Primary productivity of the Yellow Sea

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Outline

- Backgrounds
  - Uncertainty in PP estimation in the YS
  - Env. characteristics
- Results of our previous study
- Things to consider further
- Current efforts & future directions
The Yellow Sea is the most productive sea in NP, or is it?

(PICES NPESR, 2004)
Primary productivity of YS
(limitation of current knowledge)

- Point measurements vary in the range of 11.78 ∼ 3,175 mg C m⁻² d⁻¹ depending on time and space.
- Some of in-situ estimates on annual production are ∼150 gC m⁻² y⁻¹, which is small compared to fish landings.
- Uncertainty is significant
~600 gC m⁻² yr⁻¹
Annual Global Primary Production
(IMCS, Rutgers)
Comparison of CHL by OC4 (standard) algorithm and in-situ CHL
Some env. characteristics of the YS

- Major forcing of hydrographic condition (Guo, 1993)
  - Wind stress (monsoon) and heat exchange with atmosphere
  - Strong tides (max. ~11 m excursion)
  - Fresh water input
- Extreme temperature range (seasonally and vertically)
- Extreme turbidity range (Secchi transparency: >12 m ~ <0.2m)
Bathymetry and vertical temp. structure

Xia et al. (2006)
Better algorithm is needed for:

- Better retrieval of CHL and KPAR
- Estimation of photosynthesis rate in extreme turbidity range.
- Vertical structure of chlorophyll
  - Error of PP estimation when ignoring subsurface chlorophyll maximum = 17.7%~30.1%
  (Park, 2000)
Our previous approach
(Son et al., 2005)

- We divided the YS into three areas and got averages from each.
  - P-I parameters (141 sets)
  - Vertical CHL profiles were parameterized (86 profiles).
- Smith model (1936) was used for photosynthesis.
- KPAR was derived from nLw555
- Empirical local algorithm (Ahn, 2004) was used to retrieve chlorophyll

\[ y = 0.267x^{0.7472} \]
\[ R^2 = 0.5964 \]

\[ y = 0.2249x^{0.7269} \]
\[ R^2 = 0.5504 \]
### Primary production in the 3 regions of the Yellow Sea

<table>
<thead>
<tr>
<th>Sub-region</th>
<th>Area $\times 10^3$ km²</th>
<th>Mean Primary Production Rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mgC m² d⁻¹</td>
<td>$\times 10^4$ ton C d⁻¹</td>
</tr>
<tr>
<td>CCW</td>
<td>58.9</td>
<td>590.3</td>
<td>589.3</td>
</tr>
<tr>
<td>MYW</td>
<td>147.4</td>
<td>946.5</td>
<td>722.6</td>
</tr>
<tr>
<td>KCW</td>
<td>28.9</td>
<td>734.2</td>
<td>553.7</td>
</tr>
<tr>
<td>mean</td>
<td></td>
<td>835.6</td>
<td>672.4</td>
</tr>
<tr>
<td>total</td>
<td>235.2</td>
<td></td>
<td></td>
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</tbody>
</table>
Limitations of the previous study

- Estimation was possible only for two seasons (spring and autumn).
- Regions were fixed geographically but not optically.
  - Averages of P-I parameters were used.
  - Averages of CHL profile parameters were used.
- PP in the turbid region was not modeled accurately.
- CHL algorithm needs improvements.
Seasonal changes of KPAR (m$^{-1}$)
Seasonal changes of depth-integrated PAR (mE m\(^{-2}\) s\(^{-1}\))
Two types of production systems in YS

- **Tidally-mixed zone**
  - Light-limited
  - Dark-adapted
  - Tyco-pelagic species

- **Seasonally stratified region**
  - Nutrient-limited in the upper layer
  - SCM production is significant
Optical characteristics

Fig 2. Below-surface reflectance at 9 stations.

May, 1998
(Yoo & Park, 1998)
P-I curves in the turbid zone

Yoo & Shin (1995)
Current efforts

- Better parameterization of physiological parameters
  - In turbid environment
- More in-situ measurements are planned.
  - Turbid waters
  - Winter
- Better estimation of CHL vertical structure
- Chlorophyll algorithm
  - YOC workshop (YS Ocean Color Database)
Can we retrieve/estimate CHL structure parameters from surface properties (CHL, KPAR, SST)?
Yellow Sea Ocean Color Database
(Bio-optical measurements)

- **China**
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Thank You!