Absorption-Based Size-Specific Primary Productivity Algorithm for the River-Influenced Northern Gulf of Mexico

Steven E. Lohrenz[1], Sumit Chakraborty[2], Kjell Gundersen[3]

[1]School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA 02744, U.S.A. (slohrenz@umassd.edu)

[2]Mote Marine Laboratory, Sarasota, FL 34236, U.S.A. (schakraborty@mote.org)

[3]Institute of Marine Research (IMR), PO Box 1870 Nordnes, NO-5817 Bergen, Norway

(kjell.gundersen@hi.no)

- Introduction
  - Brief overview of study area and data
- Approach
  - The productivity algorithm
  - Model inputs
- Results and Conclusions
  - Preliminary evaluation of model performance
- Knowledge Gaps and Priorities

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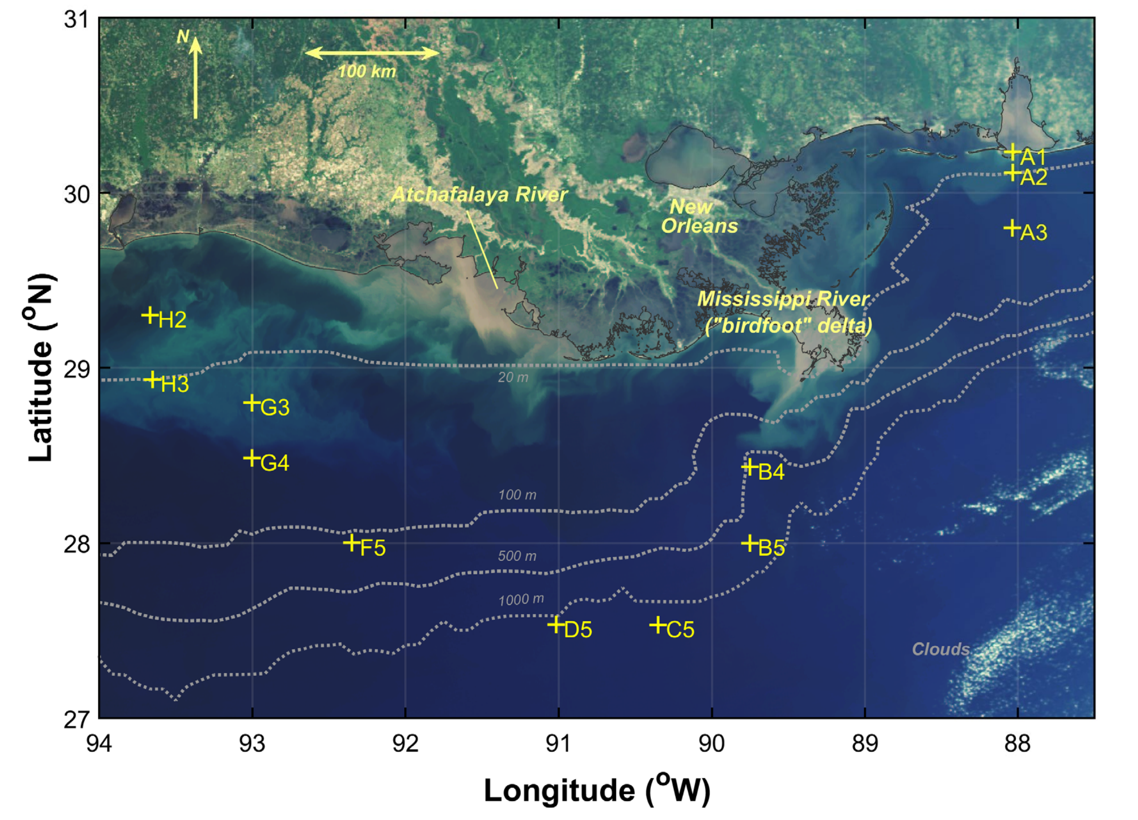
Introduction – Study Area and Data

- Large river system associated with the Mississippi and Atchafalaya rivers and one of the largest signals for carbon cycling in the North American continent



- Global PP models may not be able to realistically simulate regional conditions
- Here, we examine a regional absorption-based and size-specific productivity algorithm that can be implemented using satellite-retrievable observations
- Cruise conducted in April 2009
- Stations included coastal, mid-shelf and slope waters
- Dataset included:
  - P-E measurements
  - Quantitative filterpad
  - Hyperspectral irradiance profiles

Algorithm – Absorption-based and size-specific

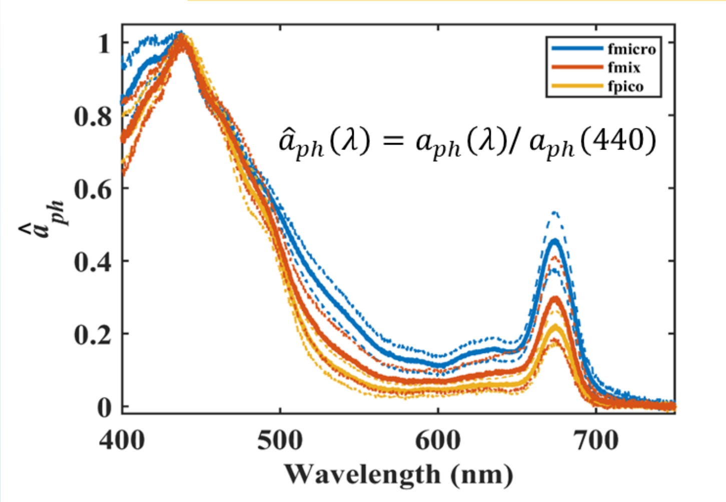
- $P(z,t) = \bar{a}_{ph} P_{max}^{a_{ph}} \left[1 - \exp\left(- \frac{a_{ph}(440)\phi_{max}^{C} PUR(z,t)}{\bar{a}_{ph} P_{max}^{a_{ph}}} \right) \right] (mol\ C\ m^{-3}\ h^{-1})$
  - $PUR(z,t) = \int_{PAR} \hat{a}_{ph}(\lambda) E_d(z,\lambda,t) d\lambda$ where $\hat{a}_{ph}(\lambda) = a_{ph}(\lambda)/\ a_{ph}(440)$
  - $\bar{a}_{ph} = \frac{\int_{400}^{700} a_{ph}(\lambda) E_d(z,\lambda,t) d\lambda}{\int_{400}^{700} E_d(z,\lambda,t) d\lambda}$ where $a_{ph}(\lambda) = \hat{a}_{ph}(\lambda)\ a_{ph}(440)\ (m^{-1})$
  - $\phi_{max}^{C} = 0.345 aph\_slope^2 + 0.195 aph\_slope + 0.017\ (mol\ C\ (mol\ quanta)^{-1})$

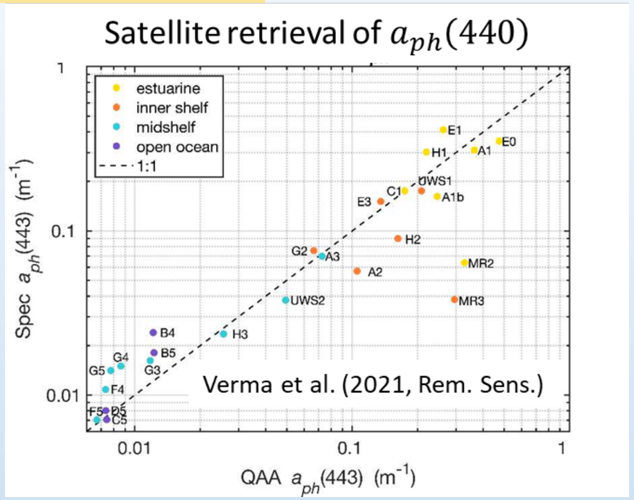
    where $aph\_slope = \frac{[a_{ph}(443) - a_{ph}(510)]}{510 - 443}\ (m^{-1}\ nm^{-1})$
  - $P_{max}^{a_{ph}} = Chl \cdot P_{max}^{B} / \bar{a}_{ph} = 2.00x10^{-5} e^{0.306(T)} (mol\ C\ m^{-2} h^{-1})$

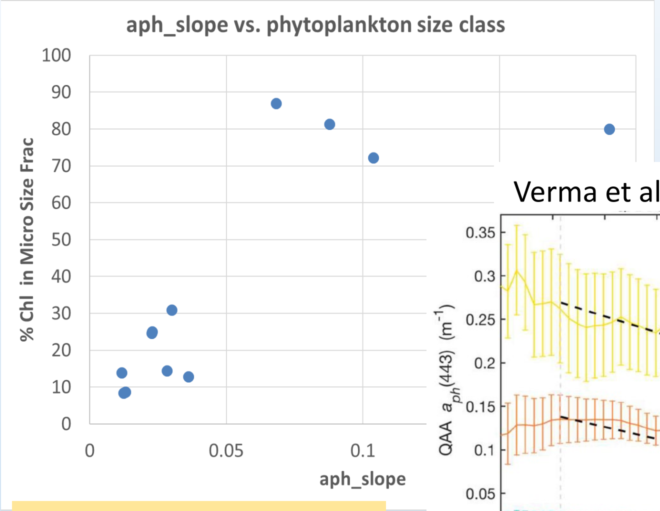
- $IP = \int_0^{DL} \int_0^{D} P(z,t) dz dt$ (mol C m^{-2} d^{-1}) where DL is daylength and D is water column depth

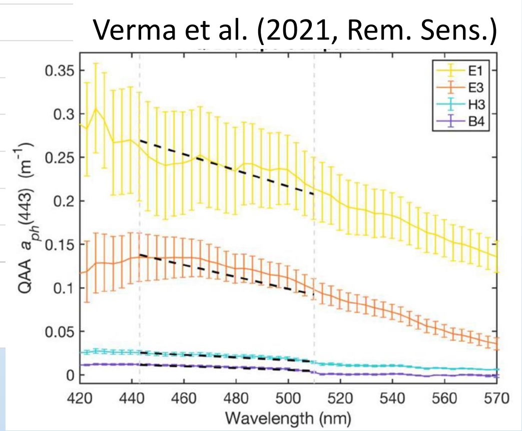
Model Inputs

Absorption shape vectors and $a_{ph}(440)$



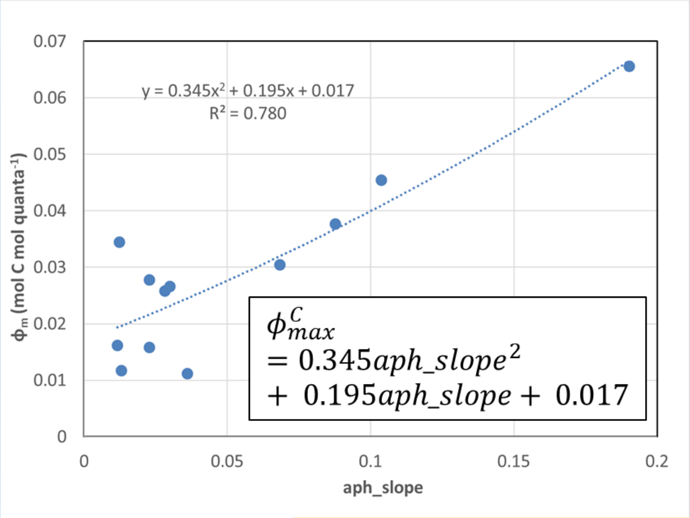






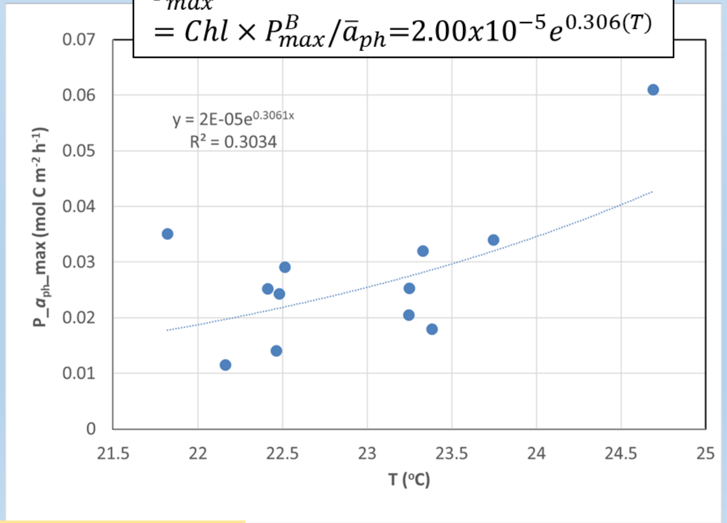
Absorption slope

$$\bar{a}_{ph} = \frac{\int_{400}^{700} a_{ph}(\lambda) E_d(z,\lambda,t)\, d\lambda}{\int_{400}^{700} E_d(z,\lambda,t)\, d\lambda} \text{ where } a_{ph}(\lambda) = \hat{a}_{ph}(\lambda)\, a_{ph}(440)\ (m^{-1})$$

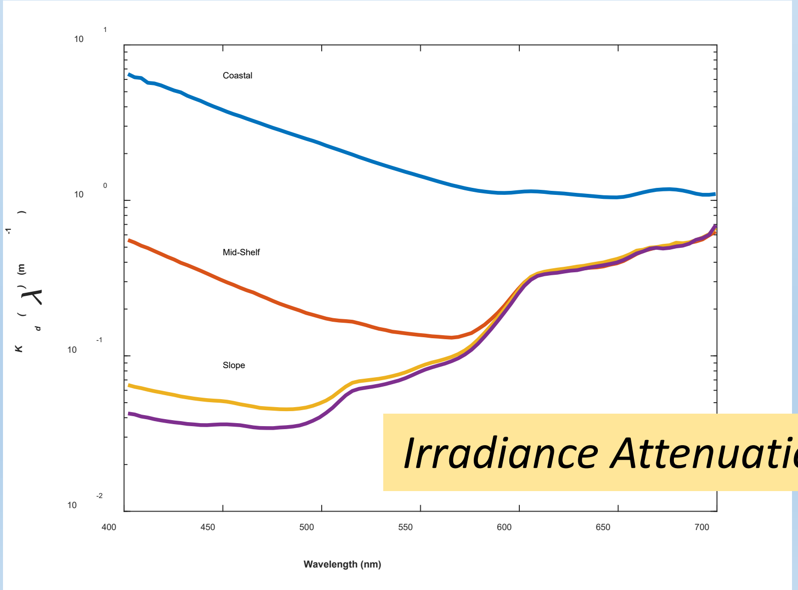


$\phi^{C}_{max} = 0.345 aph\_slope^2 + 0.195 aph\_slope + 0.017$

$P^{a_{ph}}_{max} = Chl \times P^{B}_{max}/\bar{a}_{ph} = 2.00\text{x}10^{-5} e^{0.306(T)}$



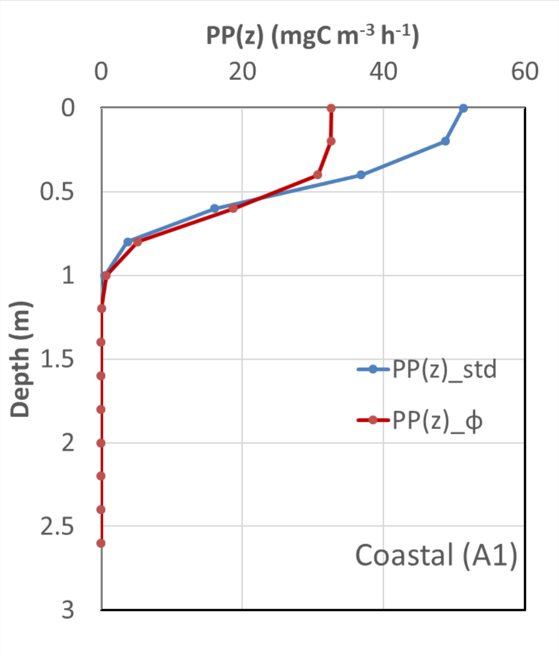
Photophysiological parameters



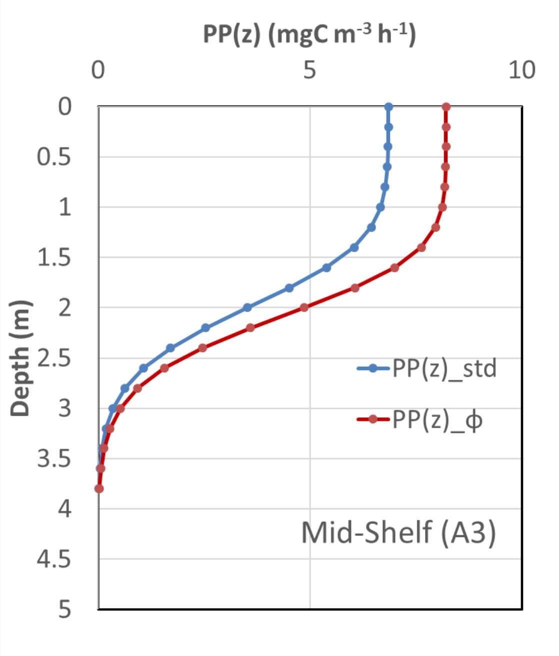
Irradiance Attenuation

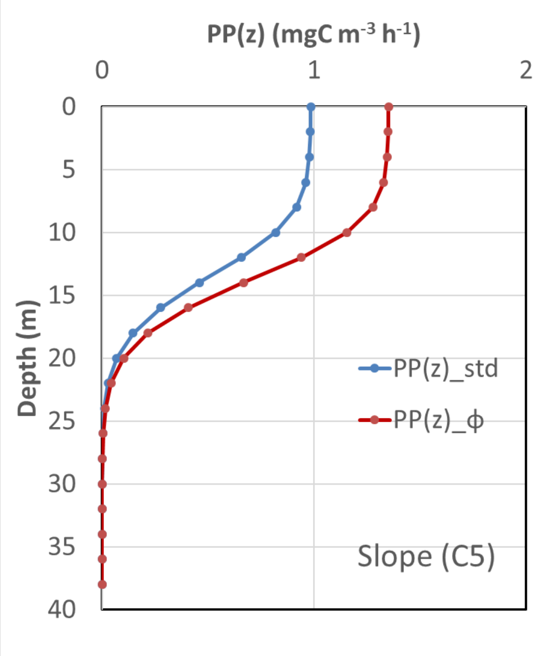
Results and Conclusions

- Preliminary demonstration of model shows it is able to represent order of magnitude variations in productivity from nearshore to slope waters
- Largest deviations were in near surface waters, where sensitivity to maximum photosynthetic rate estimates were highest
- Positive bias in model for slope and mid-shelf and negative for coastal



PP(z)_ϕ = model
PP(z)_std = measured





Knowledge gaps and priorities

- Knowledge gaps
  - Large source of uncertainty in absorption-based models in the maximum photosynthetic rate parameter
  - Need for additional in situ measurements to better characterize PP parameters
- Priorities
  - 1 year
    - Expand analysis to include datasets from other seasons and conditions to provide more comprehensive representation of photophysiological parameters
    - Evaluate performance of model using satellite-retrieved parameters ($a_{ph}(440)$, *aph_slope*, K_d, and T)
  - 5 year
    - Apply algorithm to emerging hyperspectral sensors (PACE, GLIMR, SBG)
    - Compare model performance to other formulations including global algorithms
  - 10 year
    - Explore performance and suitability of algorithm in other regions, and potential “nesting” of models