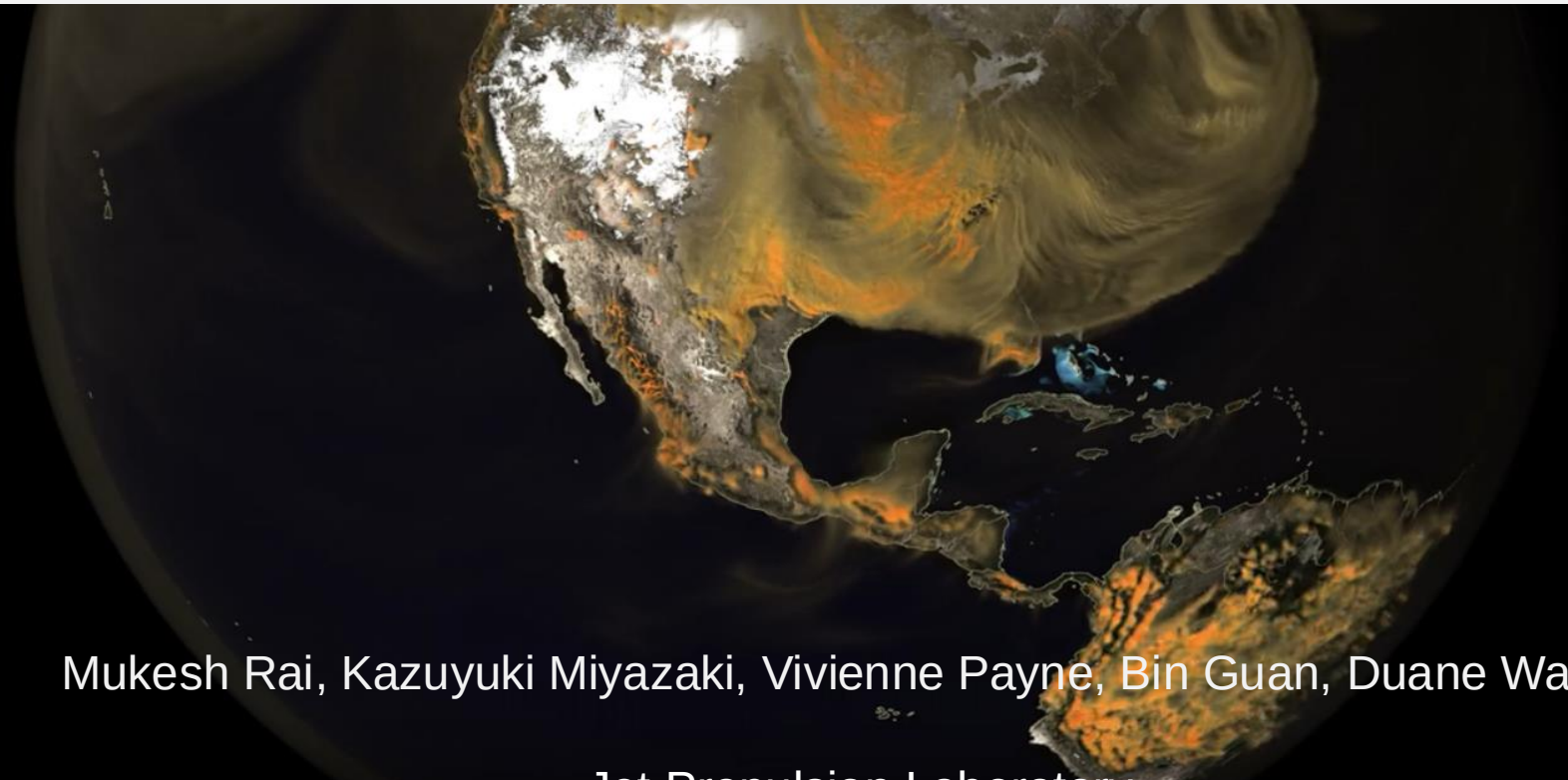
Jet Propulsion Laboratory
California Institute of Technology

# Exploring the role of trace gas atmospheric rivers in extreme air pollution events: Case studies illustrated using TROPESS-CrIS products and TCR-2 reanalysis



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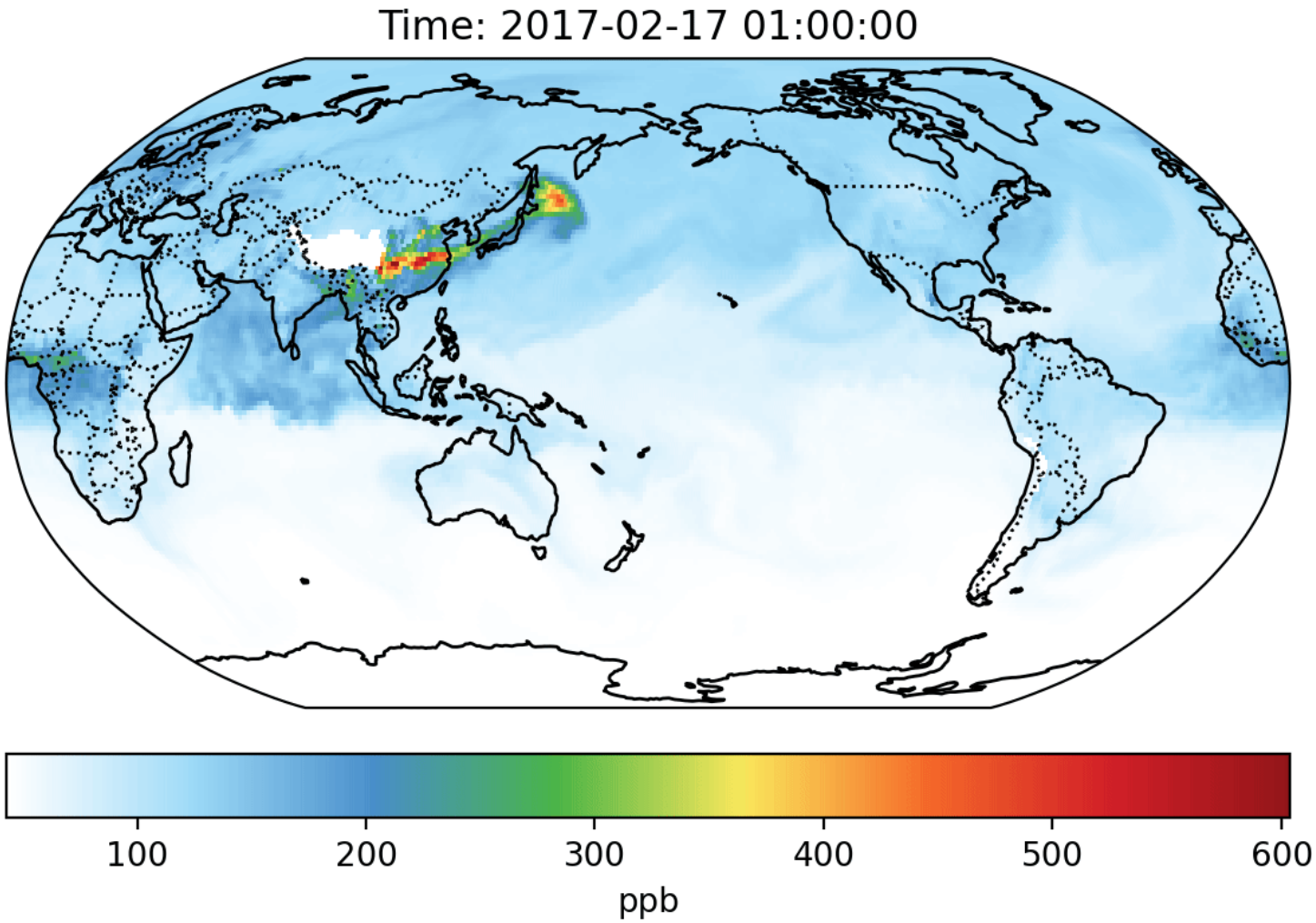
# Motivations

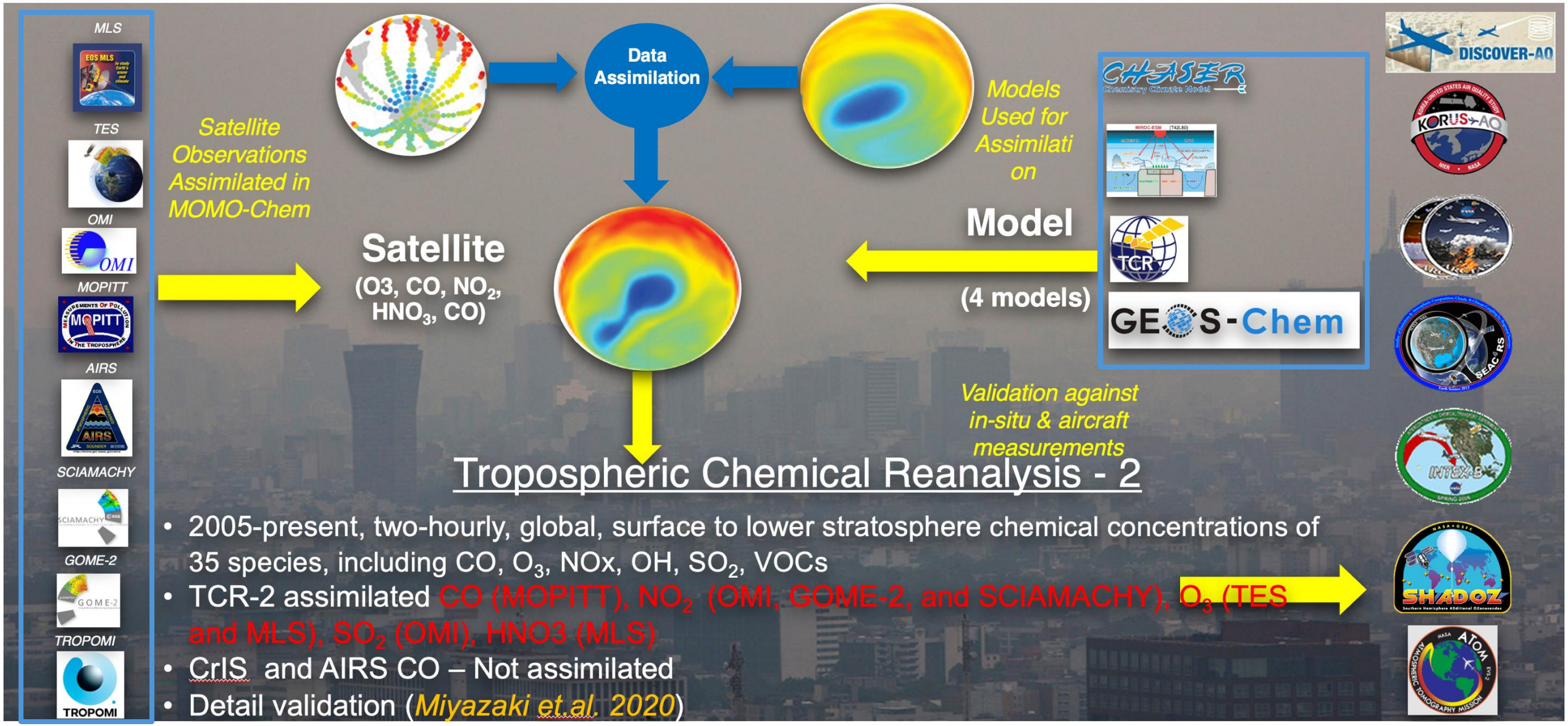
- Air quality in a region is influenced by both local emissions and long-range transport
- How can we characterize the impact of long - range transport on local air quality?
- Introduce new framework - Trace Gas Atmospheric River framework

Vertically integrated (surface-650 hPa) CO data from Tropospheric Chemical Reanalysis version 2



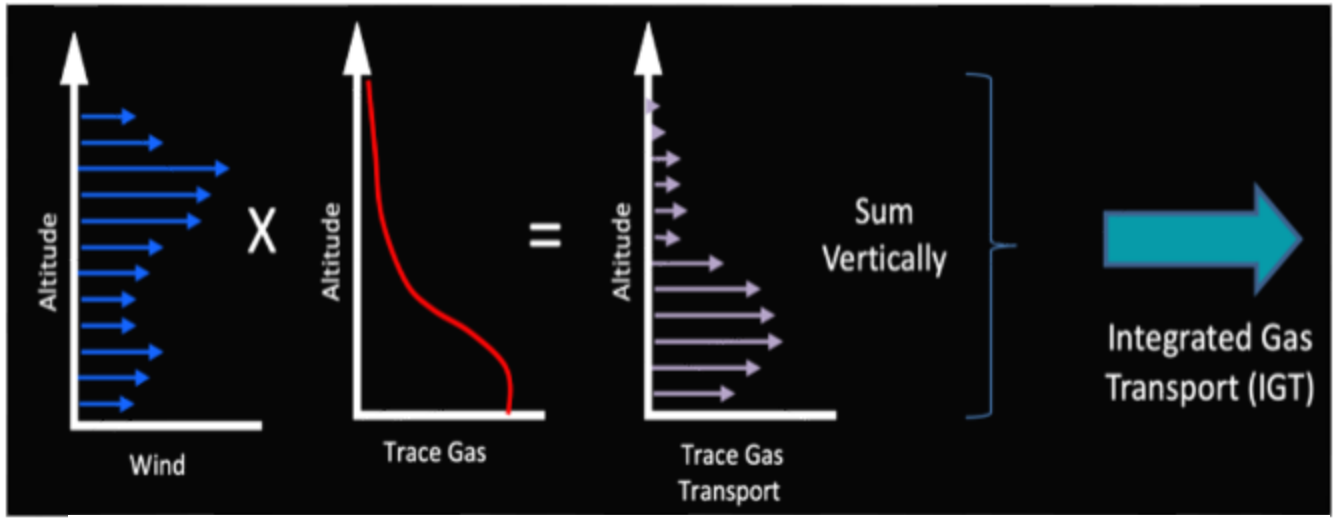
# TROPESS : Tropospheric Chemical Reanalysis version-2 (TCR-2)

## MOMO-Chem (Multi-mOdel Multi-cOnstituent Chemical) Data Assimilation System

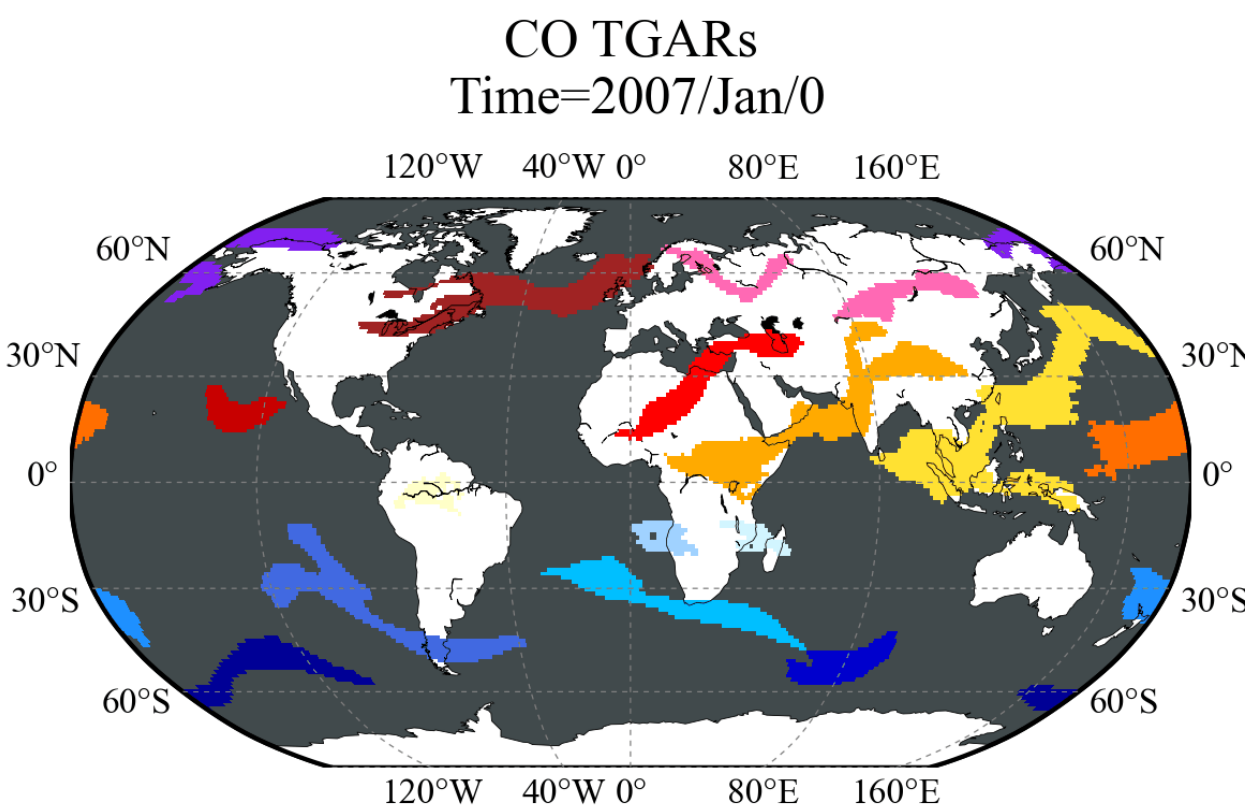


# Integrated gas transport (IGT) and Trace Gas Atmospheric River (TGAR) result from (TCR-2)

IGT calculation approach

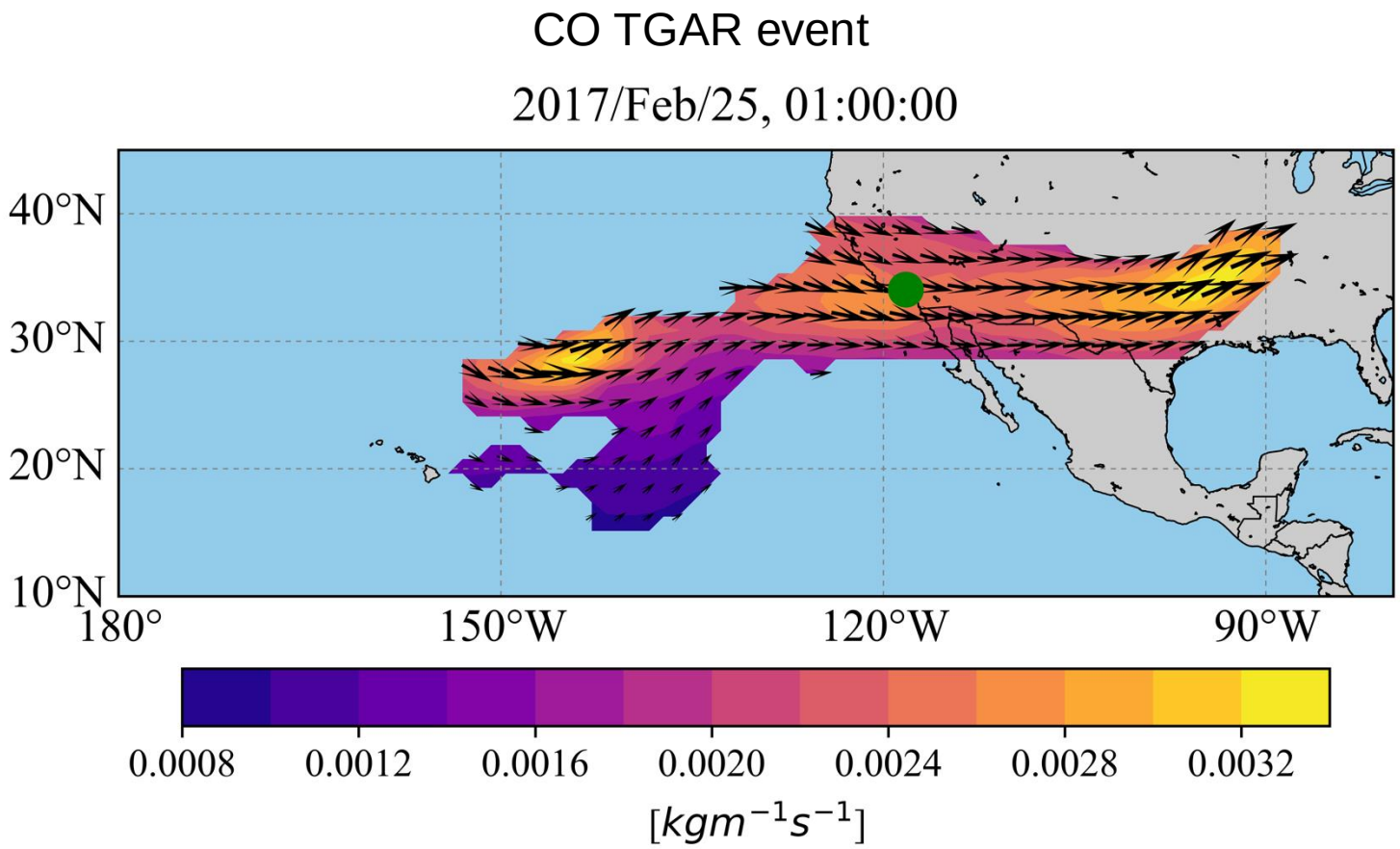



The 3D fields from the chemical reanalysis allow us to look at the integrated gas transport for a given species.



# Introduce the concept of trace gas atmospheric river (TGAR) (*Rai et. al. in prep*)

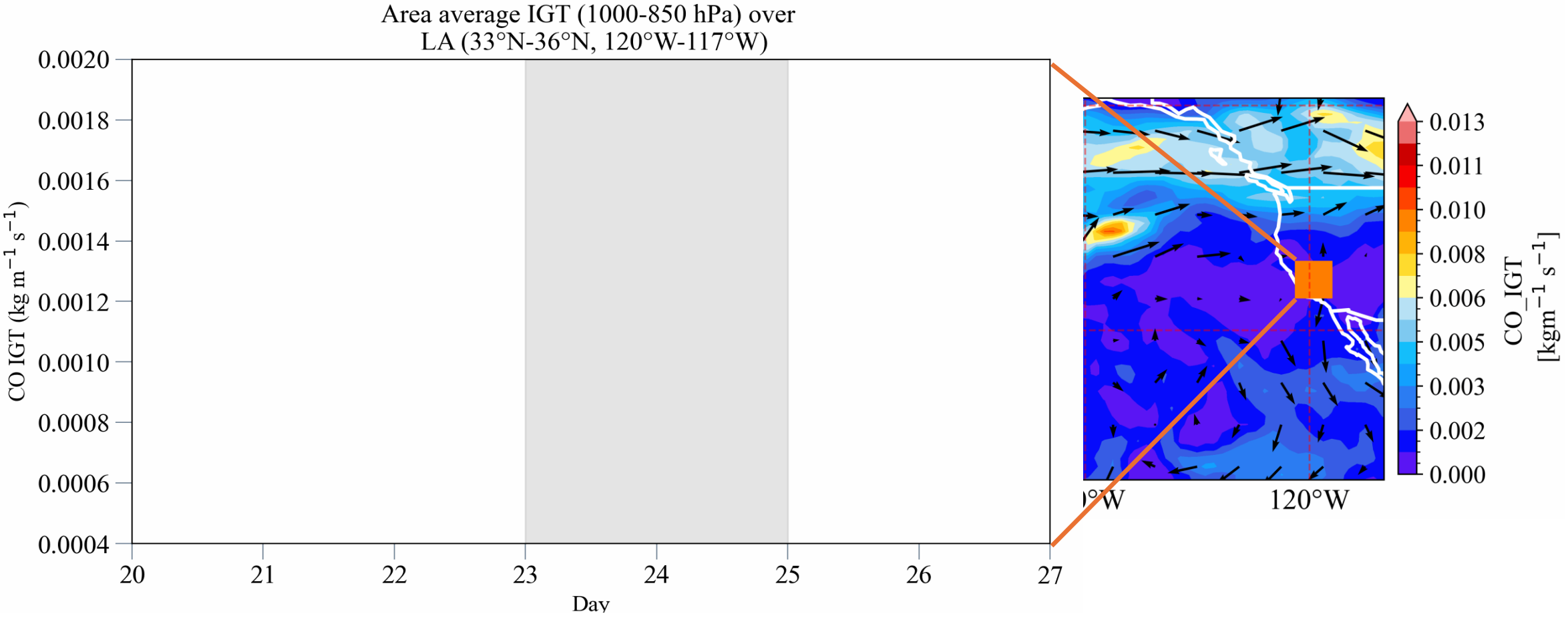
- Adapted and optimized from atmospheric River *Guan and Waliser et.al. (2015)*
- Integrated gas transport can be used to identify “Trace Gas Atmospheric River” events
- Provide climatology, seasonality, long-term change, and characteristics of TGAR




**Did this long - range transport event affect air quality in LA?**
**Ozone and its precursors: CO and PAN**

# Results – Influence of lower troposphere transport

Over LA, lower tropospheric integrated gas transport (IGT) increased CO by 20 ppb and $O_3$ by 6 ppb for simultaneously during TGAR event, suggesting the TGAR impact on air quality



# Additional data

1) **Satellite data (**TROPESS SNPP - CrIS **)**

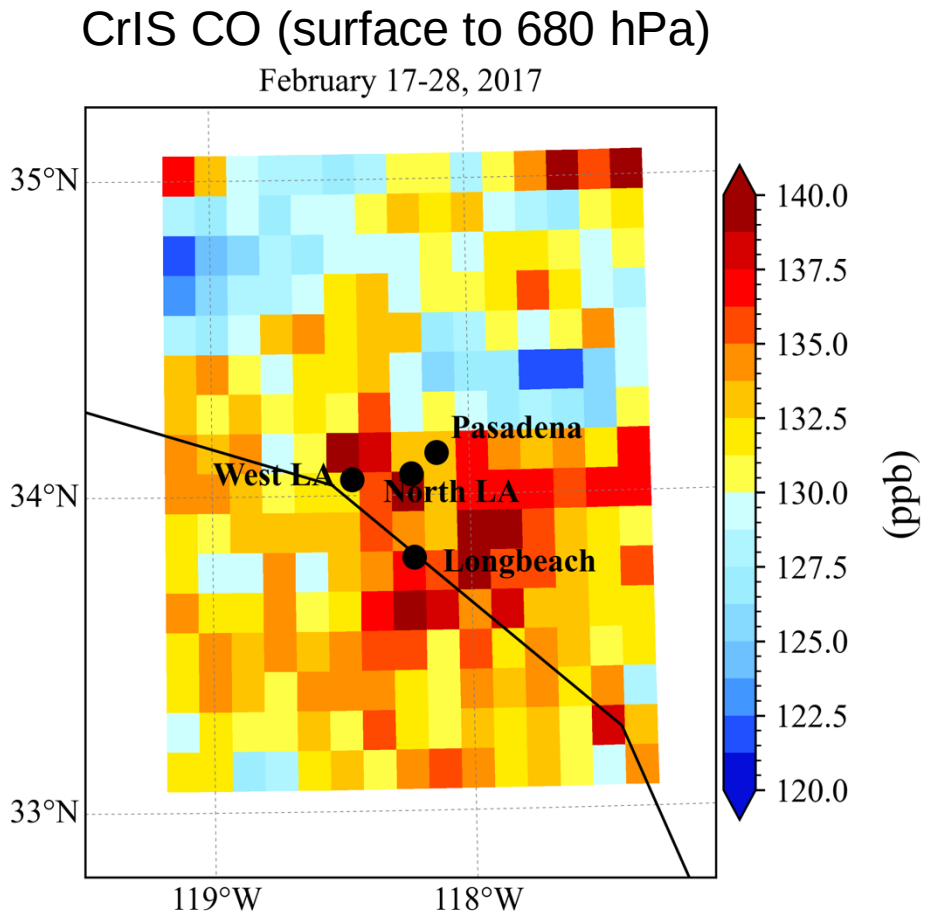
   a) Reanalysis stream (global) – to provide the spatial extent of transport)

   b) Megacity special collection (Los Angeles)

Megacity data

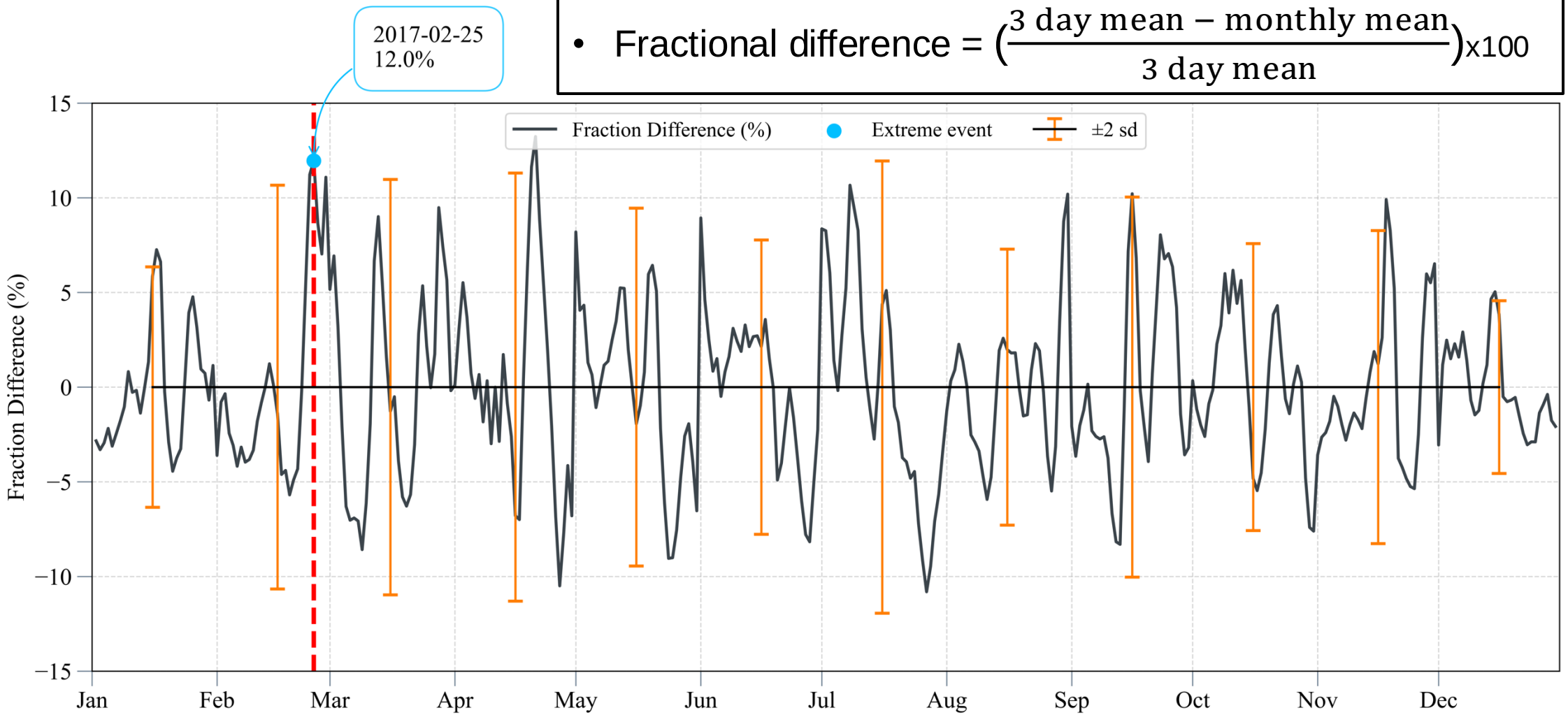
*https://disc.gsfc.nasa.gov/datasets/TRPSYL2ALLCRSMGLOS_1/summary?keywords=tropess%20megacity%20Los%20angeles*

**2) Ground in-situ (EPA)**



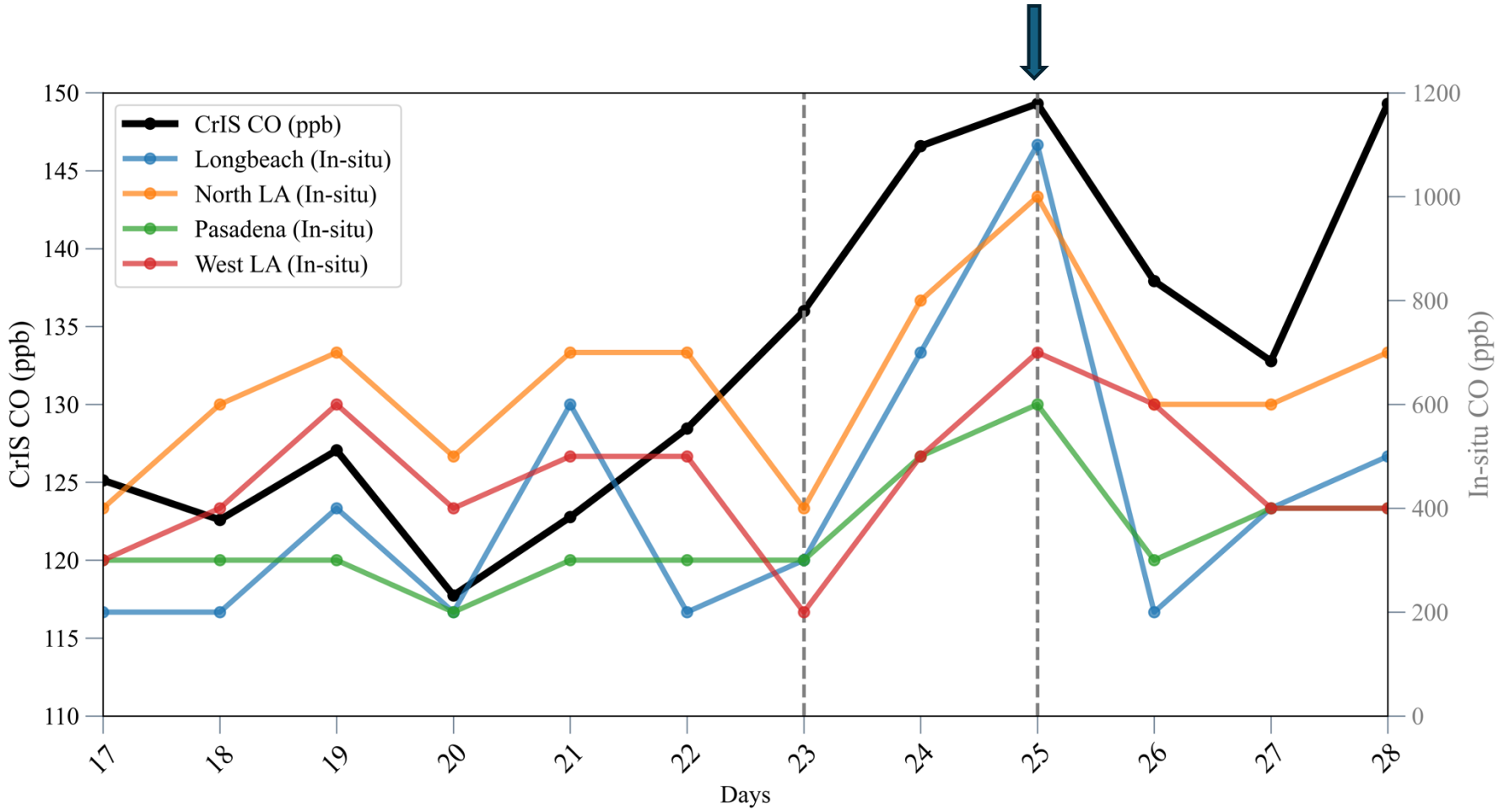
# Time series of satellite-based CO (2017) from megacity collection (Los Angeles)

- Identification of air pollution event
- Fractional difference = $\left(\frac{\text{3 day mean} - \text{monthly mean}}{\text{3 day mean}}\right)$x100



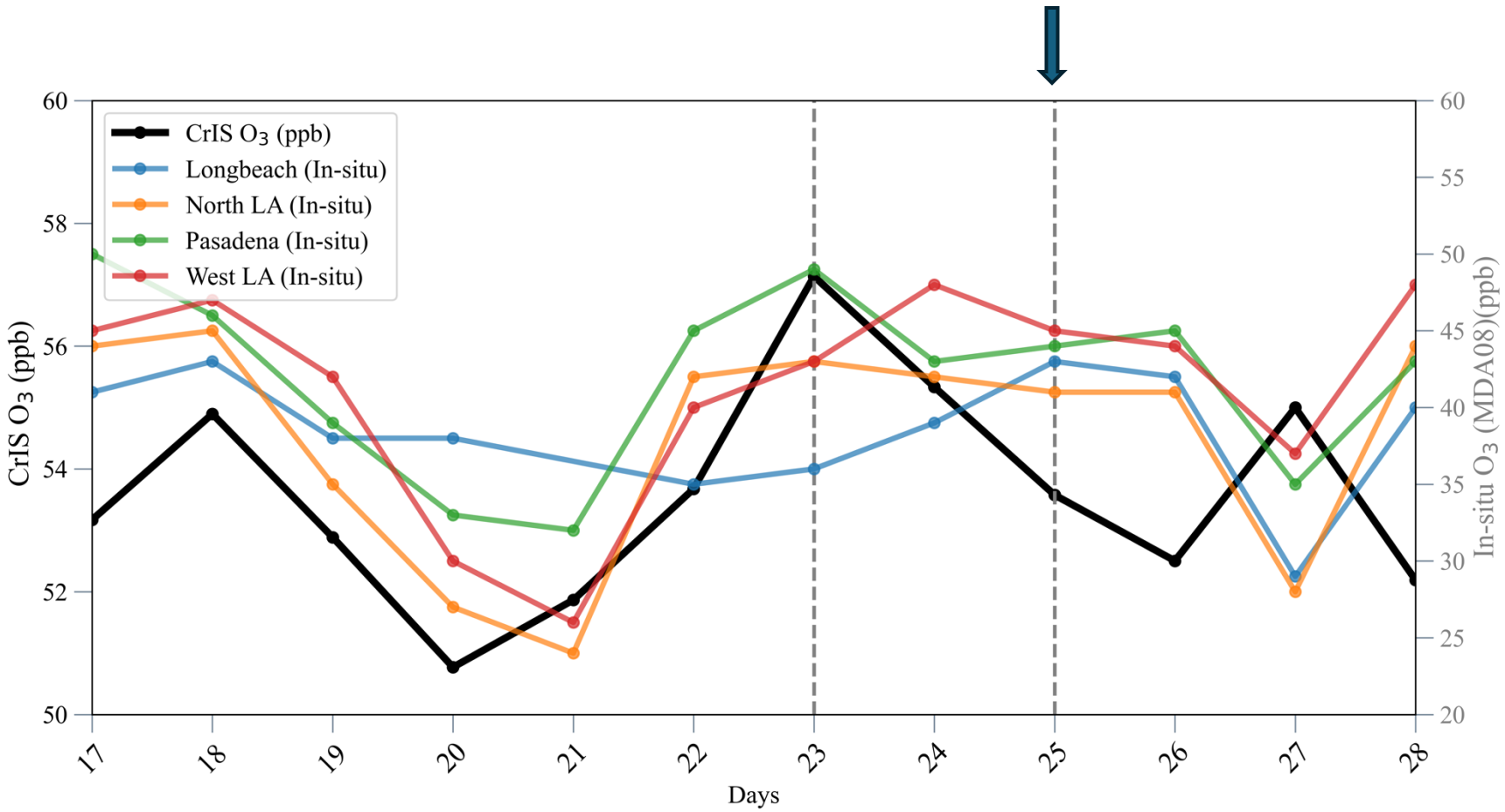
# Results – In-situ and satellite CO (Surface - 680 hPa) concentration in Los Angeles

- In-situ and satellite CO observation shows similar pattern
- During air pollution event, surface CO enhancement



# Results – In-situ and satellite $O_3$ (Surface - 680 hPa) concentration in Los Angeles

The association between long-range transport and surface $O_3$ concentration is less clear for this event



# Summary

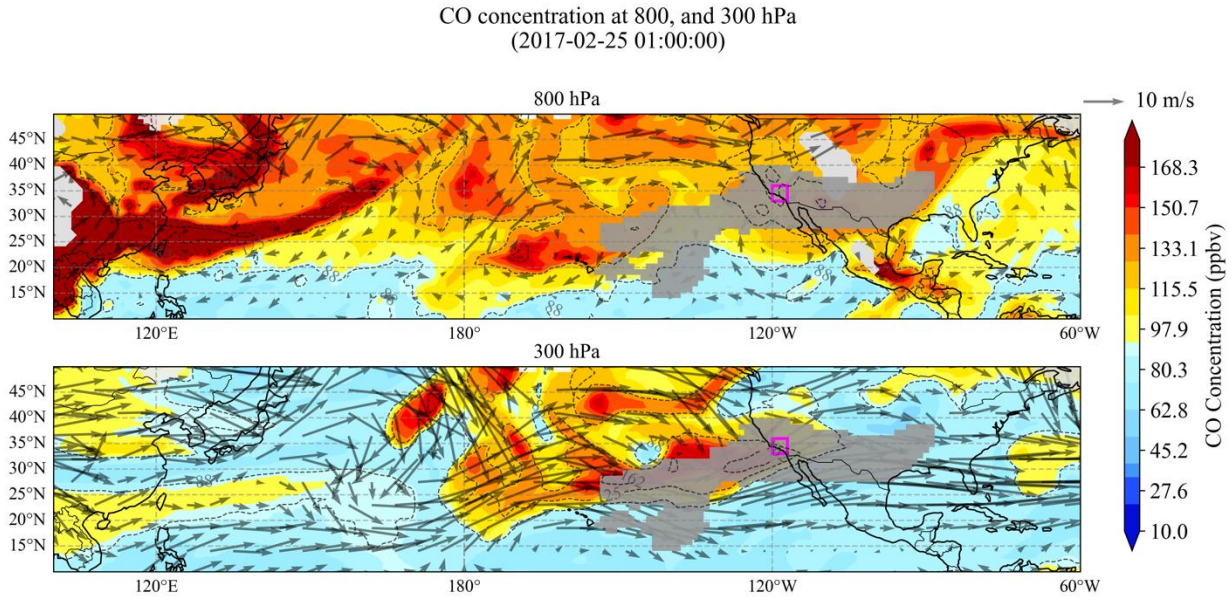
- Introduce  new Trace Gas Atmospheric River (TGAR) framework to examine the impact of long-range transport on local air quality.

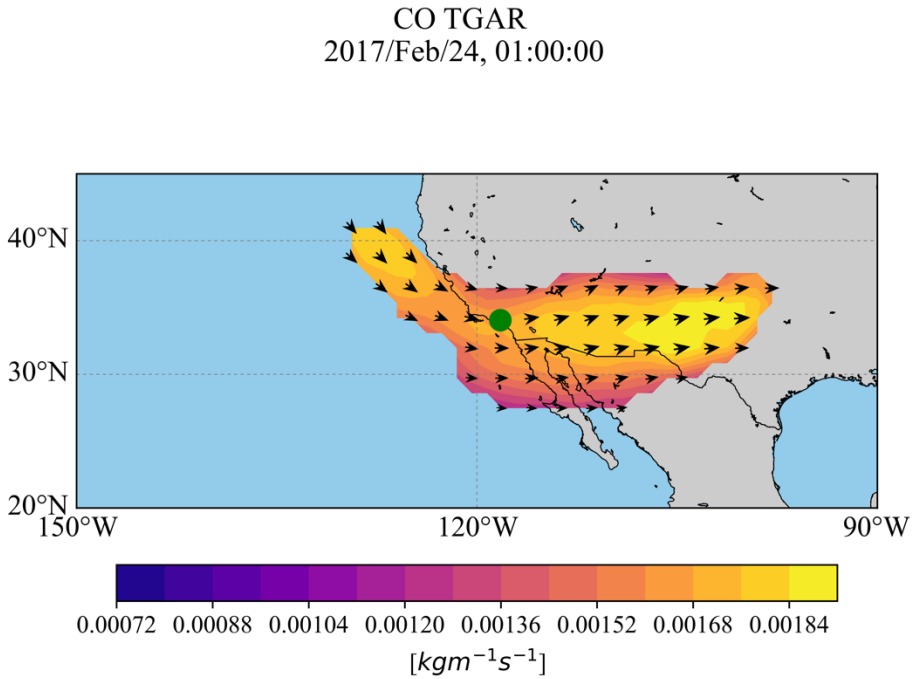
- The CrIS satellite and ground-based in-situ measurements during an air pollution event (Feb 25, 2017) over Los Angeles
    - Reveal elevated CO levels
    - Suggesting that transport event has large impact on local air quality

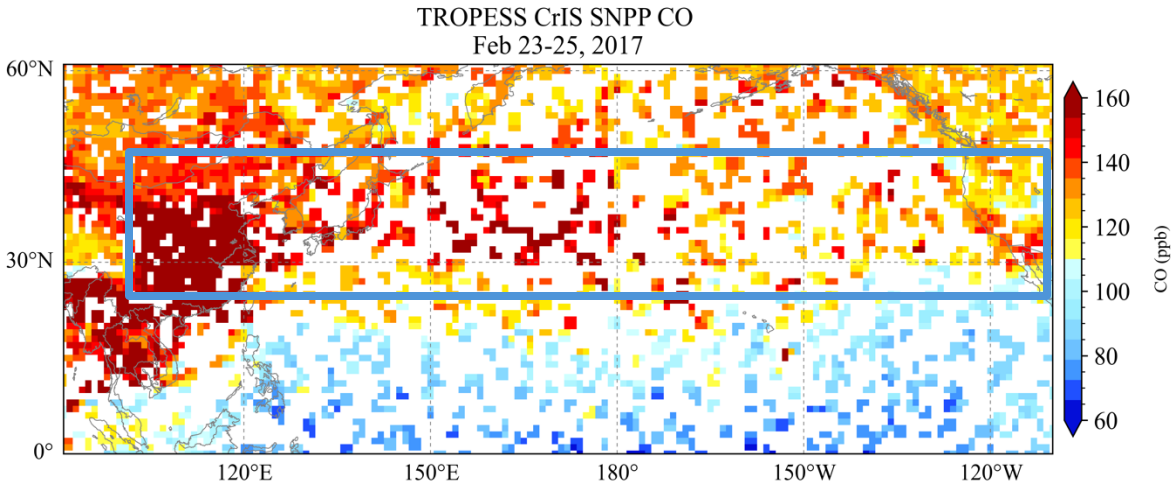
- The impact of long-range transport on surface ozone during this air pollution event is less clear for this event.

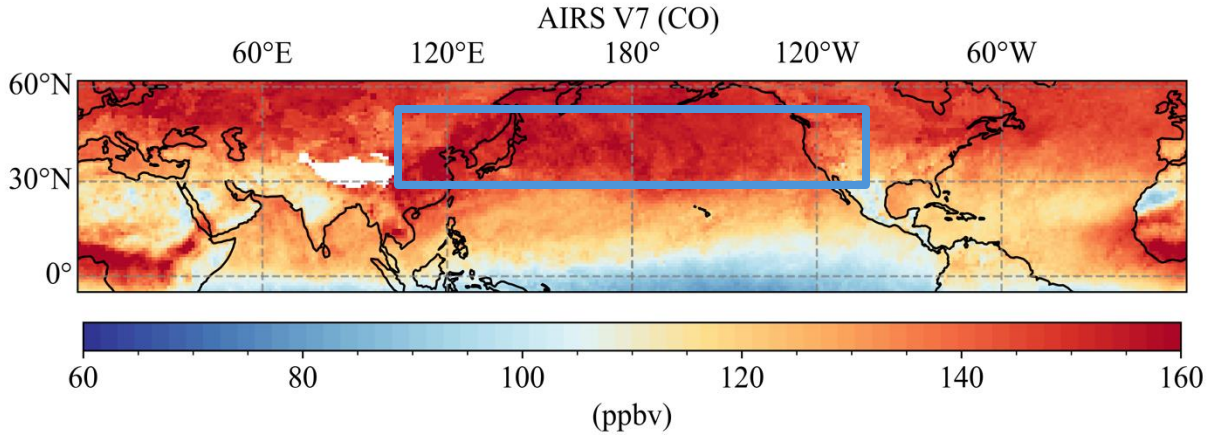
# Thank you

# Backup slides – Spatial map and CO TGAR



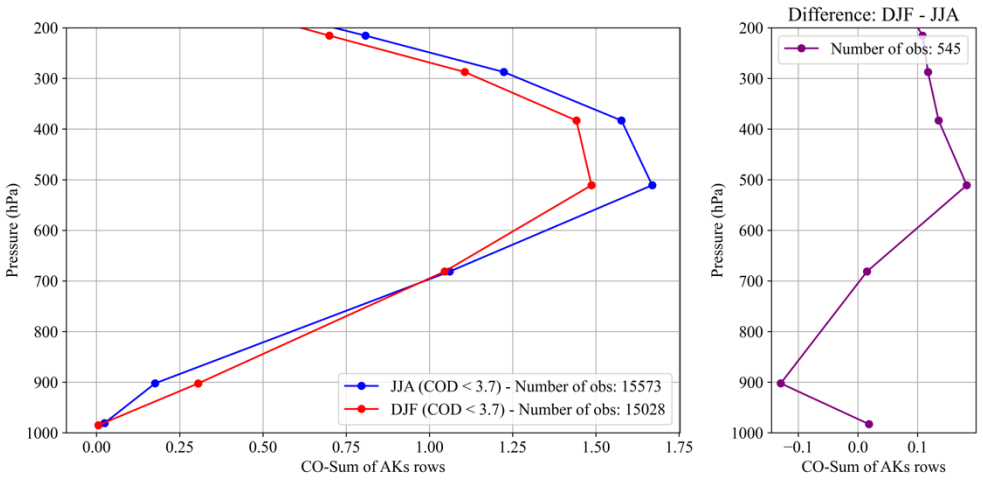



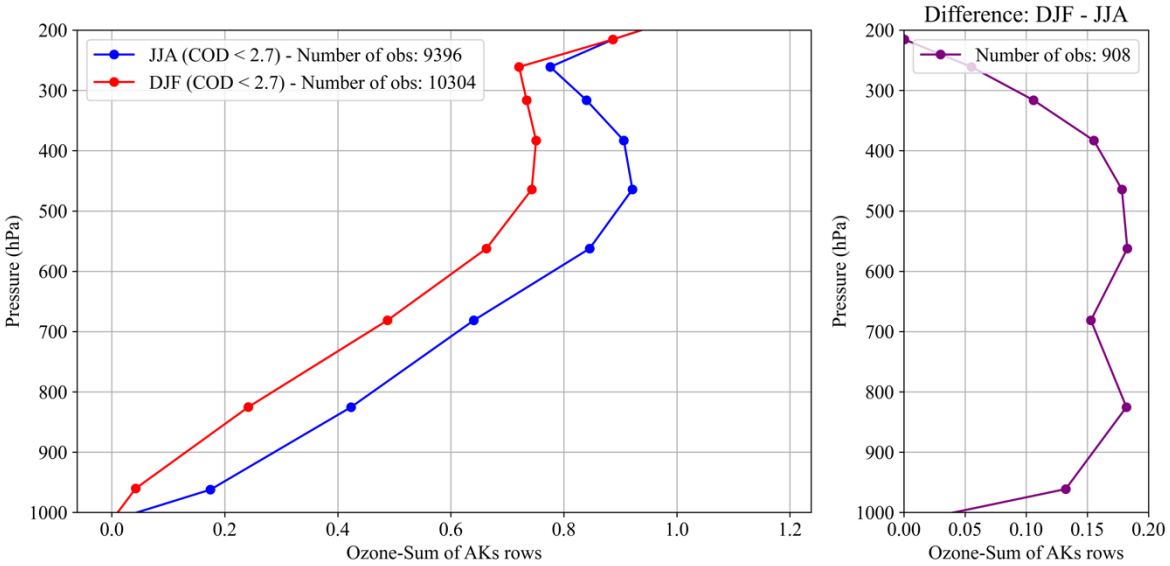



# Backup slides – Averaging Kernel profiles

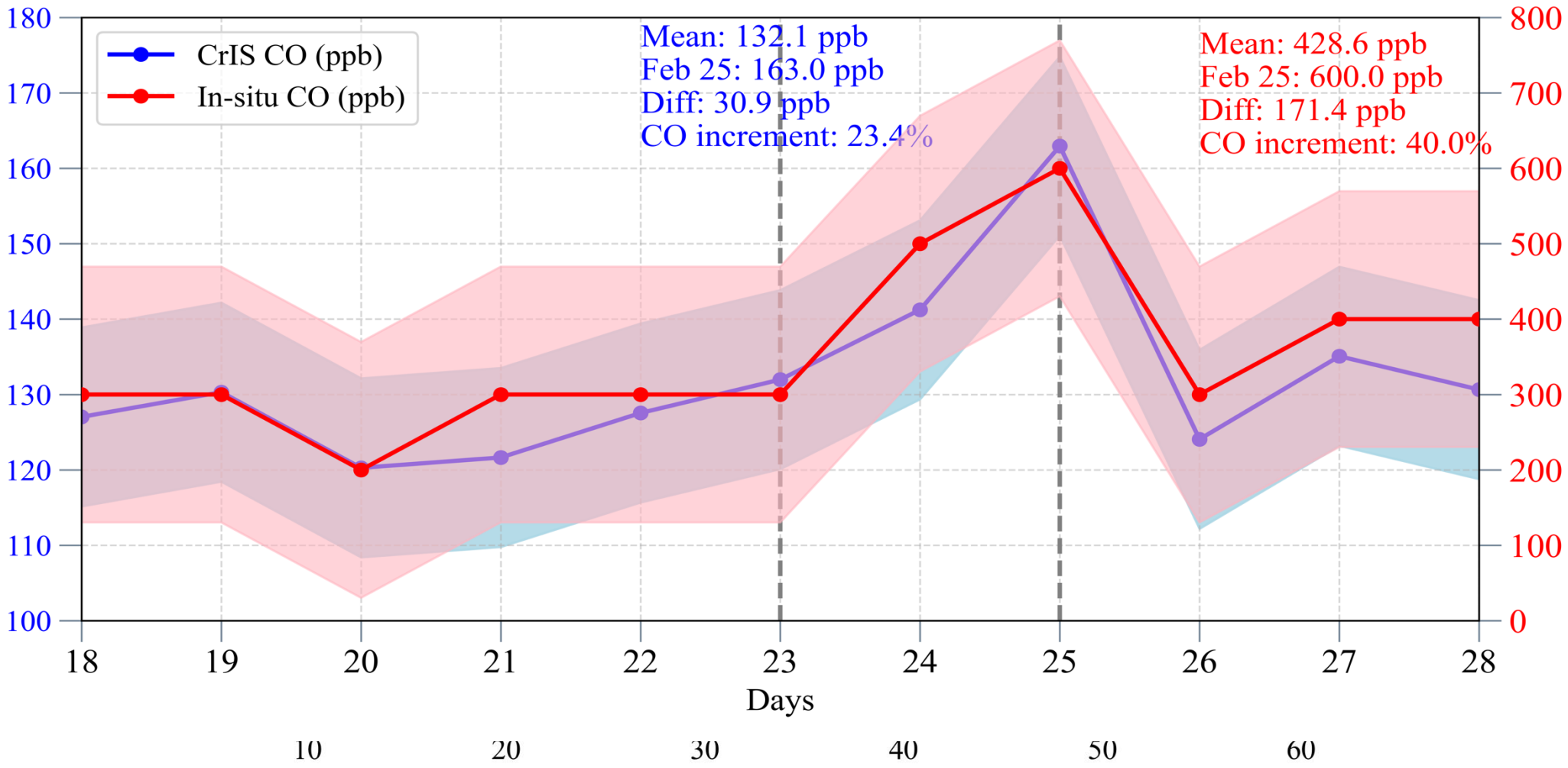
## CO

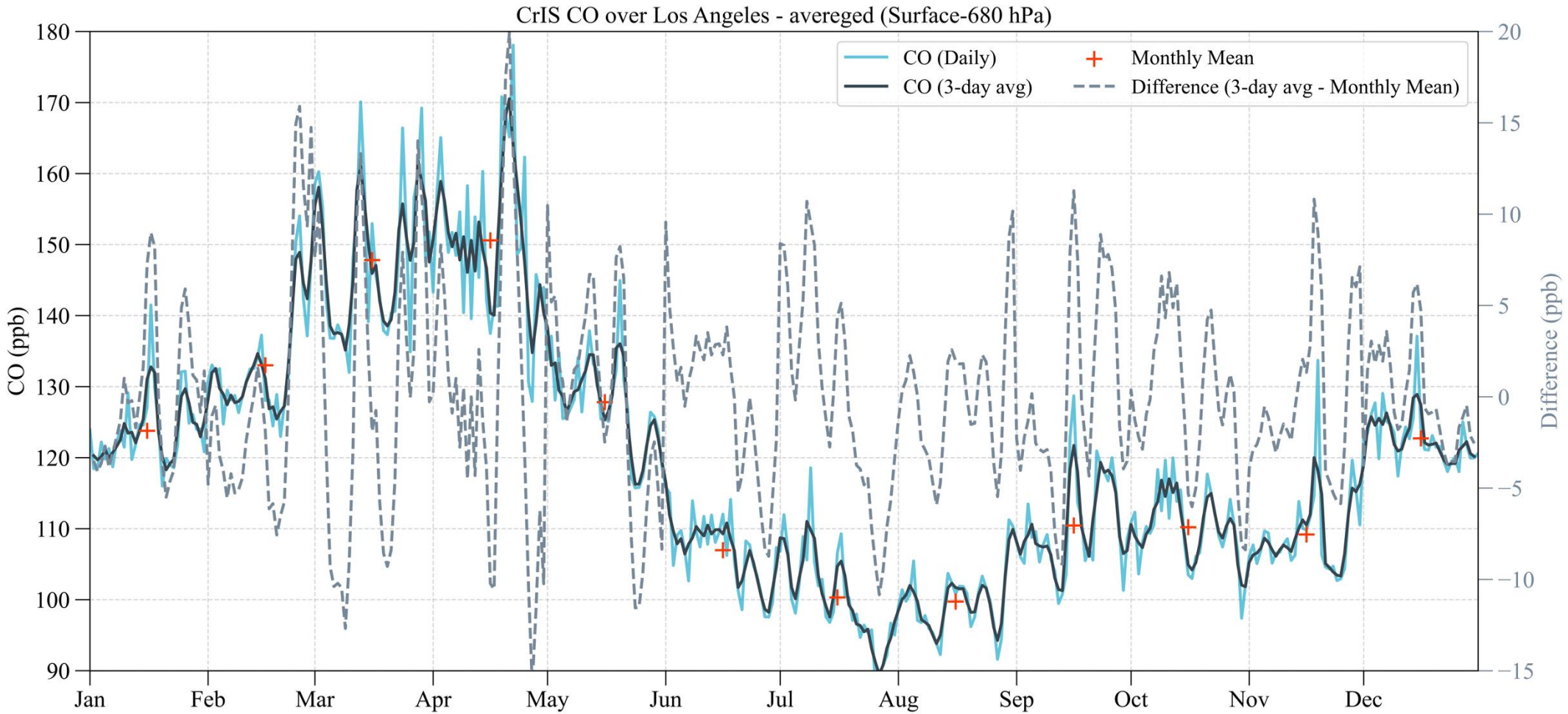



## $O_3$



# Fractional attribution of CO TGAR to total transport from 2005 to 2019




CrIS CO over Los Angeles - avereged (Surface-680 hPa)
CO (Daily)
CO (3-day avg)
Monthly Mean
Difference (3-day avg - Monthly Mean)
CO (ppb)
Difference (ppb)
180
170
160
150
140
130
120
110
100
90
20
15
10
5
0
−5
−10
−15
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec