North American Land Surface Albedo and Nearshore Shallow-Bottom Properties from Landsat and MODIS/VIIRS

Crystal B. Schaaf, Zhongping Lee
Environmental Earth and Ocean Sciences (EEOS)
University of Massachusetts Boston
Yanmin Shuai
ERT Corp

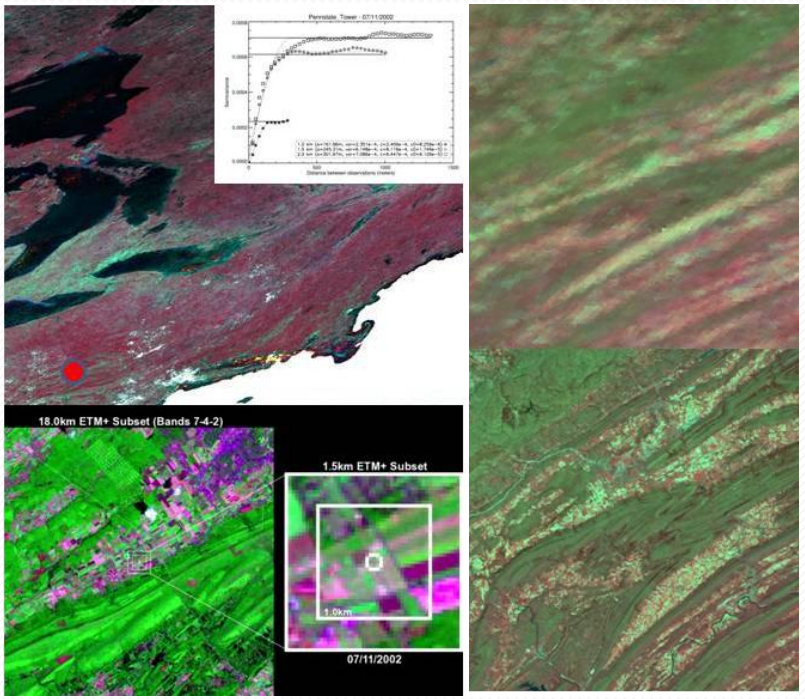
Zhuosen Wang, Nima Pahlevan
University of Massachusetts Boston
Feng Gao USDA-ARS
Jeffrey Masek NASA/GSFC
Christopher Williams Clark University

North American Land Surface Albedo and Nearshore Shallow-Bottom Properties from Landsat and MODIS/VIIRS

- Produce Land Surface Albedo over North America by coupling Landsat with MODIS daily BRDF/Albedo retrievals
- Extend through the LDCM era with both MODIS and VIIRS BRDF/Albedo retrievals
- Extend to Nearshore Substrates (albedo and bathymetry) through the use of the extra OLI ocean channel (427-459nm) and improved signal-to-noise.
- Establish a framework for producing spectral albedo from future Landsat and moderate resolution missions

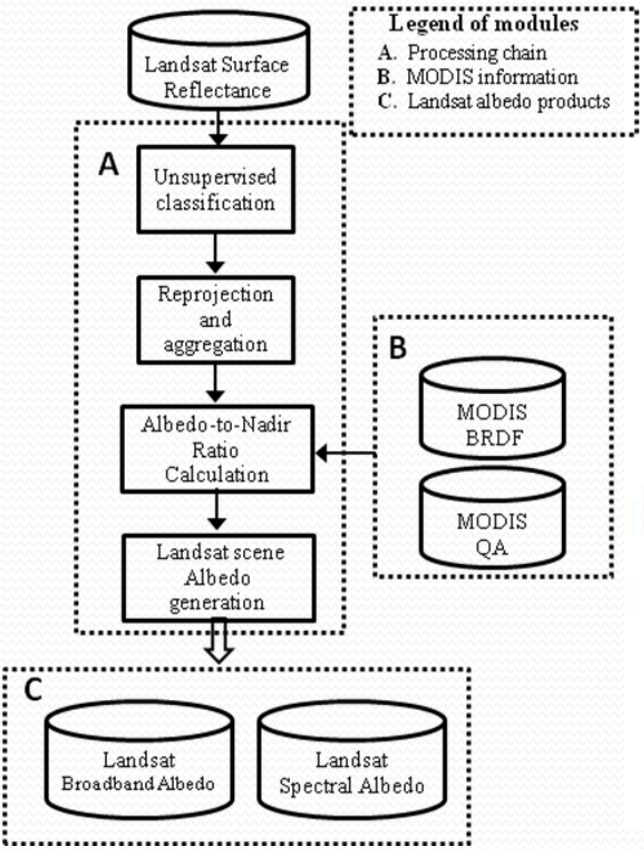
North American Land Surface Albedo

- A **concurrent** method for direct calculation of 30-meter albedo from Landsat has been developed by fusing Landsat atmospherically corrected surface reflectances with daily MODIS BRDF information (Shuai et al., 2011)
- Spectral and Broadband Albedos
- Evaluate with albedo data from spatially representative tower sites
- Explore disturbance situations
- Initially snow-free
- QA

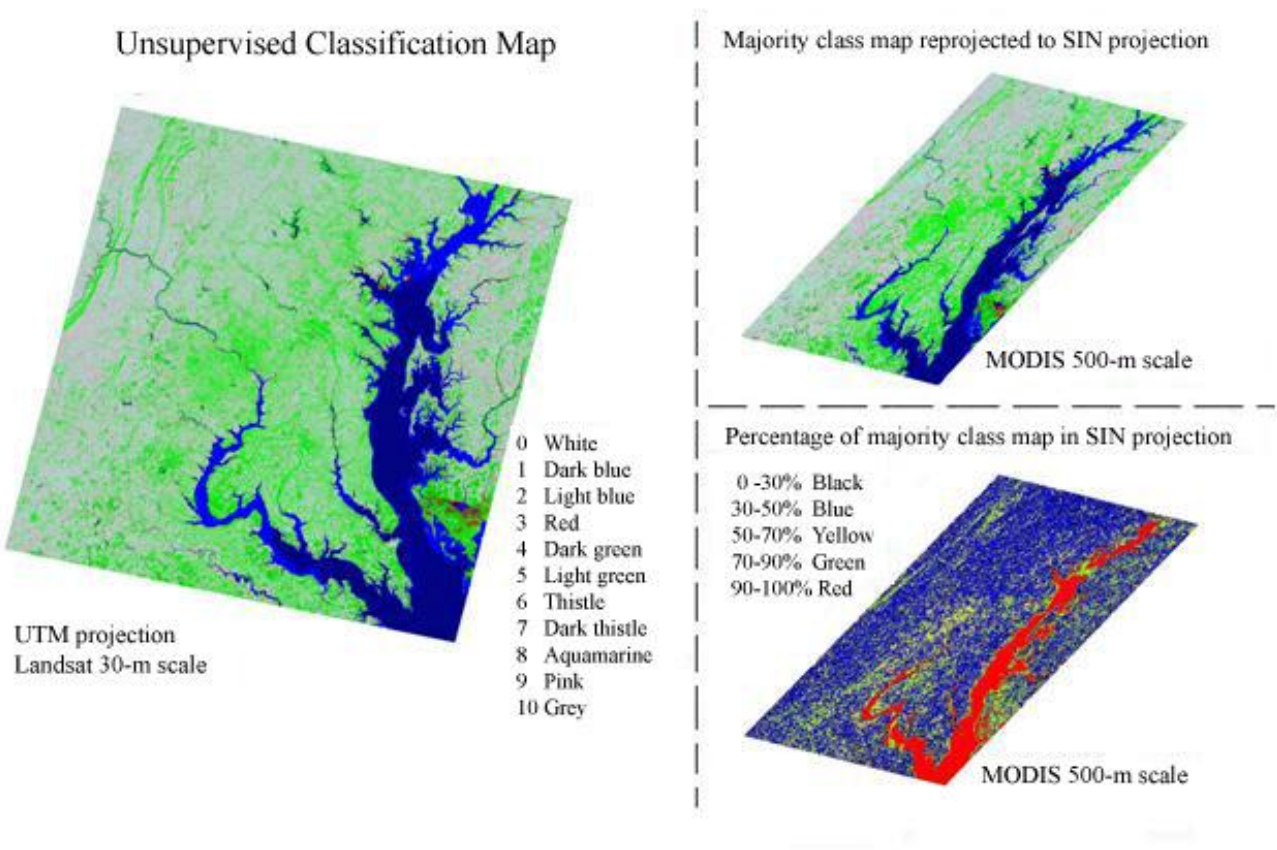


*Penn State University (PSU) tower albedometer site (spatially representative site during the leaf-on season as shown by the variogram performed on the Landsat image in lower left). On right, a white-sky albedo comparison at a 80*80 km area centered on the PSU site (near-infrared, red, and green) from MODIS (upper, SIN projection) LandSat (lower, UTM projection)*

North American Land Surface Albedo

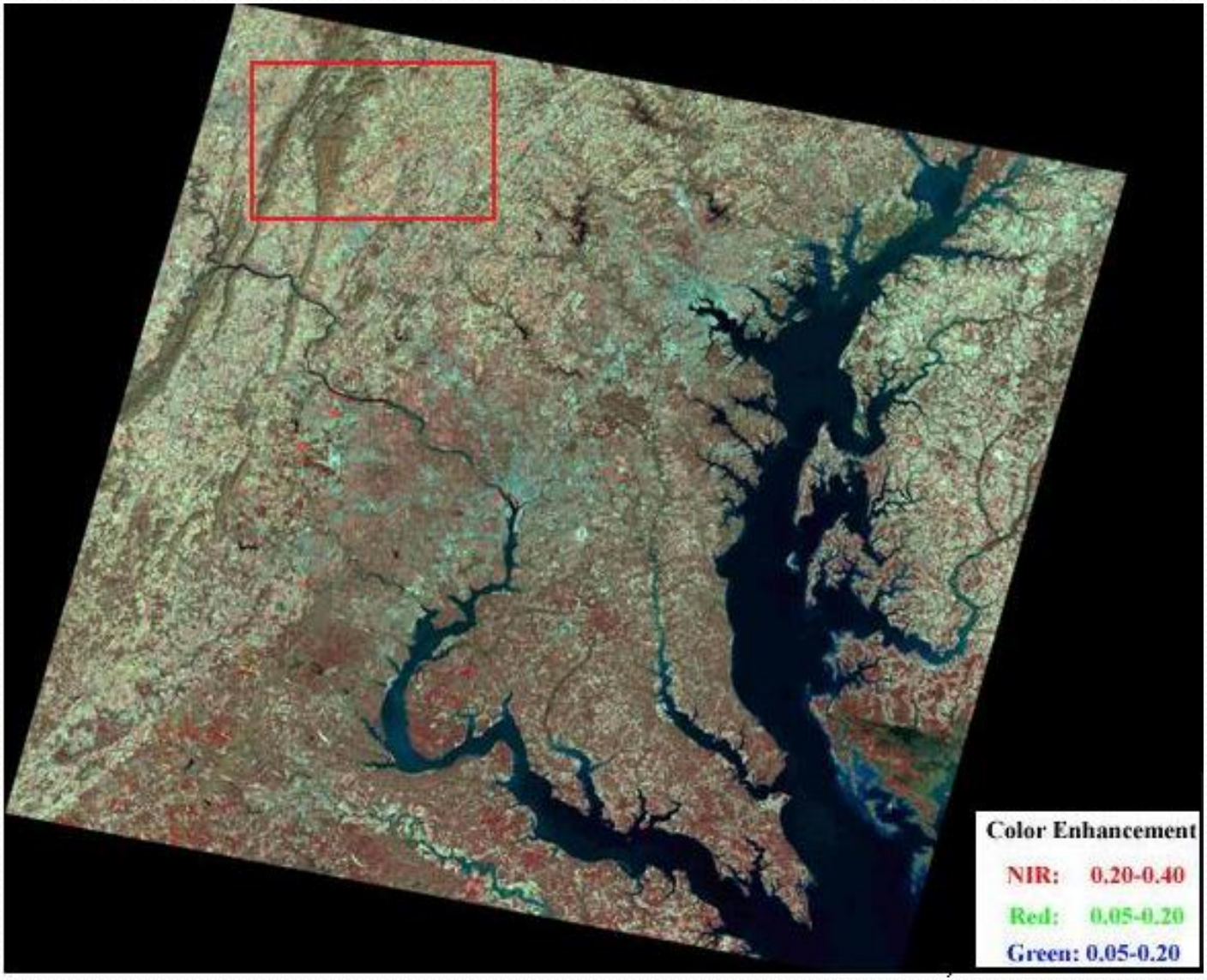


Data processing flow chart for the Concurrent Landsat Land Albedo



Upper left, a modified 30m unsupervised classification map in UTM of Maryland, DC, eastern Virginia, 19 March 2001, with a majority class map (upper right) and percentage map related to the aggregated majority class (lower right) at MODIS 500-m scale in SIN projection. (Shuai et al., 2011)

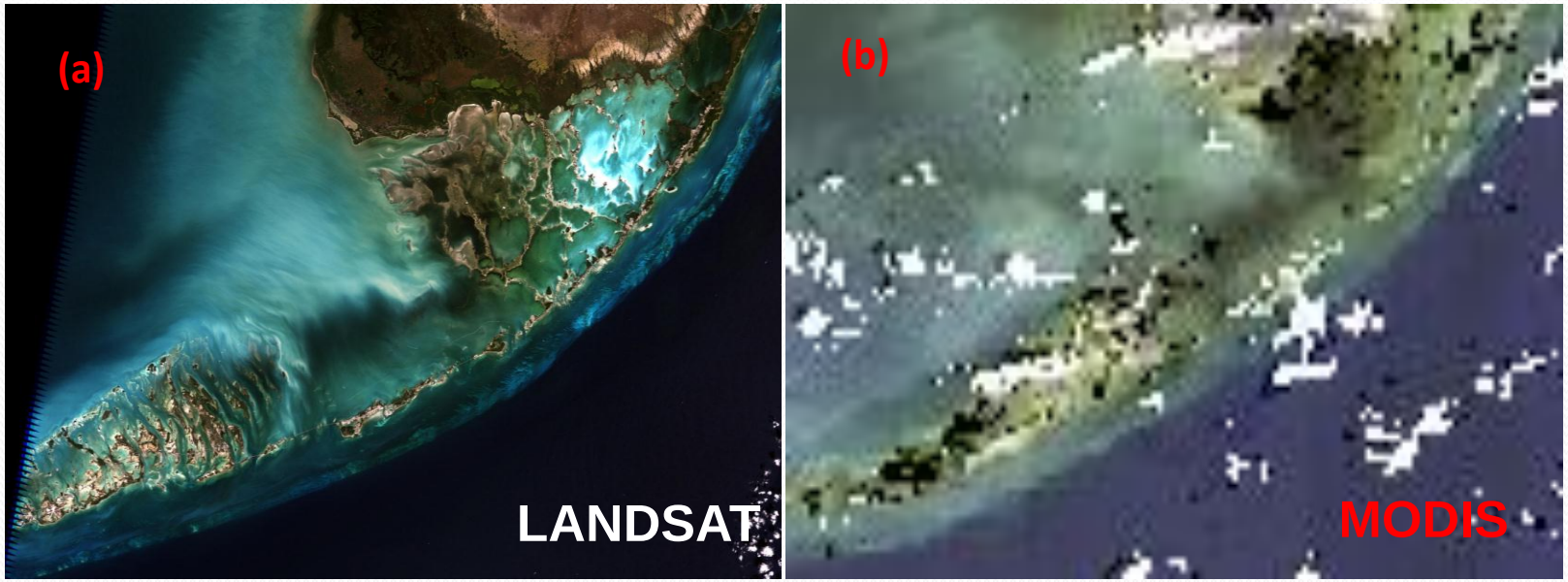
North American Land Surface Albedo



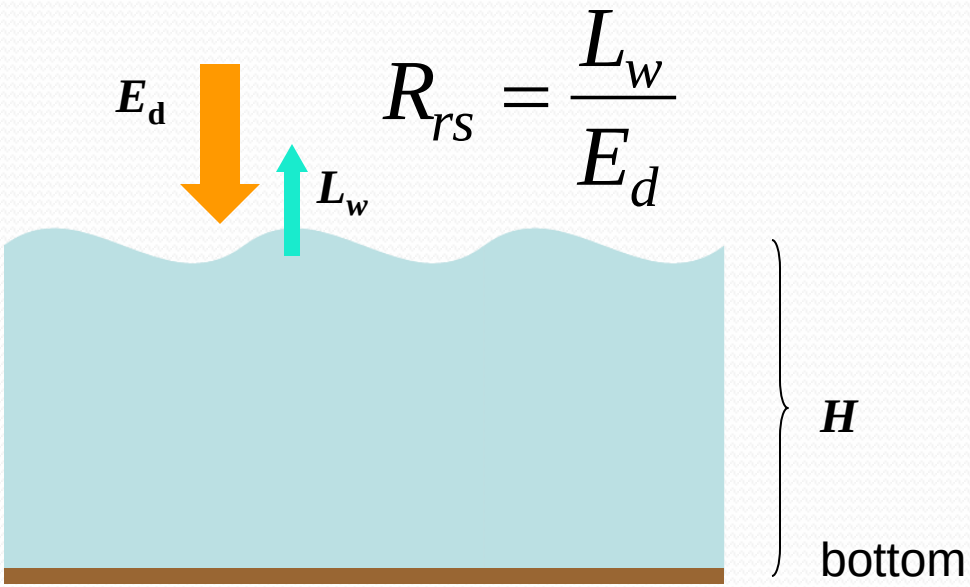
. *Resultant Landsat 30-m white-sky albedo image 19 March 2001(Shuai et al., 2011)*

North American Nearshore Shallow-Bottom Properties

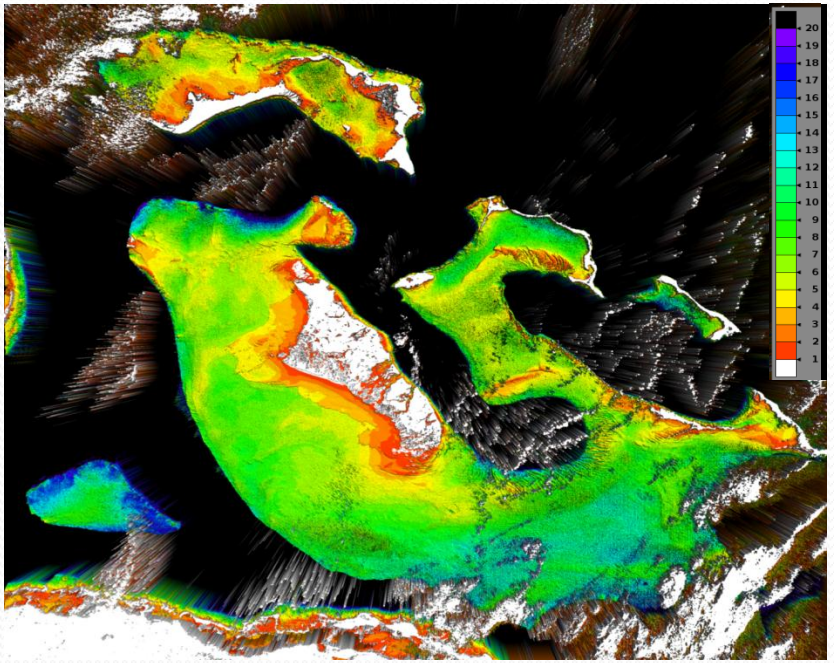
- **Obtain 30 m spatial-resolution shallow bottom properties (bathymetry and albedo) of near-shore regions by inverting coupled measurements from OLI and MODIS/VIIRS**



Remote Sensing of Shallow Waters:



$$R_{rs} = \frac{L_w}{E_d}$$



Bathymetry of the Bahamas Bank derived from MERIS 300m

$$R_{rs}(\lambda) = F[\underbrace{a(\lambda), b_b(\lambda)}, \underbrace{\rho(\lambda), H}]$$

Water property | **bottom property**

a: absorption
b_b: back-scattering
ρ: bottom albedo
H: bottom depth

North American Nearshore Shallow-Bottom Properties

- Characterize the SNR of OLI over aquatic ecosystem

$$SNR = \frac{L_t}{NE\Delta L}$$

Image derived mean

Image derived variance

- Vicarious calibration of OLI over aquatic ecosystem

  Using concurrent MODIS/VIIRS measurement as reference

- Landsat atmospheric correction over aquatic environments

  Either MODIS/VIIRS aerosol properties or Cloud-Shadow Approach

- Validation of OLI-derived R_{rs}

  Selected sites with our latest ground-truth measurement method

- Inversion of shallow bottom properties

  Combination of data from both ocean (MODIS/VIIRS) and OLI sensors

North American Land Surface Albedo and Nearshore Shallow-Bottom Properties from Landsat and MODIS/VIIRS

- North American Land Surface Albedo
  - MODIS and VIIRS (2000 to 2017)
- Nearshore Shallow-Bottom Bathymetry and Albedo
  - MODIS and VIIRS (2013-2017)
- Establish a framework for producing spectral albedo from future Landsat and moderate resolution missions