Fog Processing of atmospheric organic compounds during the California Regional PM10/PM2.5 Air Quality Study (CRPAQS)

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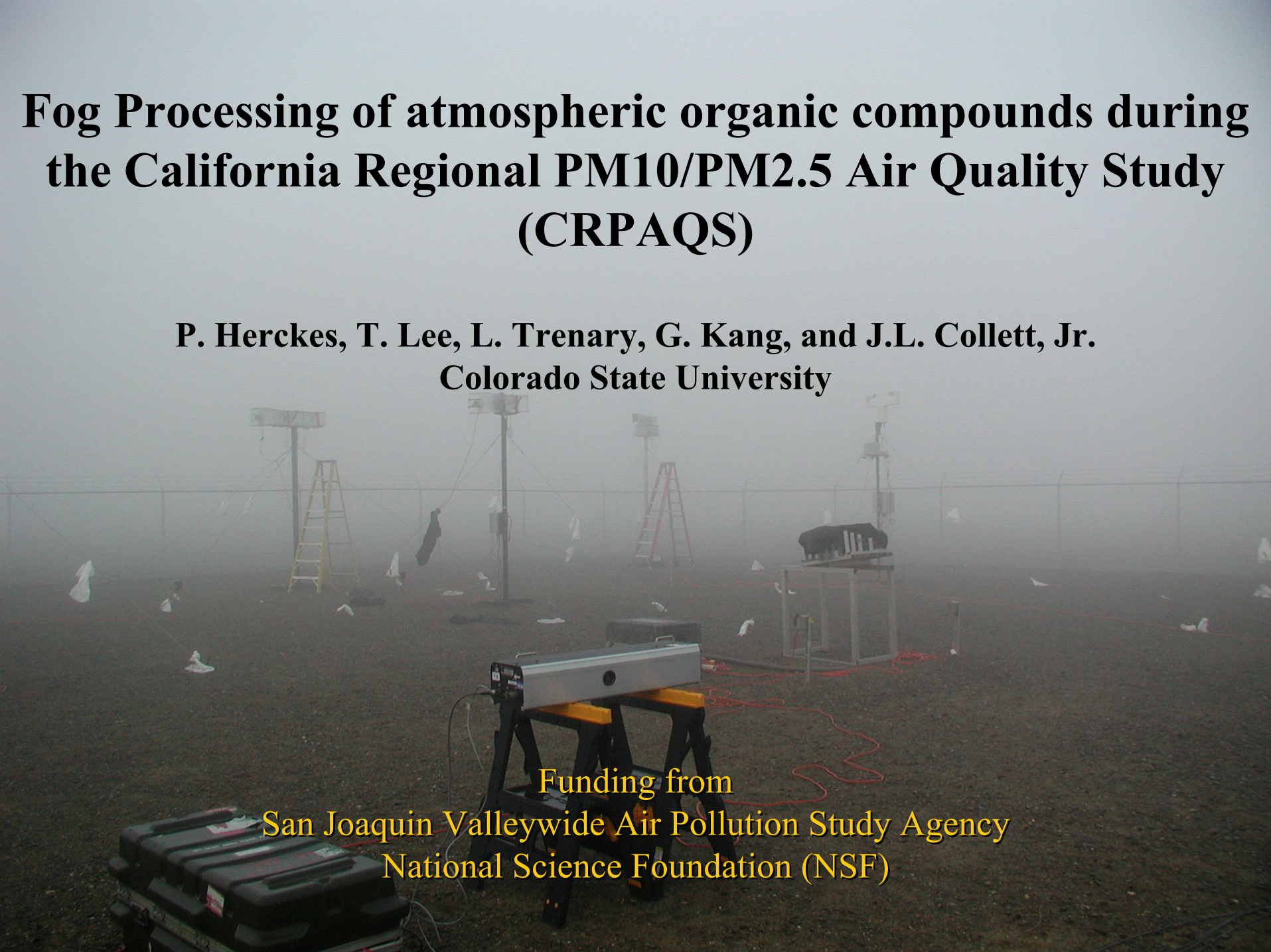
Colorado State University



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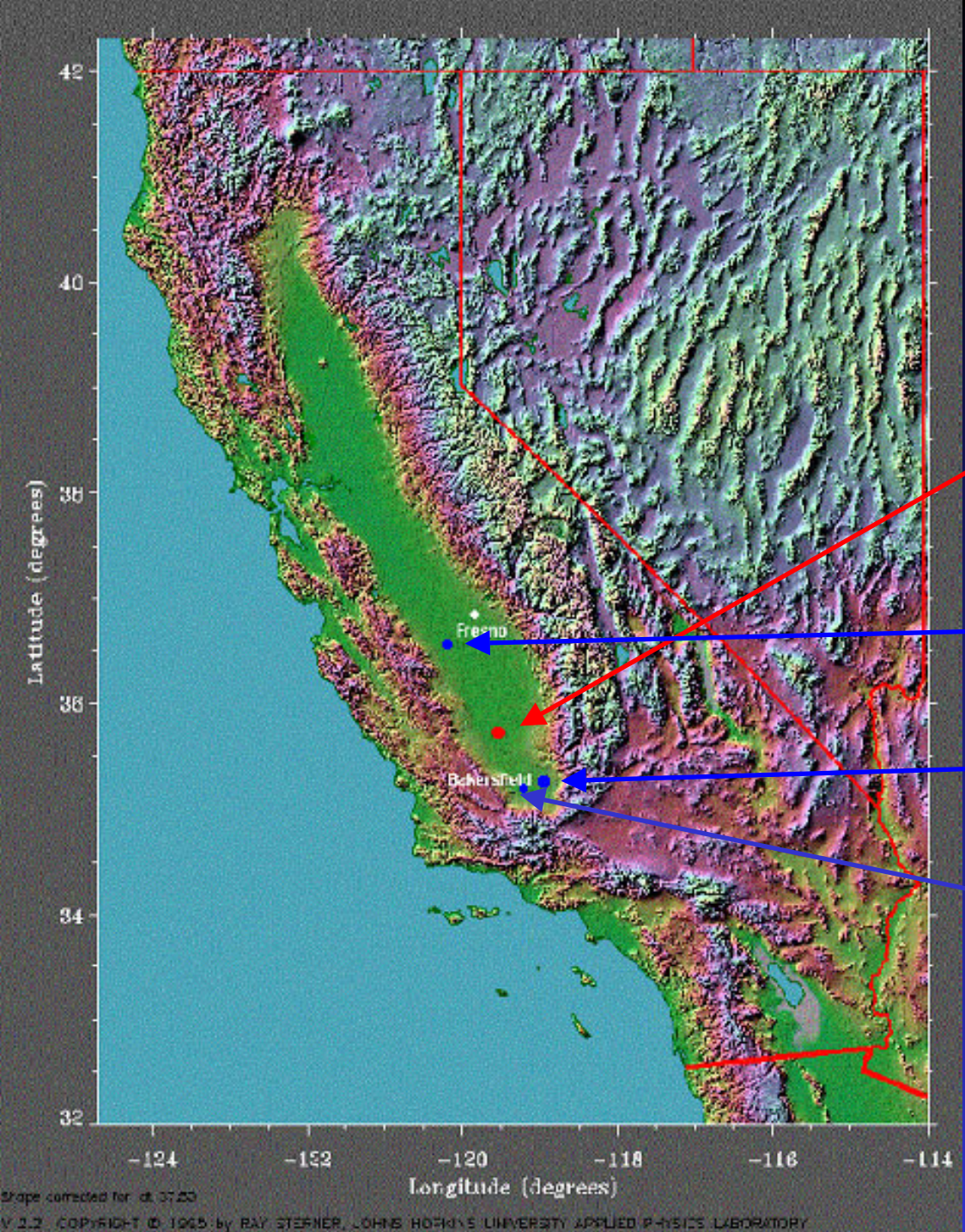


Fog study sites

Main site: Angiola

Satellite sites:
Helm

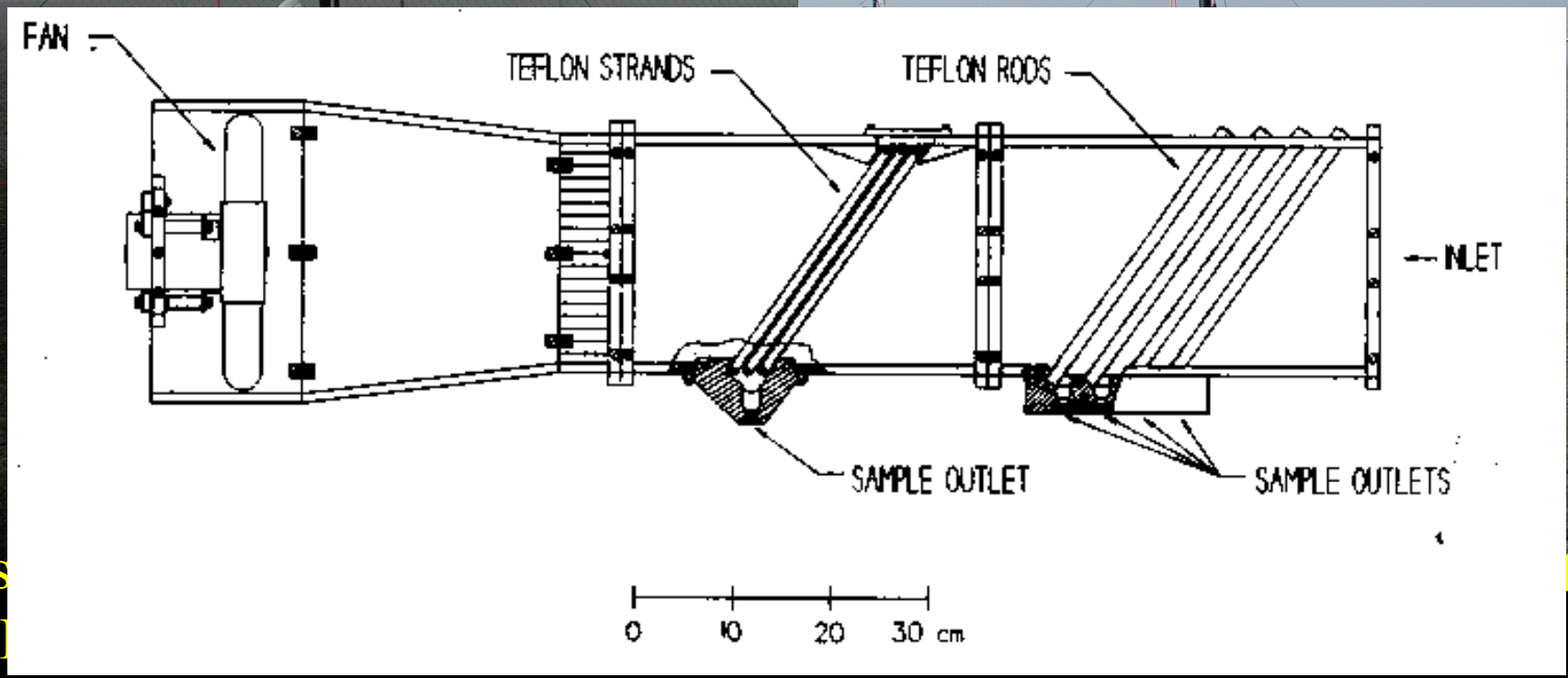
Bakersfield

McKittrick

Instrumentation

CASCC, sf-CASCC, ss-CASCC, ss-sf-CASCC, 5-stage fog collector,
CHRCC, Tower (4 levels of Al-CASCC2), Deposition Plates
PVM, CSASP, CSU-OFD
MOUDI, organic Aerosol, Continuous Peroxide Analyzer

fog/ground based cloud sampling



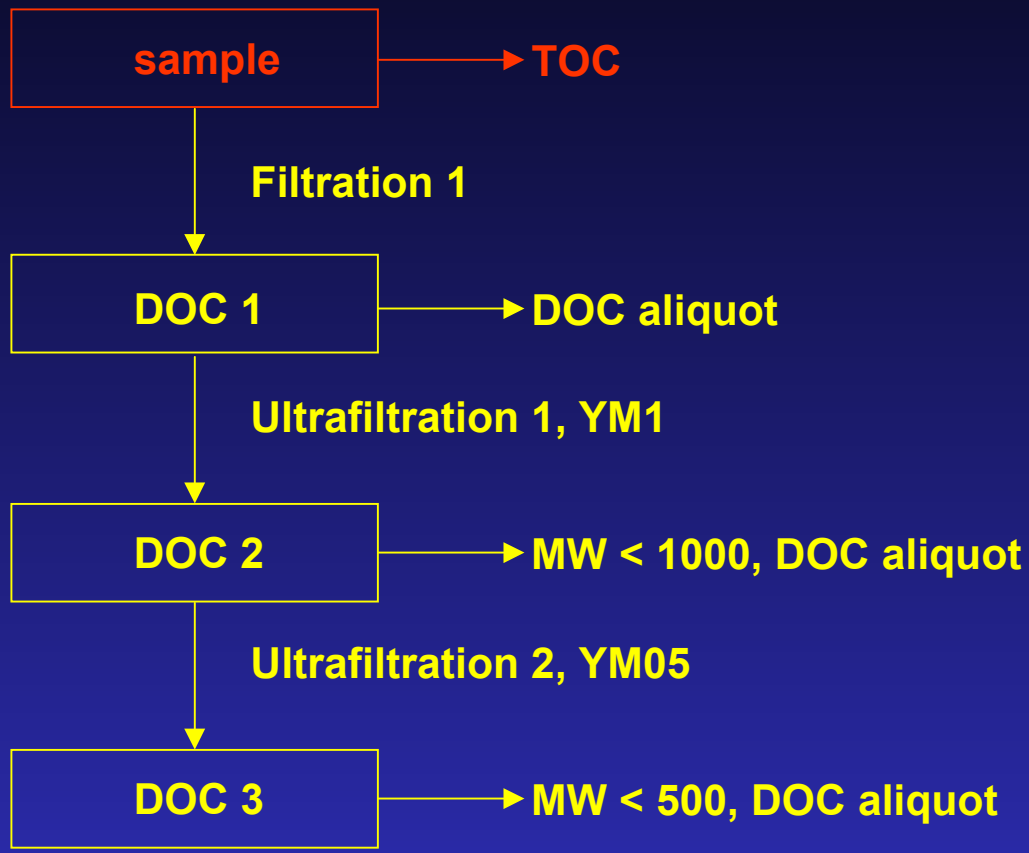
Investigation of bulk properties of OM

Individual compound speciation

Variation with drop-size

Processing of carbonaceous particles

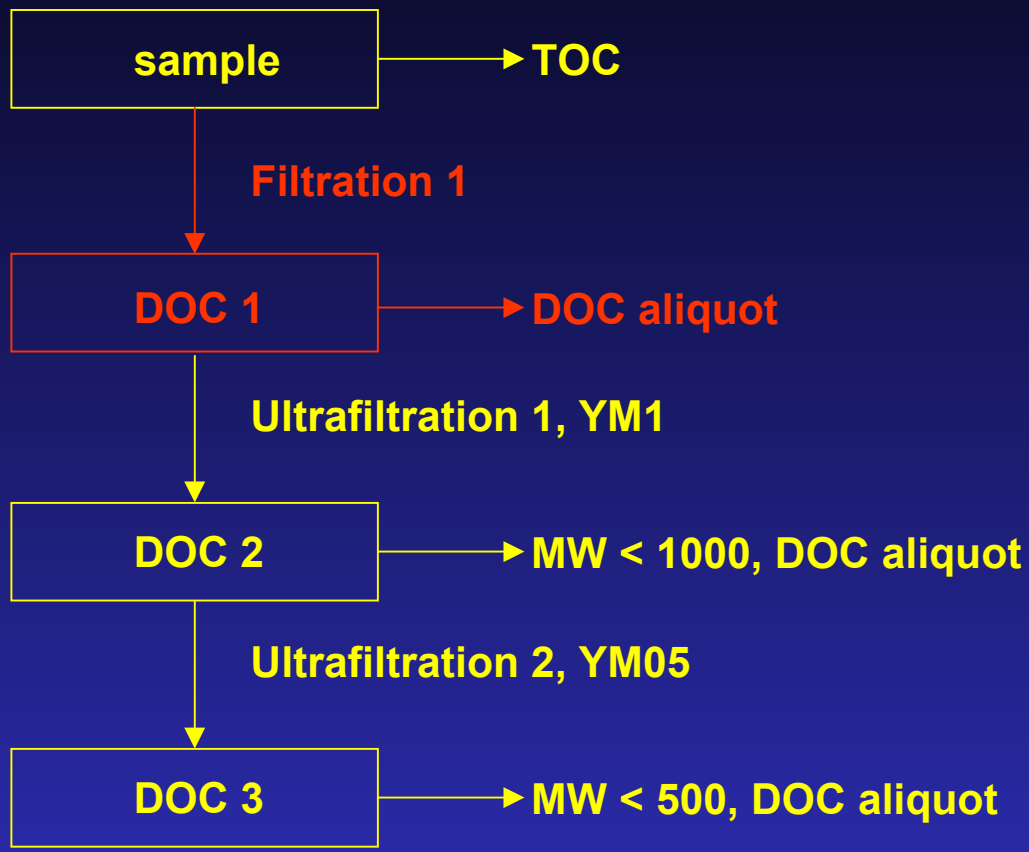
Total and Dissolved Organic Matter Characterization



Total Organic Carbon concentrations

	TOC mgC/L avg (min-max)	
CRPAQS		
Angiola	10 (2-41)	Herckes et al., 2002
Helm	6-16	Herckes et al., 2002
Bakersfield	27	Herckes et al., 2002
IMS 95	5-41	Collett et al., 1999
Bakersfield	9-276	Jacob et al., 1984
Davis	32.5 (5-111)	Zhang et al, 2001
Po Valley fogs (Italy)	15-108	Gelencser et al., 2000

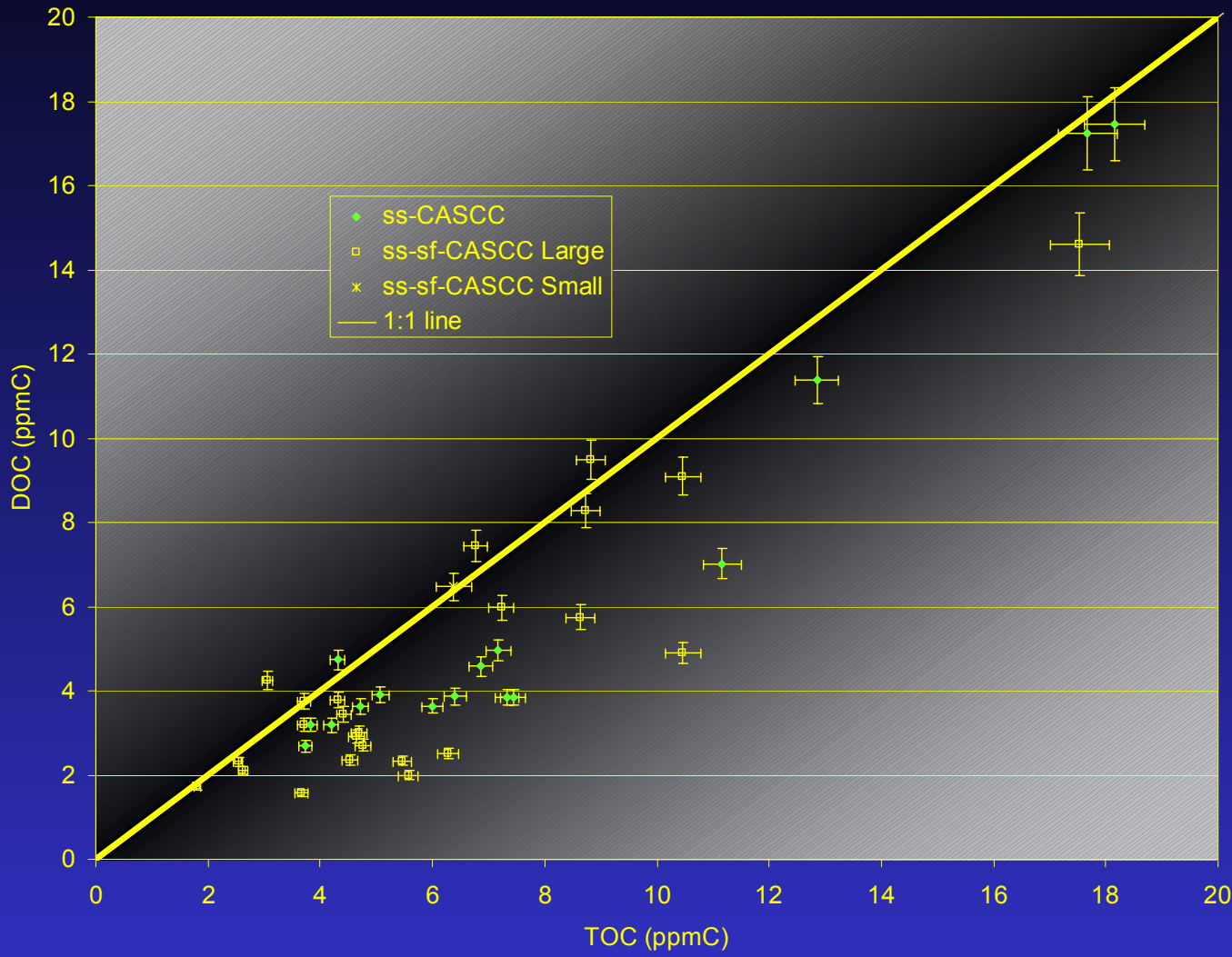
Total and Dissolved Organic Matter Characterization



Total vs Dissolved Organic Carbon

fog-Angiola (SJV, Ca)

25% insoluble
(0-64%)



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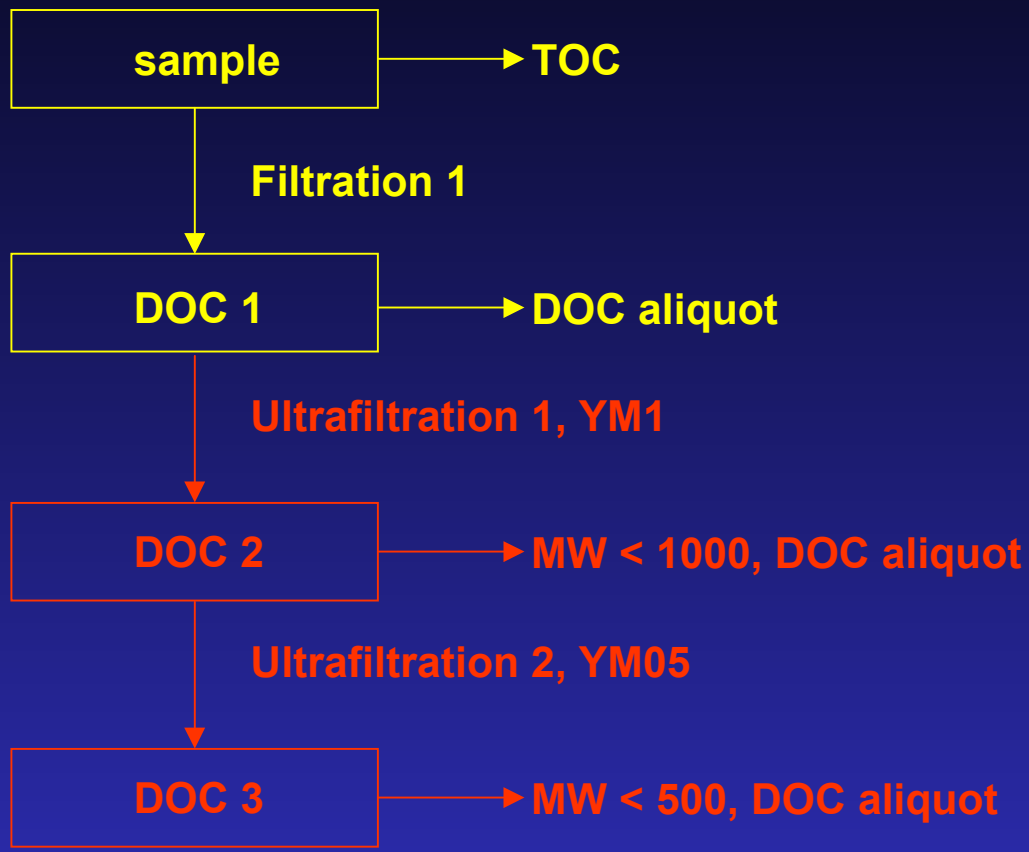
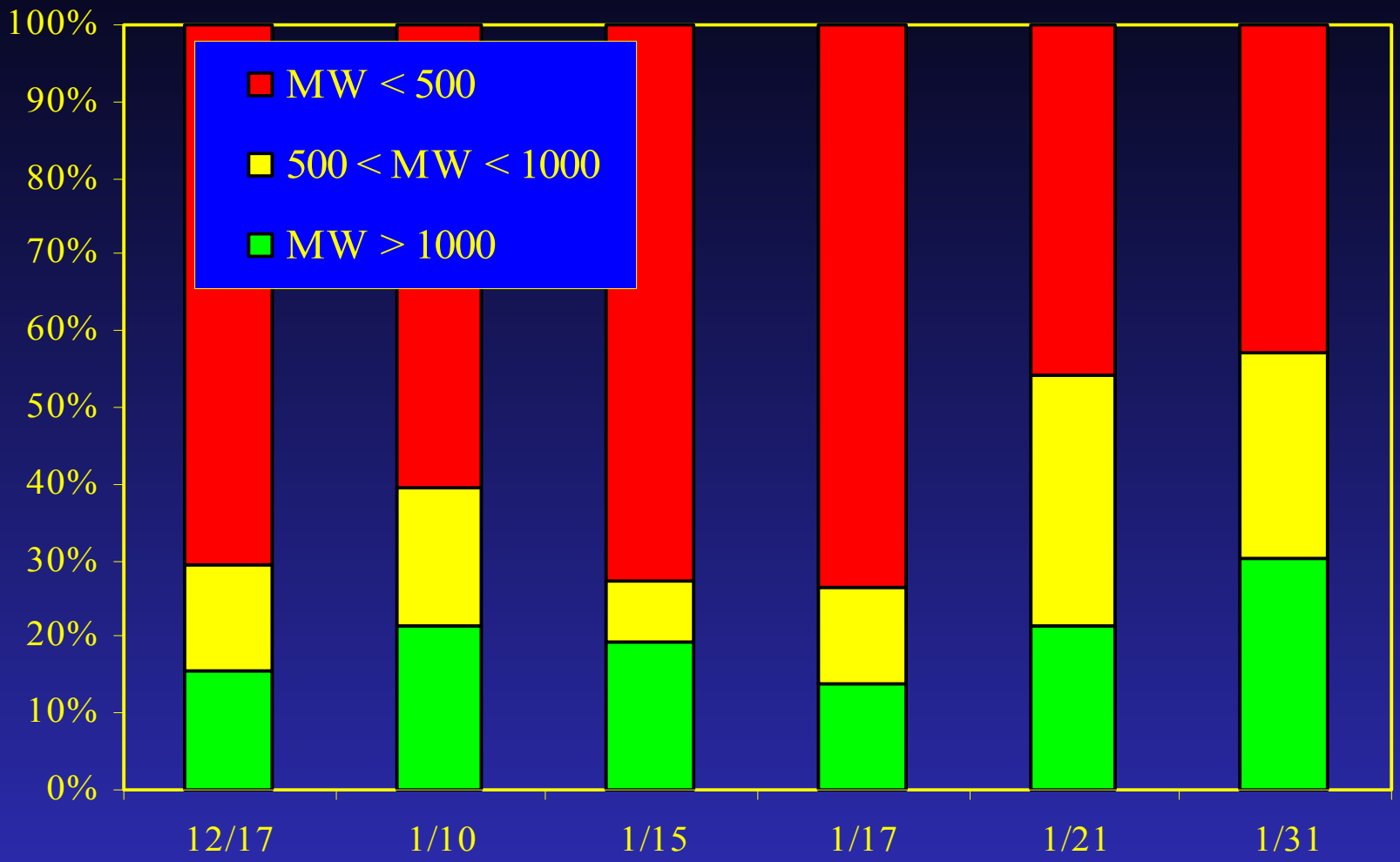


Dissolved Organic Matter



significant fraction of DOC has high Molecular Weight (MW)

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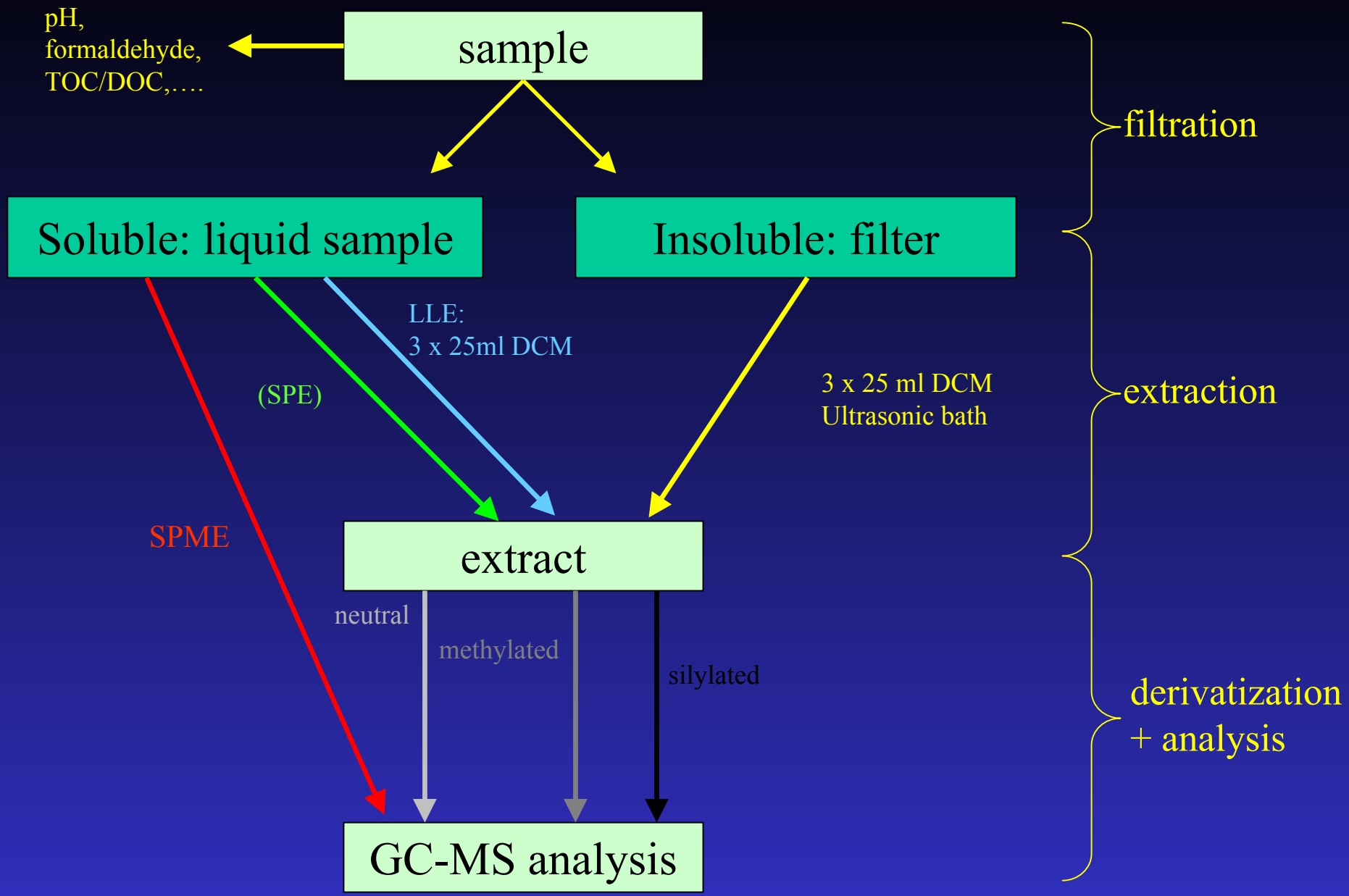

pH,
formaldehyde,
TOC/DOC,….
sample
Soluble: liquid sample
Insoluble: filter
LLE:
3 x 25ml DCM
(SPE)
3 x 25 ml DCM
Ultrasonic bath
SPME
extract
neutral
methylated
silylated
GC-MS analysis
filtration
extraction
derivatization
+ analysis

Molecular composition of organic matter in California fog

A large number of different compounds has been identified in the fogwater

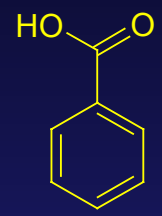
Polar compounds:

carboxylic acids (C1-C36)
di-carboxylic acids (C2-C9)
aromatic acids (benzoic acid…)
resin acids (pimaric acid,…)
aldehydes (formaldehyde,..)
phenols (phenol, nitro-phenol….)
methoxyphenols (vanillin, ethyl-guaiacol,…)
oxygenated PAH (9, 10 Anthracenedione,..)
pesticides (Diazinon, Penoxaline,..)

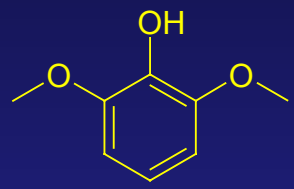
Nonpolar compounds:

n-alkanes (C20* – C39)
Polyaromatic Hydrocarbons (PAH) (pyrene,…)
…

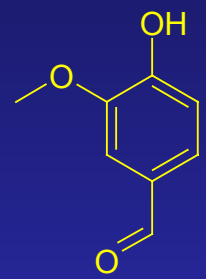
pimaric acid



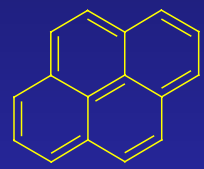
benzoic acid

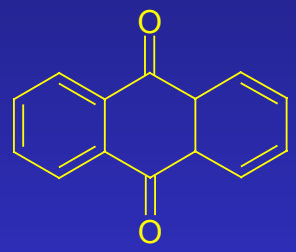


syringol



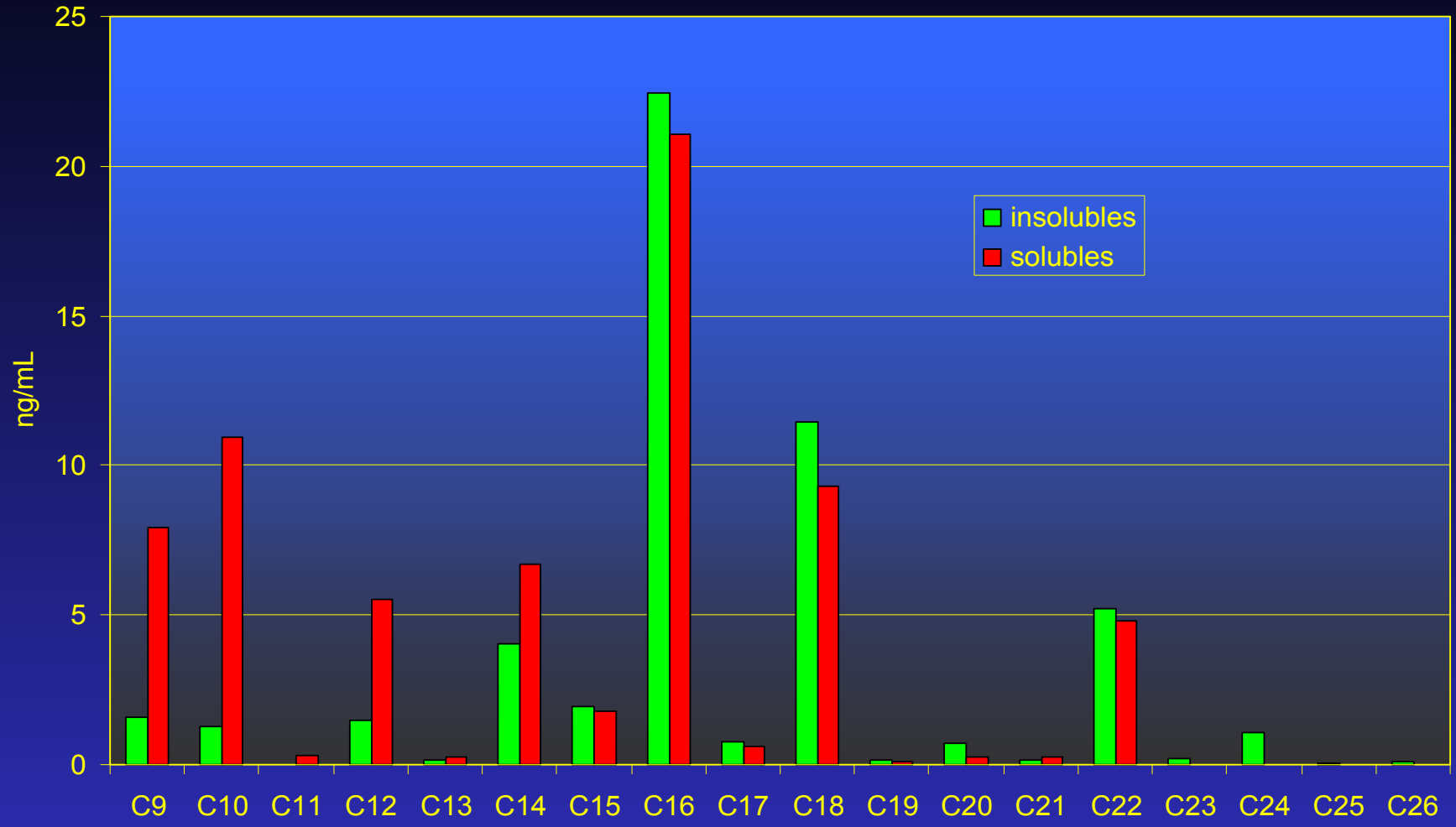
vanillin


pyrene



9,10 anthracenedione

n-alkanoic acids (Angiola (CA), December 17, 2000)



Smaller MW compounds predominantly soluble
Larger MW compounds predominantly insoluble

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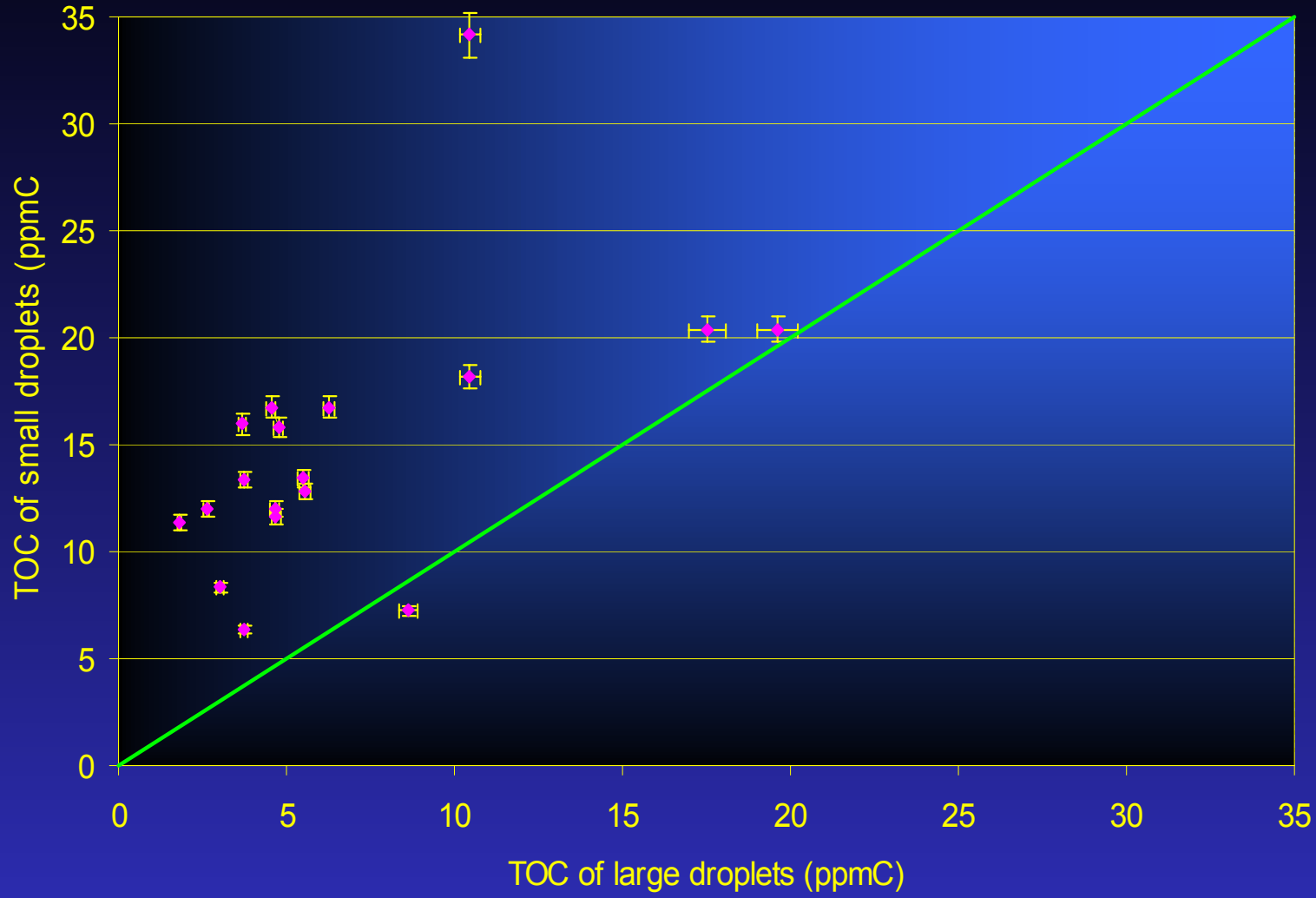
Variation with drop-size

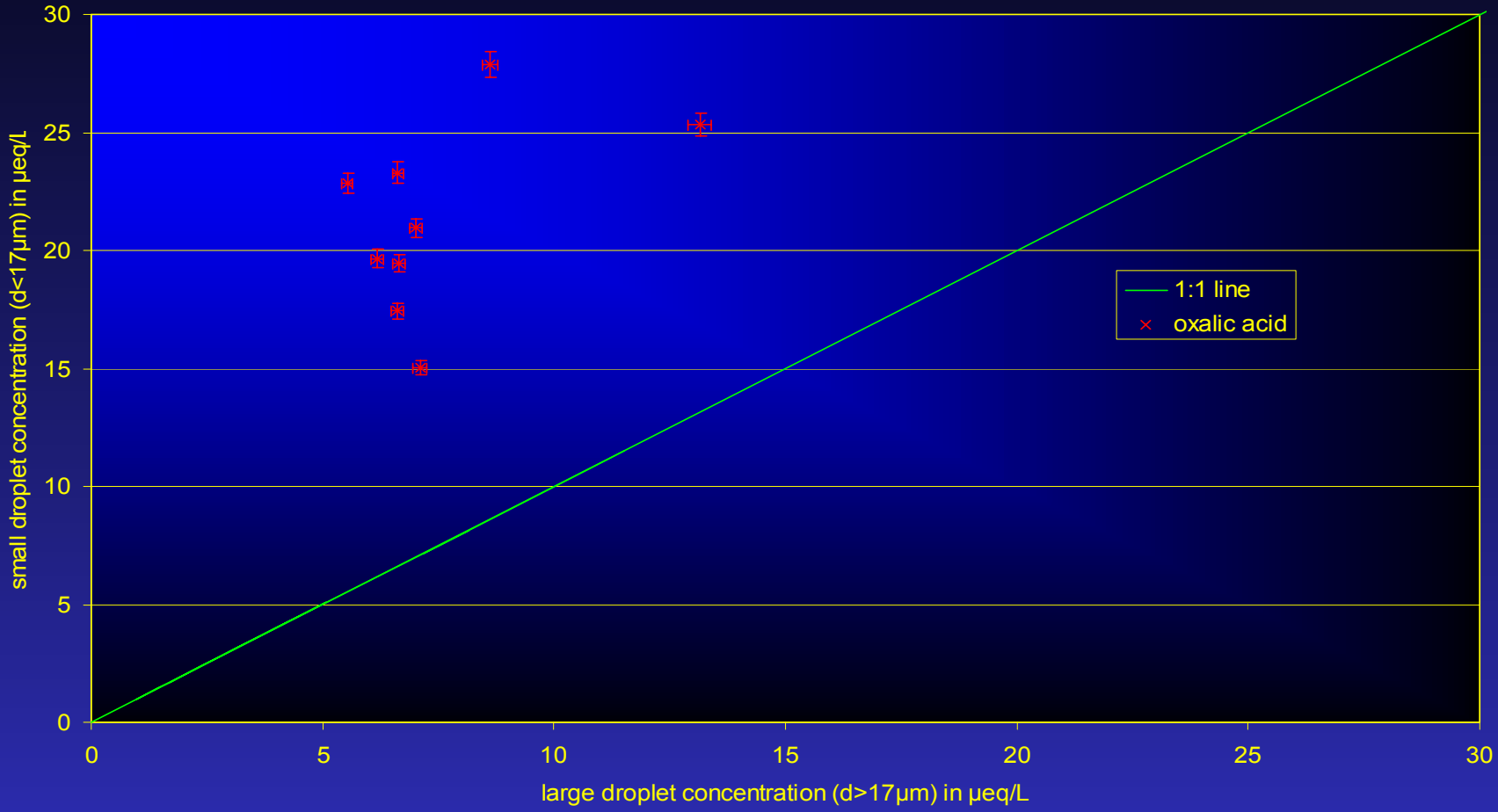
Processing of carbonaceous particles

TOC variation with droplet size



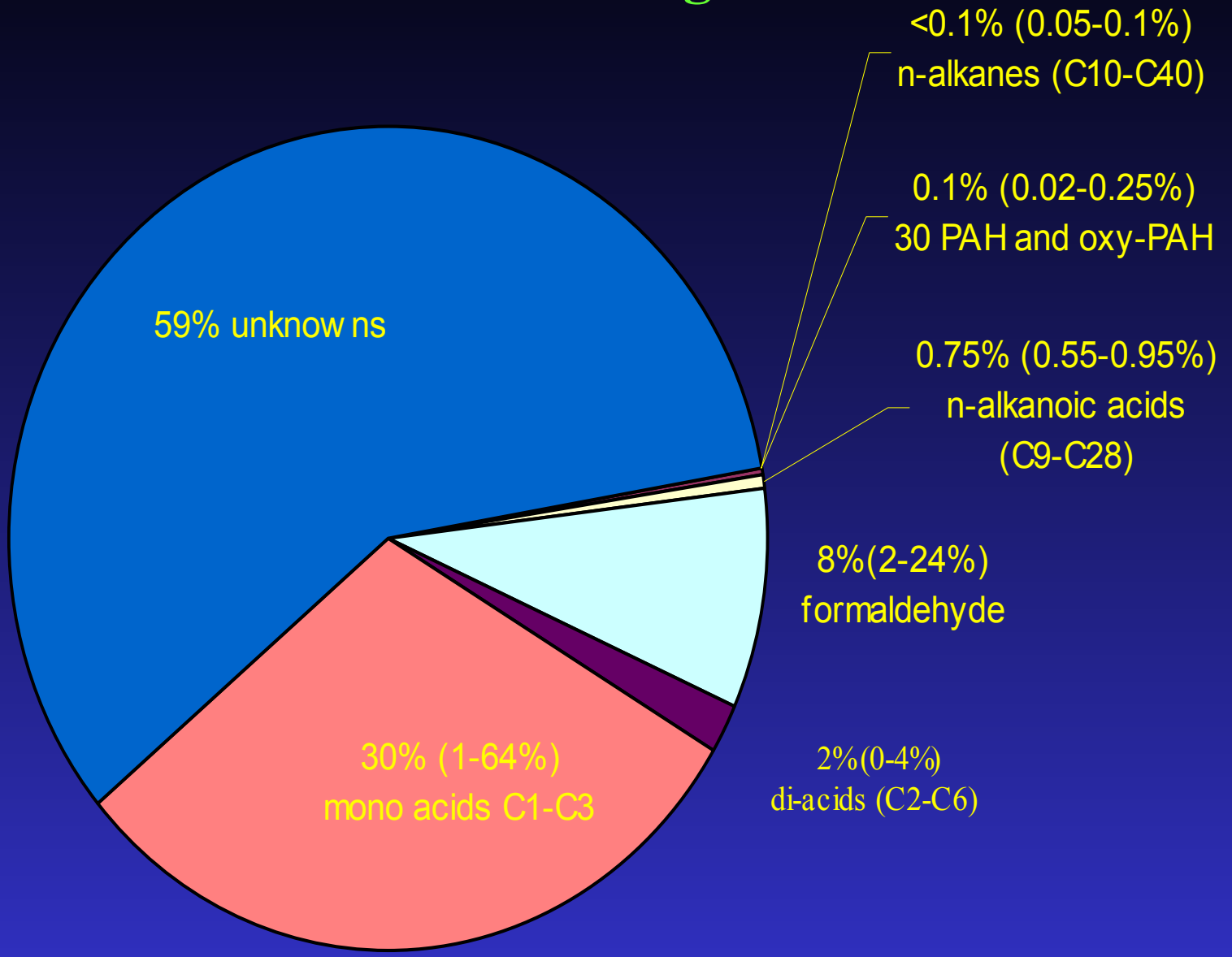
Higher concentrations in smaller droplets
Ratio 2.8 on average (0.8-6.3)

Individual organic compounds

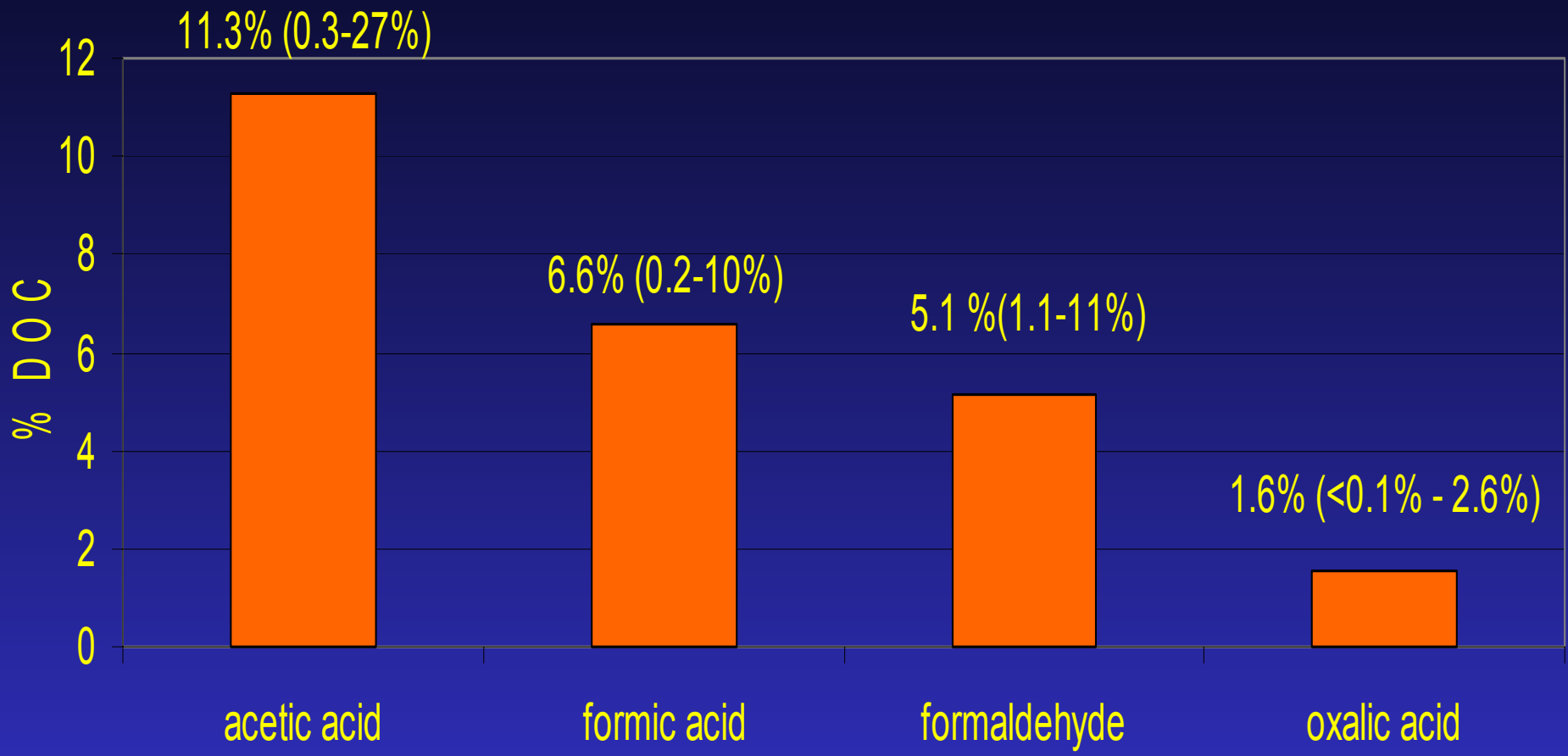


Consistent with inorganic compounds

What we learned about the organic matter



Dominant individual organic species



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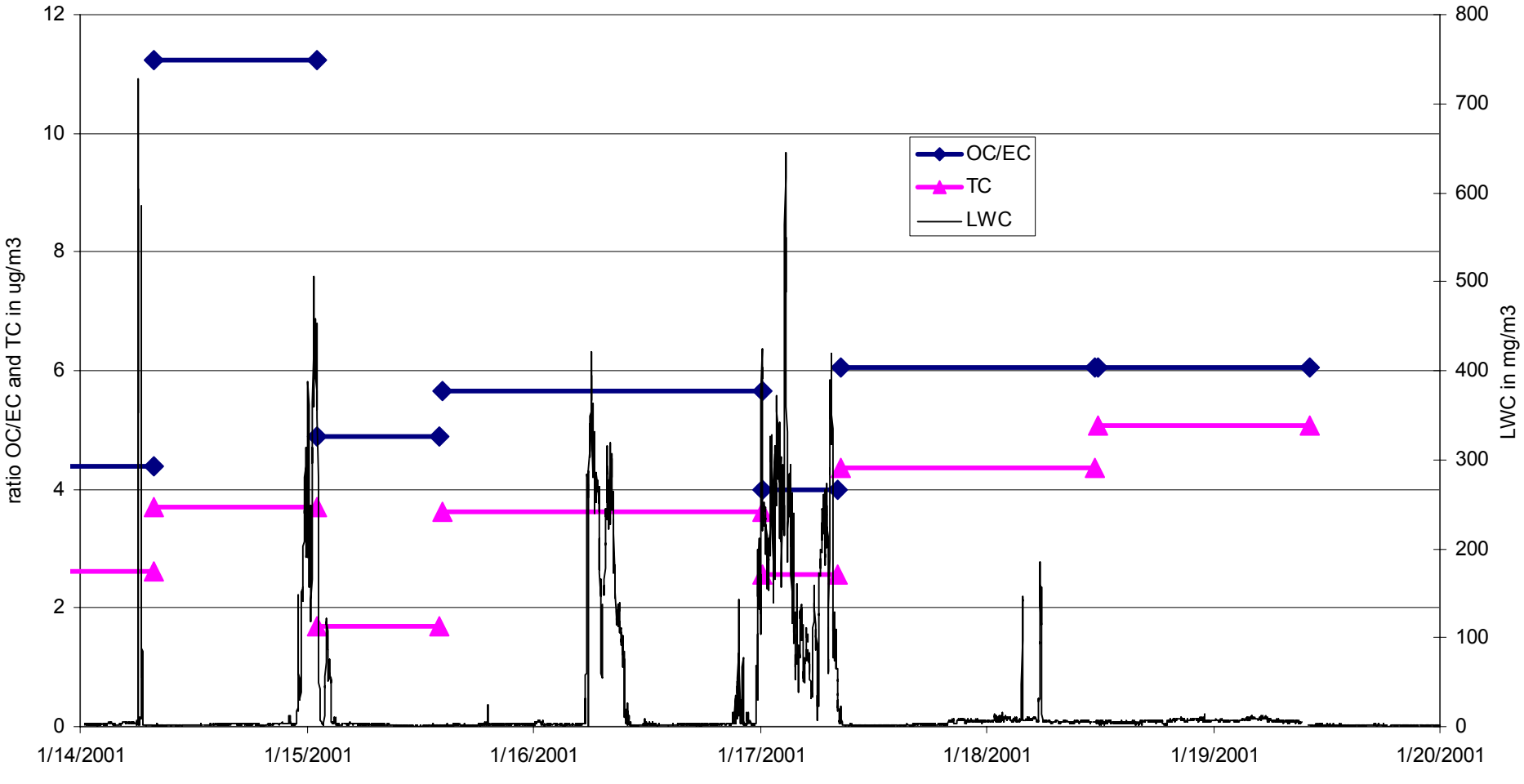
Scavenging of organic carbon



Limited information due to low time resolution

Fog deposition flux: case example December 17/18th, 2000

13 hour fog event:

- ➡ 294 g/m^2 water (1 inch =25.4kg/m^2)
- ➡ 1.2 mg of C/m^2

Considering a fog layer of 100m depth

- ➡ decrease of 12 µgC/m^3
- ➡ significant removal of ambient OC (~10µgC/m$^{3)}$
  - some from volatile species!
  - entrainment from upper layers

Conclusions

- organic matter (OM) is an important component of SJV fogs
- 25% of OM is associated with insoluble material
- large fraction of OM has high molecular weight
- only a small fraction is identified at molecular level
- monocarboxylic acids are the dominant species
- small droplets are enriched in OM
- deposition fluxes suggest a significant removal of OM by fogs

Related posters

"Overview of fog studies during the California Regional PM10/PM2.5 Air Quality Study (CRPAQS)"

7PB10

"Aerosol Processing and removal by fogs: Observations in radiation fogs during the CRPAQS study "

7PB11

Acknowledgements

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