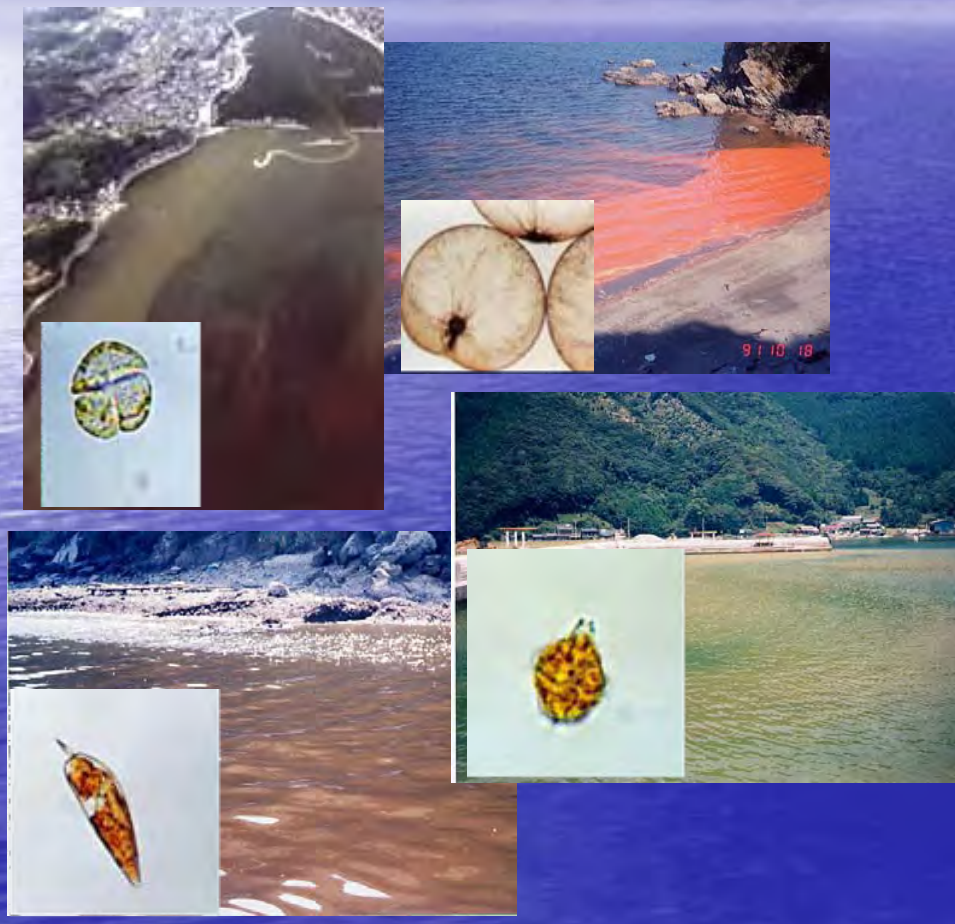
Status and perspective remote sensing data use to reduce the damage caused by red tides (Harmful Algal Bloom) in Japan

Joji Ishizaka[1], Kazuyoshi Miyamura[2], Ken Furuya[3] and Shigeru Itakura[4]

1 Hydrospheric Atmospheric Research Center, Nagoya University
2 Oita Prefectural Agriculture, Forestry and Fisheries Research Center
3 Graduate School of Agricultural and Life Science, University of Tokyo
4 National Research Institute of Fisheries and Environment of Inland Sea

Damage to Aquaculture



Red tide

Damage

Survey to 27 Local Fisheries Experimental Stations (2009)

- Red tide is problem for most of the regions.
- Most of the regions have monitoring system, but less money – need efficient monitoring system
- Few people used but high expectation
- Need more information (training, manuals, software,,)
- Technical problems – some may be able to solve but some not.
  - Accuracy (Case II), Specific group identification, Subsurface population
  - High resolution, High frequency

Use of High Resolution Satellite

(MSS, TM, AVNIR,,,)

- Suitable for detail spatial structure

Use of High Resolution Satellite

(MSS, TM, AVNIR,,,)

- Suitable for detail spatial structure

- Low temporal resolution: not suitable for quick change of coastal environment
- Broad spectral band: difficult for quantitative analysis

Use of Medium Resolution Satellite

(OCTS, SeaWiFS, MODIS, GLI,,,)

- 1km resolution: OK for large scale red tide
- Possible for time series analysis (Nearly 10 years with several days of interval)

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- 1km resolution: OK for large scale red tide
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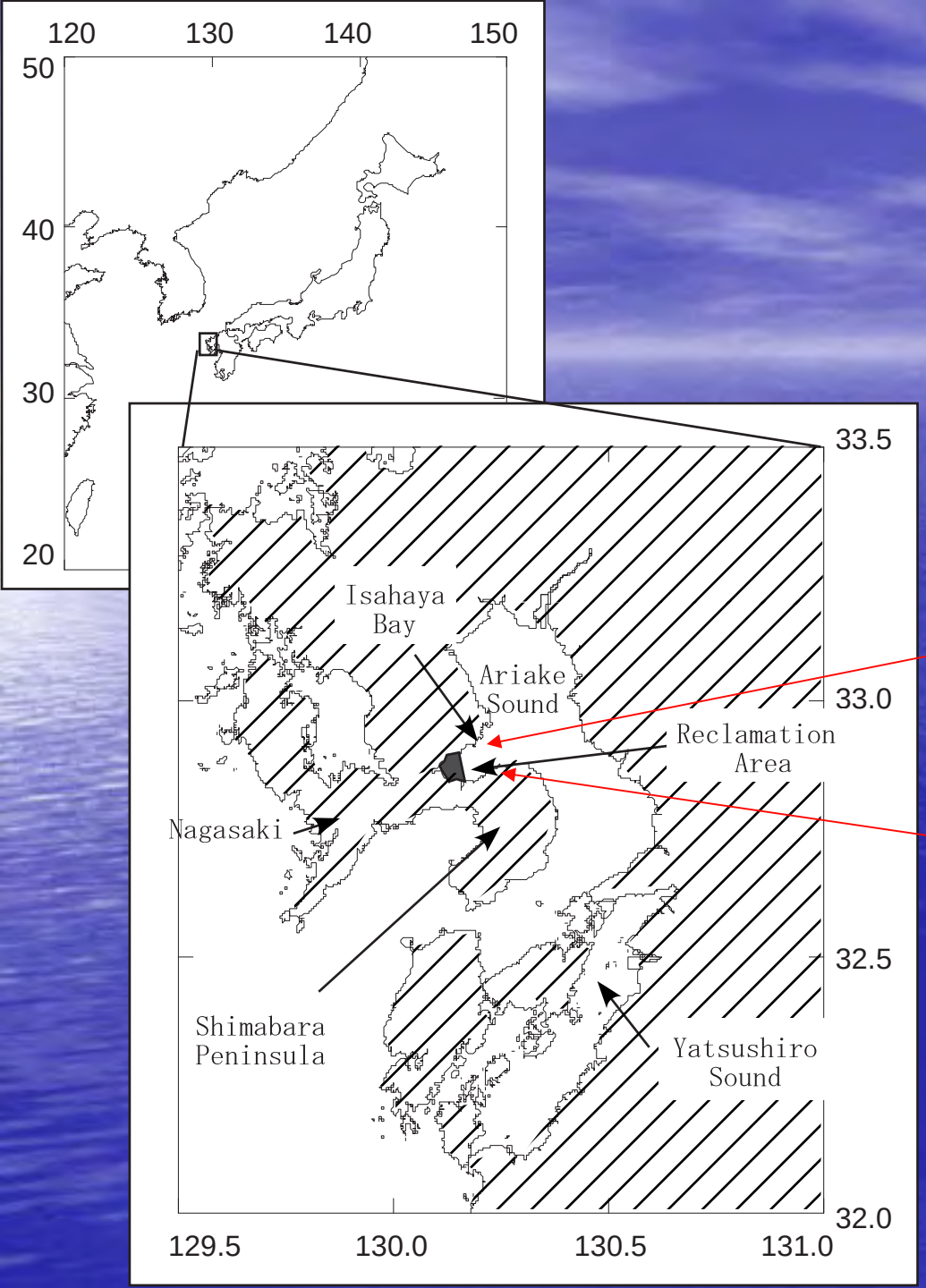
Location of the Ariake Sound



Isahaya Bay

Reclamation Area 1996～

諫早湾干拓

Red Tide Number in Ariake Sound（Isobe, 2000）

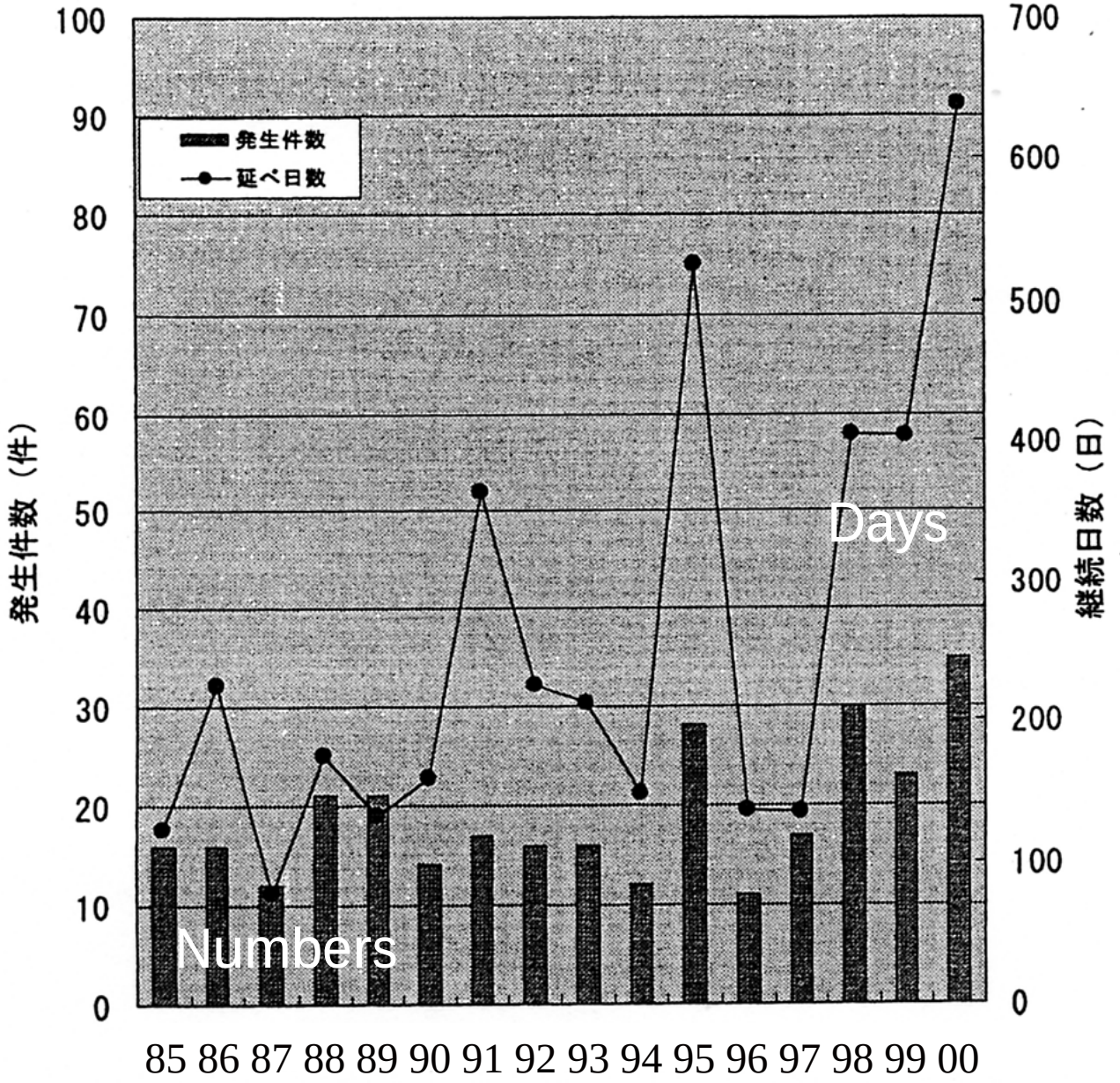


図７　有明海における赤潮発生状況の経年変化[2)]

000 SeaWiFSカレンダー

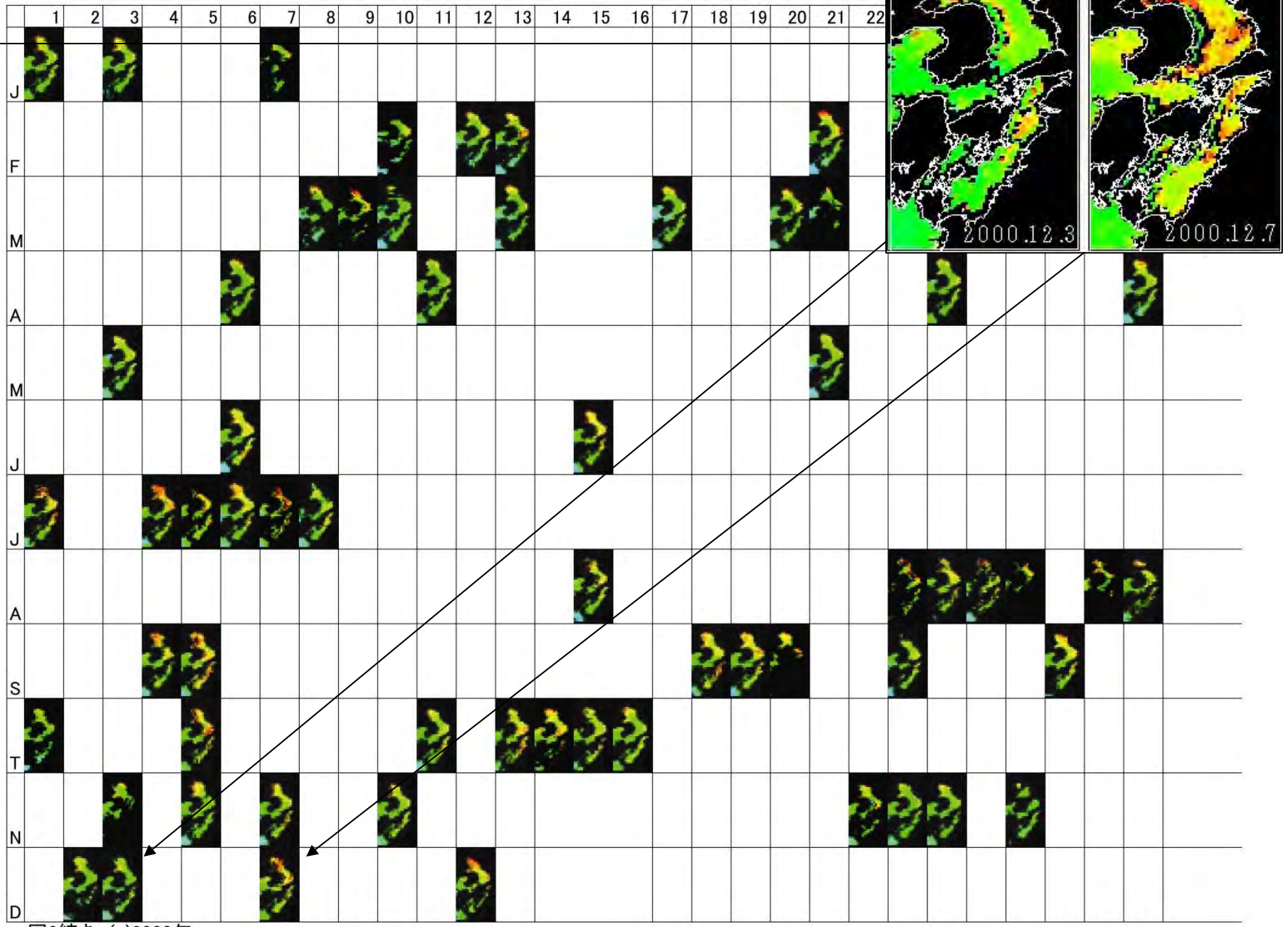
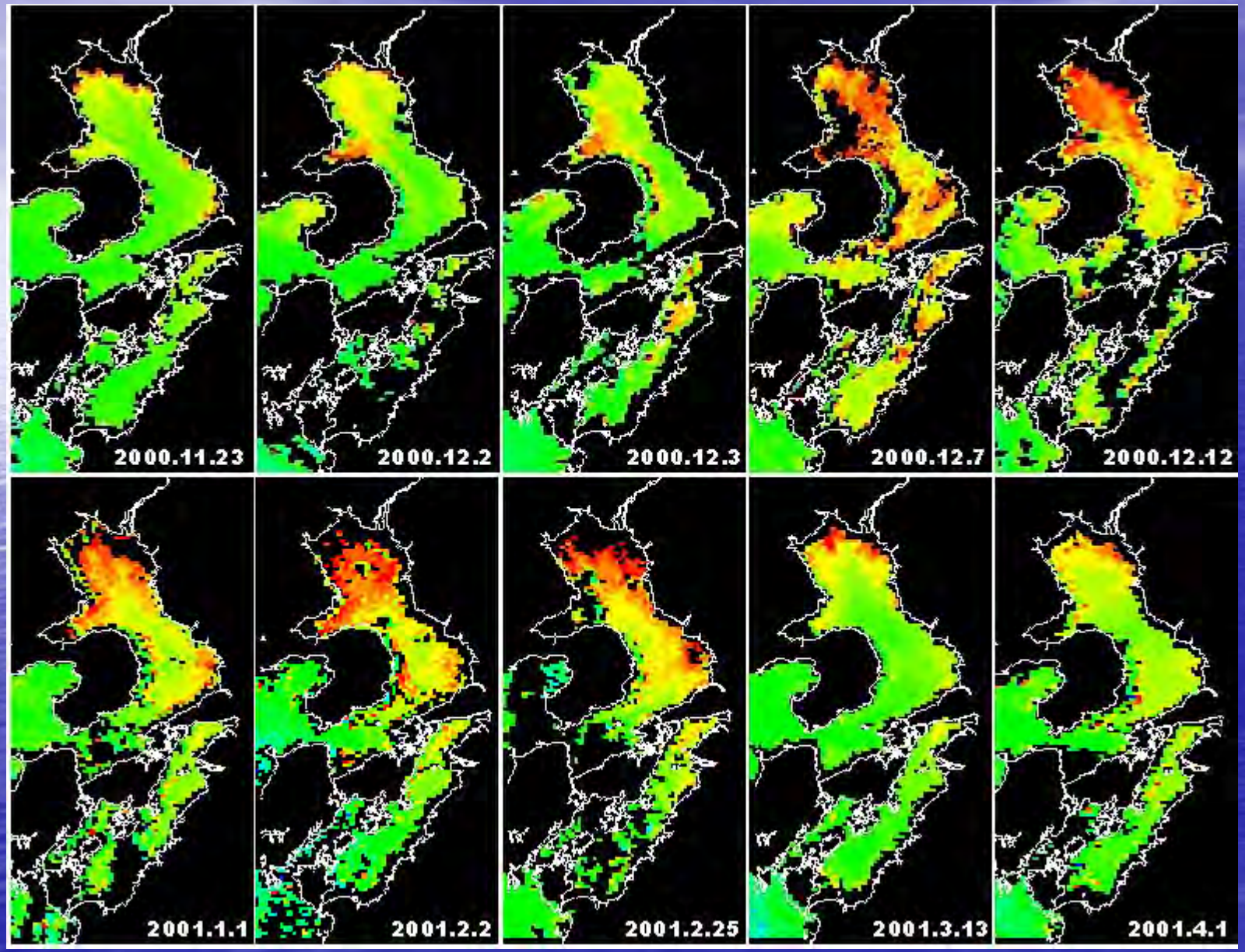
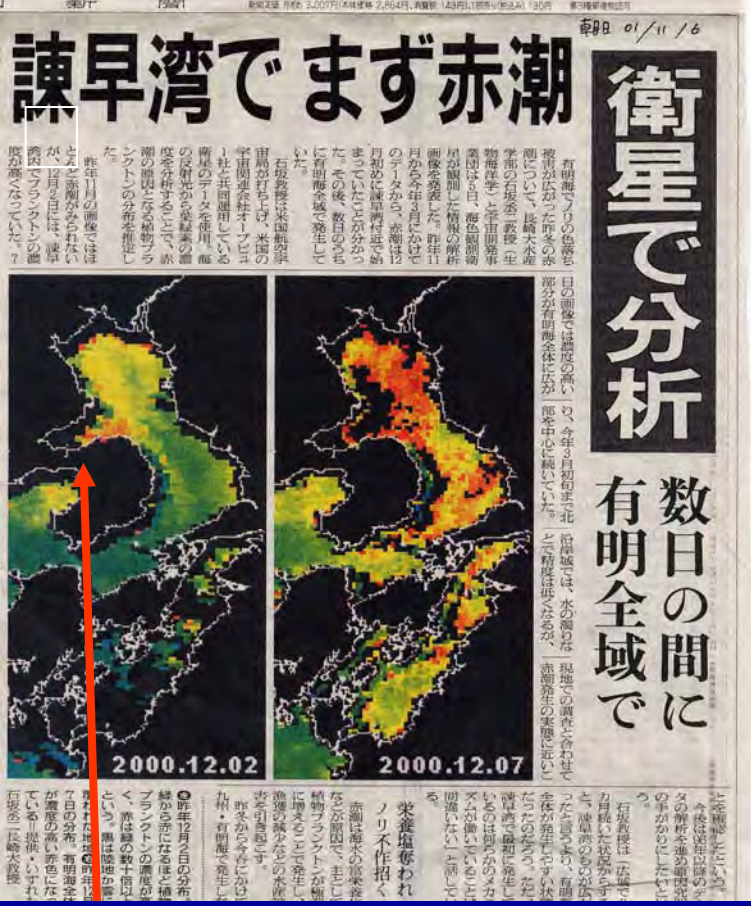


図2続き （c)2000年

SeaWiFS (2000.11.23-2001.4.1)



Comparison of High Satellite Chl-a to Red Tide Report


諫早湾でまず赤潮

衛星で分析

数日の間に有明全域で

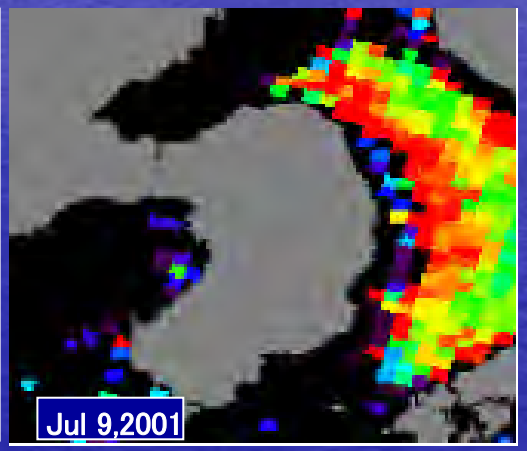
2000.12.02

2000.12.07

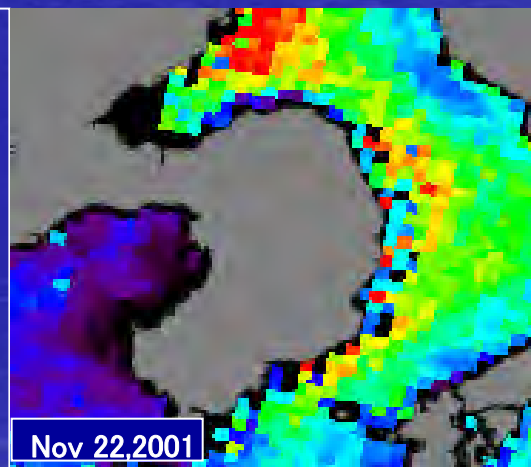
Red Tide in Ariake Bay: Starting from Reclamation Area?

Ishizaka et al.
(J. Oceanogr. 2006)

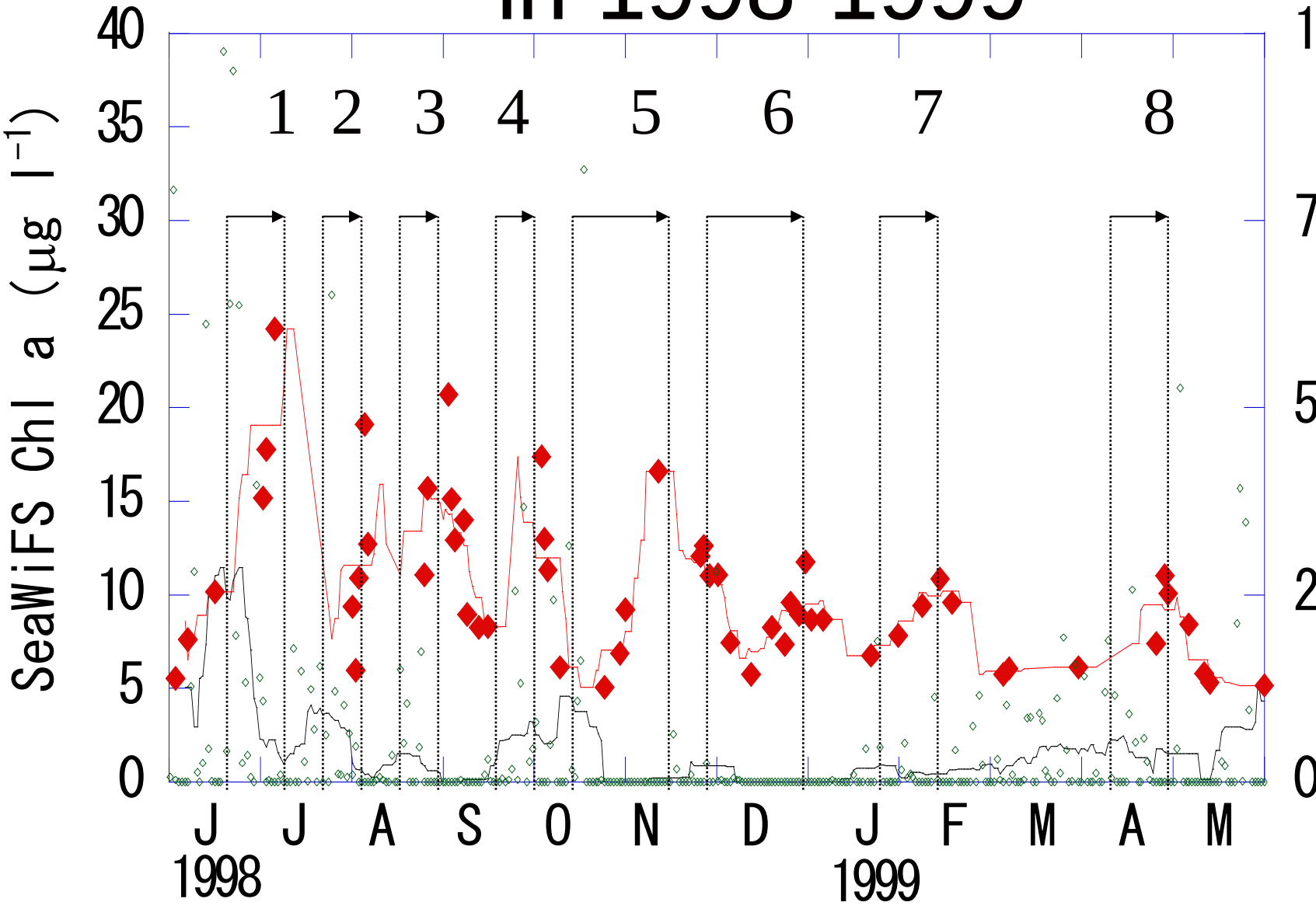
July 8-13, 2001



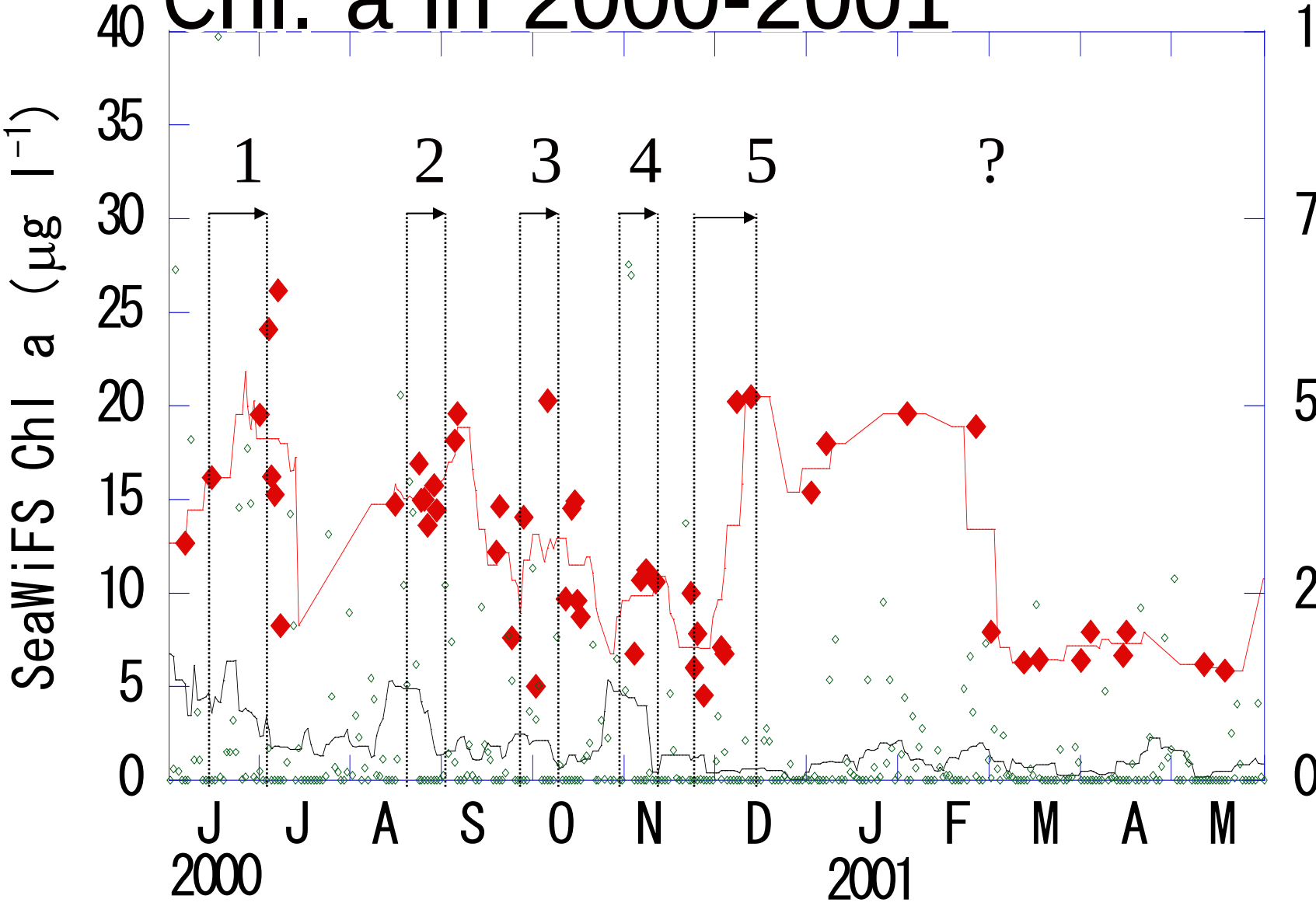
Nov. 9-Dec. 6, 2001



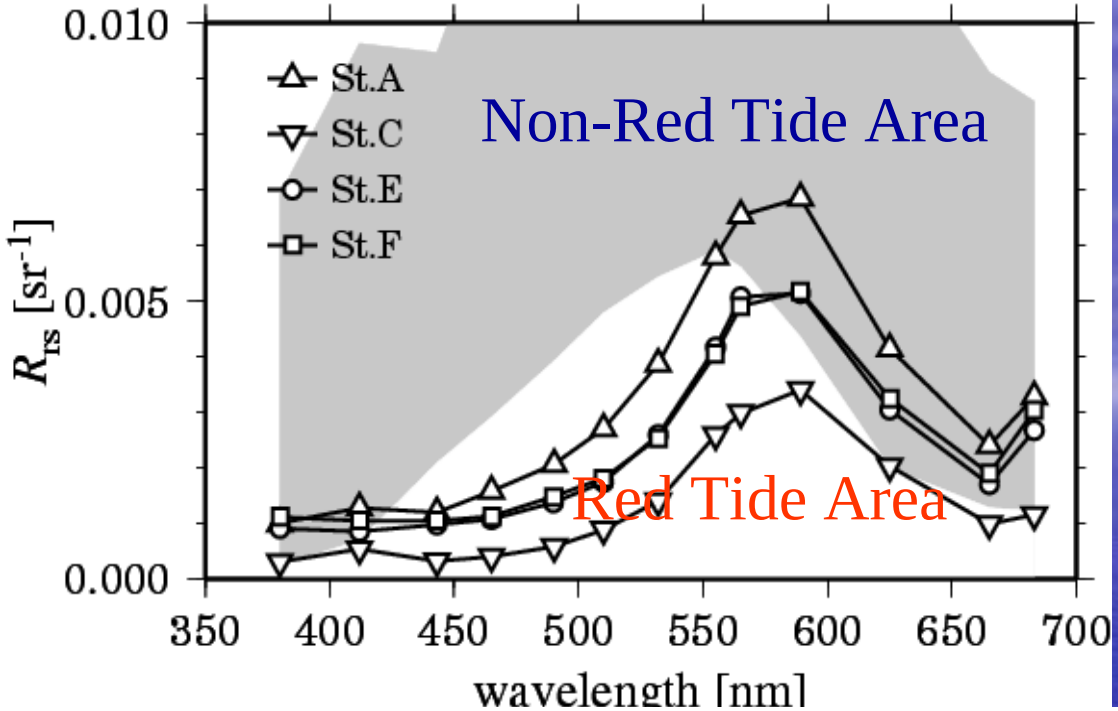
Precipitation and SeaWiFS Chl in 1998-1999

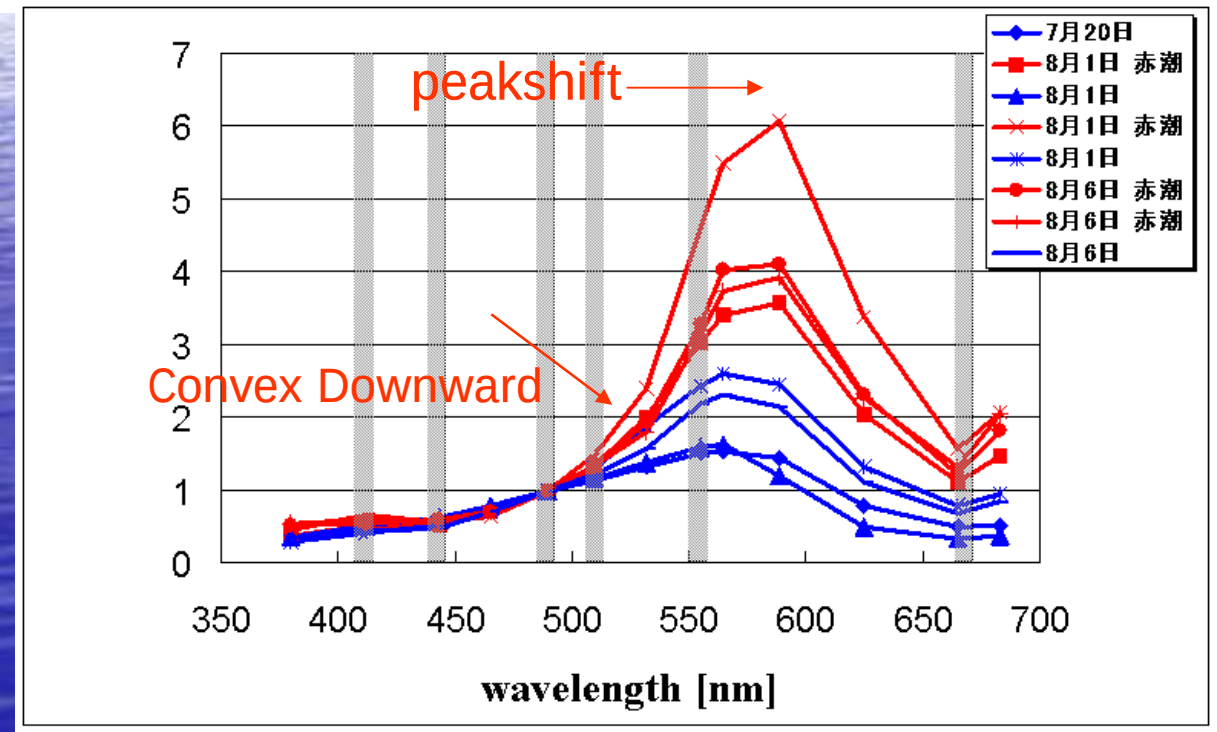


Precipitation and SeaWiFS Chl. a in 2000-2001



In situ Rrs Spectra around Red Tide of Ariake Bay

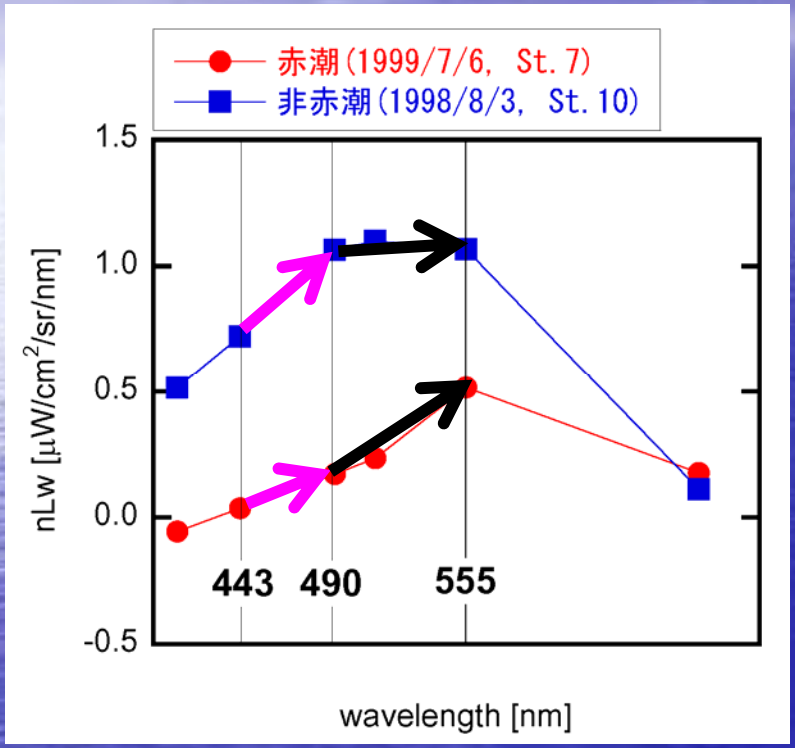


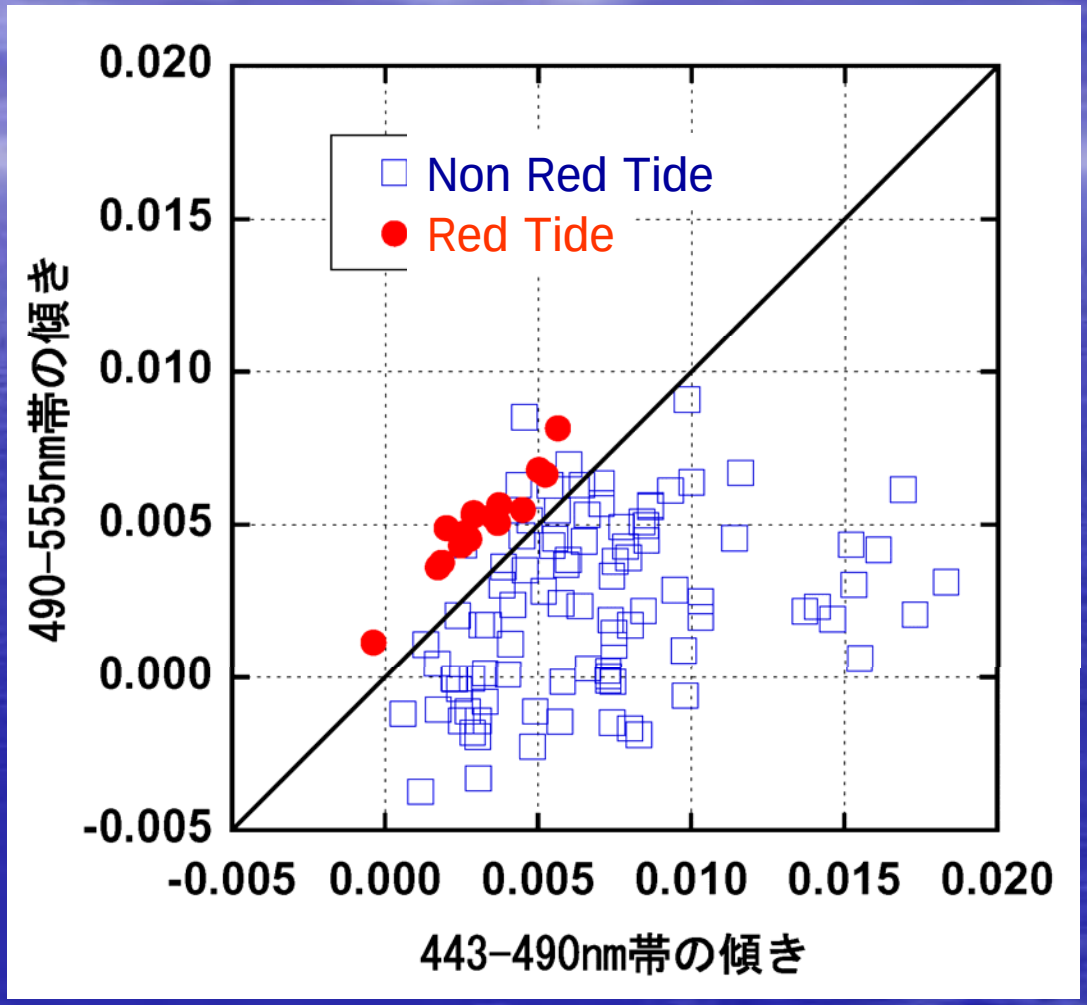


Normalized Rrs Spectra

(Sasaki et al., JO-2008)

Satellite Measurement of Red Tide SeaWiF nLw Spetra in Seto Inland Sea

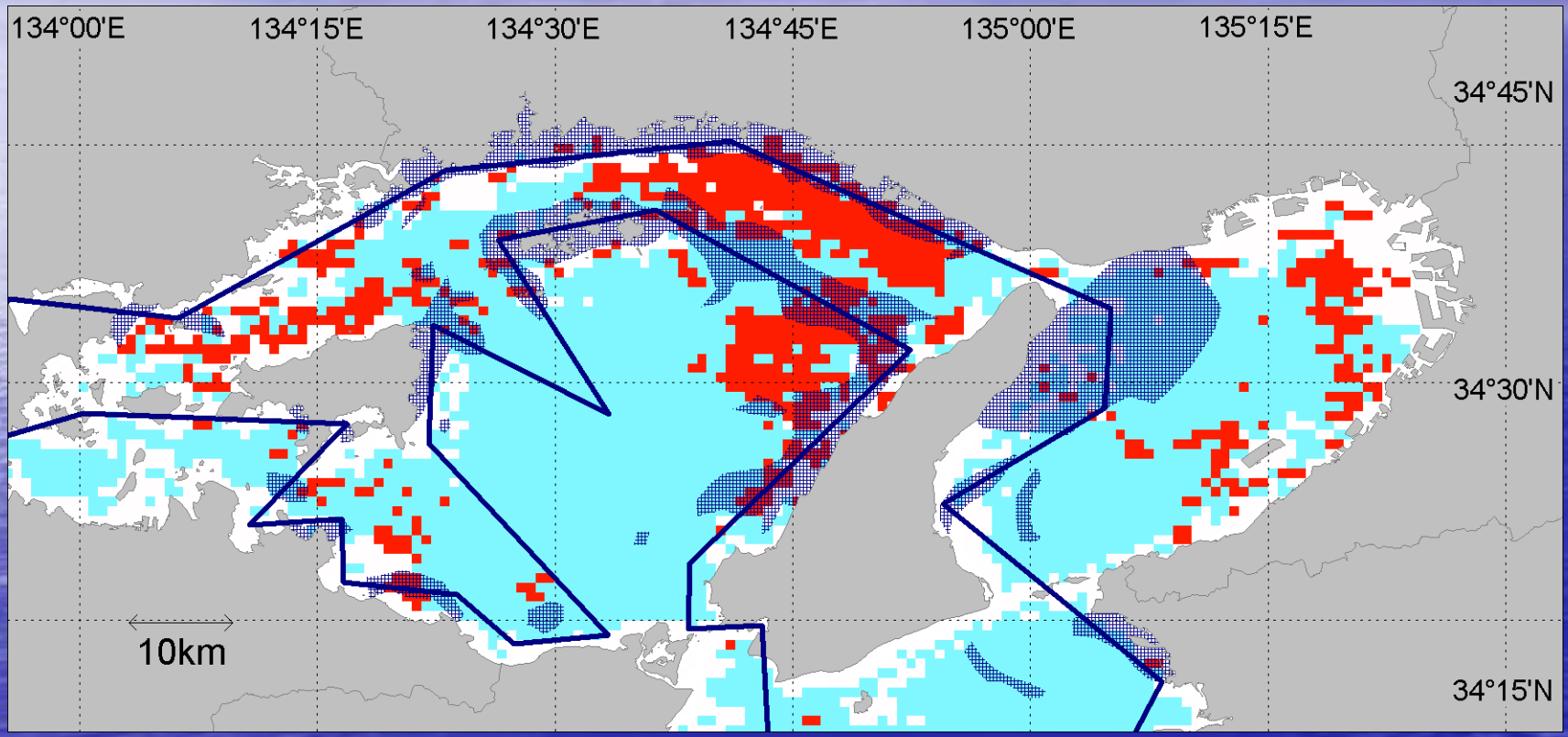




✓ Slope 490～555nm > Slope 443～490nm

（Takahashi et al., JO-09）

Comparison of SeaWiFS based detection and Airplane based eye observation on 2002/7/23 (Harima-Nada, Seto Inland Sea)

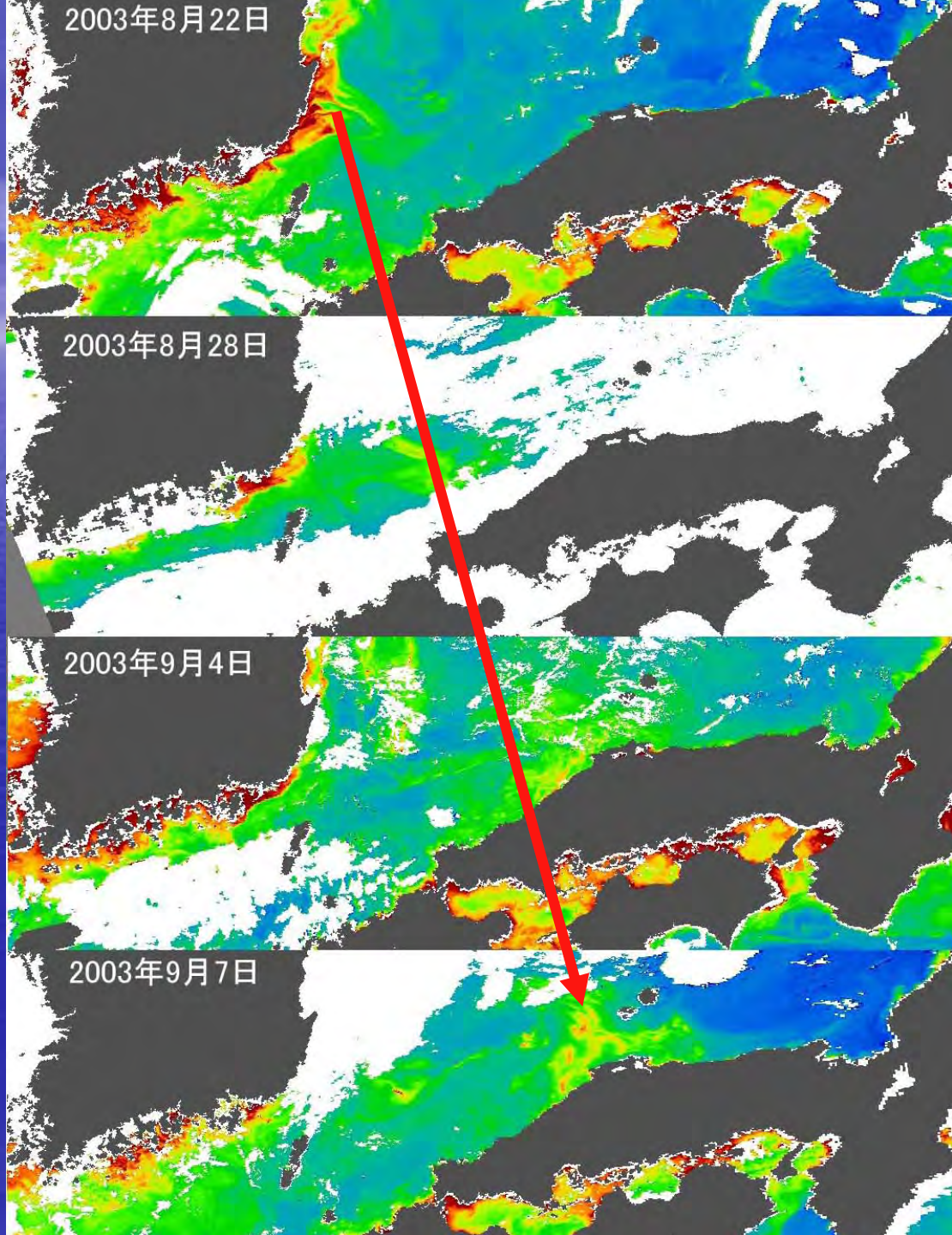


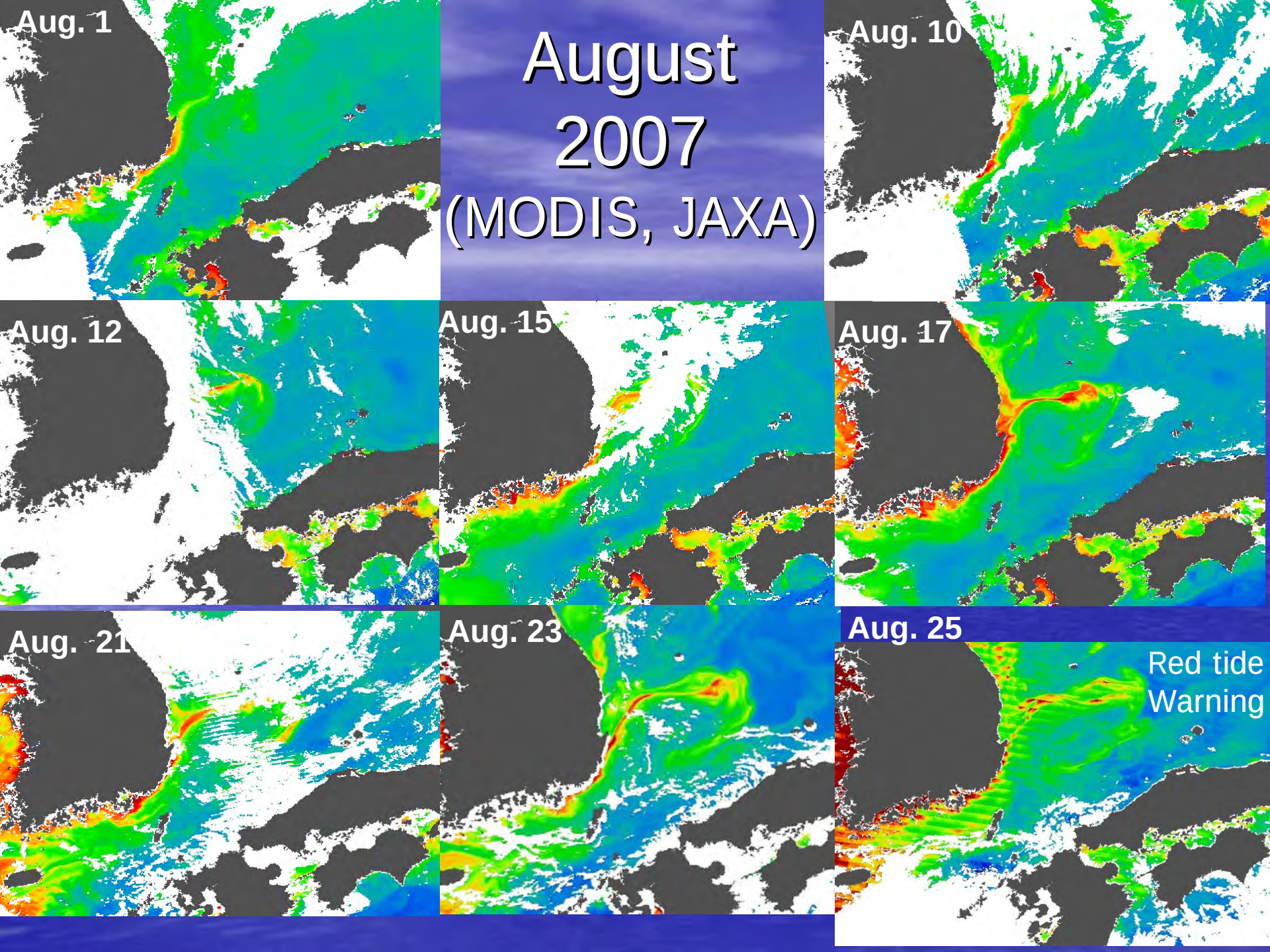
2002/7/17-29 *Chattonella antiqua*, *Chattonella marina* (Hyogo-pref. Fish. Exp. Station)

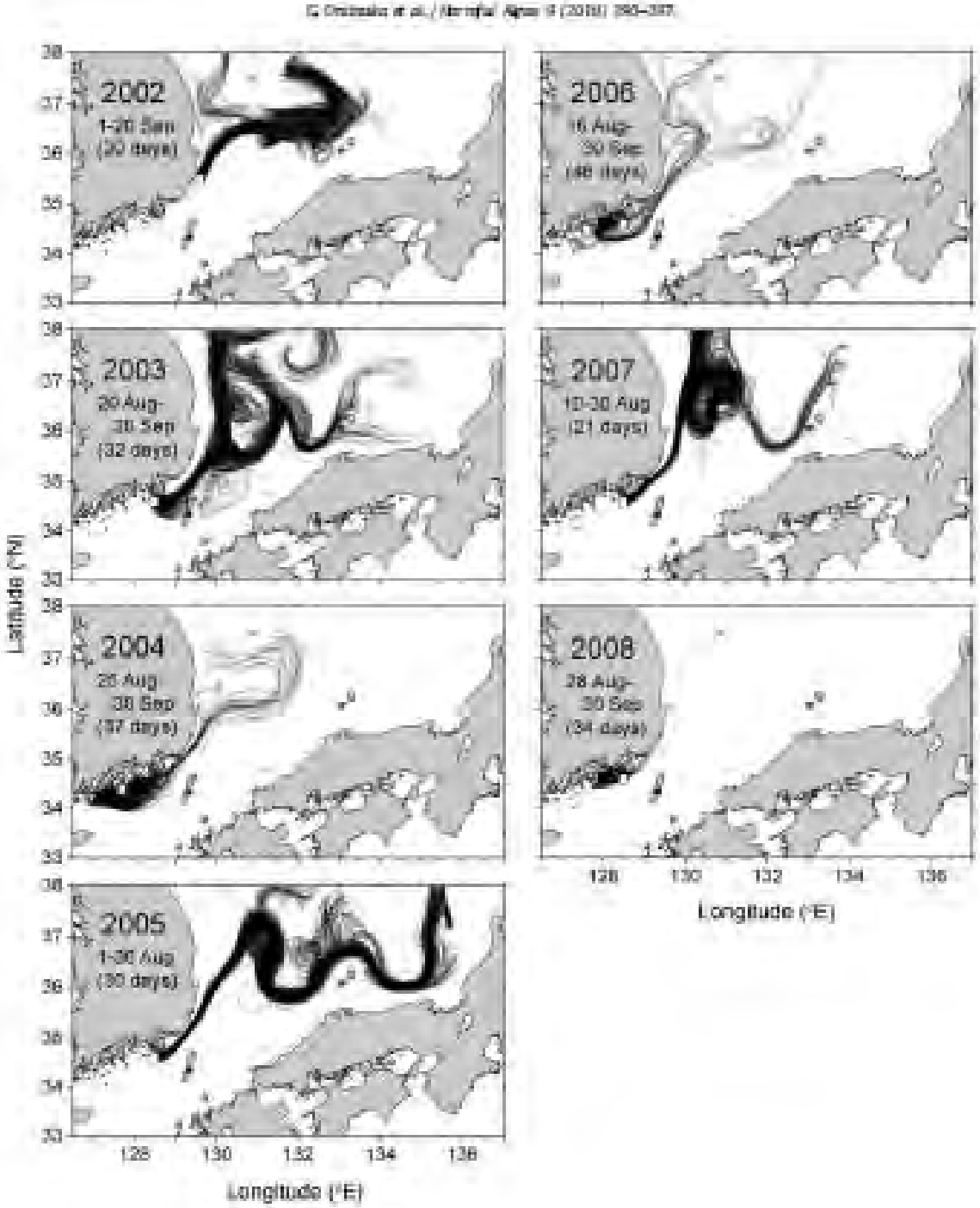
（Takahashi et al., JO-09）

C. Polykrikoides Red Tide? 2003 Aug.-Sept. (MODIS, JAXA)

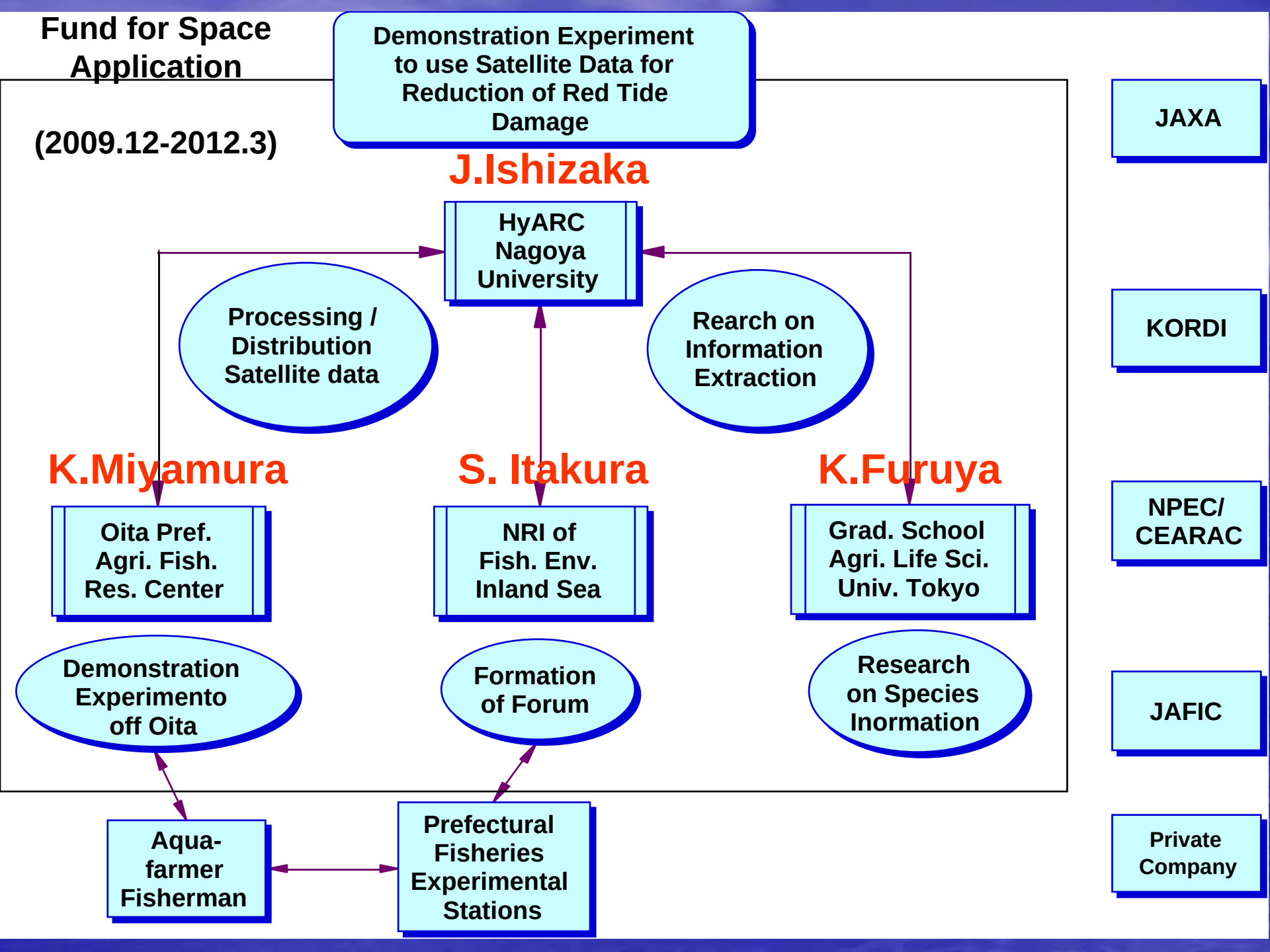
(Miyahara et al., 2005)




Aug. 1
August
2007
(MODIS, JAXA)
Aug. 10
Aug. 12
Aug. 15
Aug. 17
Aug. 21
Aug. 23
Aug. 25
Red tide
Warning



Onitsuka et al. 2010


Fund for Space Application
(2009.12-2012.3)
Demonstration Experiment to use Satellite Data for Reduction of Red Tide Damage
J.Ishizaka
HyARC Nagoya University
Processing / Distribution Satellite data
Rearch on Information Extraction
K.Miyamura
S. Itakura
K.Furuya
Oita Pref. Agri. Fish. Res. Center
NRI of Fish. Env. Inland Sea
Grad. School Agri. Life Sci. Univ. Tokyo
Demonstration Experimento off Oita
Formation of Forum
Research on Species Inormation
Aqua-farmer Fisherman
Prefectural Fisheries Experimental Stations
JAXA
KORDI
NPEC/ CEARAC
JAFIC
Private Company

Countermeasure for Karenia mikimotoi Red Tide

Satellite Information

Monitoring

↓

Red tide information Prediction

↓

Quick Response

↓

Reduction of Damage

***Study of Mechanism**

***Monitoring and Education with Fisherman**

*** New Method for Information Service**

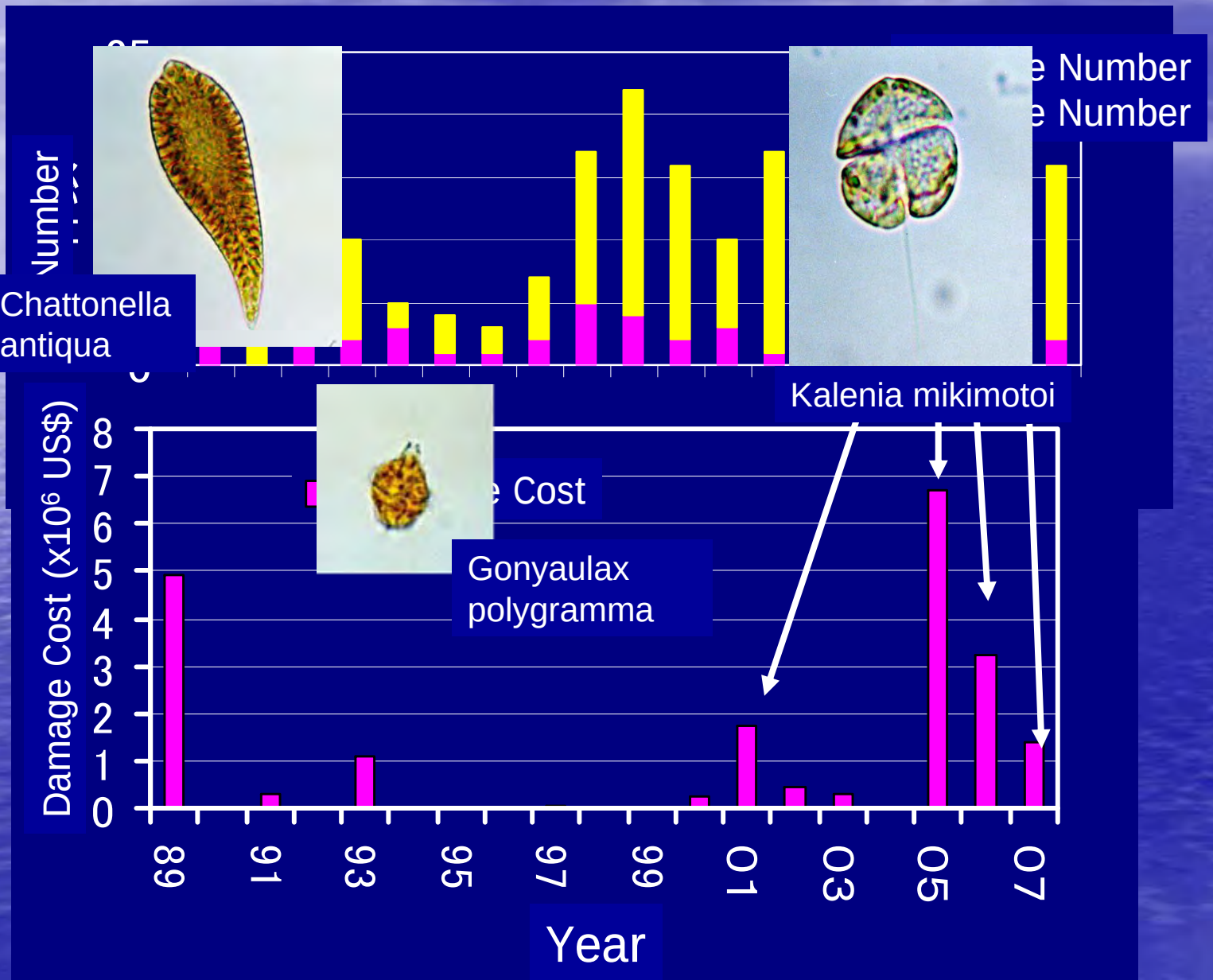
*** Inform Everyone**

***Education for Countermeasure**

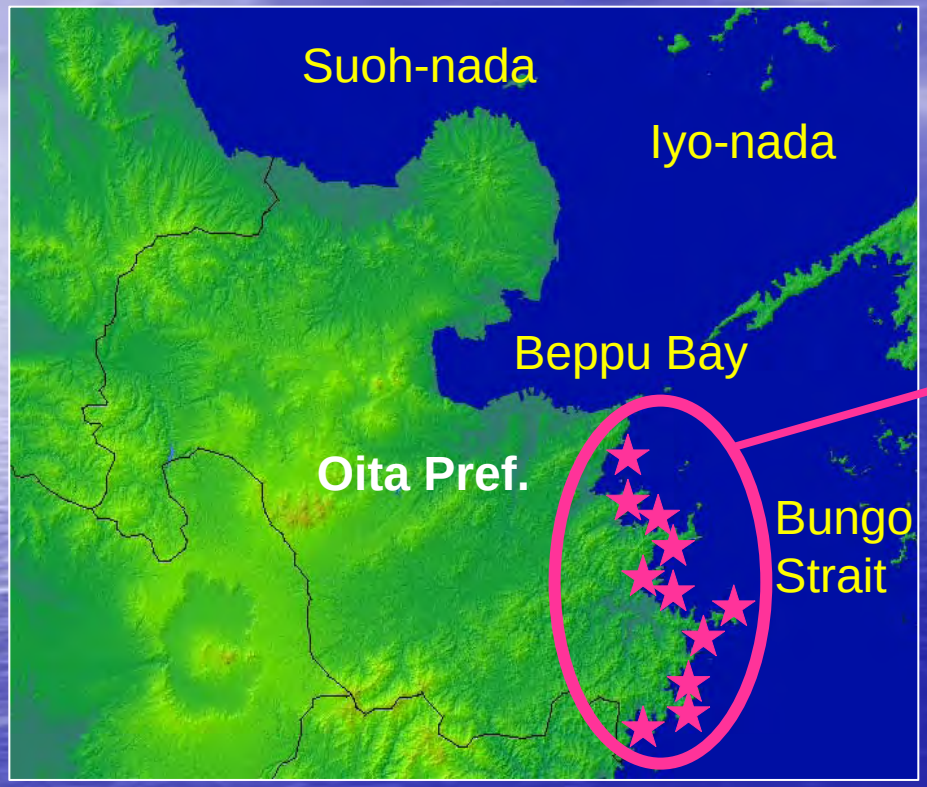
Move Raft

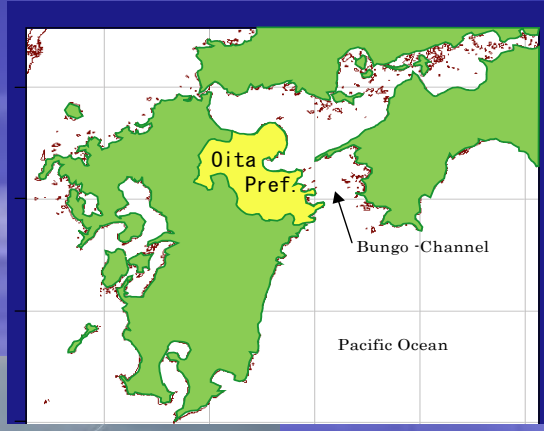
Stop Feeding

Cost and Number of Red Tide Damage in Oita Prefecture (out of 47 Prefecture in Japan)



Aquaculture in Oita

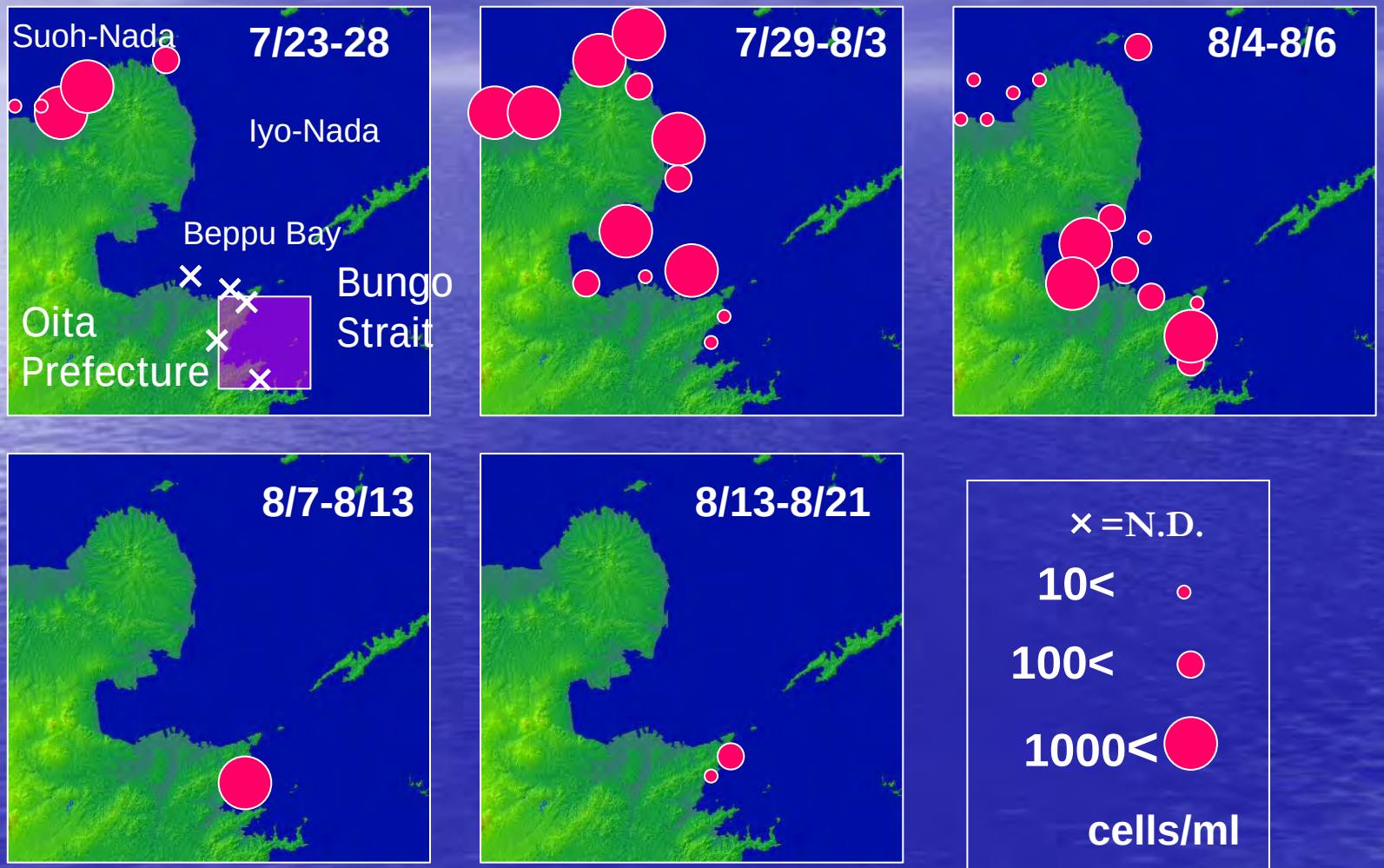




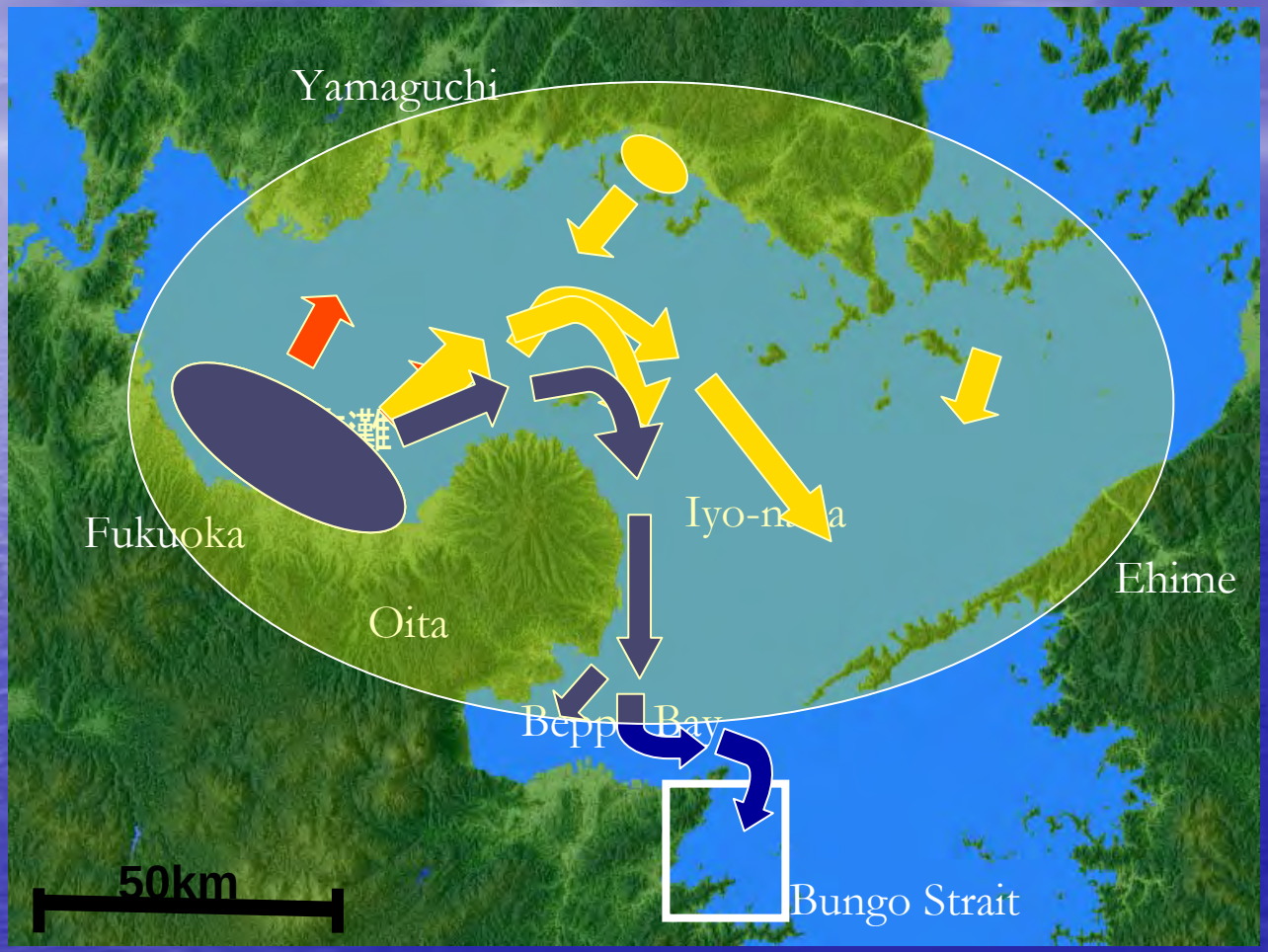
- Mostly Bungo Strait
- New Species
- Offshore

Transport of *K. mikimotoi* Red Tide

（North of Bungo Strait 2003 summer）



Transport and Expansion of *K. mikimotoi* Red Tide

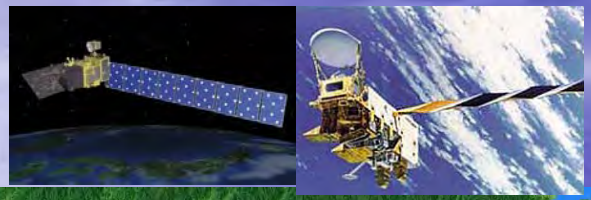


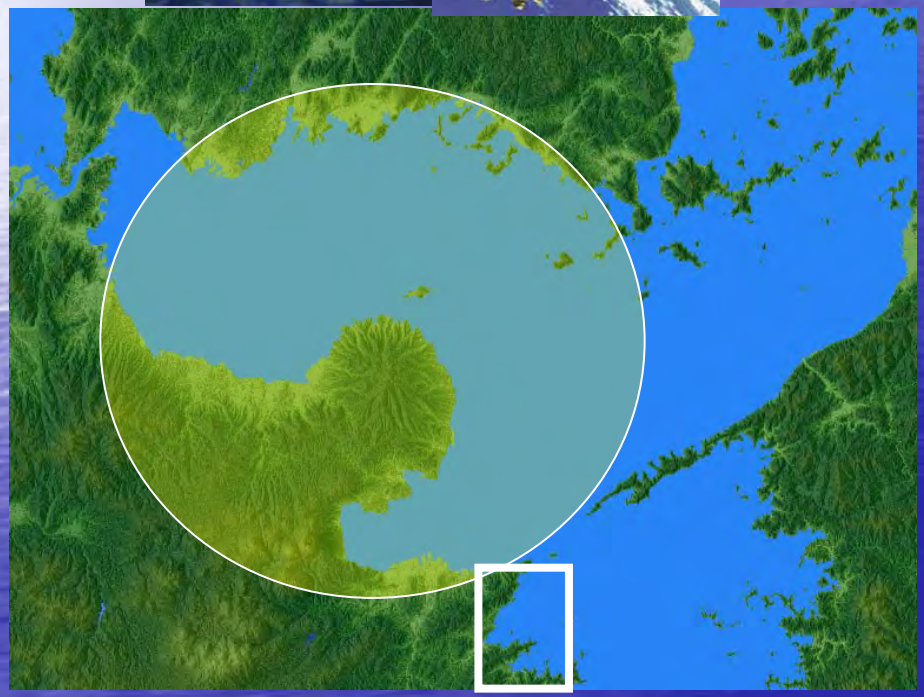
Tamori et al. (1991) Fish. Sci. 57(12) 2179-2186

Koizumi et al. (1994) Oceanogr. Japan 3(2) 99-110

Miyamura et al. (2005) Res. Fish. Oceanogr. 69(2) 91-98

Prediction of red tide in Bungo Strait



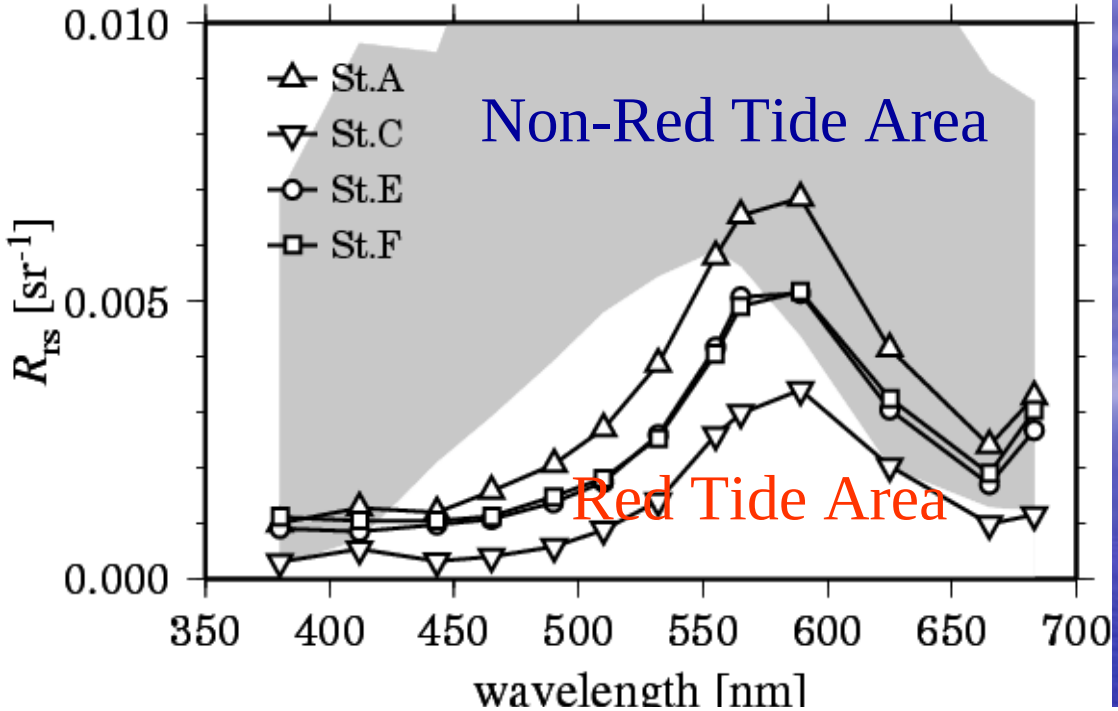


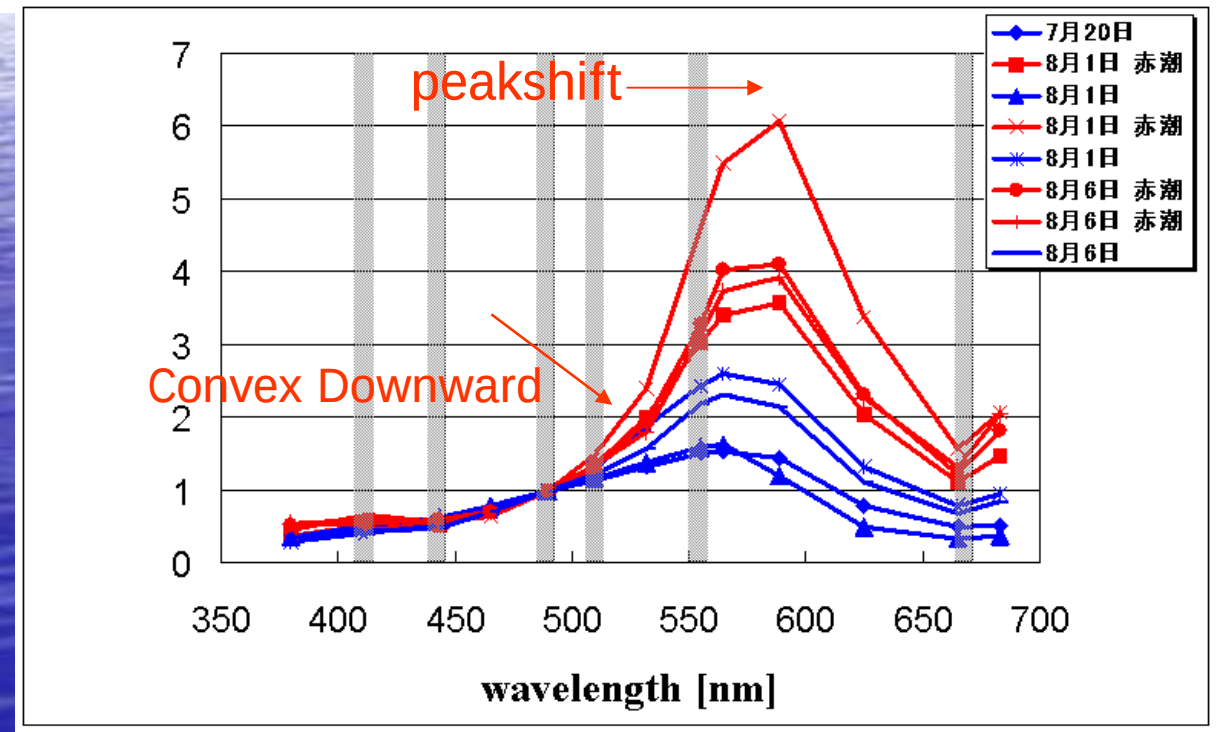
Challege

- **Study of transport pathway of red tide from northwest.**
- **Efficient monitoring of red tide in large scale**

Necessity of Remote Sensing Technique

In situ Rrs Spectra around Red Tide of Ariake Bay

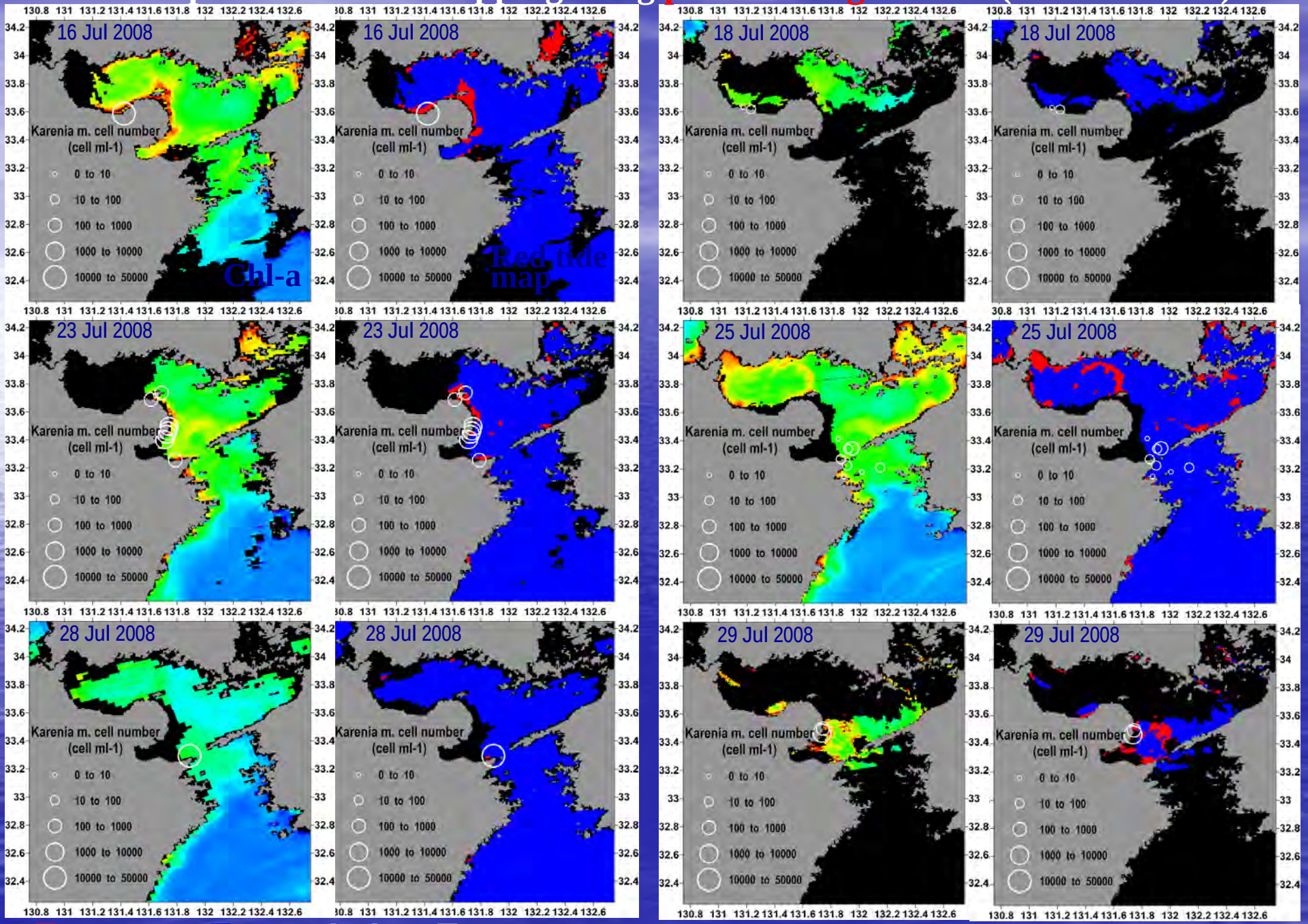




Normalized Rrs Spectra

(Sasaki et al., JO-2008)

Examples of red tide mapping using peak shifting method (summer 2008)



Red tide Non-red tide Cloud/no data Land

http://redtide.hyarc.nagoya-u.ac.jp/

赤潮被害軽減のための衛星データ利用実証試験

平成21年度宇宙利用促進調整委託費～衛星利用の裾野拡大プログラム
（衛星データ利用を促進する手法等の実証プログラム）に採択された
「赤潮被害軽減のための衛星データ利用実証試験」
（研究代表者 名古屋大学地球水循環研究センター　石坂丞二）のホームページです。

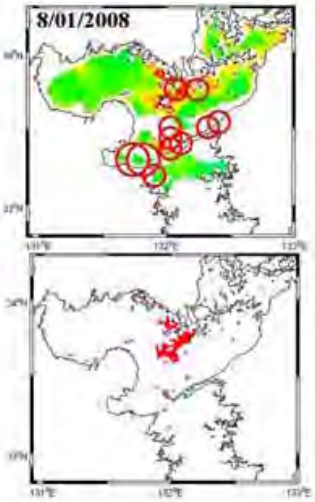
このプロジェクトでは、近年でも西日本を中心に大きな被害の出ている赤潮に関して、衛星データを用いてその被害を軽減するための実証試験を大分県沖合い中心に行い、その手法を多くの海域でも活用してもらうことを目指しています。

大分沖のKarenia mikimotoi赤潮（写真提供：大分水試）

提案書（PDF:303 KB）
名古屋大学地球水循環研究センター衛星生物海洋学研究室

赤潮衛星データベース 周防灘

最新1ヶ月分を表示(chla)
最新1ヶ月分を表示(赤潮画像)



（リアルタイムデータは 北海道大学水産学研究科衛星海洋学研究室 で受信されたMODIS(Aqua/Terra)データと NASA Ocean Color Home Page からダウンロードしたMODIS(Aqua/Terra)データです。）

赤潮検知に有効な他の衛星データリンク先

宇宙航空研究開発機構地球観測センターMODIS準リアルタイム画像
環日本海海洋環境ウォッチ

赤潮被害軽減のための衛星データ利用実証試験

検索条件指定

開始日指定: 2010 年 11 月 08 日から
終了日指定: 2010 年 12 月 08 日まで
衛星: ☑ aqua ☑ aqua-h ☑ terra ☑ terra-h
プロダクト: ☐ chla ☑ redtide
範囲: 周防灘
表示形式: ◉サムネイル表示 ○リスト表示
表示順: ○昇順 ◉降順
1ページの表示数: ○10件 ○20件 ◉30件
検索

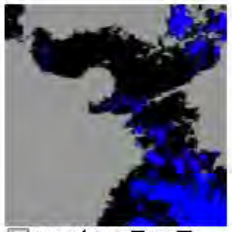
ダウンロードファイルリスト

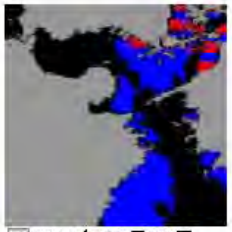
画像が選択されていません。

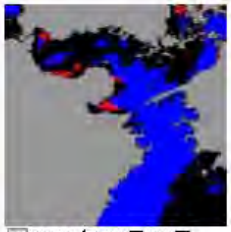
○HDF ○BIN ○PNG
ダウンロード
リストをリセット

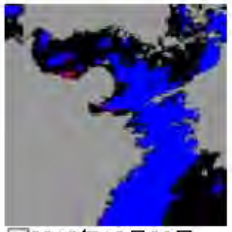
リストに追加

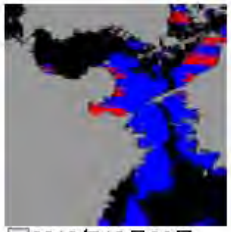
1 2


☐2010年12月08日 04時32分00秒 [aqua-h | redtide]


☐2010年12月08日 01時12分00秒 [terra-h | redtide]


☐2010年12月06日 04時45分00秒 [aqua | redtide]


☐2010年12月06日 04時45分00秒 [aqua-h | redtide]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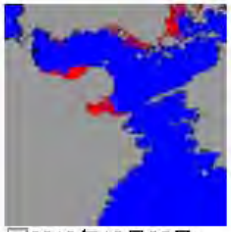
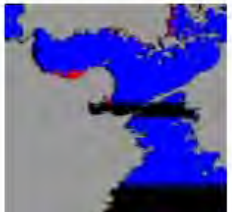
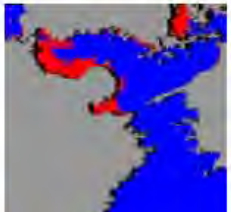

☐2010年12月05日 04時05分00秒 [aqua | redtide]





http://redtide.hyarc.nagoya-u.ac.jp/

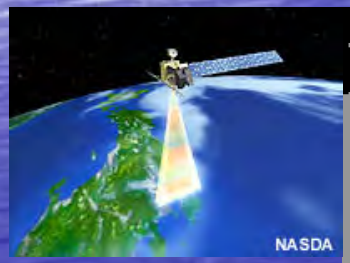
Group Identification

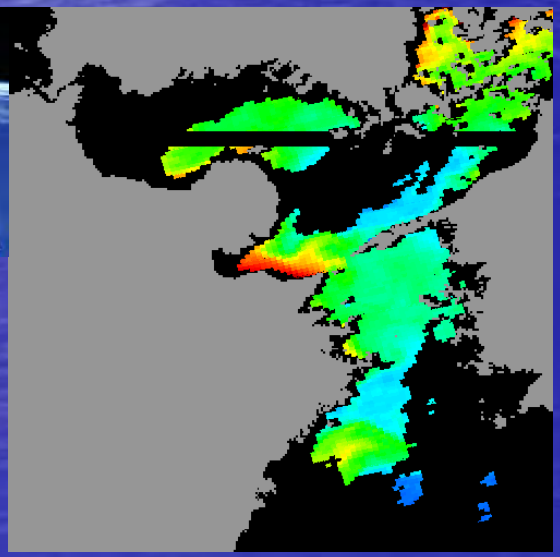
In situ Monitoring

Multi Parameter

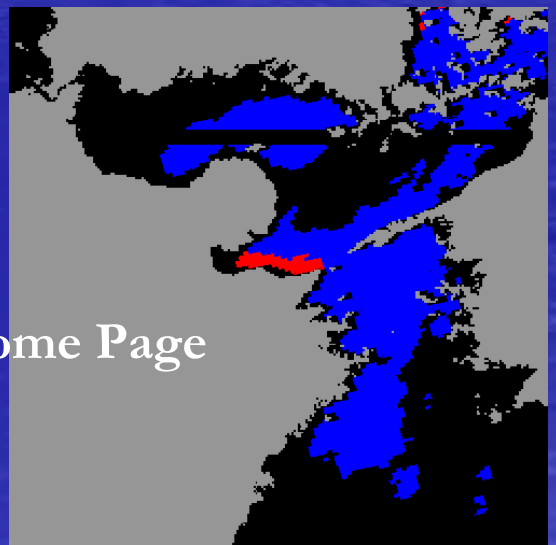
FLOW-CAM

Continuous Monitoring of Water Quality and Phytoplankton Group with Pictures

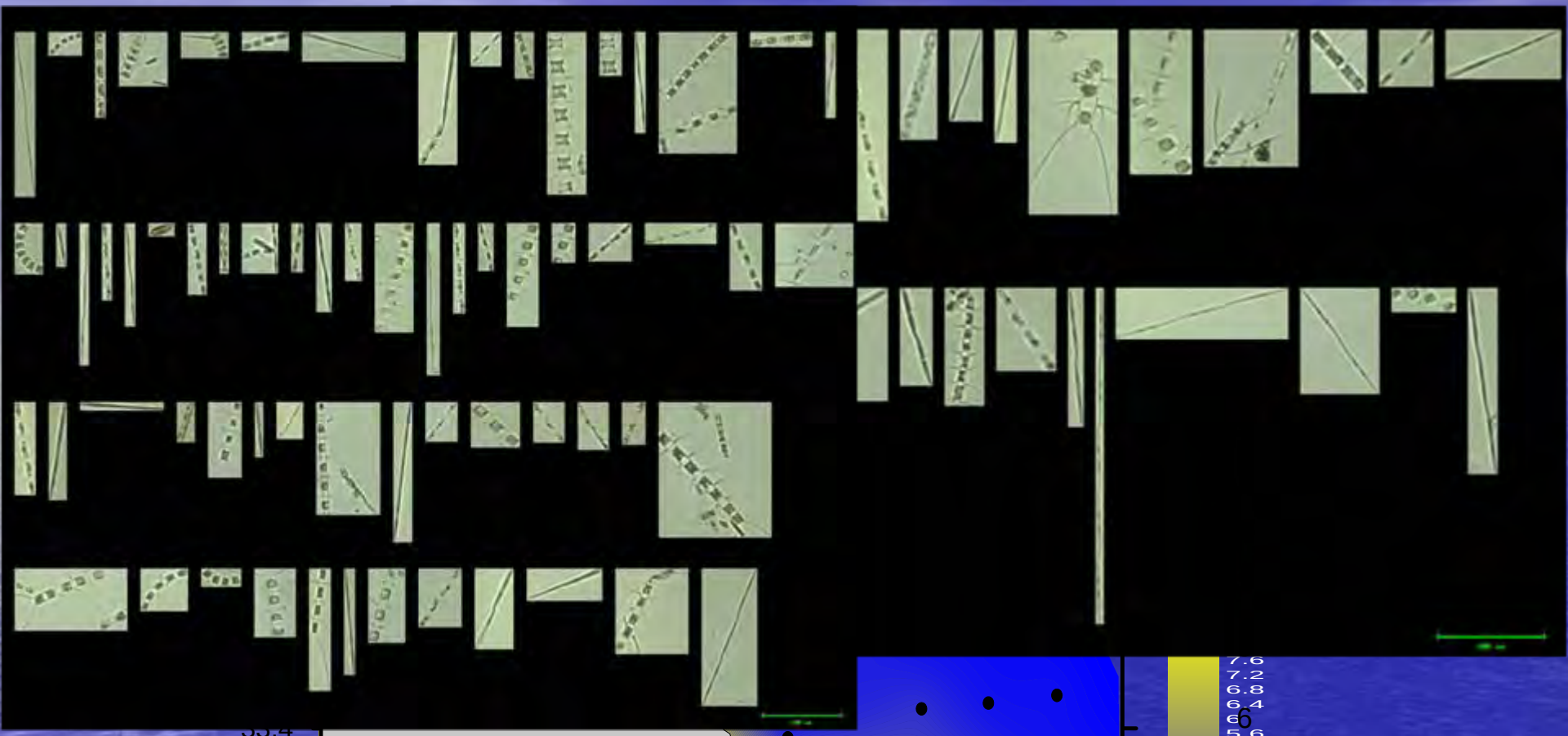


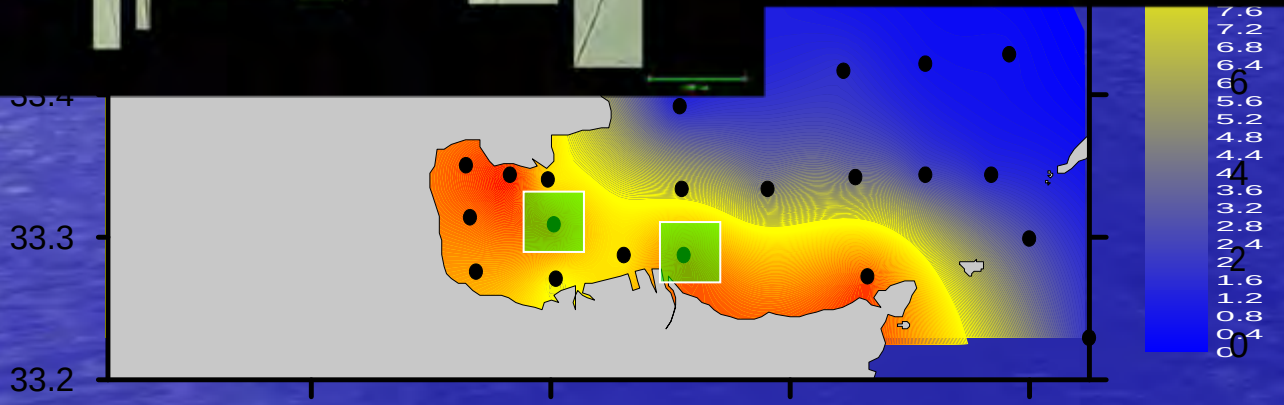


Satellite Monitoring



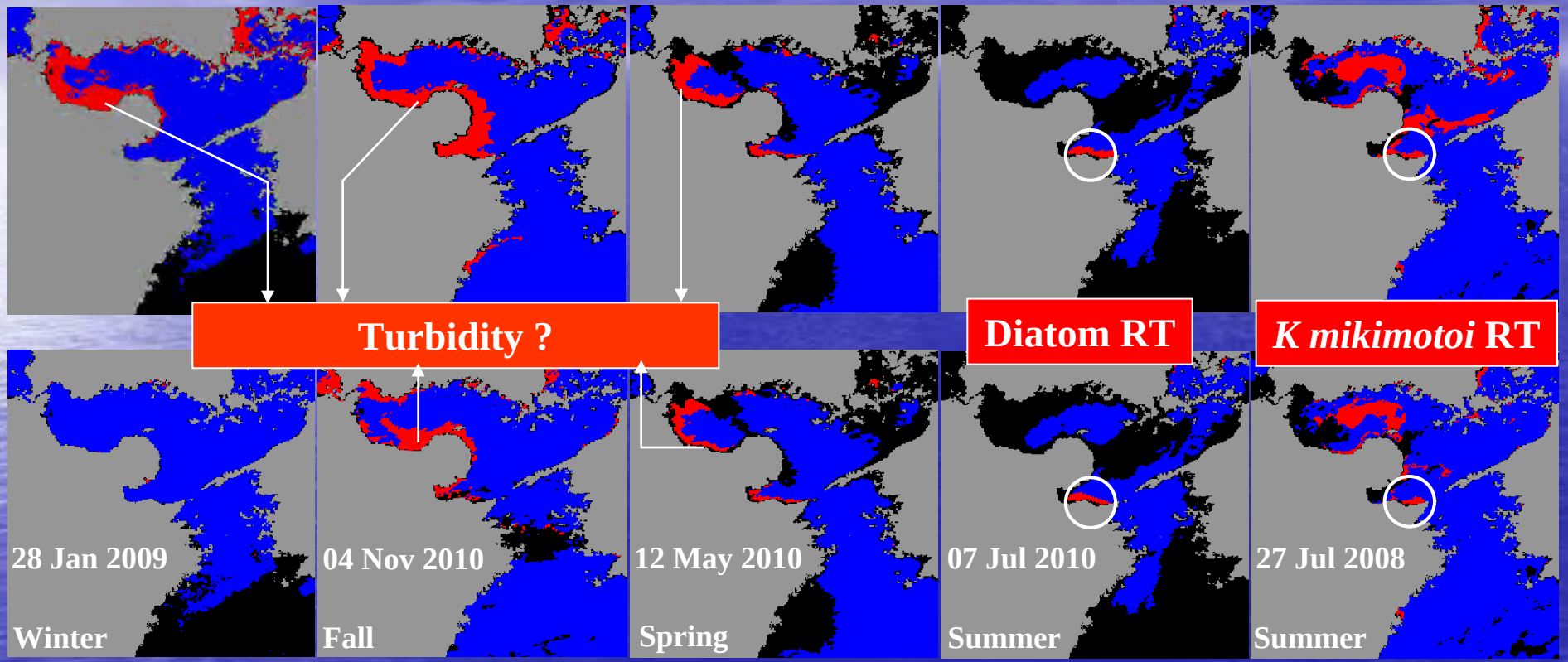
Home Page




33.4
33.3
33.2
7.6
7.2
6.8
6.4
6
5.6
5.2
4.8
4.4
4
3.6
3.2
2.8
2.4
2
1.6
1.2
0.8
0.4
0

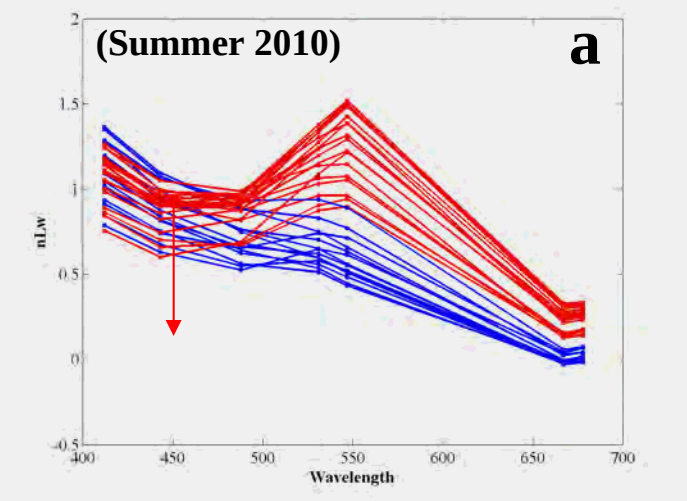
Peak Shift

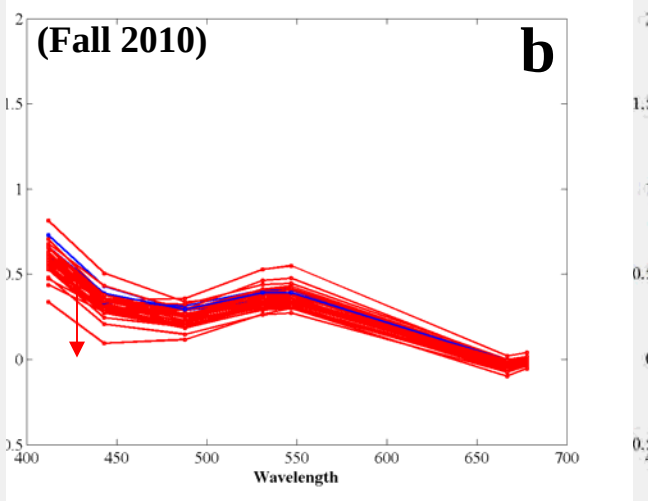
$Max(nlw_{547}, nlw_{488}, nlw_{443})=nlw_{547}$ ➔ Red Tide

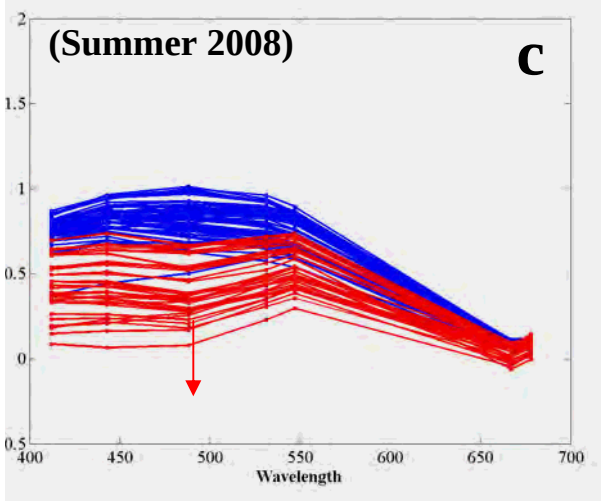


Peak Shift + Low Rrs443

$Max(nlw_{547}, nlw_{488}, nlw_{443})=nlw_{547}$ & $nlw_{488\text{-}443}$ slope < $nlw_{547\text{-}488}$ slope ➔ Red Tide



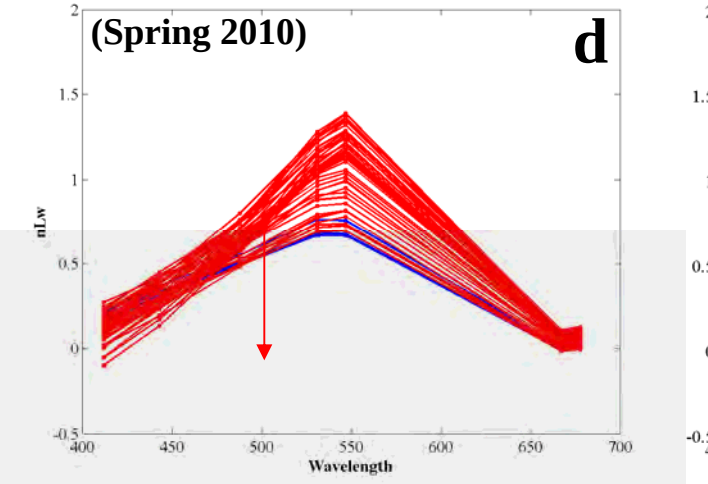


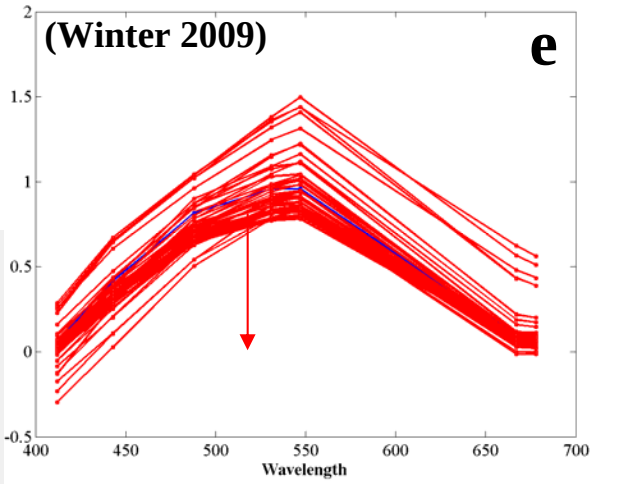


Diatom Red Tide (*Chaetoceros, Nitzschia, Skeletonema*)

Diatom Red Tide (Mixed Population)

***K. mikimotoi* Red Tide**





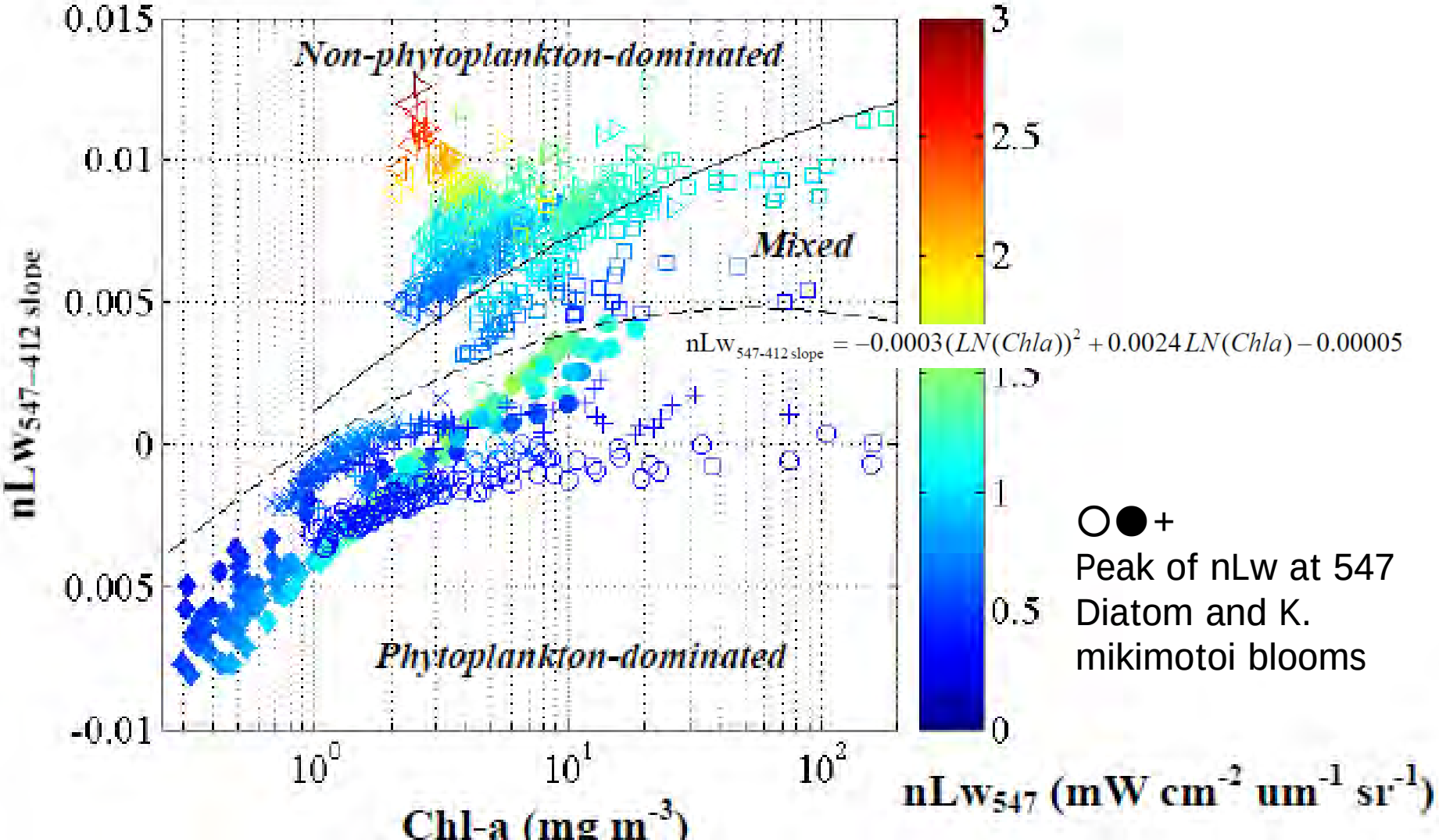
Phytoplankton + Suspended and/or Dissolved Matter?

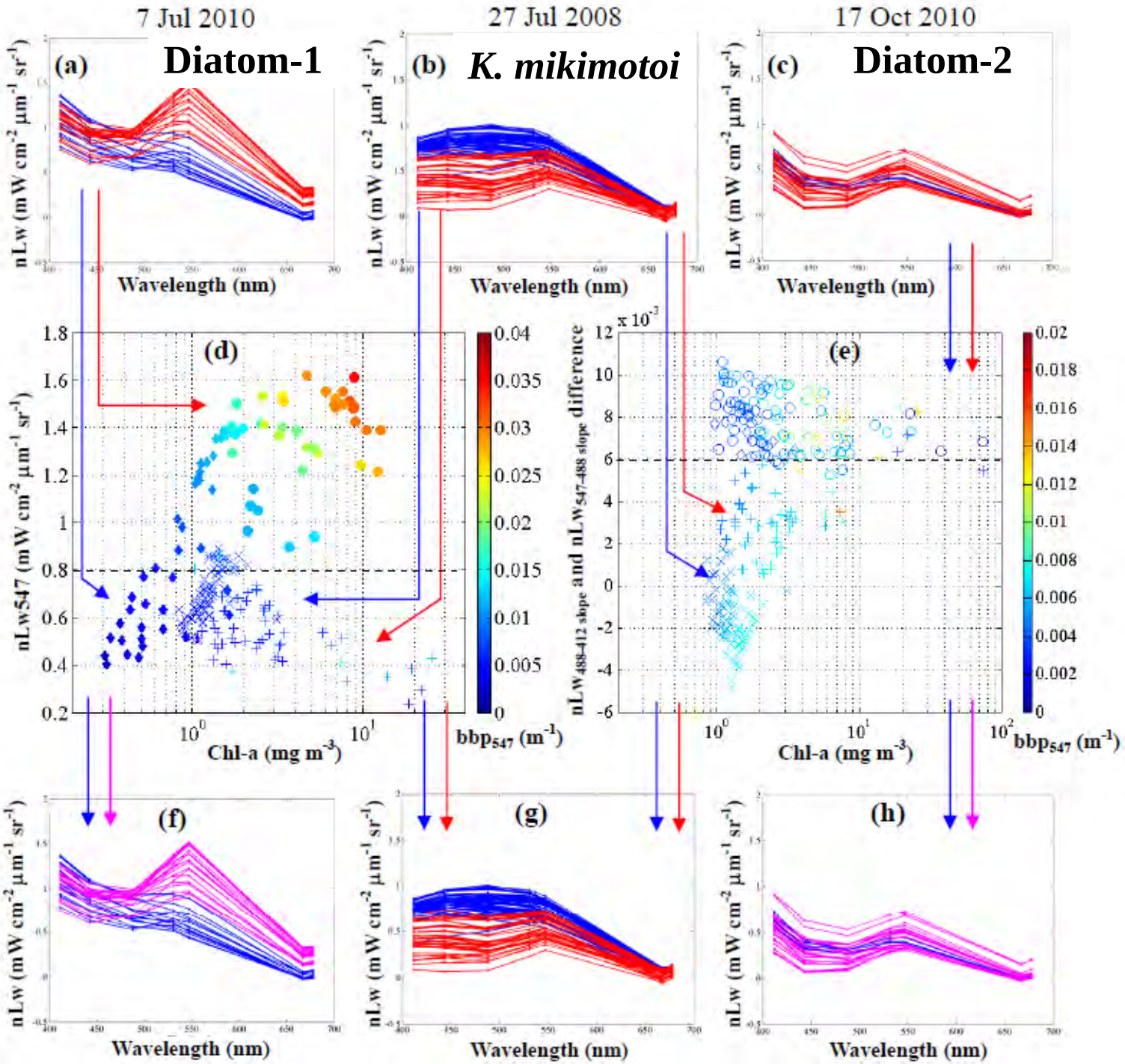
Suspended and/or Dissolve Matter?

See Poster of Eko Siswanto

Phytoplankton : Non-Phytoplankton

(Siswanto et al. Submitted)



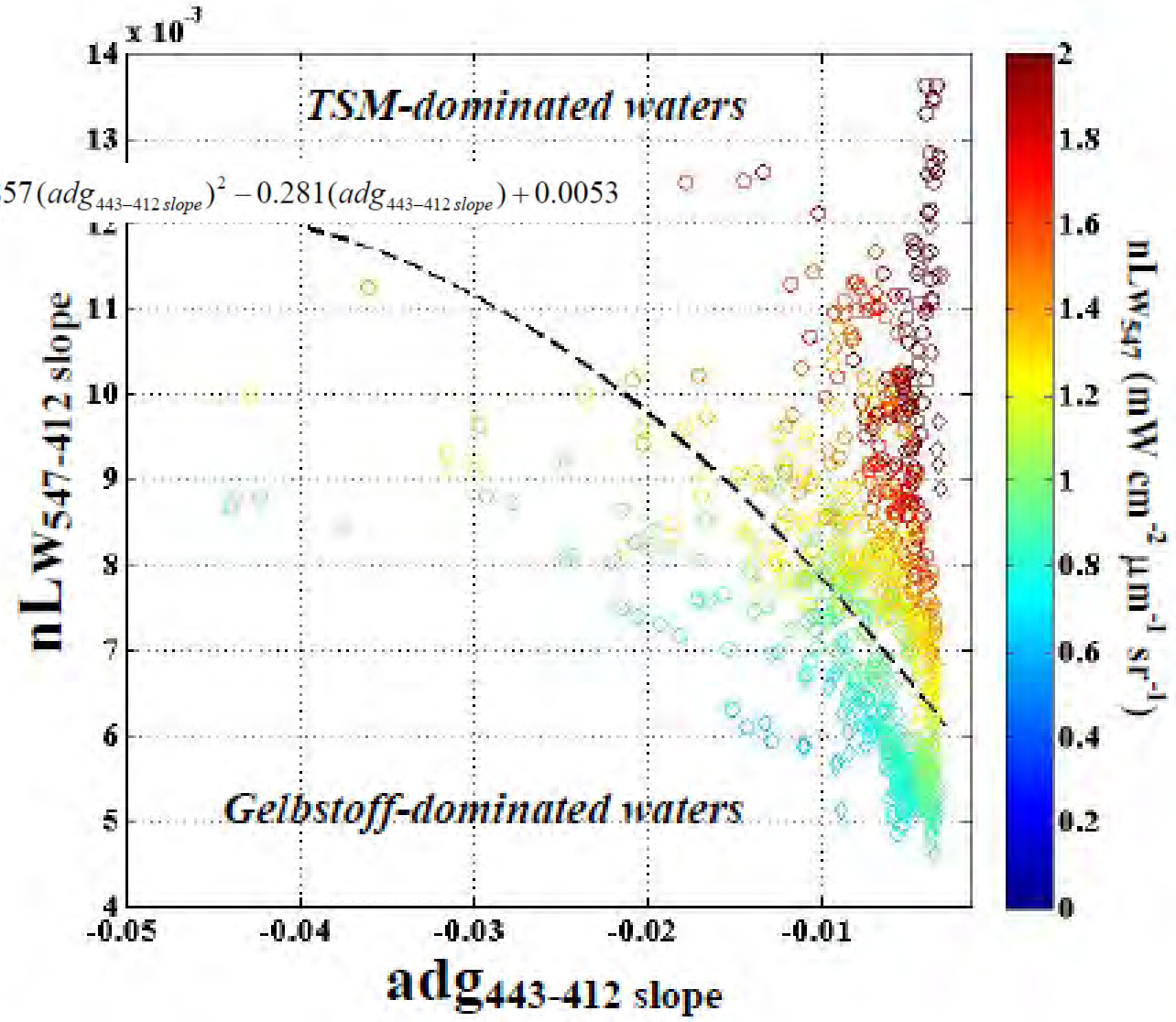


(Siswanto et al. Submitted)

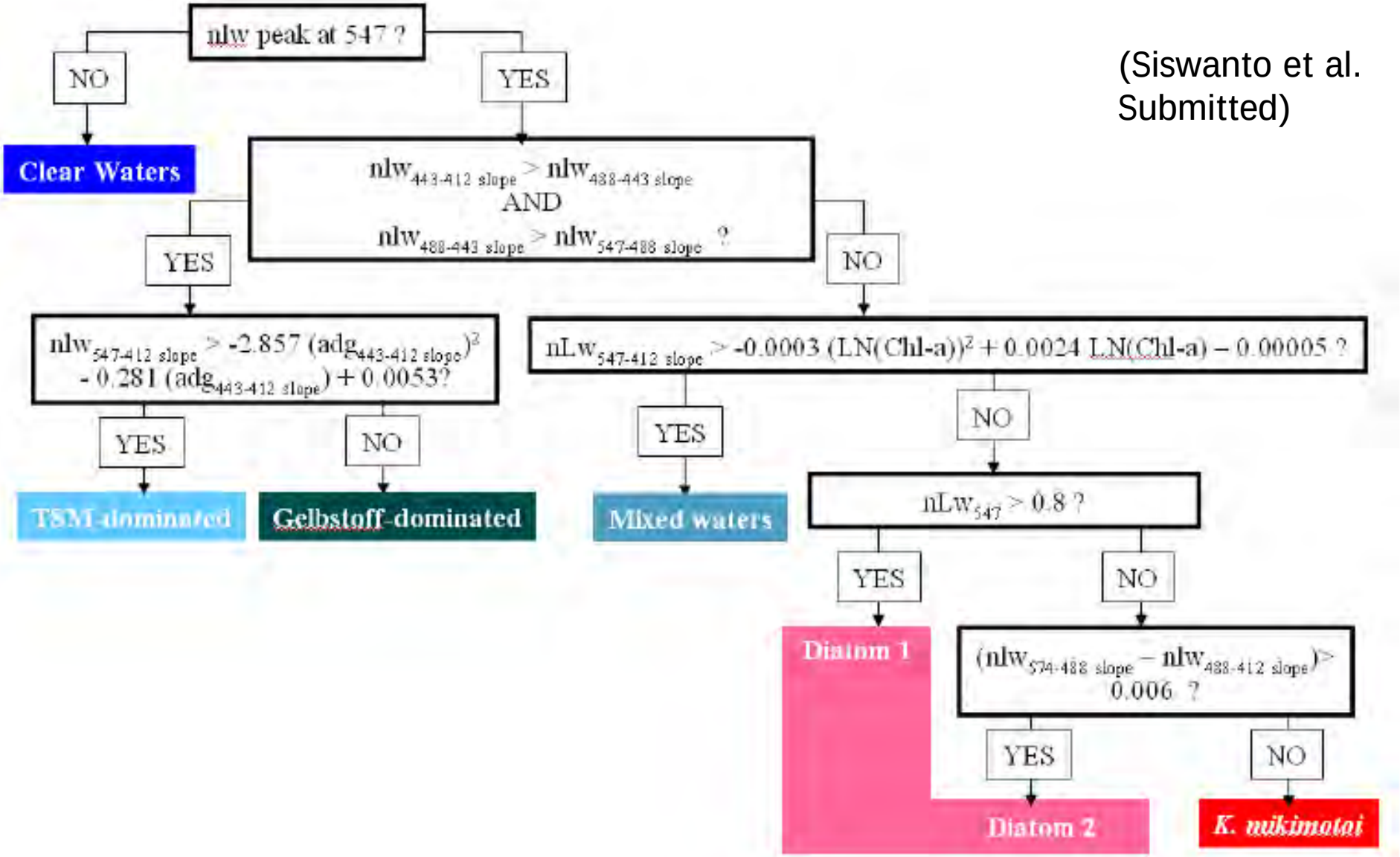
TSM-adg Dominated Water

(Siswanto et al. Submitted)

$$nLw_{547\text{-}412\ slope} = -2.857(adg_{443-412\ slope})^2 - 0.281(adg_{443-412\ slope}) + 0.0053$$

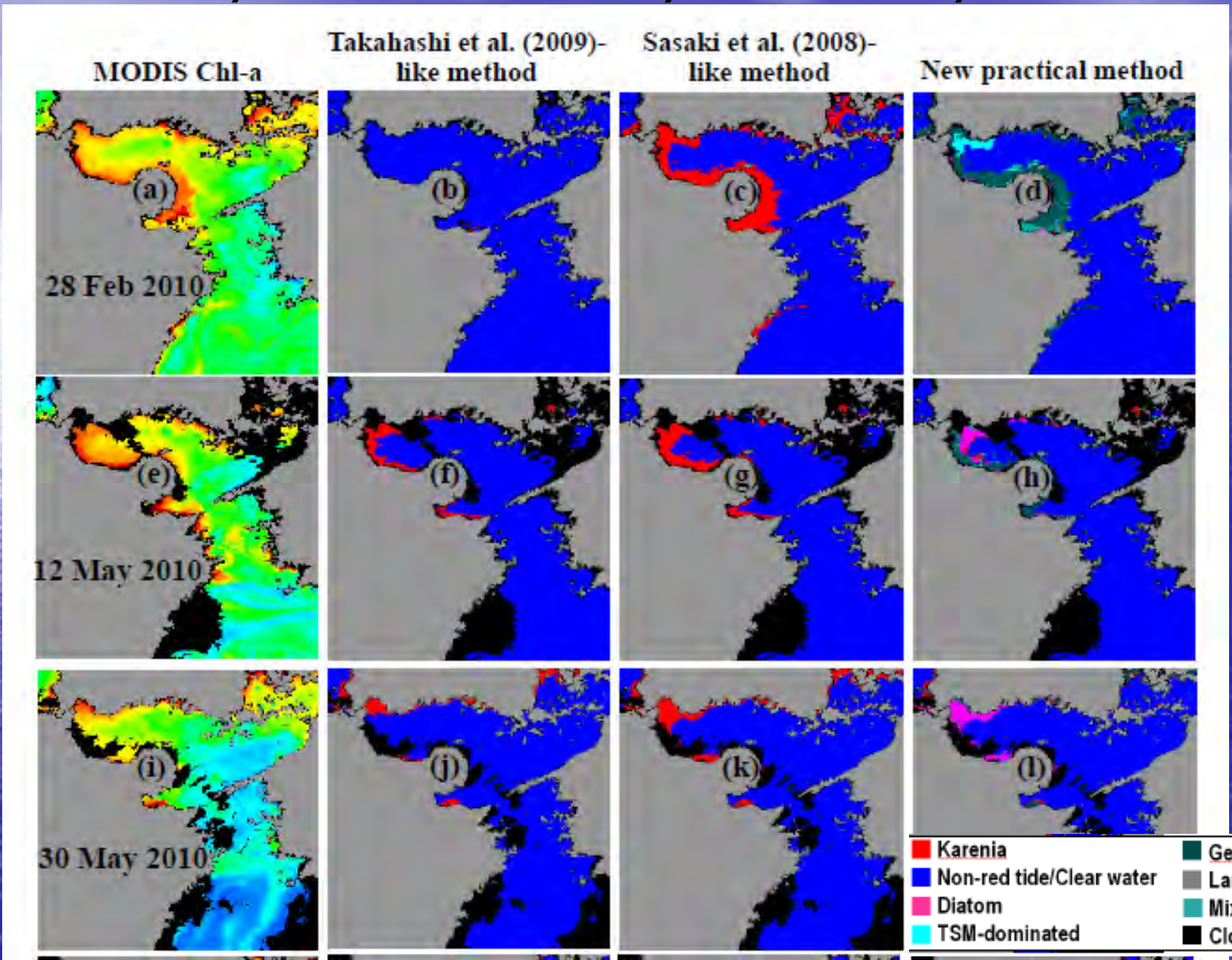


HAB Detection Scheme off Ohita



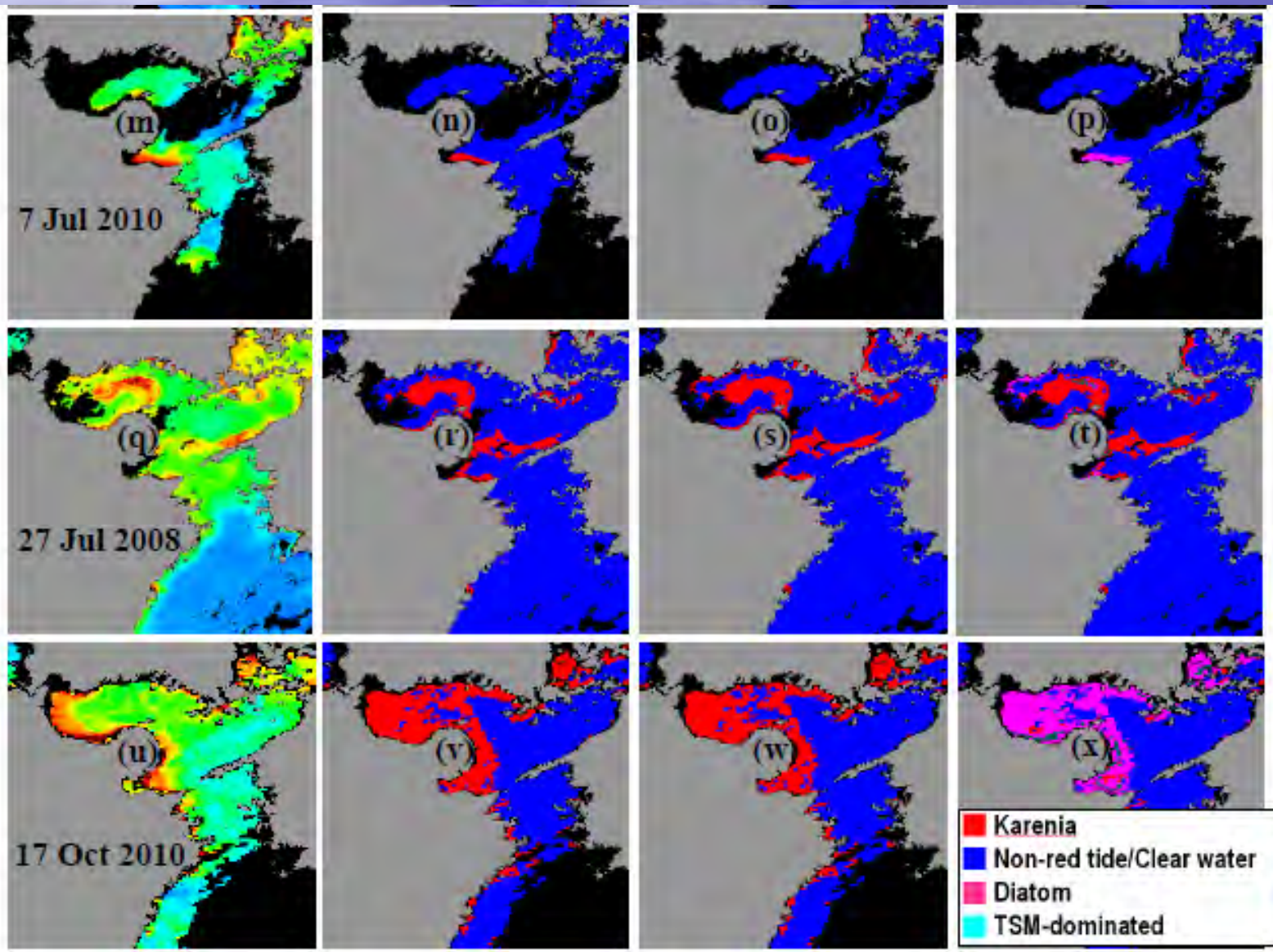
(Siswanto et al. Submitted)

Chl-a, Takahashi, Sasaki, This Res.

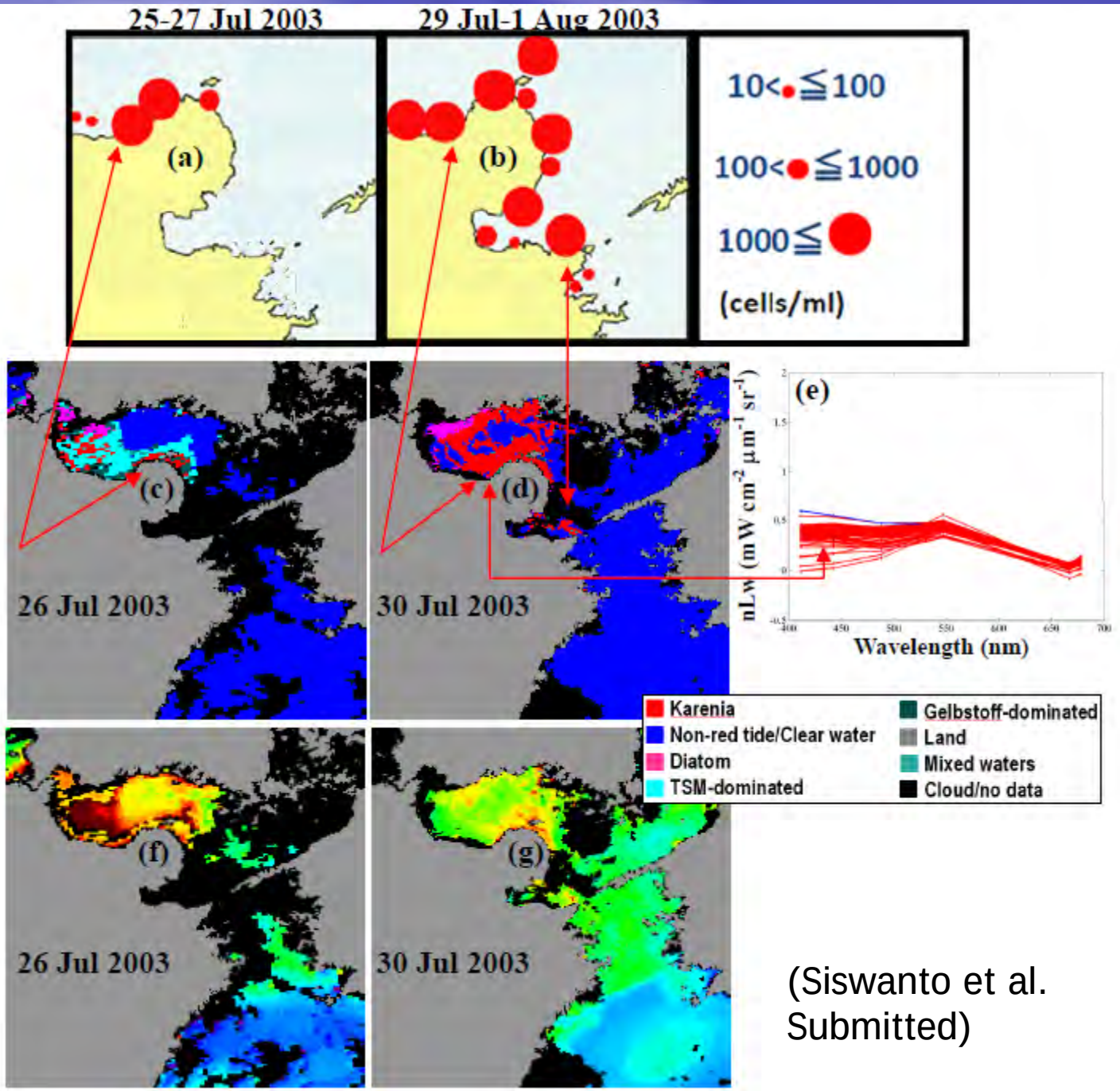


(Siswanto et al. Submitted)

Chl-a, Takahashi, Sasaki, This Res.

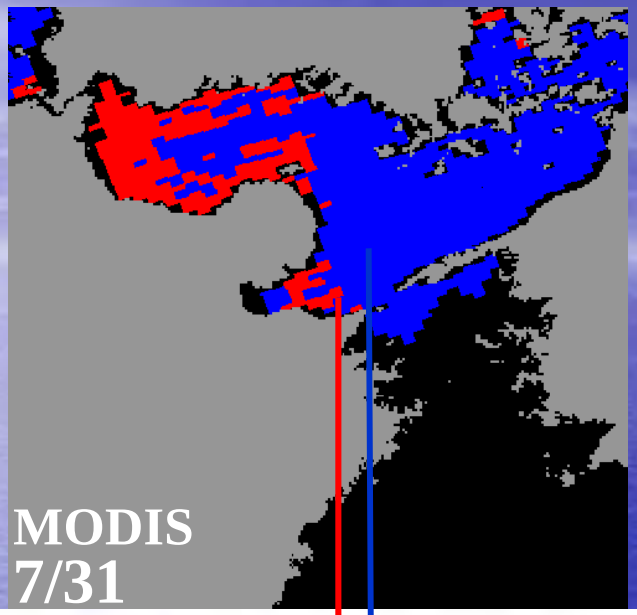


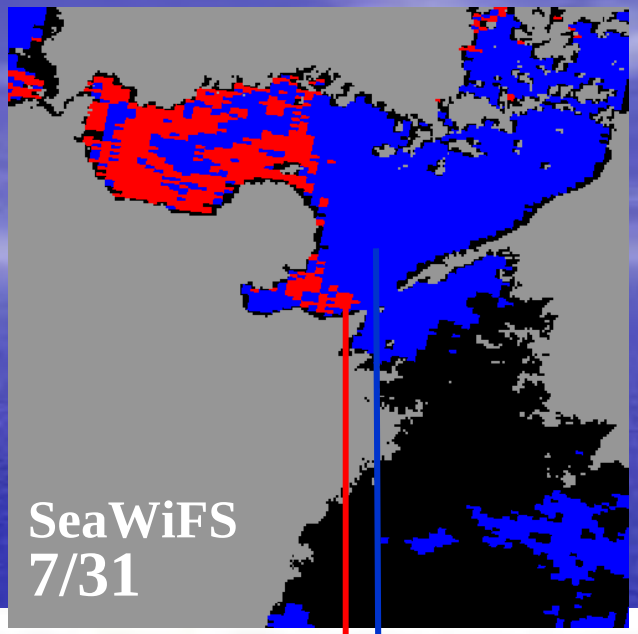
(Siswanto et al. Submitted)

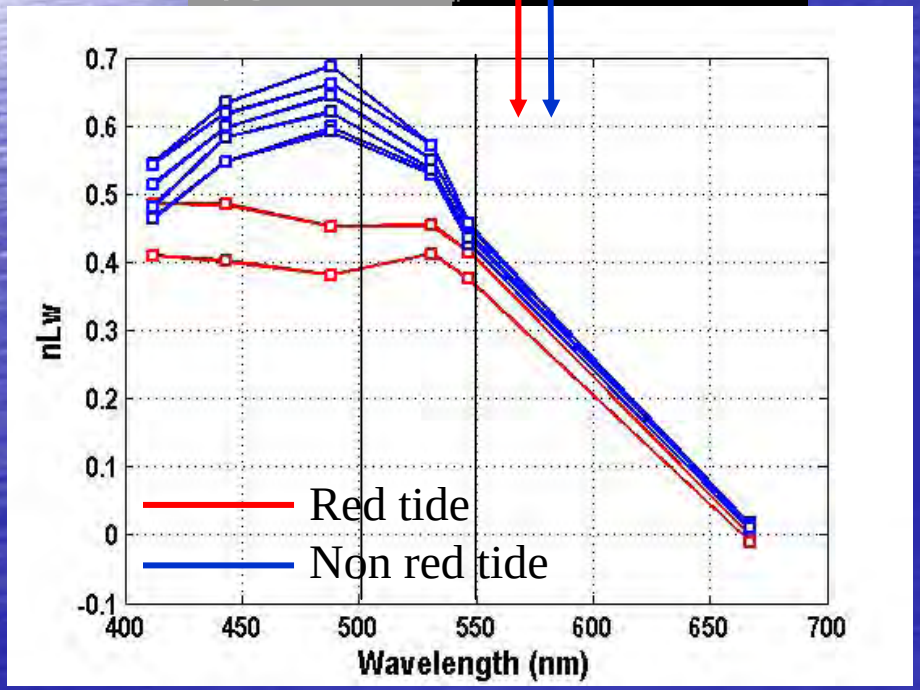


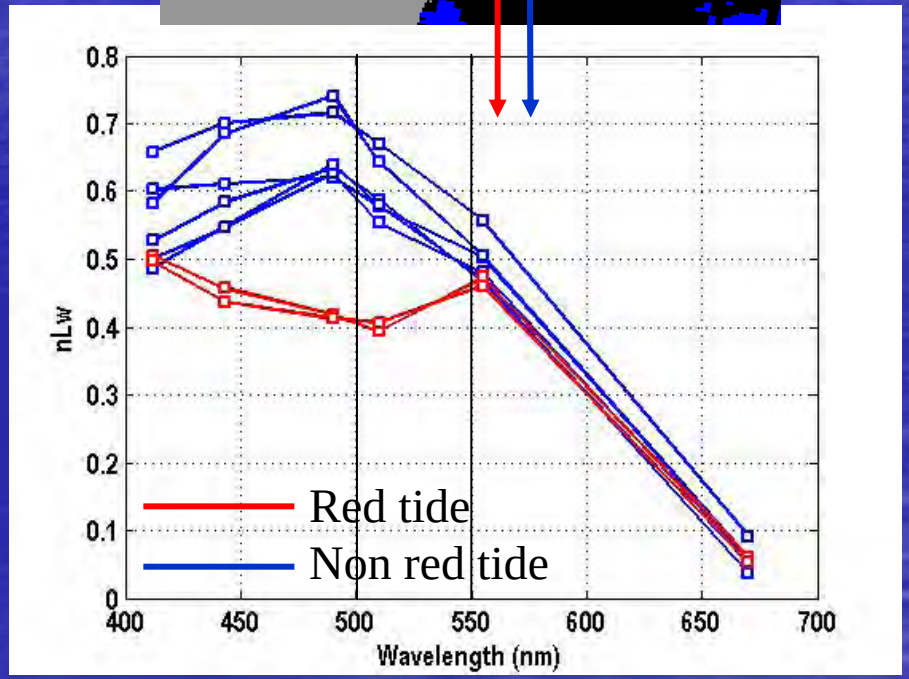
(Siswanto et al. Submitted)

MODIS & SeaWiFS nLw Spectrum during red tide and non red tide









Conclusion

- Integrated red tide warning system including satellite information is required
- If the pathway and the wide distribution by satellite data are available, it is easy to predict.
- Peak Identification Method seems working, but further testing is required.
- Differentiation of Diatom and Dinoflagellate need to be verified, and it may be required to combine with field observations.
- Combination with physical numerical modeling is more effective.
- Korean Geostationary Ocean Color Sensor (GOCI, 2010-) and Japanese GCOM-C (250m, 2014-)

We should not expect too much for satellite. We need integrated system, including satellite, field observations and modeling, for prediction and countermeasure.

Real Challenge

- To predict local occurrence of red tide, further understanding of the ecosystem is necessary.
- Final goal should be development of an integrate coastal managing system including aquaculture (using satellite information).

Satellite Ocean Color Data Availability

- CZCS (78-86): US Experimental
- OCTS(96/97), GLI(02/03):Japan
- SeaWiFS(98-04), MODIS-Terra(99-)
  MODIS-Aqua(02-) :US
- MERIS(02-): EU
- OCM(99-), OCM-2(09-):India
- GOCI(2011-):Korea Geostationally

Data Distribution System

- NPEC Environmental Watch System
- JAXA MODIS Real Time Data
- Ocean Color Home Page (NASA)
- Korea Ocean Satellite Center
- Nagoya Univ. Red Tide

Software

- Giovanni

- SeaDAS (NASA)
- BEAM (ESA)
- WIM (Mati Kahru)
- GDCS (Korea)