



# HOKKAIDO UNIVERSITY

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| Title            | Establishment of an Amur-Okhotsk Consortium toward Future Sustainability in the Sea of Okhotsk                                                                                                                                                                                           |
| Author(s)        | Shiraiwa, Takayuki                                                                                                                                                                                                                                                                       |
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Sustainability Weeks 2009  
Opening Symposium 091102

# **Establishment of an *Amur-Okhotsk Consortium* toward Future Sustainability in the Sea of Okhotsk** **オホーツク海の未来可能性に向けた国際コンソーシアム構築**

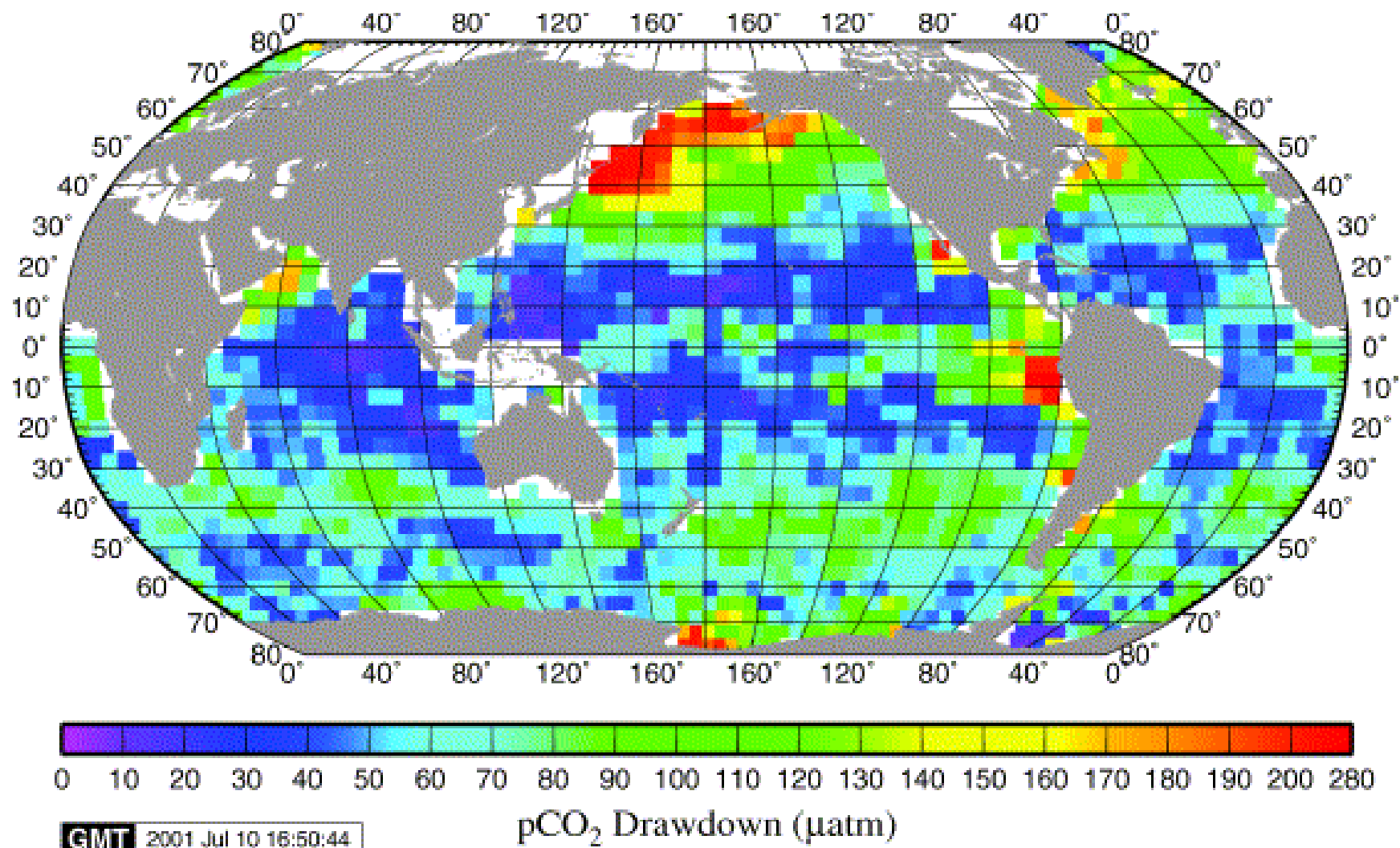
**Takayuki Shiraiwa**

**白岩孝行**

**Research Institute for Humanity and Nature  
Inst. Low Temp. Science, Hokkaido Univ.**

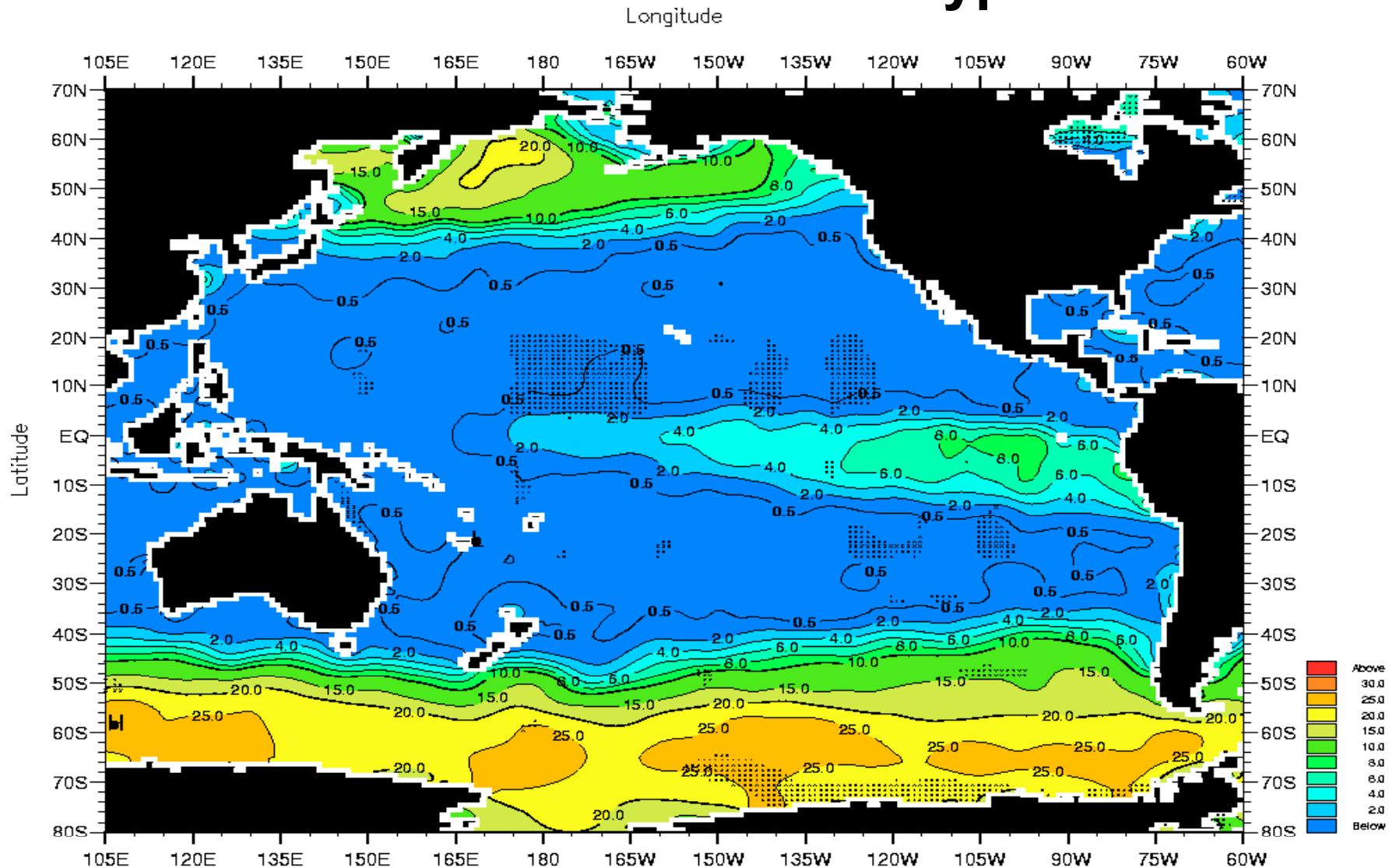
In collaboration with  
PORC/ILTS and SRC, Hokkaido University  
NER, Kitami Inst. Technology  
HRDB/MLIT, HUISD  
and ISTC/MEXT

# The world richest ocean



Takahashi et al., 2002

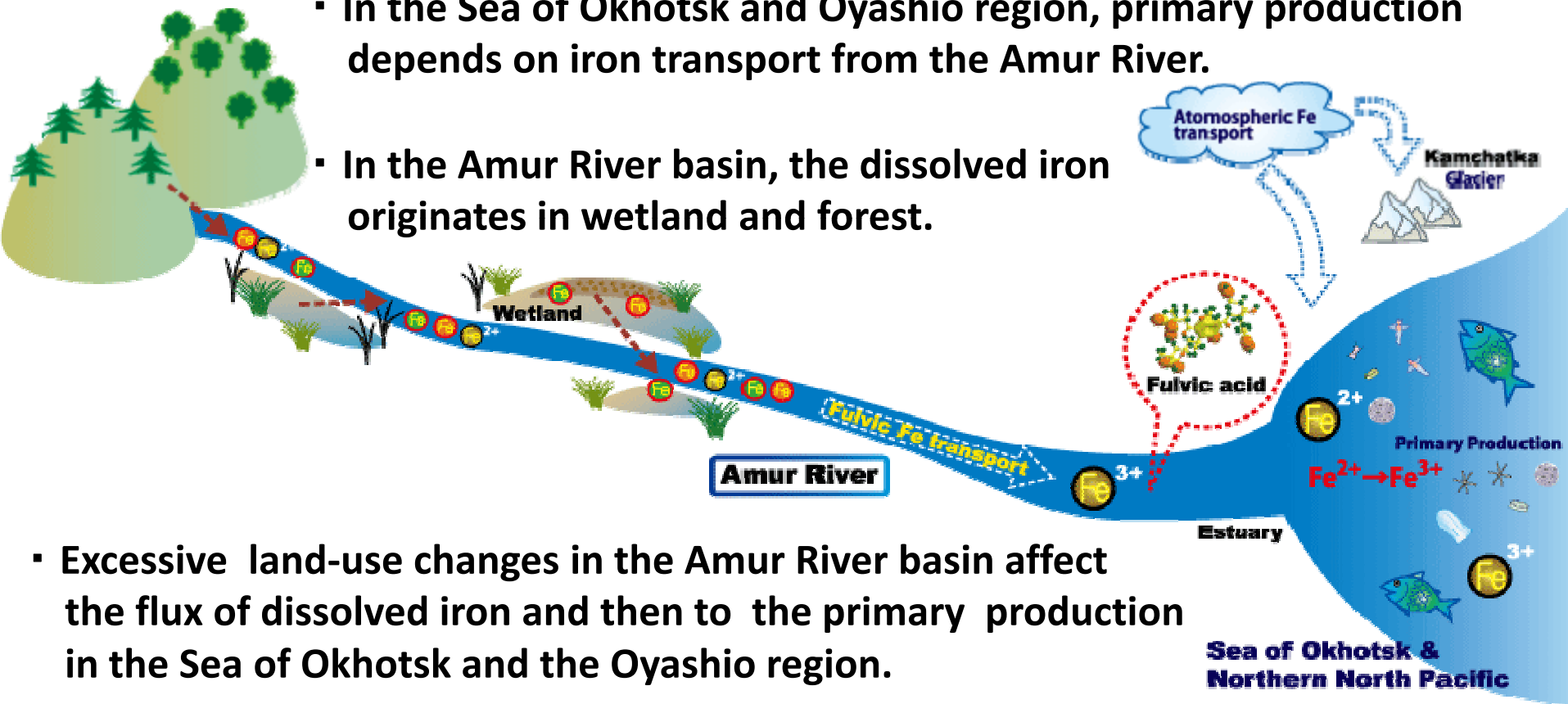
# HNLC and iron limitation hypothesis



# Giant Fish-Breeding Forest hypothesis

-Ecological linkage between the continent and open waters-

- In the Sea of Okhotsk and Oyashio region, primary production depends on iron transport from the Amur River.
- In the Amur River basin, the dissolved iron originates in wetland and forest.

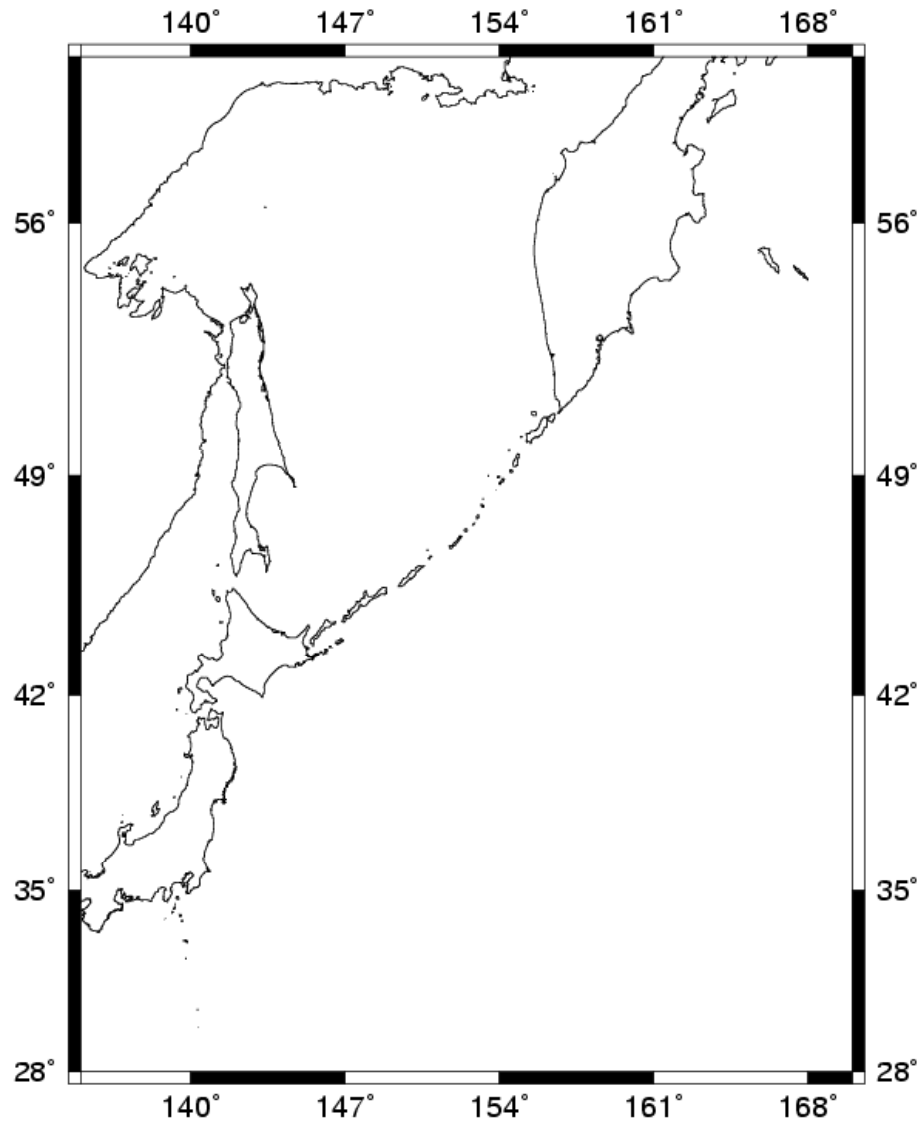


- Excessive land-use changes in the Amur River basin affect the flux of dissolved iron and then to the primary production in the Sea of Okhotsk and the Oyashio region.
- International cooperative effort on conservation on the GFBF is necessary for the sustainability of marine ecosystem in the Sea of Okhotsk and Oyashio open water.

# Amur River basin and the Sea of Okhotsk



# Intermediate Water Iron Hypothesis (Nakatsuka, Nishioka and others)



# Intermediate Water Iron Hypothesis (Nakatsuka, Nishioka and others)

Most of the dissolved iron precipitates in the estuary area and it is transported to the continental shelf area

(2)

Supply of large amount of dissolved and particulate iron from Amur River

(1)

Redistribution of iron into a wide range of intermediate depth by tidal mixing through straits

(5)

Entrainment of particulate iron from the shelf bottom to sea-ice brine water (Dense Shelf Water) due to the strong tidal mixing there

(3)

Penetration of particulate iron into the intermediate layer together with Dense Shelf Water and southward transport by East Sakhalin Current

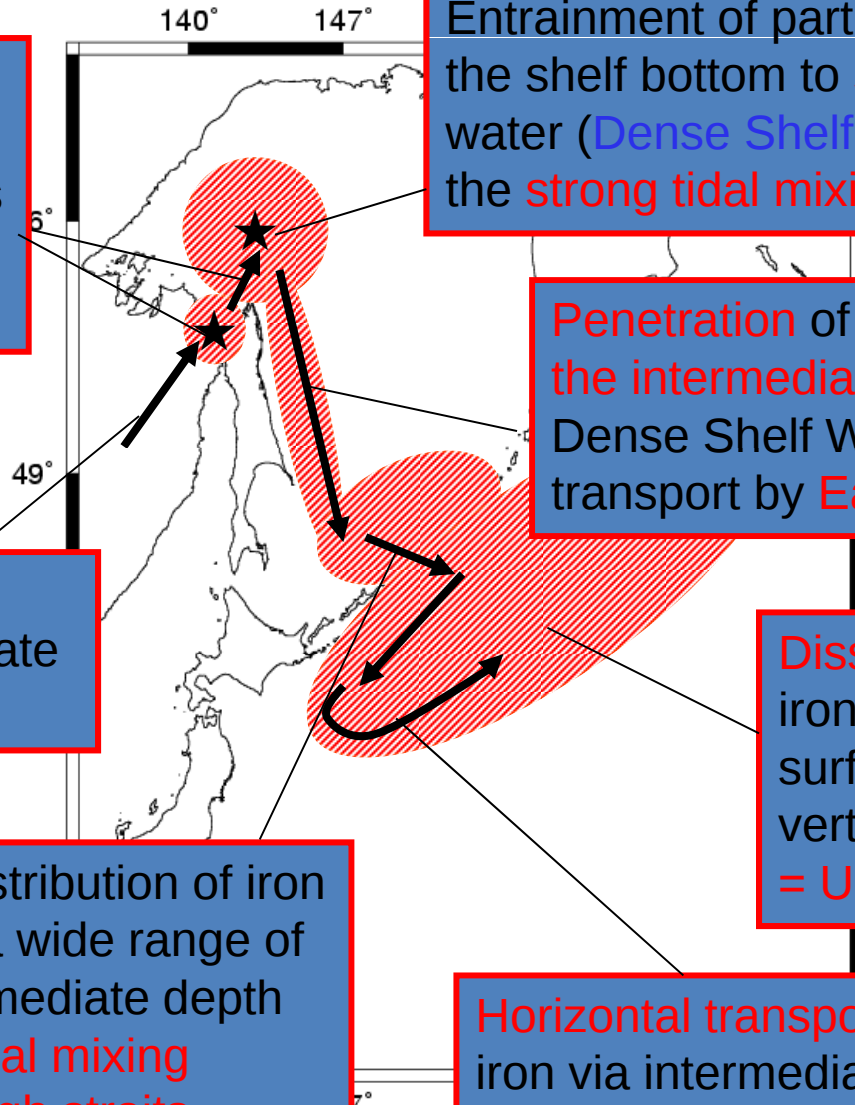
(4)

Dissolution of particulate iron and its supply into surface layer by winter vertical mixing = Uptake by organisms

(7)

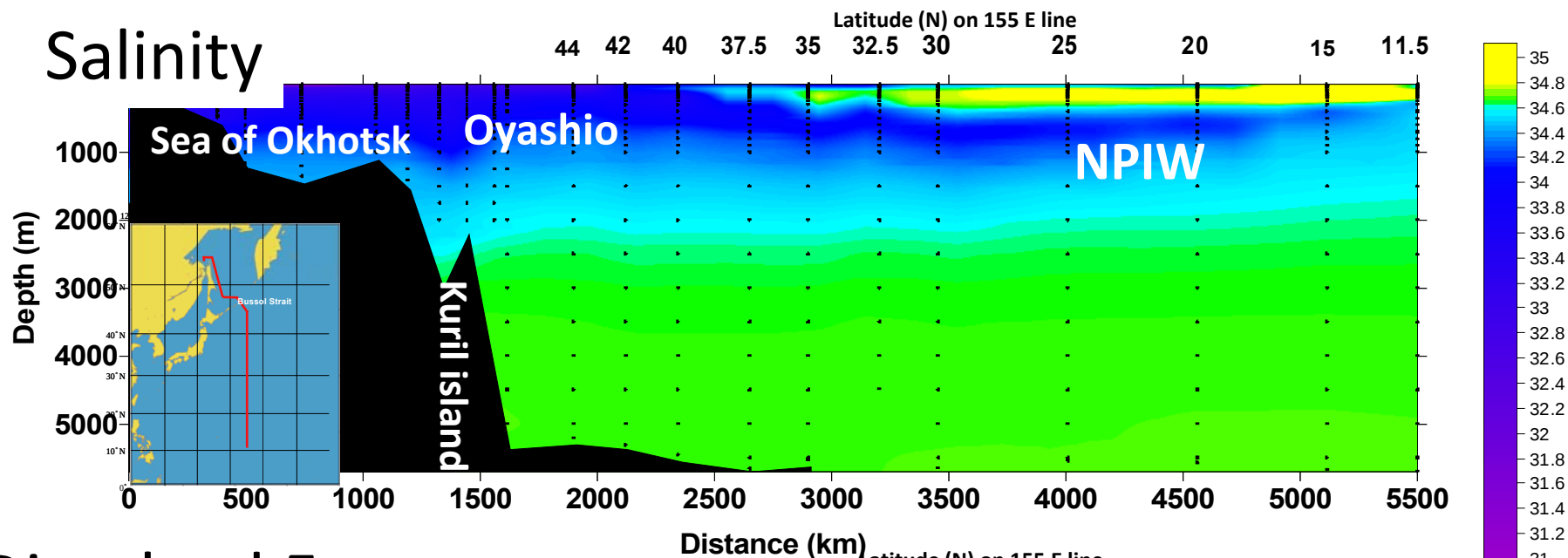
Horizontal transport of iron via intermediate layers in the region of Oyashio and Western North Pacific

(6)

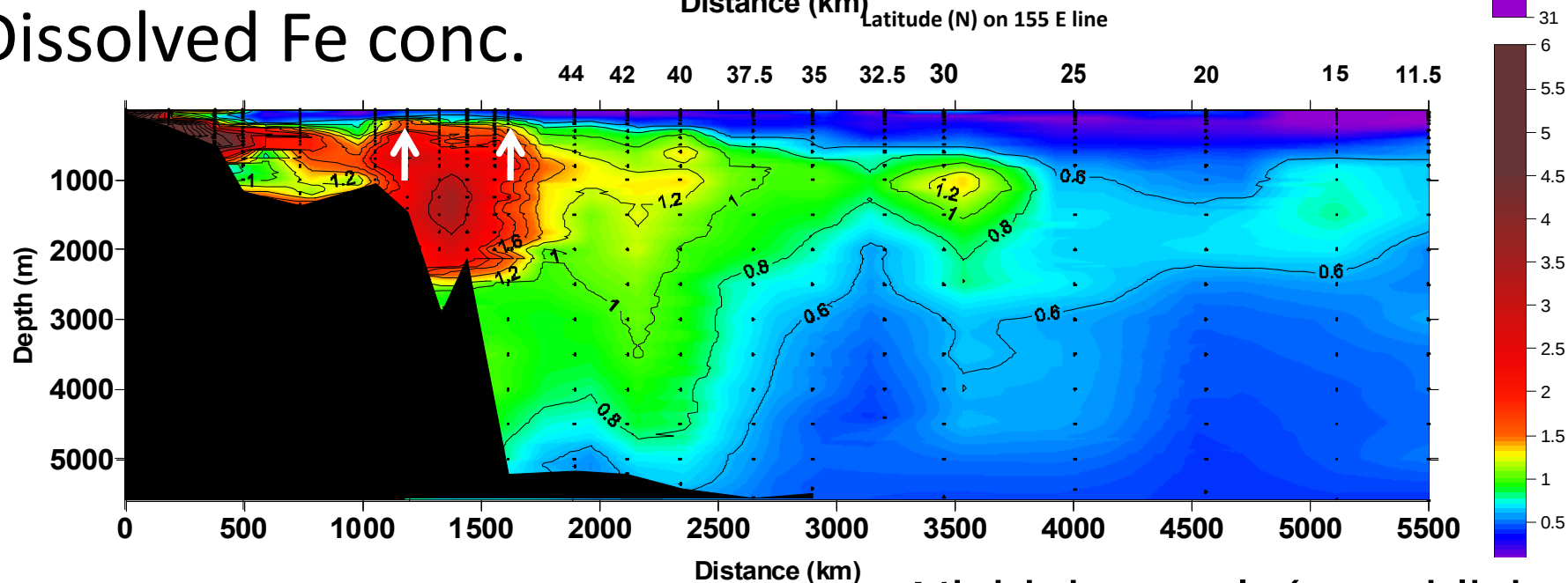


# Transport of the dissolved iron - Intermediate depth water

## Salinity



## Dissolved Fe conc.



Nishioka et al. (unpublished)

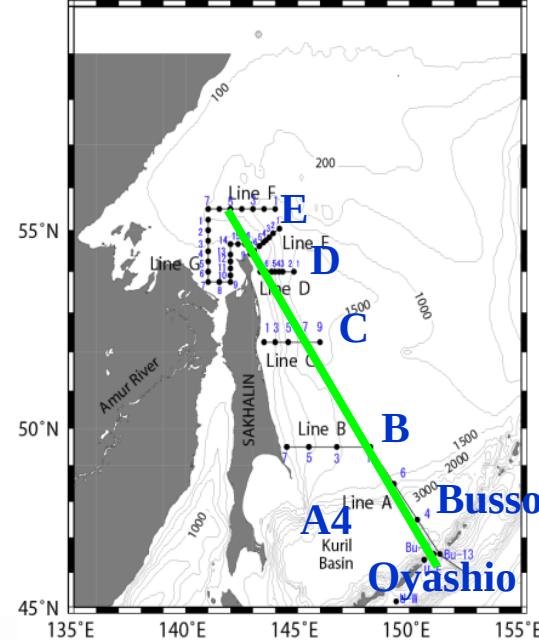
# Summary of total iron (g/yr) transport

Amur R.

$1.1 \times 10^{11}$

$2.2 \times 10^9$

$2.0 \times 10^7$



Atmospheric

$1.2 \times 10^8$

NPIW

$4.7 \times 10^{11}$

$1.9 \times 10^{10}$

$6.0 \times 10^9$

$1.5 \times 10^8$

Sea of Okhotsk

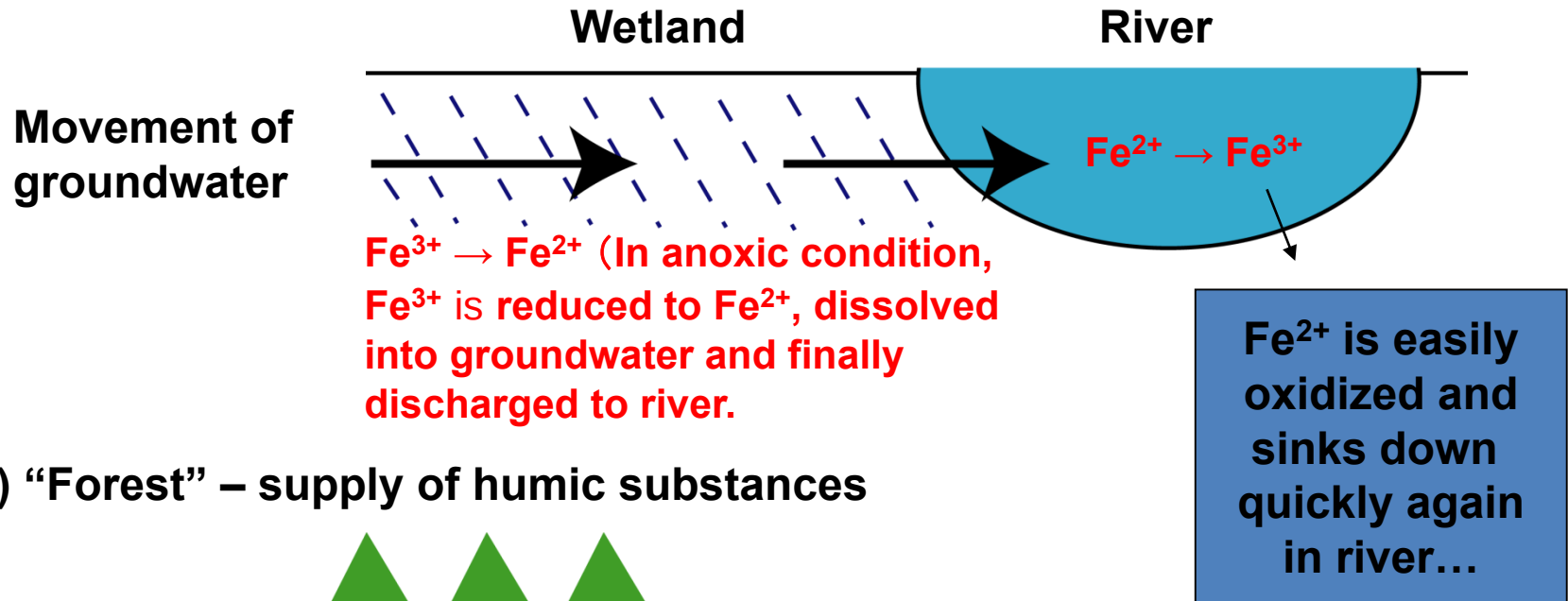
Oyashio

Kuril Islands

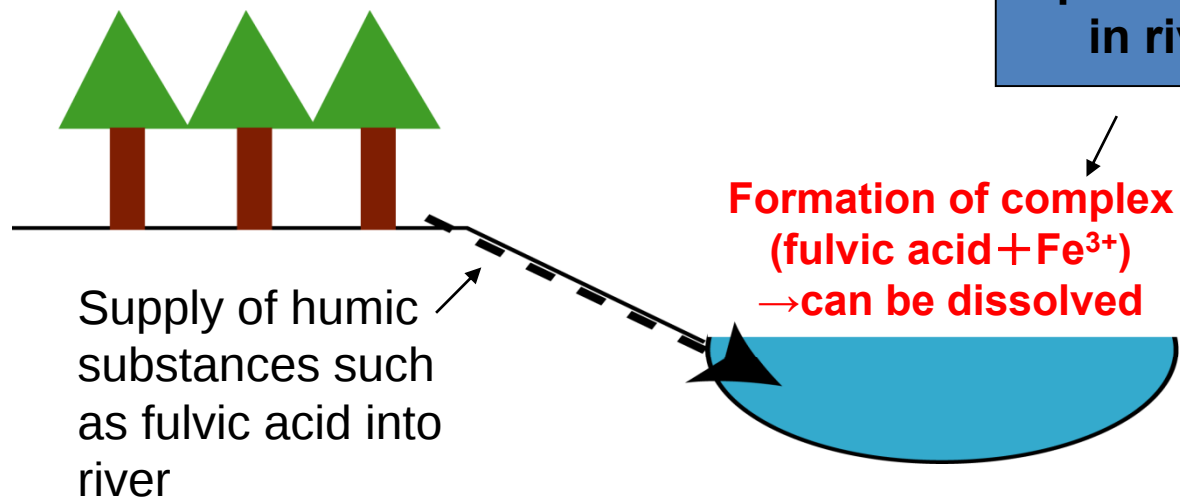
# Conditions to dissolve iron (Fe) into river (Amur)

In oxic environment, iron is  $\text{Fe}^{3+}$ . It cannot be dissolved in water.

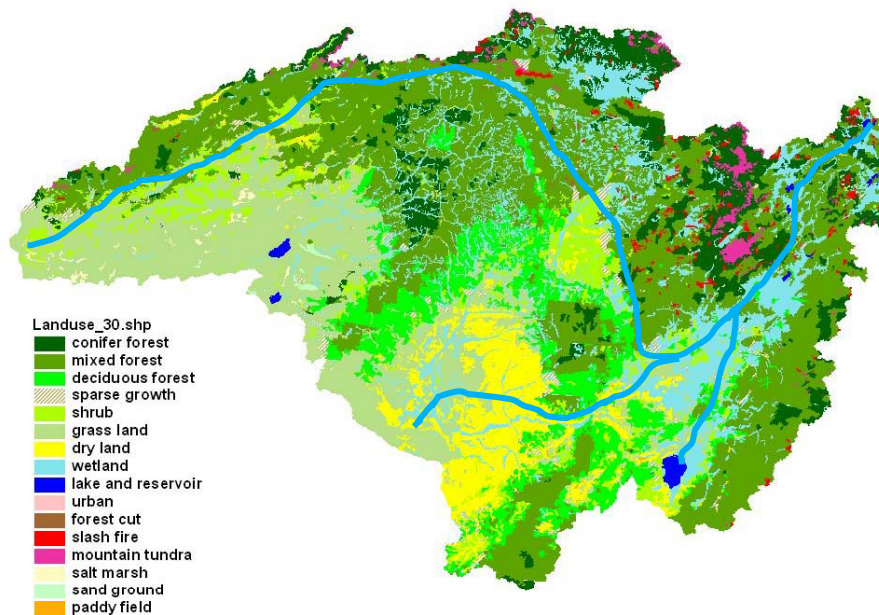
## (1) “Water” – environment such as Wetland



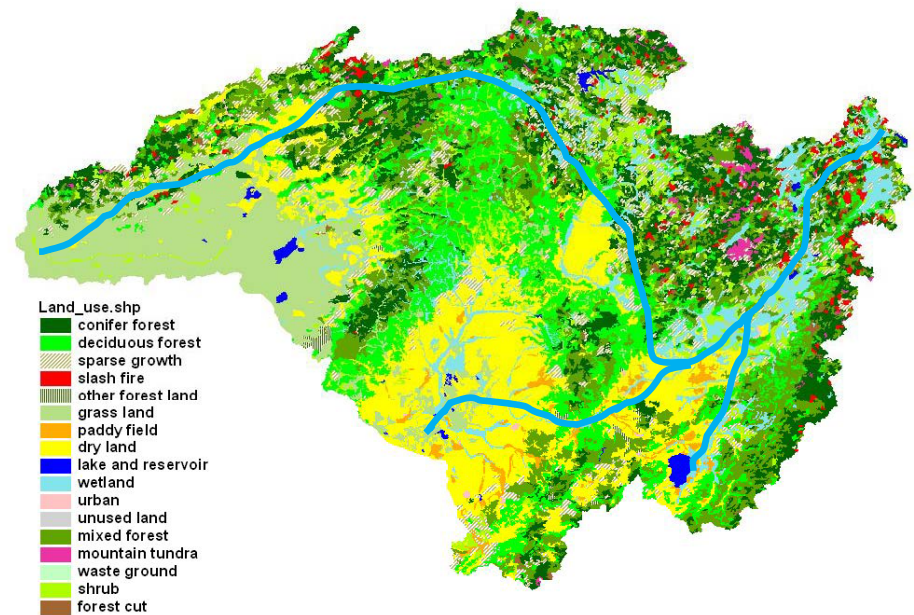
## (2) “Forest” – supply of humic substances



# Land cover/Land use changes in the Amur River basin between 1930s and 2000



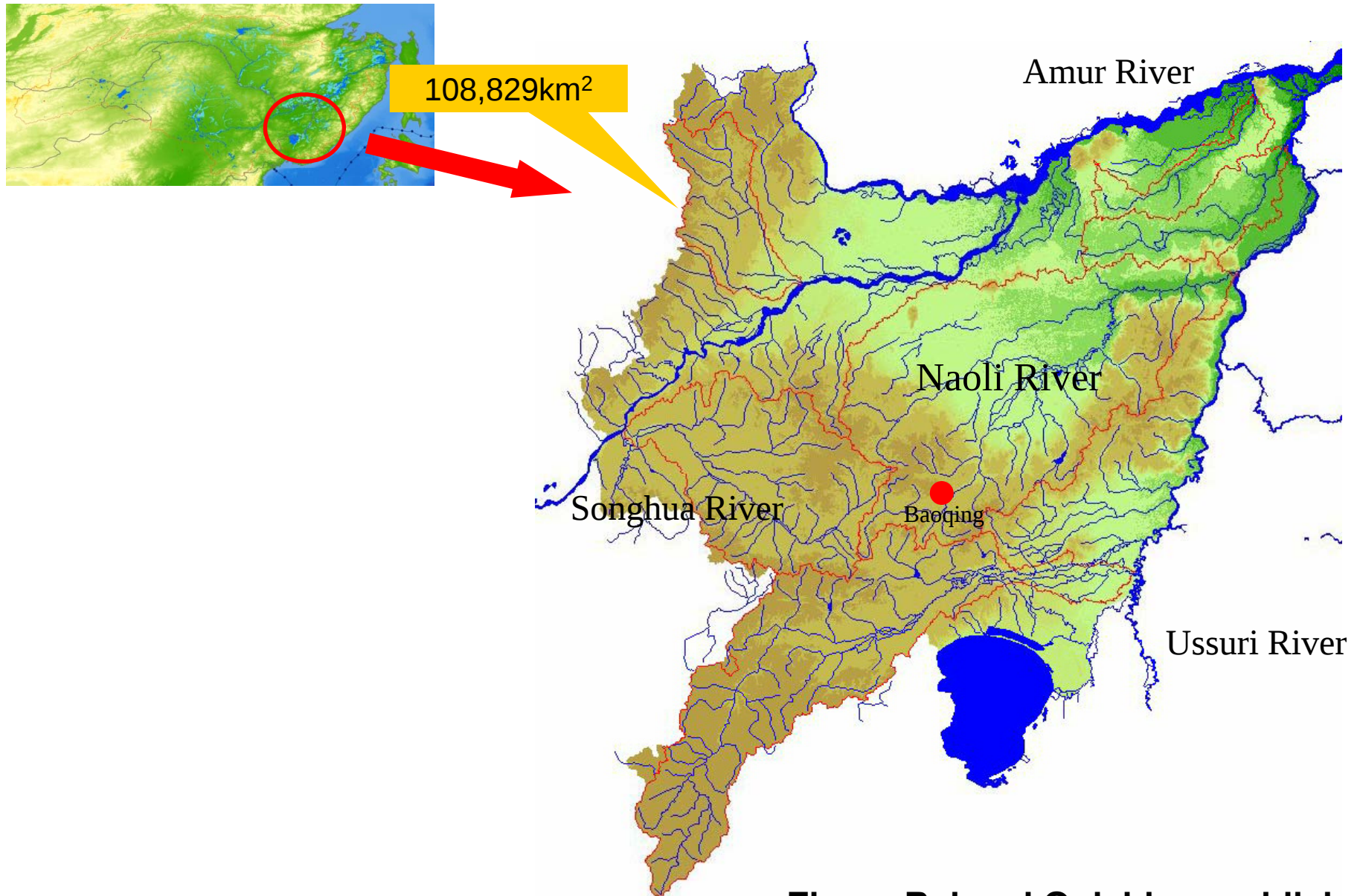
1930s



2000

Ermoshin and Ganzey (2008)

# Drastic wetland decrease in the Sanjiang plain



Zhang Bai and Onishi, unpublished

# Drastic wetland decrease in the Sanjiang plain

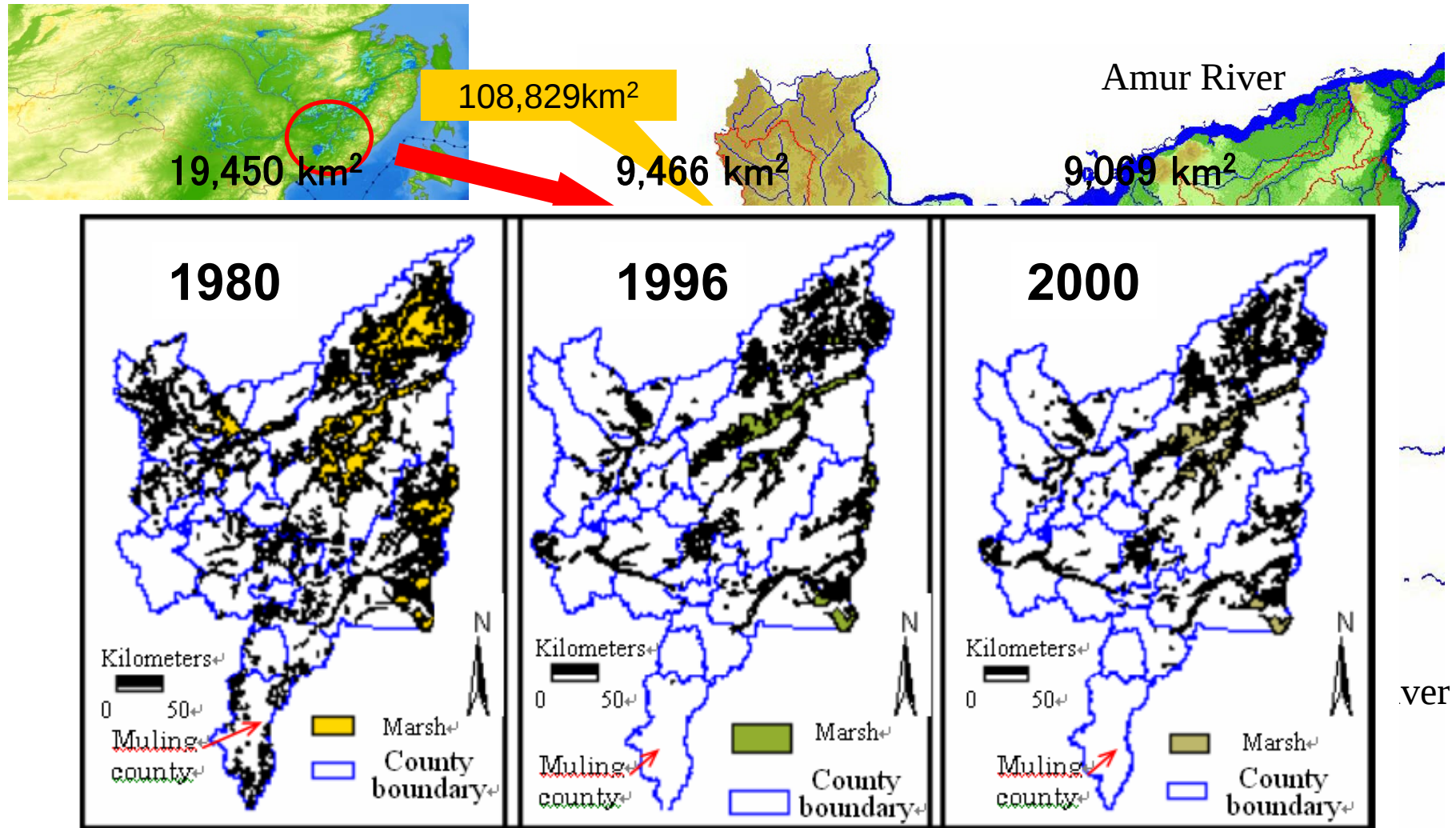
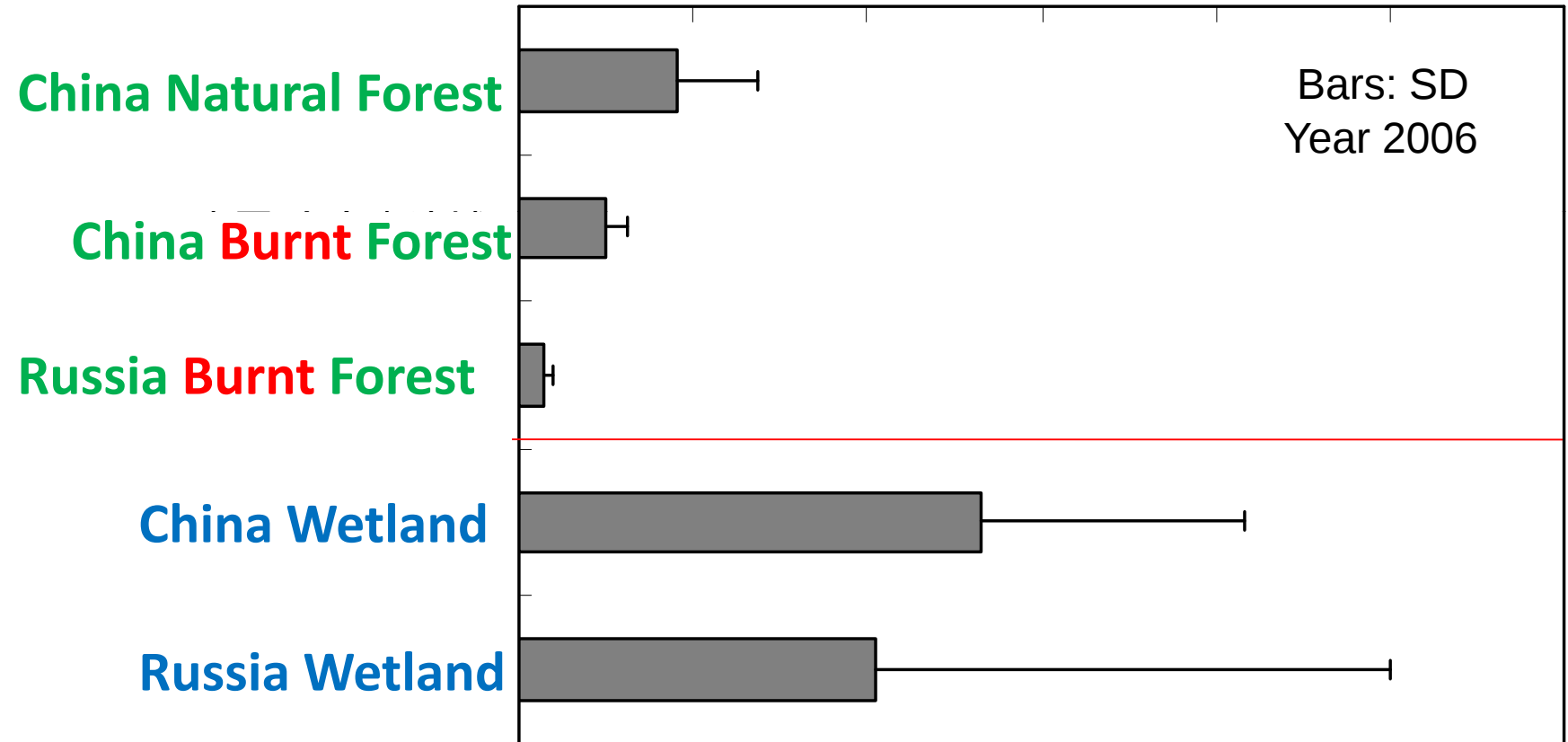


Figure 3. The marsh map in the Sanjiang Plain, 1980(a), 1996(b), 2000(c)

# Dissolved iron concentrations ( $\text{mg L}^{-1}$ ) measured at basins having various land-covers

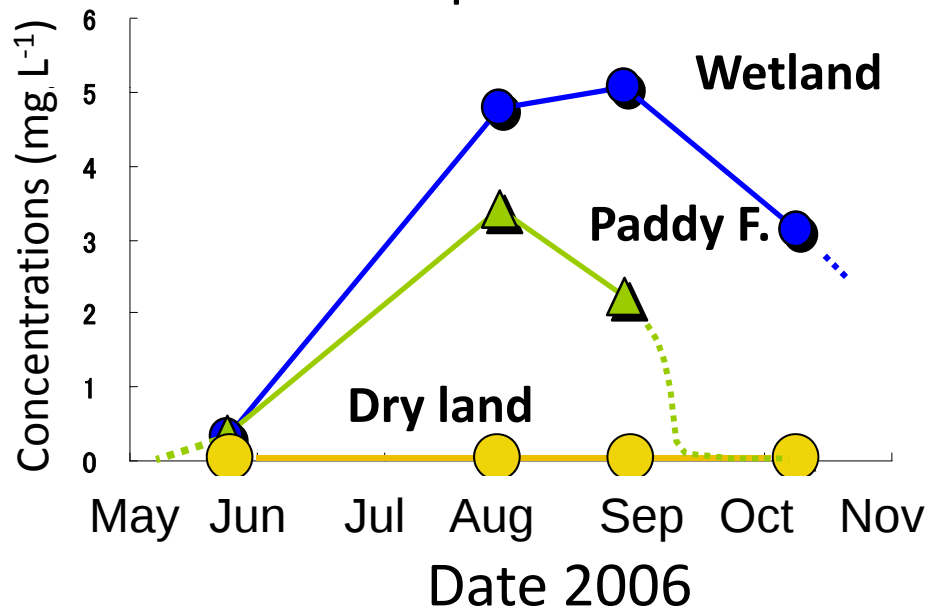
0.0 0.5 1.0 1.5 2.0 2.5 3.0



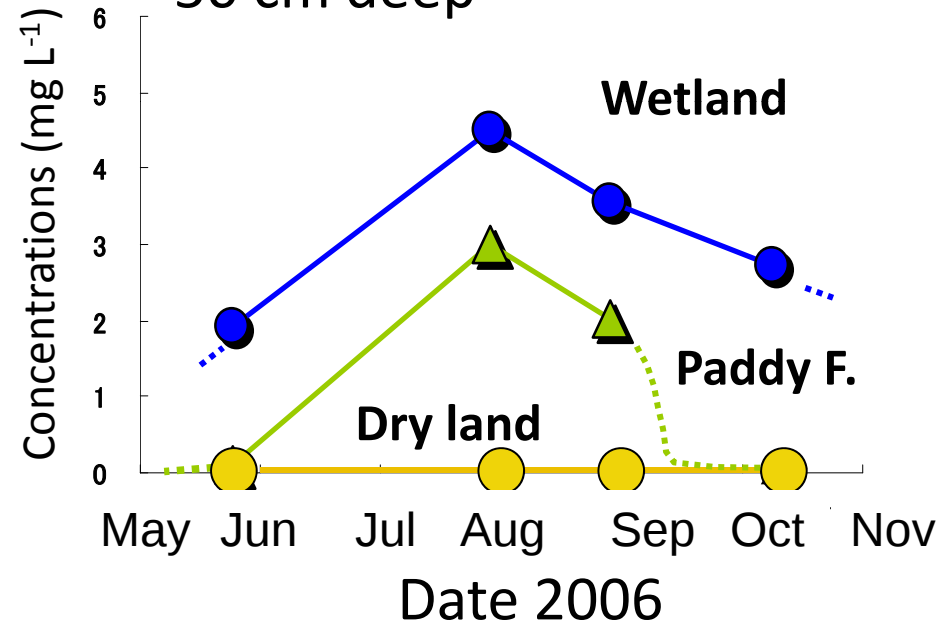
Shibata et al. (unpublished)

# Seasonal changes in dissolved iron concentrations in the interstitial soil water at various land-cover in the Sanjiang Plain 2006

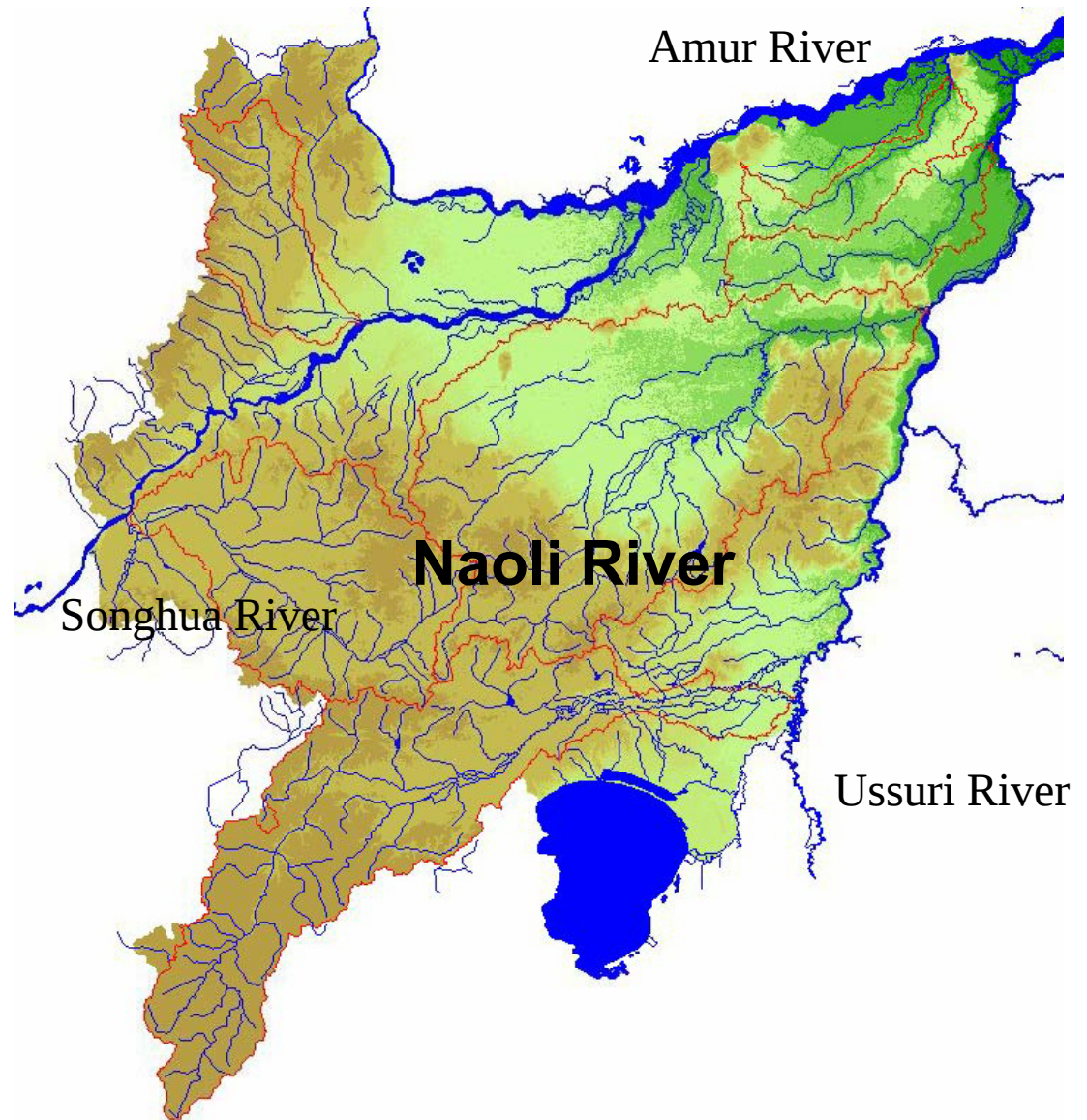
10 cm deep



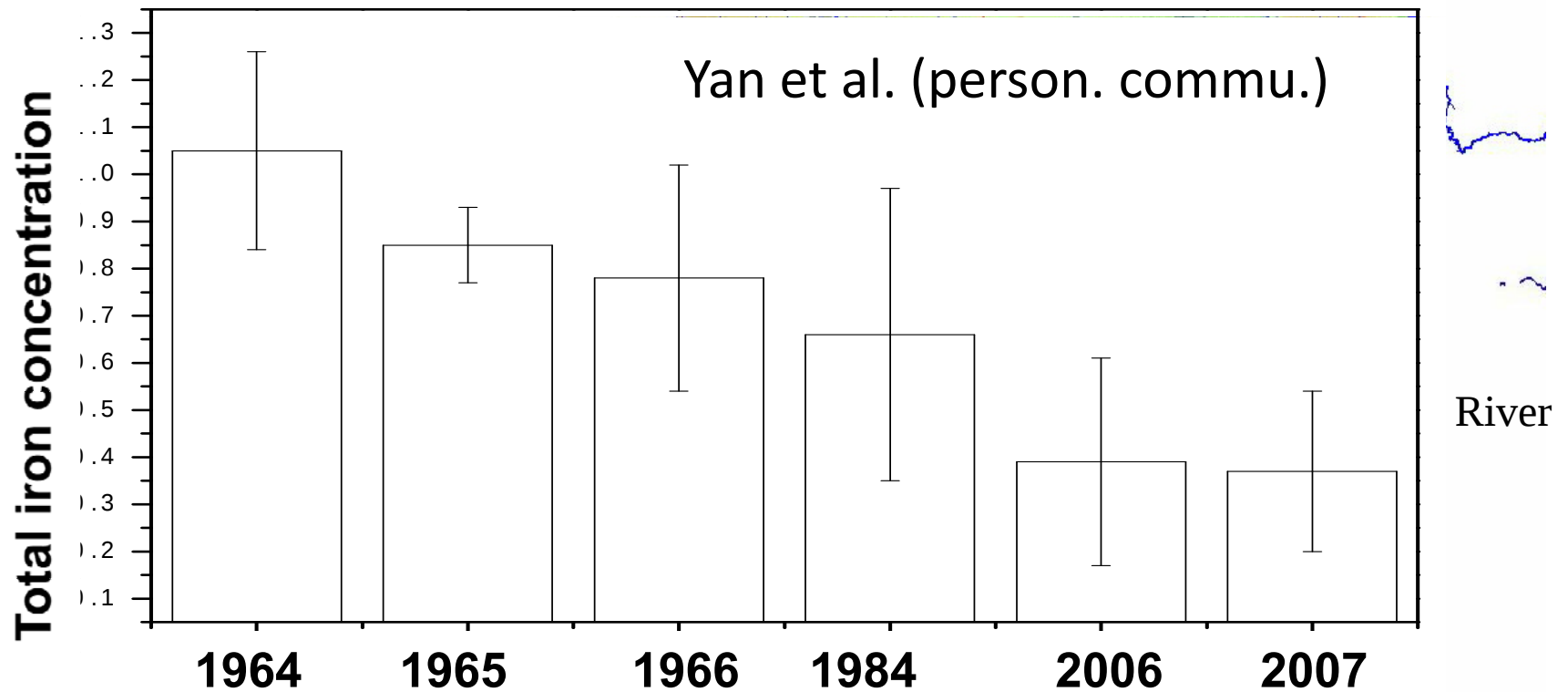
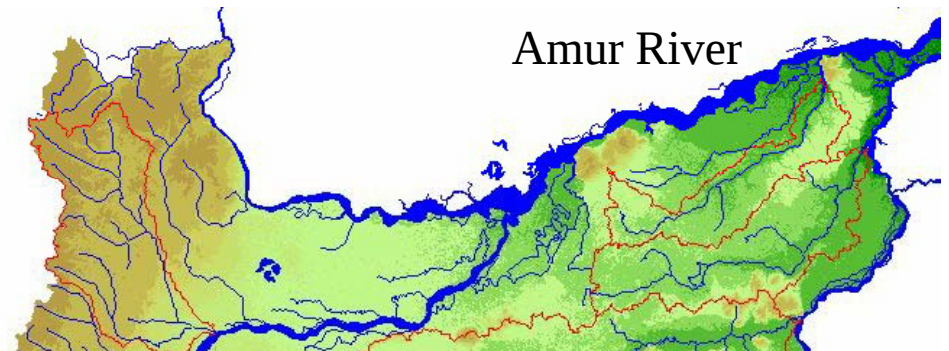
50 cm deep



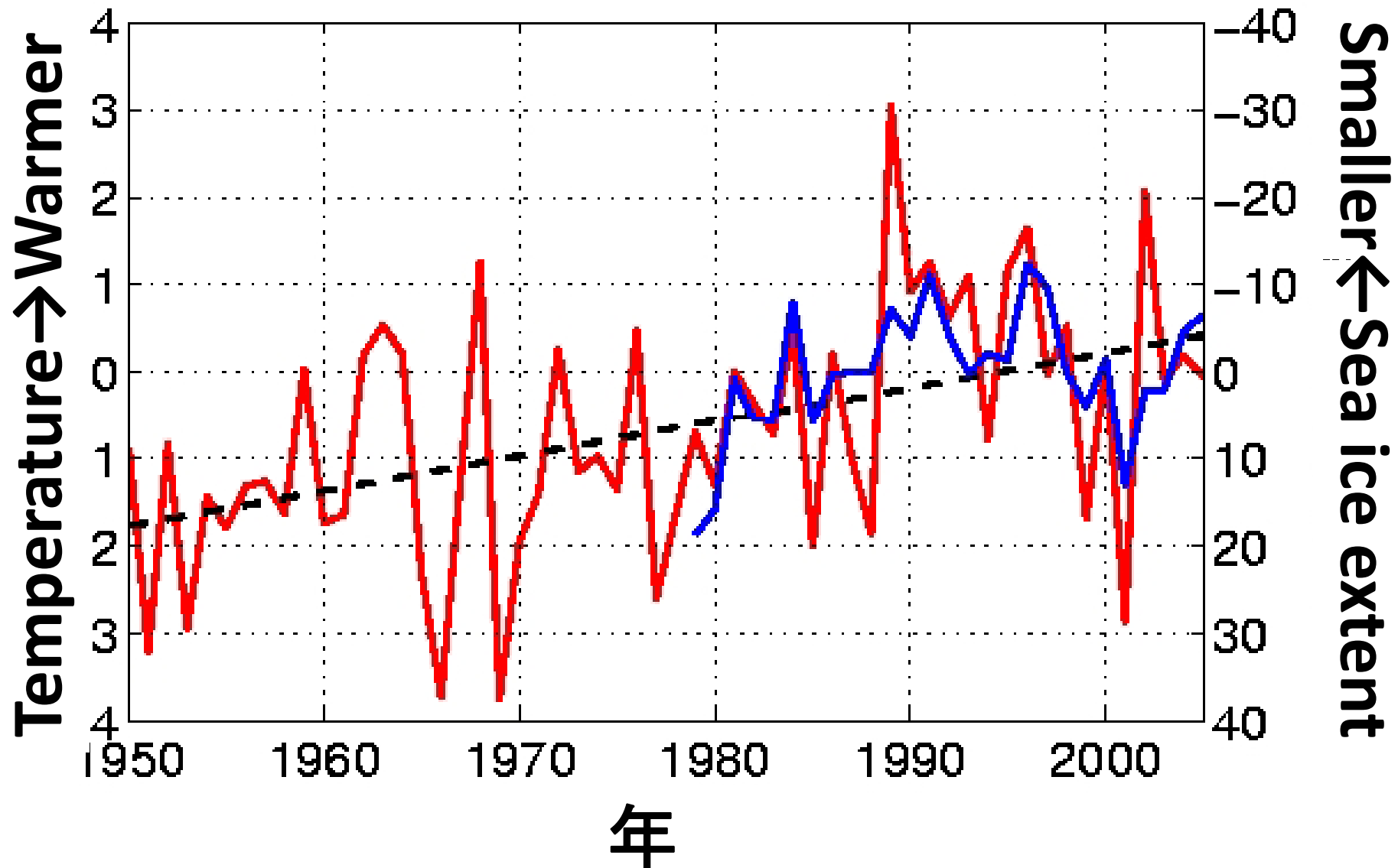
# Total iron conc. in Naoli River, Sanjiang plain, China ( $\text{mgL}^{-1}$ )

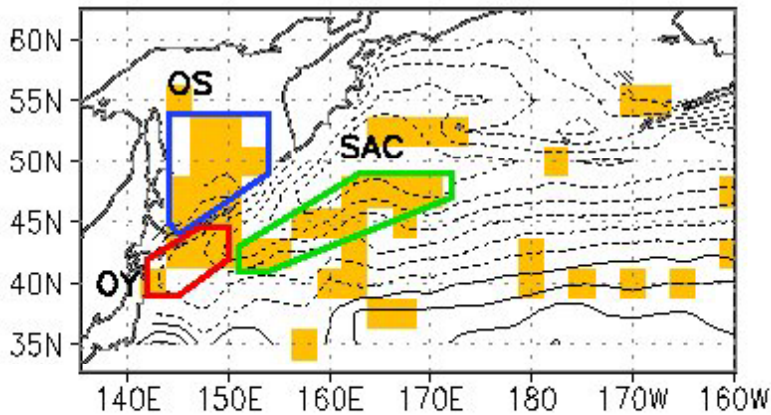


# Total iron conc. in Naoli River, Sanjiang plain, China ( $\text{mgL}^{-1}$ )

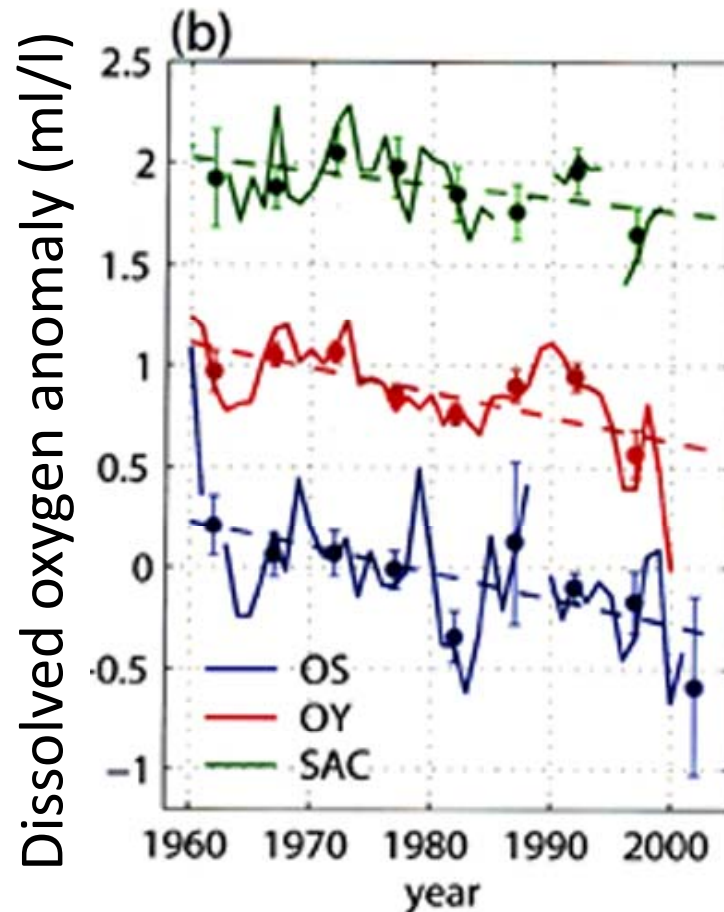
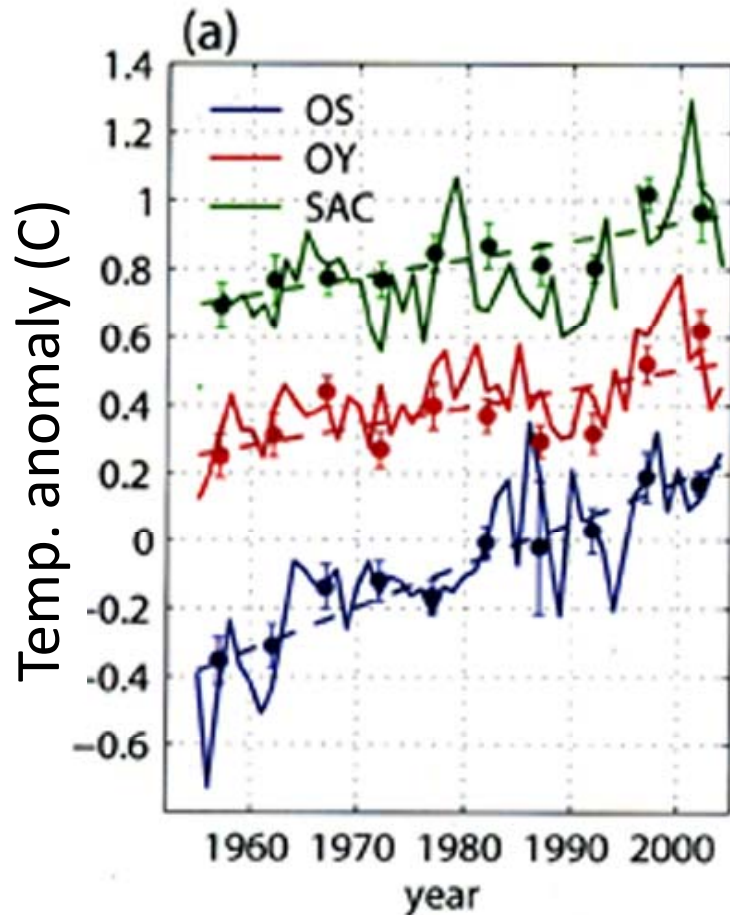


# Decreasing trend of the sea ice extent in the Sea of Okhotsk (Nakanowatari et al., 2007)





**Increasing NPIW temperature and decreasing dissolved oxygen in the NPIW  
(Nakanowatari et al., 2007)**

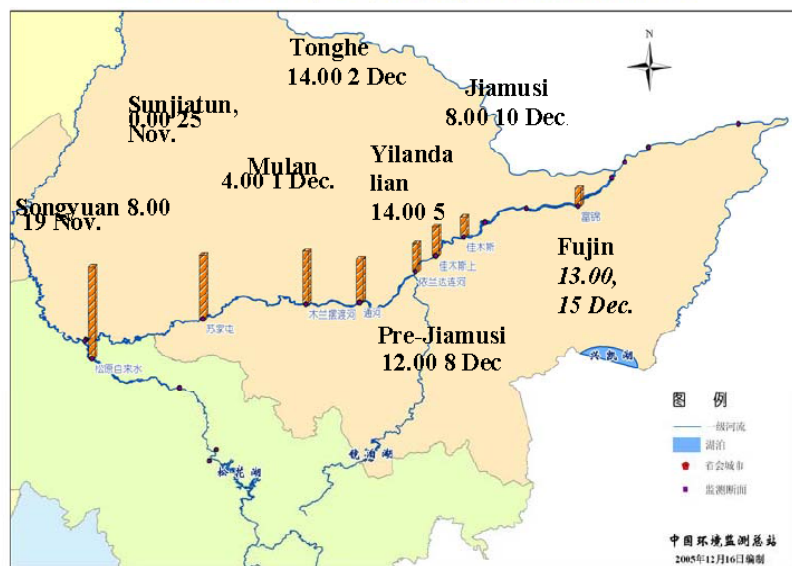




# United Nations Environment Programme

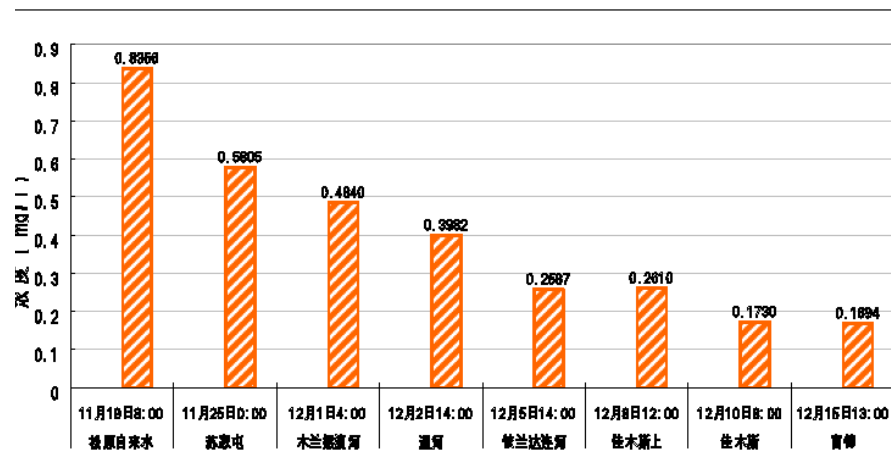
## The Songhua River Spill China, December 2005

松花江流域数据较齐全断面硝基苯最大浓度及出现时间



Source: SEPA, December 2005

Peak Nitrobenzene concentrations measured in the Songhua River.



|                |                |               |                |                |                |                |                 |
|----------------|----------------|---------------|----------------|----------------|----------------|----------------|-----------------|
| Songyuan       | Sunjiatun      | Mulan         | Tonghe         | Yilandalian    | Pre-Jiamusi    | Jiamusi        | Fujin           |
| 8.00<br>19 Nov | 0.00<br>25 Nov | 4.00<br>1 Dec | 14.00<br>2 Dec | 14.00<br>5 Dec | 12.00<br>8 Dec | 12.00<br>8 Dec | 13.00<br>15 Dec |

Source: SEPA, December 2005

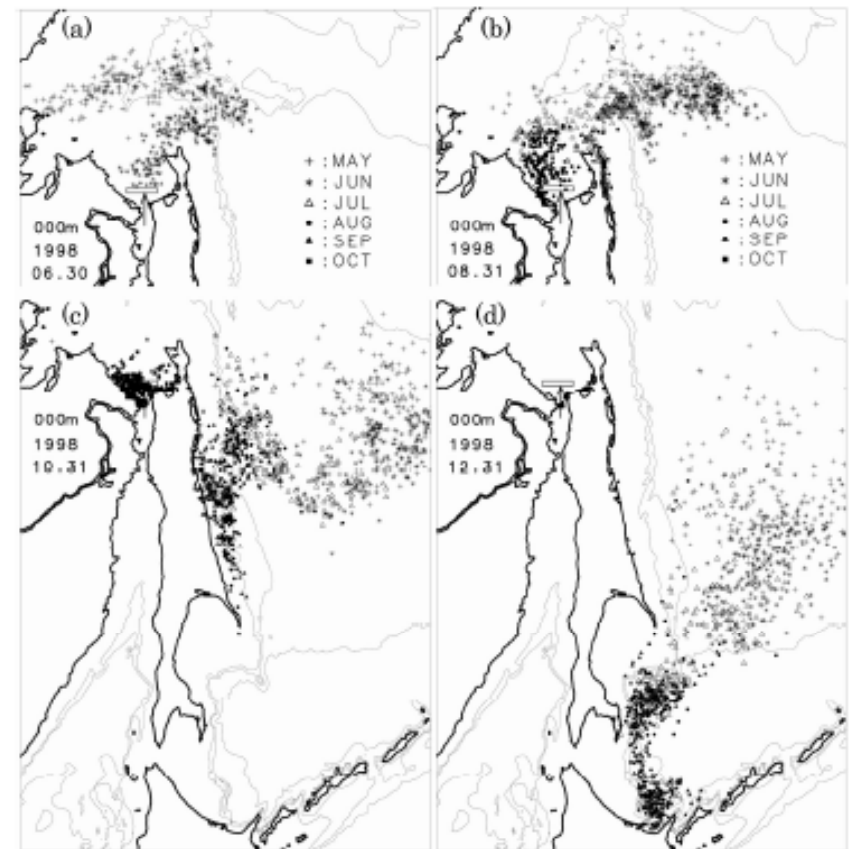
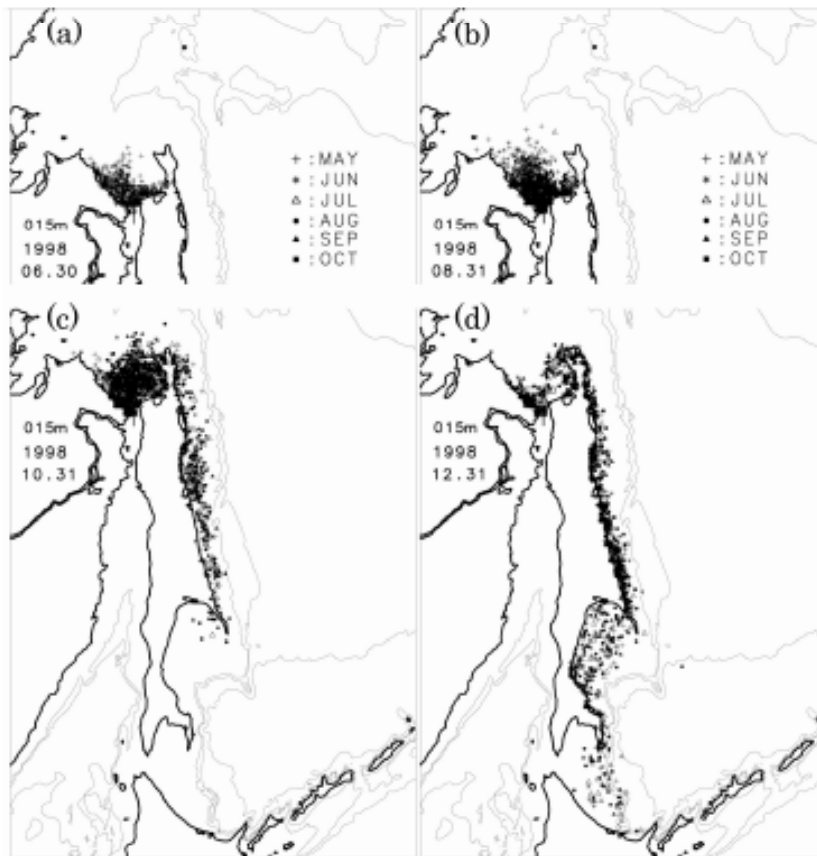
UNEP (2006)

# PARTICLE TRACKING EXPERIMENT ON A MODEL OF THE OKHOTSK SEA: SPREADING OF THE AMUR ORIGIN WATER

OHSHIMA KAY I.<sup>1</sup> AND SHIMIZU D.<sup>1</sup>

15 m deep

Surface



Ohshima and Shimizu (2007)

***“Giant” Fish-Breeding Forest***  
( Guiding Principle or Concept )

Initiatives of IOs (UNEP, UNDP, GEF) or NGOs  
bilateral economic assistance (ODA)

***North-Eastern Asia GFBF Partnership***

Interlinkage and coordination of the  
international legal regimes

Law of the conservation of nature,  
species and biodiversity

Law of the  
international  
watercourses

Law of the marine  
living resources  
and diversity

Grassroots activities of NGOs

**Conclusion of new environmental  
agreements**

Bilateral agreements or  
joint declaration, communiqué

Agreements among neighboring  
provinces or local governments

National legal system or policy  
(coordination between the laws and agencies)

Local government policy  
(inc. coordination between national and local policy)

Commitment or participation of the  
local or indigenous peoples

# HELCOM

## Helsinki Commission

All the coastal states around the Baltic Sea and EU are working together to protect the Baltic marine environment from all sources of pollution, as spelled out in the “Convention on Protection of the Marine Environment of The Baltic Sea Area” (Helsinki Convention).

HELCOM has overall responsibility for the implementation of the Helsinki Convention.



### STRUCTURE OF HELCOM



# オホーツク海の 未来可能性のために

Environmental Conservation of the Sea of Okhotsk: Cooperation between Japan, China and Russia  
オホーツク海の環境保全に向けた日中露の取り組みにむけて

11/7 SAT ★ 8 SUN

北海道大学学術交流会館 第一会議室  
〒060-0808 札幌市北区北8条5丁目 TEL: 011-706-2141 (会費無料)

| プログラム | 日本語 中国語 ロシア語 (同時通訳あり)

11月7日(土) 9:15 ~ 18:00

- セッション1 アムール川流域とオホーツク海の自然
- セッション2 アムール川流域の土地利用変化とその影響
- セッション3 アムール川流域の土地利用変化の背景

11月8日(日) 8:30 ~ 19:00

- セッション4 アムール川保全のための日中の取り組み
- セッション5 オホーツク海保全のための日露の取り組み
- セッション6 黒炭工・林産工保全のための日中協力
- セッション7 多国間の協働によるオホーツク海の保全
- 総合討論 学術ネットワークの確立にむけて

| 主催 | 北海道大学地球科学研究所 オホーツク海研究センター  
北海道大学スラブ研究センター  
総合地球環境学研究所  
AMRI 北見工業大学未来エネルギー研究センター  
国土交通省北海道開発局  
国領科学技術センター  
北海道大学「地球可能性の未来」国際戦略本部

| 共催 | 文部科学省

参加  
無料  
事前申込  
不要

| お問い合わせ先 |

北海道大学地球科学研究所  
オホーツク海研究センターシンポジウム事務局

FAX: 011-706-7142  
E-mail: ao-sym.posum@glwtem.hokudai.ac.jp  
<http://www.chikyuu.ac.jp/AMORE/2009symposium.html>

## Amur Okhotsk Consortium

Regular meeting: 1 time / 2 years  
Network for academic researchers  
Information/data exchanges  
Japan, China, Russia (Mongolia)

Tentatively based on  
Pan-Okhotsk Research Center,  
Institute of Low Temp. Science,  
Hokkaido University

## Kick-off Symposium November 7-8 at Hokkaido University

# Conclusions

1. Amur River transports a total of  $10^{11}$  g/yr dissolved iron to the Sea of Okhotsk/Oyashio region, and it contributes to the primary production in these oceans.
2. The supply of dissolved iron to the Sea of Okhotsk/Oyashio region is likely to decrease by excessive land use changes and decreasing trend of the sea-ice.
3. Pollutions of the Amur River is the world-wide concern and it is highly probable to affect the Sea of Okhotsk unless any counter-measures are conducted.
4. We propose to establish a multilateral relationship among researchers ***“Amur-Okhotsk Consortium”*** to discuss our future sustainability in the Sea of Okhotsk.