

Exploring the role of atmospheric rivers in extreme air pollution events

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1. Research motivation

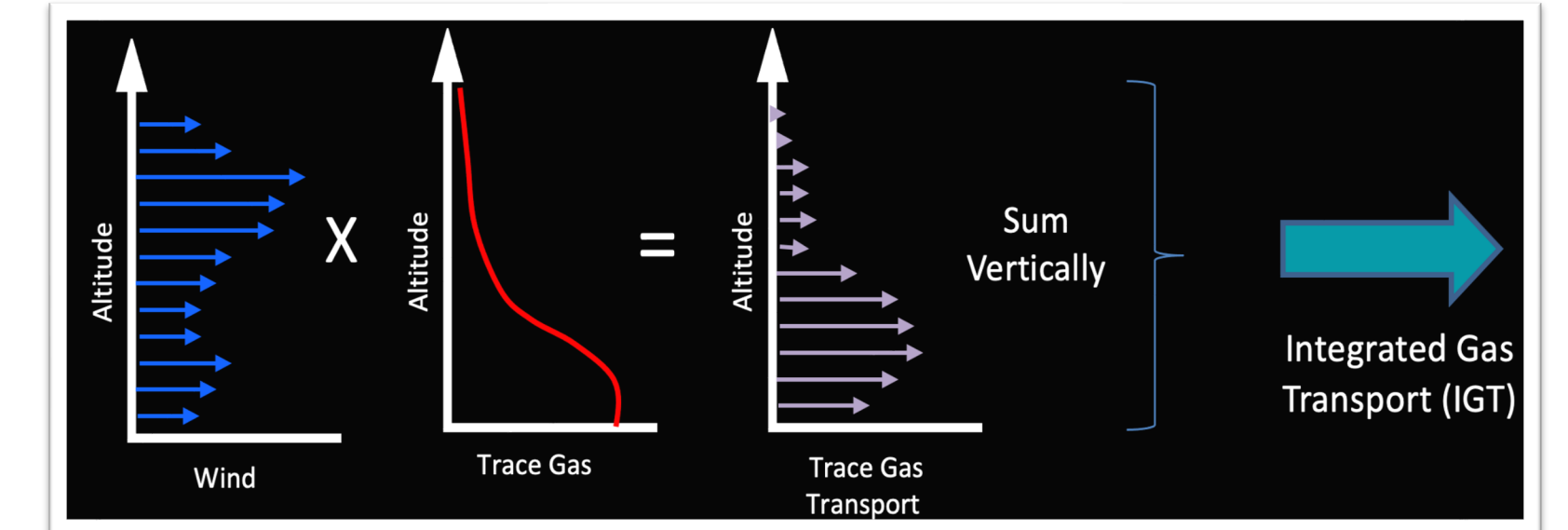
This study assesses the impact of long-range transport associated with atmospheric rivers on regional and local air quality during extreme pollution events. To this end, the Trace Gas Atmospheric Runoff Rivers (TGAR) concept was applied to NASA JPL's Multi-Model Multi-Component Chemicals (MOMO-Chem) data assimilation under NASA's Atmospheric Composition Modeling and Analysis Program (ACMAP).

2. Data

- Tropospheric Chemical Reanalysis version-2 (TCR-2) produced using the JPL MOMO-Chem data assimilation system
- 2005-2019 @1.1°X1.1° [Global], 6 hourly], 1000-60 hpa, 27 levels
- Pollutants: Ozone (O₃), Peroxyacetyl Nitrate (PAN), Carbon Monoxide (CO)
- JPL TROPESS Product: CrIS PAN standard product

3. TGAR approach

- Optimized the AR algorithms to TGARs (pixel size, degree of filtering, threshold percentile)
- Integrated gas transport (IGT) is estimated for the troposphere
- TCR-2 data was validated against CrIS PAN, ozonesonde, and in-situ measurements
- Calculated global landfall frequency, and total number of landfall in major cities (3X3 deg)



4. Results

Fig 1. Fractional TGAR O₃ attribution to total transport. Dotted black line indicates attribution greater than 50%.

Fig 4. Total number of TGARs landfall over major cities in the world respectively for CO, O₃ and PAN. Total number of landfall (y-axis) and trace gas species (x-axis). Different colors represents the cities.

Fig 5. TROPESS CrIS ozone from megacity special collection over Los Angeles (3X3 deg).

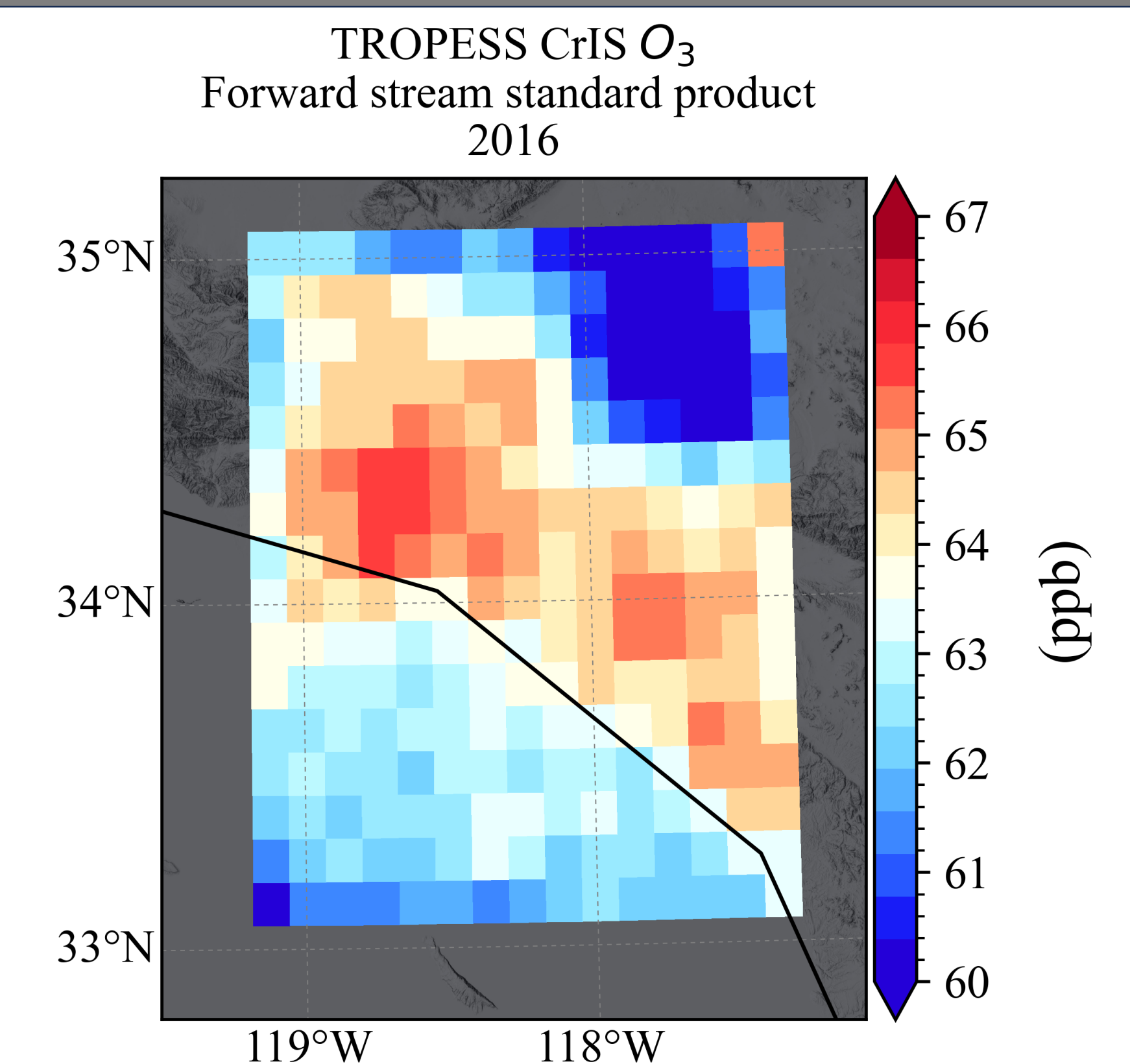
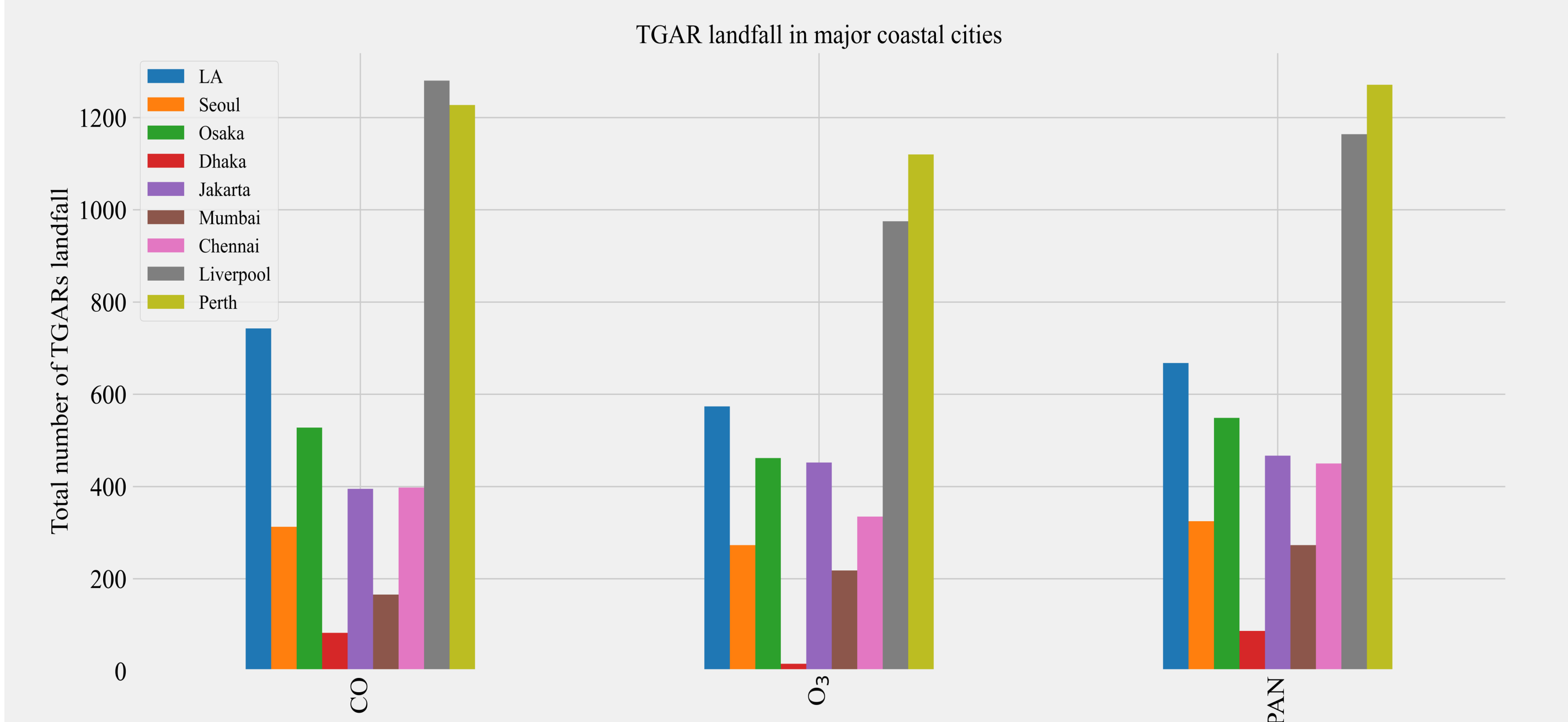
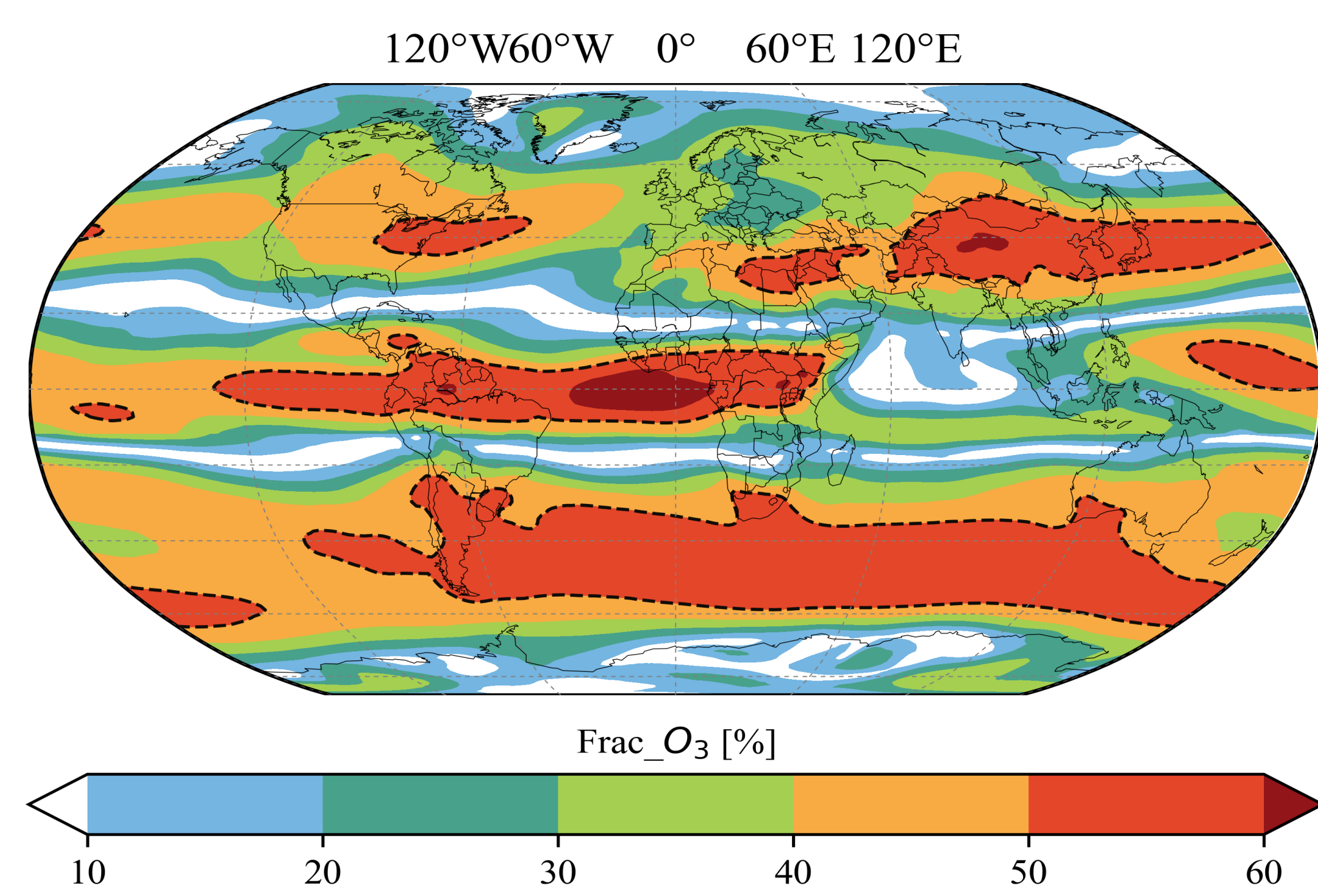


Fig 2. A snapshot of O₃ TGAR occurred during extreme event crossing over the Pacific ocean from the Asia to US. The shaded color shows the IGT magnitude. The red dot shows the Los Angeles. The detected ozone TGAR object is highlighted by solid yellow in the global map.

TGAR_O₃ over Pacific @2016/March/30, 19:00:00

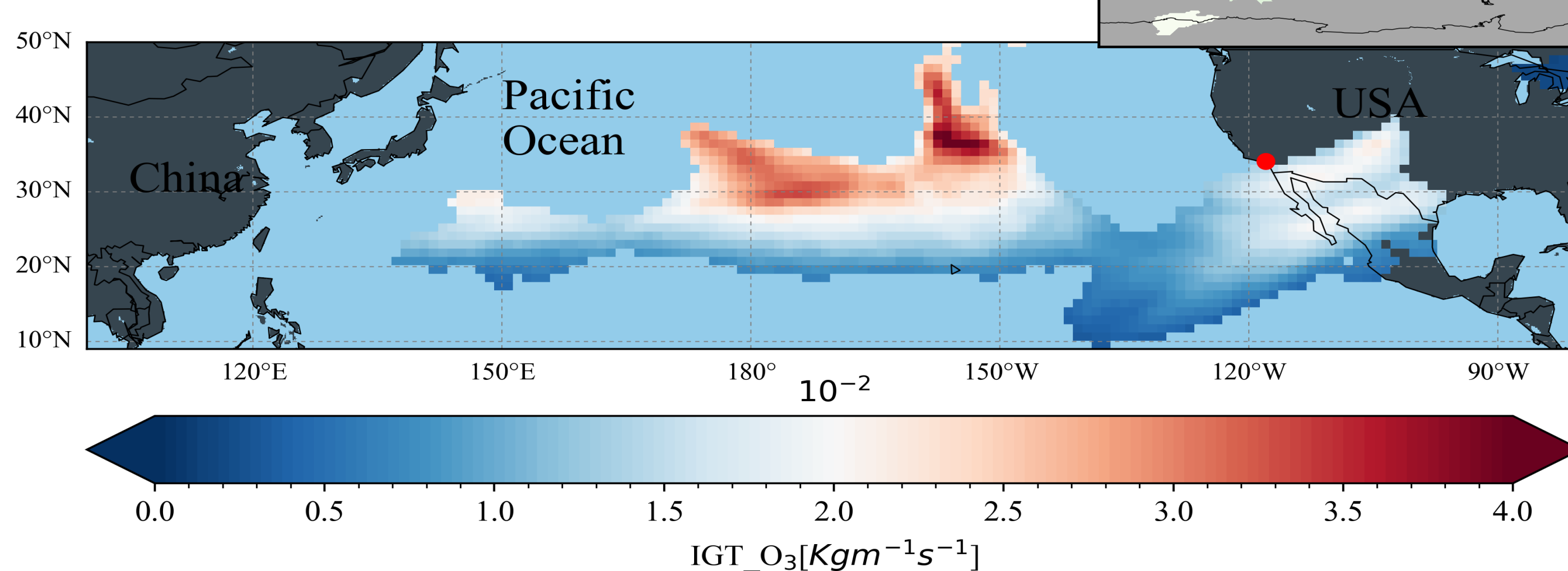
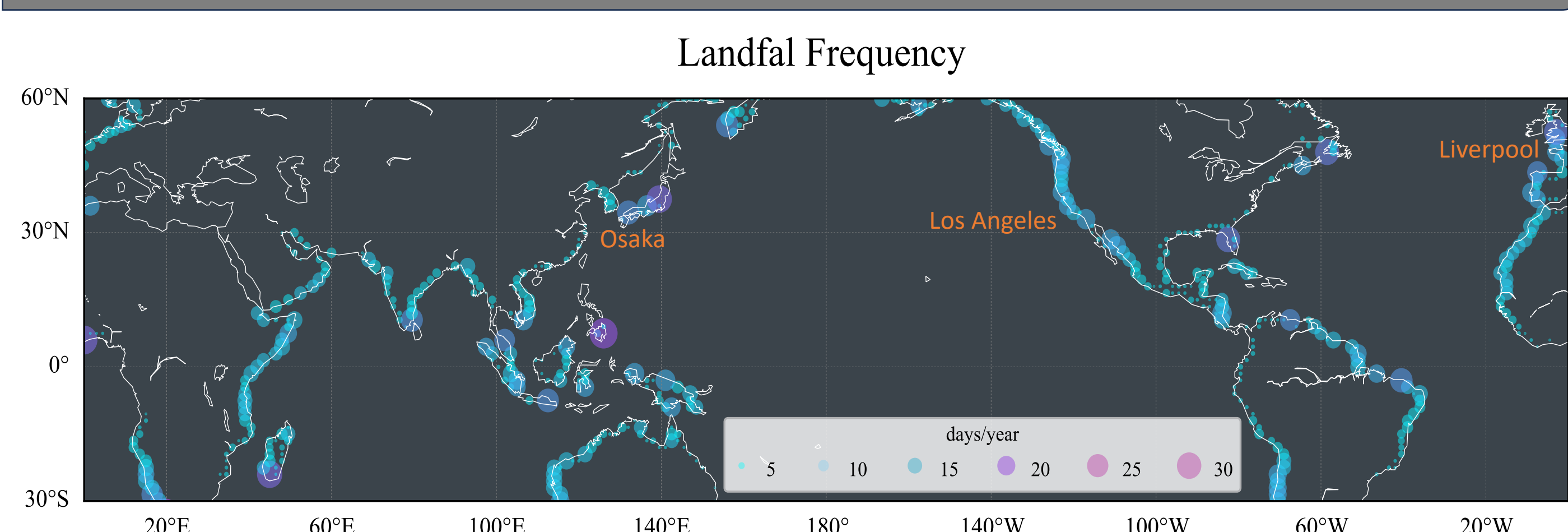


Fig 3. Ozone TGAR landfall occurrence over 30S-60N latitudinal range. The circles size represents the number of TGAR landfall days in a year.



5. Conclusions

- TGAR algorithm detected ~300K events globally, representing 60% of total long-range transport of trace gases (Fig 1).
- Among the most populous cities, Los Angeles (USA), Perth (Australia), and Liverpool (UK) have the highest frequency of TGAR landfalls, where TGAR has the potential to degrade local air pollution (Fig 3 - 4).
- The CrIS satellite provides detailed spatial information on both air pollutant and its precursors (Fig 5 - 7). Combining with the TGAR results, they could provide us with improved understanding of extreme air pollution and its origins.
- Combining TGAR results with various measurements is expected to improve our understanding of extreme air pollution and its origins to inform policy decisions.
- The TGAR concept is useful for better understanding air quality drivers.

Fig 6. Time series plot over Los Angeles basin (3X3 deg). The red and blue solid lines indicates the CrIS O₃ (in ppb) and TCR-2 IGT (in kgm⁻¹s⁻¹) respectively. The identical shaded color represents $\pm 1\sigma$. Vertically gray shaded area represents the extreme events.

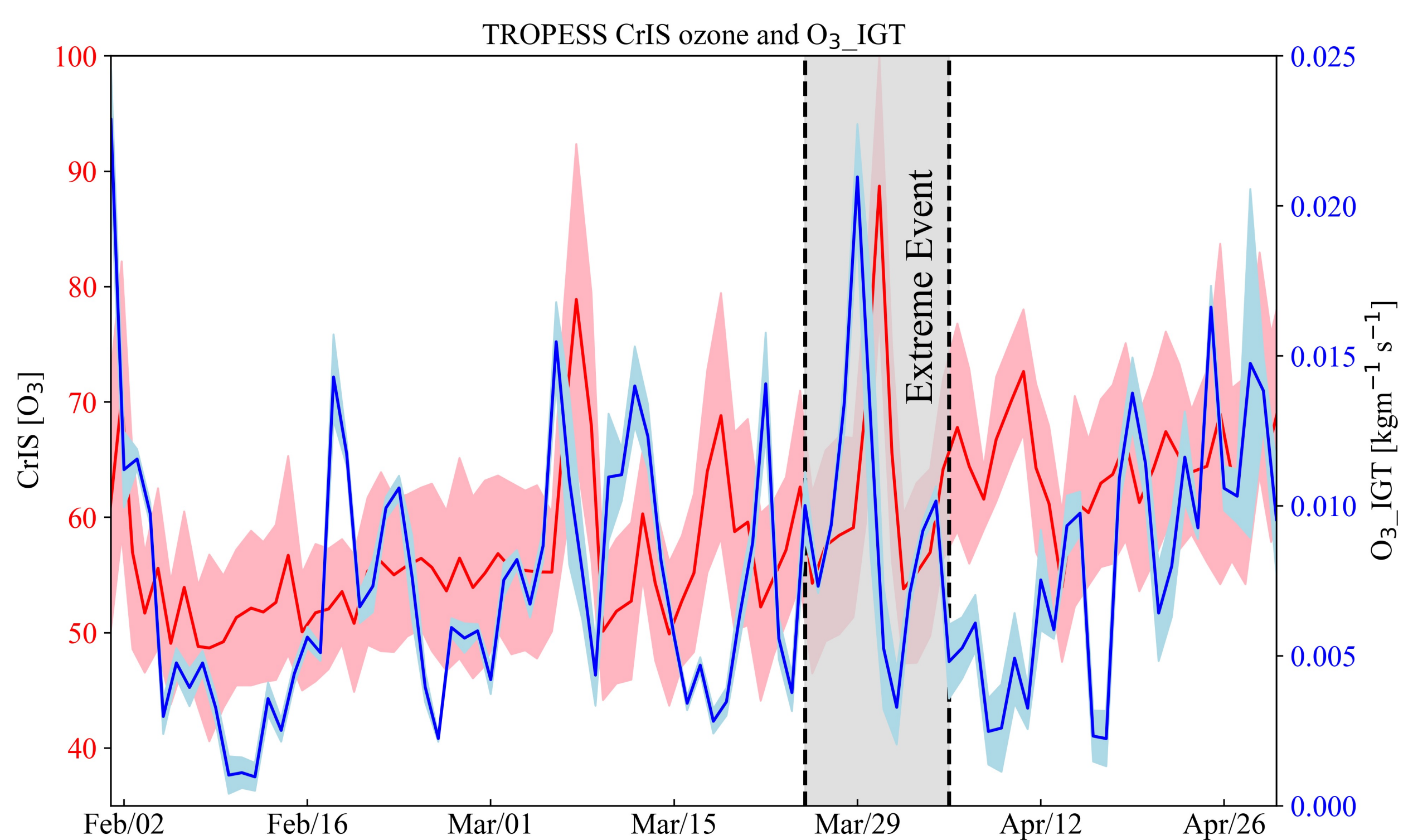
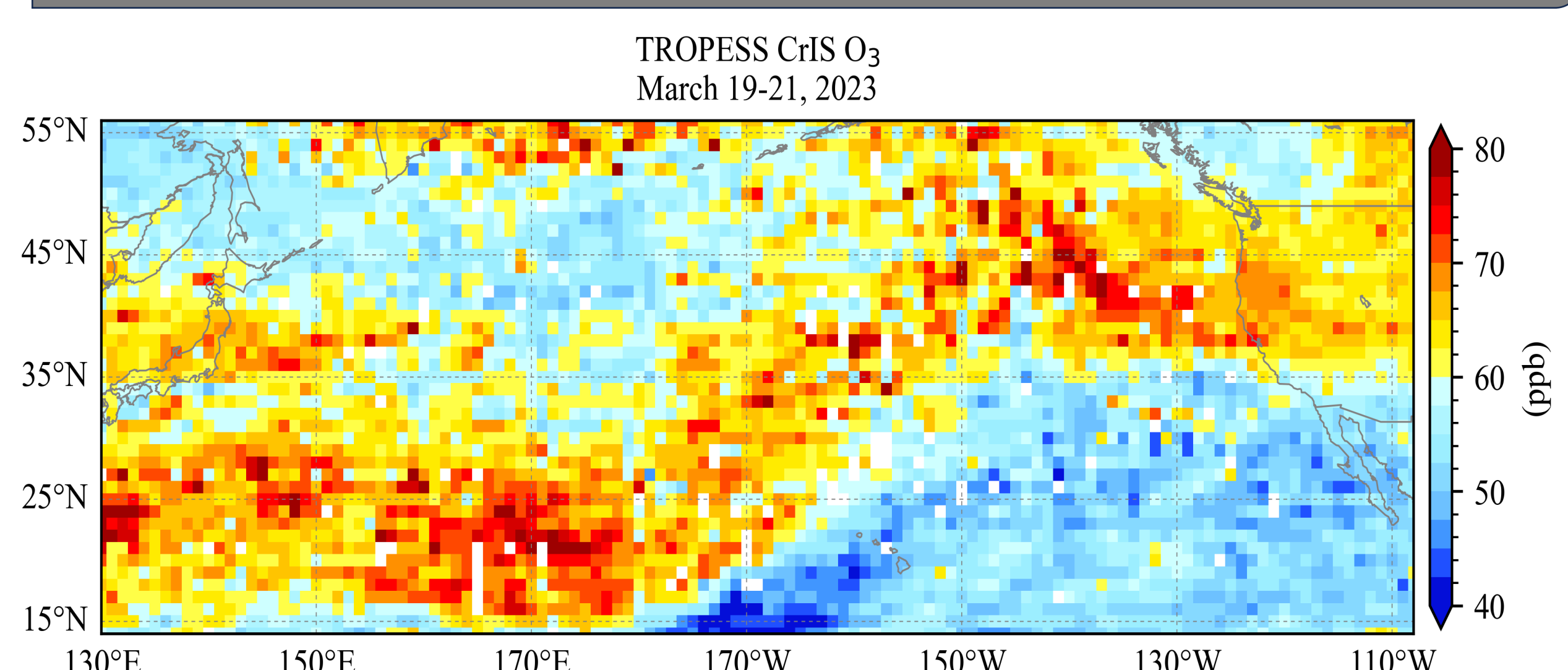


Fig 7. Spatial map of TROPESS CrIS ozone from forward stream standard product over the Pacific.



Data availability

The TCR-2 data used in this study is available through <https://search.earthdata.nasa.gov/search?q=TCR-2&fj=TROPESS>
TROPESS CrIS megacity level data can be obtained from <https://disc.gsfc.nasa.gov/datasets/tropess%20megacity%20ozone%20standard&page=1>
TROPESS CrIS reanalysis stream data could be access via <https://disc.gsfc.nasa.gov/datasets/tropess%20reanalysis&page=1&source=Suomi-NPP%20CrIS&project=TROPESS>