Summertime free tropospheric PAN over the U.S. as observed by TES and simulated by GEOS-Chem

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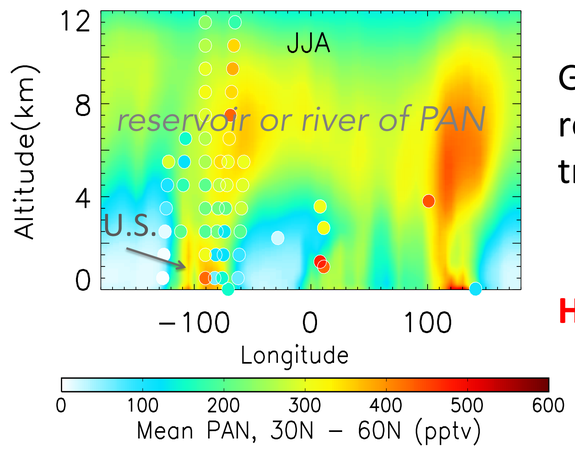
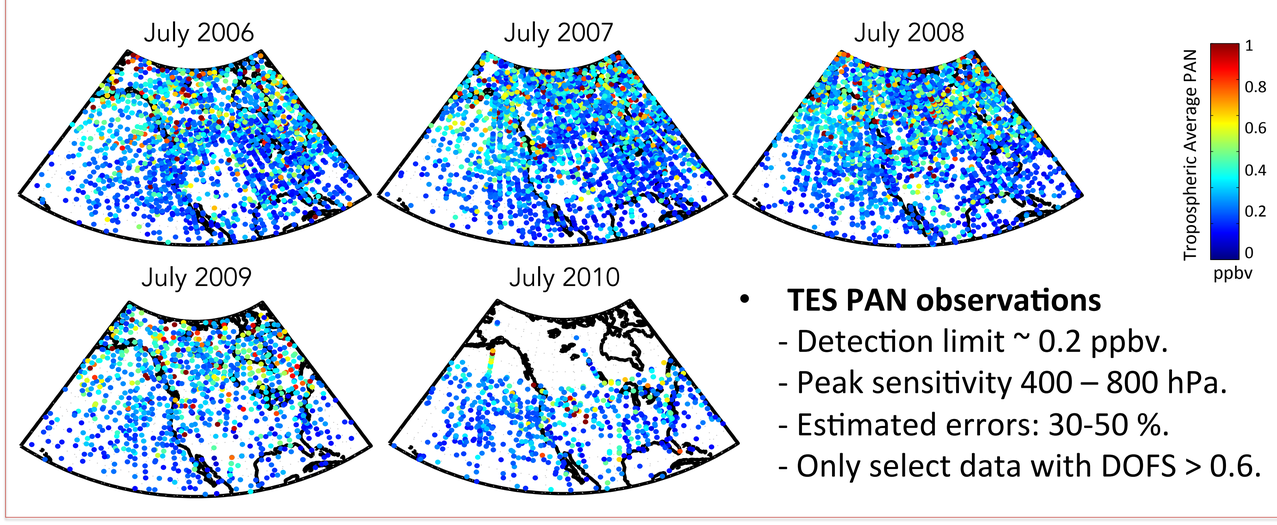
Motivation



GEOS-Chem predicts a reservoir of PAN in the mid-troposphere during summer.

How do fires contribute?

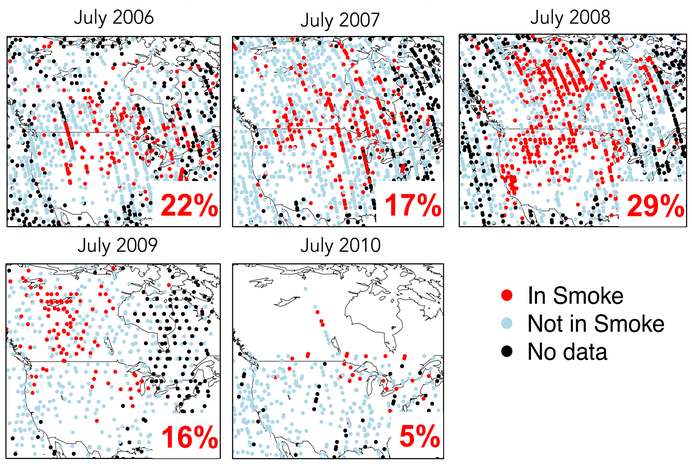
TES PAN observations



- **TES PAN observations**
  - Detection limit ~ 0.2 ppbv.
  - Peak sensitivity 400 – 800 hPa.
  - Estimated errors: 30-50 %.
  - Only select data with DOFS > 0.6.

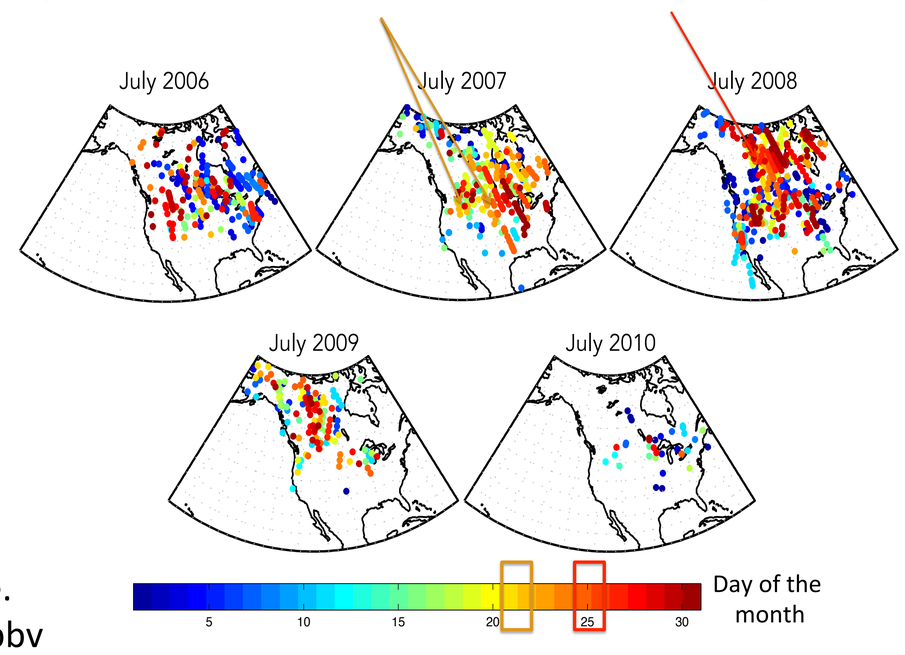
PAN was associated with smoke

- **Up to 15 – 30% of the successful PAN observations can be within Hazard Mapping System (HMS) smoke plumes.**



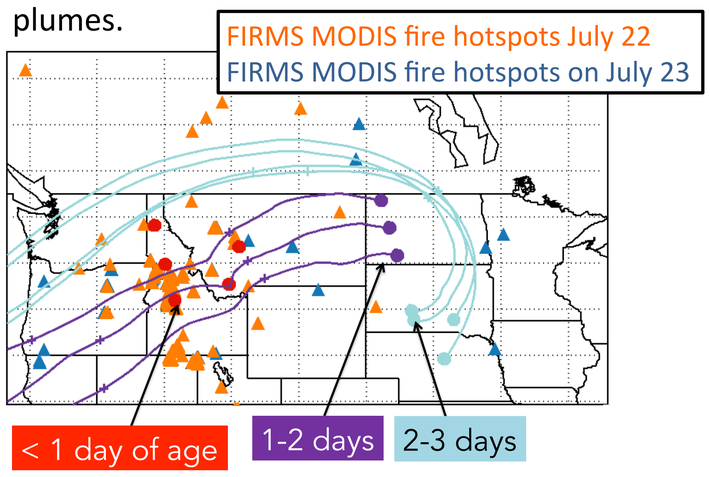
- There is not more PAN when a successful retrieval is located in an HMS smoke plume.
- There is usually between 200 pptv and 1 ppbv of PAN in the plumes, but there can be more.

- **TES Special Observations allow observations of smoke plumes at various ages, even in the same day.**

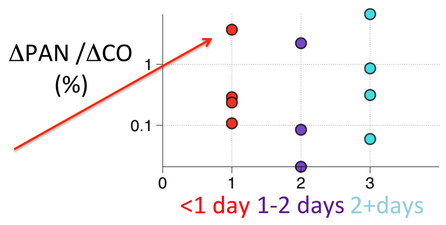


- **Case study:**

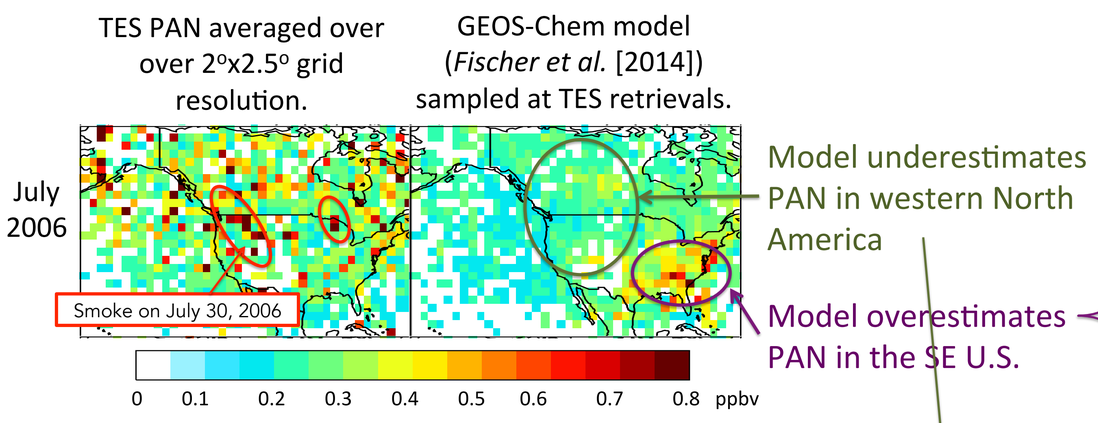
Fires in Idaho and Montana during July 2007 offer the opportunity to look at aged versus fresh plumes.



PAN enhancement ratios can be > 1%.

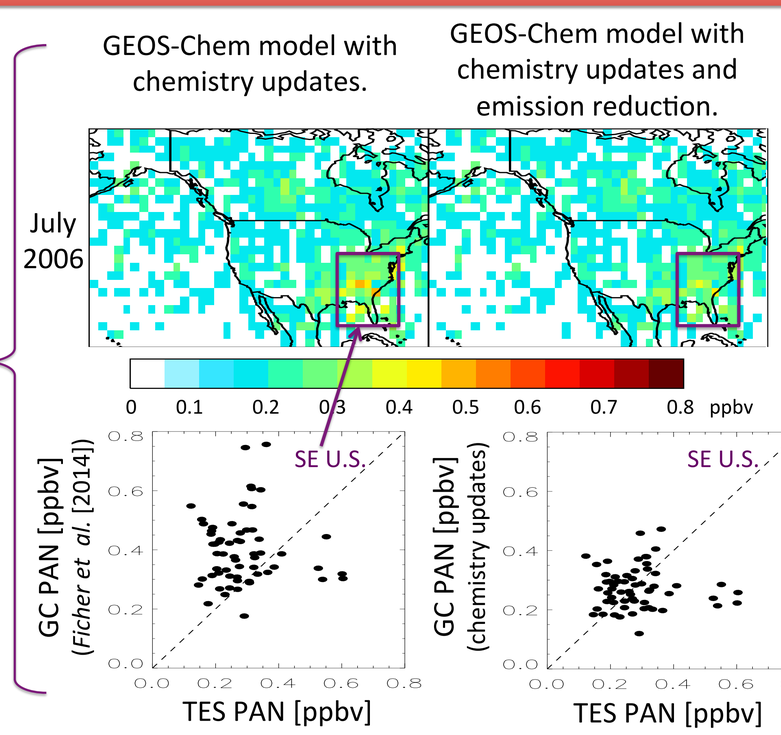


TES PAN observations vs GEOC-Chem simulations



Fischer et al. [2014] PAN Simulation:

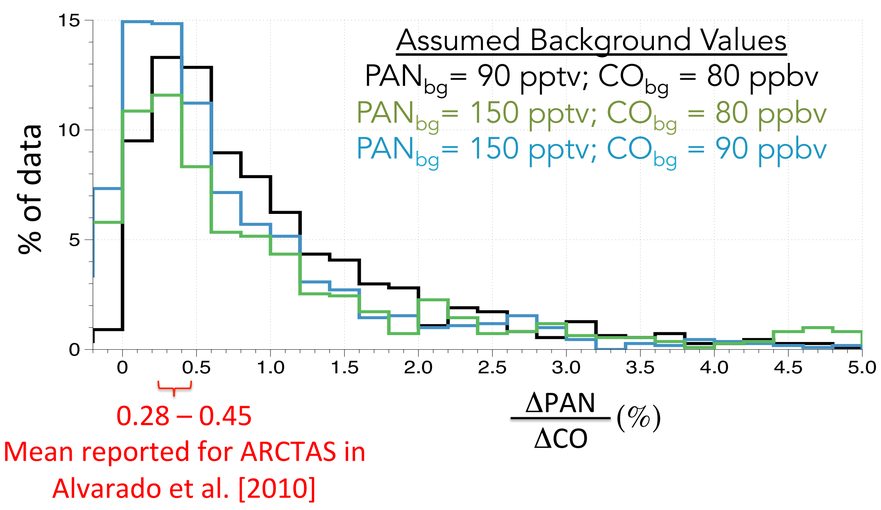
- 40 % of BB NO_x (*Akagi et al.* [2011]) directly emitted as PAN;
- NO_x emission factor reduced by 2/3;
- Model has PAN "emission ratio" relative to CO of ~0.3%;
- 35 % of BB smoke emitted above BL;



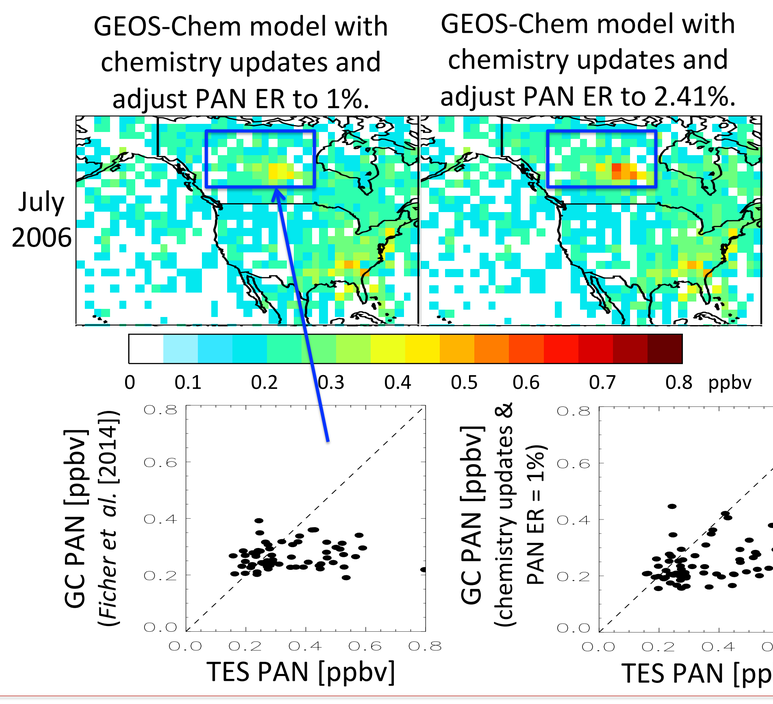
GC PAN simulation improved in the SE U.S.

- GEOS-Chem isoprene oxidation chemistry updates based on *Travis et al.* [2016].
- Emissions reduction: annual NO_x emissions reduced by 53% in the SE U.S.; MEGAN v2.1 isoprene emissions reduced by 21%.

Range of enhancement ratios for PAN in plumes as measured by TES.



For a summary of pitfalls with enhancement ratios, see *Yokelson et al.* [2013] AMT.



GC PAN simulation improved over boreal Canada

- NO_x emission restored;
- PAN emission ratio (ER) = 1%: 33% of BB NO_x directly emitted as PAN;
- PAN emission ratio (ER) = 2.41%: 80% of BB NO_x directly emitted as PAN.