Primary productivity of the Yellow Sea

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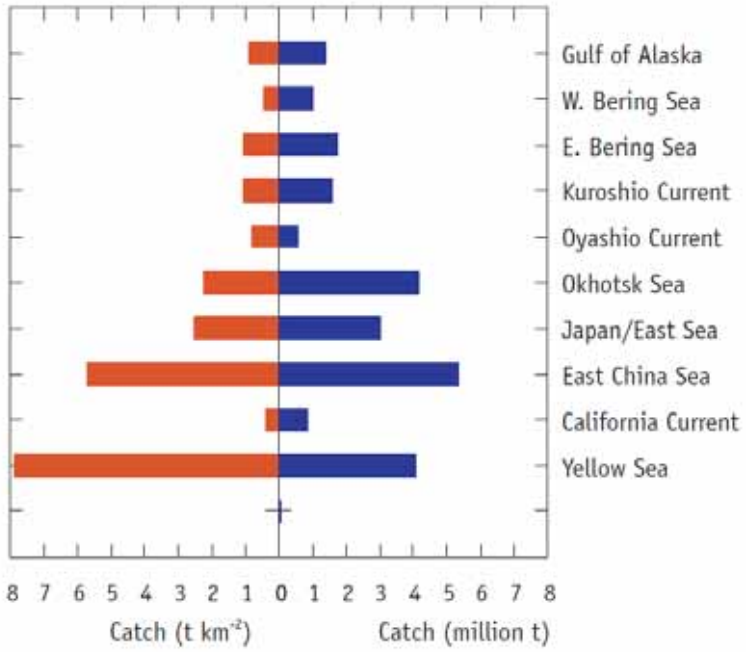
Outline

- 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?



[Figure 11] Disaggregated FAO catches in the North Pacific by region (million t - blue) and adjusted by area within each region (t per km² - red).[4]

(PICES NPESR, 2004)

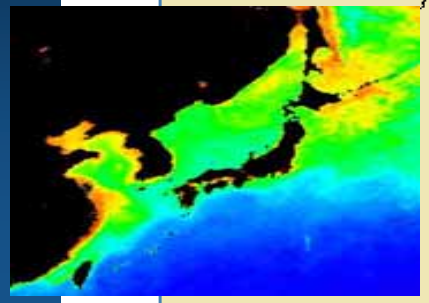
Primary productivity of YS
(limitation of current knowledge)

- 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

Web Products: Large Marine Ecosystems

Main page

LME: Yellow Sea



Legend FAO areas

Area:	437,376 km²
Coral Reefs:	0 % of world
Sea Mounts:	0 % of world
Primary Production:	1643 mgC·m⁻²·day⁻¹

~600 gC m^{-2} yr^{-1}

Select FAO area:

NW Pacific

Catches by:

Values by:

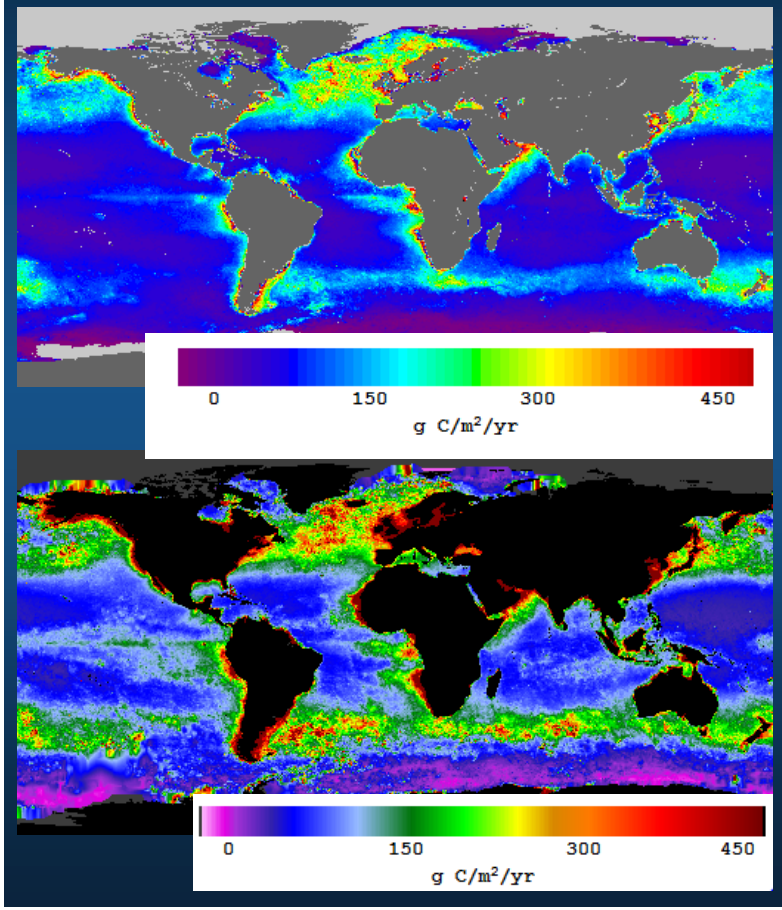
Biodiversity

Ecosystems

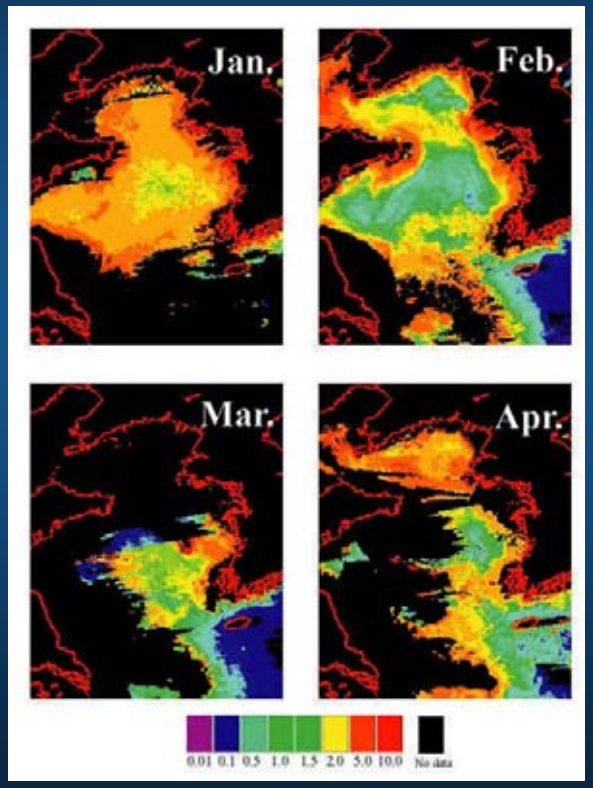
Governance

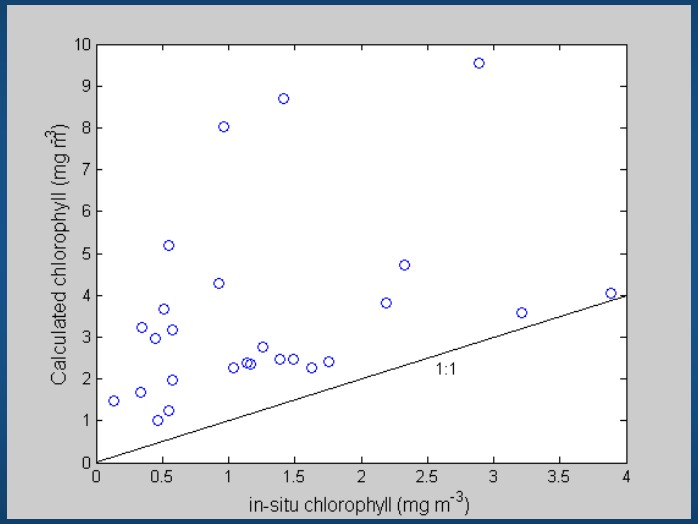
Feedback

The Fisheries Centre THE PEW CHARITABLE TRUSTS The University of British Columbia



Annual Global Primary Production (IMCS, Rutgers)



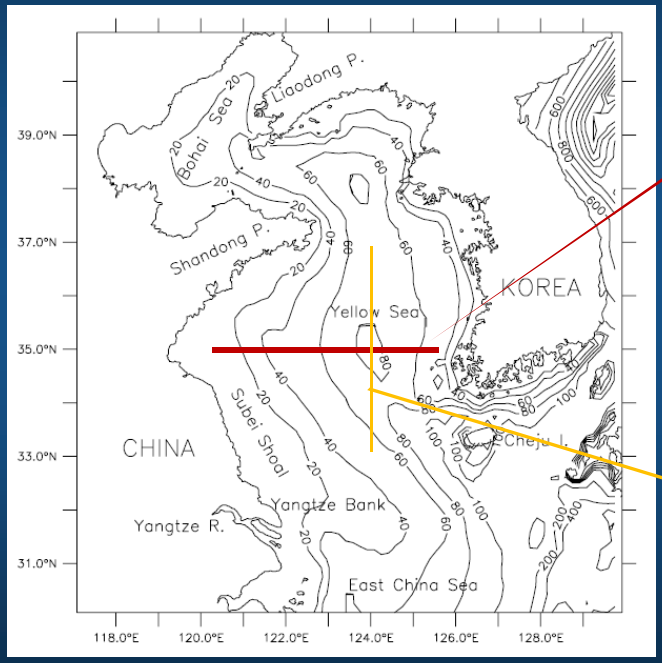


Comparison of CHL by OC4 (standard) algorithm and in-situ CHL

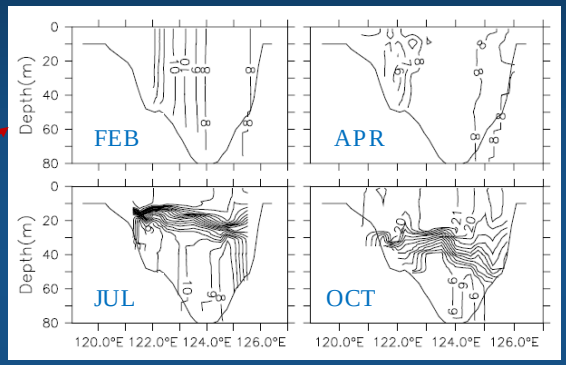
Some env. characteristics of the YS

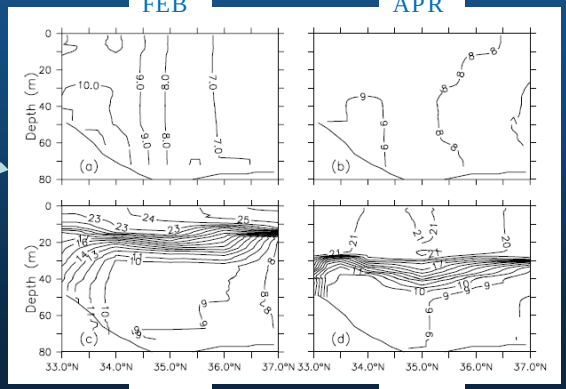
- Major forcing of hydrographic condition (Guo, 1993)
  - Wind stress (monsoon) and heat exchange with atmosphere
  - Strong tides (max. ~11 m excursion)
  - Fresh water input
- Extreme temperature range (seasonally and vertically)
- Extreme turbidity range (Secchi transparency: >12 m ~ <0.2m)

Bathymetry and vertical temp. structure



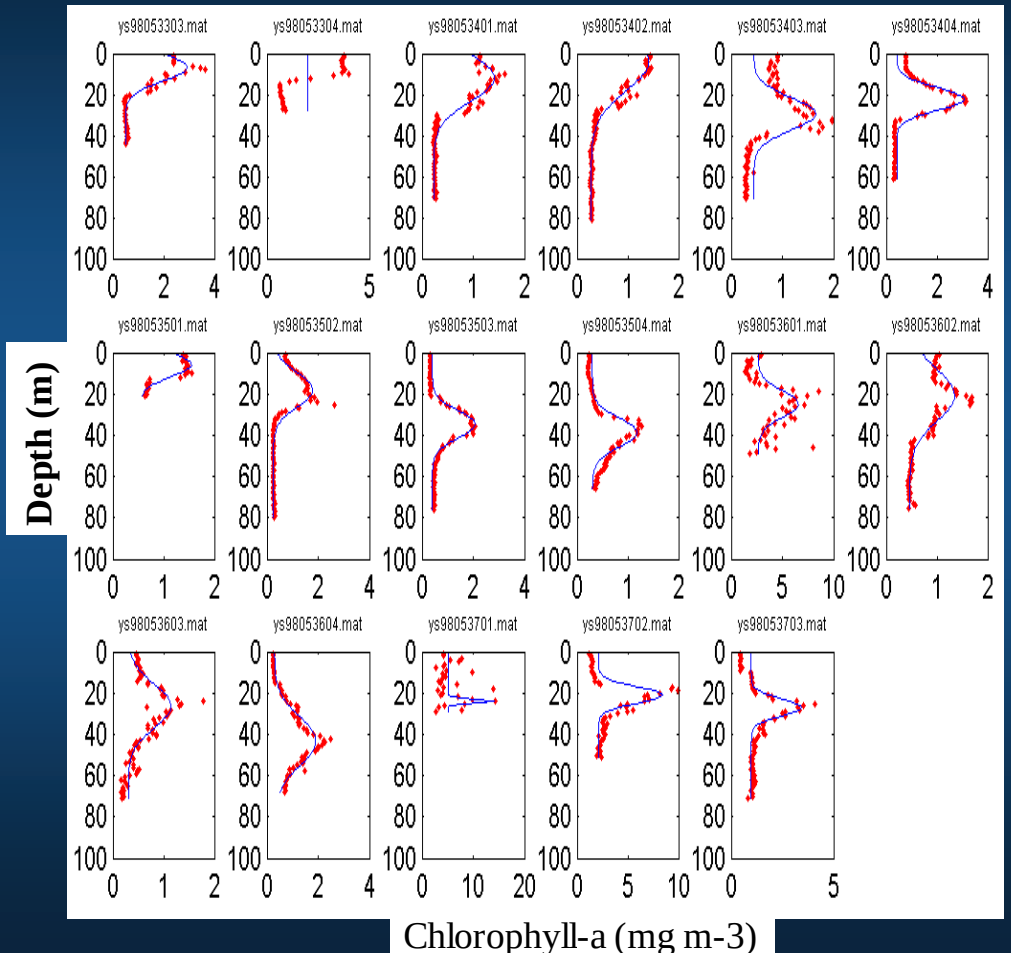
Xia et al. (2006)





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)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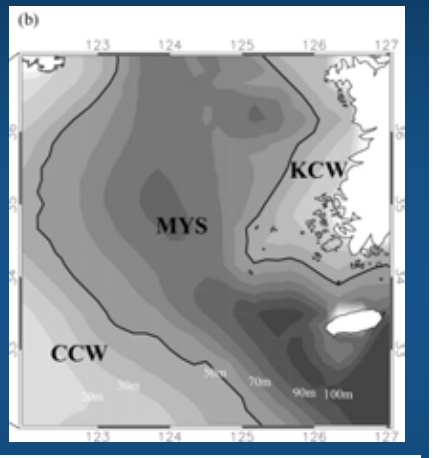
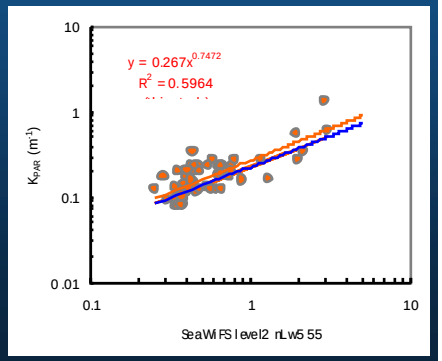
ys98053602.mat
ys98053603.mat
ys98053604.mat
ys98053701.mat
ys98053702.mat
ys98053703.mat
Depth (m)
Chlorophyll-a (mg m-3)

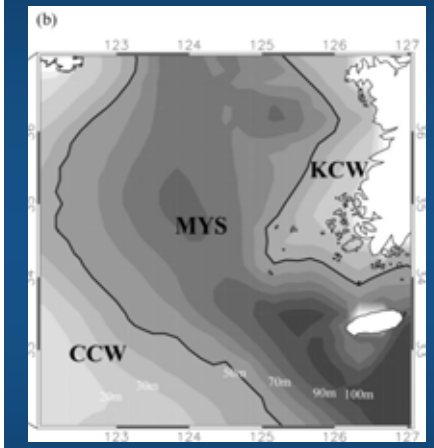
Our previous approach
(Son et al., 2005)

- 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





Primary production in the 3 regions of the Yellow Sea

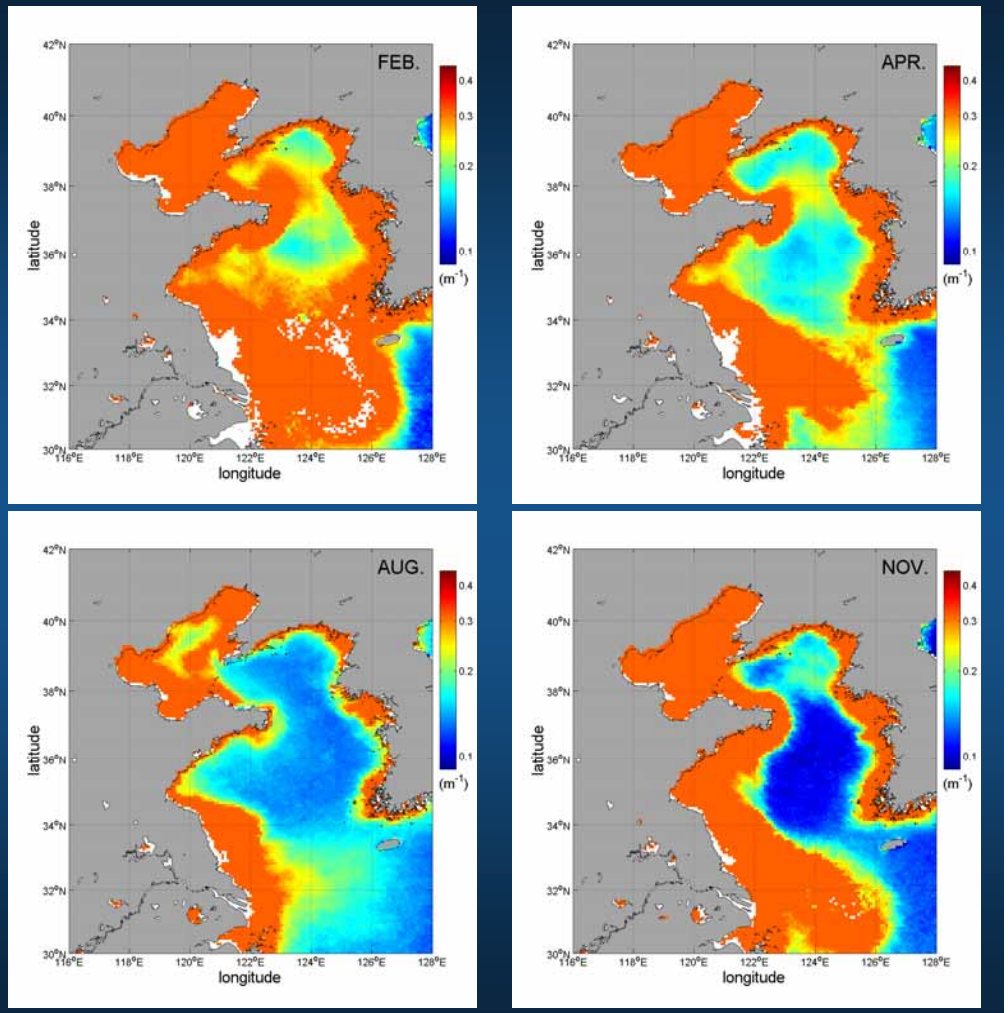


Sub-region	Area $\times 10^3$ km^2	Mean Primary Production Rate			
		mgC m^{-2} d^{-1}		$\times 10^4$ tonC d^{-1}	
		May	**Sep**	**May**	**Sep**
CCW	58.9	590.3	589.3	3.5	3.5
MYW	147.4	946.5	722.6	13.9	10.6
KCW	28.9	734.2	553.7	2.1	1.6
mean		**835.6**	**672.4**		
total	235.2			**19.7**	**15.8**

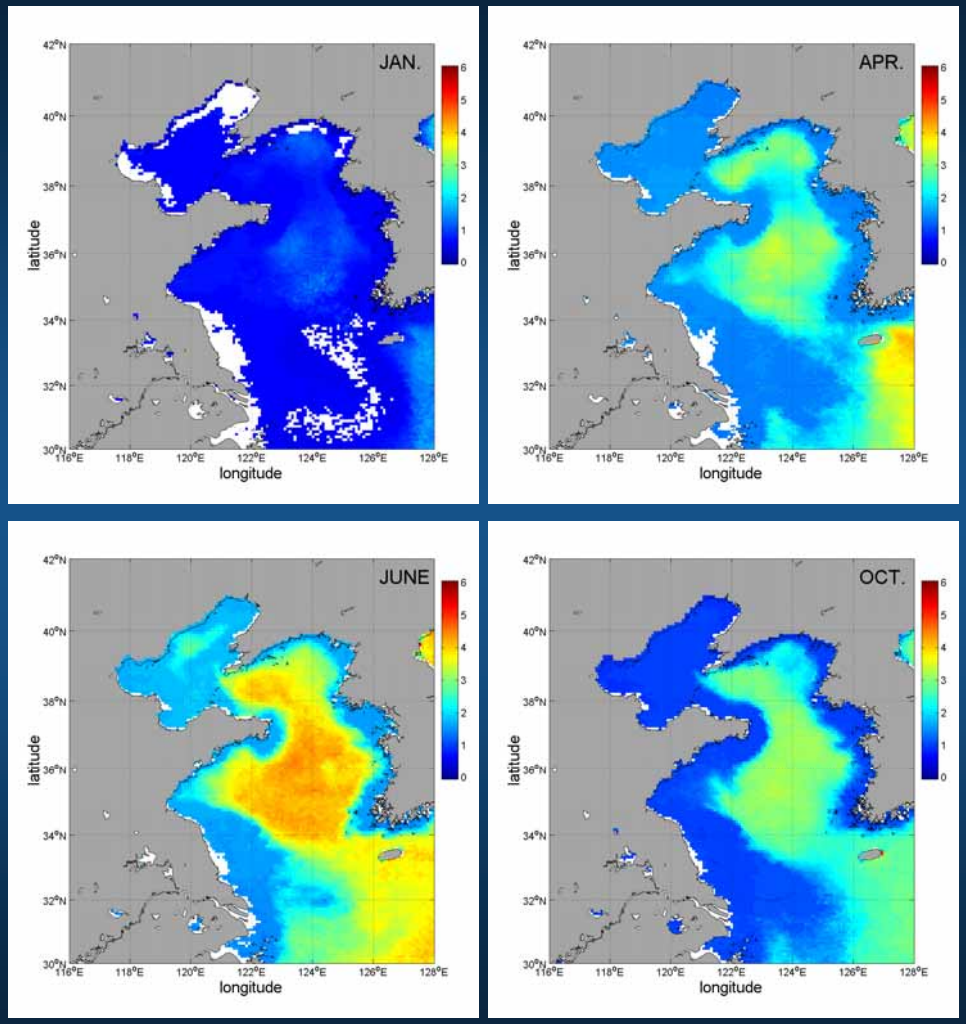
Limitations of the previous study

- 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})

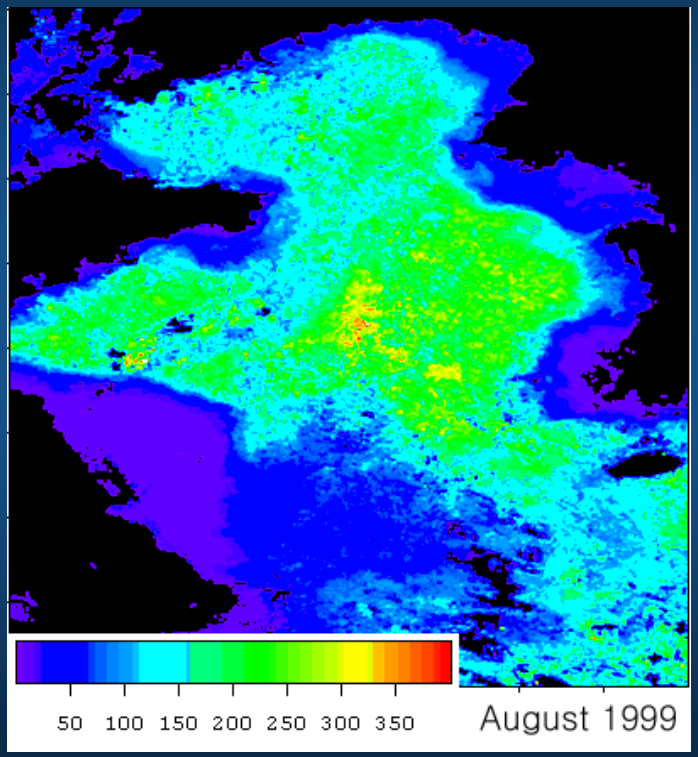


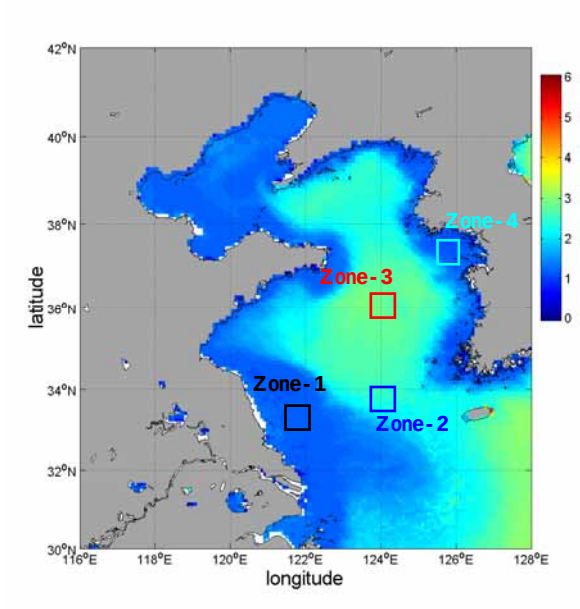
Seasonal changes of depth-integrated PAR (mE m^{-2} s^{-1})



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




42°N
40°N
38°N
36°N
34°N
32°N
30°N
116°E
118°E
120°E
122°E
124°E
126°E
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latitude
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Zone-4
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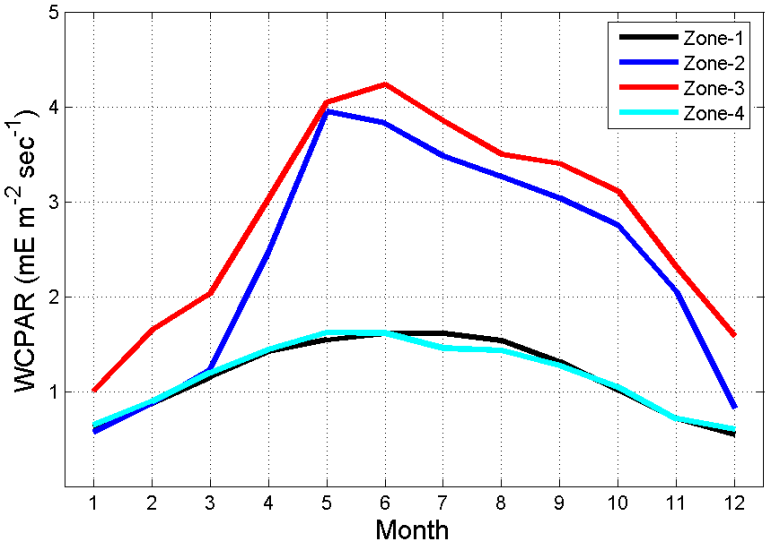
Zone-2
6
5
4
3
2
1
0


Zone-1
Zone-2
Zone-3
Zone-4
WCPAR (mE m-2 sec-1)
Month
1
2
3
4
5
6
7
8
9
10
11
12

Optical characteristics

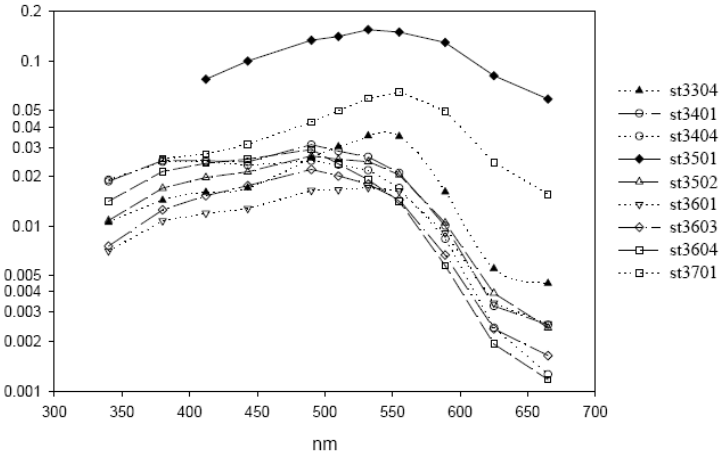
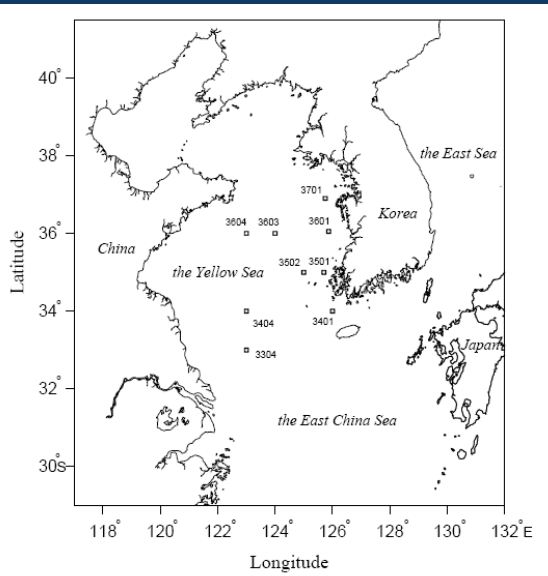


Fig 2. Below-surface reflectance at 9 stations.



May, 1998
(Yoo & Park, 1998)

P-I curves in the turbid zone

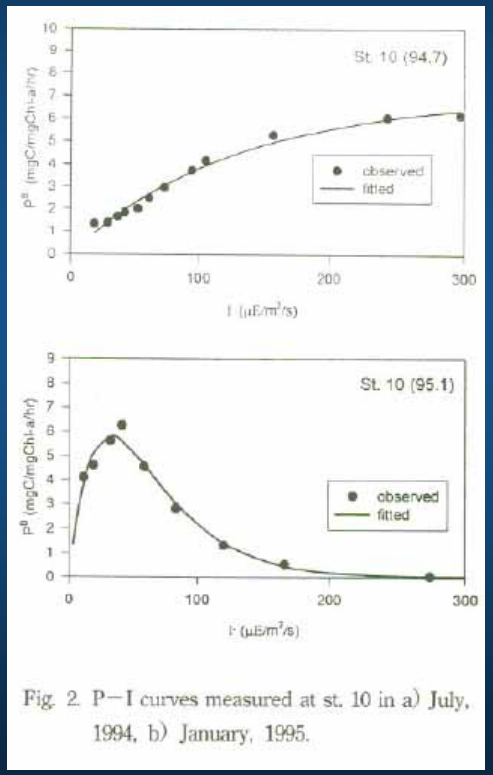
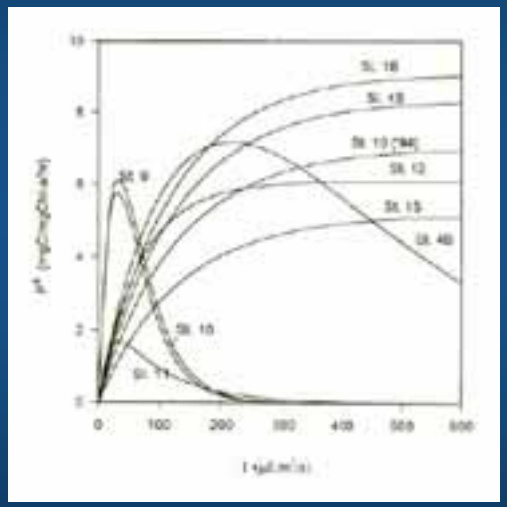


Fig. 2. P−I curves measured at st. 10 in a) July, 1994, b) January, 1995.

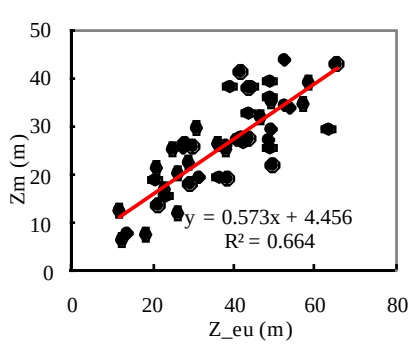


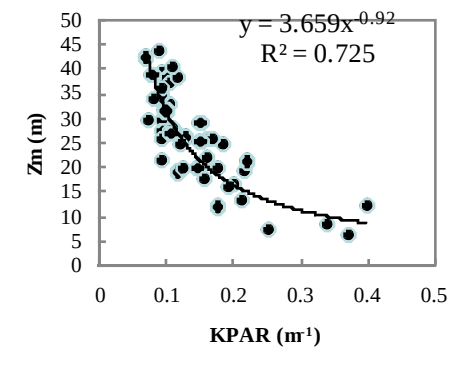
Yoo & Shin (1995)

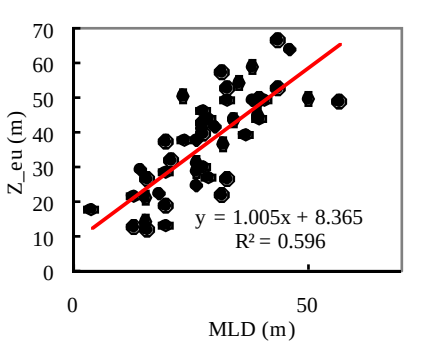
Current efforts

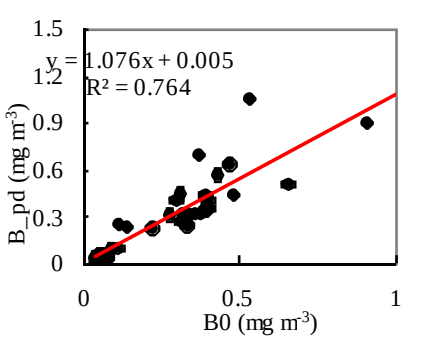
- Better parameterization of physiological parameters
  - In turbid environment
- More in-situ measurements are planned.
  - Turbid waters
  - Winter
- Better estimation of CHL vertical structure
- Chlorophyll algorithm
  - YOC workshop (YS Ocean Color Database)

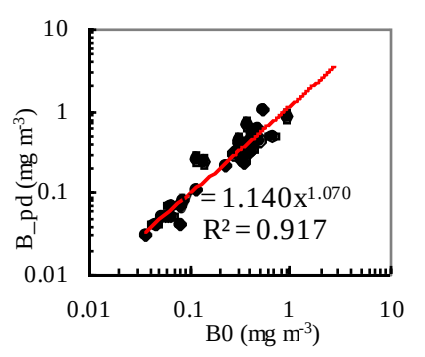
Can we retrieve/estimate CHL structure parameters from surface properties (CHL, KPAR, SST)?

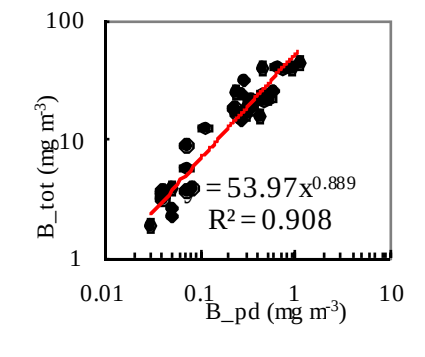




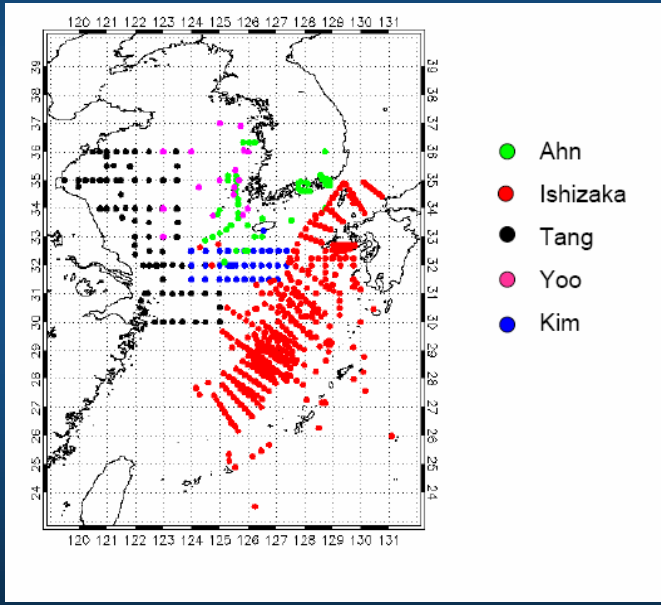








Yellow Sea Ocean Color Database
(Bio-optical measurements)



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Thank You!