FTIR: a Promising Method for Evaluating Organic PM on IMPROVE Teflon Filters

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Why do we need additional ways to characterize organic PM?

- Quartz filters are prone to artifacts
- Organic O, H, N and S not currently measured
  - Must estimate OM from C alone
- Fundamental information about organic material (functional groups) useful for:
  - Identifying sources
  - Understanding atmospheric transformations

Overview

- Capabilities and limitations of FTIR
- Research at Tonto and Phoenix IMPROVE sites using FTIR
- Forest fire PM measured in Davis, CA
- Proposal on Secondary Organic Aerosol from Wood Burning

Fourier Transform InfraRed (FTIR) Spectroscopy

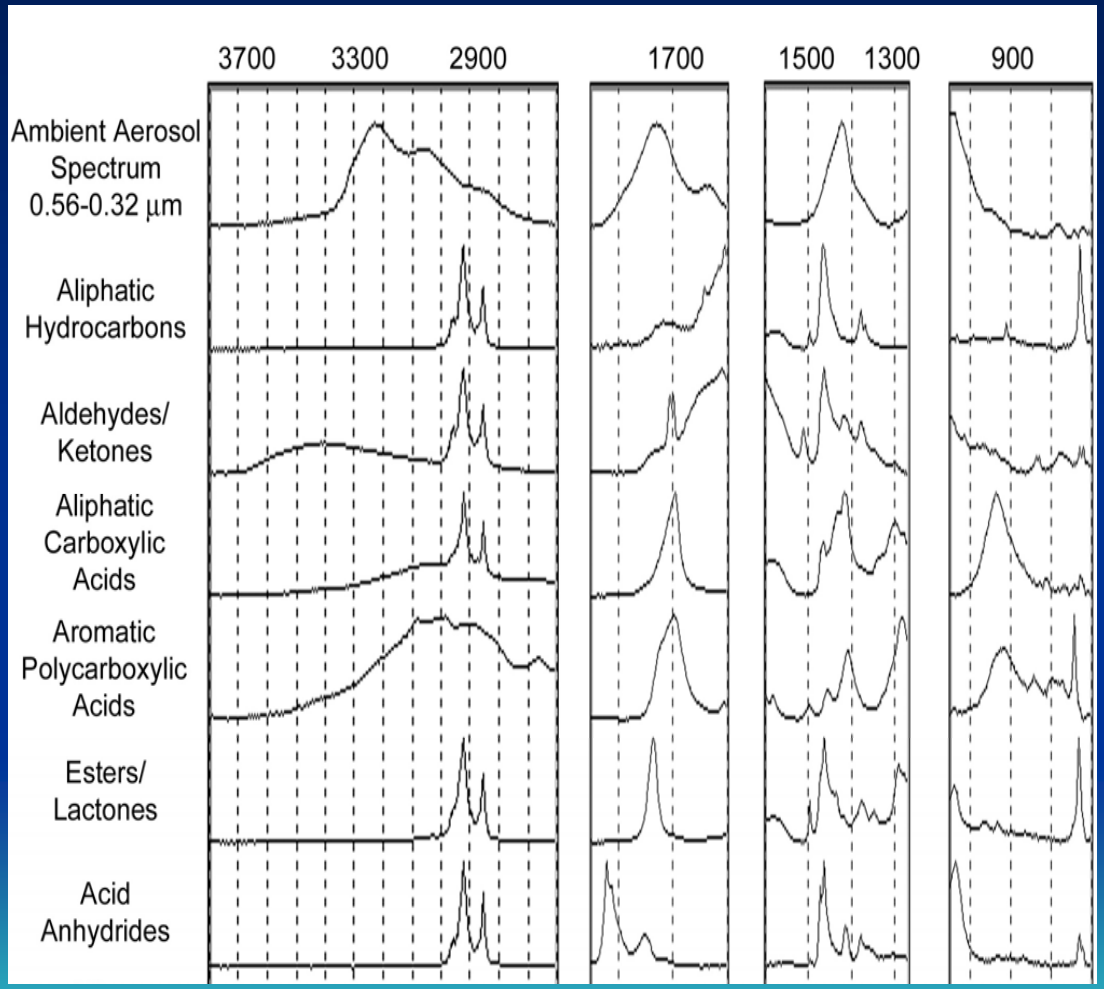
- Performed on Teflon filters
  - Less prone to artifact than quartz
- High sensitivity
- Quantitatively measures organic functional groups (C-H, C-O, C=O)
  - Direct measurement of OM
  - Source identification
  - Atmospheric aging
- Destructive and non-destructive techniques
- Not compound specific (e.g., levoglucosan)
- Does not measure graphitic carbon
- Goal: use for special investigations

Sources of OC in Superstition Wilderness

- FTIR (destructive)
- Quantitatively measured
  - 9 organic functional groups
  - 2 inorganic compounds
- Sampling
  - Tonto IMPROVE site
  - Phoenix IMPROVE site
  - an intermediate site
- 24 hr samples
- 5 bins < 1 μm (MOUDI)
- Teflon substrates

Tonto National Monument IMPROVE site

FTIR spectra



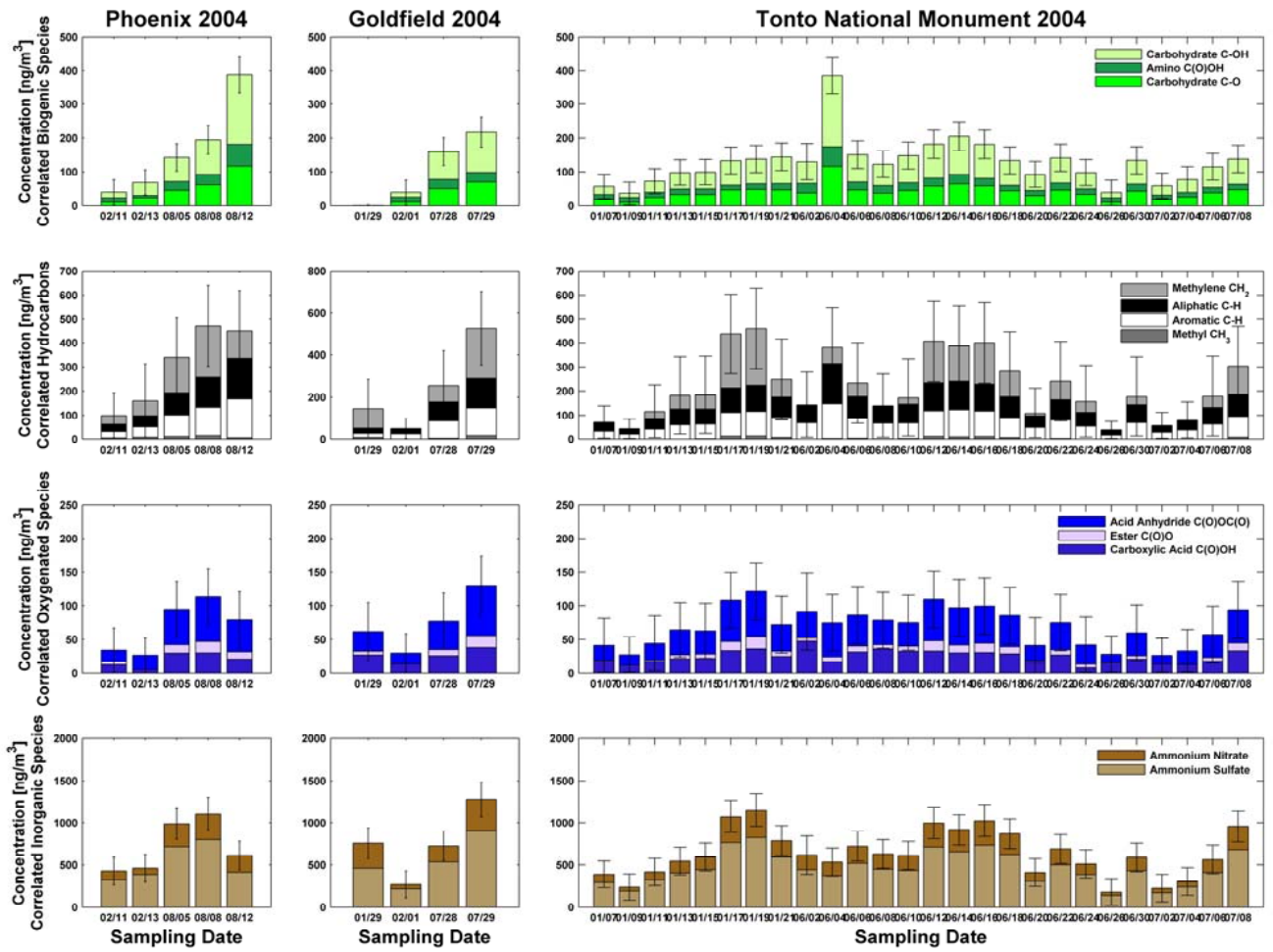
Coury, C., Dillner A. M. (2008)

Calibration

- Calibration standards
  - 75 standards
  - Known amounts of all observed classes
  - Varied concentrations of classes
  - Spectra look like ambient samples
- Multivariate calibration algorithm (PLS)
  - Uses whole spectra
  - Based on peak areas
  - Accounts for interactions between functional groups

Coury, C., Dillner A. M. (2008)

Functional Group Results



Coury, C., Dillner A. M. (2009)

Results from Tonto and Phoenix

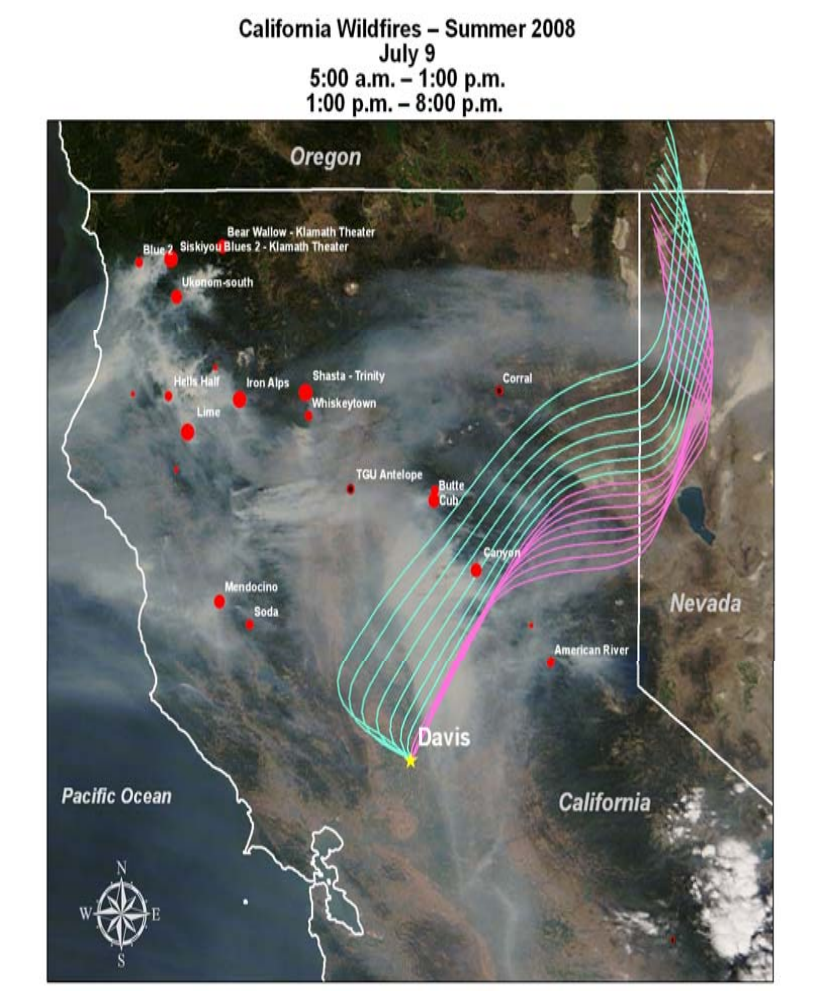
- FTIR has high sensitivity
  - Quantified 9 organic functional groups and 2 inorganic compounds in size segregated samples
  - MDLs ≤ 25 ng/m^3
  - Parallel thermal optical OC < MDL
- FTIR quantified 91 ± 38% of gravimetric mass
  - Graphitic carbon, metal oxides
- Dominant sources identified
  - Biogenic
  - Urban influenced
  - Background

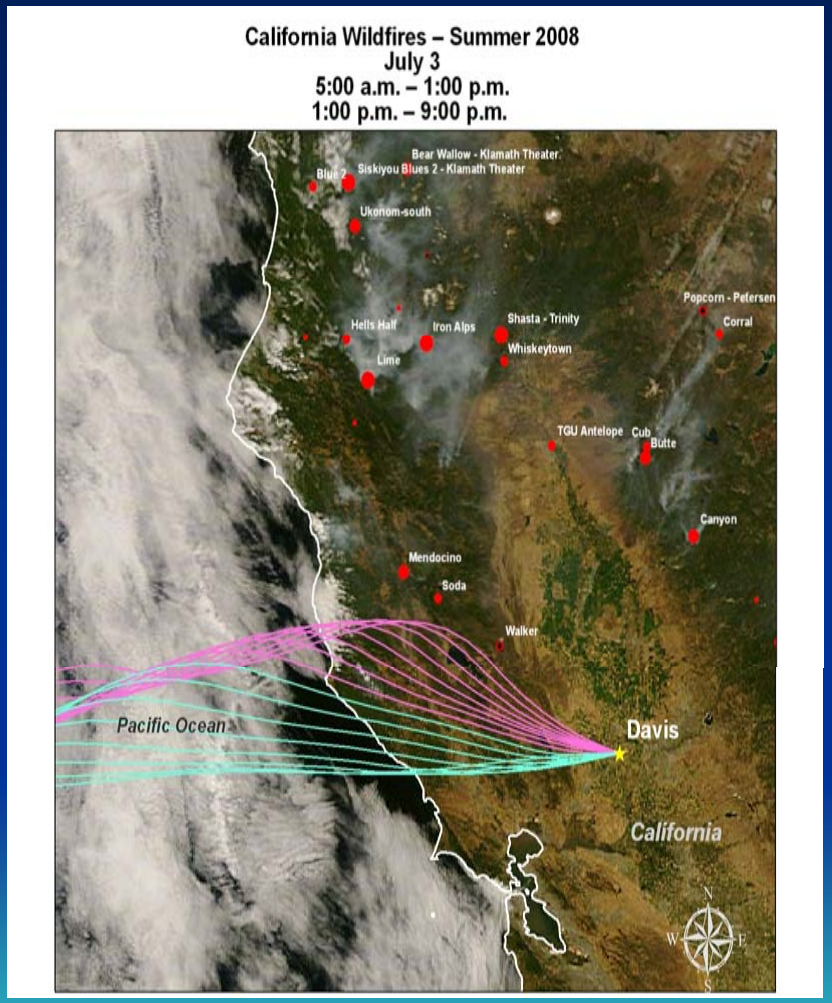
Coury, C., Dillner A. M. (2008, 2009)

2. Forest Fire PM Summer 2008

- 8 hour IMPROVE samples
- 1 month, Davis CA
- PM2.5
  - Mass
  - Elements (XRF)
  - Carbon
    - OC/EC
    - FTIR (functional groups)
    - HIPS (light absorption)
  - Ions
    - Sulfate, nitrate
    - Ammonium, K^+?
    - Unidentified peaks

Fires Impact Davis





ArcGIS, satellite images, fire data, back trajectories

Goals of FTIR on Forest Fire samples

- Characterize functional groups from wild fires and non-wild fire samples
  - Aging
  - Fuels
  - Fire intensity
- Spectral IR spectral signatures from fires
- Develop non-destructive FTIR method for IMPROVE PM2.5 samples

Quantifying secondary organic aerosols (SOA) from wood burning

- Proposal to NSF with 2 UCDavis researchers
- Laboratory study
  - Known gases emitted from fires
  - Add “sunlight” and oxidants
  - Use FTIR to characterize non-volatile products (SOA)
    - Quantify functional groups
    - Characterize spectral signature
- Whole smoke
  - Burn hard and soft wood in lab
  - Collect gases
  - Add “sunlight” and oxidants
  - Use IR to characterize non-volatile products (SOA)
    - Quantify functional groups
    - Characterize spectral signature

FTIR - A promising technique

- FTIR has high sensitivity
- FTIR quantifies functional groups and total OM in PM
  - Chemical nature of OM
  - Sources
  - Aerosol aging
- Current projects
  - Develop non-destructive technique for IMPROVE samples
  - Characterize ambient aged PM from forest fires
  - Characterize SOA from fires (proposal)
- Longer term goals: Use FTIR on specific IMPROVE samples with suspected fire impact and special studies

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