In remote sensing of vegetation, one category that is often ignored, and comprises a large fraction of ecosystem carbon, is non-photosynthetic vegetation (NPV). NPV includes standing dead, litter, and wood, and their masses are often estimated, albeit poorly, from photosynthesis and vegetation greenness. In cases where NPV is detected directly, despite different components of NPV having unique biochemical compositions, all components are often grouped together in remote sensing. This is due to presumed consistency in lignin and cellulose concentrations that cause relatively similar appearances in imaging spectroscopy. NPV detection at the individual component level is vital for tracking ecosystem dynamics resulting from climate, fires, disease, and insect outbreaks.

Field spectroscopy, *in situ* biomass sampling, aerial spectroscopy flights, and satellite spectroscopy, have all been used (although not extensively) to examine NPV, with varying degrees of success. Lab spectroscopy has shown that NPV components have identifiable features in the short-wave infrared (SWIR) range, between 2000-2400 nm, features that are far more distinguishable with increased spectral resolution. If spectra unique to NPV components are known, and the background soil types in areas of interest are also known, NPV can be classified and estimated with greater accuracy across ecosystems. Distinct spectral features aid in scaling observations to the resolution of satellite missions with full wavelength range (FWR) spectral sensors and improve large-scale identification of NPV components. The improved understanding of the constituent parts of terrestrial ecosystem NPV provided by this project is essential for the monitoring of land cover and ecosystem services over time.

Throughout the peak growing seasons of 2024 and 2025, FWR spectral resolution field spectral samples were taken across a variety of ecosystem types in a mid-Atlantic mixed land use system. These spectral samples were followed by vegetation harvest samples of the spectrometer footprint, sorted into photosynthetic vegetation, standing dead, and litter. We tested the ability of field spectra to predict NPV component percentage and biomass. The National Ecological Observatory Network (NEON) Aerial Observation Platform (AOP) imaging spectrometer (NIS) data collected over the same field site in 2025 were used to scale field-based predictions of NPV components to the spectral and spatial resolution of aerial spectroscopy data. Using high-resolution RGB imagery to validate spectral estimates, NEON data shows promise in identification of NPV.

NEON AOP and field spectroscopy data were rescaled to the spatial and spectral resolutions of recent and upcoming NASA satellite missions, such as NASA's Earth Surface Mineral Dust Source Investigation (EMIT), to test the ability of these satellite data to predict NPV components across ecosystems at broader spatial extents. Spectral signatures and methods found most effective in predicting NPV component cover and biomass, and differentiating components from each other, will be made publicly available to inform future research with data from various platforms.

Greater Earth system coverage will be possible with hyperspectral satellites, and this project created a baseline of *in situ* spectra associated with NPV components for large-scale projects to utilize. This will enhance our understanding of the distribution of ecosystem carbon, related to phenological dynamics and disturbances, and hence create more accurate terrestrial ecosystem and biogeochemistry estimations and models.