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Tidal transport of DOC, Hg, and MeHg, from Shark River Estuary, Everglades NP

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Tidally Driven Export of Dissolved Organic Carbon, Total Mercury, and Methylmercury from a Mangrove-Dominated Estuary

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Background and motivations

The fate and transport of ***total and methyl mercury*** in almost all aquatic environments is completely intertwined with the source, fate, and transport of DOM. (Aiken et al., 2011)

DOM flux ***from mangroves*** represents a large fraction of the global flux of DOM to the oceans. (Dittmar et al, 2006)

Measuring fluxes in tidal systems is hard, but ***DOM absorbance and fluoresence*** can be used to quantify the flux of mercury and methyl mercury in tidal wetlands. (Bergamaschi et al., 2011, Bergamaschi et al., 2012)

Problem(s)

- In coastal SW Florida, there is high mercury in fish, but…..
  - Not from inflows (Rumbold et al. 2010)
  - MeHg might be from sediments (Rumbold et al. 2010)
- Flux of DOC and Hg from mangroves is not well constrained (Bouillon et al. 2008)

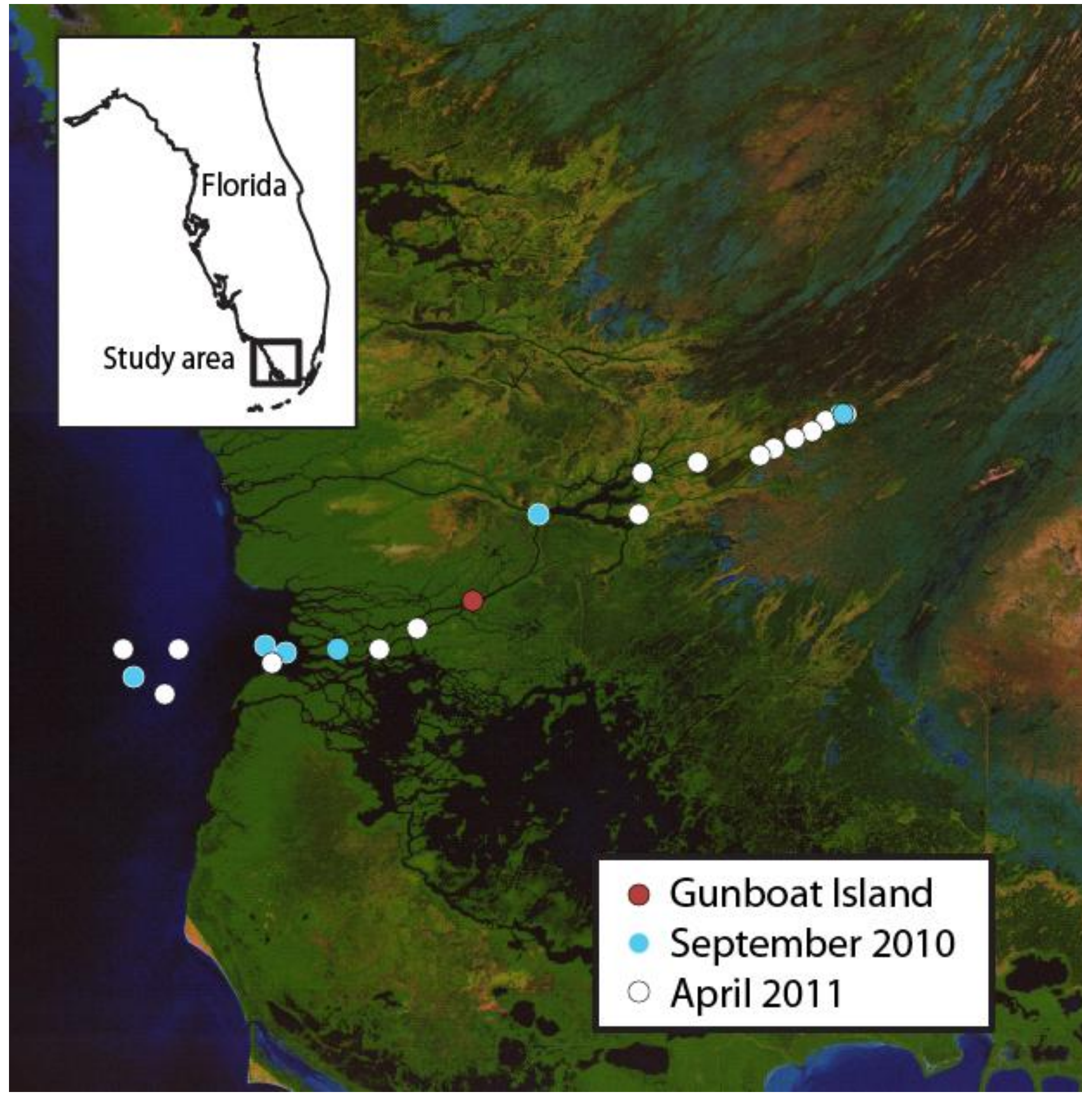
Could the flux from mangroves into coastal waters be significant?

Things you should know (if you don't already)

- DOC flux from mangroves represents 10% of the terrestrial DOC flux to the oceans, even though 0.1% of area – DOM flux approximately the same as the Amazon DOM flux (Dittmar et al. 2006)
- MeHg is the form of mercury that bioaccumulates in food webs.
- Mangroves swamps represent ideal conditions for methylation of mercury.
- Mangroves have among the highest leaf tissue concentrations of THg and MeHg (Ding et al. 2011)

Study Area

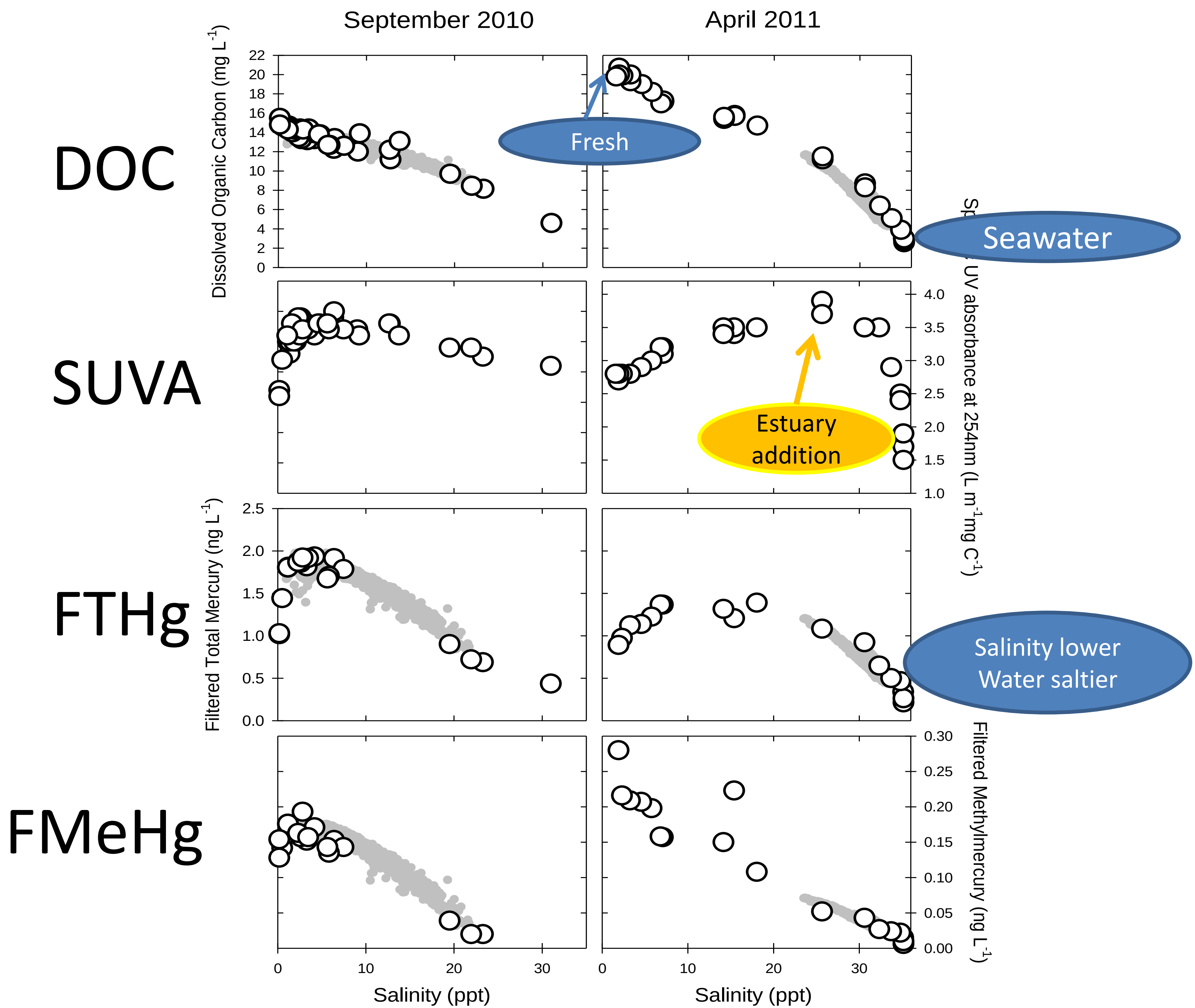
- Shark River Estuary
- Wet season and dry season sampling campaigns
- Continuous measurements at Gunboat Island



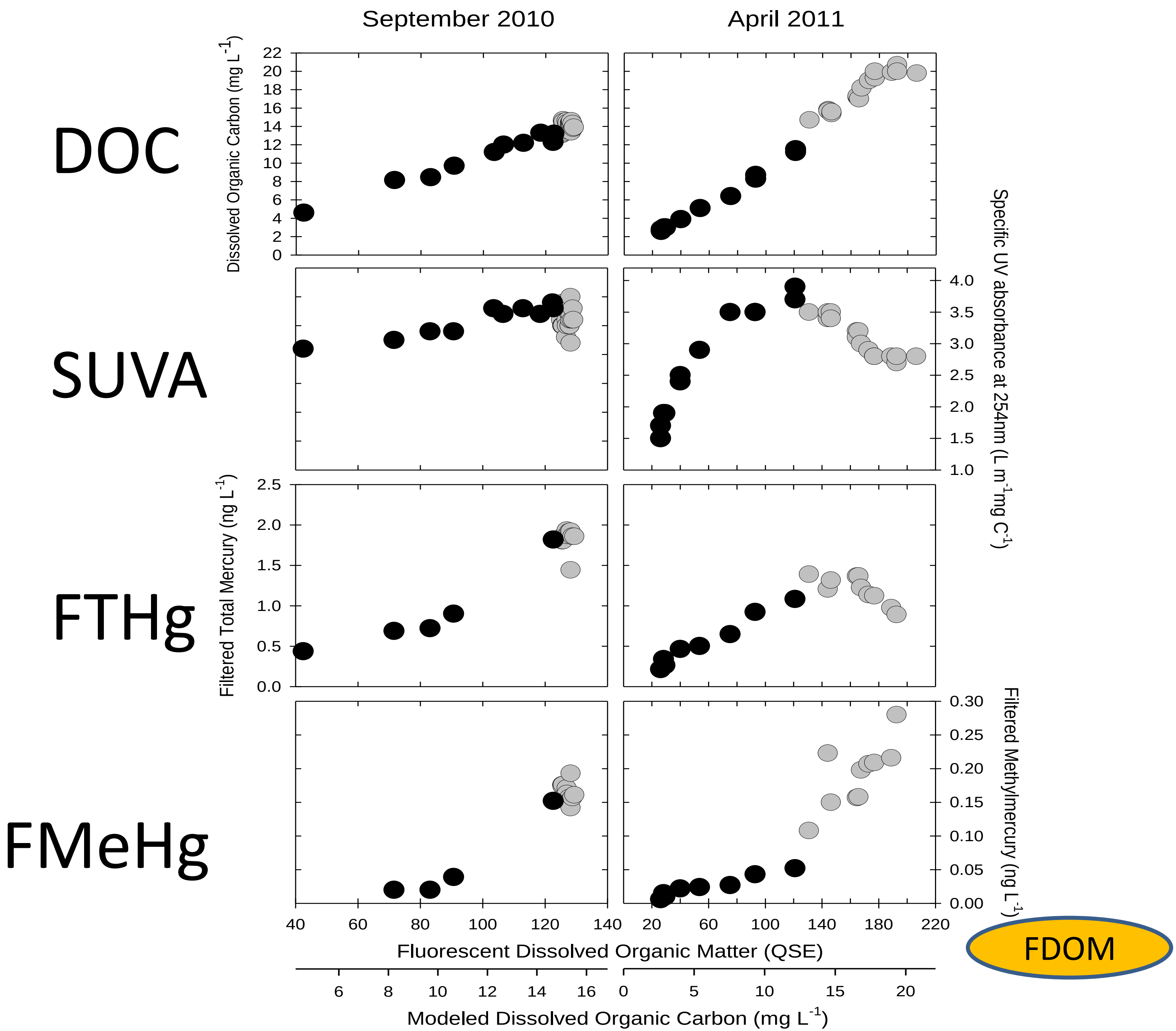
Measurements

- **Lab**
  (discrete samples at stations indicated on map)
  - DOC
  - Full absorbance and fluoresence
  - THg
  - MeHg

- **In Situ**
  (continuous measurements at Gunboat Island)
  - Discharge
    - ADCP
    - Rated
  - FDOM (ex370 em420)
    - WetLabs Wetstar
  - Stage
  - Salinity
  - DO, pH, temperature



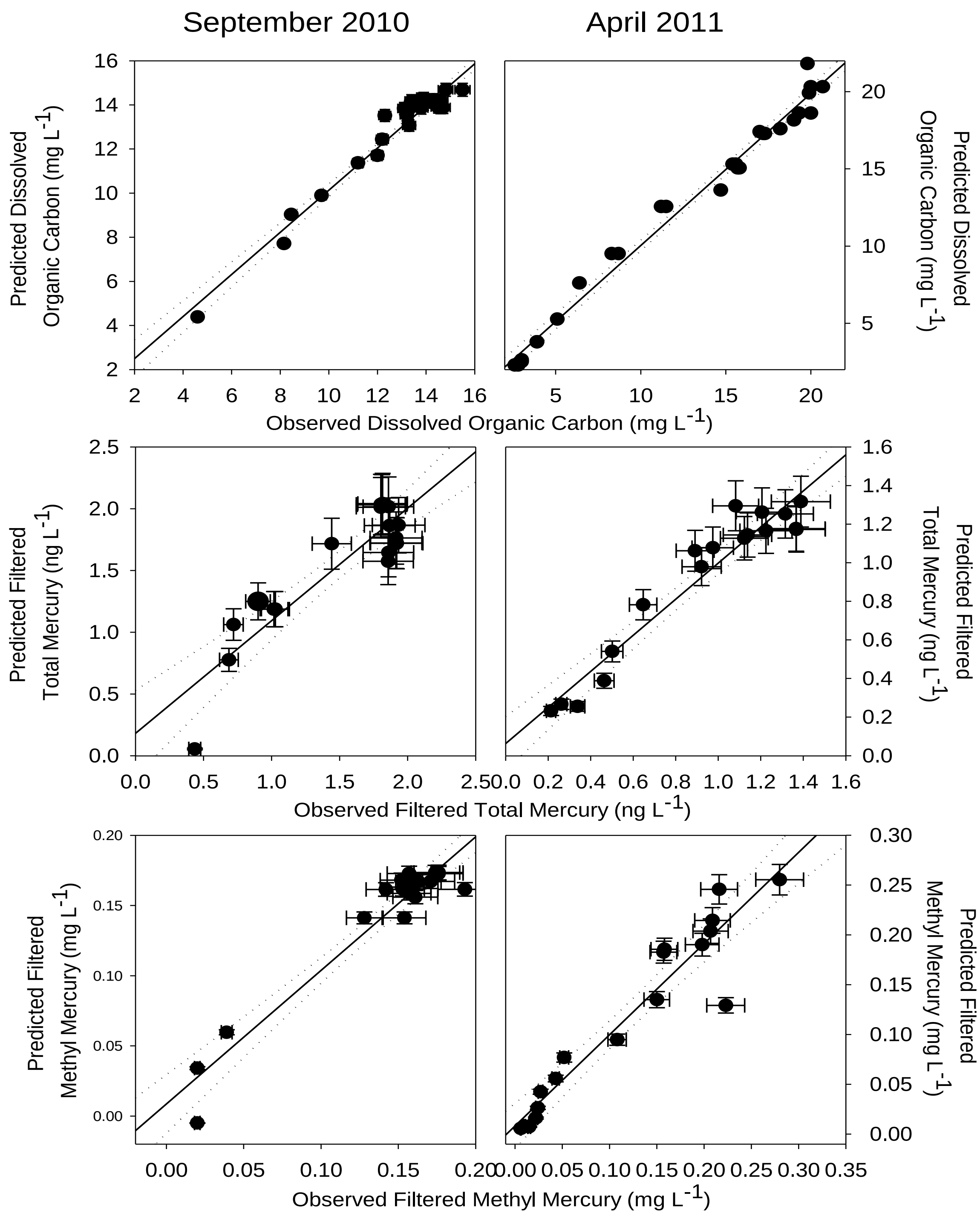
September 2010
April 2011
DOC
SUVA
FTHg
FMeHg
Dissolved Organic Carbon (mg L-1)
Specific UV absorbance at 254nm (L m-1mg C-1)
Filtered Total Mercury (ng L-1)
Filtered Methylmercury (ng L-1)
Fresh
Seawater
Estuary addition
Salinity lower
Water saltier
Salinity (ppt)
Salinity (ppt)


September 2010
April 2011
DOC
SUVA
FTHg
FMeHg
Dissolved Organic Carbon (mg L-1)
Specific UV absorbance at 254nm (L m-1 mg C-1)
Filtered Total Mercury (ng L-1)
Filtered Methylmercury (ng L-1)
Fluorescent Dissolved Organic Matter (QSE)
Modeled Dissolved Organic Carbon (mg L-1)
FDOM

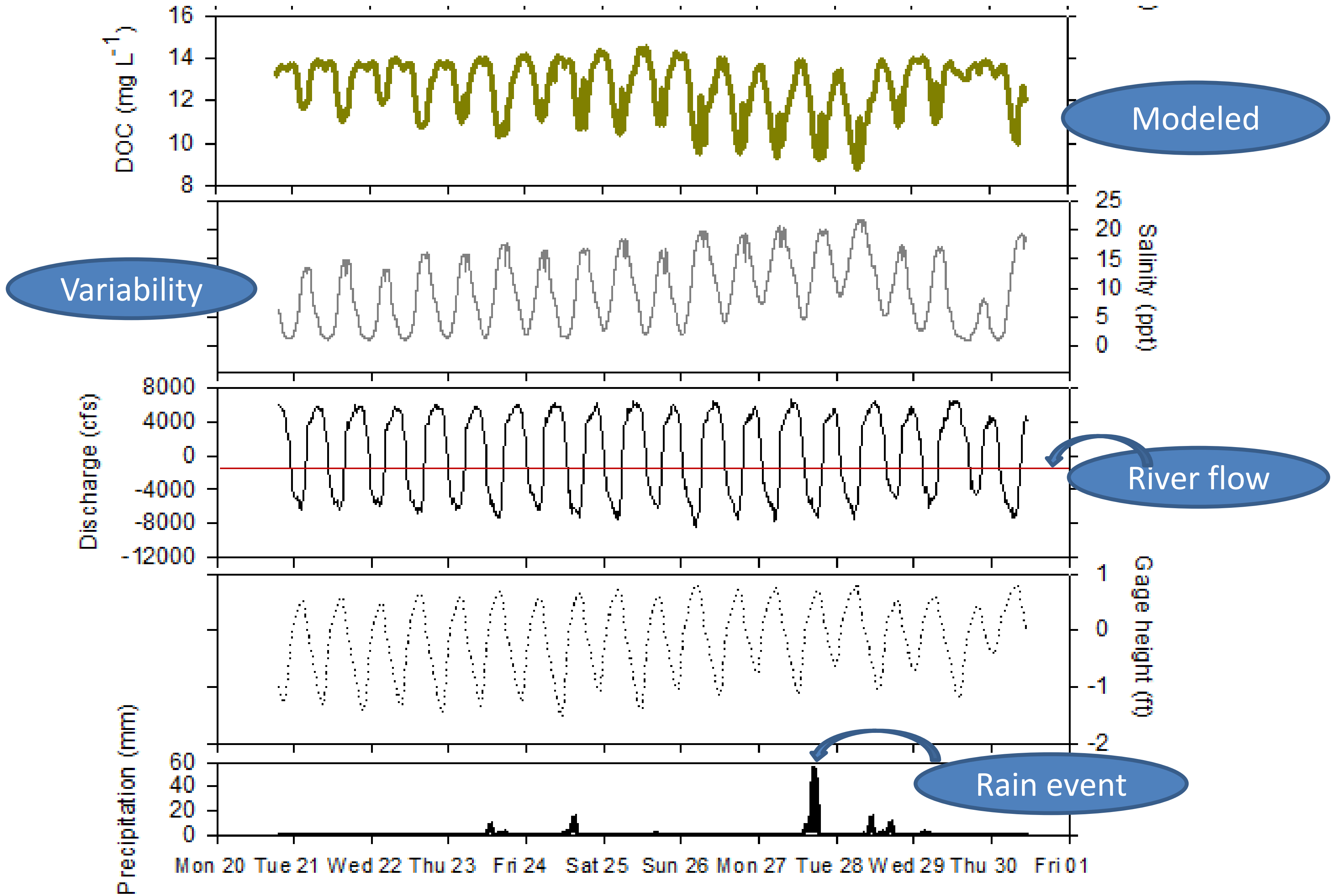
DOC

FTHg

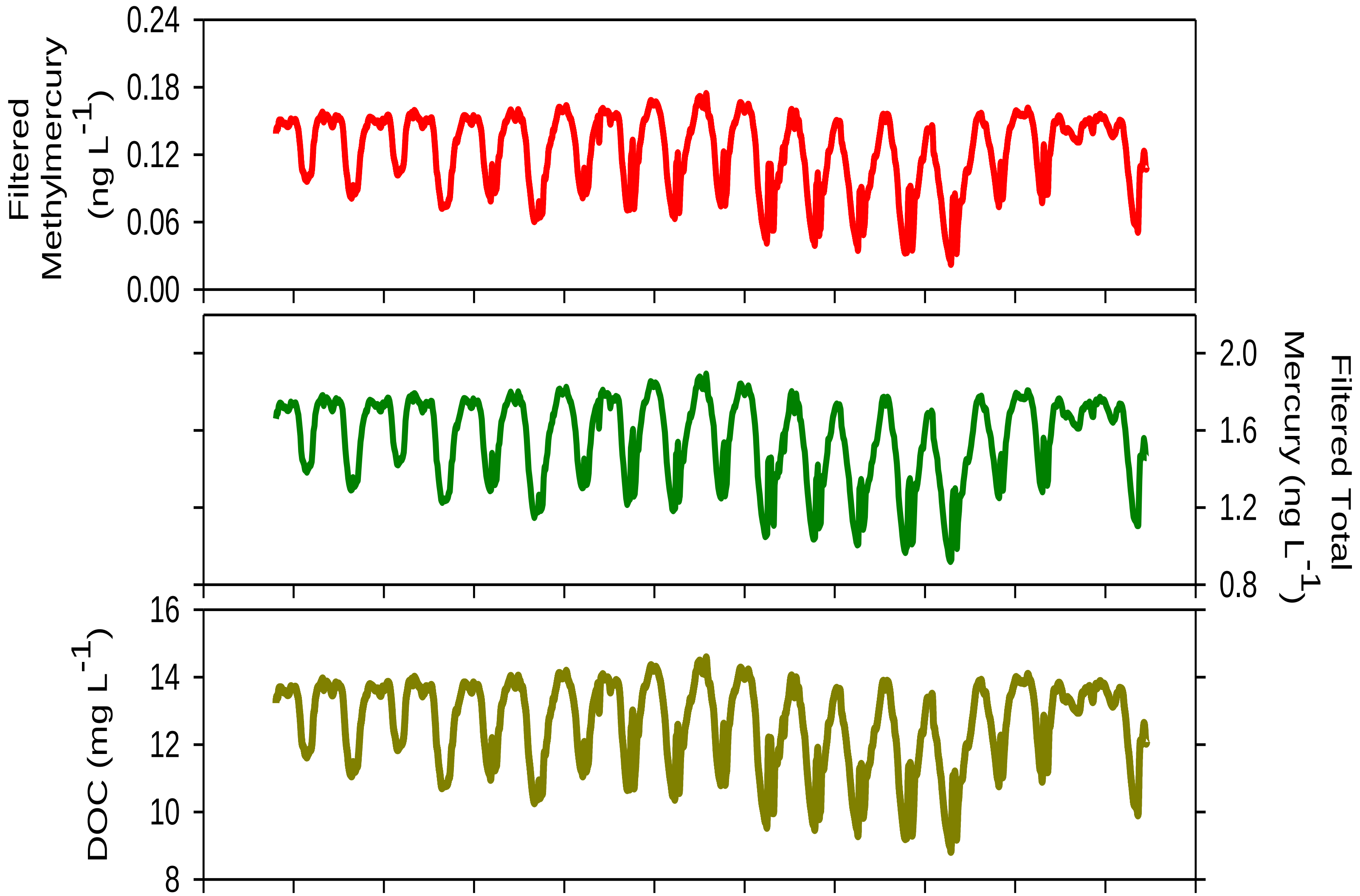
FMeHg



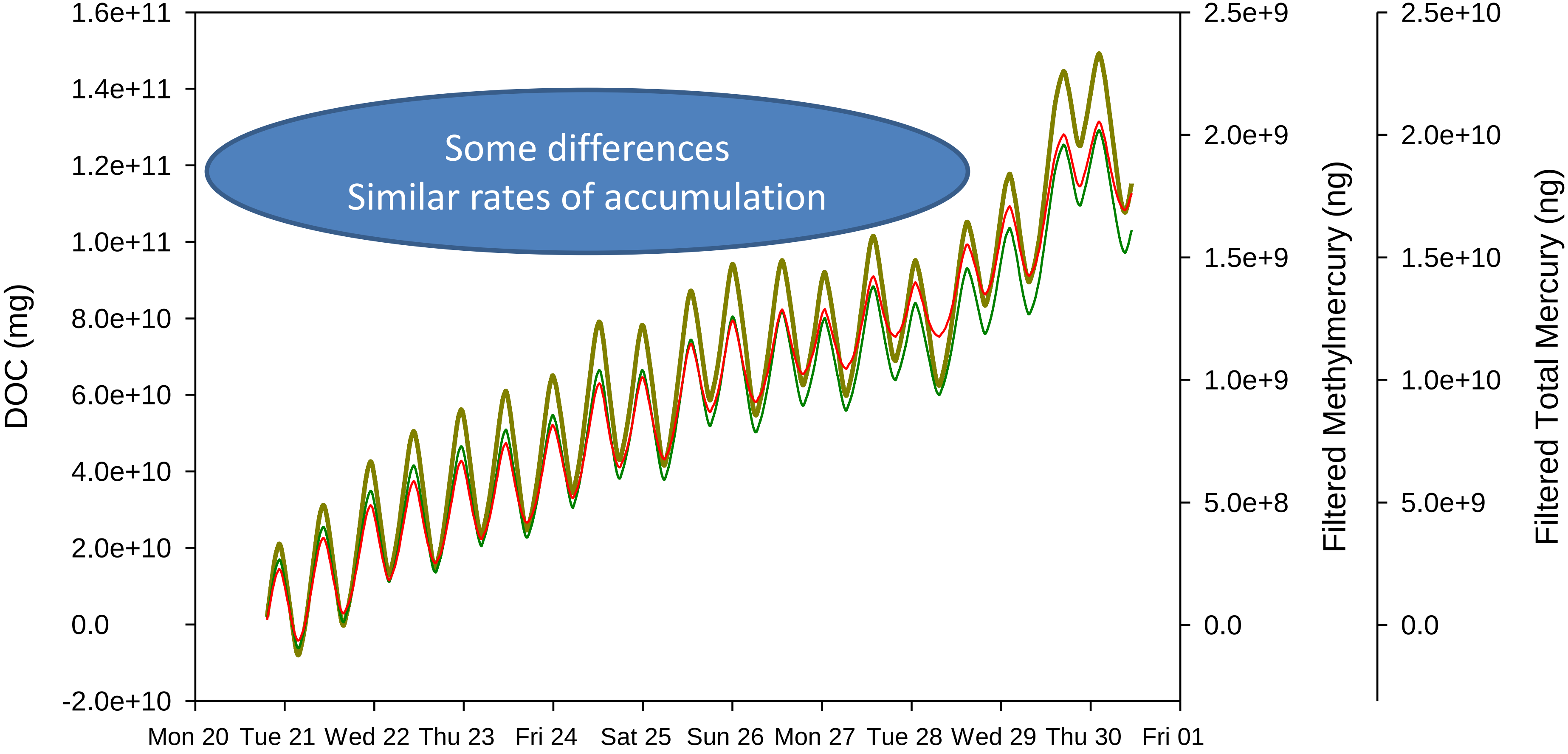
Gunboat Island September 2010



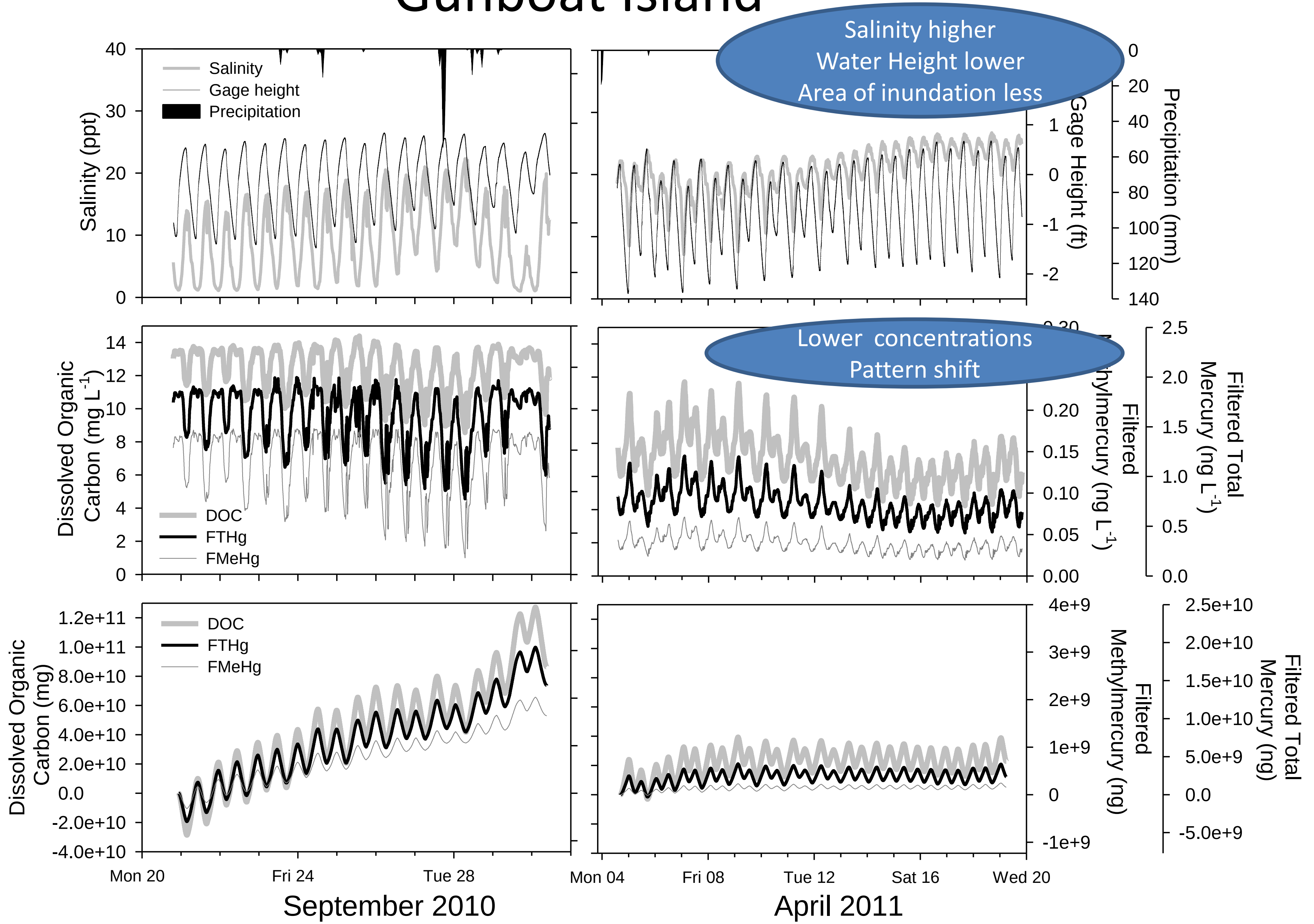
Gunboat Island September 2010



Gunboat Island September 2010



Gunboat Island



Important features of this method

- Integrates over a broad area
- Integrates over long time scales (multiple tides, spring-neap, seasonal, etc.)
- Captures events and ephemeral processes (storms, rain, wind direction, changes in barometric pressure, etc.)

Yield per unit area

- DOC was 180 ± 12.6 g C m^{-2} yr^{-1}.
  - Compares well to the 44 to 381 g C m^{-2} yr^{-1} range summarized in a recent review (Bouillon et al. 2008).
- FTHg was 28 ± 4.5 μg m^{-2} yr^{-1},
  - Among the highest previously reported for FTHg flux in wetlands (Shanley et al. 2008; St Louis et al. 1994; Krabbenhoft et al. 1995)
  - Higher than atmospheric deposition – likely from canopy capture (Ding et al. 2011).
- FMeHg was 3.1 ± 0.4 μg m^{-2} yr^{-1},
  - 10x – 100x generally reported values (e.g. Schwesig and Matzner 2001; Shanley et al. 2008; Brigham et al. 2009).
  - Near the previously published value of 2.5 μg m^{-2} yr^{-1} for tidal tule wetland (Bergamaschi et al. 2011)

How big <u>could</u> fluxes of DOC, Hg and MeHg from mangroves be in comparison to other sources?

- Extrapolated over 1400 km^2 of mangroves in SW Florida
- Compared to 5000 km^2 of coastal waters

Source	DOC	Total Mercury	Methyl Mercury
Mangroves	250 MT	55 kg	6.5 kg
Sediments/Water	750000 MT	-	0.6 kg
Rainfall	Negligible	130 kg	Negligible
Mangrove %	<1%	30%	90%

Conclusions

- Tidal pumping from mangroves is important
  - *Should be included in regional budgets*
- FDOM is a good proxy, easily measured in situ.
  - *Continuous measurements are possible*
- Tidal systems are dynamic – cannot extrapolate from one or a few tides and get the right answer.
  - *Need continuous measurements*
- Large fluxes of MeHg from mangroves (if proven out by future studies) may help explain high concentrations in coastal fish in GOM
  - *Need long term studies*

THANKS!

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Methyl mercury dynamics in a tidal wetland quantified using in situ optical measurements.

Bergamaschi, B. A.; Fleck, J. A.; Downing, B. D.; Boss, E.; Pellerin, B.; Ganju, N. K.; Schoellhamer, D.; Heim, W.; Stephenson, M.; Fujii, R.

Limnol. Oceanogr. **2011, 56 (4), 1355–1371**

Quantifying fluxes and characterizing compositional changes of dissolved organic matter in aquatic systems in situ using combined acoustic and optical measurements.

Downing, B. D.; Boss, E.; Bergamaschi, B. A.; Fleck, J. A.; Lionberger, M. A.; Ganju, N. K.; Schoellhamer, D. H.; Fujii, R.

Limnol. Oceanogr.: Methods. **2009, 7, 119–131.**

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