Determination of carbohydrates, phospholipids, and proteins associated with particulate matter in Boulder, CO

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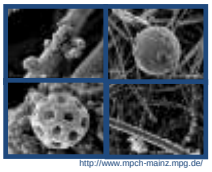
Aerosols (Particulate Matter)

- Aerosols are small particles (solid or liquid) suspended in the atmosphere with diameters from 0.001 to 10 µm, originating from
  - Anthropogenic sources
    - Industrial Dust
    - Biomass burning
  - Natural
    - Organic aerosol
    - Ocean Sea Salt
    - Terrestrial Dust



http://www.mpch-mainz.mpg.de/

http://www.pnl.gov/atmospheric/

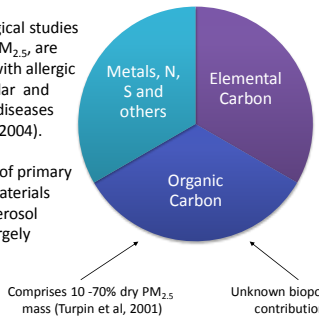
Impact of Aerosols

Impacts	General Examples
Health	Transporting toxic substances, can be inhaled through the respiratory tract
Climate	Scattering and absorption of solar radiation. Altering cloud properties through their ability to act as cloud condensation nuclei.
Ecosystem	Reduces sunlight, which could have effects in terrestrial and marine biological productivity
Visibility	Terrestrial Dust

Research Motivation

Epidemiological studies show that $PM_{2.5}$, are correlated with allergic cardiovascular and respiratory diseases (Pope et al. 2004).

Association of primary biological materials with total aerosol burden is largely unknown.



Bioaerosols

Aerosols can be analyzed for the major biopolymers comprising plant and microbiological cells

Bioaerosol = "PM_{BIO}"

PM_{BIO} = **PM_{Plant}** + **$PM_{Microbiological}$**

PM_{Plant}	$PM_{Microbiological}$
• Detrital components • Pollens, Spores, Fragments • (Hemi)cellulosic Materials	•Cells •Spores •Fragments, Hyphae, Gonidia

DNA + Lipid + Carbohydrate + Protein

Organic Carbon Basis

Biopolymers

- Carbohydrates
  - Tracers to track aerosols of biologically derived origin (Coz et al. 2010).
- Proteins
  - The most important group of allergens (Russell et al. 2000; Invitrogen Kit)
- Phospholipids
  - Markers for pollen and fungal spores (Wumiloju et al. 2003; Findlay et al. 1989)

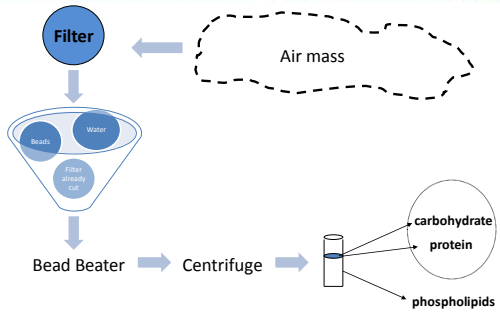
Hypothesis

- The carbohydrates, phospholipids and proteins could make a significant contribution to Organic Carbon basis.

Aerosol Sampling:

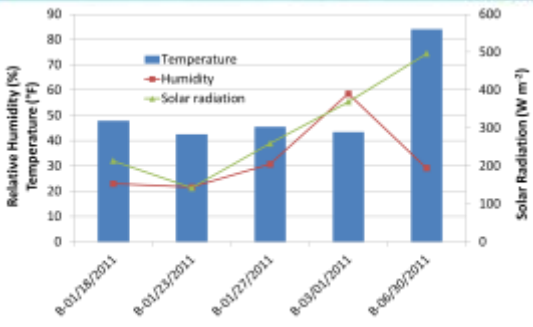
Sampling Sites

Extraction Procedure:



RESULTS

Ambient Parameters



HYSPLITs

Carbohydrates Method

PM_{10}, $PM_{2.5}$ in ambient air

↓

Filter collection and elution

↓

H_2SO_4 hydrolysis

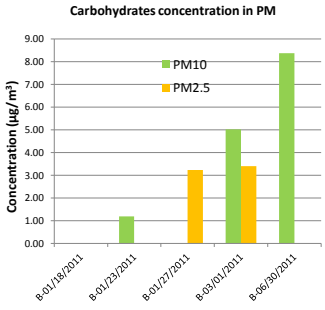
↓

Phenol complexes monosaccharides (yellow color)

Carbohydrate Quantitation (DuBoisTest)

- Sulfuric acid digestion hydrolyzes polysaccharides
- Phenol complexes monomers → COLOR
- Dextrose standard (40% OC)

Carbohydrates



Phospholipid Method

PM_{10}, $PM_{2.5}$ in ambient air

↓

Filter collection and elution

↓

Persulfate digestion

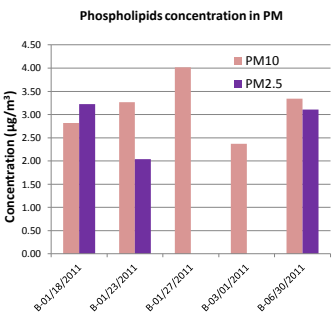
↓

Malachite green complexes phosphates (green color)

Lipid Quantitation

- Persulfate hydrolyzes phospholipids
- Malachite green complexes monomers → COLOR
- Glycerophosphate standard (**20 % OC**)

Phospholipids



Protein Method

PM_{10}, $PM_{2.5}$ in ambient air

↓

Filter collection and elution

↓

Addition of fluorochrome

↓

Protein Fluorescence

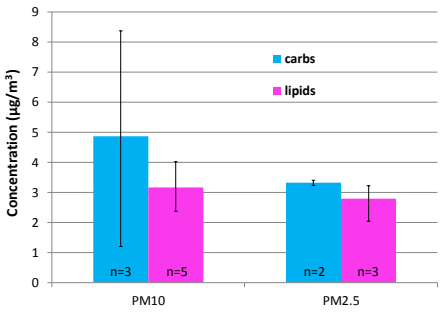
Protein Quantitation (Nano Orange) Molecular Probes

- Protein Intercalation w/ dye
- BSA (bovine serum albumin) Standard (47% OC)

Summary

	Temperature (°F)	Solar Radiation (W m-2)	Relative Humidity (%)	Carbohydrates (µg/m³) PM_{10}	Carbohydrates (µg/m³) $PM_{2.5}$	Phospholipids (µg/m³) PM_{10}	Phospholipids (µg/m³) $PM_{2.5}$	Proteins (µg/m³) PM_{10}	Proteins (µg/m³) $PM_{2.5}$
01/18/11	48	23	213	<	<	2.82	3.23	<	<
01/23/11	43	22	142	1.20	<	3.27	2.04	<	<
01/27/11	46	31	259	<	3.24	4.02	-	<	<
03/01/11	43	59	369	5.02	3.41	2.37	-	<	<
06/30/11	84	29	496	8.37	<	3.34	3.10	<	<

Summary



Conclusions

- Carbohydrates associated with PM_{10} fraction have seasonal trend
- Phospholipids content remains constant over time
- Water- Soluble Proteins were below detection limit
- Carbohydrates and Phospholipids have a contribution in OC

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