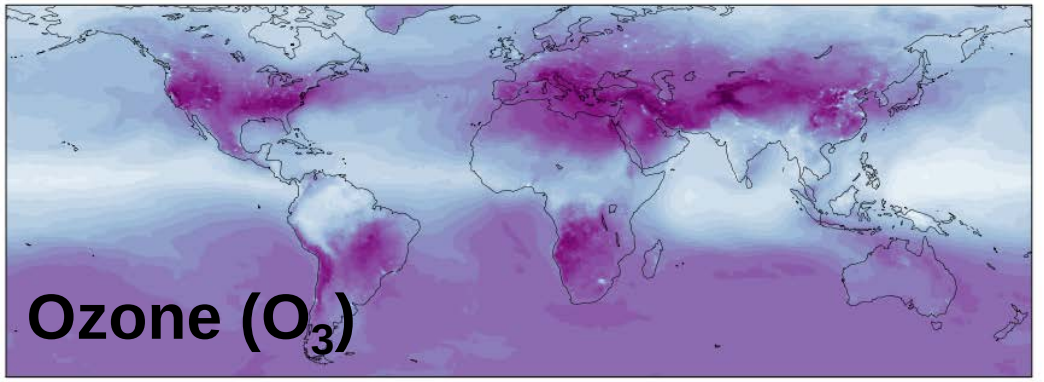


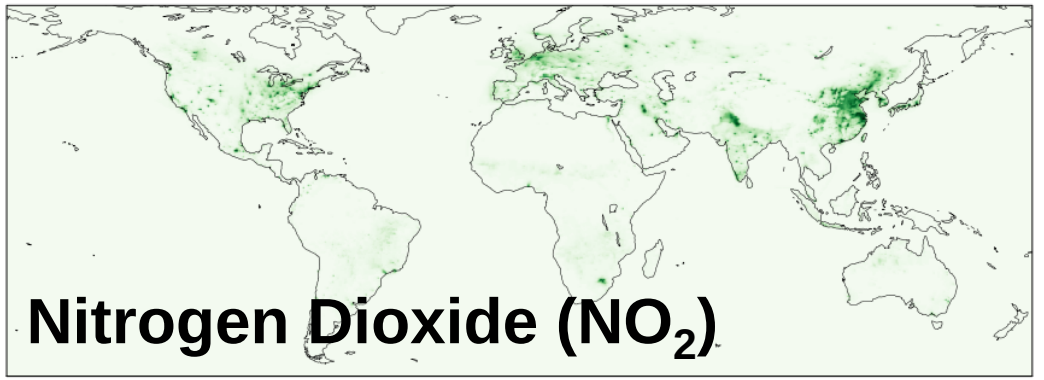
GEOS NWP

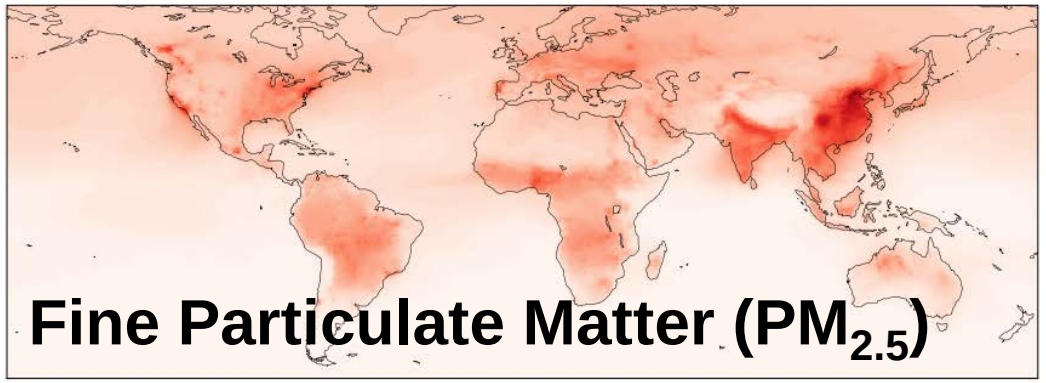


GEOS - Chem

- 250 Chemical Species
- 725 Chemical Reactions







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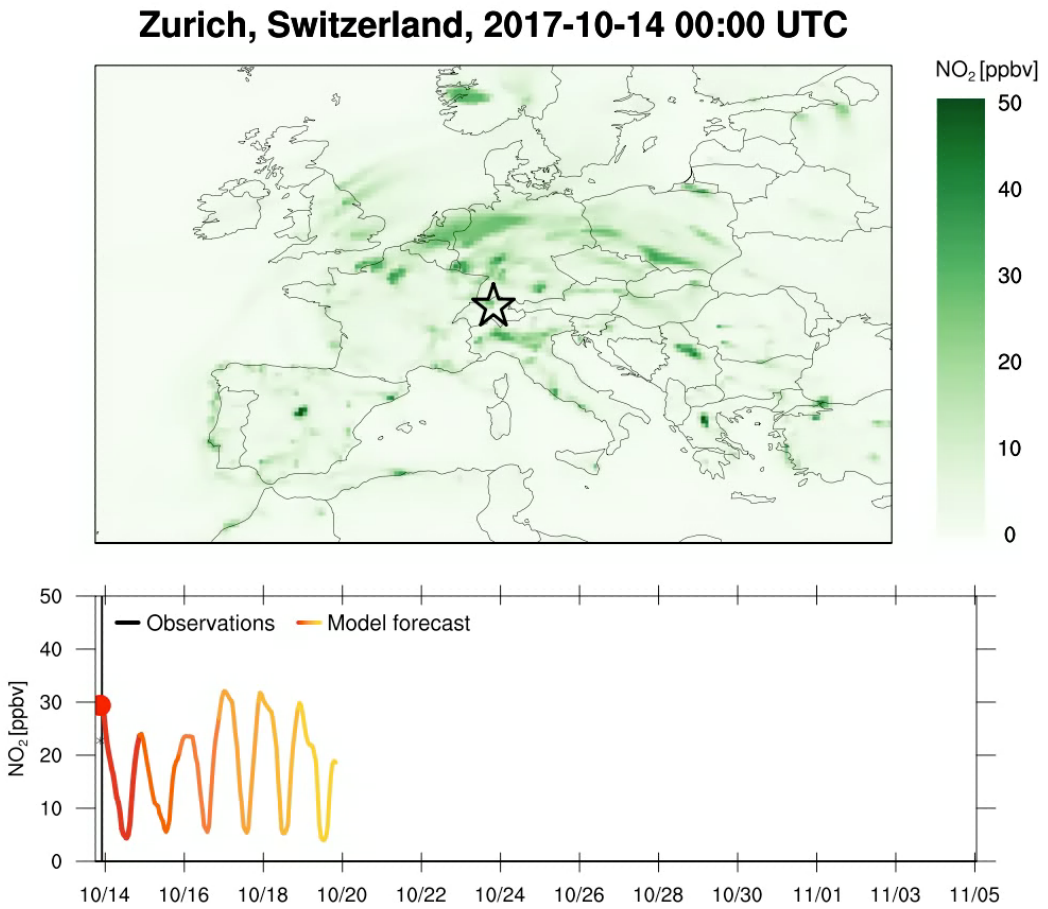
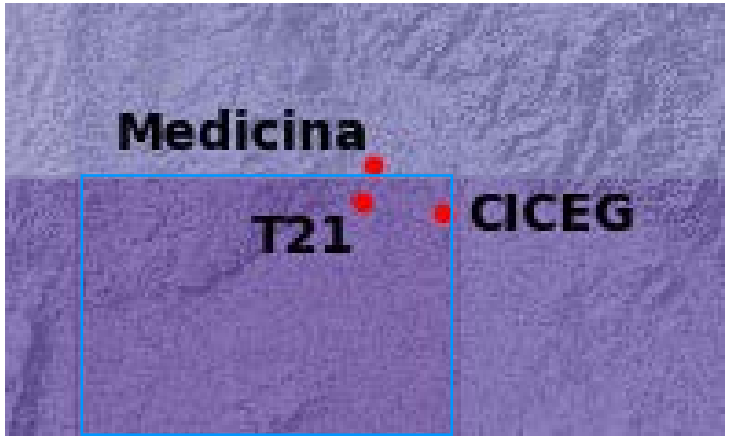
Capturing the impact of traffic over Zurich

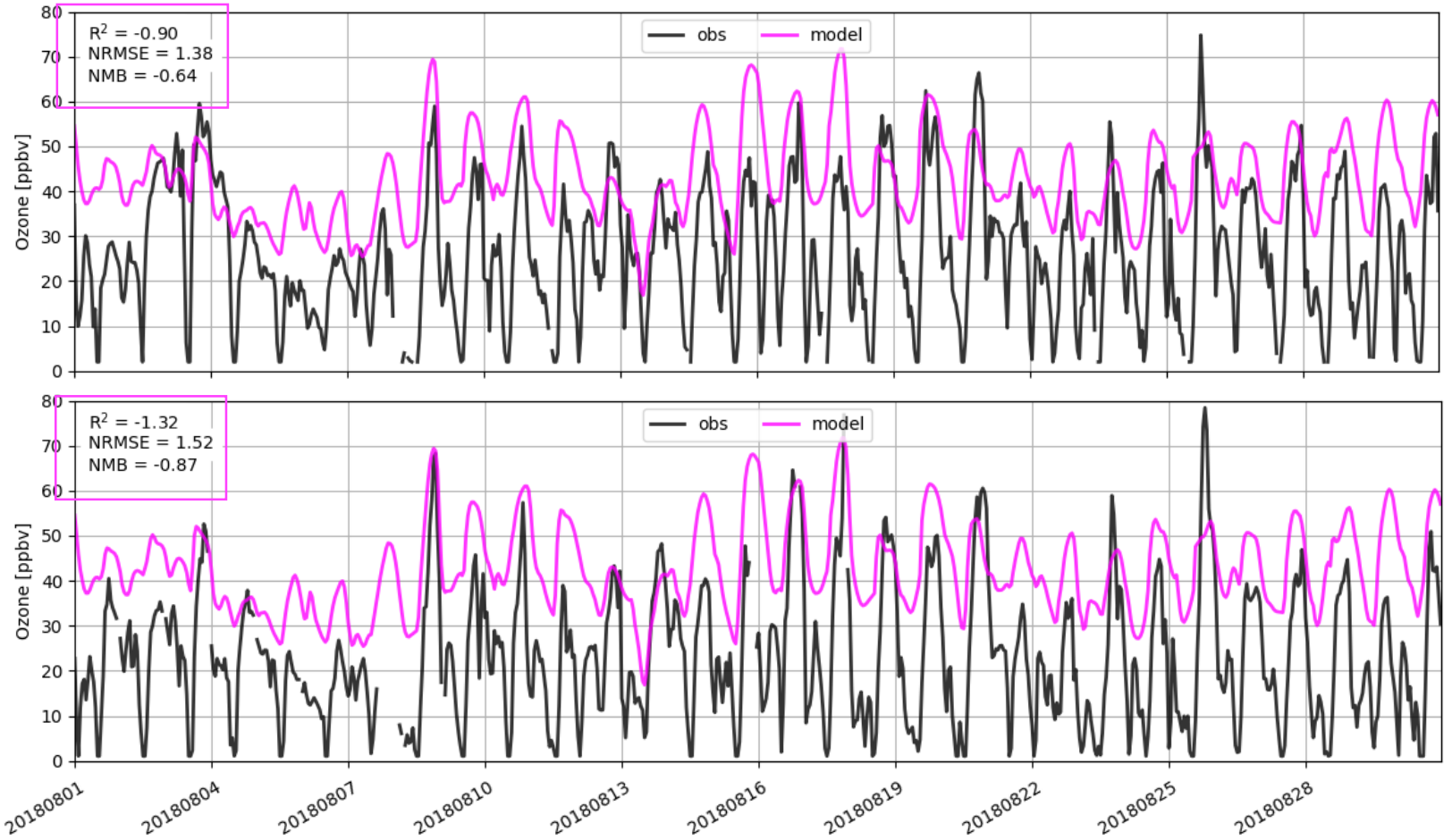


Improve local forecasts using statistical bias correction



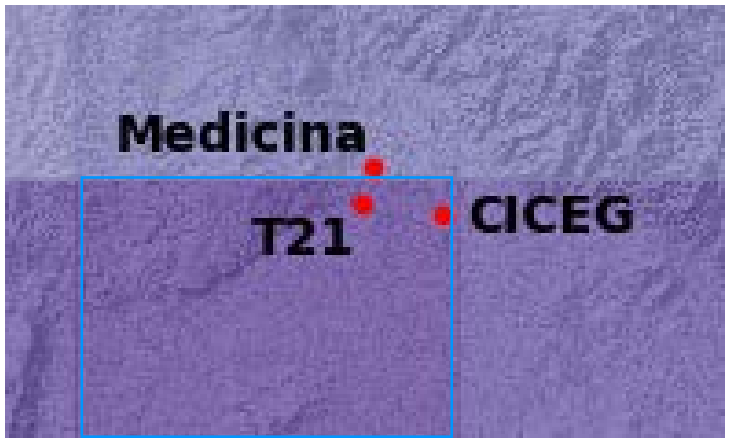
Two observation sites in the same grid box

- GEOS-CF generally over-estimates



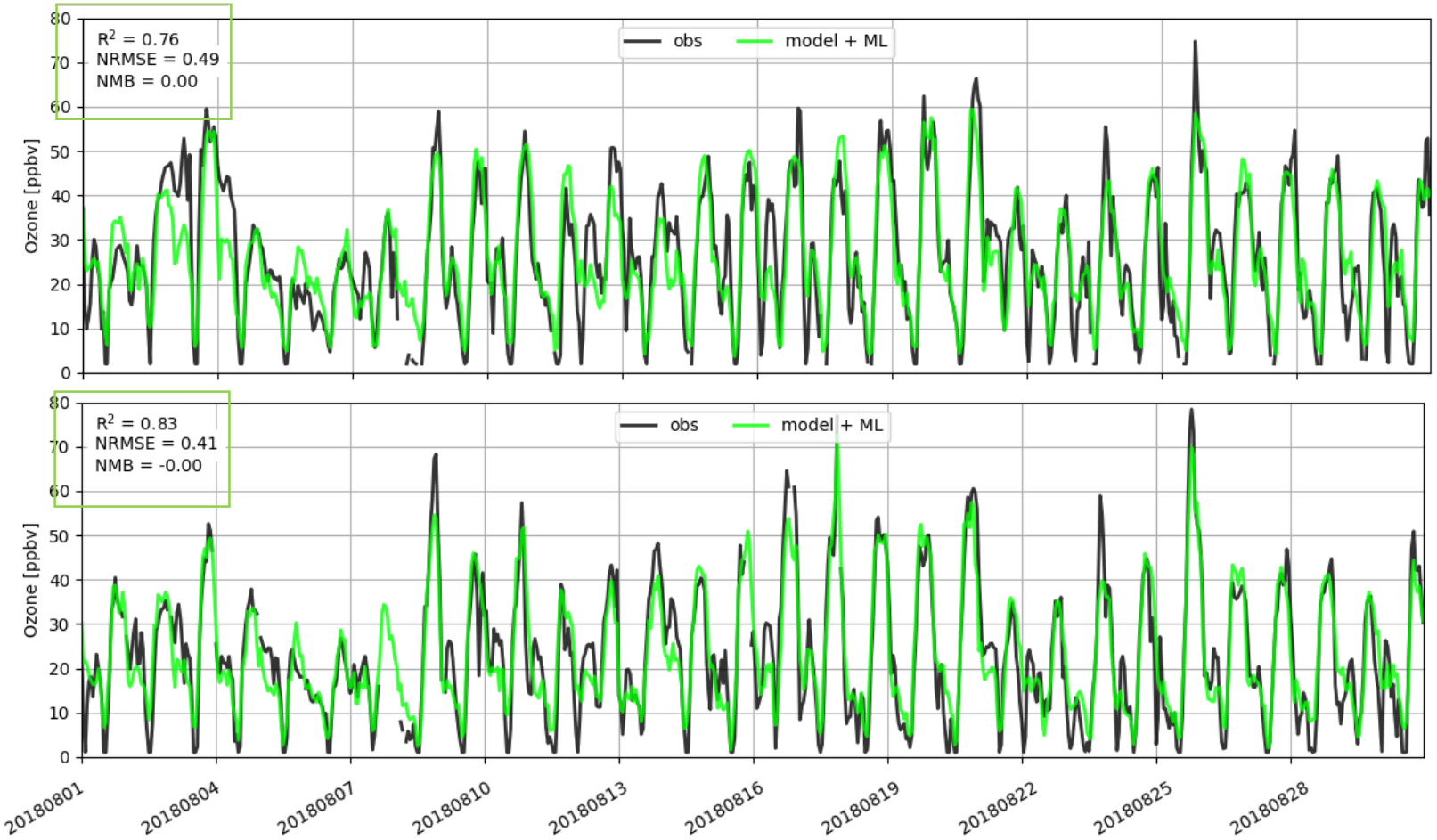
Observations Model

Improve local forecasts using statistical bias correction



Two observation sites in the same grid box

- GEOS-CF+ML captures diurnal variability at sub-grid scale



Observations Model + ML

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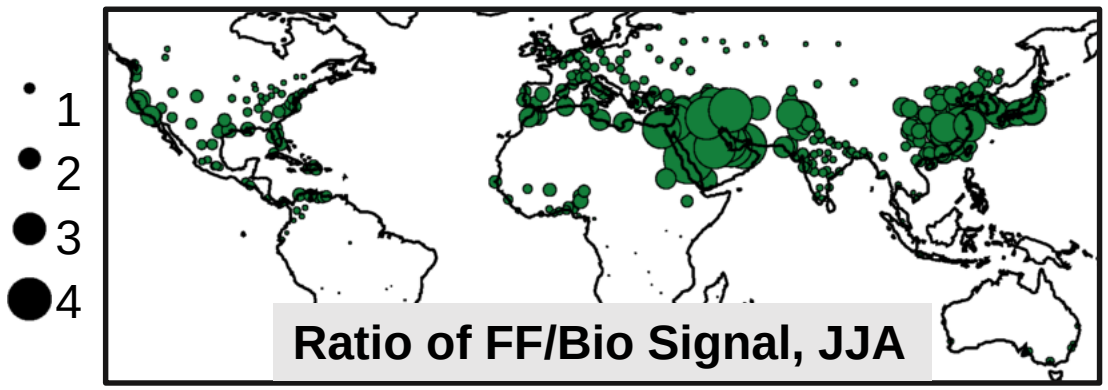
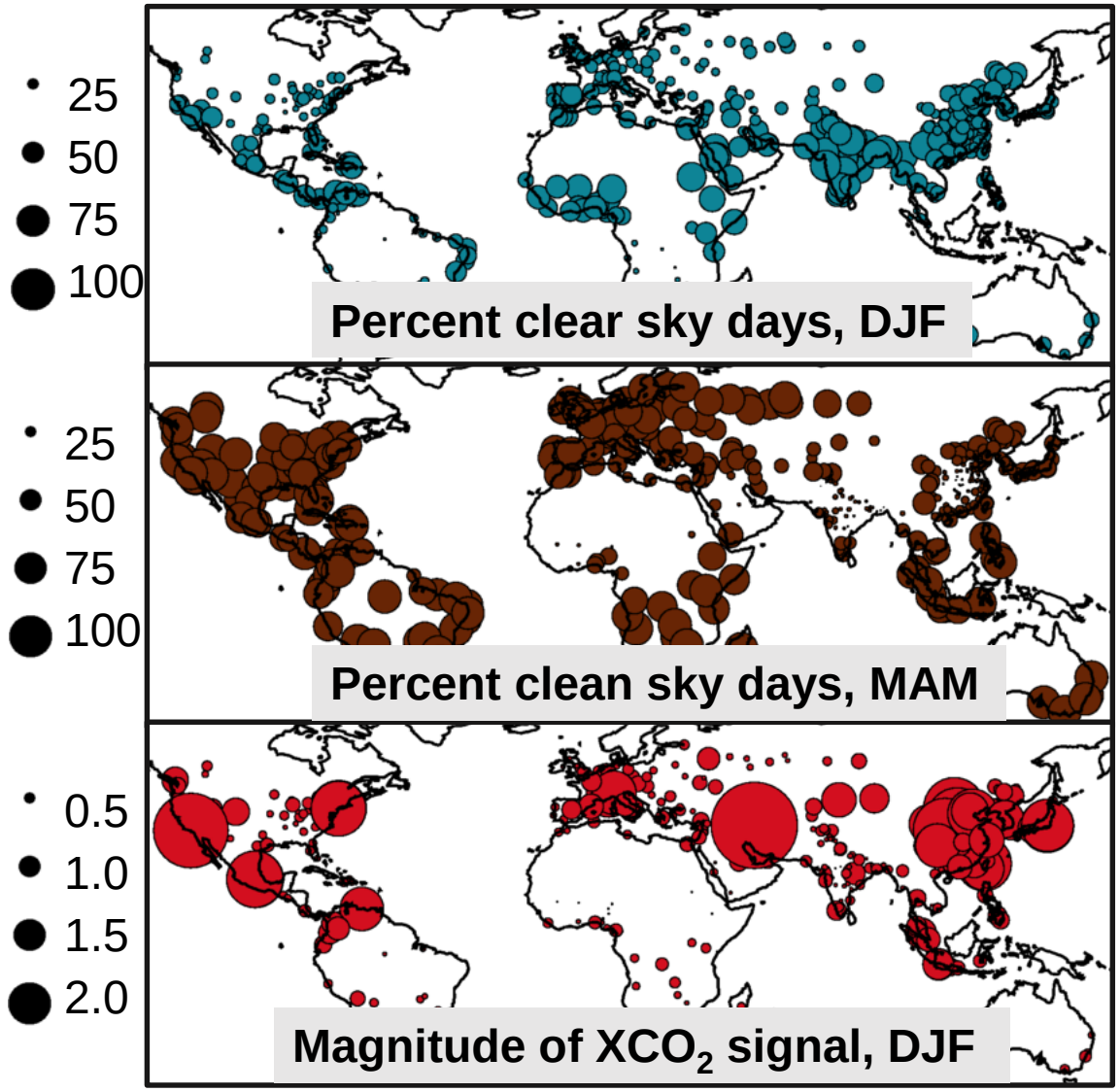
Using modeling tools to plan better observations

Using high-resolution global model runs from GEOS and the flexible resolution OLAM models, we've devised a series of metrics to assess how readily fossil fuel emissions in urban areas could be detected





Summary and next steps

- Satellite XCO2 observations from OCO-2 provide examples of urban CO_2 enhancements, but in most cities only a handful of days contain observations due to clouds and limited sampling opportunities
- Next generation satellites (OCO-3, GeoCarb, Sentinal 7) will provide more opportunities to view cities in support of greenhouse gas monitoring
- Model-based planning tools are helping us plan better observing strategies by identifying cities where we could do a better job – and identifying cities where we don't have a chance
- We're also working hard on global models to make them relevant at urban scales.
- Great opportunities for collaboration
  - Improving regional emission datasets
  - Using global model boundary fields as boundary conditions for regional models
  - Developing strategies for using proxy datasets (CO, NO_2)
  - Machine learning approaches to correct biases