Collection and Characterization of Organic Matter in NADP Wet and Dry Deposition

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INSTAAR

PM deposition at Niwot Ridge, CO

- Wet dep.
  - ~1350 kg C/yr
- Dry dep.
  - From DOC in snow: at most ~4100 kg C/yr
  - From dry deposition analyses:

    ~2700 kg C (June)

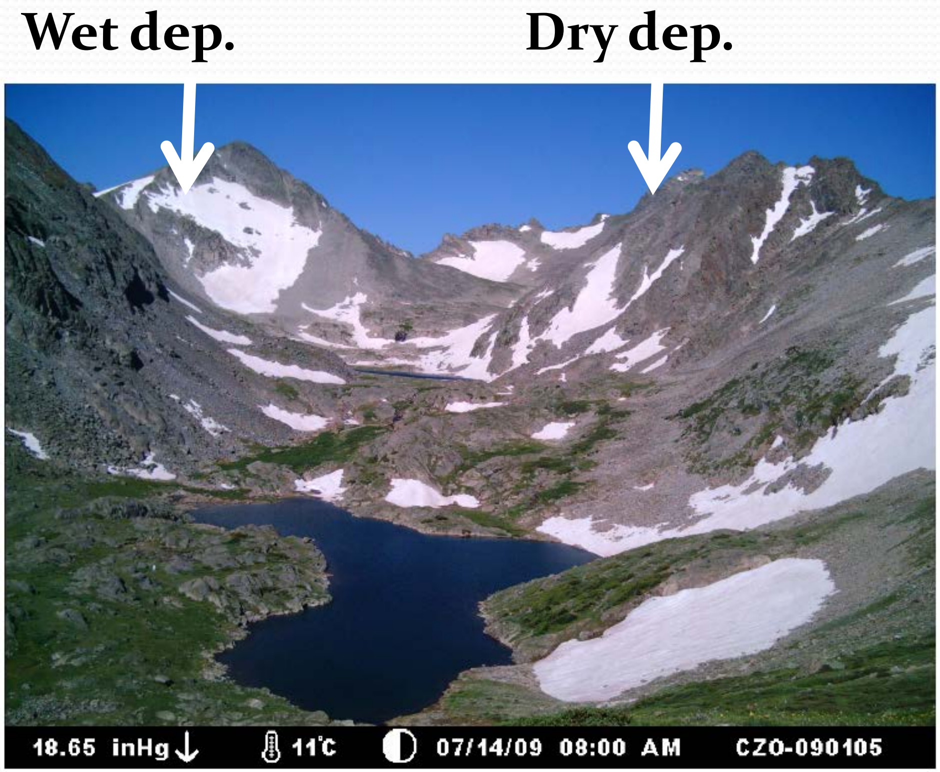
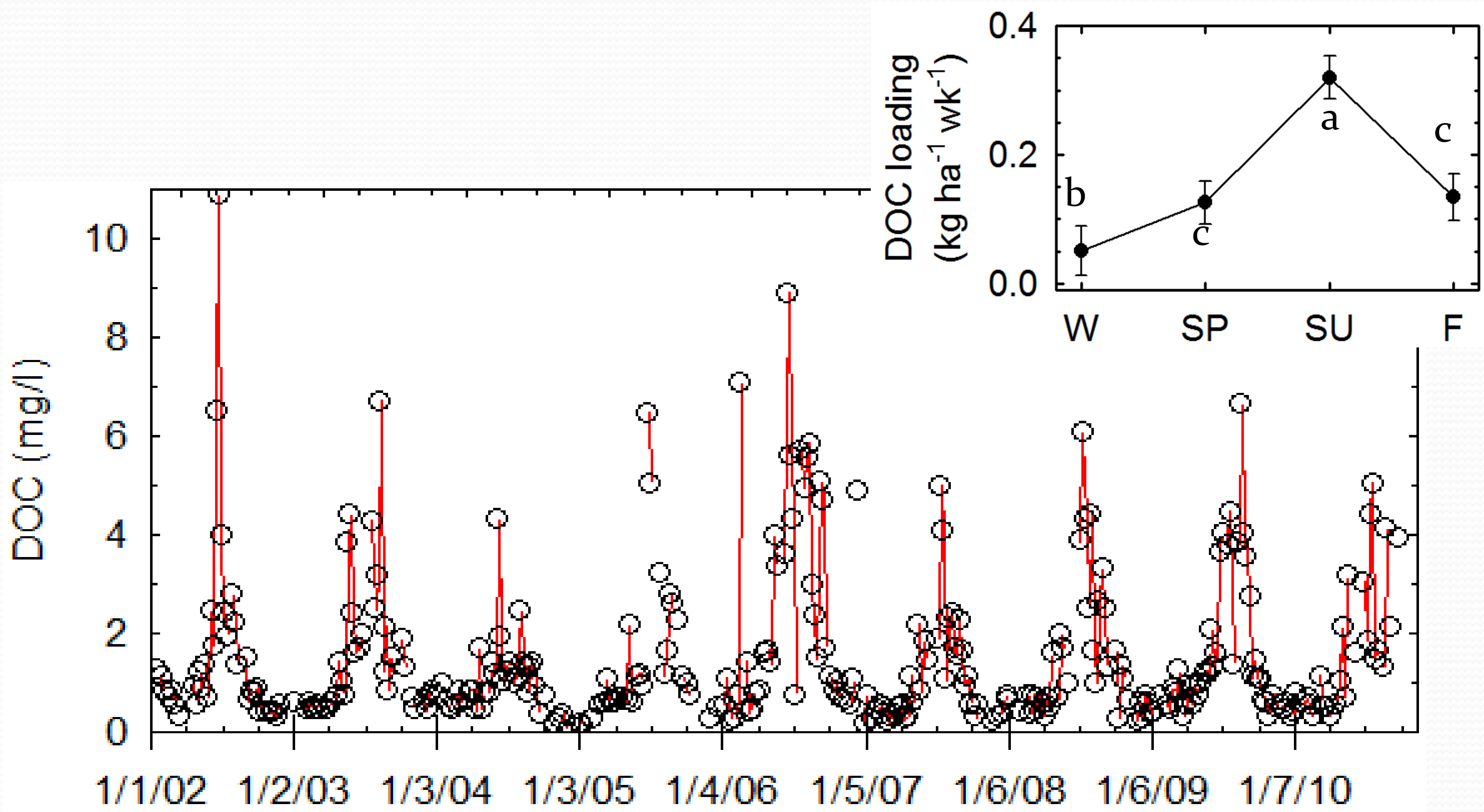


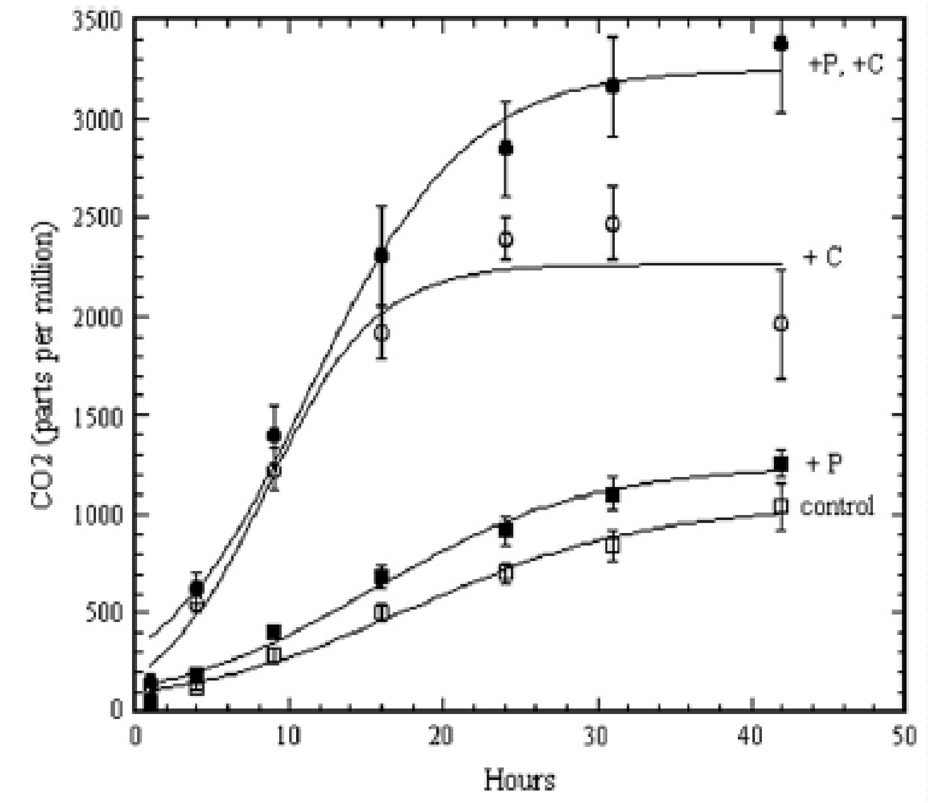
Photo Credit: Boulder Creek Critical Zone Observatory

Seasonality in Wet Deposition



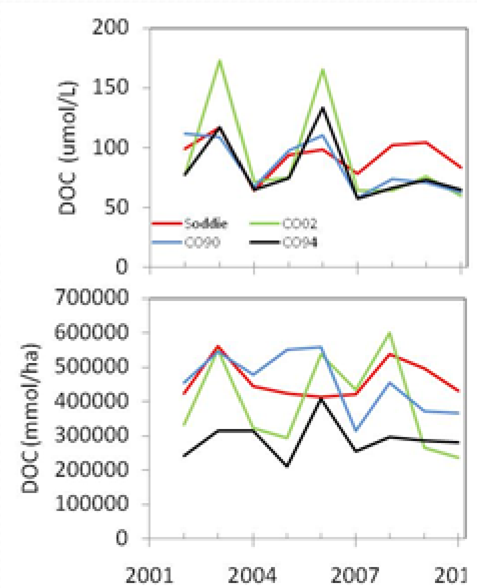
Importance of Organic Carbon

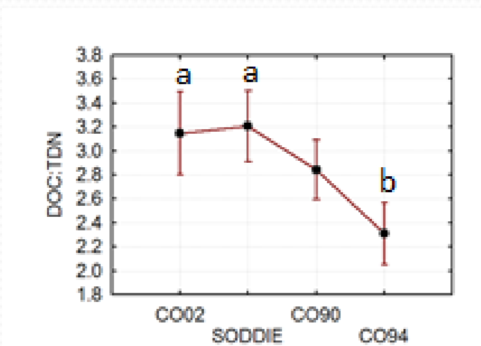
- High microbial abundance in barren alpine soils
- Microbes are carbon-limited.
- Atmospheric inputs of carbon may be important in these carbon-limited environments.
- Biogeochemical cycling of carbon affects downstream water quality



King et al., *Soil Biol Biochem,* 2008.

Elevation





- Green Lakes Valley, Colorado: NADP wet/dry deposition collectors and dedicated Soddie collector

  CO02 (3520 m)
  Soddie (3345 m)
  CO90 (3022 m)
  CO94 (2524 m)

- Volume weighted mean DOC
- One-way ANOVA analyses: significant difference between only CO02/Soddie and CO94.

Dry deposition

- Collection challenges
- Marble inserts
- Objective: To quantify organic carbon inputs in wet and dry deposition
  - Preliminary information on quality of organic matter
- Processing
  - DOC, TDN, TDP
  - Fluorescence
  - FlowCAM
  - Further chemical analyses

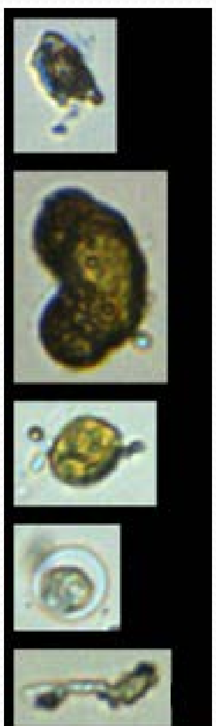
How well do the marble inserts perform?

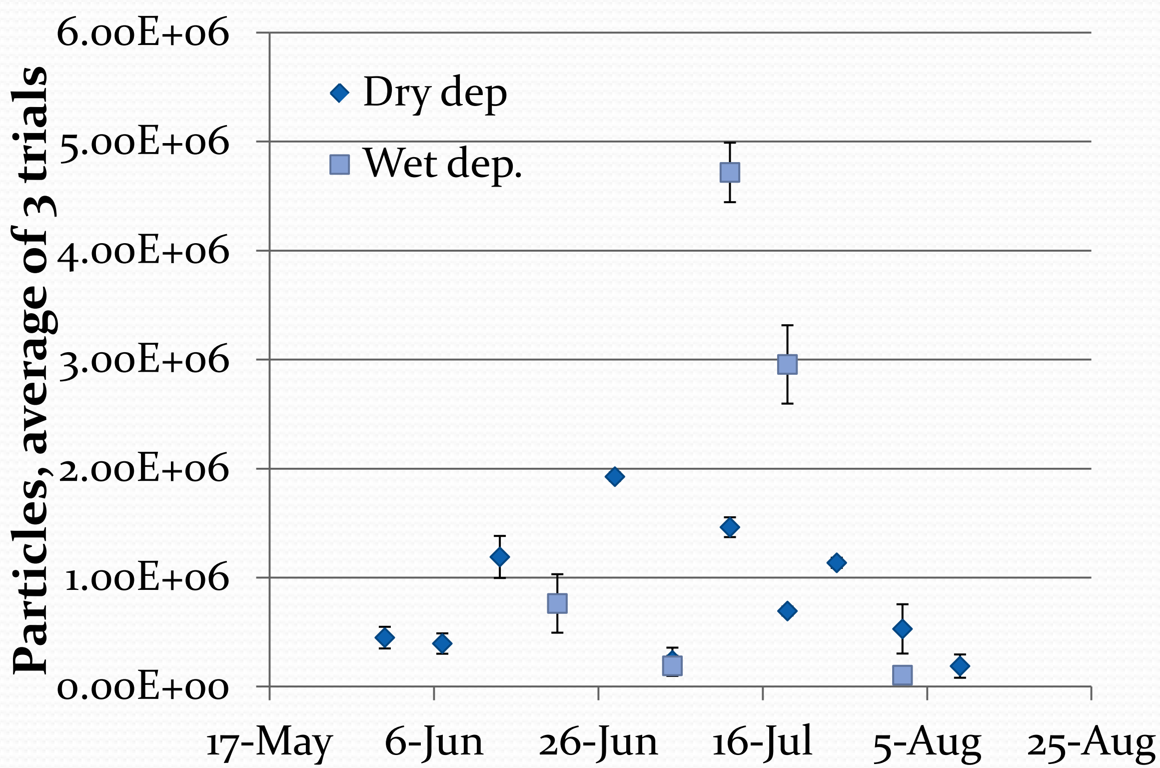
- Dust addition experiments
  - DOC, TDN, TDP
  - Percentage mass recovered
    - Humidity and detection limits

		DOC	TDN	pH	ANC
Trial A	Control	0.23	0.011	5.55	27.10
	Marbles	0.91	0.073	6.22	9.19
Trial B	Control	0.43	0.011	5.55	17.18
	Marbles	0.51	0.065	6.23	6.16
Trial C	Control	0.16	0.015	5.58	5.92
	Marbles	0.34	0.019	6.00	13.51
		$p=0.17$	$p=0.08$	$p=0.02$	$p=0.33$

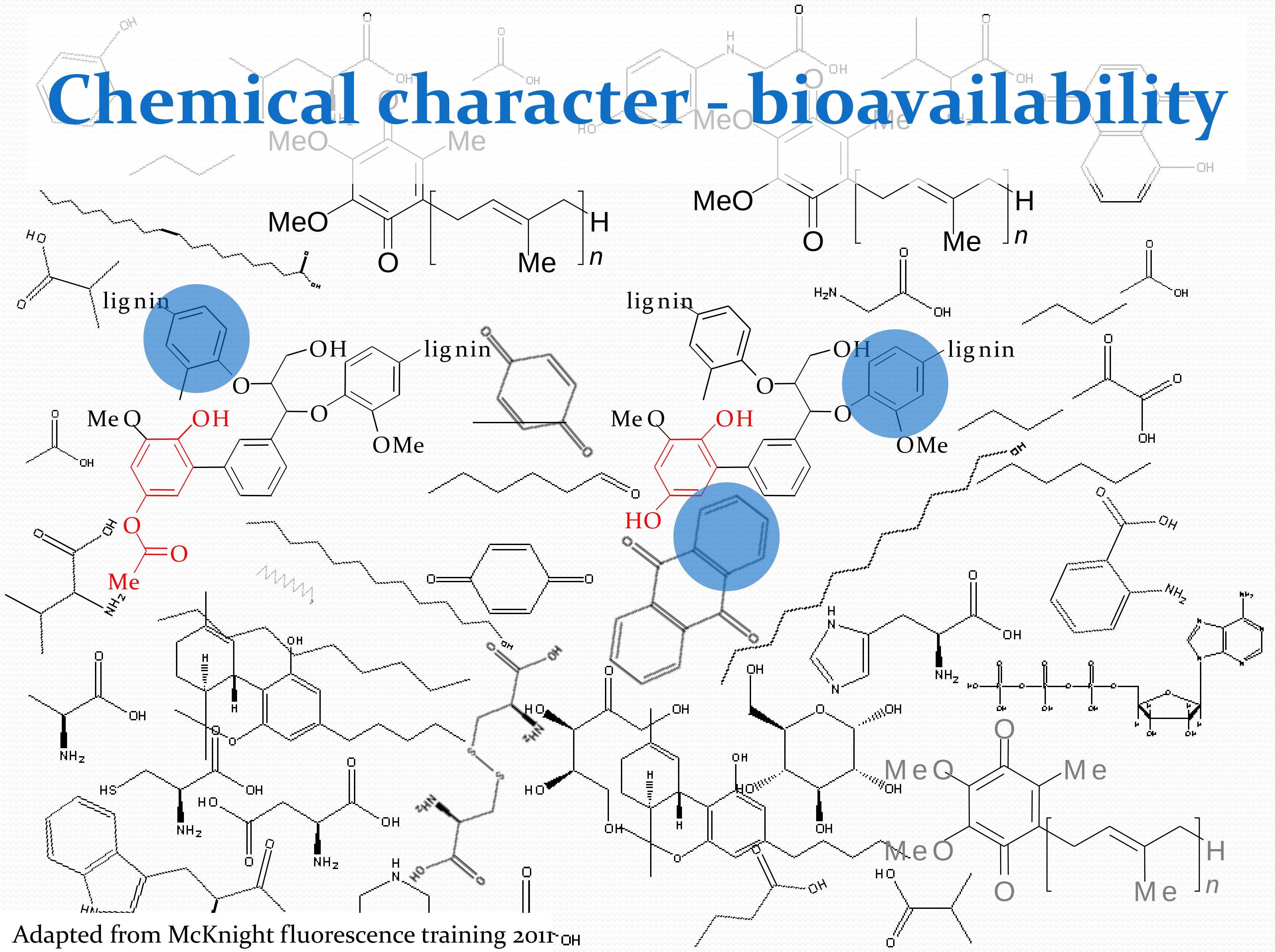
FlowCAM analysis

- Particles in wet and dry deposition
- Qualitative and quantitative analysis of large particles





Chemical character - bioavailability

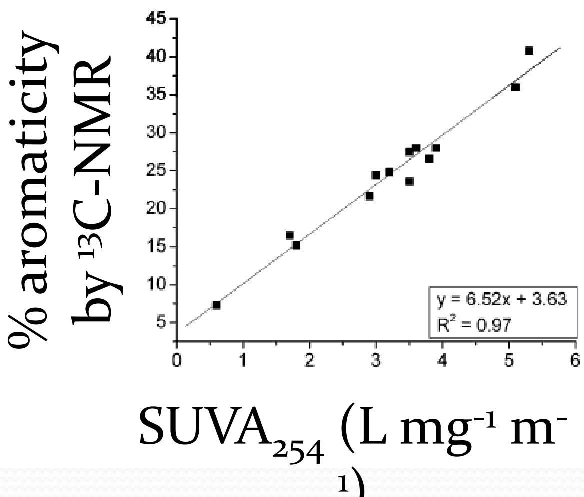


Adapted from McKnight fluorescence training 2011

Quality: Rapid DOM characterization

UV-vis absorbance

- SUVA , specific UV absorbance
  - UV absorbance/ DOC concentration
  - aromaticity proxy



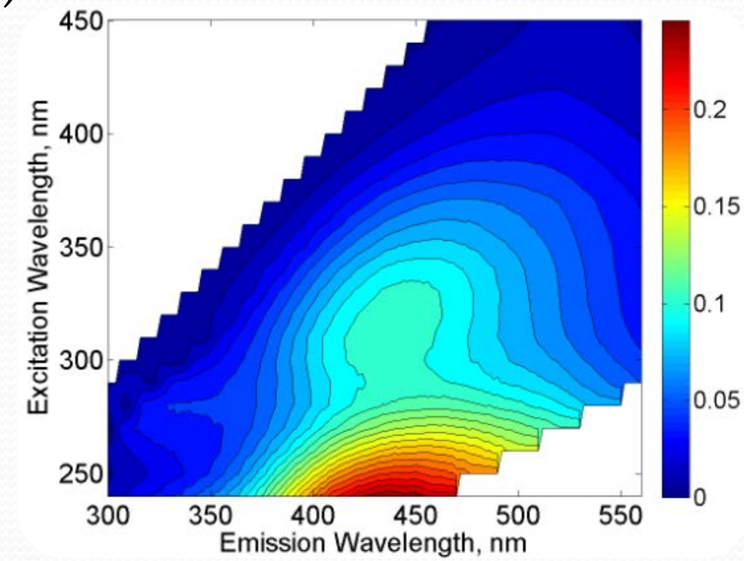
Weishaar et al. *ES&T*, 2003

Fluorescence spectroscopy

– Excitation emission matrix - **EEM**

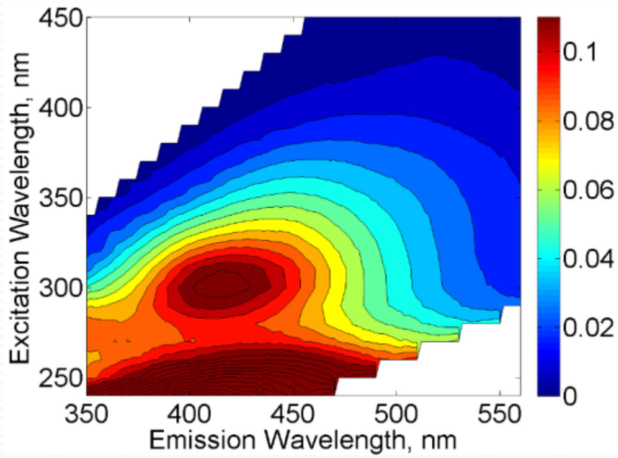
– Indices: HIX (Zsolnay et al., 1998), FI (McKnight et al., 2001)

– PARAFAC modeling (Stedmon et al., 2003)



Fluorescence in Wet Deposition

11 May
2010



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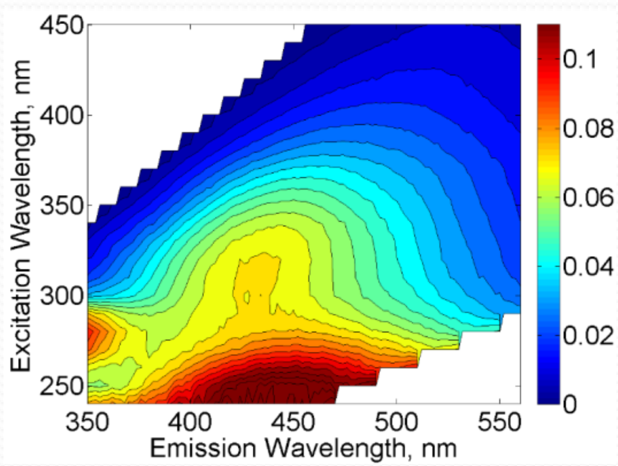
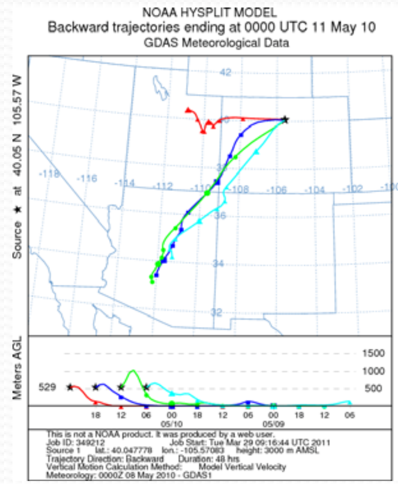
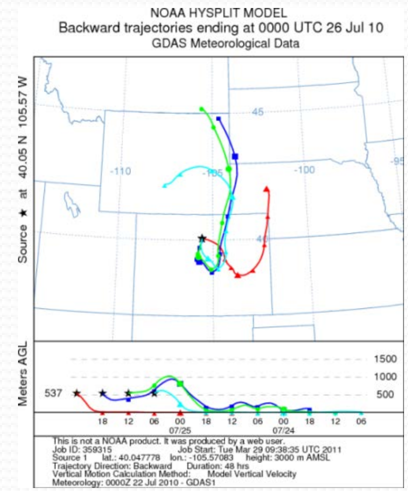
2010





DOC = 2.1 mg L^{-1}
TDN = 1.1 mg L^{-1}
TDP = 16 μg L^{-1}
Ca = 206 ueQ L^{-1}



DOC = 5.1 mg L^{-1}
TDN = 0.9 mg L^{-1}
TDP = 0.8 μg L^{-1}
Ca = 33 ueQ L^{-1}

Figure 1. Representative spring and summer EEMs with 5-day air mass backward trajectories (NOAA Hysplit model) shown below.

Spectral Slope Ratios

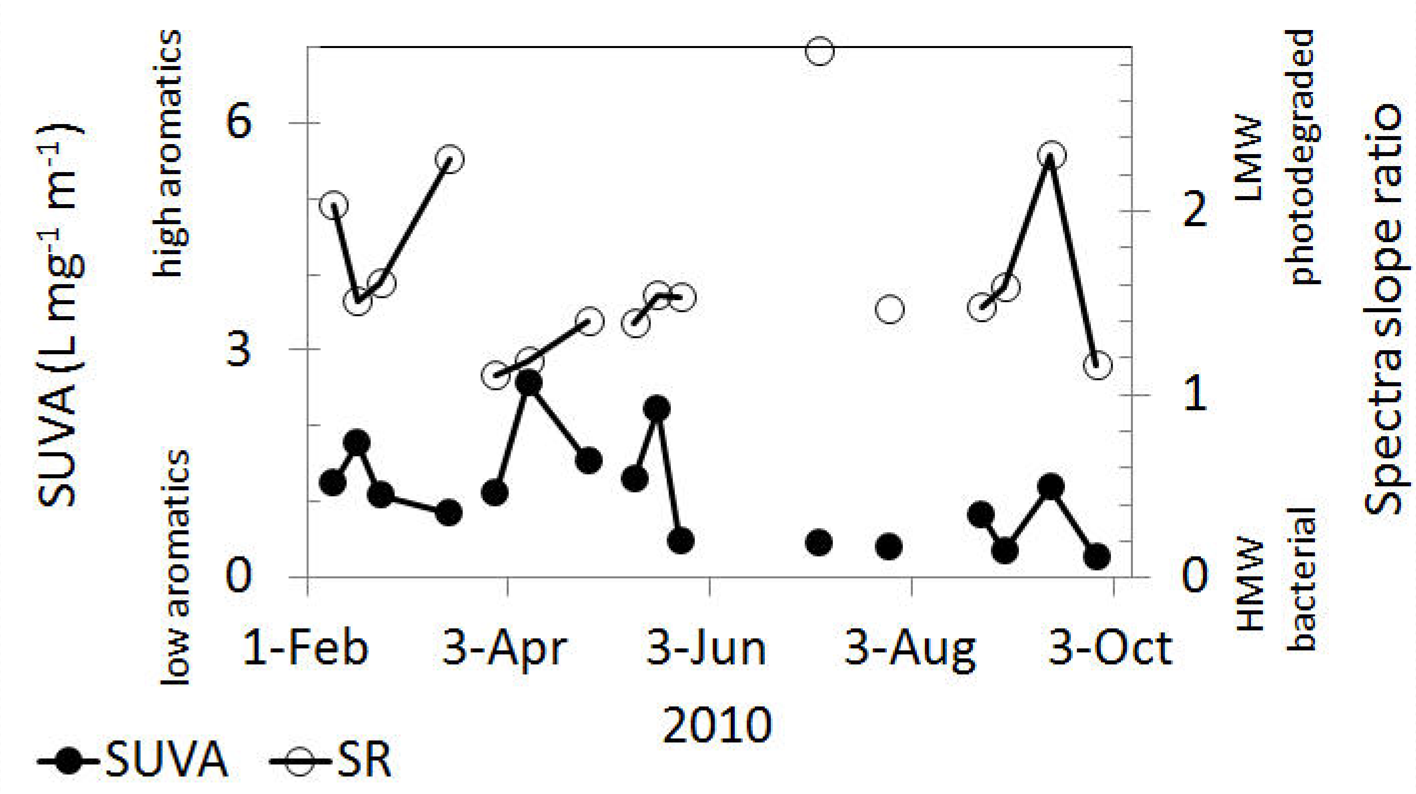


Figure 1. SUVA254 and spectral slope ratio over time.

Summary

- Dry deposition a significant contributor to PM loading
- Organic carbon deposition influenced by seasonal contributions
  - Pollen
  - Dust transport vs. bioaerosols
- High photodegradation (alpine environment) and low aromaticity
- Future work:
  - Further tests of marble inserts
  - Expansion of analyses to CO94, CO90, CO02
  - Long-term monitoring

Thank You

- Niwot Ridge LTER
- INSTAAR
- University of Colorado
- Collaborators and mentors:
  - Kurt Chowanski and Steve Schmidt
  - Kiowa Environmental Chemistry Laboratory

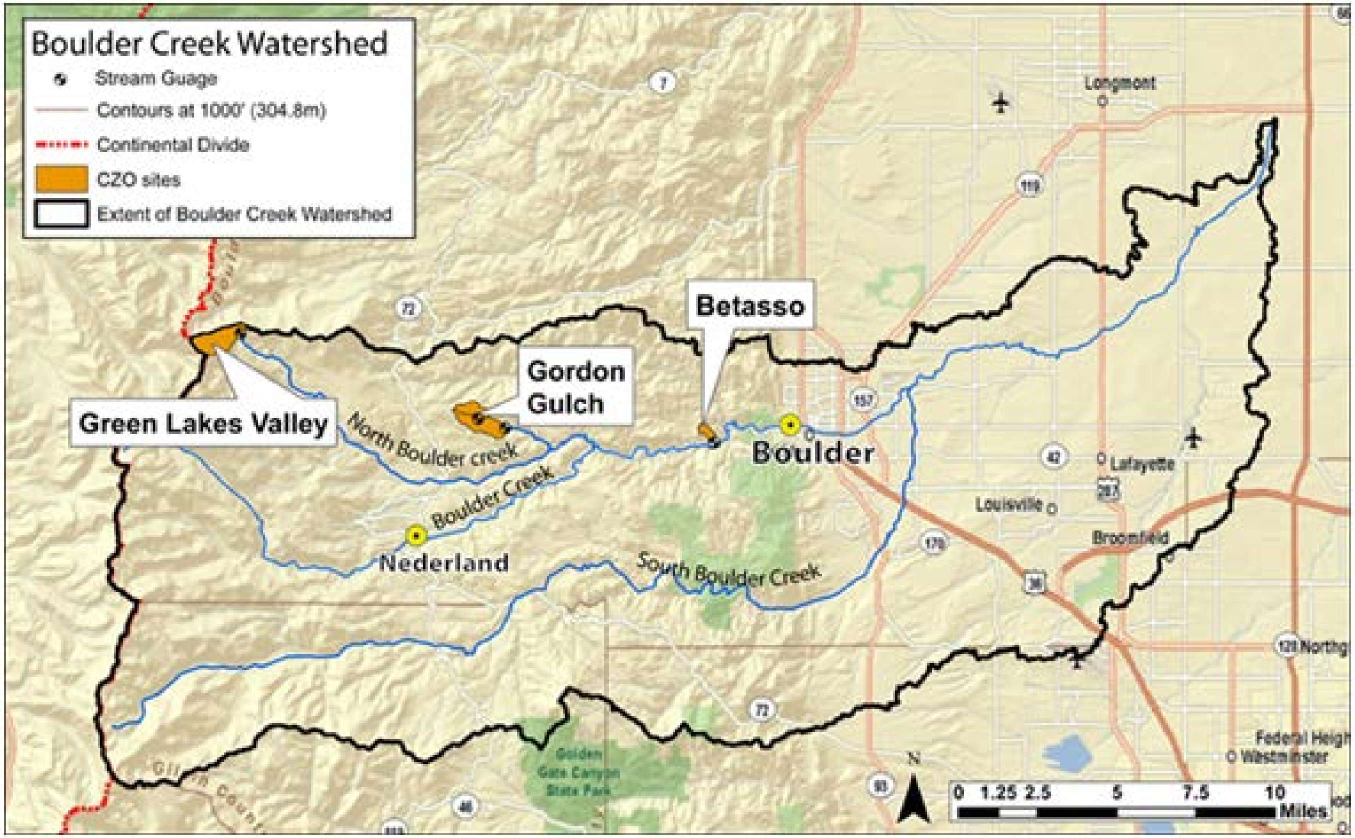
Questions?

Extra slides

PM loading

- Seasonal variance
- July loadings over GL4 watershed
  - 36600 kg/year
  - 340 g/ha/day
- # particles/area of colander per week, converted to kg/hectare/week, for wet and dry deposition
- Dry dep only: use recovered mass/avg of % mass recovered in addition experiments, then divide by area of the bucket. Convert to kg/hectare/week.

Study sites



Boulder Creek Watershed
Stream Guage
Contours at 1000' (304.8m)
Continental Divide
CZO sites
Extent of Boulder Creek Watershed
Green Lakes Valley
Gordon Gulch
Betasso
Boulder
Nederland
North Boulder creek
Boulder Creek
South Boulder Creek
Longmont
Lafayette
Louisville
Broomfield
Westminster
Golden Gate Canyon State Park
0 1.25 2.5 5 7.5 10
Miles