Supplementary Section:

Combustion type can be characterized with different methods including calculating (modified) combustion efficiency (Yatavelli et al., 2017) and using an IR camera to monitor the thermal IR emissions (Freeborn et al., 2008). In this study, we have used the rate of fuel mass change to characterize combustion type.

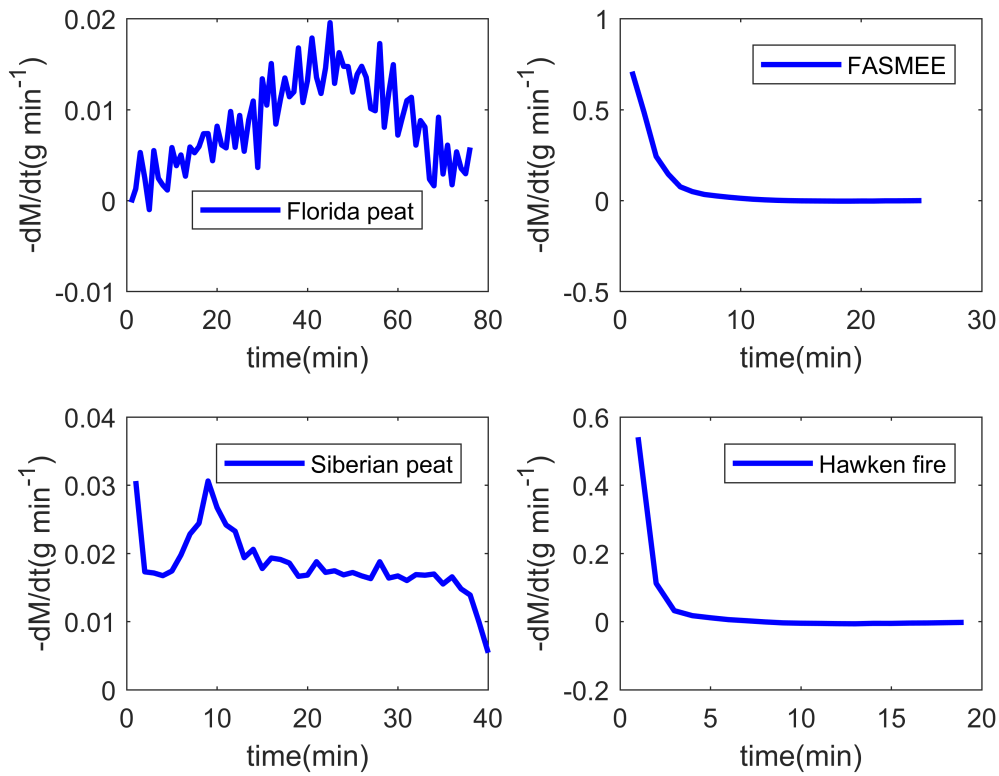


Figure S1. Burning conditions indicated by the negative rate of fuel mass change -dM/dt

The negative rate of fuel mass change per unit time -dM/dt was computed using 1-min average data. Data from one of the replicate burns for each fuel type were chosen to represent the characteristics patterns. For Florida peat, the rate of mass change was noticeably small (i.e., -dM/dt <0.02) and peaked in the middle of the burning period, consistent with smoldering combustion. For both FASMEE and Hawken fire fuels -dM/dt decreased very sharply at the beginning stage of the burn due to fast fuel consumption during the flaming stage, after which the rate slows significantly. For Siberian peat, the trend is the same as for Florida peat, except during the first seconds when an initial rapid decrease of fuel mass indicates some flaming combustion during ignition.

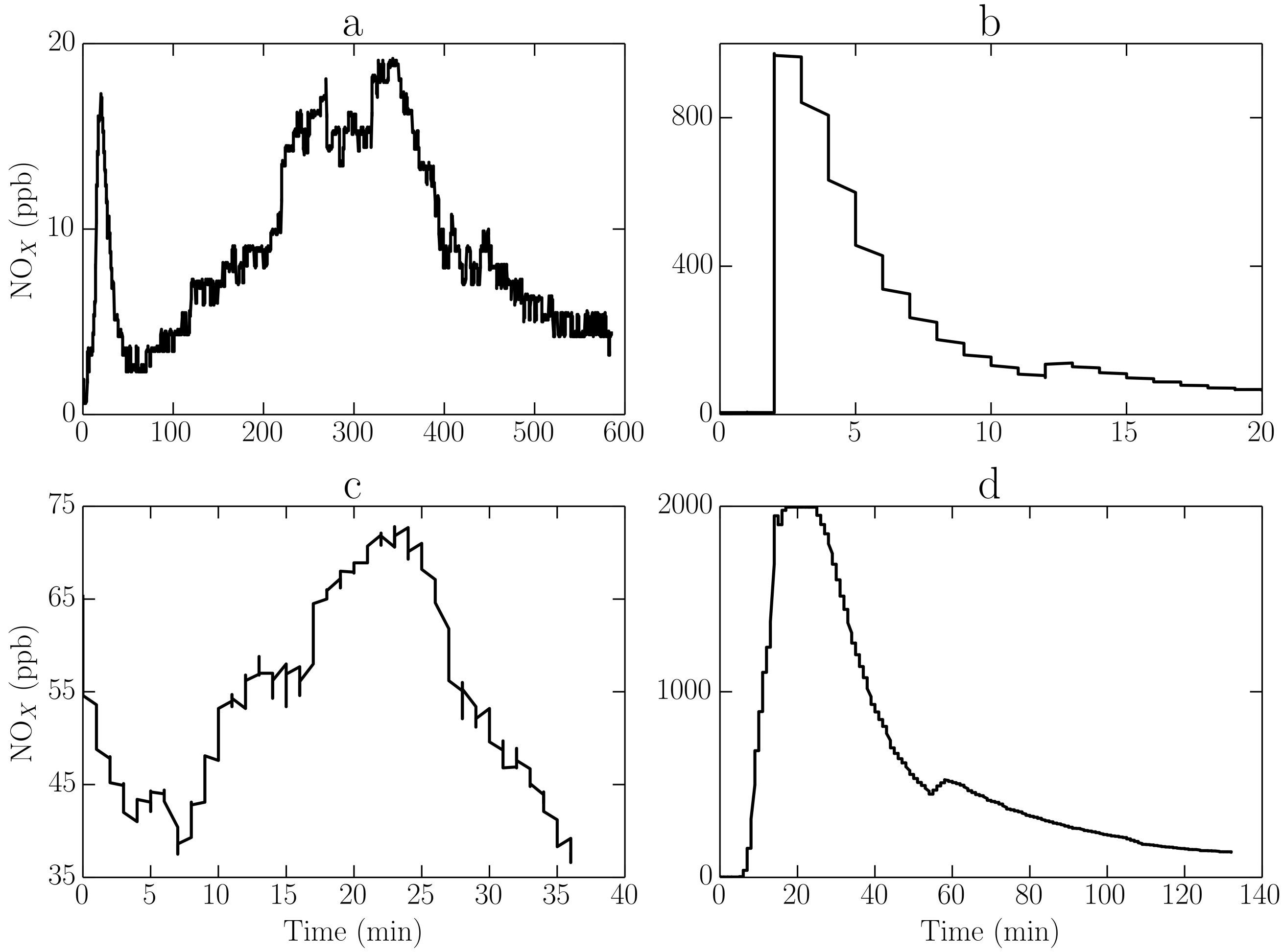


Figure S2. NOx concentration characteristics with time. (a. Florida Peat, b. FASMEE, c. Siberian peat, d. Hawken Fire).

Figure S2 represent the change in NO_x concentrations from BB experiment for four different fuels. (in left panels Florida Peat and Siberian peat: Smoldering combustion and in right panels FASMEE and Hawken fire). A high concentration of NOx (800-2000 ppb) was observed for flaming fuels at the initial stages (2-5 min) of burning experiment and then NOx decreased to background values very rapidly. NO_x concentration from fuels that undergo smoldering combustion (e.g., Florida peat) was small (20 ppb) compared to flaming combustion. The Maxima of NO_x concentration values was reached somewhere in the middle of the burning experiment (e.g. 20-25 min for Siberian peat) and then gradually decrease to background level.

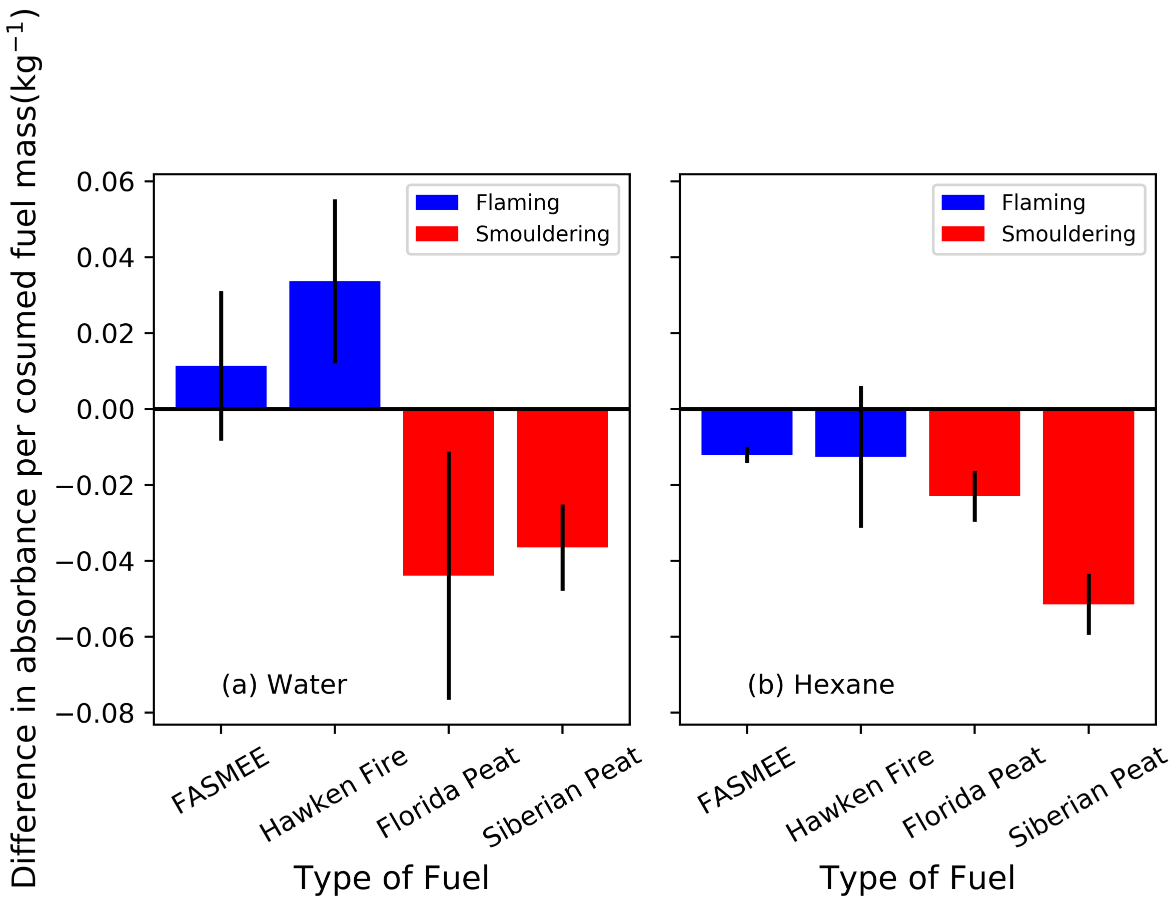
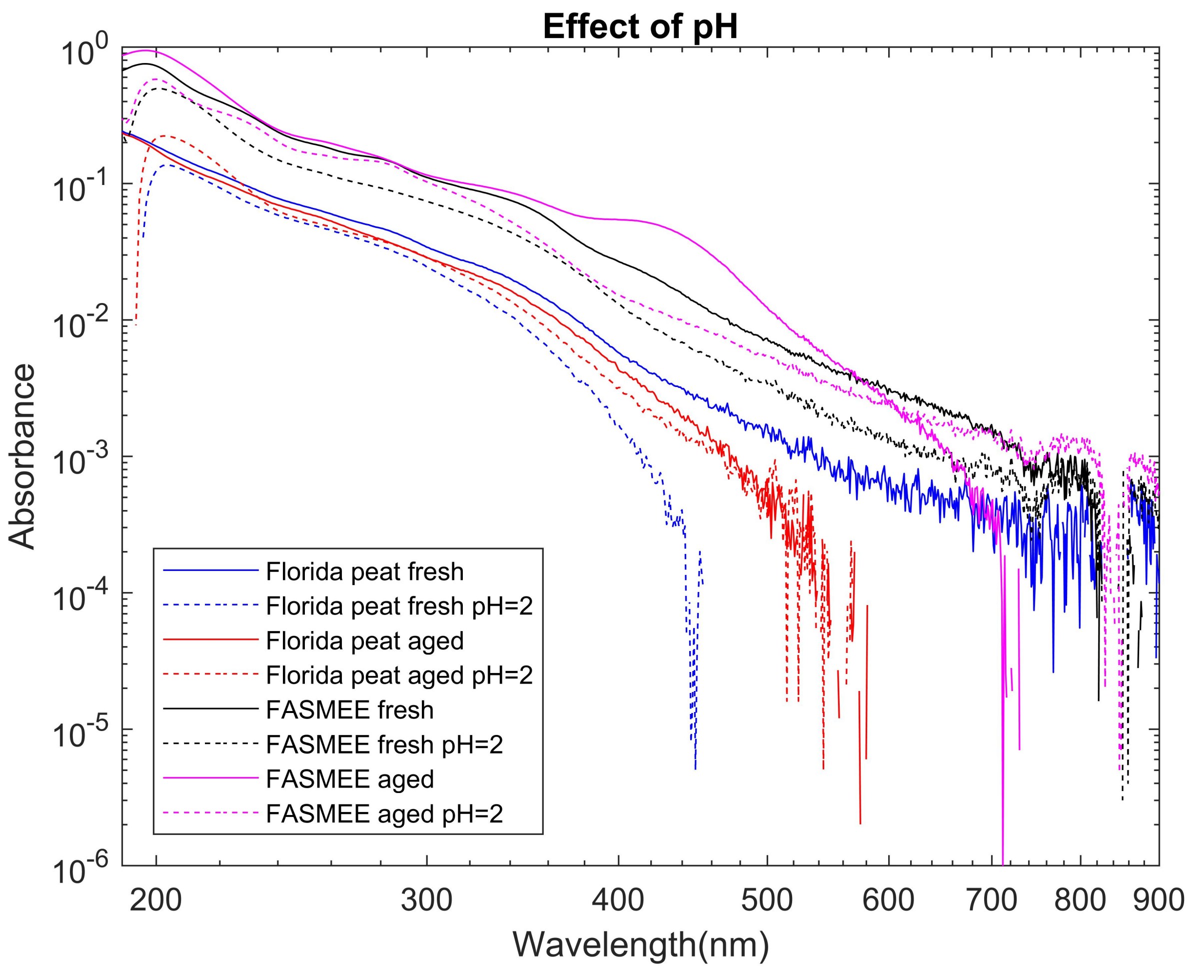
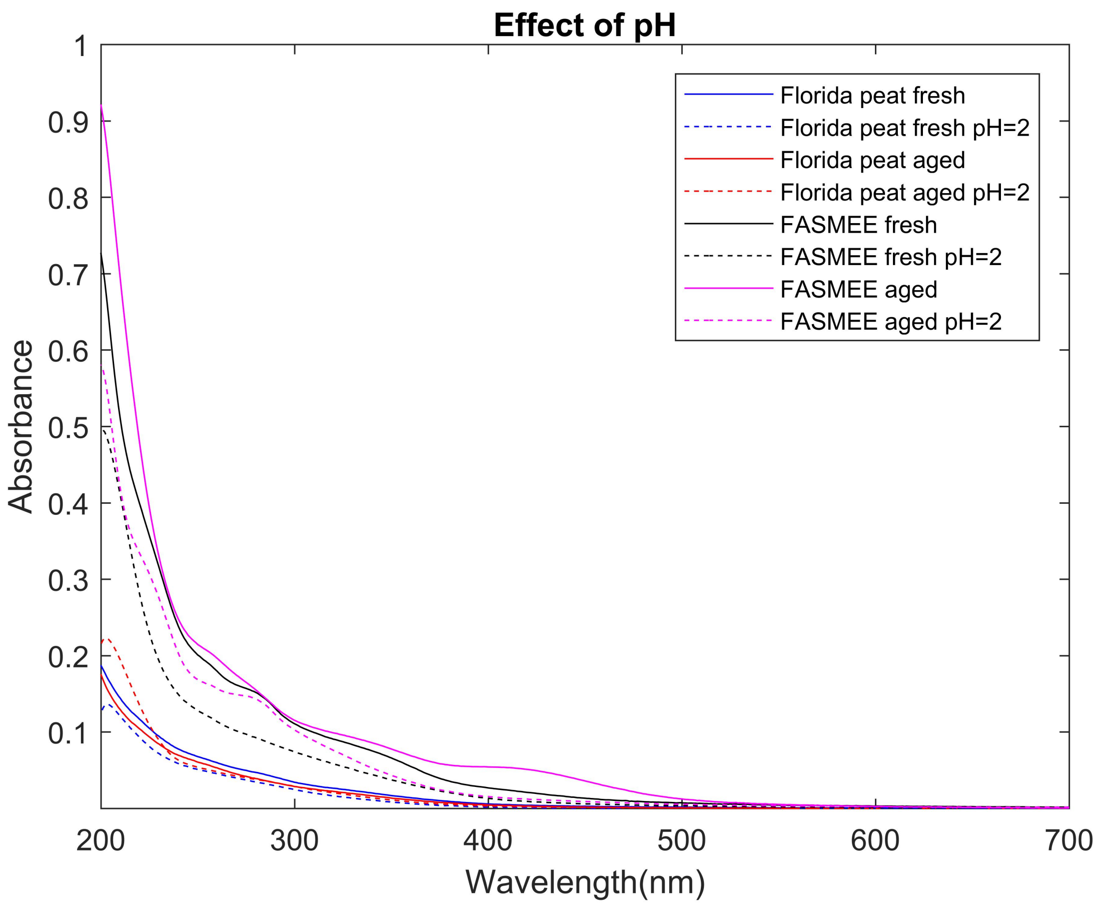


Figure S3. Difference in total absorbance per fuel mass between extracts of fresh and aged BBOA

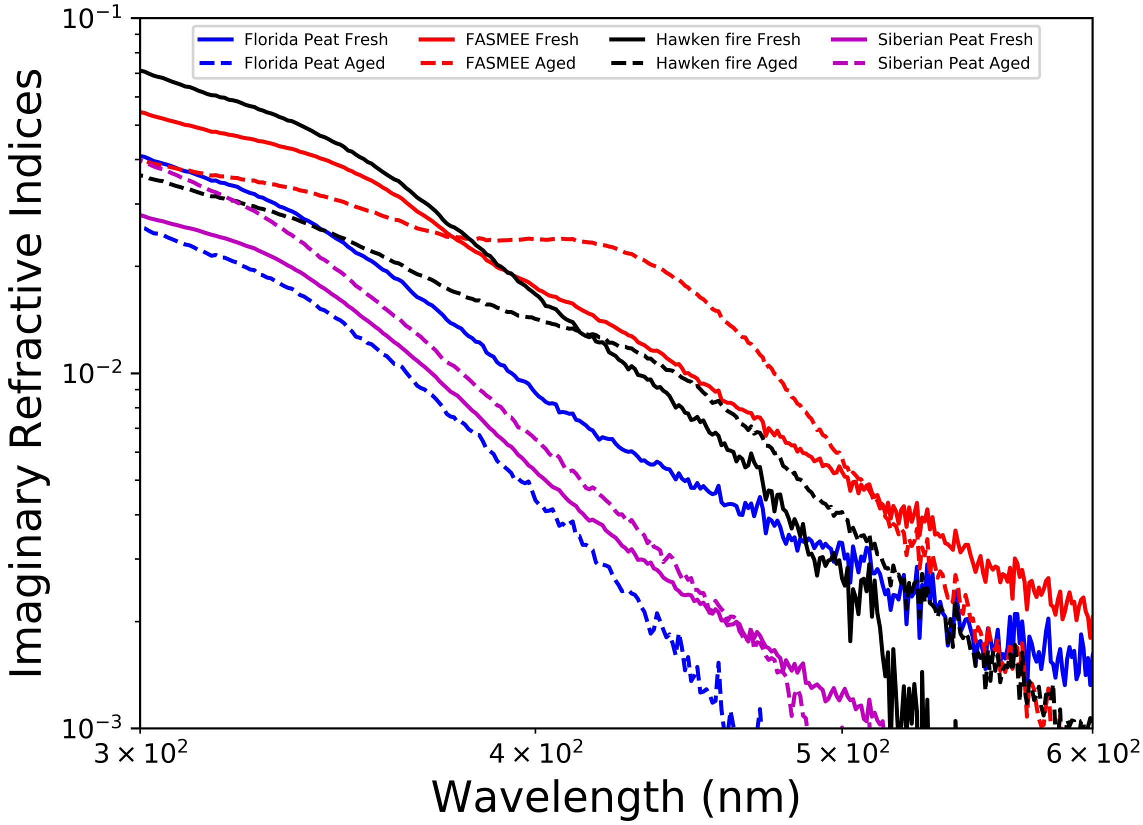
Figure S3 indicates the difference between fresh and aged emission from all four fuels categorized in two different types: flaming and smoldering. The absorbance measured with the spectrophotometer was normalized with total consumed fuel mass. The difference was calculated by subtracting normalized absorbance of fresh sample extract from that of oxidized sample extract. Therefore, a positive value of the difference plot indicates more absorption after oxidation. Averages of the differences for each fuel were plotted with bars and standard deviation from three replicates was used to plot error bars. All dilution factors were incorporated as mentioned in the experimental section for comparison of water and hexane extracts. With water extract, we observe positive values of absorbance in difference plot for fuels with characteristic flaming combustion (e.g., FASMEE). BBOA from combustion of peat fuels, that undergoes smoldering combustion all have negative absorbance values in both water and hexane extract. Further investigation is needed to find the reason behind increased absorbance of aged sample extracts associated with flaming combustion.



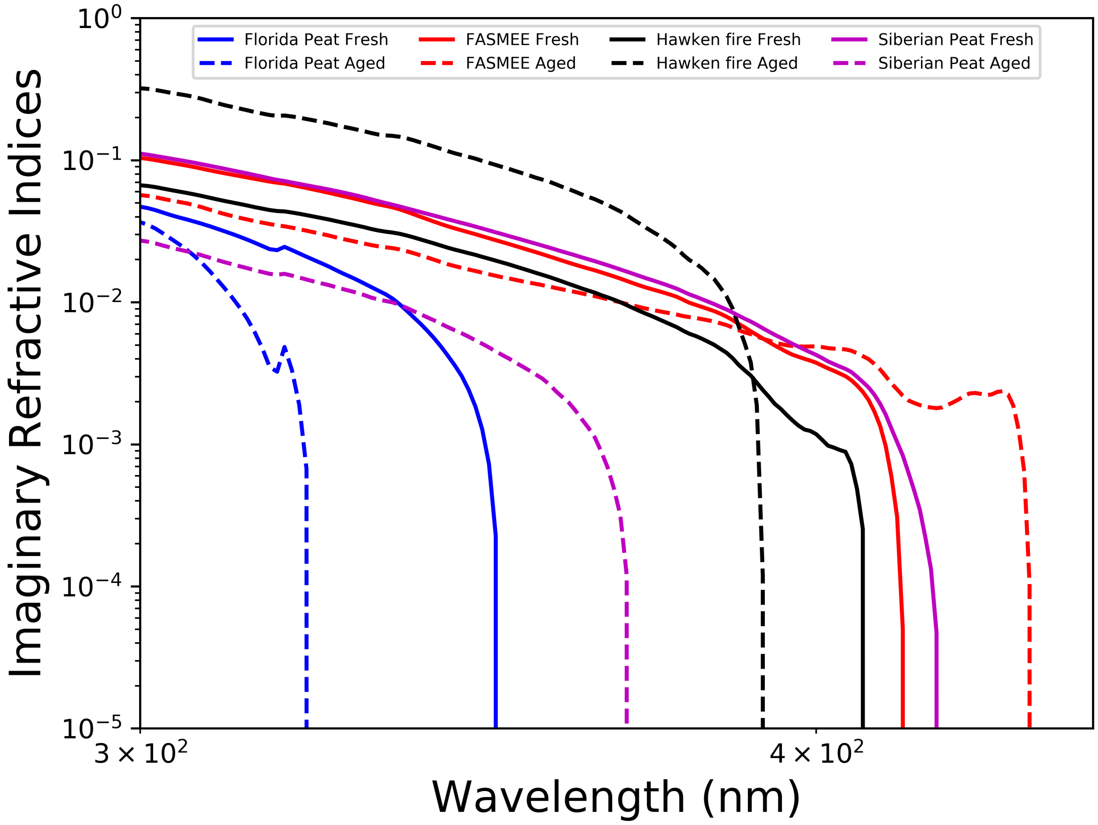
Supplementary Figure S4a: Effect of pH on absorbance of BB aerosols (plotted in log-log scale)



Supplementary Figure S4b: Effect of pH on absorbance of BB aerosols (plotted in linear scale)



Supplementary Figure S5: Imaginary part of the bulk refractive indices of water extract of fresh BBOA (solid lines) and aged BBOA (dotted lines) as function of wavelength



Supplementary Figure S6: Imaginary part of the bulk refractive indices of hexane extract of fresh BBOA (solid lines) and aged BBOA (dotted lines) as function of wavelength

Supplementary Table T1: Results of pairwise t-tests.

Fuels	p-value (water)	p-value (hexane)	p-value (HULIS)	p-value acidified	p-value MAC (water)	p-value MAC (hexane)
Florida Peat	0.198	0.040	0.676	0.226	0.184	0.007
FAASME	0.500	0.016	0.536	0.206	0.911	0.019
Hawken fire	0.158	0.442	0.400	0.444	0.878	0.184
Siberian peat	NA	NA	NA	NA	NA	NA

Supplementary Table T2: Results of pairwise t-tests.

Fuels	p-value (acidified vs neutral) (fresh)	p-value (acidified vs neutral) (Aged)
Florida Peat	0.213	0.340
FAASME	0.270	0.343
Hawken fire	0.094	0.272
Siberian peat	NA	NA