Long-Term Aerosol Chemistry Data at SGP and Organic Aerosol VAP Development
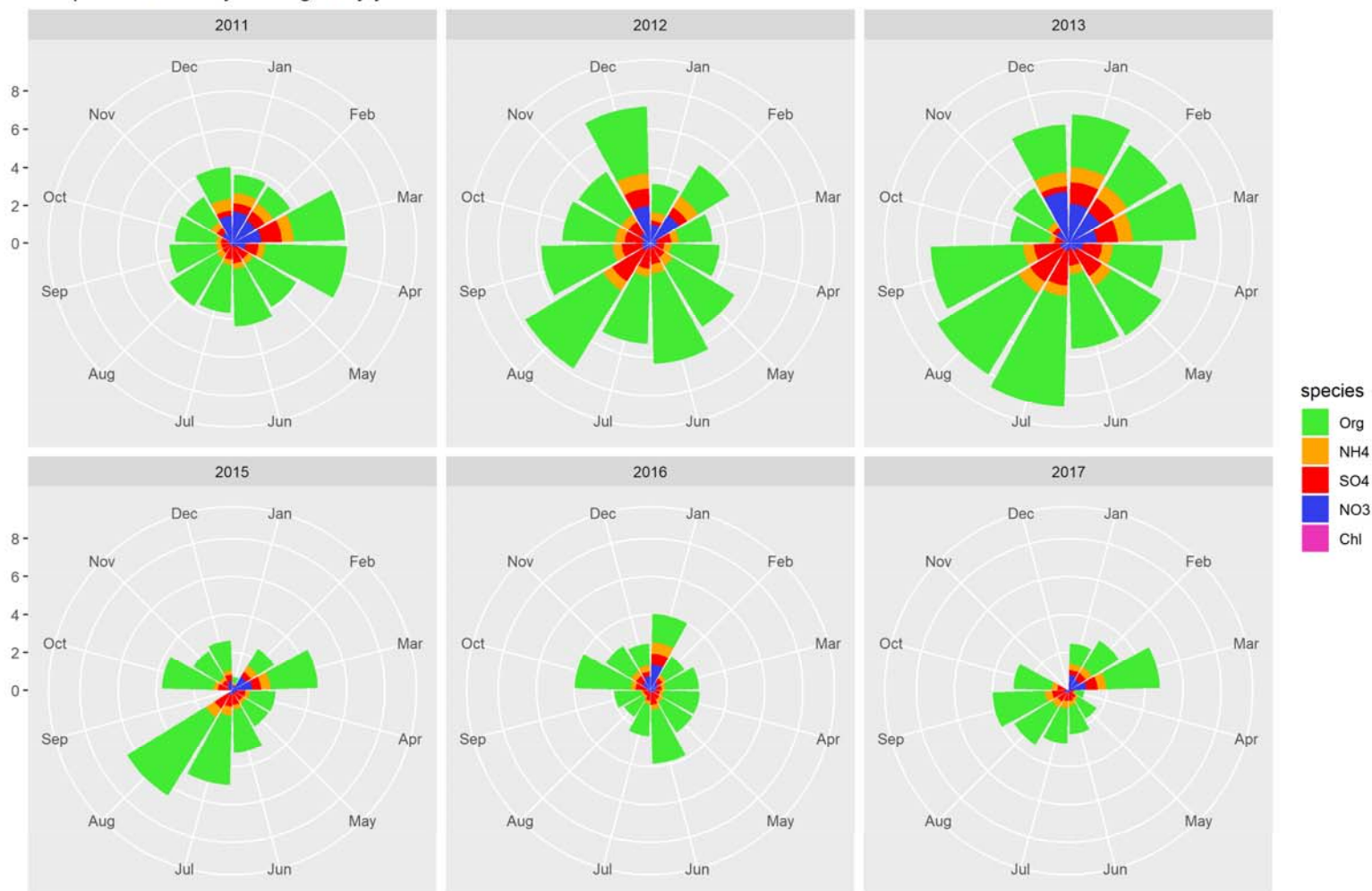
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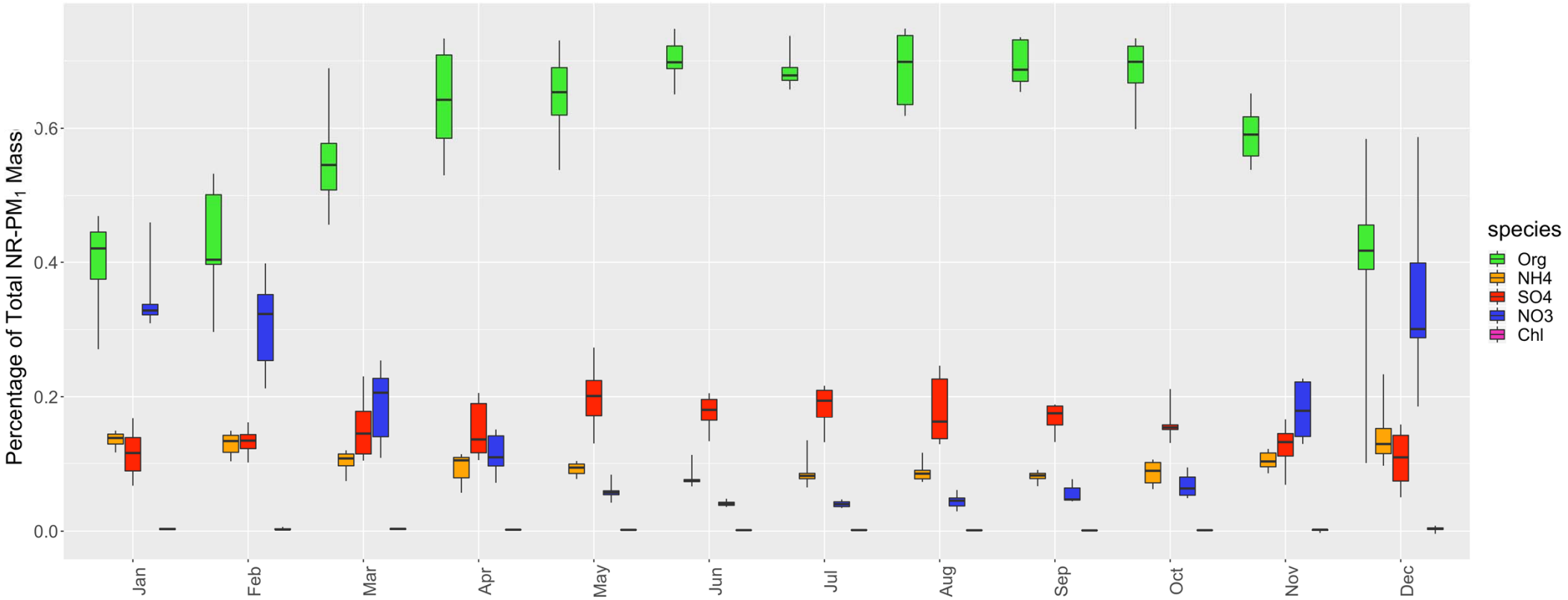
June 24, 2021 Breakout Session, ARM/ASR 2021 Virtual Joint Meeting

Organics Dominate PM$_1$ Mass at SGP

All Species - Monthly Averages By year

Organics Dominate PM$_1$ Mass at SGP

Organic Aerosol Value Added Products

- **Goal**: To represent the enormously complex atmospheric OA chemistry as <u>lumped descriptions of a limited number of components</u> that may be related to distinct sources, physicochemical properties, and atmospheric processes.

- **Methodology**: Multivariate statistical analysis of ACSM / AMS data.
  - Rolling window strategy for long term data analysis
    - Small chunk of MS matrix, continue roll over on time axis
    - Better capture time-dependent variations of factor profiles

- **Assumption:** ACSM/AMS organic aerosol data matrix is comprised of the linear combination of OA components with constant profiles that have varying contributions across the dataset.

- **Products:**
  - Mass concentration time series of OA factors (OA_i); $\Sigma(OA_i) \approx Organics$
  - Mass spectra of OA components that bear information of their distinct chemical properties, e.g., O/C, H/C, OM/OC

OAComp VAP

Contents lists available at ScienceDirect

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Long-term measurements of submicrometer aerosol chemistry at the Southern Great Plains (SGP) using an Aerosol Chemical Speciation Monitor (ACSM)

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HIGHLIGHTS   http://www.sciencedirect.com/science/article/pii/S1352231015000837
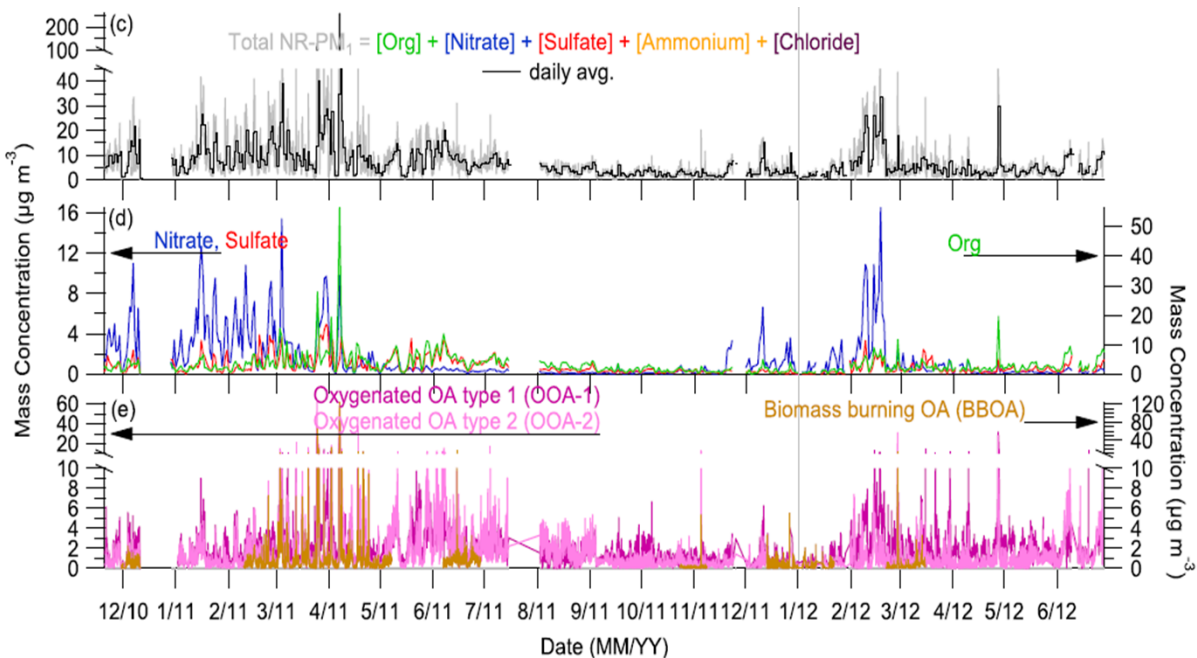
- Realtime measurements of non-refractory submicron aerosols were conducted at SGP.
- Diurnal, weekly, monthly, and seasonal variations of aerosol composition are reported.
- Two types of oxygenated organic aerosols and biomass burning OA were determined.
- Enhanced nitrate during winter was due to transport of NO_x and NH_3 combined with cooler temperatures.

Rolling Window PMF Methodology

- Standard pretreatment method applied (Ulbrich et al., 2009 & Zhang et al., 2011)
- Rolling window size = 2 weeks
  - b/c contains enough data to capture dynamic variations of aerosols and is representative of avg. lifecycle of aerosols in atmosphere
- Data increment is 1 day until end of data reached
- 3 factor solutions for this rural site:
 - BBOA and two types of OOA

https://www.osti.gov/biblio/1226569-organic-aerosol-component-oacomp-value-added-product

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Organic Aerosol Component (OACOMP) Value-Added Product

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https://doi.org/10.2172/1226569

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Abstract

Organic aerosol (OA, i.e., the organic fraction of particles) accounts for 10–90% of the fine aerosol mass globally and is a key determinant of aerosol radiative forcing. But atmospheric OA is poorly characterized and its life cycle insufficiently represented in models. As a result, current models are unable to simulate OA concentrations and properties accurately. This deficiency represents a large source of uncertainty in quantification of aerosol effects and prediction of future climate change. Evaluation and development of aerosol models require data products generated from field observations. Real-time, quantitative data acquired with aerosol mass spectrometers (AMS) (Canagaratna et al. 2007) are critical to this need. The AMS determines size-resolved concentrations of non-refractory (NR) species in submicrometer particles (PM1) with fast time resolution suitable for both ground-based [...] MS (HR-AMS), which is equipped with a high mass resolution [...] to determine the elemental composition and oxidation degrees of

Shippert, T [1]; Parworth, C; Mei, F [1]

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DOE/SC-ARM-TR-131

Organic Aerosol Component (OACOMP) Value-Added Product

J Fast   T Shippert
Q Zhang   C Parworth
A Tilp   F Mei

August 2013
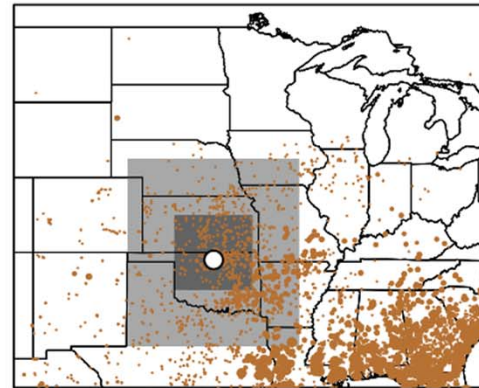
ARM CLIMATE RESEARCH FACILITY

Parworth et al., 2015

- PMF was performed on 18 months of data (Nov. 2010 – Apr. 2012) at SGP

- Three OA factors were resolved
  - low-volatile oxygenated OA (LV-OOA)
  - semi-volatile oxygenated OA (SV-OOA)
  - biomass burning OA (BBOA).

(a) Daily OC Fire Emissions, 2011
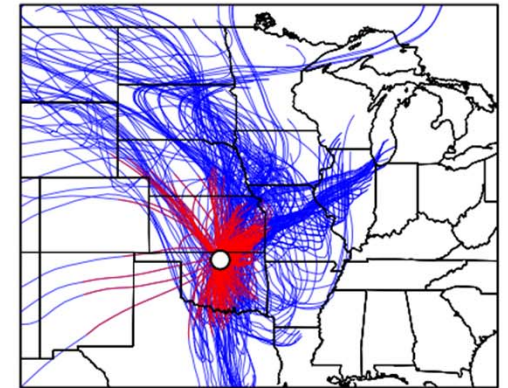
(b) BBOA at the SGP site, 2011
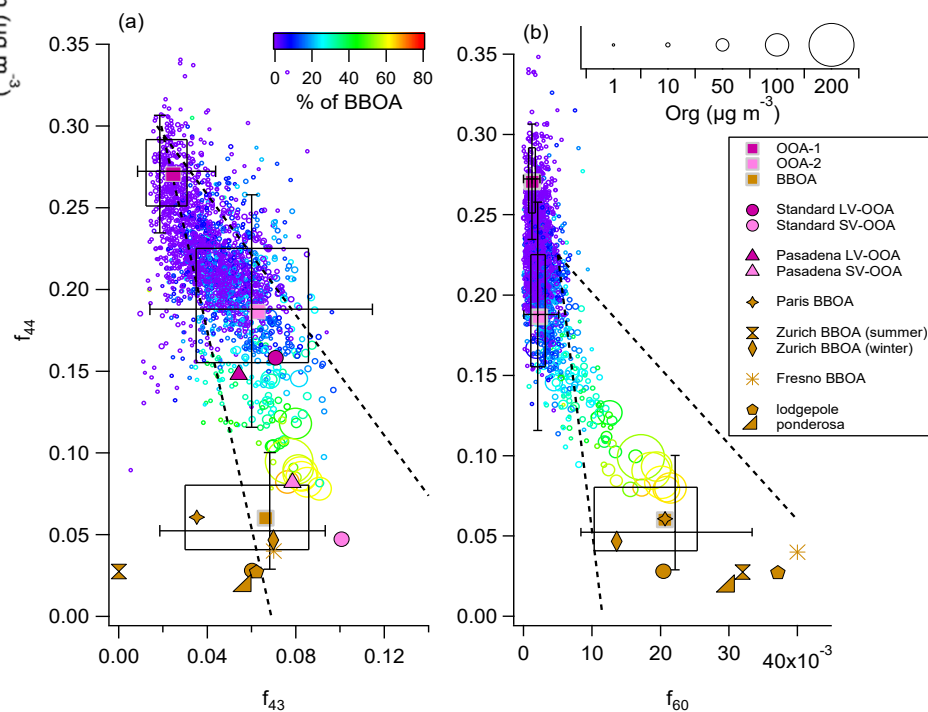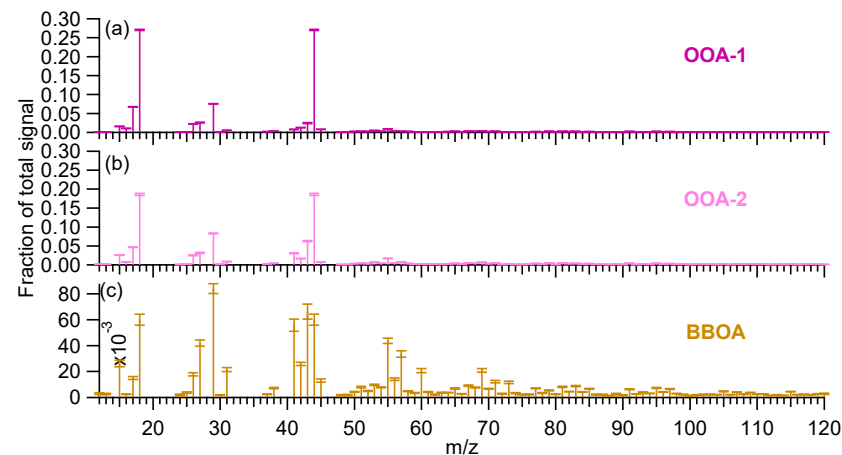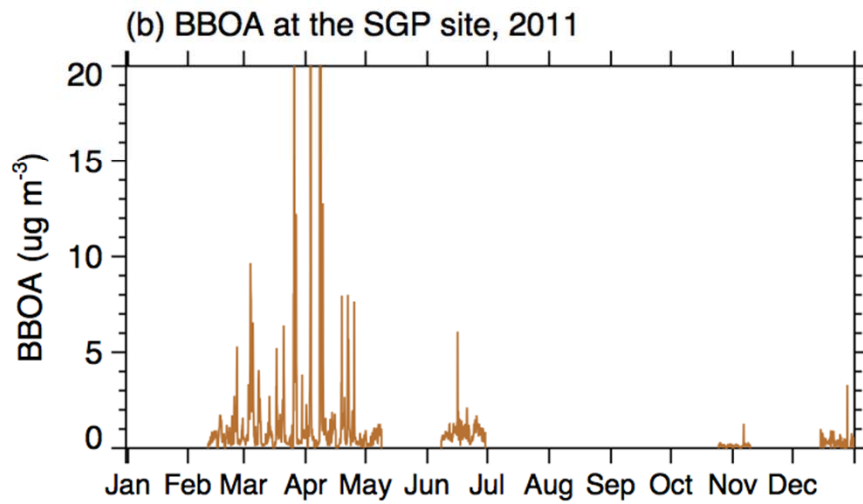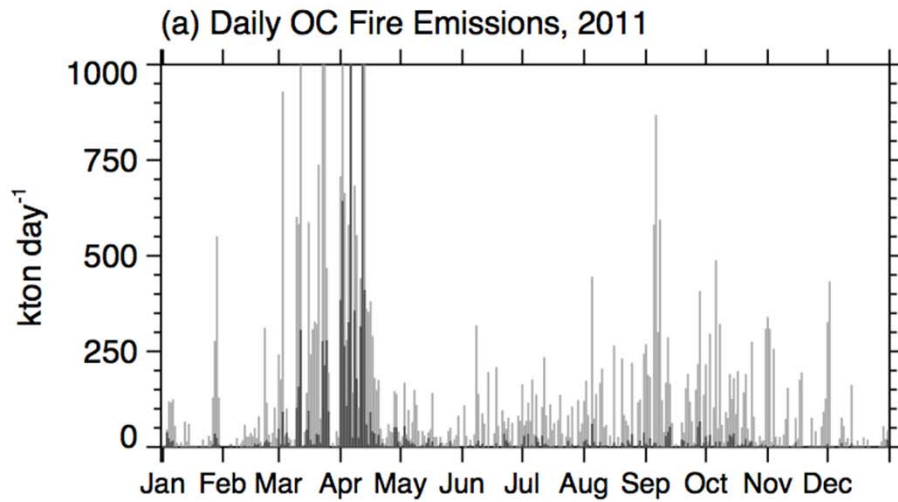
(e) Fire Locations, March 2011
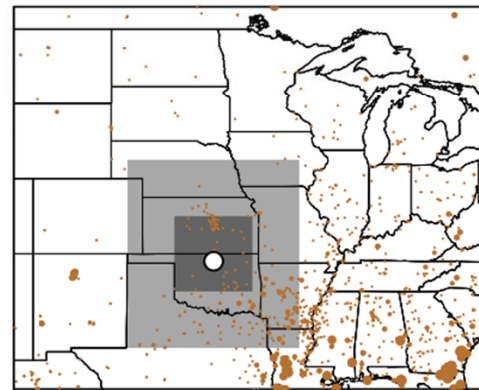
(g) Back Trajectories, March 2011

2-day transport   2 to 7-day transport

(f) Fire Locations, July 2011

(h) Back Trajectories, July 2011

Parworth et al., 2015
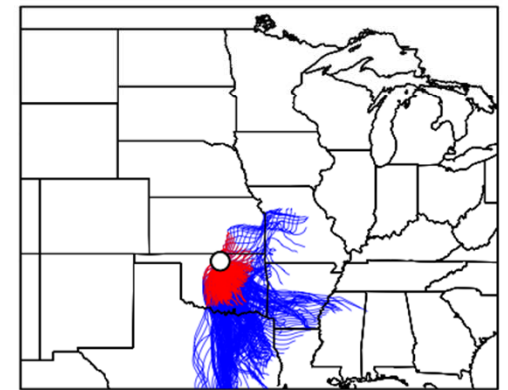
Applications of the Organic Aerosol VAP

- Addressing the lifecycle processes of atmospheric OA.
  - Temporal, diurnal, and seasonal variations
  - Correlations with tracer compounds
  - *size distributions…, integrated analysis*
- Addressing the radiative properties of OA.
  - Surrogates (e.g., O/C) for hygroscopicity and/or volatility.
  - Correlations and intercomparison with aerosol optical and radiative measurements.
- Validation and evaluations of models