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Large-scale impact of lightning NOx on the UT over the US

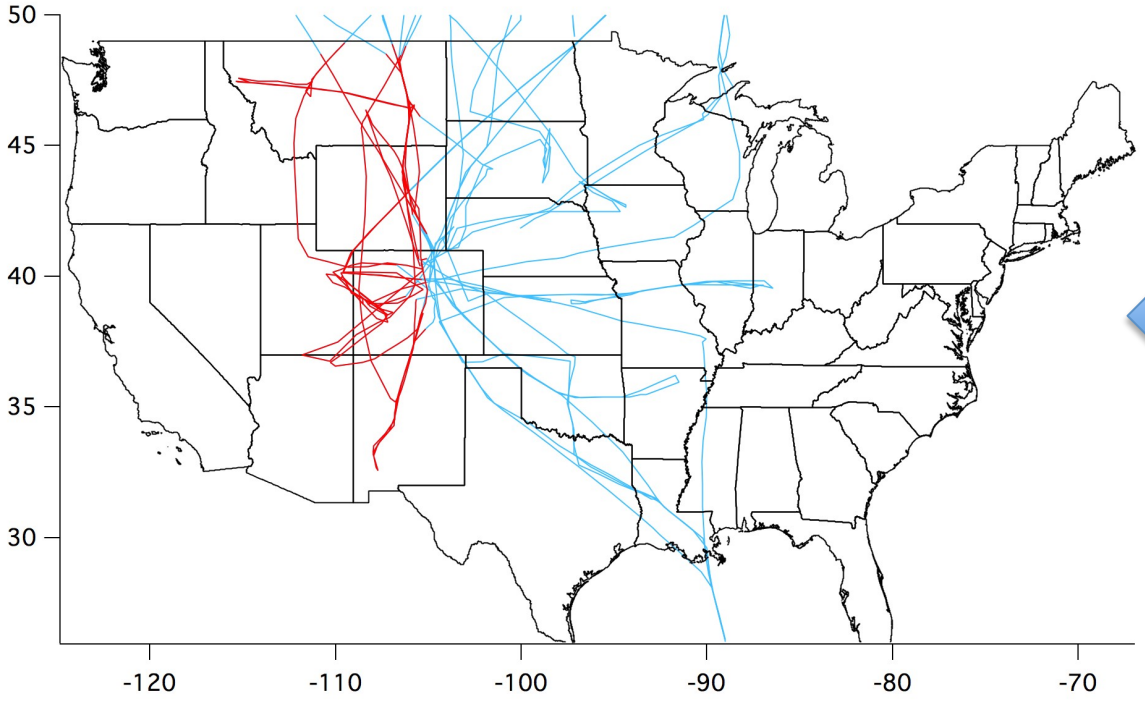
Hypothesis:

T-storms firing off the Rockies and moving E, (some becoming MCSs), and T-storms firing over the plains and moving E, should increase upper trop. NOx over the Eastern US compared to UT NOx over Western US.

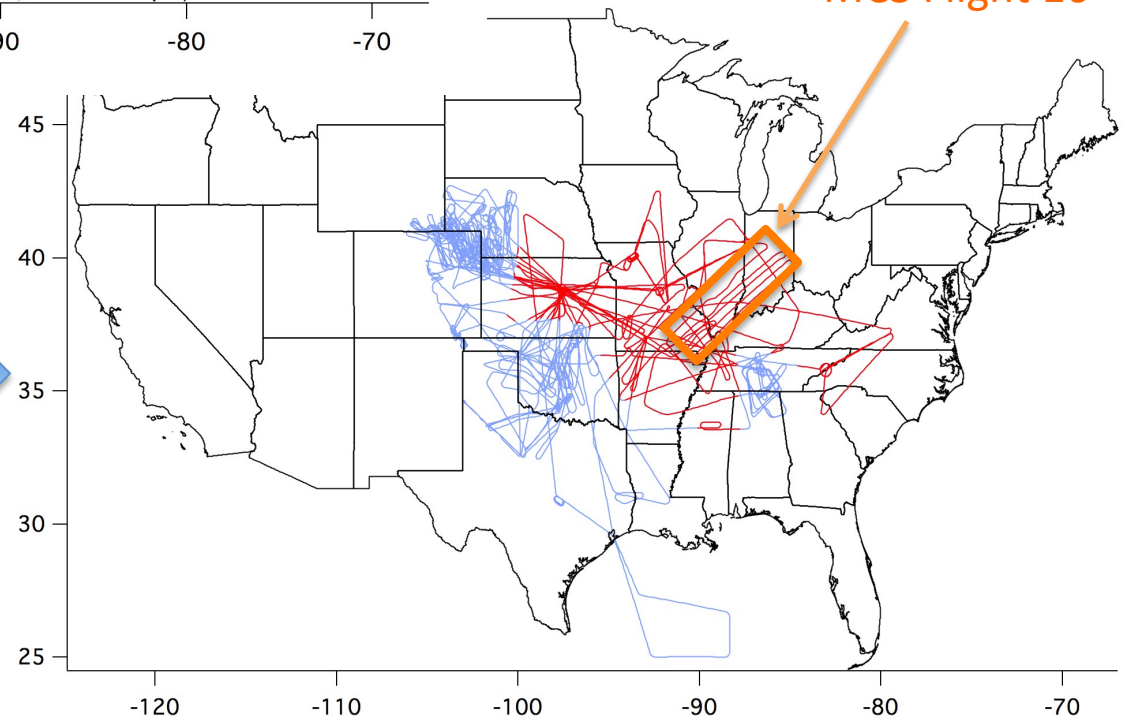
Idea:

Use summer 2008 data from START-08, parse out W-US data and compare with DC3 data (limit sampling bias by removing all direct outflow measurements).

(NO only since no NO_2 data (or J-values) for START-08)



START-08 (June 2008)
Red tracks mark flight data used here.
Further restrictions:
30-40 kft, O_3 < 100 ppb

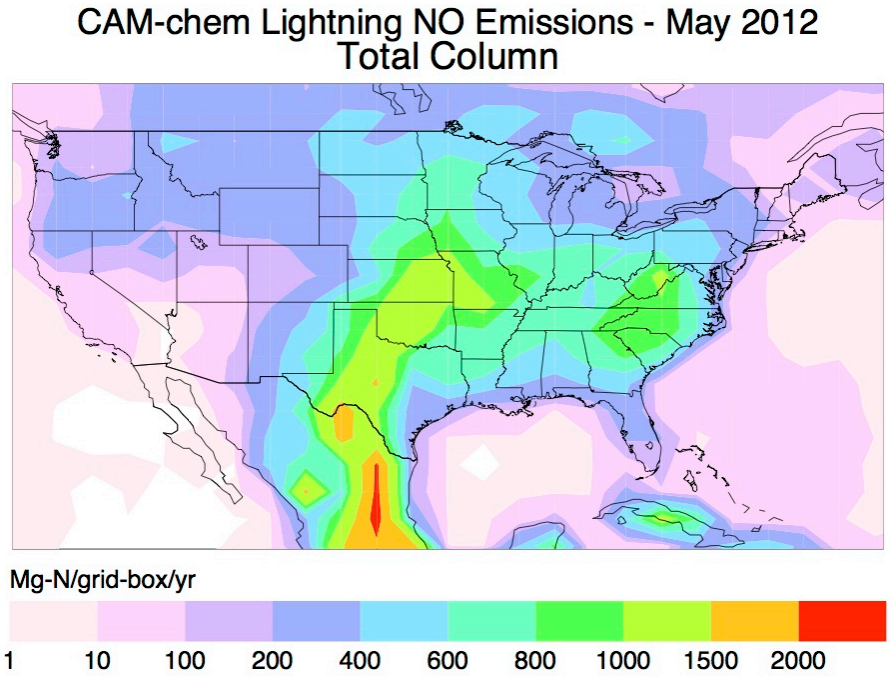


DC-3 (May/June 2012)
Red tracks mark flight data used here.
Further restrictions:
30-40 kft, O_3 < 100 ppb, calculated numbers for 2 sets of data (with and without the MCS flight, Flight 16)

CAM-chem for DC3

Louisa Emmons - NCAR/ACD

- CAM-chem – Community Atmosphere Model with Chemistry, component of NCAR CESM
- Lightning NO emissions: Price et al. [1997] with vertical distribution as in DeCaria et al. [2006]; CG=IC [Ridley et al., 2005]
- Biogenic emissions: MEGAN-v2.1 online
- Specified dynamics from GEOS-5



For this simulation, global annual total lightning NO emissions: 3 Tg-N/yr

NO in UT: CAM-chem vs Observations

	Observations Mean (Median)	CAM-chem
Western US - NO	76 (62) ppt	126 ppt
- O3	67.7 (68.4) ppb	71.5 ppb
Eastern US - NO	404 (341) ppt w/o MCS: 376 (270) ppt	220 ppt
- O3	77.9 (76.3) ppb w/o MCS: 81.3 (81.9) ppb	74.5 ppb

Observations:

Western US: START-08 (early June 2008)

Eastern US: DC3 (late May 2012)

(30-40kft, O3<100ppb, no direct outflow sampling)

CAM-chem: averaged over 310-190 hPa (9-12 km), 18-21Z, 35-48N, filtered for O3 < 100 ppb

Western US: 115-105°E, June 1-16, 2012

Eastern US: 100-80°E, May 16-31, 2012

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Conclusions:

- Data show f>4 or >300 pptv enhancement of NO over the E. US (MCS flight –expectedly- made no big difference).
- Model calculated ≈50% higher NO values for W. US than what was measured in 2008 but that could be annual variation or other biases.
- Model under-predicts NO enhancement by ≈ factor of 2 but there is still some sampling bias (we did not fly on calm weather days) and the model only averaged 3 Tg lightning NOx/year on this particular run.
- This approach might be a nice way to tackle lightning NOx representation and distribution in models.