ESTUARINE-SHELF CDOM/DOM DYNAMICS IN NORTHERN GULF OF MEXICO FROM OCEAN COLOR AND NUMERICAL MODELING

Eurico D’ Sa, Ishan Joshi, Chris Osburn, Dong Ko, Thomas Bianchi, Diana Vargas, Ana Arellano, Nicholas Ward, Nazanin Tehrani
(LSU, NCSU, NRL, UF)

Funding:
NNX14A43G & NNX09AR7OG
CDOM/DOM in GOM estuarine-shelf waters

• Estuarine complexes – important interface in the exchange of organic matter with coastal shelf systems

• Barataria Bay in LA is a particle-dominated estuary; river and shelf water exchange near the mouth of the bay

• Apalachicola Bay in FL, CDOM-dominated estuary; bar-built estuary with river a major source of freshwater

• NCOM-Navy Coastal Ocean Model, nested, 3-D; 1.9 km spatial resolution

• Field obs, satellite ocean color data (Landsat, SeaWiFS, MODIS, VIIRS) and model to examine CDOM/DOM distribution, dynamics, stocks and fluxes
Baratara Bay-shelf CDOM/DOC distribution

CDOM-Landsat (5/8)

• Goal: estuarine-shelf DOM fluxes using satellite and nested models at different temporal/spatial scales

• Challenges: seasonally varying plume and river water inflow into the bay through the passes; cold fronts, storms

Apalachicola Bay
CDOM/DOC Stocks and fluxes
VIIRS/NPP & NCOM

measurement) at each sampling station. Glint and residual corrections were applied on raw radiance measurements as suggested by Gould et al. (2001). The level-L1B VIIRS (Visible Infrared Imaging Radiometer Suite) imagery (Sensor Data Record-SDR product) was downloaded from NASA’s Ocean Color website, and processed using SeaDAS 7.3 (OBGP, NASA). Radiometrically-calibrated VIIRS imagery was converted into the CDOM absorption coefficient \( a_{412} \) and DOC concentration maps using two pathways (Fig. 2): 1) evaluating and applying a suitable atmospheric-correction scheme to the VIIRS imagery in an optically complex coastal system, and 2) developing empirical relationships between atmospherically-corrected \( R_{rs} \) and \( a_{412} \), and subsequently to DOC concentration to convert the VIIRS imagery into the CDOM maps for Apalachicola Bay.

2.3. Absorption spectroscopy
Absorbance (A) spectra were measured on a Perkin Elmer Lambda-850 double beam spectrophotometer equipped with a 150 mm-integrating sphere. Following the instrument warm up and equilibration of samples to room temperature, absorbance spectra were obtained between 250 and 750 nm at 1-nm intervals using 10-cm path length quartz cuvette. The cuvette was rinsed twice with ultrapure water (a Thermo Scientific Micro-Pure UV purification system with a purity of 18.2 \( \Omega \)) and once with filtered seawater before each measurement to avoid contamination by the previous sample. Absorption coefficients \( a_{\lambda} \) were calculated using the following equation,

\[
a_{\lambda}(\lambda) = \frac{2.303}{C \cdot A(\lambda)} \cdot L \cdot (1)
\]

where, \( A(\lambda) \) is absorbance at a wavelength \( \lambda \), and \( L \) is pathlength in meters. The absorption spectra were corrected for scattering, temperature, and baseline drift by subtracting a value of absorption at 750 nm from each spectrum (Green and Blough, 1994). Wavelength-dependent exponential decay of the absorption coefficient can be given by the following non-linear equation,

\[
a_{\lambda}(\lambda) = \frac{a_{\lambda ref}}{C_0} \cdot \frac{C_1}{C_2} \cdot e^{-S_{\lambda - \lambda ref}} \quad (2)
\]

where, \( a_{\lambda} \) is the amplitude of the CDOM absorption coefficient at any wavelength \( \lambda \), and \( \lambda_{ref} \) is the reference wavelength (Jerlov, 1976; Shifrin, 1988). The absorption spectra generally represented by a non-linear equation (Eq. (2)), were converted to a linear form by a logarithmic transformation of dependent variable. Then, a least squares regression approach was applied to calculate spectral slope between 275 nm and 295 nm \( (S_{275-295}) \), while absorption coefficient at 412 nm \( a_{412} \) was used as a quantitative parameter of the CDOM (D’Sa et al., 2006; D’Sa et al., 2014).

Fig. 1. Apalachicola Bay, Florida (USA). In situ measurements acquired at 17 stations on March 23–25, 2015 (orange symbols) with nine stations further added on November 2–4, 2015 (purple symbols). Blue and white stars illustrate hydrological and meteorological stations, respectively. CP and DB are the ANERR-maintained salinity stations, Cat Point and Dry Bar, respectively. The arrows indicate the open boundaries between the bay and shelf waters that were used to calculate the fluxes. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 2. Processing-approach to generate the \( a_{412} \) and DOC maps using the VIIRS imagery and in situ measurements in Apalachicola Bay.
VIIRS/NPP: CDOM and DOC maps

March

November

NCOM nested model - currents and salinity

- Strong linkage between river plume and overall hydrodynamic forcing controlling the distribution of DOC
DOC Stocks in Apalachicola Bay (spring and fall 2015)

Estimated DOC stocks: \( \sim 3.71 \times 10^6 \) (Mar) \( \sim 4.01 \times 10^6 \) kg C (Nov)

Volume flux (out of the bay) almost doubled for Mar 24 (735 m\(^3\)s\(^{-1}\)) relative to Nov 04 (378 m\(^3\)s\(^{-1}\)). However, estimates of DOC fluxes exported out of the bay were only marginally greater in March (0.163 \( \times 10^6 \) kg C d\(^{-1}\)) than in Nov (0.124 \( \times 10^6 \) kg d\(^{-1}\)) and reflected greater DOC stocks in the fall.

**Challenge:** assumption of well-mixed water column – DOC overestimates