Comparison of CDOM optical properties on river and non-river dominated coastal margins

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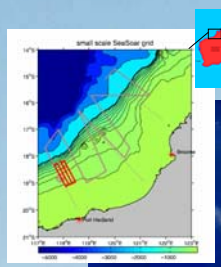
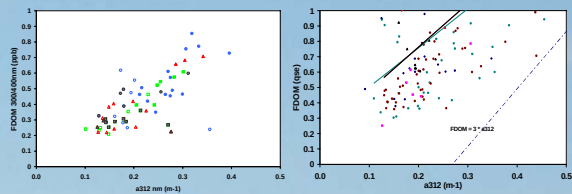
The major factor governing light penetration in the ocean is Colored Dissolved Organic Matter (CDOM), a ubiquitous pool of organic material that remains mostly uncharacterized. Spectral properties of CDOM are source dependent and can be used as a proxy for chemical structure. Hyperspectral fluorescence and absorbance techniques can be used to discriminate sources and to examine temporal and spatial changes in the underwater light field.

River-dominated coastal margins, such as the West Florida Shelf (WFS) in the Gulf of Mexico are highly dynamic regimes that exhibit CDOM chemical compositional differences driven by the dynamics of several river systems. During periods of high rainfall, coastal waters are dominated by the riverine material. Normal years have a rainy season, but large tropical storms and hurricanes also periodically effect the dynamics of the system. Geographical variability in rainfall patterns can also change the relative contribution of the rivers influencing the area, which changes the character of the CDOM on the shelf.

In the optically blue waters of the Northwest Australian Shelf, which lacks riverine influences, marine processes control CDOM dynamics year round. These same marine processes become more important in riverine driven coastal systems during the dry season, in drought years, and with increasing distance offshore throughout the year. Autochthonous production in shallow coastal bays and sediments, and from remineralization in deep waters are all sources of CDOM. Major sinks are photochemical bleaching and mixing with low CDOM water masses. In this paper, we will compare and contrast CDOM dynamics in these two very different coastal systems and examine the usefulness of various optical parameters for modeling CDOM and DOC concentration and composition.



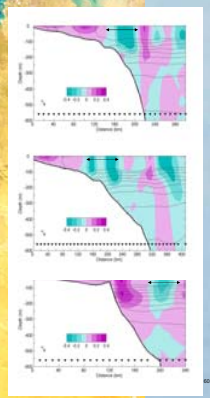
Study area on the NW Australia Shelf. Filled circles indicate discrete bottle stations on CTD transect lines.



CDOM Fluorescence vs. absorption coefficient for the West Florida Shelf and NW Australia Shelf. Although the shelves are quite different environments, a robust relationship can be established.

NW Australia Shelf

- Extremely clear shelf waters
- Devoid of any major river systems
- Experiences strong tides and evaporation
- Autochthonous CDOM sources
  - Inshore surface high S=high CDOM
  - Offshore midwaters low S- high CDOM

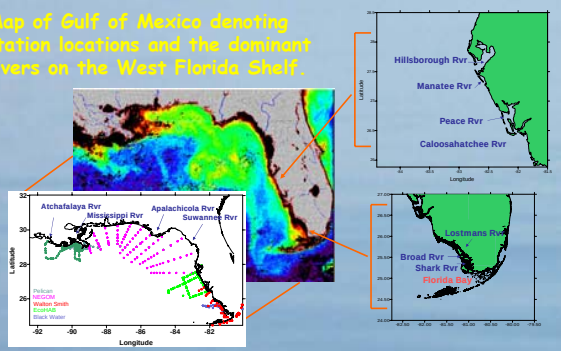


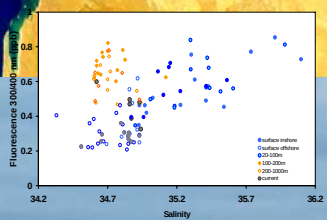
ADCP cross sections for 3 CTD transects on the NW Australia Shelf. Arrows show location of the southward flowing Leeuwin Current.

Fluorescence Efficiencies (F/a)

- WFS and NW Australia shelf waters show a strong relationship between fluorescence and $a_{312}m^{-1}$, where highest values were found for inshore surface waters and 100-200m deep offshore waters
- Slope of the fluorescence efficiency at $a_{312}m^{-1}$ was similar for both the WFS and NW Australia, ranging between 2.5 and 4.0
- Indicates that photobleaching equally effects both fluorescence and absorbance at this wavelength

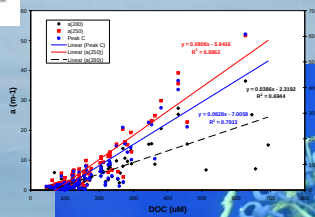
Map of Gulf of Mexico denoting station locations and the dominant rivers on the West Florida Shelf.

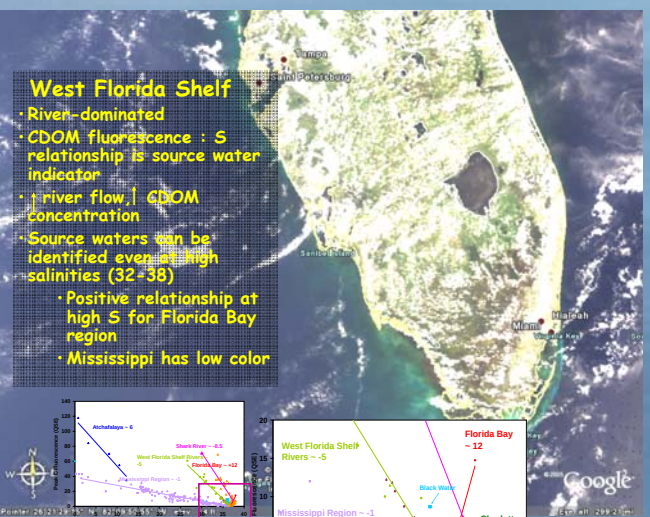




CDOM fluorescence vs. salinity on the NW Australia Shelf. Fluorescence can distinguish between offshore surface, deep water and inshore waters.

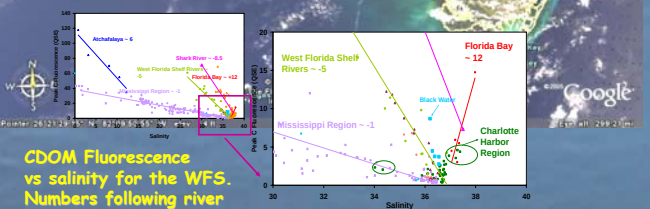
Comparison of several CDOM optical parameters vs DOC concentrations for samples collected on the WFS in 2001. Data were collected during both wet and dry periods.





West Florida Shelf

- River-dominated
- CDOM fluorescence : S relationship is source water indicator
- ↑ river flow,↓ CDOM concentration
- Source waters can be identified even at high salinities (32-38)
  - Positive relationship at high S for Florida Bay region
  - Mississippi has low color



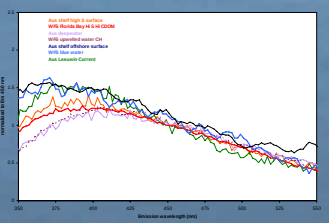
CDOM Fluorescence vs salinity for the WFS. Numbers following river designation represents linear regression coefficients.

CDOM Spectral Changes

- Spectral properties relate to differences in chemical composition
- Normalized fluorescence emission spectra from both shelves show strong similarity
  - Offshore NW Australia new CDOM similar to WFS upwelled water
  - High CDOM, high S waters formed in shallow waters show slightly less curvature at short wavelengths, indicative of partial CDOM photobleaching
  - Leeuwin Current waters have slightly higher concentrations than surface offshore waters, so not fully photobleached
  - Offshore surface waters show no curvature in the blue part of the spectrum, indicative of advanced stages of photobleaching

Increasing degree of photobleaching

Normalized emission spectra for different water types on the two shelves. Variations at shorter wavelengths is related to chemical composition.



Optical indicator of DOC

- The optical parameter that best correlates with DOC concentration on the WFS is the absorption coefficient at 250 nm (a_{250}), and not fluorescence
- Absorption coefficients at longer wavelengths have an increasingly poor correlation

Findings

- Although geographically different, shelf waters on a river dominated (WFS) and a non-river dominated (NW Australia Shelf) margin were found to be spectrally similar
- CDOM fluorescence is a very strong proxy of absorption across the spectrum in all seasons and regions of the WFS and for the NW Australia Shelf
- a(250) was found to be an optical indicator of DOC on the WFS regardless of season and salinity

We would like to acknowledge *for support of this work*