Transport of passive tracers during TRACER-AQ campaign in Houston, TX

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Introduction

- The Houston metropolitan area is recognized as a "marginal" non-attainment region by routinely exceeding the ozone national standards.
- Earlier studies identified emissions from petrochemical and industrial complexes along with abundant mobile and stationary pollution sources as the major factors driving the relatively high ozone levels in the area.
- Houston lies within a unique climate regime where sea-breeze circulation often interacts with local emissions that degrade air quality. Earlier studies have also identified the **transport of plumes of pollutions from out of state** as a major contributor to ozone and particulate matter in Texas.
- As an important effort in September 2021, the Tracking Aerosol Convection Interactions ExpeRiment/Air Quality (TRACER-AQ) campaign aimed to investigate the regional air quality and its association with emissions, chemistry, and meteorological patterns in Houston, TX.

Objective

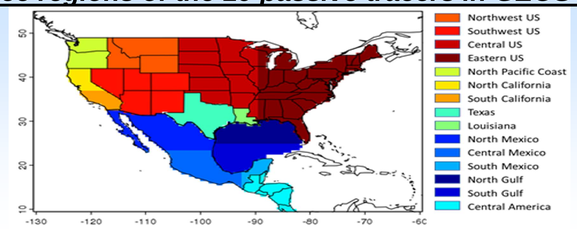
- This study tries to analyze the transport pattern of pollutants to the Houston region during the TRACER-AQ campaign.

Methodology

- TRACER-AQ experimental campaign
  - Aircraft measurements
  - Boat-based observations
  - Stationary/mobile laboratories

  → Identifying pollution episodes: September 6th – 11th; September 23rd – 26th
- GEOS-Chem model
  - We defined 19 source regions across the U.S. where passive tracers with a fixed lifetime of 7 days were emitted at a constant rate of 10^{-10} kg/m^2/s.
  - Passive tracer simulations were performed for years 2015−2021:
    - Global simulation was performed with a resolution of 2°×2.5° using the MERRA-2 meteorological data.
    - Flex-grid simulation was conducted using MERRA-2 data with a native spatial resolution of 0.5°×0.625° over North America.
  - When the tracers' levels in 2021 exceeded the 75th percentile of the corresponding concentrations during 2015 − 2020, the observation **had the potential** to influence the site of interest during a perceived event.
- HYSPLIT model
  - Backward trajectories were run on an hourly basis at 500 meters above the ground level for 72-hour durations.

Source regions of the 19 passive tracers in GEOS-Chem.



Results

Mean spatial variation of the 7-day lifetime ideal tracer

September 6th – 11th | September 23rd – 26th

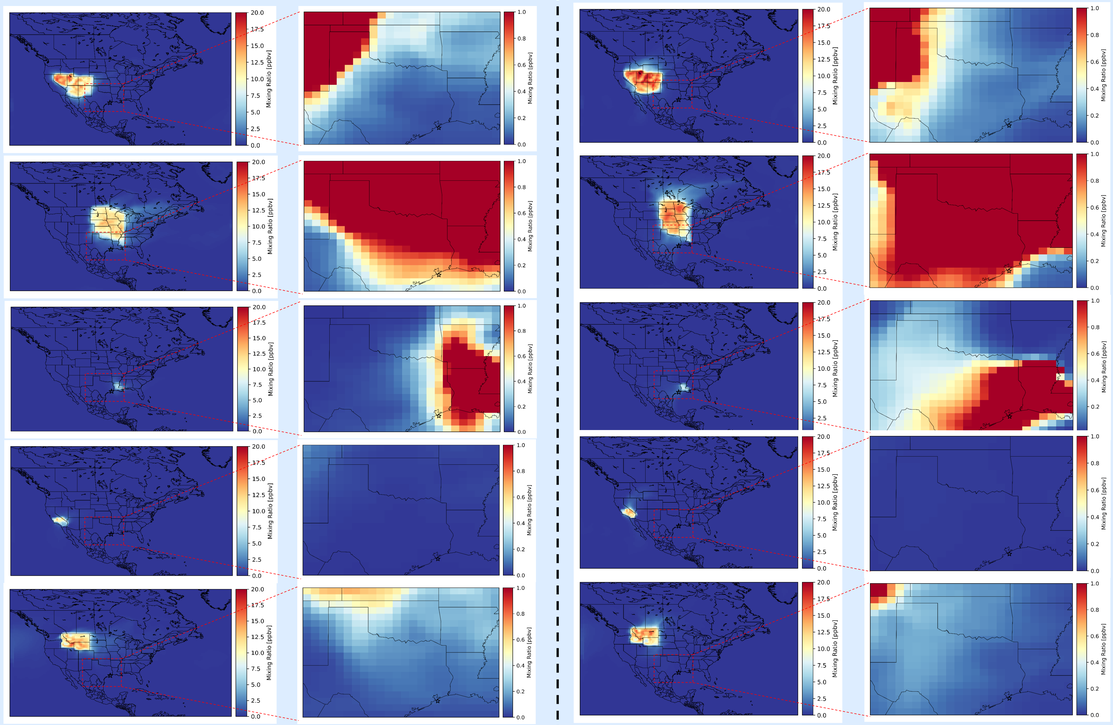
Southwest USA

Central USA

Louisiana

South California

Northwest USA



The long-range transport pattern of air masses during pollution episodes

Conclusions

- The GEOS-Chem model anticipated that Southwest USA, Central USA, Louisiana, South California, and Northwest USA source regions had the potential to influence Houston air quality during the TRACER-AQ campaign.
- It should be noted that the identified source regions were determined based on the assumption of constant pollutants' emission from the corresponding areas during the entire investigation period.
- The outputs of GEOS-Chem model were in agreement with back-trajectory analysis, in which HYSPLIT identified central USA as the major source region of air masses in the Houston area during pollution episodes.

References

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