National Aeronautics and Space Administration

Imaging Spectroscopy Applications for Assessing Suspended Sediment in Louisiana's Coastal Wetlands

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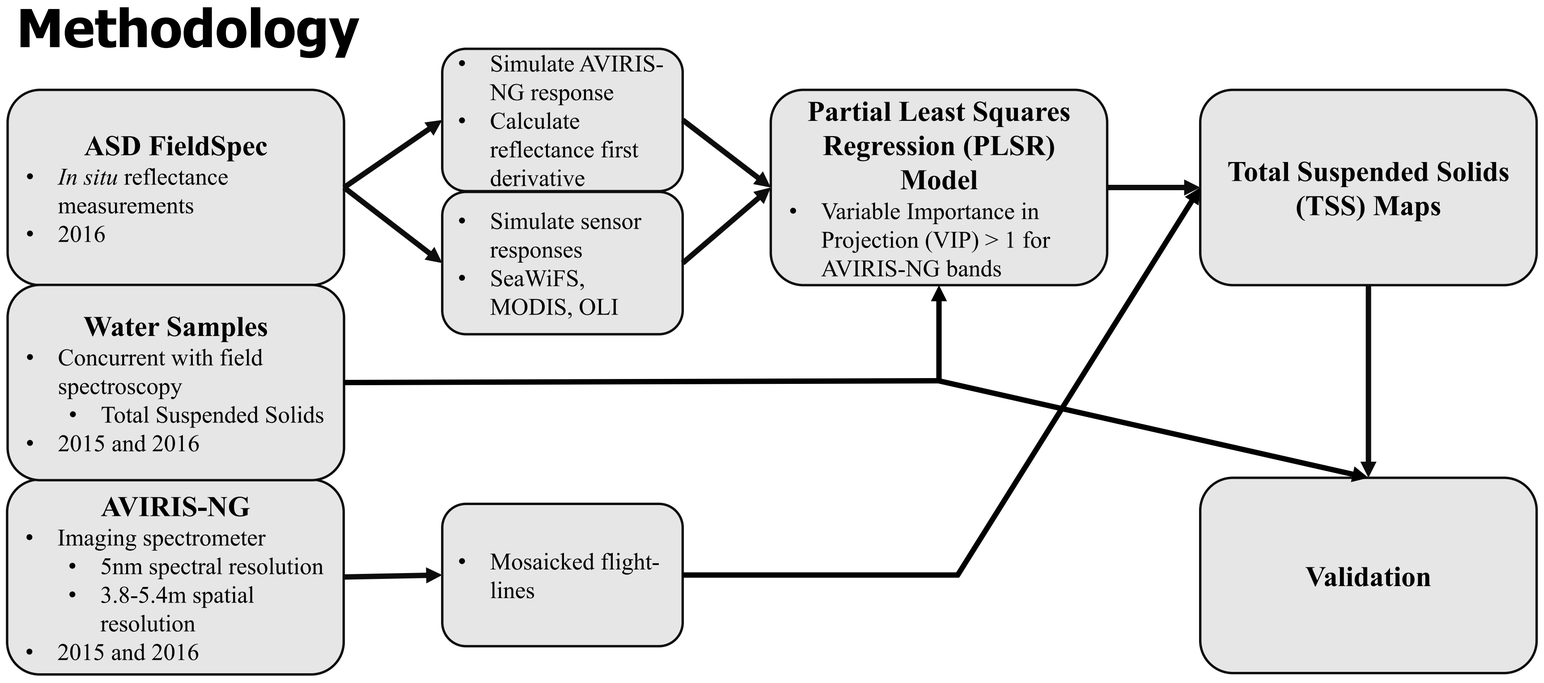
Abstract

Louisiana's coastal wetlands face severe rates of degradation and loss. Relative sea level rise—the combination of eustatic sea level rise and land subsidence—is the primary driver of this loss, which is in turn largely driven by a restricted sediment supply within wetlands. Wetlands depend on captured sediment borne by adjacent waterways to accrete surficial material and maintain their elevation. If a marsh's accretion rate is outpaced by the rate of relative sea level rise, it will submerge and die. Imaging spectroscopy can be employed to model and map water contents within Louisiana's coastal wetland ecosystems, including suspended sediment. AVIRIS-NG data was collected over the Atchafalaya River and Wax Lake Delta region in May-June 2015 and October 2016, concurrent with field measurements of water contents. Partial Least Squares Regression (PLSR) models for the waterways' total suspended solids (TSS) concentrations were developed with in situ water samples and ASD field spectrometer-based reflectance derivatives, then applied to AVIRIS-NG mosaics. These maps in turn may inform analysis of current ecosystem health and enable predictions of future wetland loss.

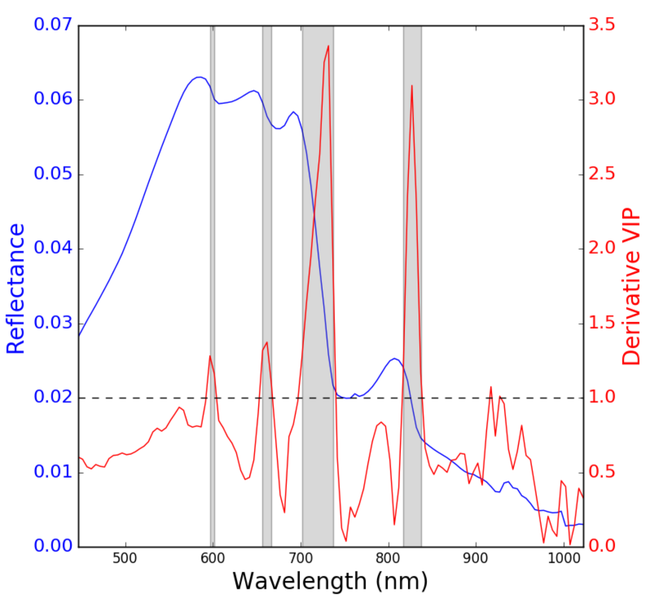
Study Area

Atchafalaya and Wax Lake Deltas, Louisiana, USA

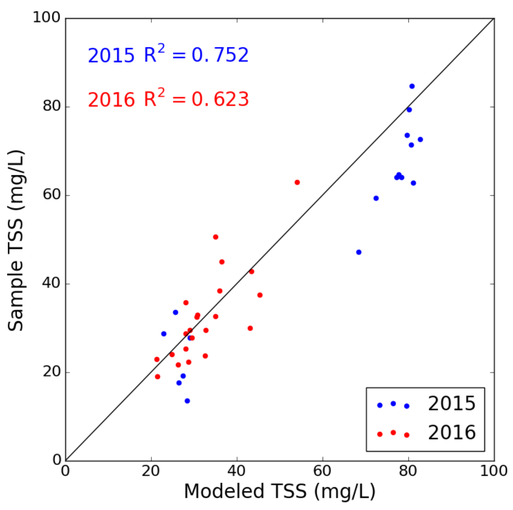
Methodology



PLSR modelling: Sample field spectra (mean reflectance spectrum pictured in blue) derivatives fed into PLS algorithm. VIP for each band (pictured in red) was calculated, and bands with a VIP > 1 were selected to construct the final PLSR model to apply to AVIRIS-NG imagery.

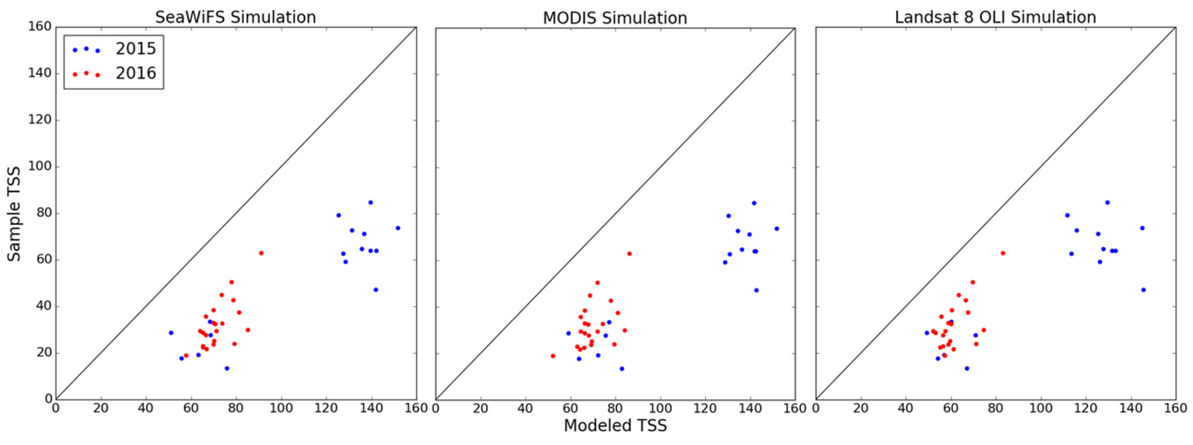


Results



Left: Validation scatterplot for TSS retrievals from AVIRIS-NG TSS maps (May-June 2016, October 17, 2016, and October 18, 2016). The PLSR model was developed with field spectra collected in 2016 and applied to imagery from both years. Modeled values were extracted from a 3 × 3 pixel mean around sample coordinates. TSS measurements collected within three days of AVIRIS-NG flights in 2015 were used for independent validation. 2016 samples were treated as independent with respect to modeled TSS map values.

Below: Validation scatterplots for TSS retrievals from simulated sensor reflectance.



Right: TSS maps, calculated from first derivative PLSR models, for each AVIRIS-NG mosaic.

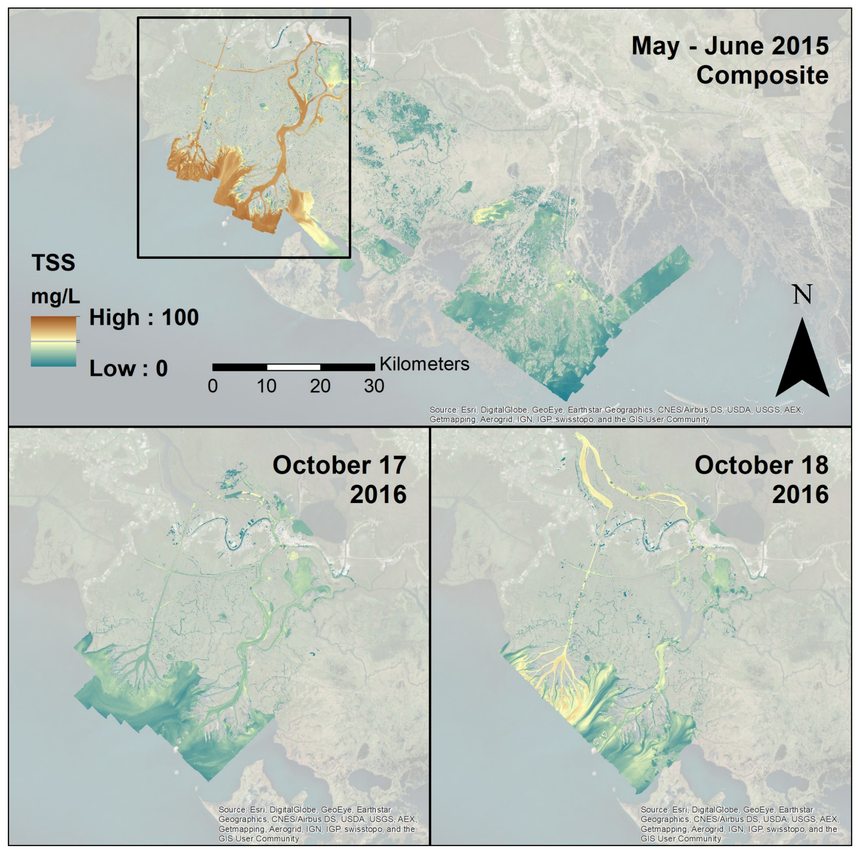


Table: Validation statistics for TSS retrievals from AVIRIS-NG derivatives and simulated sensor reflectance.

	AVIRIS-NG		SeaWiFS		MODIS		Landsat 8 OLI	
Model R^2	0.833		0.725		0.749		0.714	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Validation R^2	0.752	0.623	-	-	-	-	-	-
Pearson R	0.944	0.790	0.891	0.688	0.898	0.545	0.848	0.643
RMSE (mg/L)	11.403	6.328	61.57	40.02	64.726	38.664	55.087	30.295

Conclusions

- Imaging spectroscopy, by providing additional spectral information and enabling spectral derivation, provides the highest fidelity TSS retrievals.
  - VIP analysis shows the visible and near-infrared absorption feature characteristics that are most sensitive to TSS concentrations.
  - Imaging spectrometer validation scatterplot indicates a greater capability for TSS retrieval in highly turbid waters than its multispectral simulation counterparts.
- Reflectance-based empirical models from the simulated multispectral sensors are not sufficient for TSS retrieval beyond the immediate study area and period.
- Validation results from 2015 and 2016 indicate a generalized model for TSS retrieval may be developed for imaging spectroscopy data.

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