The dynamics of dissolved organic matter during in situ iron enrichment experiments in the subarctic North Pacific

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Background

DOC has an important role in C cycle

DOC production
- Algal extracellular release
- Protozoan grazing
- Sloppy feeding
- Viral lysis

DOC removal
- Heterotrophic bacteria
- UV

DOC production:
- Phytoplankton
- Zooplankton
- Bacteria
- DOC release

DOC removal:
- Mixing
- Diffusing
- Sinking
Objective

An iron enrichment experiment
→ Case study of a natural phytoplankton bloom

The present study was conducted to discuss
Production or decomposition of DOC from
changes in the DOC inventory
during the development or decline of
iron-induced phytoplankton blooms
Study sites

Three in situ iron enrichment experiments

- **SERIES**
  - 9 July – 4 August 2002 (26 days)

- **SEEDS**
  - 18 July – 31 July 2001 (13 days)

- **SEEDS-II**
  - 20 July – 15 August 2004 (26 days)
Experimental method

**Sampling**
The day of 1st iron enrichment: Day 0
- SEEDS: Day 0 - Day 13
- SERIES: Day 15 - Day 26
- SEEDS-II: Day 0 - Day 26

IN (centre of the iron patch)
OUT (surrounding waters)

Niskin or Niskin-X bottles
In-lined GF/F filtration

**DOC Analysis**
High temperature combustion (Shimadzu TOC-5000)
+-0.1–1.4 µmol L⁻¹ (SD)
Results: SEEDS 2001

DOC increased with the bloom development

0 - 20 m

Chl a (mg m$^{-2}$)

DOC (mmol m$^{-2}$)

5 m

Chl a (µg L$^{-1}$)

Days

Days
Positive correlation between DOC and Chl a

In the growth phase (Day 4 - 9) DOC / Chl a (mol / g) = 0.68
Gross DOC production
253 mmol m\(^{-2}\)

POC production (\(^{13}\)C)
314 mmol m\(^{-2}\) (Kudo et al. 2005)

45% of algal fixed carbon was converted into DOC
While Chl a decreased rapidly, DOC fluctuated in our observation period.
SERIES: DOC production

At the peak of the bloom

Net Chl a accumulation
175 mg m\(^{-2}\)

Net DOC accumulation
106 (74 – 142) mmol m\(^{-2}\)

DOC / Chl a (mol / g)
= 0.61 (0.42 – 0.81)
Results: SEEDS-II 2004

DOC fluctuated in the mixed layer throughout the observed period.

**0-30 m**

- **Chl a (mg m$^{-2}$)**
  - IN
  - OUT

- **DOC (mmol m$^{-2}$)**
  - IN
  - OUT

**IN, 5 m**

- **Chl a (µg L$^{-1}$)**
  - Days

**Growth phase**

- Days 0-12: IN increased, OUT decreased

**Decline phase**

- Days 12-26: IN decreased, OUT increased

**DOC fluctuated in the mixed layer throughout the observed period.**
Mean value in 0 - 30 m
A: 1835 ± 24
B: 1843 ± 28
The difference is NOT significant

Mean value in 30 - 75 m
A: 2462 ± 56
B: 2564 ± 78
The difference is significant

DOC increased below the surface mixed layer after the peak of the bloom
**Summary**

A significant portion of the organic carbon production was observed as DOC

<table>
<thead>
<tr>
<th></th>
<th>Growth phase</th>
<th>Decline phase</th>
<th>Dominant phytoplankton</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEEDS</td>
<td>DOC/Chl a = 0.68</td>
<td>No data</td>
<td>Large centric diatom</td>
</tr>
<tr>
<td></td>
<td>45% of fixed C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERIES</td>
<td>DOC/Chl a = 0.61</td>
<td>Fluctuated in the ML</td>
<td>Large pennate diatoms</td>
</tr>
<tr>
<td>SEEDS-II</td>
<td>Not detected</td>
<td>Increased below the ML</td>
<td>Small phytoplankton</td>
</tr>
</tbody>
</table>

*We need to discuss the DOC dynamics with*
Bacterial production or abundance
Sinking POC flux