Seasonal change of surface $p\text{CO}_2$ distribution in the East China Sea

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Northwest Pacific Sea

- East China Sea
- Kuroshio Current
- Tsushima Warm Current
- North Equatorial Current
- Equatorial Countercurrent
Northwest Pacific Sea

- Tsushima Warm Current
- Kuroshio Current
- North Equatorial Current
- Equatorial Countercurrent
Objectives

Surface $pCO_2$ variation in the East China Sea

- What are major controlling factors?
  temperature
  salinity (river discharge)
  biological process
  water column stability (mixing)
Study Area

Study Period
- Aug. 26 ~ Sep. 2, 2003 (Summer)
- Apr. 28 ~ May 7, 2004 (Spring)

Measurements
- Surface water (every 1 min): Temp, Sal., pCO₂
- Hydrocasting (about 50 stations): Temp, Sal., Nutrients, Chl-a, POC
Surface $pCO_2$ ($\mu$atm)

Summer

Spring
CO$_2$ Flux (mmol m$^{-2}$ d$^{-1}$)

**Summer**

- **Source & Sink**

**Spring**

- **Source & Sink**

Legend:
- Source: positive values (red)
- Sink: negative values (blue)
- Summer: top map
- Spring: bottom map
Temperature (°C)

Summer

Spring

Temperature Variation
Correlation for $pCO_2$ & temp. and salinity

**Summer**

- Equation: $y = 17.453x - 143.98$
- $R^2 = 0.7851$
- Points colored by region:
  - Blue: East
  - Pink: West

**Spring**

- Equation: $y = 9.9422x + 116.91$
- $R^2 = 0.5679$
- Points colored by region:
  - Green: East
  - Orange: West
Correlation for $p\text{CO}_2$ & temp at east part

$Y = 8.1x + 151.2$  
($R^2=0.92$)

Diagram showing the correlation between $p\text{CO}_2$ (µatm) and temperature (C) with a linear regression line and data points indicating spring and summer seasons.
Surface $pCO_2$ at temp=25°C

Summer

Spring
What are major controlling factors?

<table>
<thead>
<tr>
<th></th>
<th>west</th>
<th>east</th>
</tr>
</thead>
<tbody>
<tr>
<td>summer</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>spring</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

Temperature

Salinity (river discharge)?
Yangtze River discharge

COPEX-ECS (Sept., 1998)
- 20 cm/s
- 40 cm/s

KOREA

CHINA

KORDI
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Surface $pCO_2$ at temp=25°C & sal=33

Summer

Spring
What are major controlling factors?

Temperature

Salinity (river discharge)

<table>
<thead>
<tr>
<th>Summer</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>Yes</td>
</tr>
<tr>
<td>East</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Yangtze river discharge after three-Gorge Dam in 2009?
Nutrients (NO$_{3+2}$ & PO$_4$)

**summer**

**NO$_{3+2}$**

**PO$_4$**

**spring**

**NO$_{3+2}$**

**PO$_4$**
**Chl-a and POC**

**summer**

**Chl-a**

**spring**

**Chl-a**

**POC**

**POC**
Correlation for $pCO_2$ & Chl-a and NO$_3$

Chl-a

\[ y = -92.886x + 392.17 \]
\[ R^2 = 0.3788 \]

NO$_3$

\[ y = 14.415x + 308.05 \]
\[ R^2 = 0.8622 \]

\[ y = -30.093x + 365.26 \]
\[ R^2 = 0.1083 \]

*summer*  *spring*
Hydrocasting station

Aug. 2003 (Summer)  Apr. 2004 (Spring)
Vertical profile of temp.

West

East

summer

spring

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Mixing depth (m)

- Summer

- Spring

50 m, 100 m
Biological process and mixing

\[ \text{CO}_2 + \text{H}_2\text{O} (+\text{N&P}) \rightarrow \text{CH}_2\text{O(NP)} \]

\[ \text{CH}_2\text{O(NP)} ightarrow \text{CO}_2 + \text{H}_2\text{O} \]
Surface $pCO_2$ variation in the East China Sea
- What are major controlling factors?

<table>
<thead>
<tr>
<th>Season</th>
<th>West</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>Mix</td>
<td>temp</td>
</tr>
<tr>
<td>Summer</td>
<td>Sal</td>
<td>temp</td>
</tr>
</tbody>
</table>
Conclusion

At the East China Sea in summer and spring

- Surface $pCO_2$ : 230~450 $\mu$atm, sink area

- Seasonal variation : opposite pattern at east and west part of the study area

- East part : temperature is main factor in summer and in spring

- West part : in summer, salinity (river discharge) in spring, mixing
Thank you !!!