Jet Propulsion Laboratory
California Institute of Technology

Long range pollution transport and air quality events in Los Angeles: Case studies illustrated using TROPESS-CrIS products and TCR-2 reanalysis

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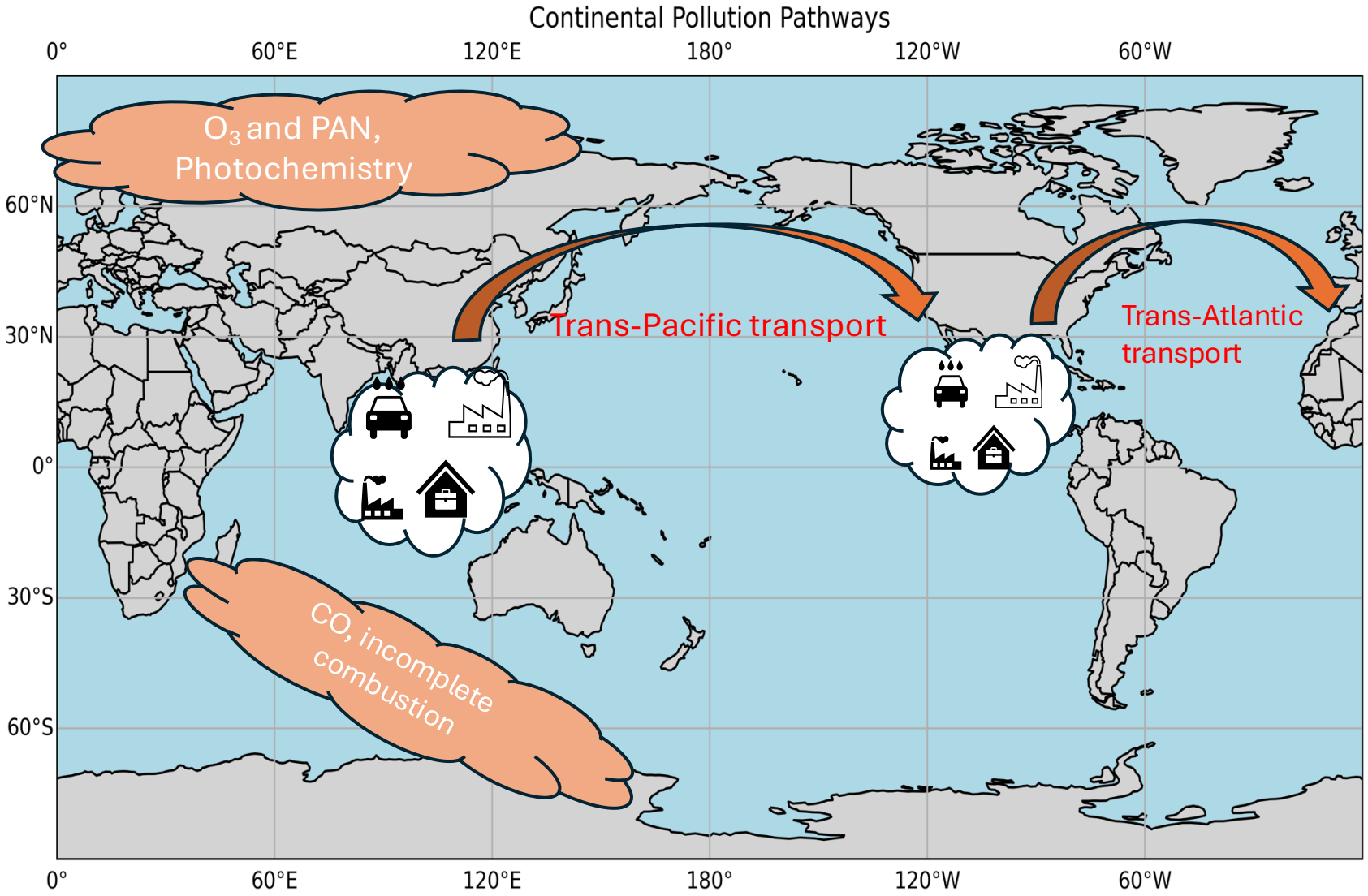
Introduction

- Inter-continental transport (ICT)- transboundary issue – does not respect geo-political boundary. ICT occurs through two mechanisms:
  1) Episodic advection
  2) Increasing the global background, which enhance surface concentration

- Introduced new framework - Trace Gas Atmospheric River (TGAR) framework - detects and measures extreme long-range transport events



Data

1. TRopospheric Ozone and Precursors from Earth System Sounding (TROPESS) CrIS products

- Single field of view (FOV) retrievals from L1B radiances
- TROPESS CrIS products at GES DISC: **CO, O_3, PAN**, CH_4, NH_3, H_2O, HDO and temperature.
  - CO – long lifetime – transport long distance, tracer for studying long-range pollution transport
- **TROPESS CrIS-SNPP L2 for Los Angeles Megacity**
  - All CrIS FOVs processed for 3 by 3 degree box centered on LA, Jan 2016 to May 2021
  - Other megacities also available. See (*Shogrin et al., 2024)*
- **TROPESS CrIS-SNPP L2 for Reanalysis Stream**:
  - **Sub-sampled** global CrIS dataset, Dec 2015 to Dec 2022. Processing underway in batches.
  - Batch 01 dataset at GES DISC: ~4,000 obs/day.
  - Eventual delivery: ~40,000 obs/day

2. Tropospheric Chemical Reanalysis version-2 (TCR-2)

- **Tropospheric Chemical Reanalysis version-2 (TCR-2)** (*Miyazaki et al., 2020a, b*)
  - MOPITT CO products assimilated in the reanalysis. No CrIS or AIRS CO products are assimilated.
- 2005-2021 @1.125°X1.125°
- Global, 6 hourly, 1000-60 hPa

3. In-situ observation data

Ground measurement data downloaded from EPA site (daily max - 8 hr)

Approach

1 . Identify time periods of extreme pollution over Los Angeles

- Utilized TROPESS CrIS megacity standard product
- Calculated 3 days mean and monthly mean, take the difference and divided by days average to calculate fractional difference

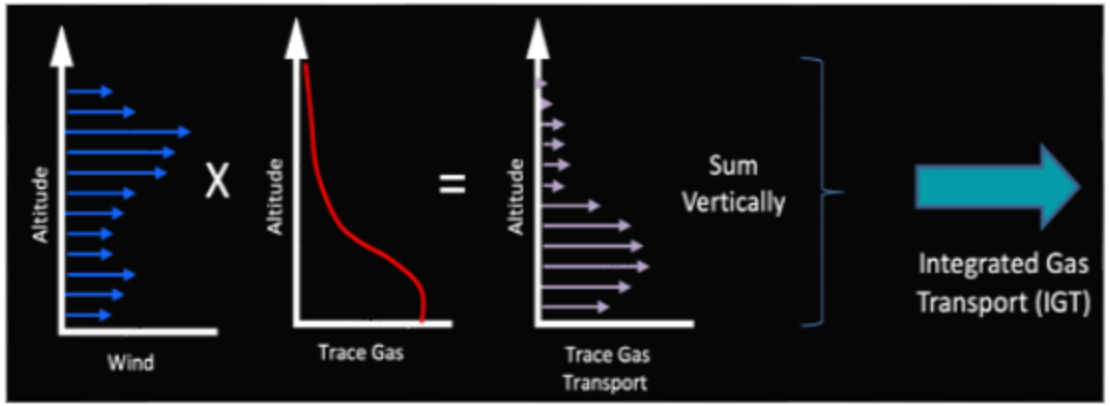
2. Examine horizontal and vertical structure of pollution transport

- Utilize TCR-2 chemical reanalysis fields
- Computed mass flux in the zonal and meridional directions to compute integrated gas transport (IGT) values for trace gas at each grid.

3. Identify long-range transport event

- Trace Gas Atmospheric River (TGAR) framework (*Rai et al., in prep*)

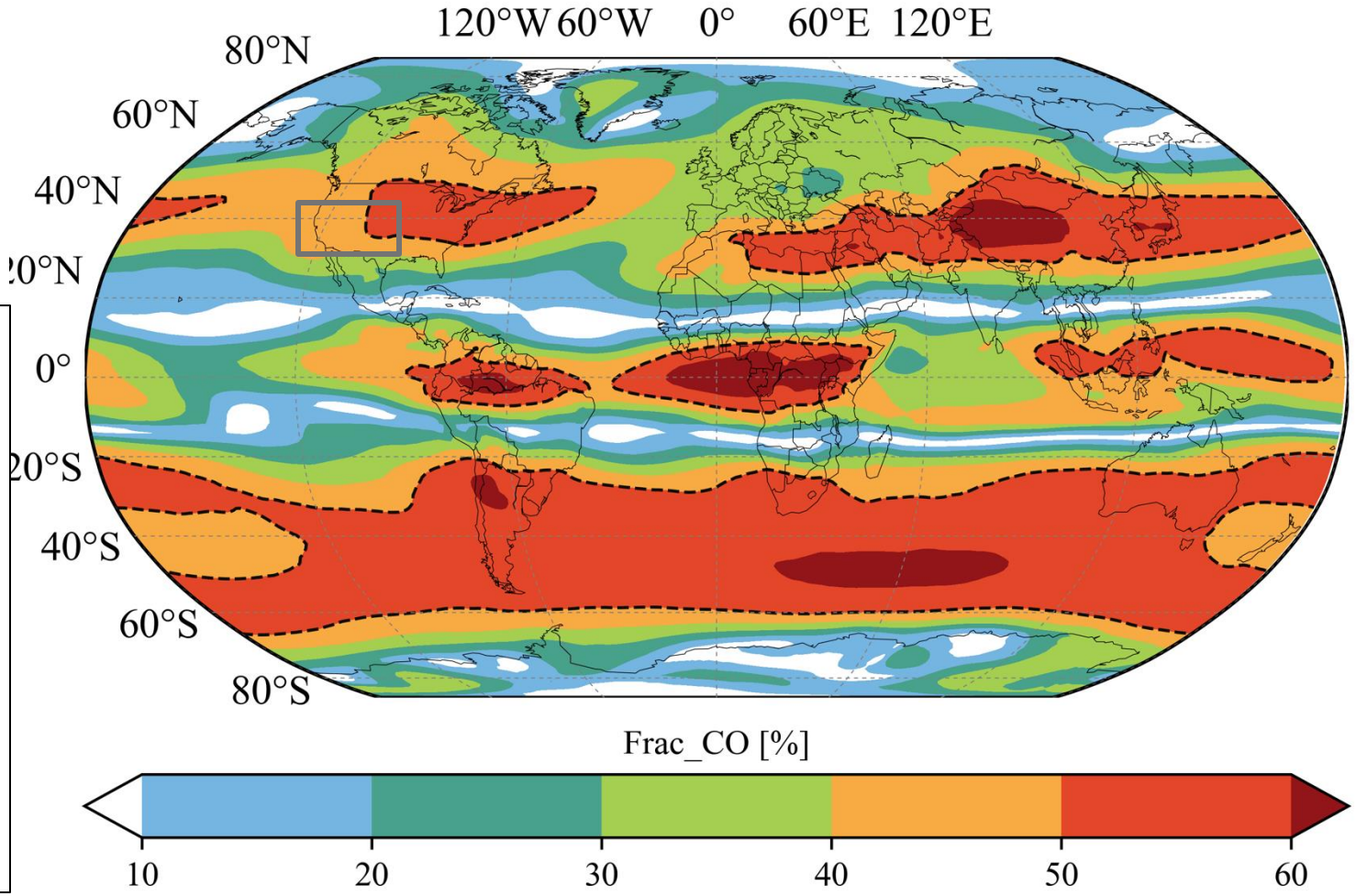
4. Selected TGAR candidate that align with the time periods of extreme pollution event over Los Angeles (from step 1)



Vertical integration approach

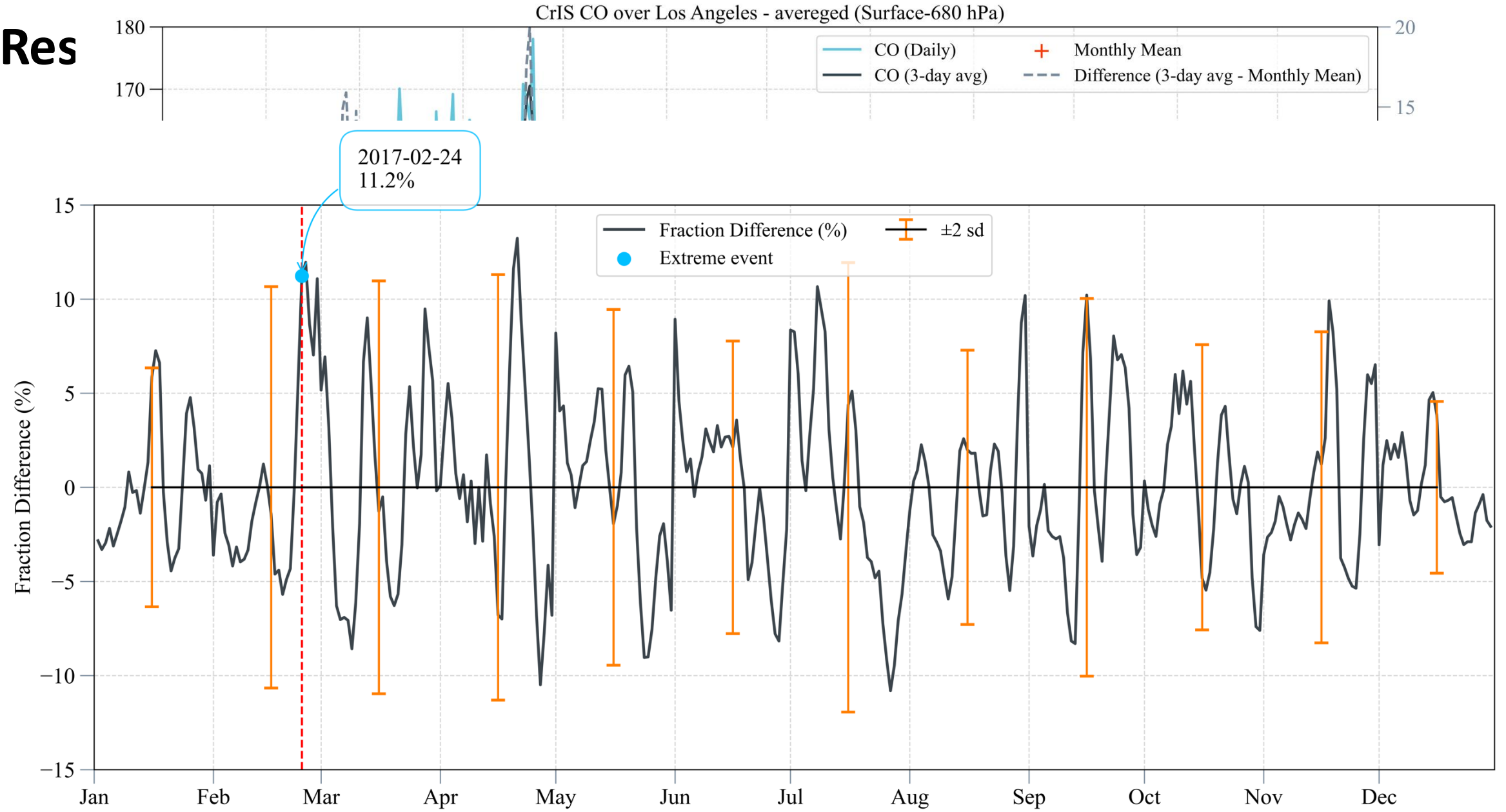
Results: TGAR contribution to CO transport

- TGAR accounted ~ 40-50 % of total CO transport over Los Angeles
- CO transport from Asia to North America begins in the boundary layer of eastern Asia



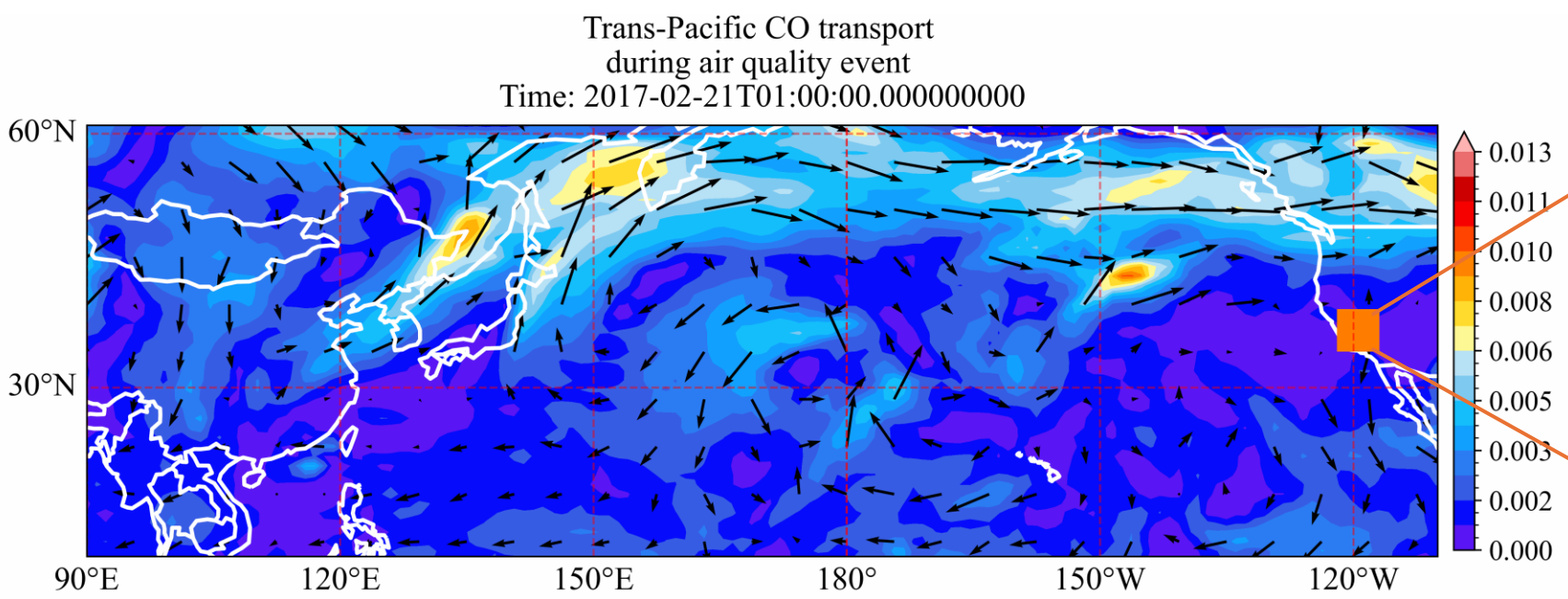
Contribution of CO TGAR events to total transport for 14 years (2005-2019)

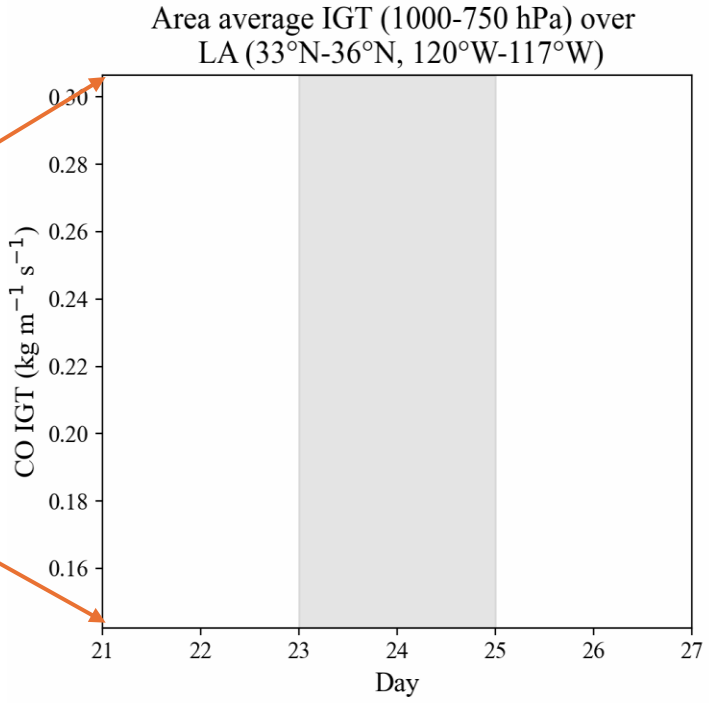
Res


CrIS CO over Los Angeles - avereged (Surface-680 hPa)
CO (Daily)
CO (3-day avg)
Monthly Mean
Difference (3-day avg - Monthly Mean)
2017-02-24
11.2%
Fraction Difference (%)
Extreme event
±2 sd
Fraction Difference (%)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

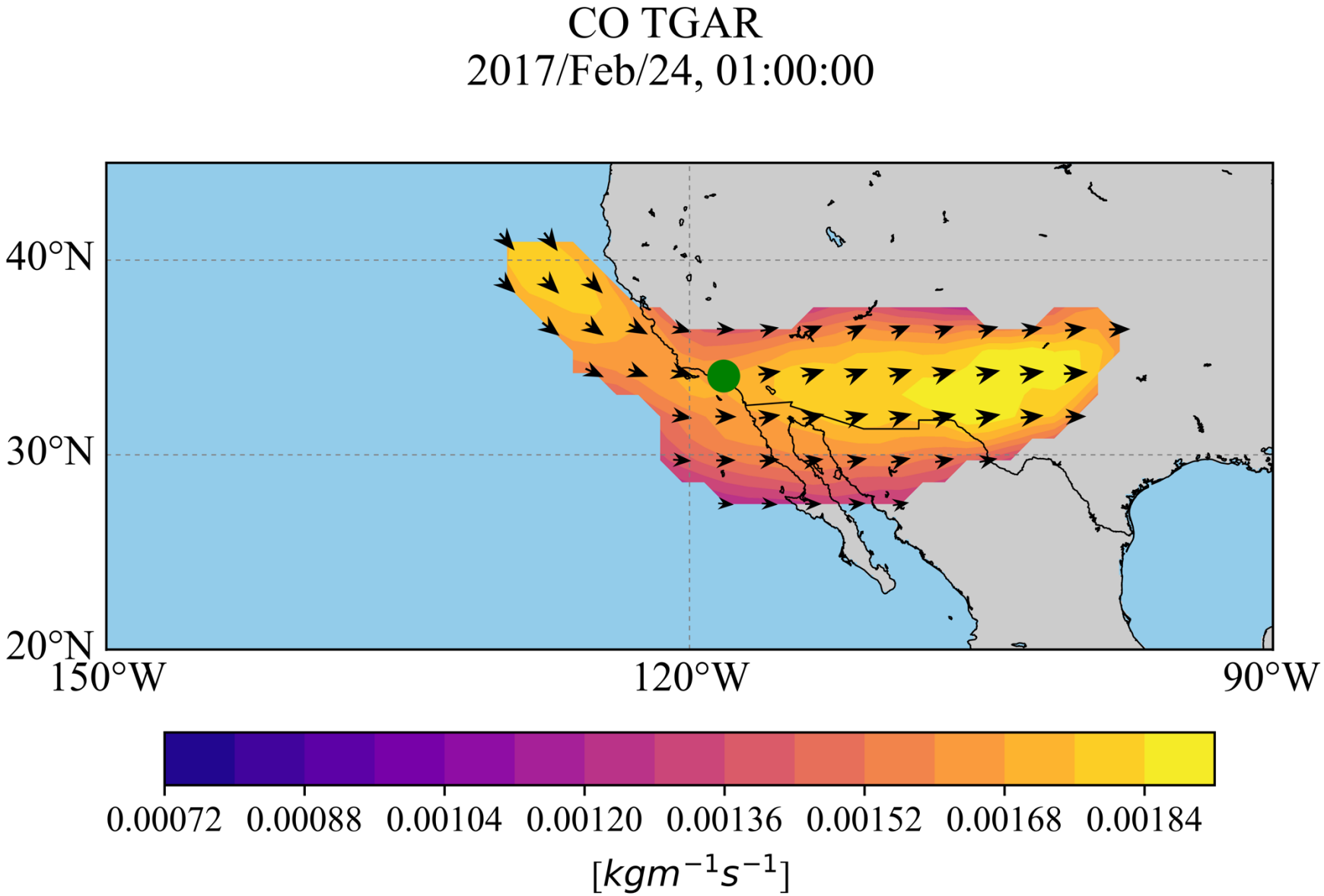
Results: Influence of lower tropospheric transport

Enhanced CO integrated gas transport (IGT) found over Los Angeles in lower troposphere during CO TGAR event



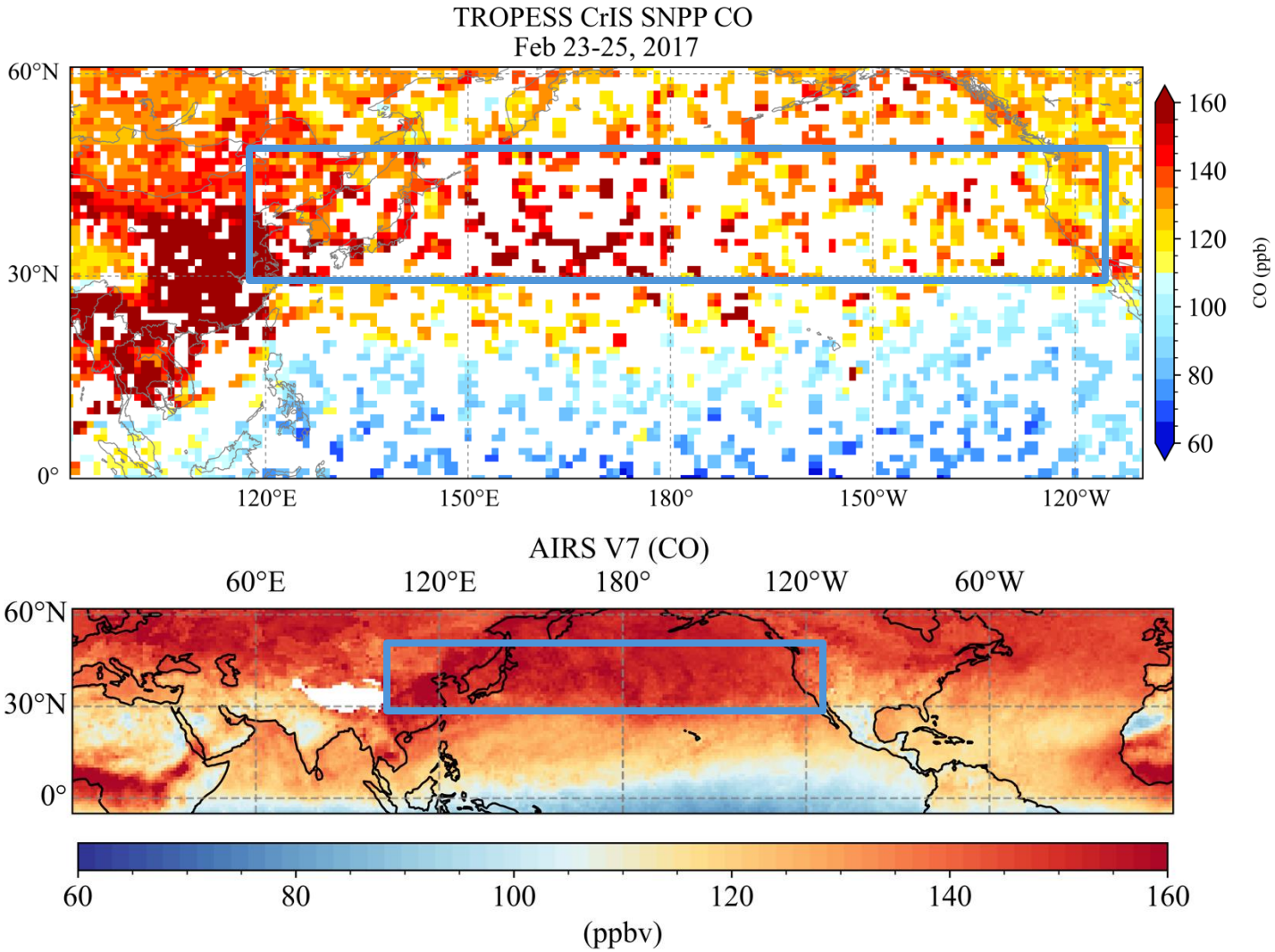


Results: CO TGAR for the time periods of extreme pollution event



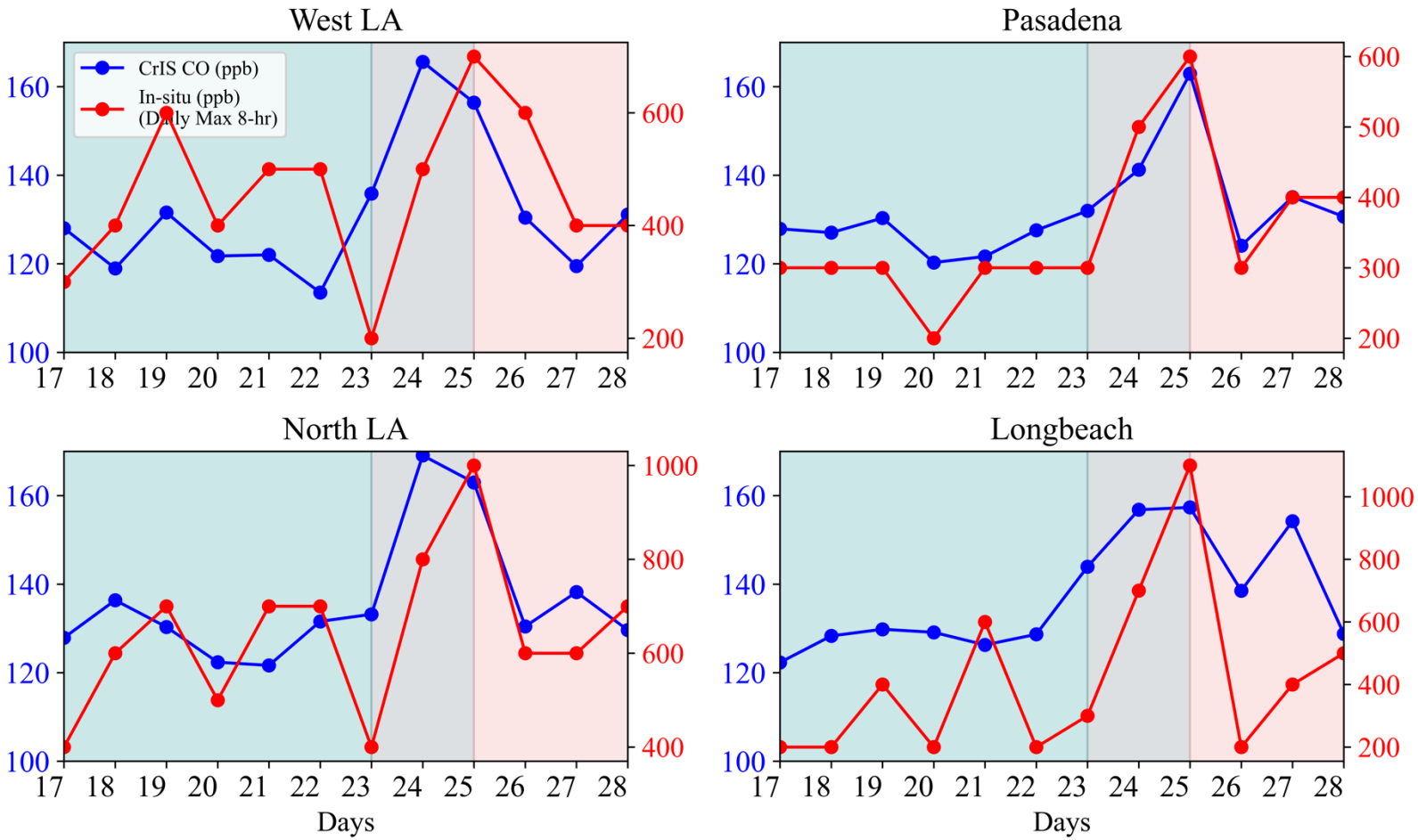
Results: Satellite observation during air quality event

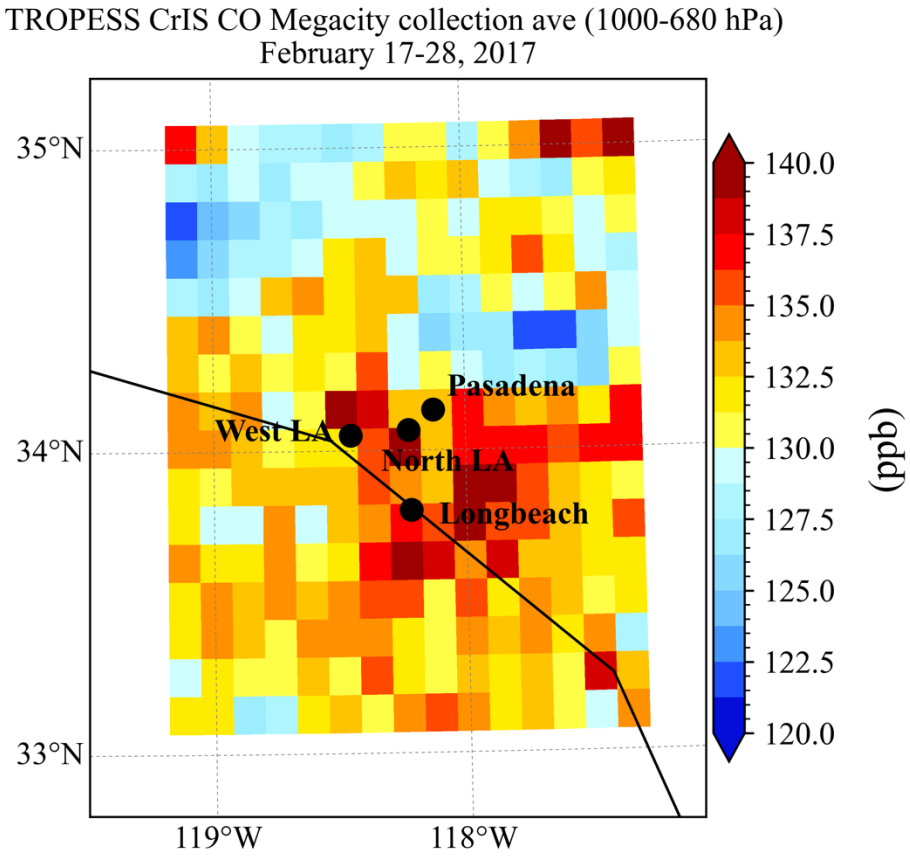
Both TROPESS CrIS and AIRS V7 product shows fingerprint of Trans-Pacific transport of CO



Results: Comparison of CO satellite observation with in-situ data

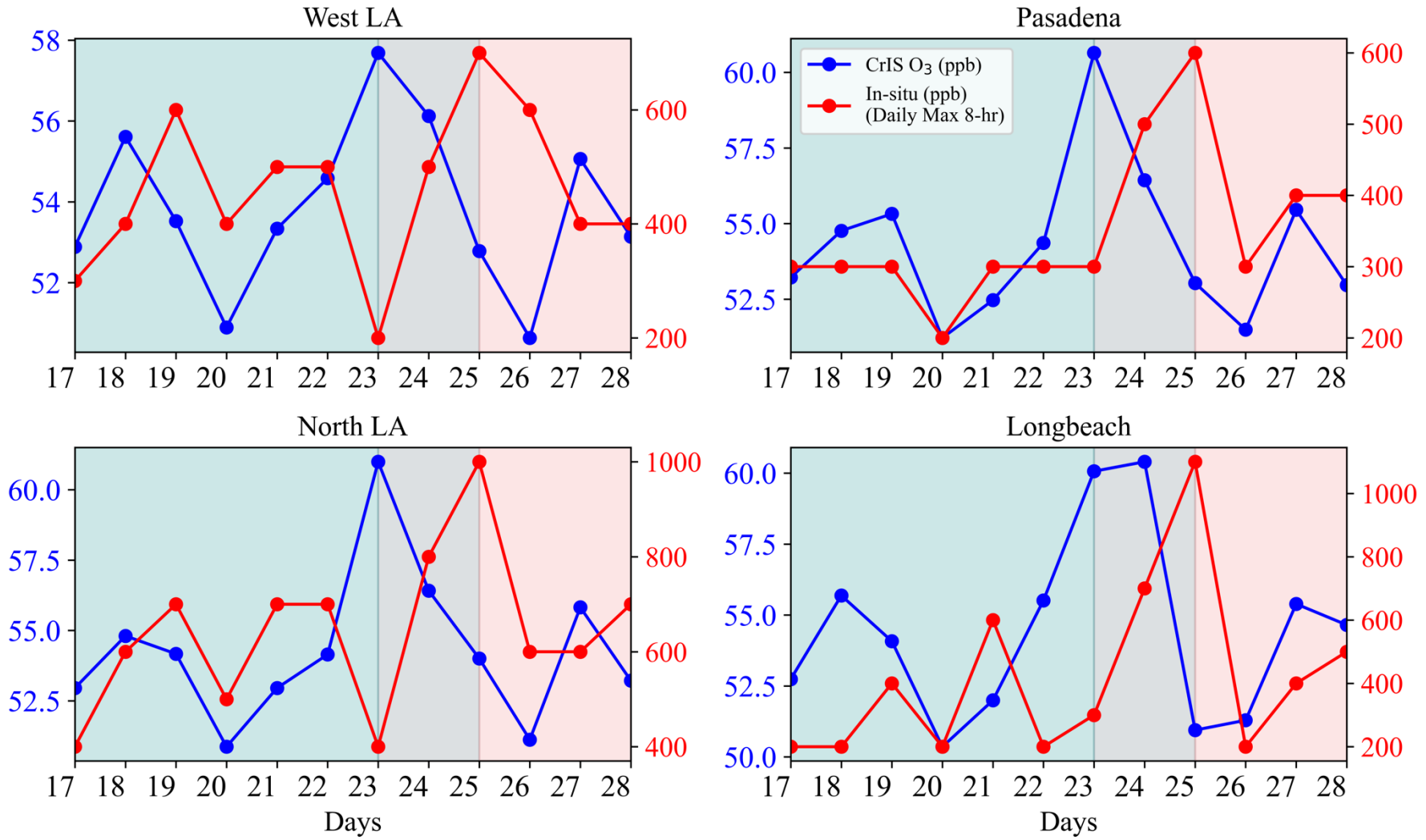
Satellite and in-situ observations in four stations in Los Angeles shows the sharp increased in CO concentrations during air quality event (i.e. CO TGAR events)





Results: Comparison of O_3 satellite observation with in-situ data

- O_3 also shows the increase during air quality event over different location in Los Angeles
- Ozone variability is not well understood either from long-range transport or photochemistry production



Conclusions

- Introduced new framework (TGAR) that detect extreme event transport by leveraging TCR-2 data.

- The surface CO increase observed in Los Angeles during the air quality event was linked to a CO TGAR event transported from East Asia.

- Further detail study is needed to explain the tropospheric ozone variability by utilizing chemistry transport model and sensitivity analysis on key chemical parameters (e.g., photolysis rates, NOx, VOC emissions) are needed.

- This case study shows how the TGAR framework can help explain observations and determine whether air quality events are caused by long-range transport or local emissions.

Thank you

Back up

CO TGAR contribution to lower surface