Jet Propulsion Laboratory
California Institute of Technology

Trace Gas Atmospheric Rivers: Remote Driver of Air Pollutants

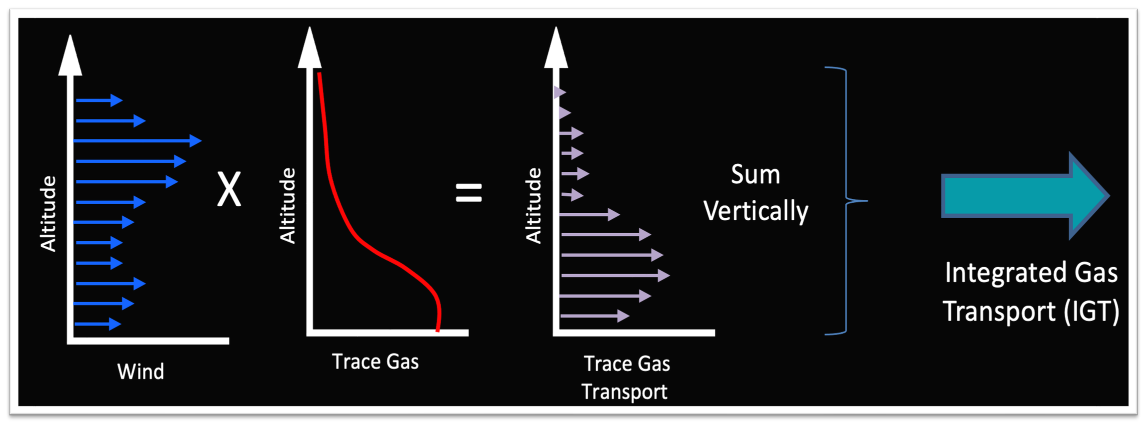
Mukesh Rai[1], Kazuyuki Miyazaki[1], Vivienne Payne[1], Bin Guan[1,2], Duane Waliser[1]
[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
[2]Joint Institute for Regional Earth System Science and Engineering
University of California, Los Angeles, California, USA

1. Research motivation

This study, under NASA's atmospheric composition modeling and analysis program (ACMAP), applies trace gas atmospheric river (TGAR) concept to global trace gas data from the NASA JPL multi-model multi-constituent chemical (MOMO-Chem) data assimilation system to track major pollution transport events and evaluates changes in pollution transport over time

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
- 3 pollutants: Ozone (O_3, Peroxyacetyl Nitrate (PAN), Carbon Monoxide (CO)
- JPL TROPESS satellites: CrIS PAN for validation



3. Methods

- Vertical integration calculation

$$IGT(U,V)_{co,pan} = \sum_{1000hpa}^{60hpa} C_{co,pan} \times (U,V)$$

$$IGT(U,V)_{o_3} = \sum_{1000hpa}^{300hpa} C_{o_3} \times (U,V)$$

- Validated against CrIS PAN, ozonesonde, and CO in-situ measurements
- Atmospheric river ?
- Stream of water vapor moving in the sky
- Optimized the AR algorithms to TGARs (pixel size, degree of filtering, threshold percentile)

4. Results

Fig 1. Interannual trend of concentration [upper panel] and IGT [lower panel] of CO, O_3, and PAN

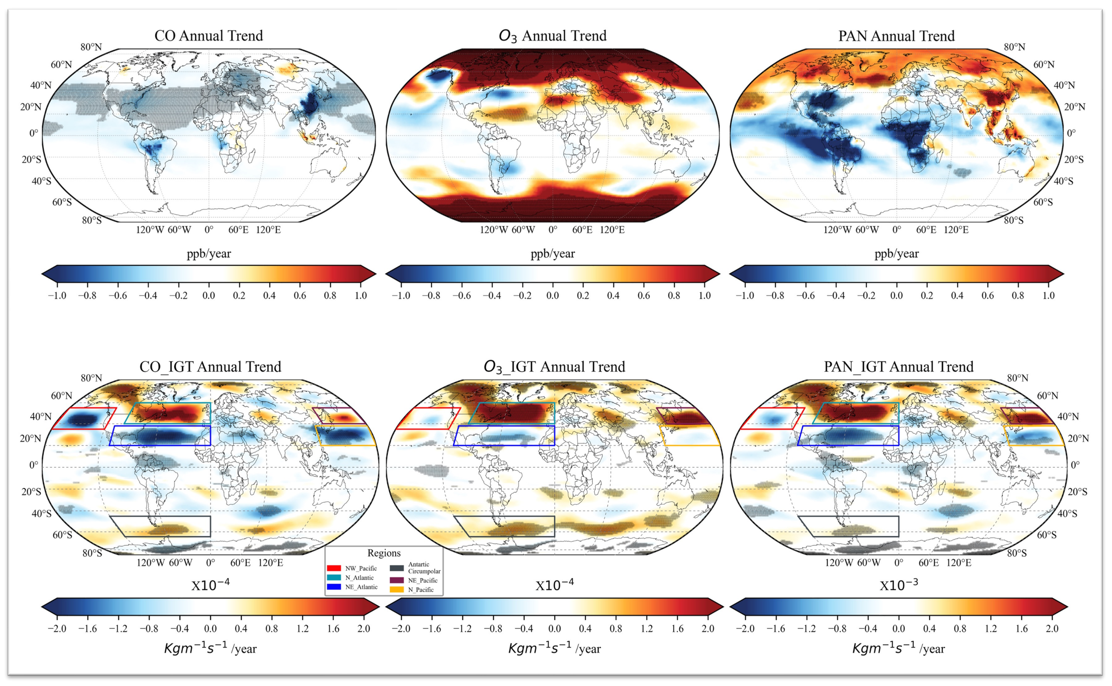


Fig 2. Total transport over the period [upper panel], and fractional contribution of transport accounted by TGARs events for identical species. Dashed black line indicate TGARs contribution above 50%.

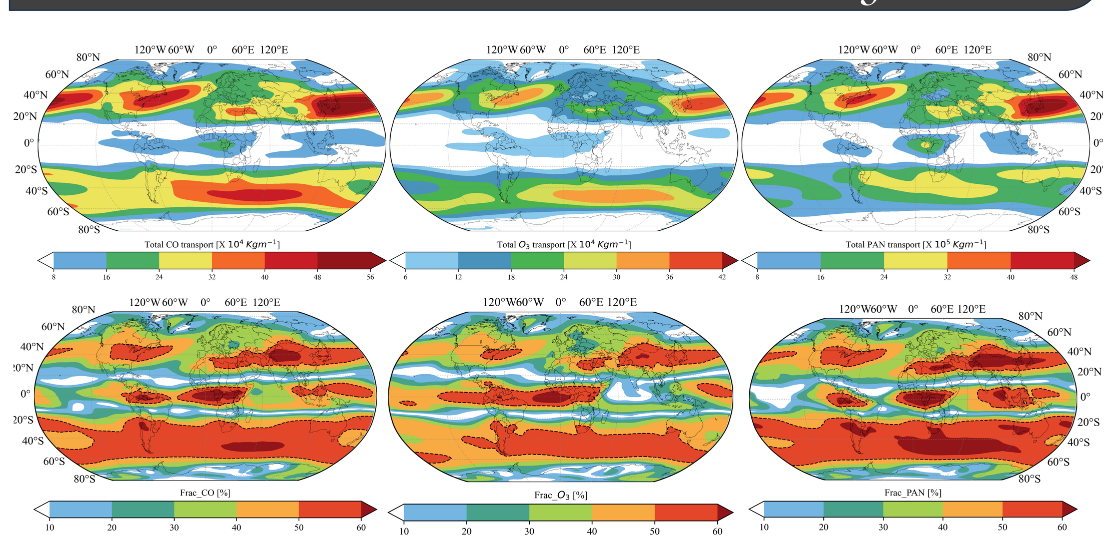
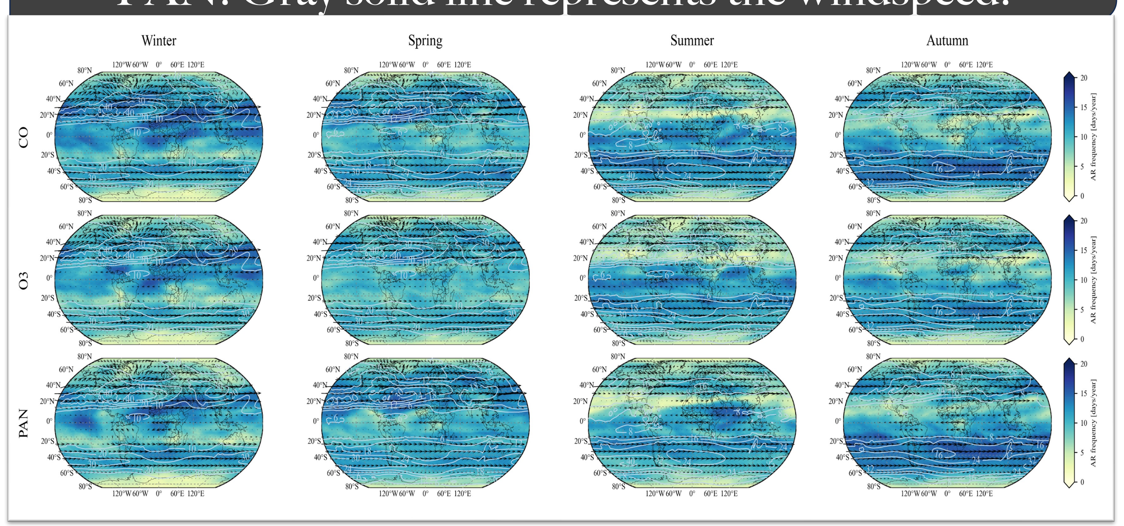


Fig 3. Seasonal TGARs frequency for CO, O_3, and PAN. Gray solid line represents the windspeed.



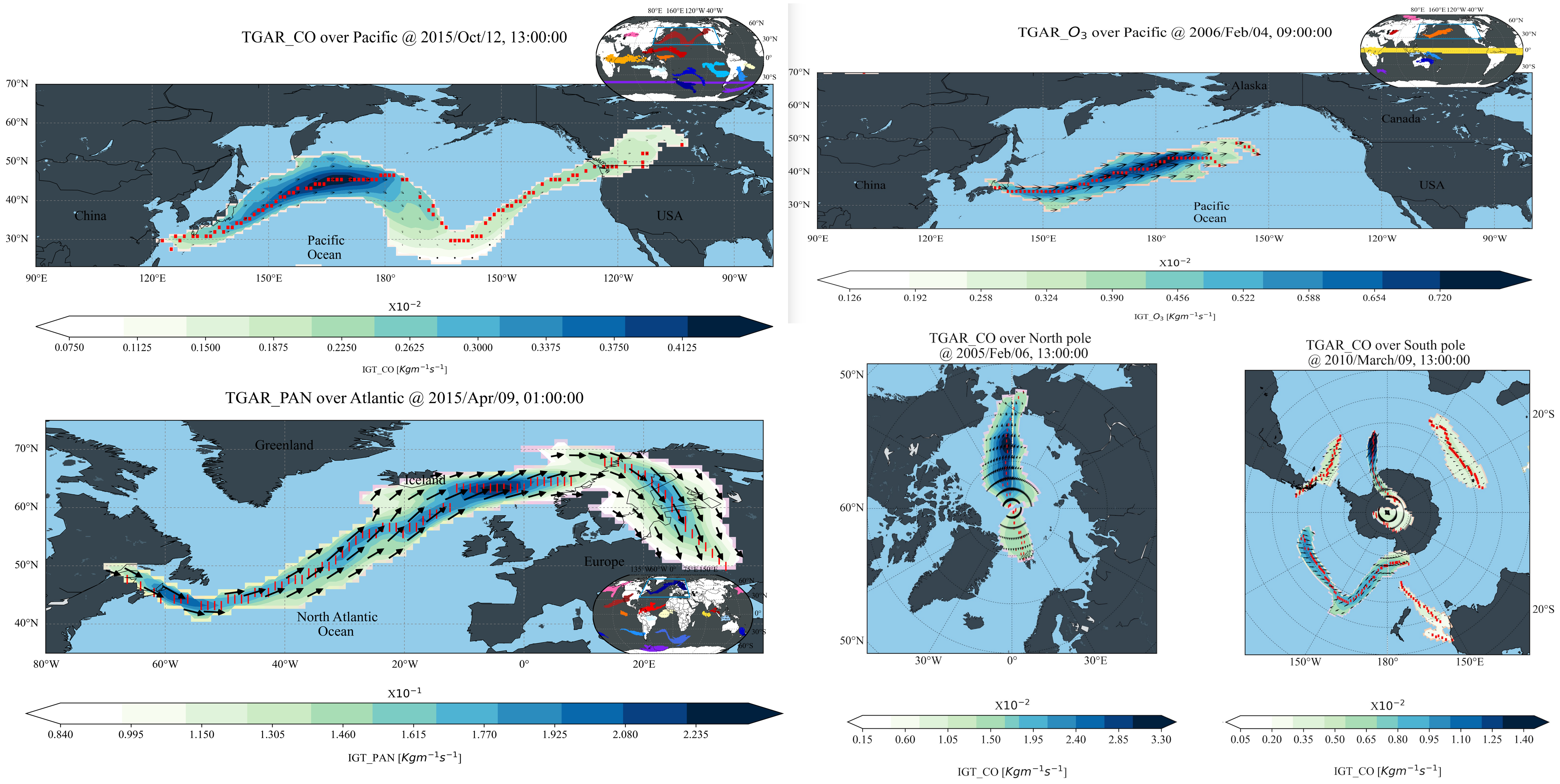


Fig 4. Snapshot of atmospheric river [AR] features detected in each timestamp by TGARs algorithm over Pacific and Atlantic. The red dashed line indicate AR axis, and vectors represent the intensity.

5. Conclusions

- TGAR algorithm detected about 300, 000 events globally, which corresponded to up to 20 days/year frequency of occurrence and was responsible for up to >60 % of the annual total transport over North Atlantic Ocean, South temperate zone, central Asia, Africa, Pacific Ocean.
- Analyzing TGARs of various chemical species with different characteristics can provide a comprehensive understanding of the impact of human and natural activities on the global environment and climate through long-range transports.

6. Takeaway messages

- This framework can be useful for better understanding air quality drivers and improving chemical transport models.
- TGAR events impact not only within emission source but also to distance afar.
- Further study needed to investigate the long-term air pollutant trend, compositions, and driving mechanism of transport.

7. References

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Email: mukesh.rai@jpl.nasa.gov