Airborne Imaging Spectrometer Products over Coastal Louisiana from NASA’s Delta-X Campaign

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Abstract

- Aboveground biomass (AGB) plays a critical functional role in coastal wetland stability, as high biomass vegetation contributes to organic matter production, sediment accretion potential, and carbon storage. Here we use Airborne Visible/Infrared Imaging Spectrometer—Next Generation (AVIRIS-NG) data from NASA’s Delta-X mission in coastal Louisiana to map vegetation types and herbaceous AGB across the 2021 growing season.
- AVIRIS-NG imagery was obtained with a coincident herbaceous vegetation survey that harvested biomass (n=84) in April and August 2021 (Castañeda-Moya and Solohin 2022). We used these paired samples and reflectance spectra in a machine learning-based regression model that leverages visible-shortwave infrared reflectances. This model estimated seasonal AGB and carbon across the Atchafalaya and Terrebonne Basins’ herbaceous wetlands. We additionally used the AVIRIS-NG data to map vegetation type across this domain. This classification scheme was based on the image-derived reflectance spectra from the Delta-X vegetation survey combined with 2021 Coastwide Reference Monitoring System (CRMS) survey plots coincident with the AVIRIS-NG imagery. We applied a Principal Components Analysis (PCA) to this compiled spectral library and trained a machine learning-based classifier on selected component responses. We applied the PCA rotation to the AVIRIS-NG imagery along with the classifier to map vegetation types.

Methods

- AVIRIS-NG: Spring and Summer mosaics produced for Atchafalaya and Terrebonne Basins
- Field Samples: 0.25 m² herbaceous vegetation plots (Castañeda-Moya and Solohin 2022). AGB harvested, dried, and weighed
- CRMS Plot Data: 2021 plot locations with vegetation species, Dominant species >50% cover

Results

- Figure 1: Study area in Louisiana’s Atchafalaya and Terrebonne Basins. Map shows these basins’ contrasting patterns of wetland gain and loss from 1864-2020 (Jensen et al. 2022).
- Figure 2 (right): Aboveground biomass (g/m²) maps derived from the corrected AVIRIS-NG surface reflectance data and corresponding Random Forests model. Analysis of herdaceous AGB in the early growing season. Analysis from Jensen et al. (in review). Data available via ORNL DAAC (Jensen et al. 2023).
- Figure 3 (below): Carbon (megagrams/hectare) allocated in herbaceous vegetation from early to peak growing season, 2021.

Conclusions

- The Atchafalaya Basin overall sees more significant seasonal growth. Saltmarshes in the southern Terrebonne Basin see significant seasonal growth, while the brackish marsh interiors exhibit less aboveground productivity. This is consistent with ongoing observations that coastal Louisiana’s brackish marsh interiors are less stable and seeing greater loss.
- Mean carbon concentrations from April-August: Atchafalaya 0.94 ± 4.00 Mg/ha, Terrebonne 1.54 ± 3.60 Mg/ha
- Imaging spectroscopy/hyperspectral remote sensing provides effective data for accurately mapping vegetation types in wetland environments.
- Overall Vegetation Type Accuracy = 85%, Kappa = 0.81
- Future imaging spectroscopy missions such as NASA’s Surface Biology & Geology will enable consistent trait maps for vulnerable wetland environments around the globe.

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Figure 1: Study area in Louisiana’s Atchafalaya and Terrebonne Basins. Map shows these basins’ contrasting patterns of wetland gain and loss from 1864-2020 (Jensen et al. 2022).

Figure 2 (right): Aboveground biomass (g/m²) maps derived from the corrected AVIRIS-NG surface reflectance data and corresponding Random Forests model. Analysis of herbaceous AGB in the early growing season. Analysis from Jensen et al. (in review). Data available via ORNL DAAC (Jensen et al. 2023).

Figure 3 (below): Carbon (megagrams/hectare) allocated in herbaceous vegetation from early to peak growing season, 2021.

Figure 4 (above): Vegetation type map of the Atchafalaya and Terrebonne Basins.