Characterization of emissions from the laboratory combustion of wildland plant species

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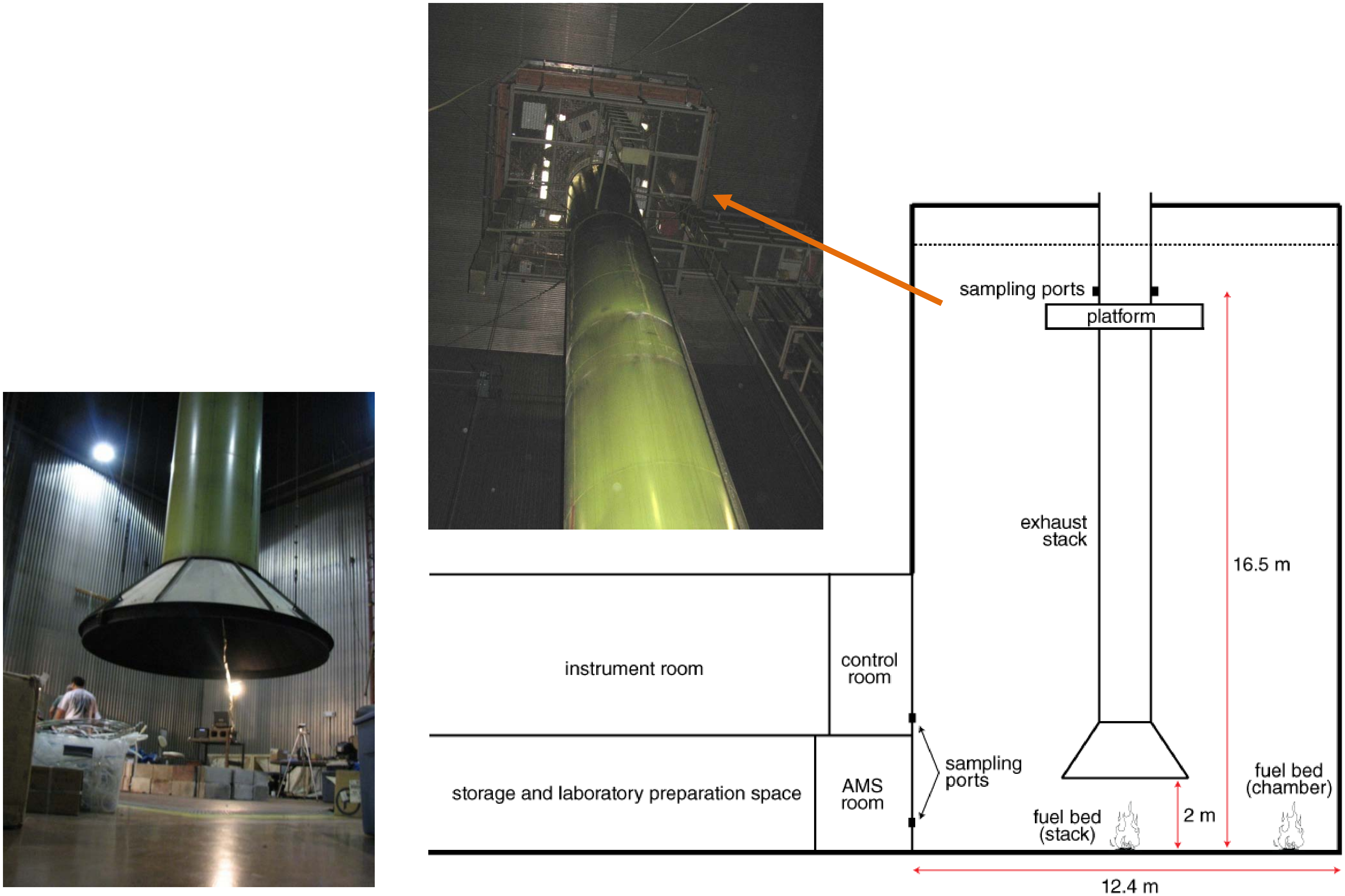
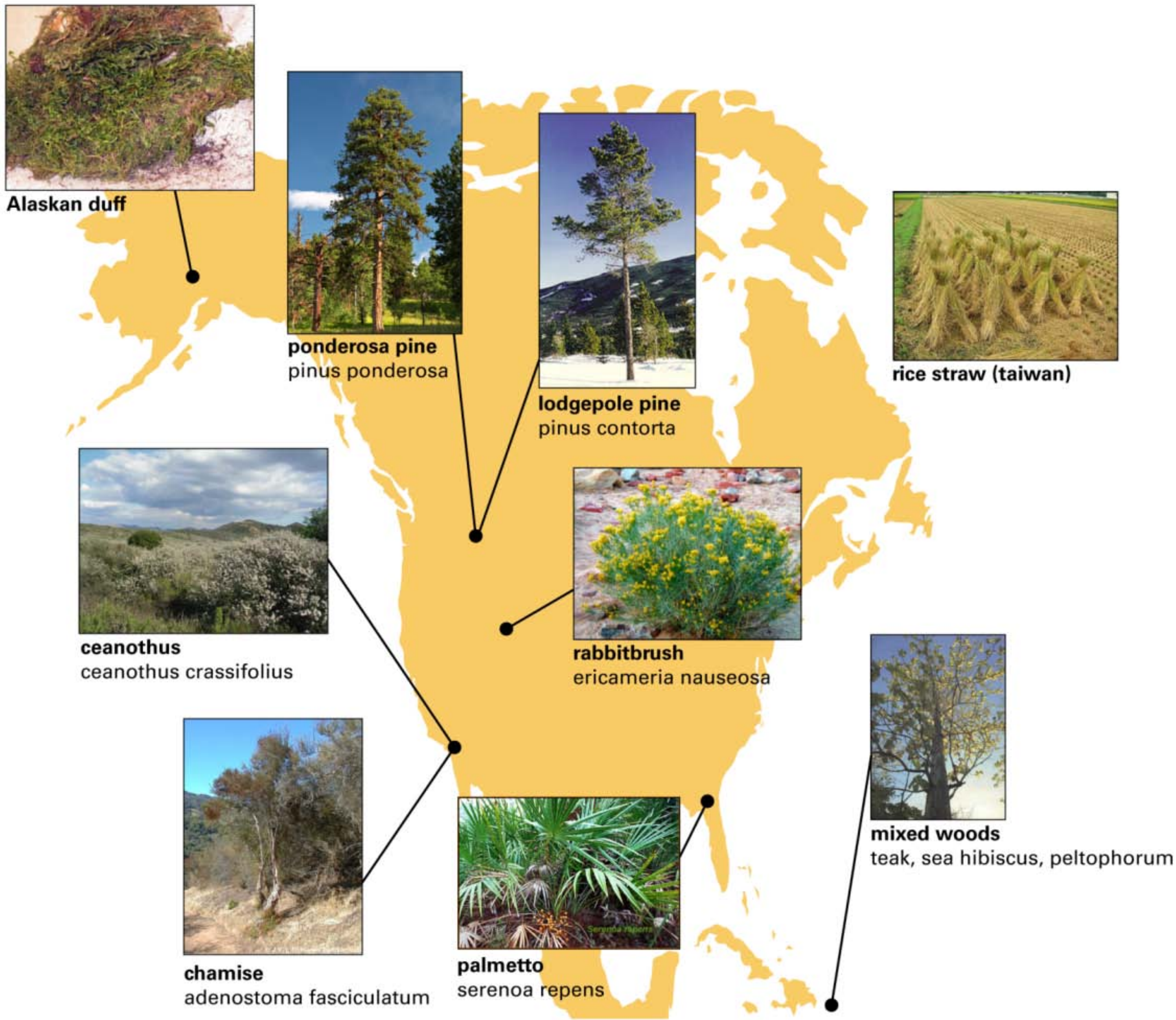
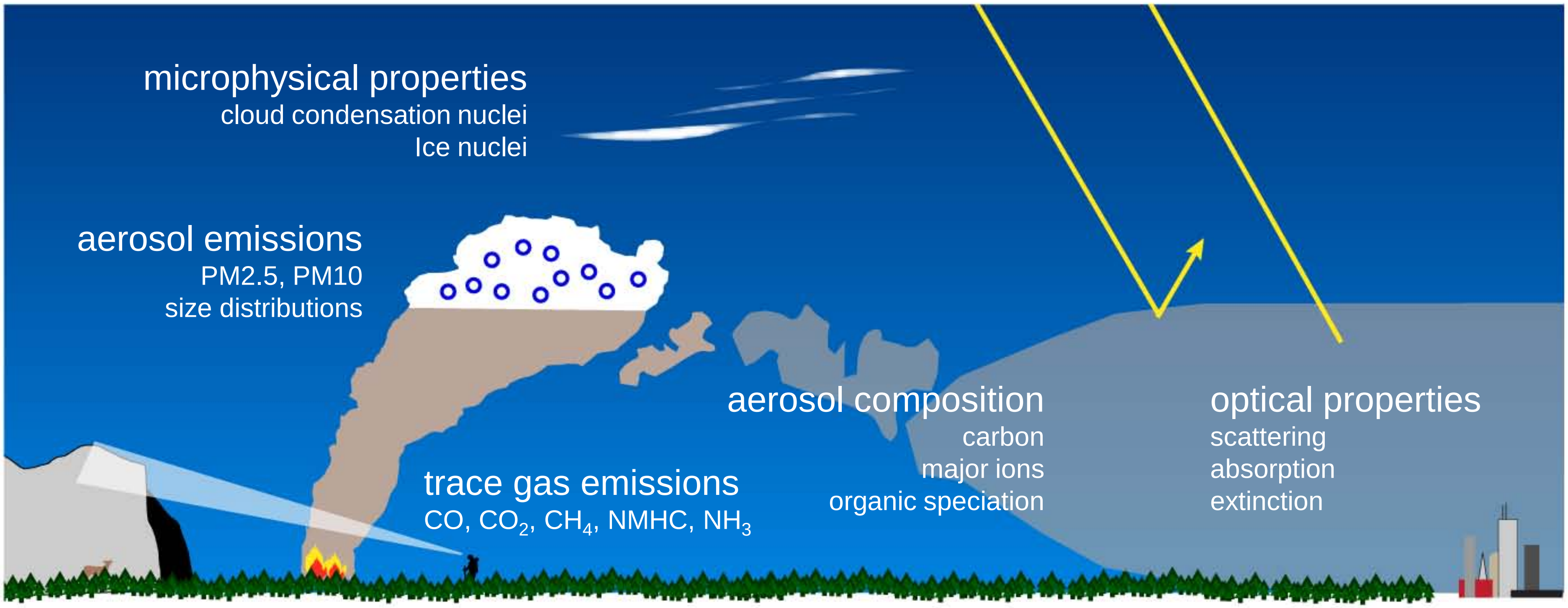
The Fire Laboratory at Missoula Experiment (FLAME).



Fuels we burned during FLAME.



What we measured during FLAME…and why.

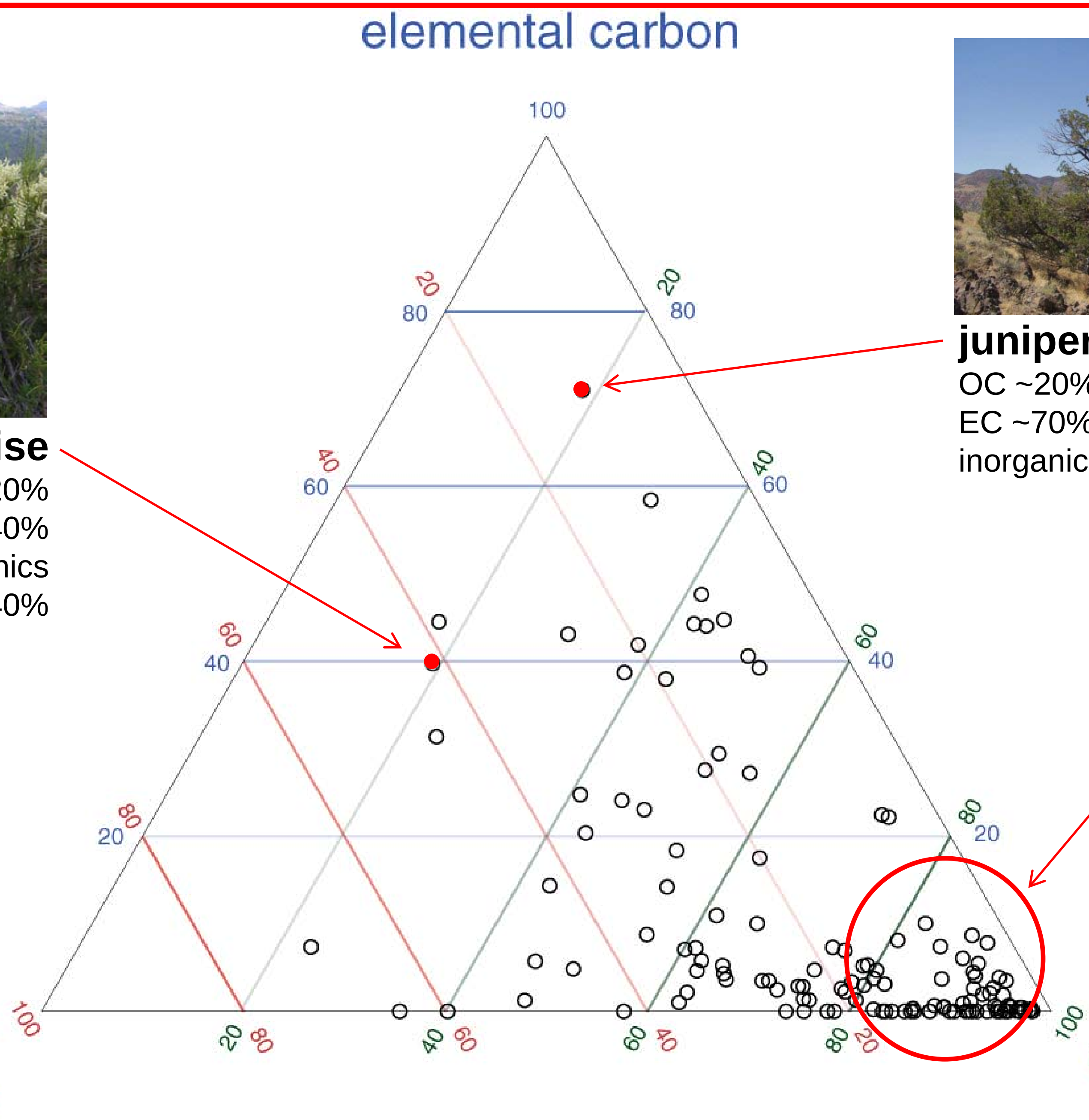


fire behavior
fuel mass
fuel moisture
C- and N-content
fire radiance

other
aerosol volatility
aerosol morphology (microscopy)
sp2 hybridization
molecular structure (H-NMR)

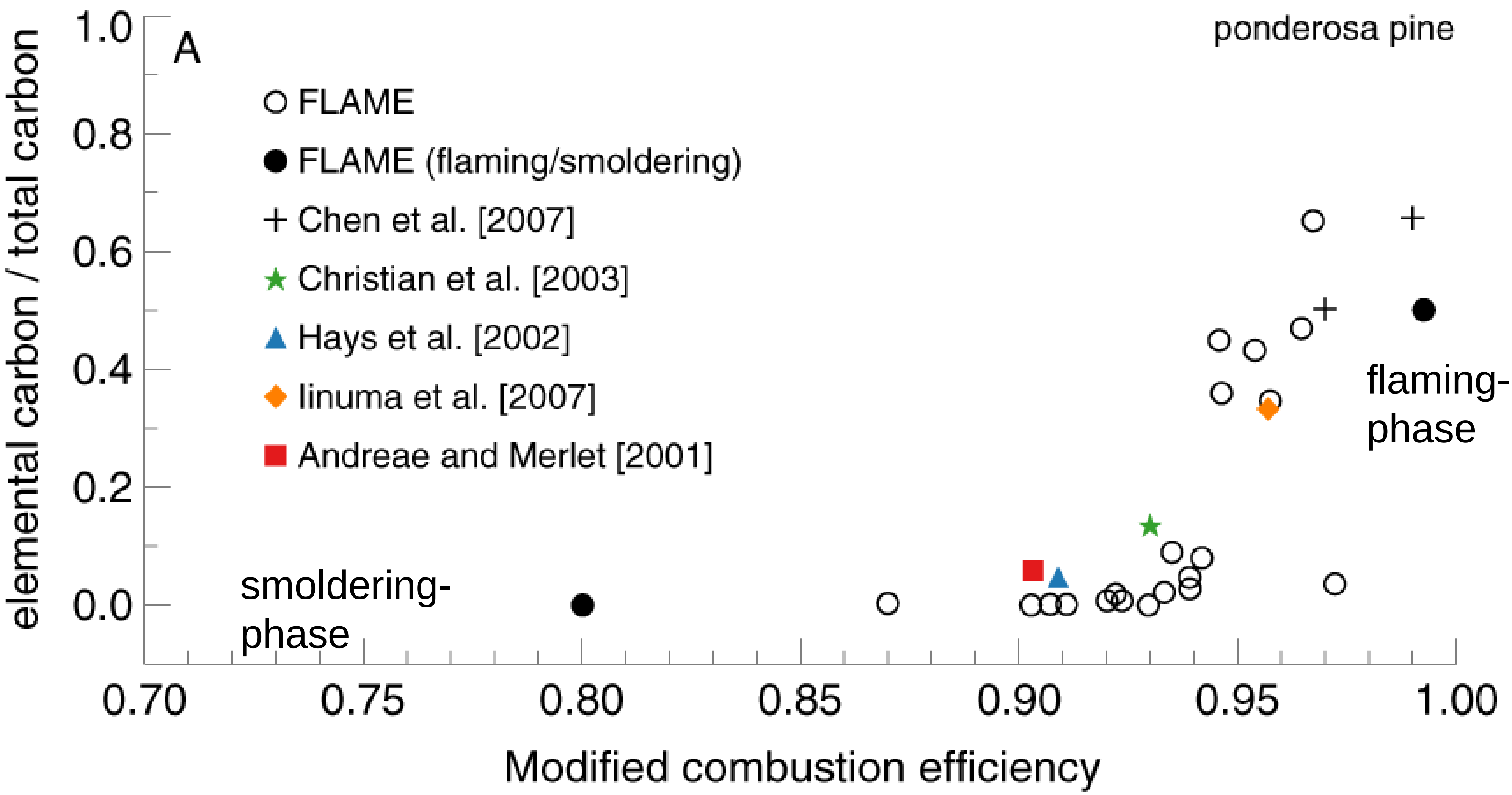
Aerosol composition was dominated by organic carbon.

chamise
OC ~20%
EC ~40%
inorganics
~40%



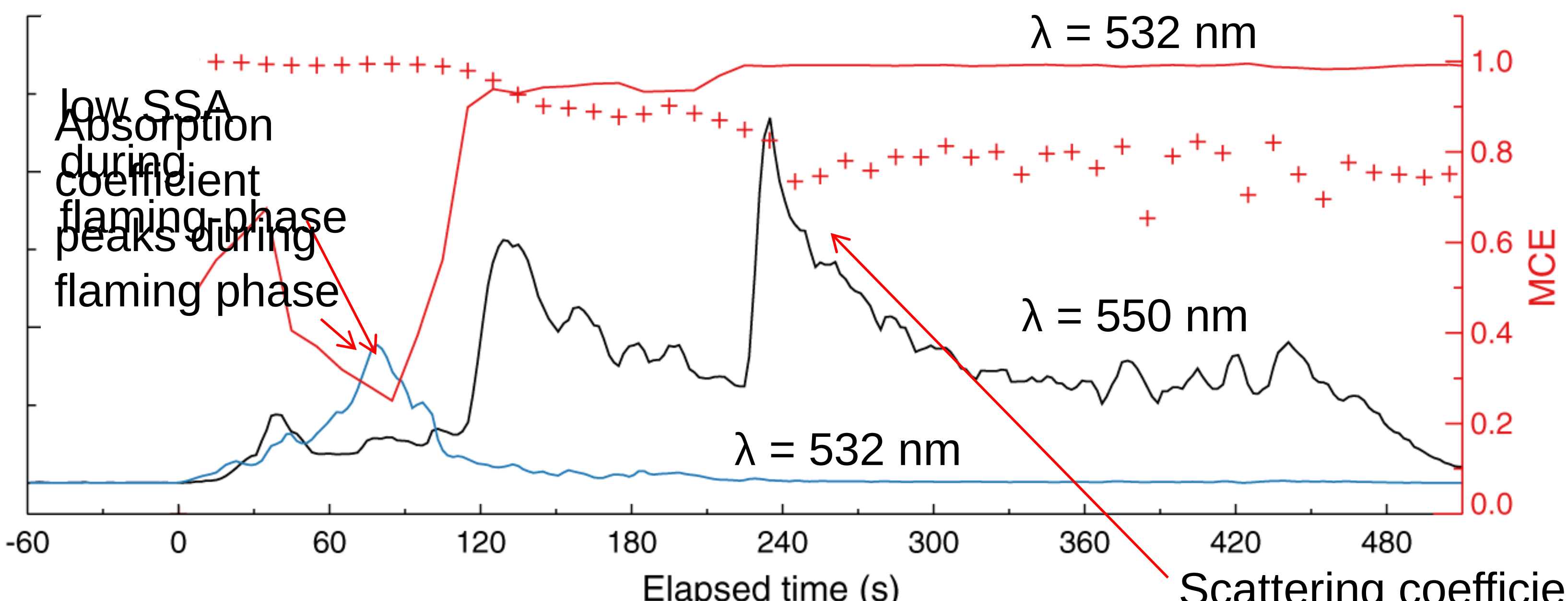
juniper
OC ~20%
EC ~70%
inorganics ~10%

Combustion conditions determined emissions of elemental and organic carbon for many fuels.



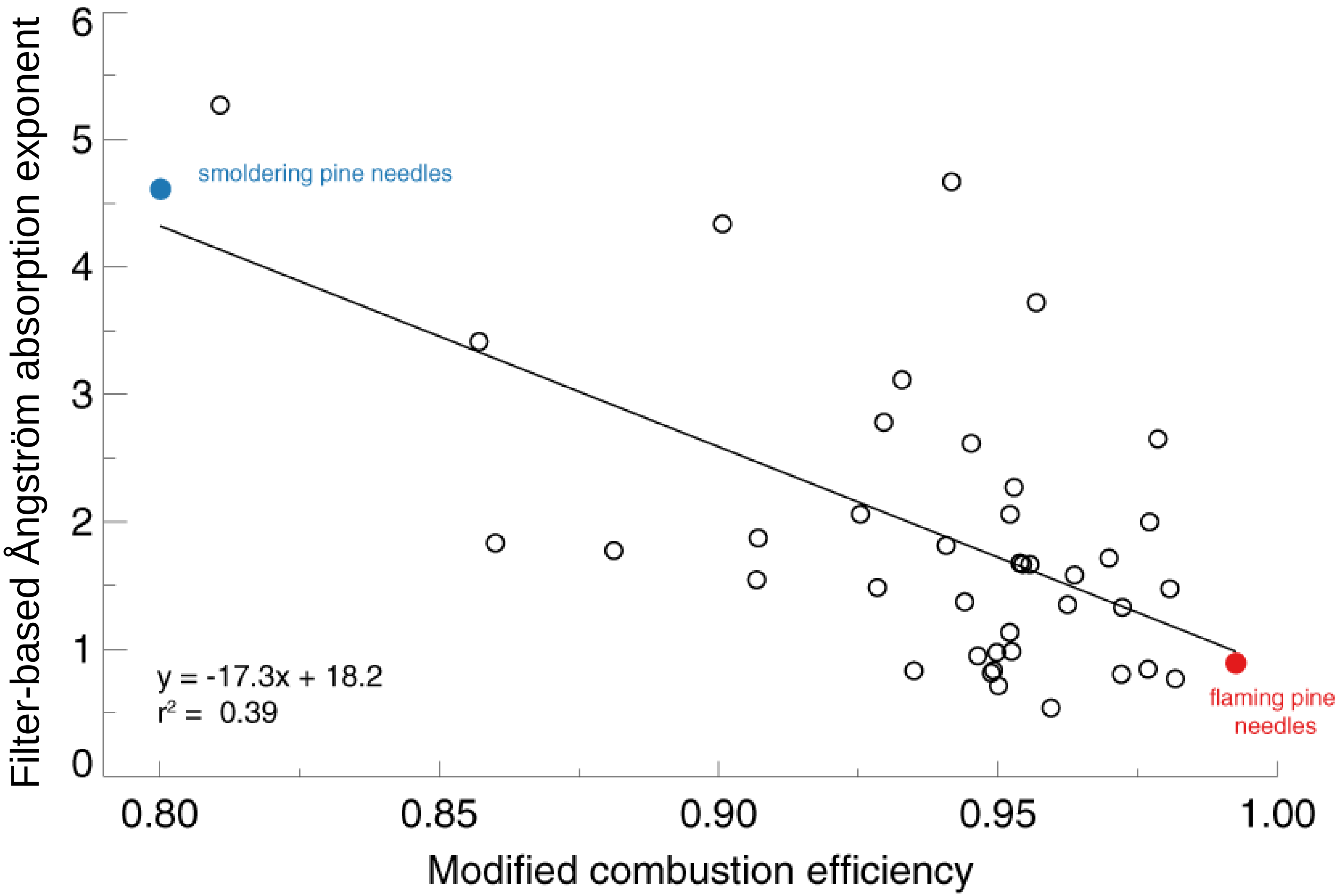
$$MCE = \frac{\Delta CO_2}{\Delta CO + \Delta CO_2}$$

Optical properties during a ponderosa pine litter burn.

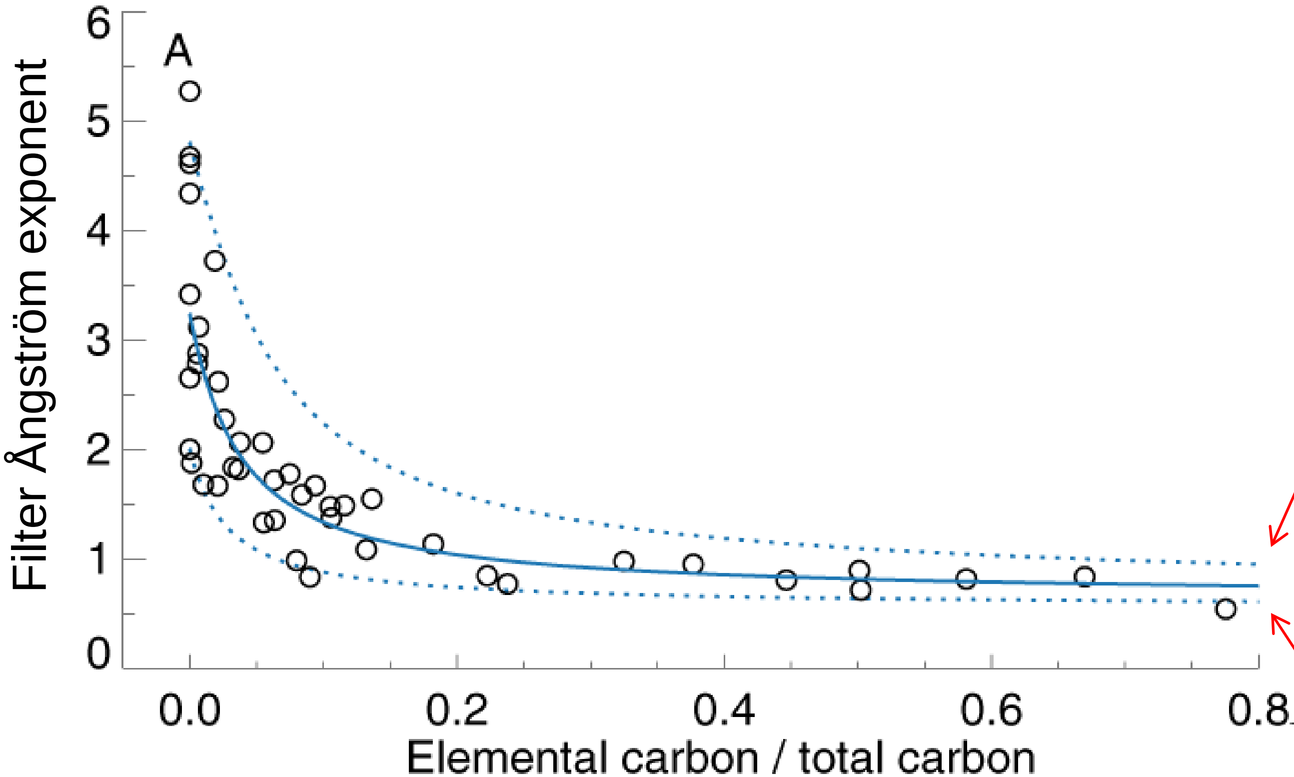


Scattering coefficient peaks during smoldering phase.

Combustion conditions affect Ångström exponents.



Bulk aerosol Angstrom exponents are related to EC/TC.

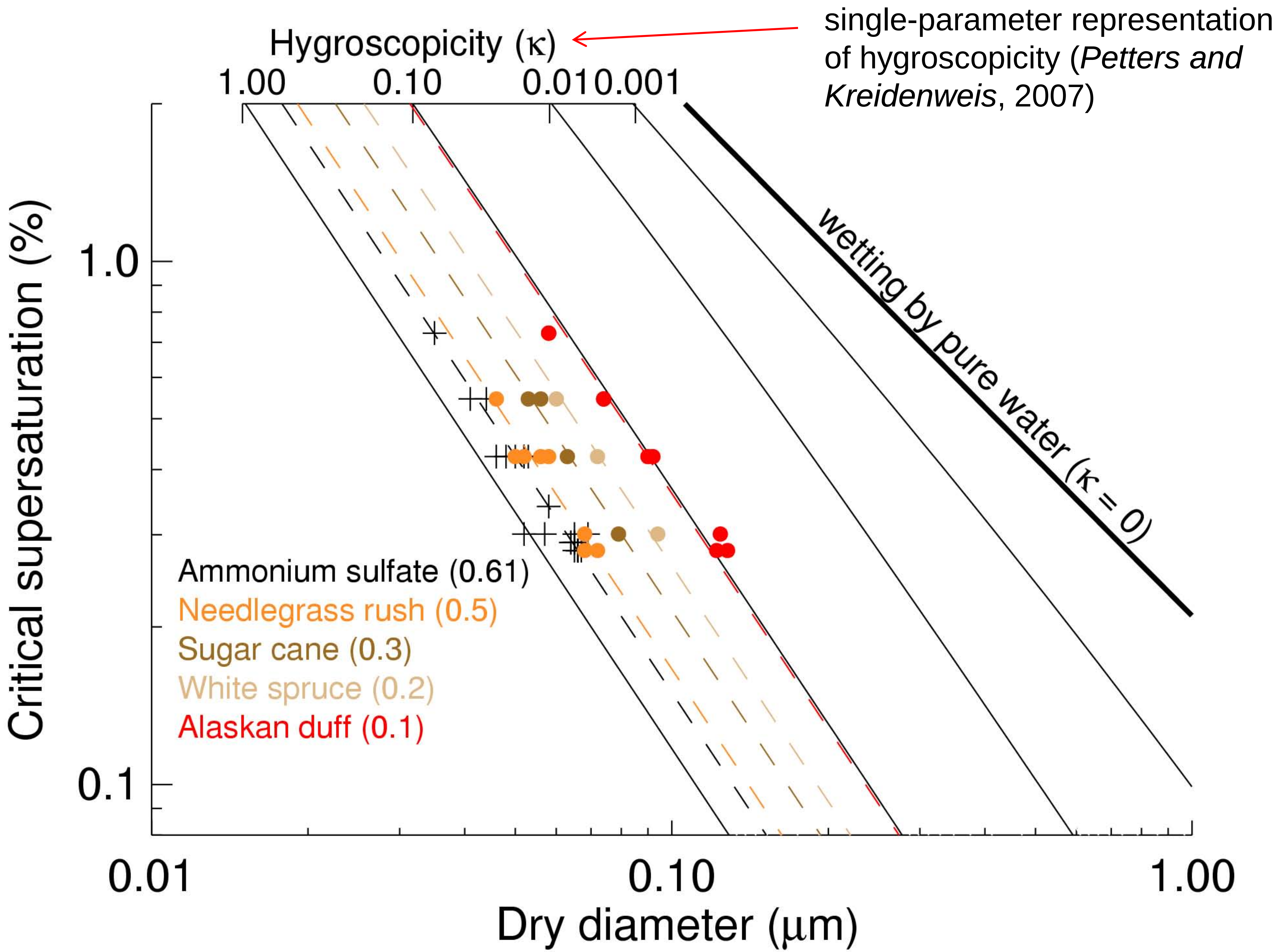


upper limit
organic carbon Å = 4.8
elemental carbon Å = 0.9

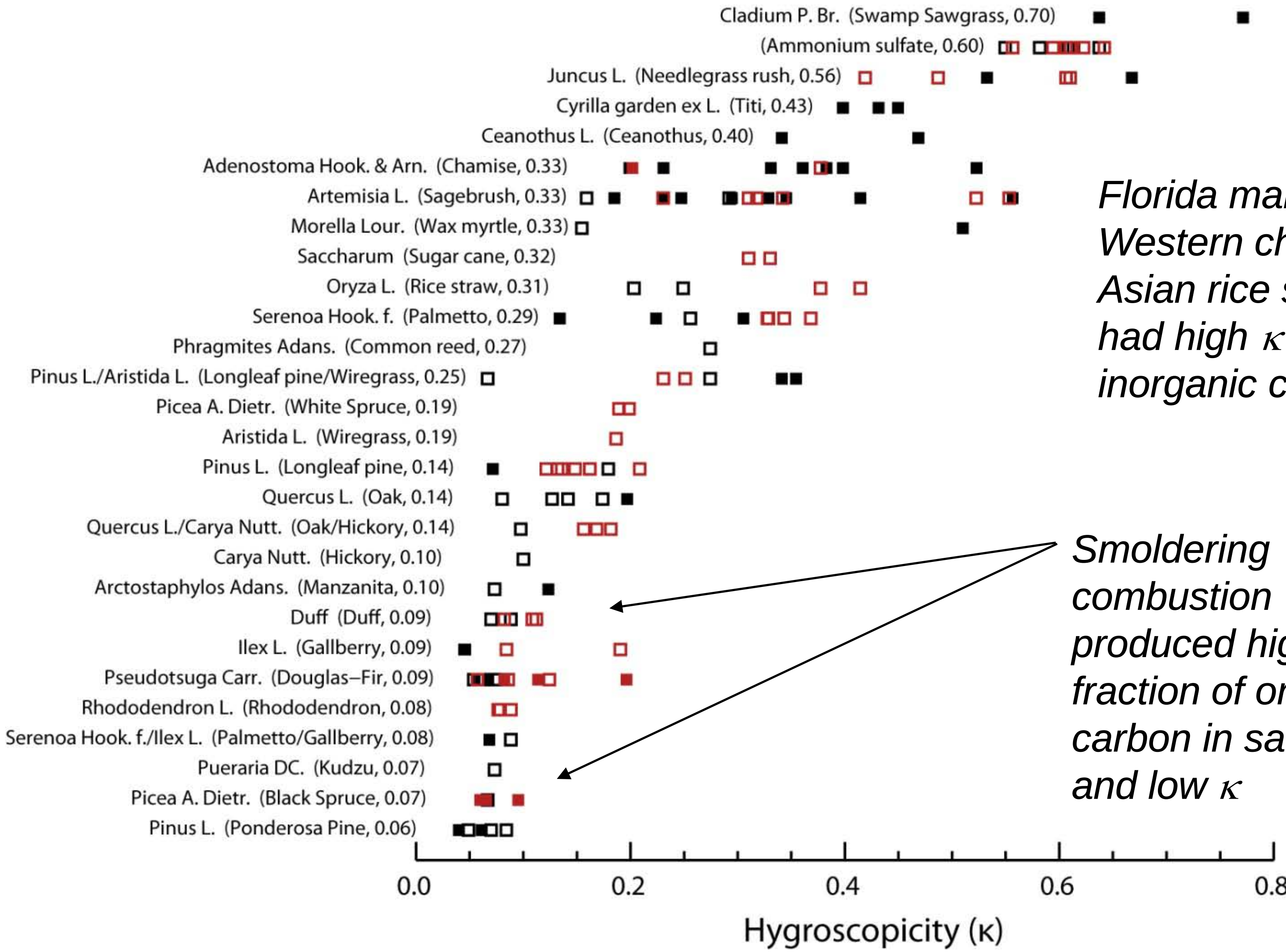
organic carbon Å = 3.3
elemental carbon Å = 0.8
EC ~60 times more absorbing than OC per unit mass

lower limit
organic carbon Å = 2.0
elemental carbon Å = 0.6

CCN activity of aerosol emitted during FLAME



Hygroscopicity parameter ranged from ~0.05–0.7

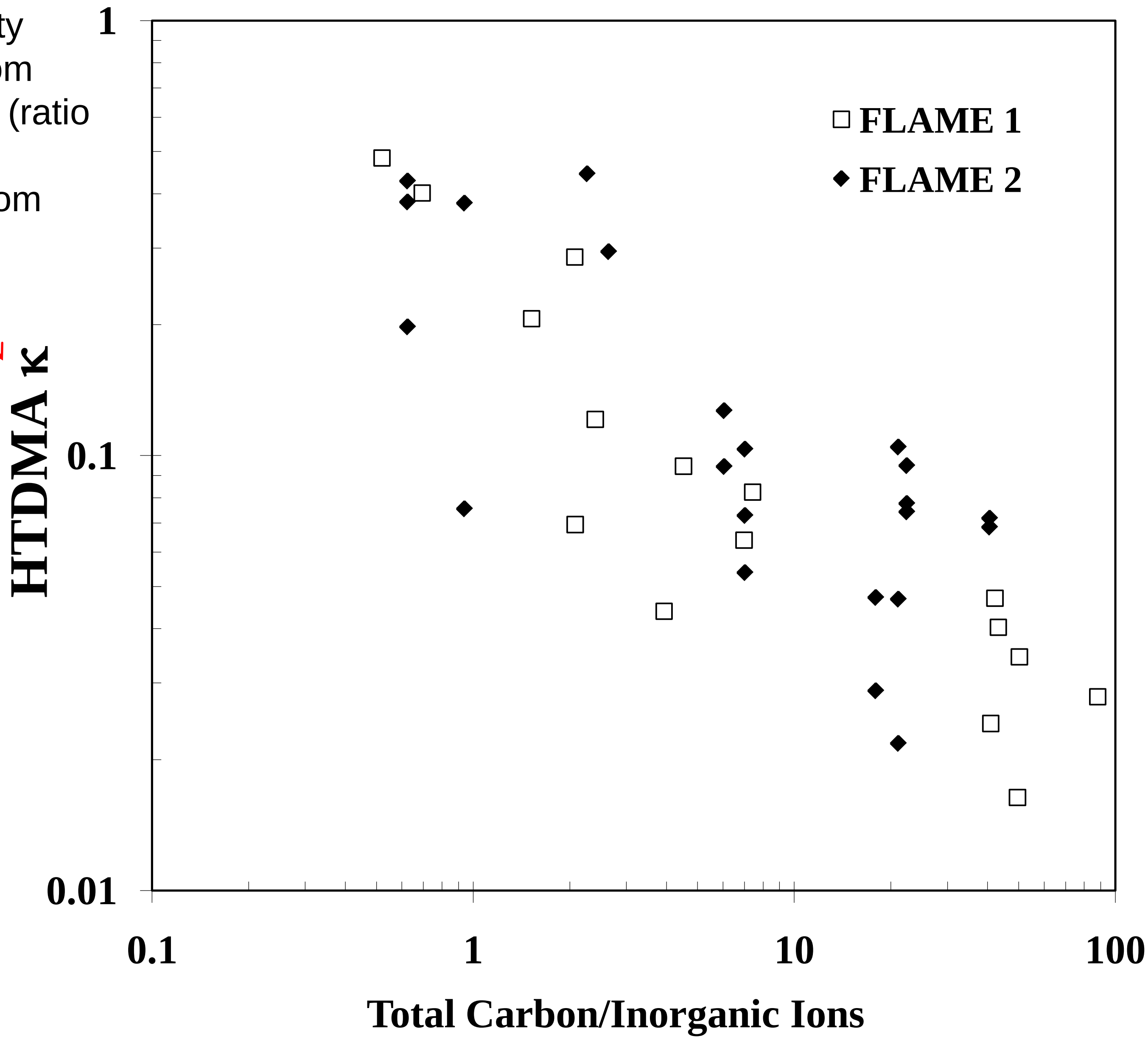


Florida marsh species, Western chaparral, Asian rice straw had high κ and large inorganic content

Smoldering combustion produced high fraction of organic carbon in sample and low κ

Hygroscopicity depends on inorganic aerosol content

Hygroscopicity calculated from growth factor (ratio of wet-to-dry diameters) from HTMDA



Conclusions

Fires emit aerosol with large variability in optical and hygroscopic properties.

Combustion conditions strongly influence emissions of organic and elemental carbon, but have a weak impact on inorganic emissions.

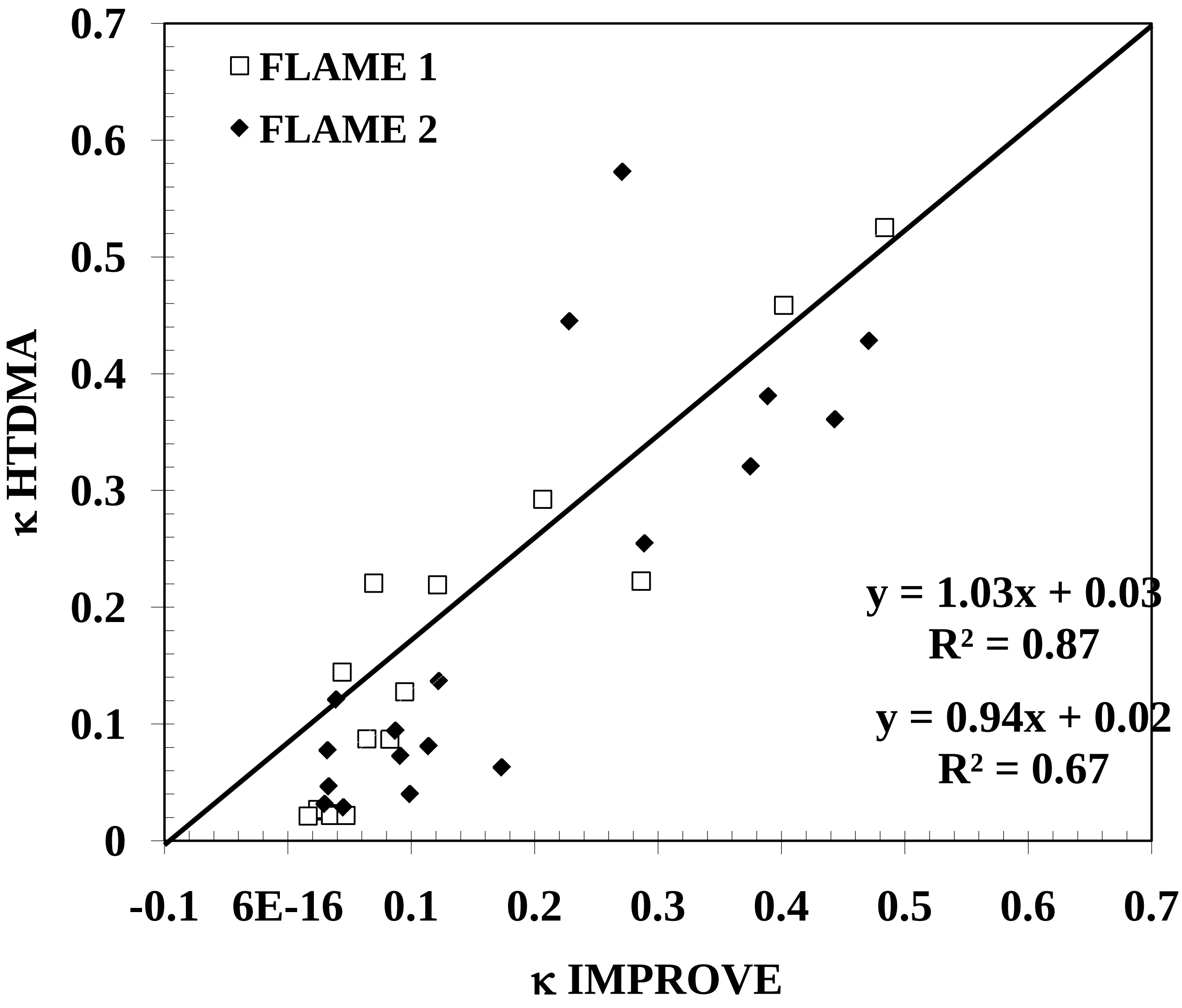
Aerosol dry optical properties were more sensitive to organic/elemental carbon emissions, so depend more strongly on combustion conditions.

Aerosol hygroscopicity was a stronger function of inorganic content, which depended more on plant species/component than on combustion conditions.

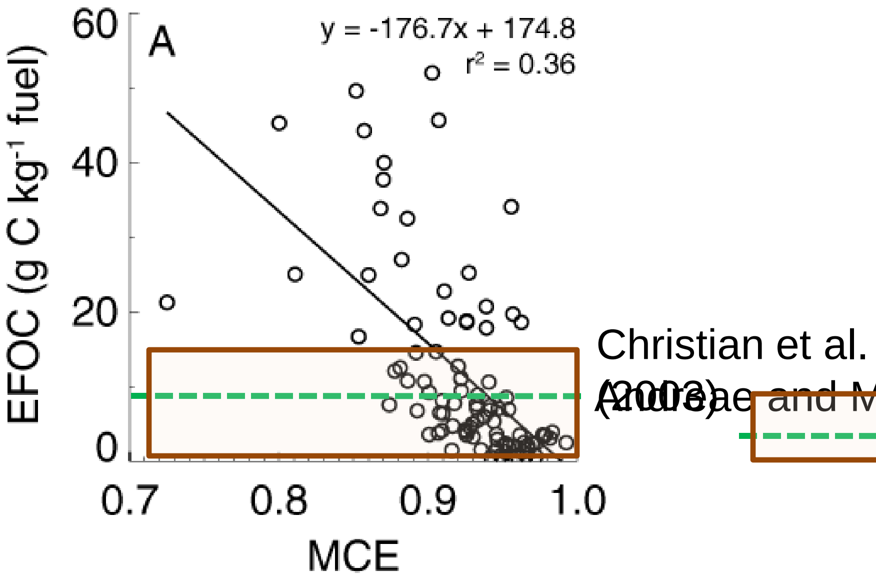
Questions?

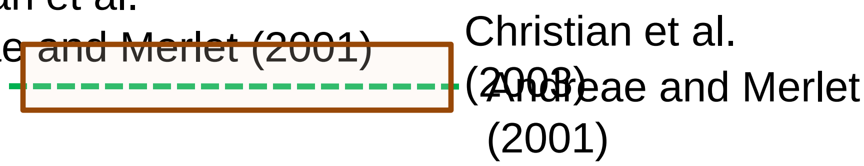
Reconstructed versus measured kappa

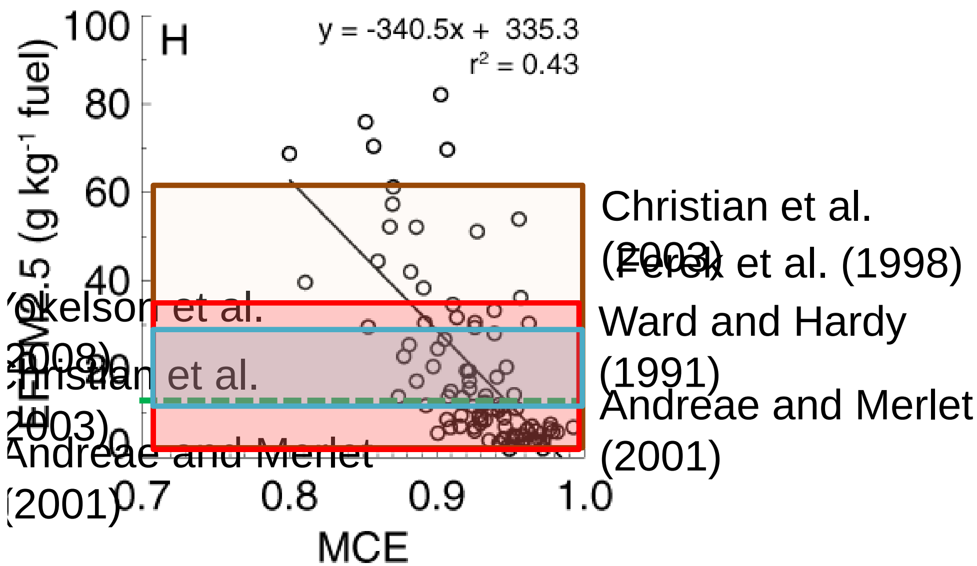
κ = 0.022*OC + 0*(EC+other) + 0.55*(NH4+ + SO42- + NO3-) + 1.0*(K+ + Na+ +Cl-)#



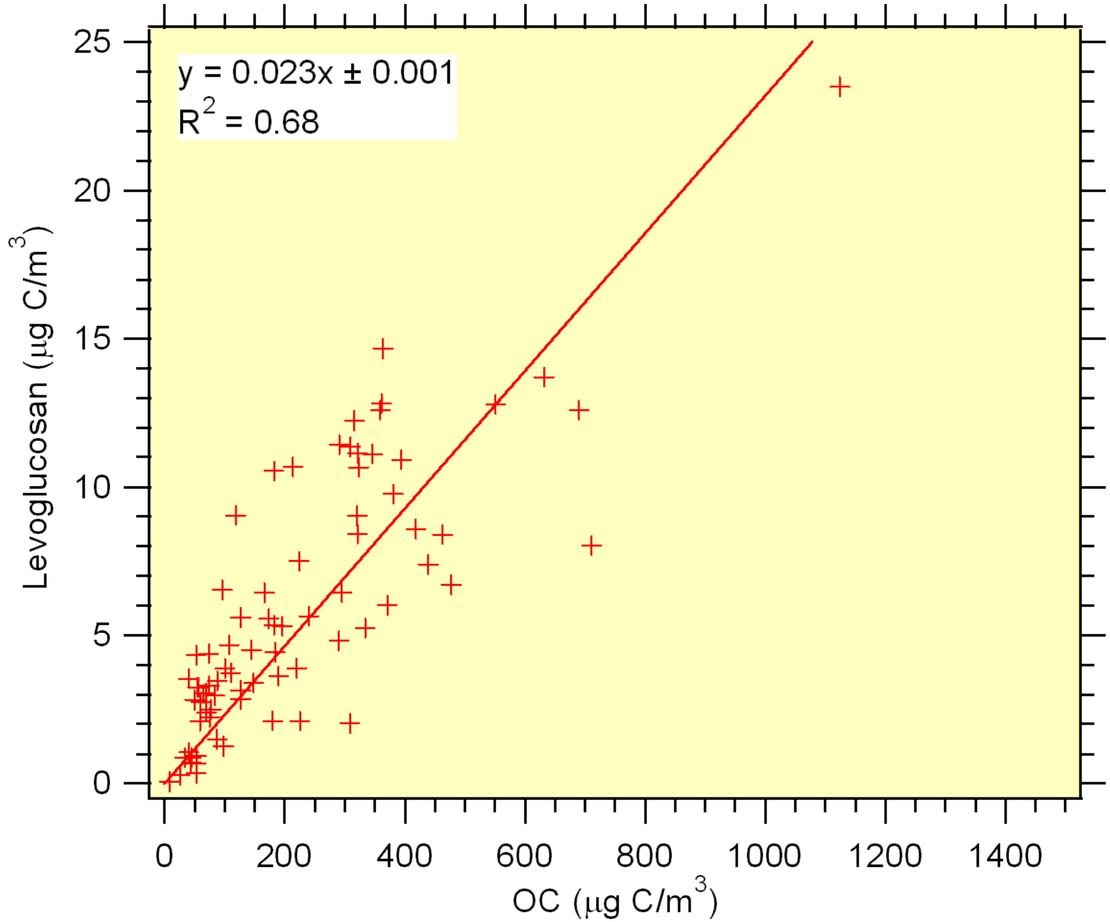
Aerosol emission factors







Hygroscopicity depends on inorganic aerosol content

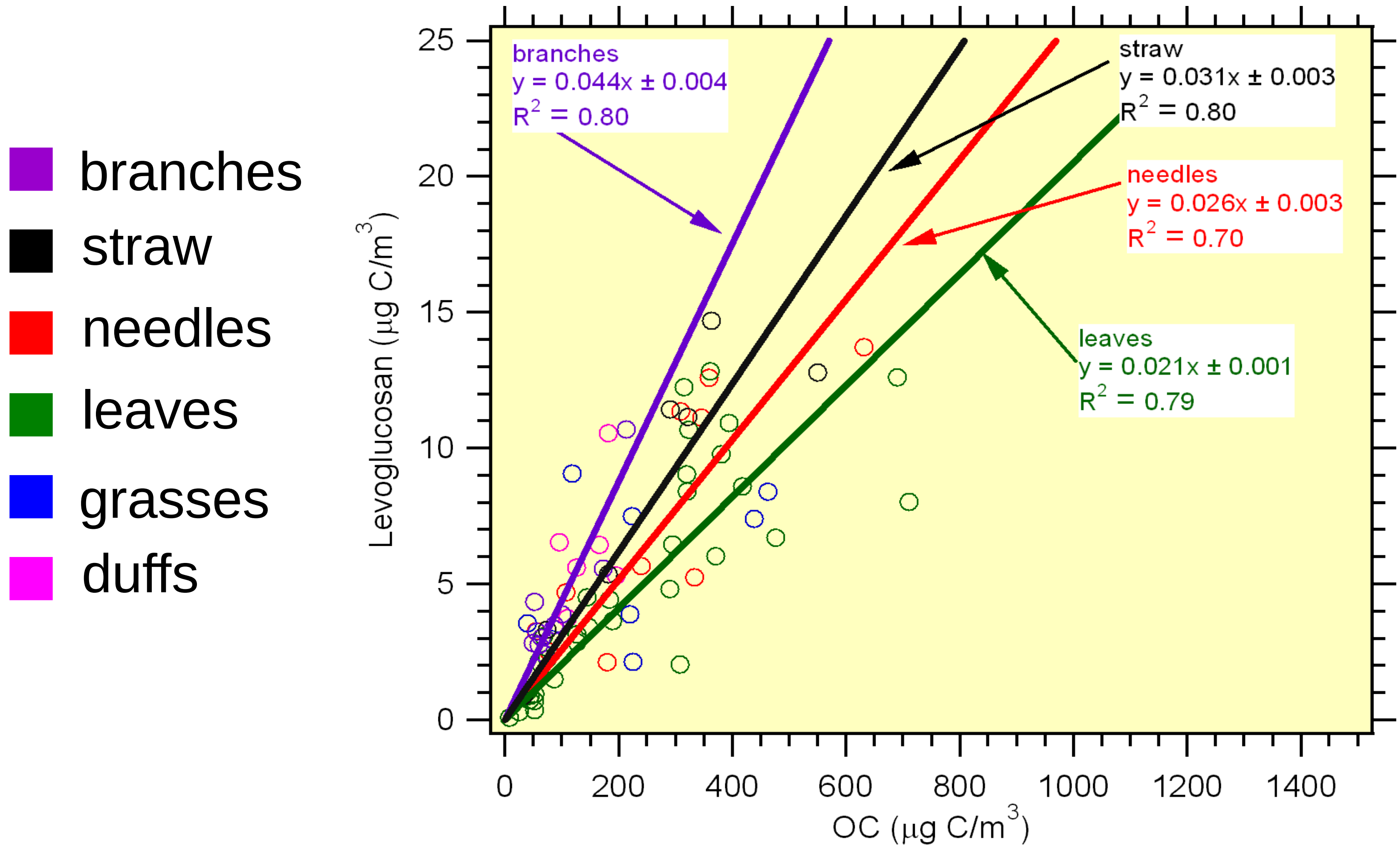


-Fairly correlated

-Fraction is small, slope = 0.023 μg C/μg C

-Average = 0.031   0.017 μg C/μg C

Hygroscopicity depends on inorganic aerosol content



-Pattern based on fuel component

-Suggests potential exists to create regional source profiles