The Bernard M. Gordon
Center for Subsurface Sensing and Imaging Systems

NSF Engineering Research Center

Mission: "to revolutionize the existing technology for detecting and imaging biomedical and environmental-civil objects or conditions that are underground, underwater, or embedded in the human body."

Core Academic Partners:

- Northeastern University (Lead Institution)

- University of Puerto Rico at Mayagüez

- Renssalaer Polytechnic Institute

- Boston University

CCRI Funded Research Summary

Objective: The primary objective of the proposed project is to provide a more comprehensive assessment and mapping of the shallow coastal resources for selected areas along the coast of Puerto Rico. Specifically, we will extract information on habitat composition and water properties using the enhanced capabilities of hyperspectral remote sensing. Output from this research will exceed the existing map resources for this area by providing managers with a spatially explicit indication of the distribution of existing coastal resources.

Motivation: Remote sensing is increasingly being employed as a significant component in the evaluation and management of coral ecosystems. Advantages of this technology include both the qualitative benefits derived from a visual overview, and more importantly, the quantitative abilities for systematic assessment and monitoring. Advancements in instrument capabilities and analysis methods, particularly with respect to hyperspectral remote sensing, are continuing to expand the accuracy and level of effectiveness of the resulting data products. Not only do hyperspectral instruments offer the spatial and temporal capabilities of traditional remote sensing, but also the spectral detail necessary to extract multiple layers of information from the optically complex environment associated with coral reefs and other shallow coastal subsurface environments.

Airborne Image of La Parguera Coast

Digital imagery acquired by NASA-JPL coincident with August 2004 AVIRIS hyperspectral mission to Puerto Rico.
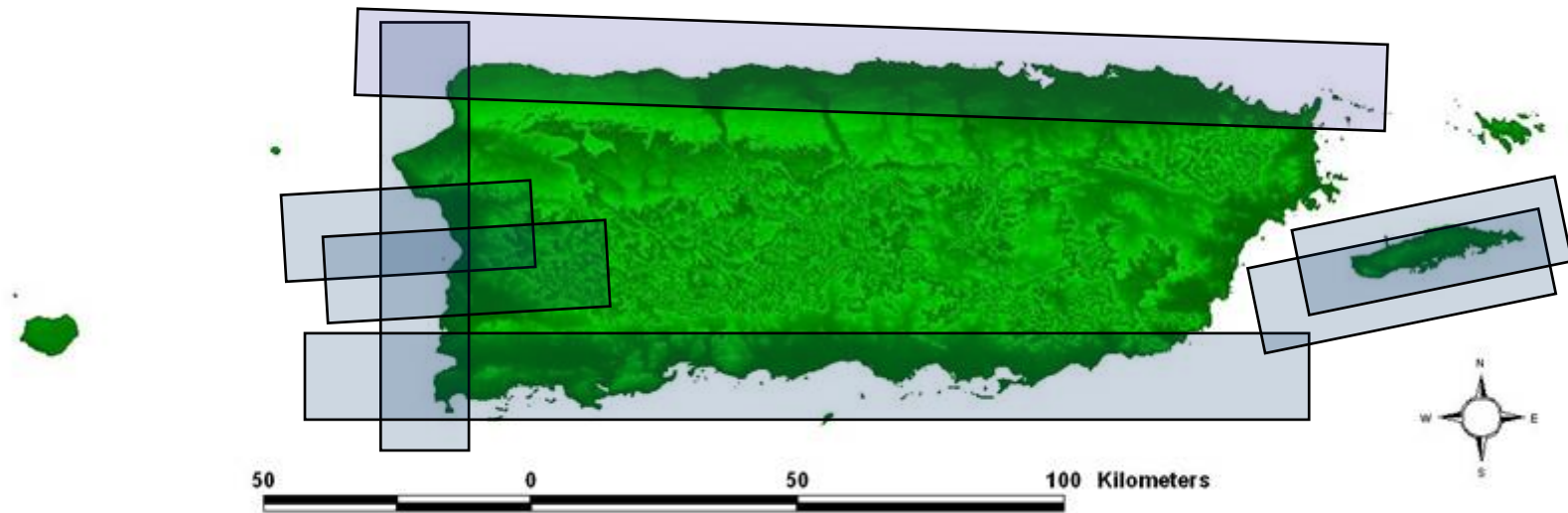
AVIRIS RGB Composite of La Parguera Coast

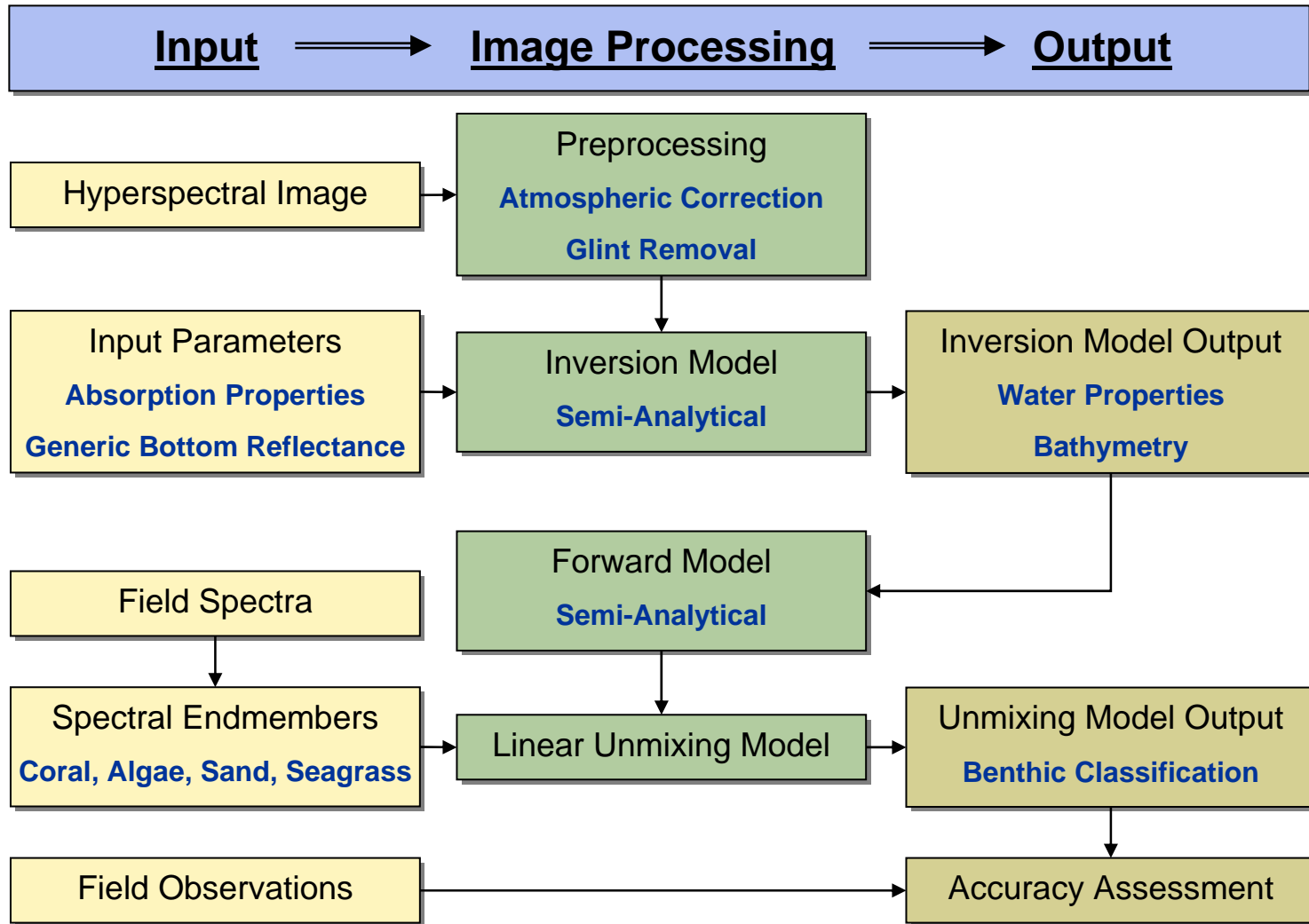AVIRIS hyperspectral imagery acquired by NASA-JPL during August 2004 mission to Puerto Rico.

AVIRIS 2004 Data Acquisition

AVIRIS Flightlines
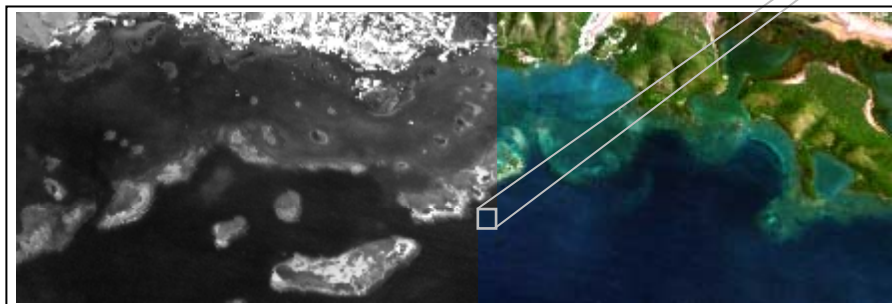
- August 2004 Puerto Rico

AVIRIS Data Processing Flow

Input	⟶	Image Processing	⟶	Output

Hyperspectral Image

Preprocessing
Atmospheric Correction
Glint Removal

Input Parameters
Absorption Properties
Generic Bottom Reflectance

Inversion Model
Semi-Analytical

Inversion Model Output
Water Properties
Bathymetry

Field Spectra

Forward Model
Semi-Analytical

Spectral Endmembers
Coral, Algae, Sand, Seagrass

Linear Unmixing Model

Unmixing Model Output
Benthic Classification

Field Observations

Accuracy Assessment

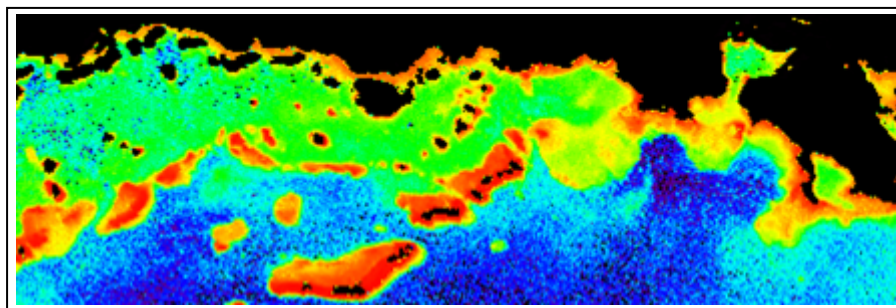# Preliminary Image Analysis Results
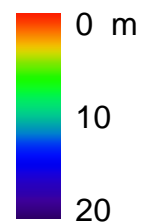
AVIRIS Hyperspectral

- August 2004 Puerto Rico

224 Bands

10 nm Spectral Resolution

17 m Spatial Resolution

Habitat Map

Sand

Coral ⟷ Algae

Water Depth

0 m

10

20
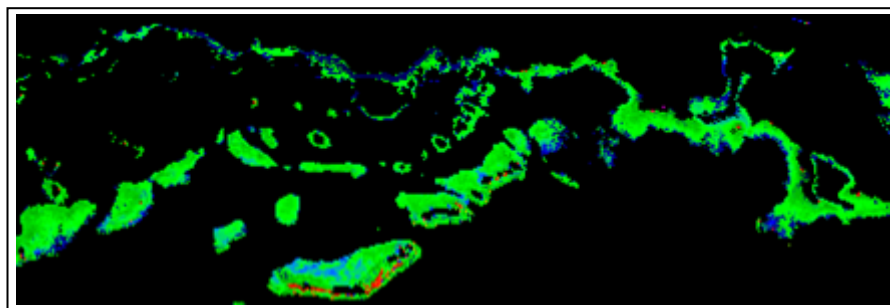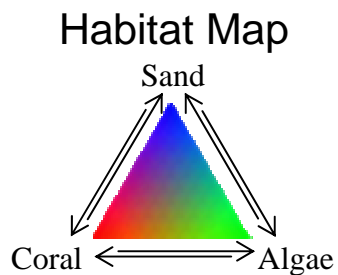
James Goodman, PhD, PE

Bio: Dr. James Goodman is a researcher in the CenSSIS research group at the University of Puerto Rico at Mayagüez, where he focuses on developing the next generation of analysis tools for subsurface remote sensing of shallow aquatic ecosystems. He received his Ph.D. in Hydrologic Sciences from the University of California, Davis in June 2004. His dissertation, entitled "*Hyperspectral Remote Sensing of Coral Reefs: Deriving Bathymetry, Aquatic Optical Properties and a Benthic Spectral Unmixing Classification Using AVIRIS Data in the Hawaiian Islands*," involved the development of innovative hyperspectral analysis techniques for mapping and monitoring coral reef ecosystems. Dr. Goodman holds a B.A. in engineering from Dartmouth College, a M.S. in Civil Engineering from the University of Colorado at Boulder, is a registered professional engineer and has 5 years of experience as a consulting engineer.