Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX)

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&
the INBOX Group:

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S3: POC Topic Session: Challenges in understanding Northern Hemisphere ocean climate variability and change

PICES-2012, October 18, 2012, Hiroshima, Japan

Outline

- Background
  - New technologies (floats, biogeochemical sensors, …) facilitating a holistic understanding of the ocean
- Brief overview of a new JAMSTEC interdisciplinary project: **INBOX**
- Quick look at the data from INBOX
  - Enhanced primary production associated with eddy passage

Background

- Combination of autonomous float and biogeochemical sensor technologies has enabled concurrent measurements of physical and biogeochemical parameters for wide spatial and temporal ranges.
- This could open a new world of synergistic use of those data to advance not only each discipline but also holistic understanding of the ocean.

Background (cont.)

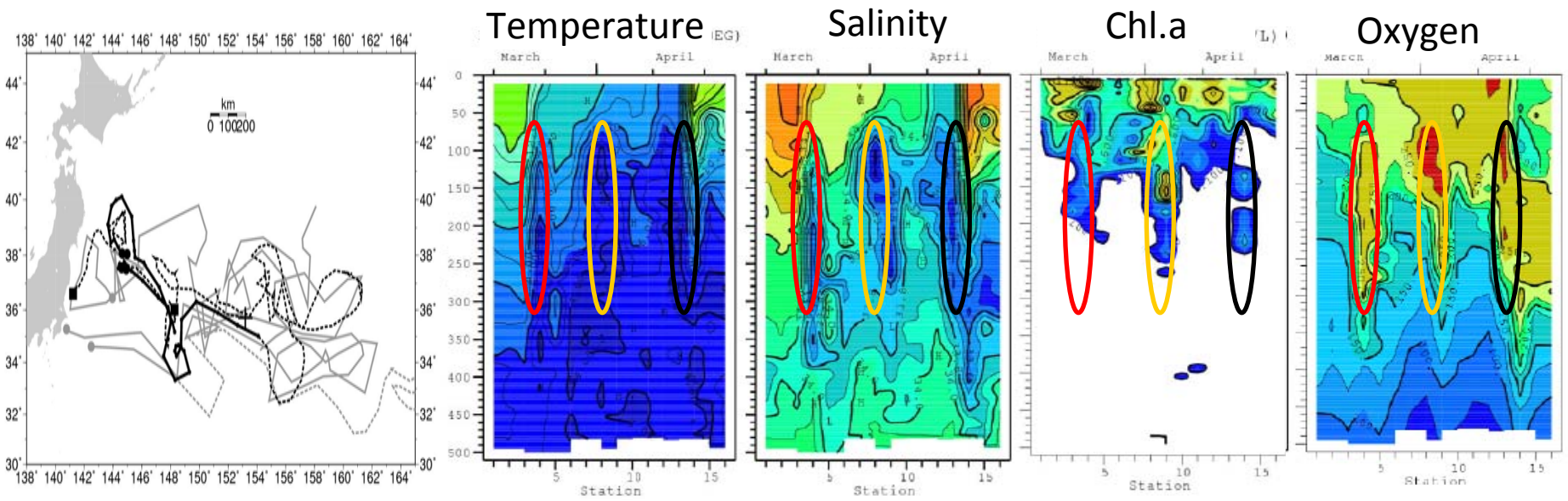
- Mesoscale and submesoscale processes must play key roles in liking physical conditions with marine ecosystems through intense convergence/divergence, upwelling/downwelling, mixing, etc.
- Given the considerable interactions between mesoscale and large-scale dynamics, even large-scale linkages will depend, at least partly, on the mesoscale/submesoscale processes.

Background (cont.)

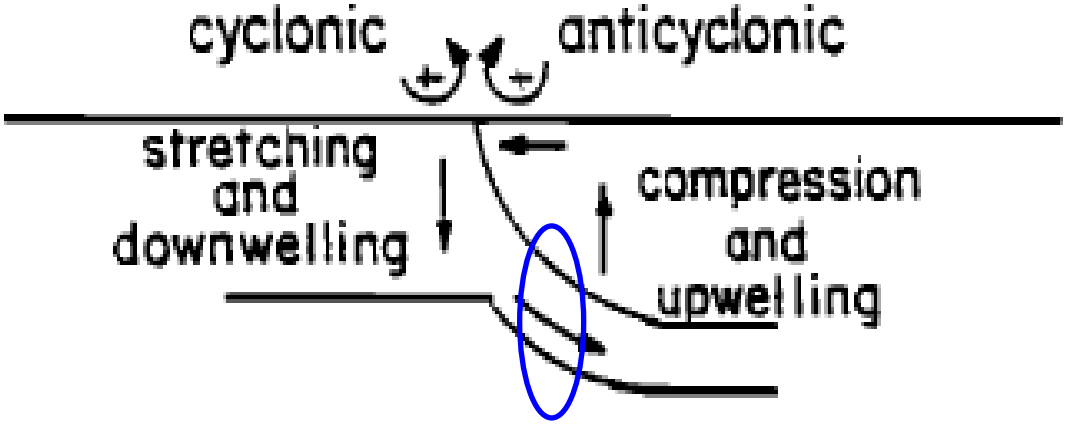
- Our understanding of mesoscale and submesoscale processes is still limited mainly due to the difficulty in measuring them despite their importance widely recognized.
- Study of these processes appears one of those areas greatly benefitted from the synergistic use of physical and biogeochemical data acquired by autonomous platforms.

Vertical transport associated with sub-mesoscale disturbance: SUPRFISH observation

Float observations (3-day interval) in the mixed water region: March, 2008 -



Cross-frontal flow associated with a Jet accelerated downstream (Spall, 1995)



Structures captured by the floats are possibly due to **subduction** associated with **frontal disturbance**.

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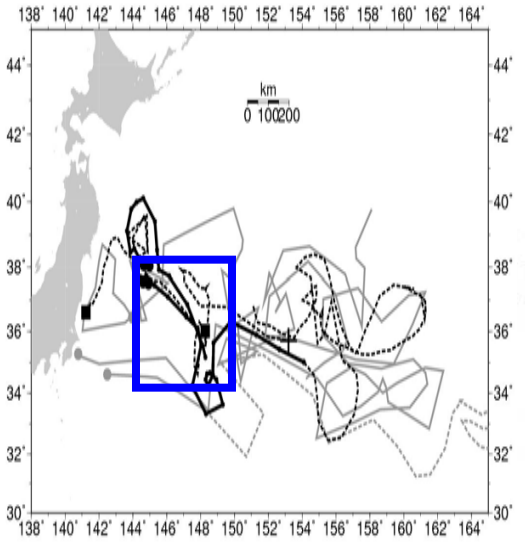
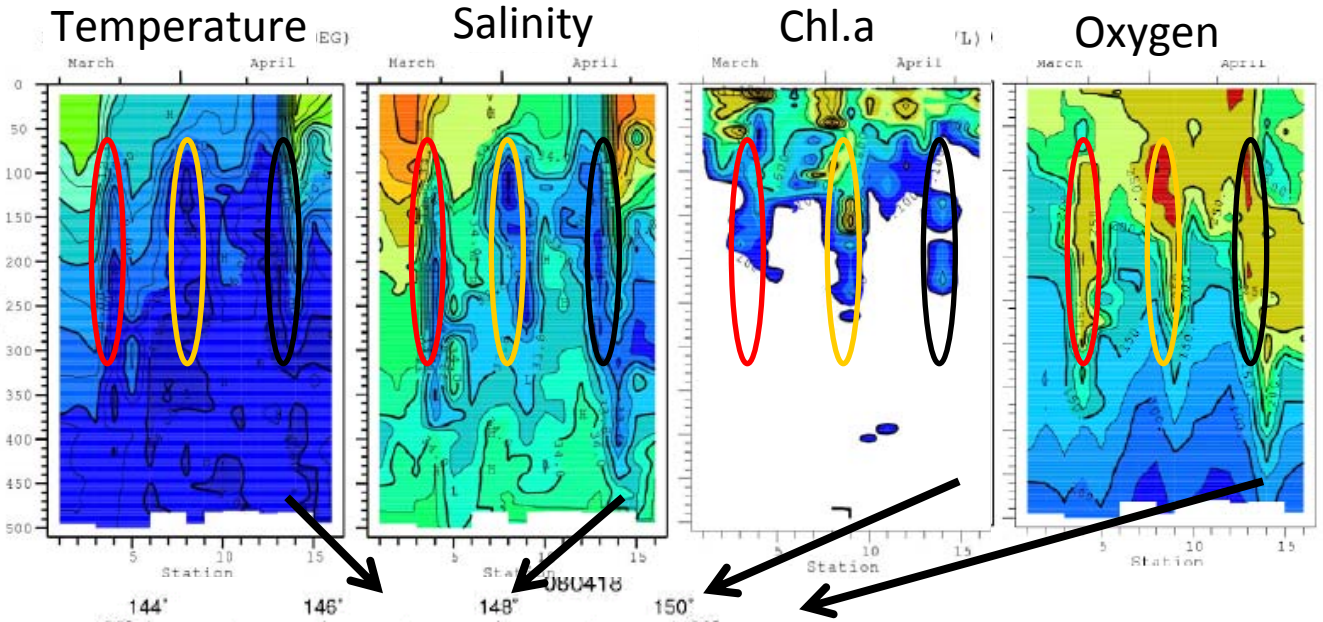
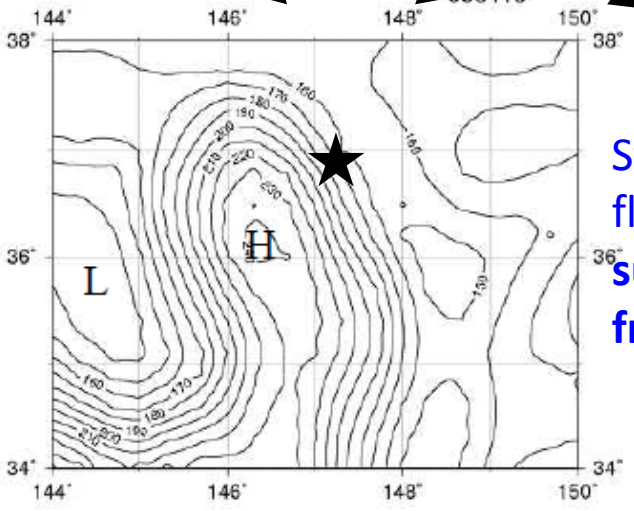




SSH on April 18, 2008



Structures captured by the floats are possibly due to **subduction** associated with **frontal disturbance**.

Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX):

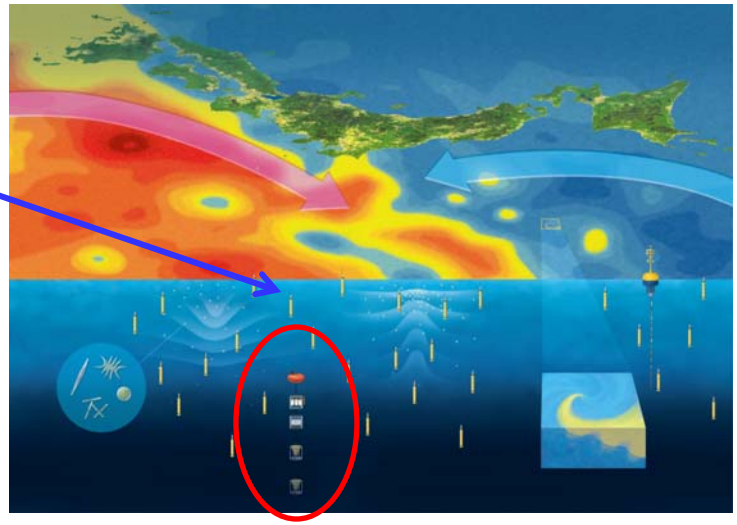
JAMSTEC interdisciplinary project launched in 2010

Objectives:

- to acquire physical-biogeochemical data which could resolve mesoscale phenomena in the western North Pacific
- to quantify impacts of physical processes on biogeochemical phenomena
- to utilize biogeochemical information for understanding physical processes
- to contribute to designing effectively sustained biogeochemical observing system

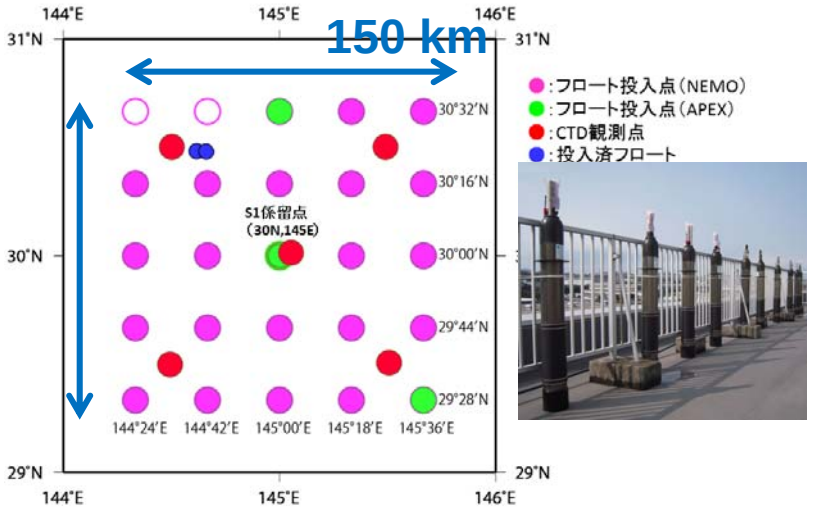
The first phase of INBOX

- **30 DO floats** (profiling cycle: 2 days)have been deployed in the 150 km x 150 km experiment region centered at Station **S1** (30N, 145E)

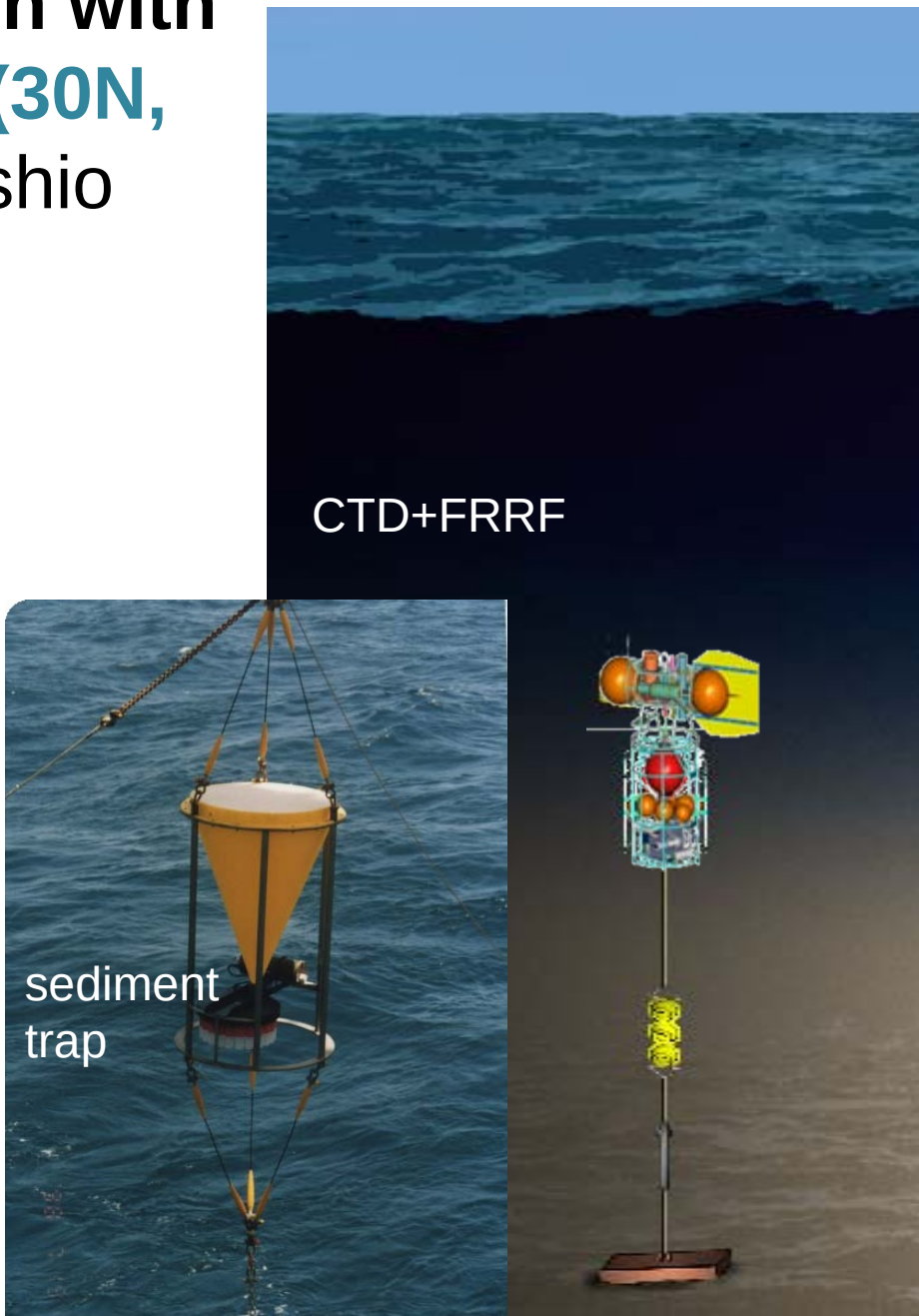


in conjunction with

- **Seasonal Ship observation**
  - CTDO-Hydrocast/water sampling
  - Surface/Subsurface current field
  - Chemistry
  - Bio-optics
  - Phyto/Zoo plankton abundance and rate processes
  - Vertical fluxes of particles



- **Time-series observation with mooring system at S1 (30N, 145E)** south of the Kuroshio Extension



The first phase of INBOX (cont.)

- **Time-series observation with mooring system** at S1 (30N, 145E)
  - Primary Productivity Profiler (FRRF)
  - Sediment trap at 200 m, 500 m & 5000 m
  - CTD for the top 200 m
  - ADCP for the top 500 m
- **Satellite altimetry, ocean color and SST data**
- **Initial targets includes:**
  - vertical transport of nutrients by mesoscale/submesoscale disturbances, mixing and entrainment due to air-sea fluxes
  - those temporal and spatial variations

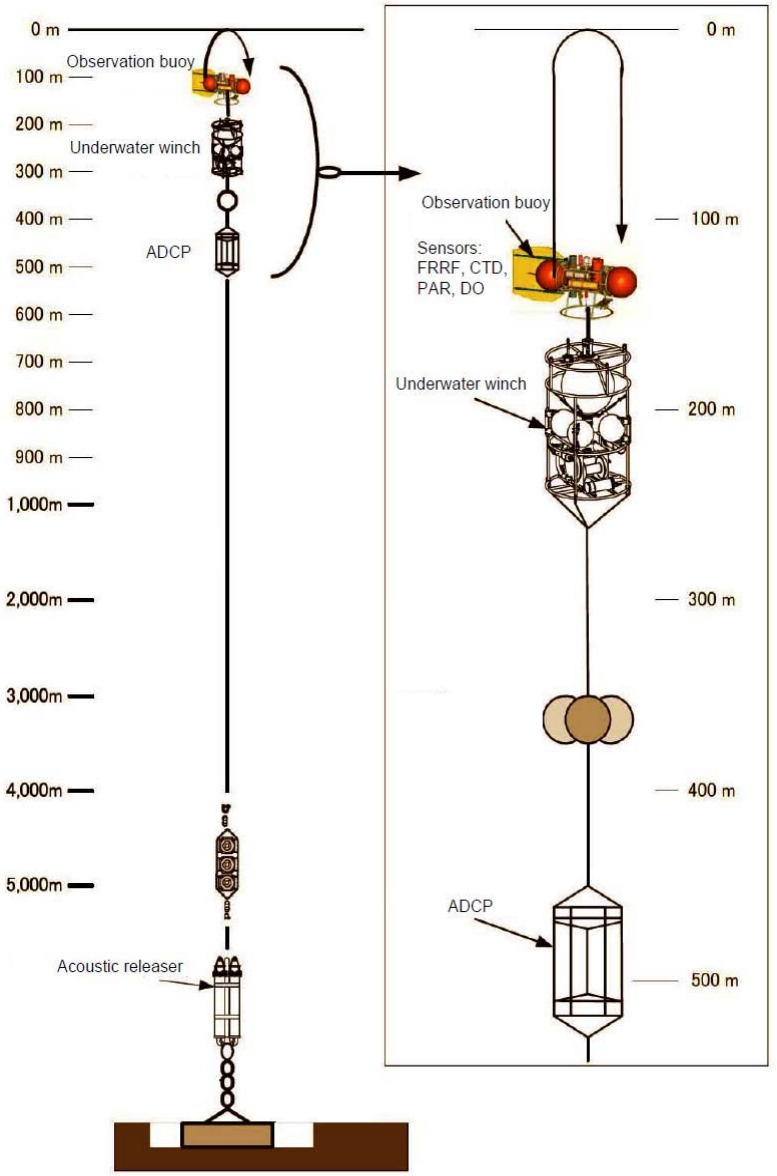


Figure 1. Schematic diagram of the primary productivity profiler.

In-situ calibration of oxygen sensors

- AANDERAA Optode sensors have significant bias depending on dissolved oxygen, pressure and temperature.
- In-situ calibration should be done.

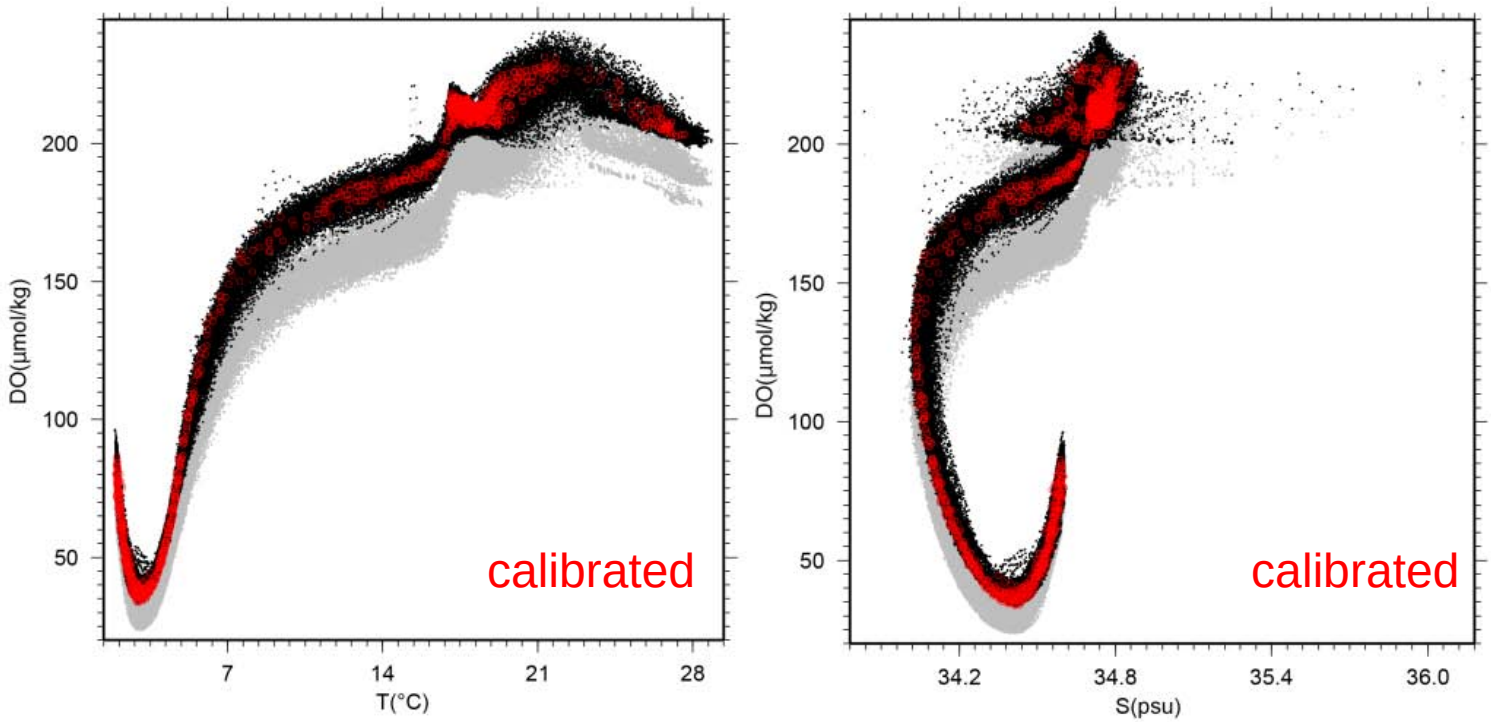
$$[O_2] = \frac{P_0 / P_c - 1}{K_{SV}} \left(1 + \frac{c_p P}{1000}\right)$$

$$K_{SV} = c_0 + c_1 T + c_2 T^2$$

$$P_0 = 1 + c_4 T$$

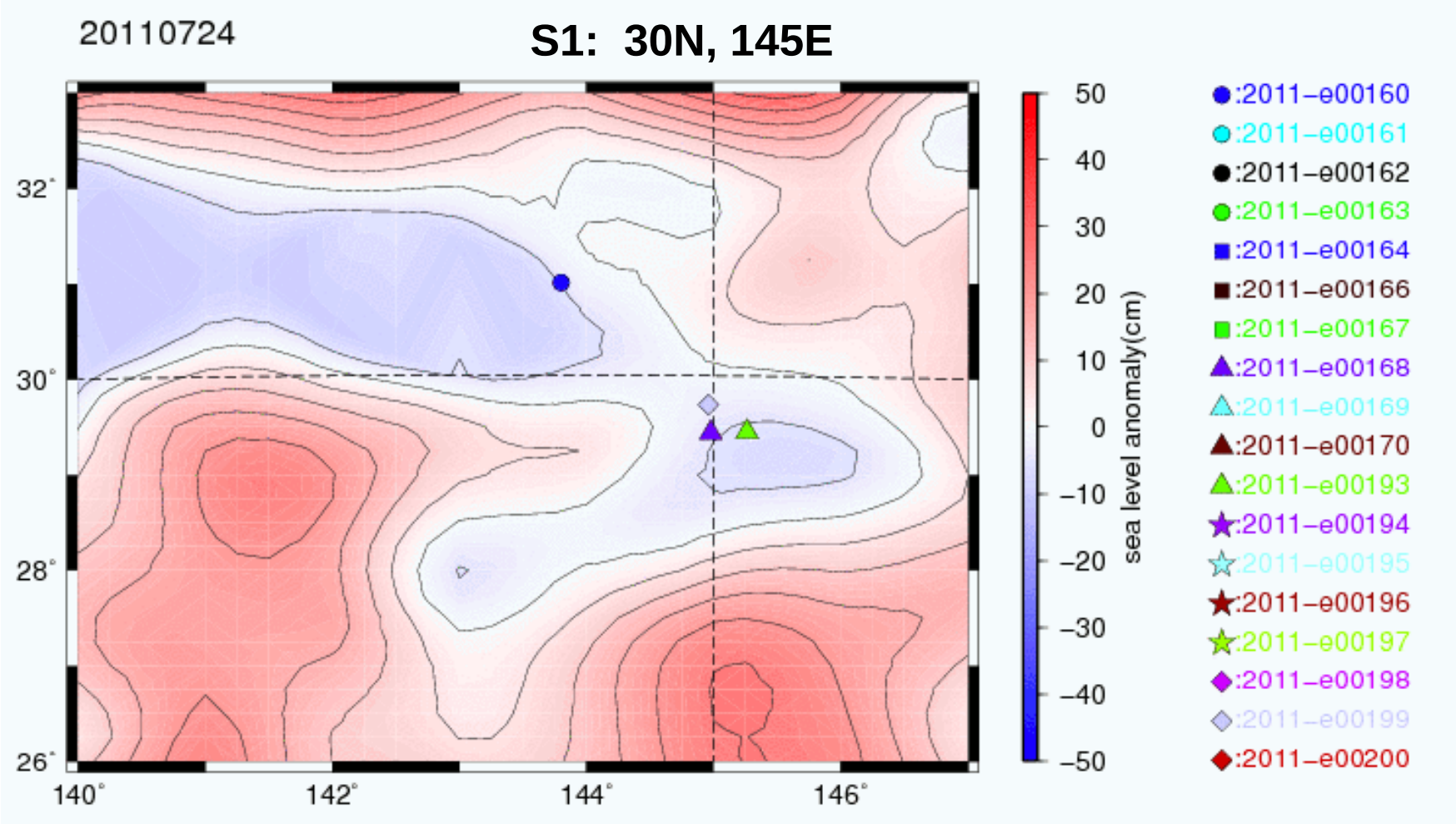
$$P_c = c_5 + c_6 P_t$$

Uchida et al. (2008)

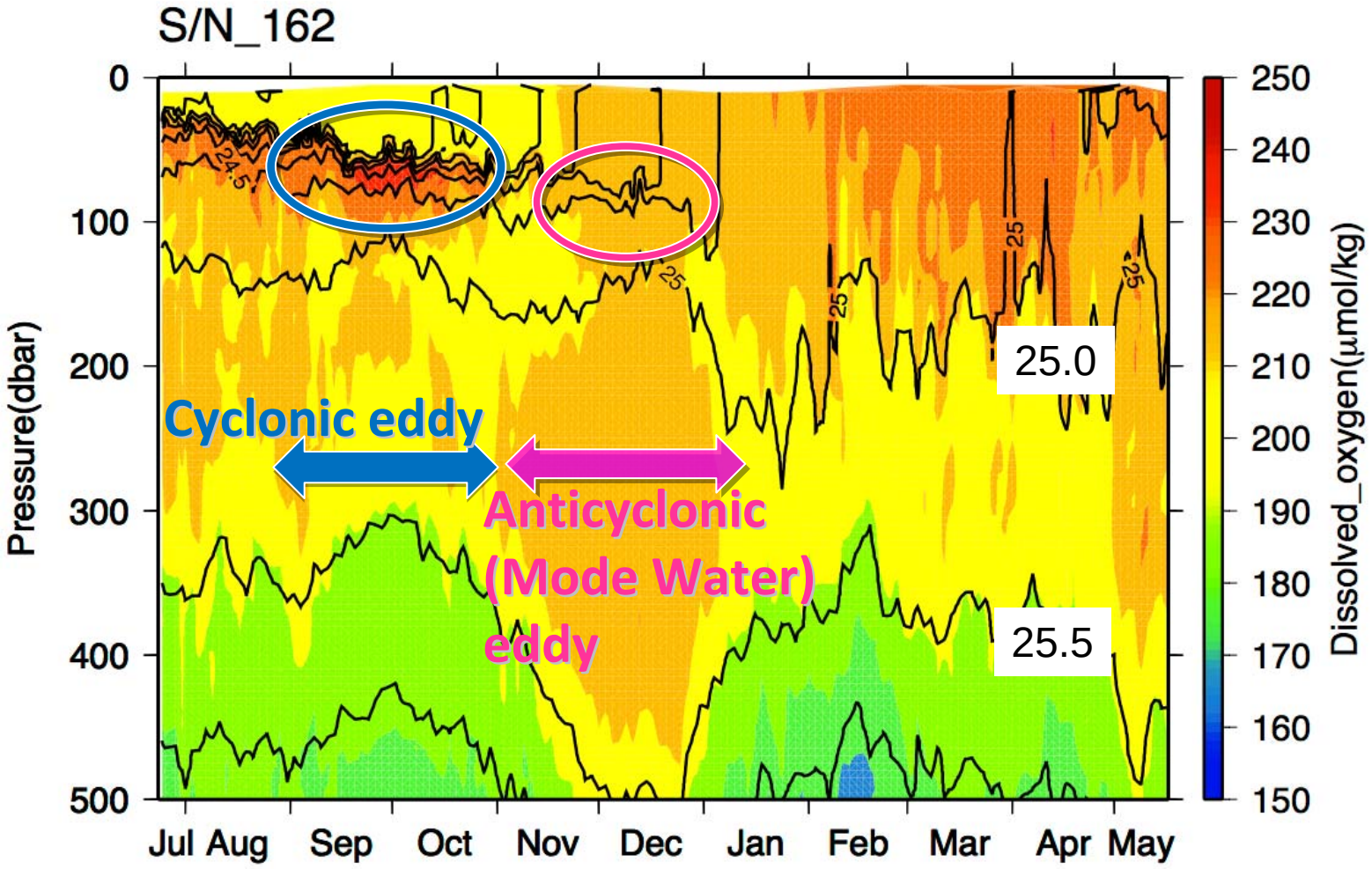


Floats drifting among cyclonic and anticyclonic eddies

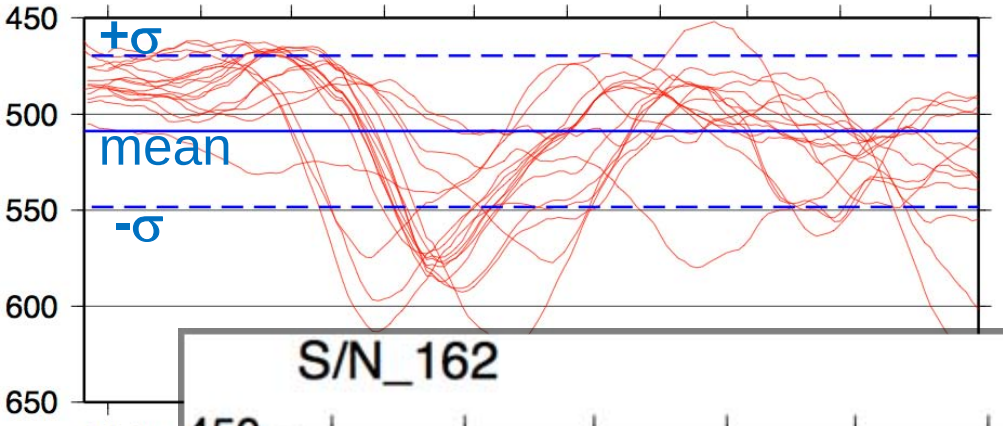
Positions of profiles and SSHA: July 2011 – May 2012



Example of vertical profile time-series: potential density (contour) and dissolved oxygen (color)

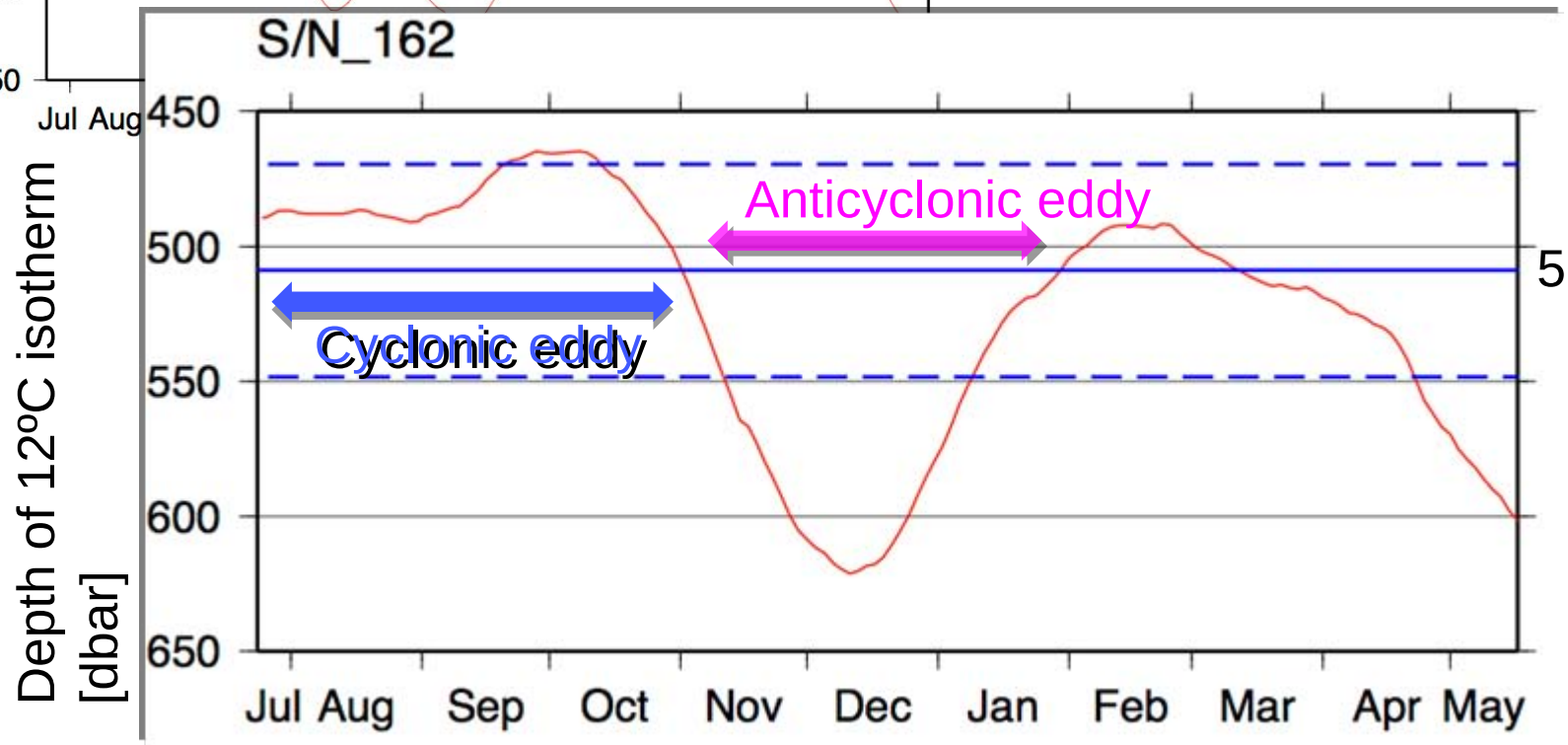


Sorting profiles into “cyclonic eddy” samples and “anticyclonic eddy” samples

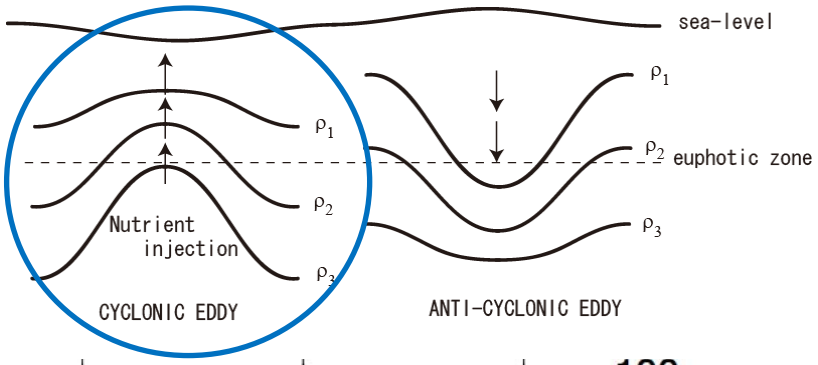


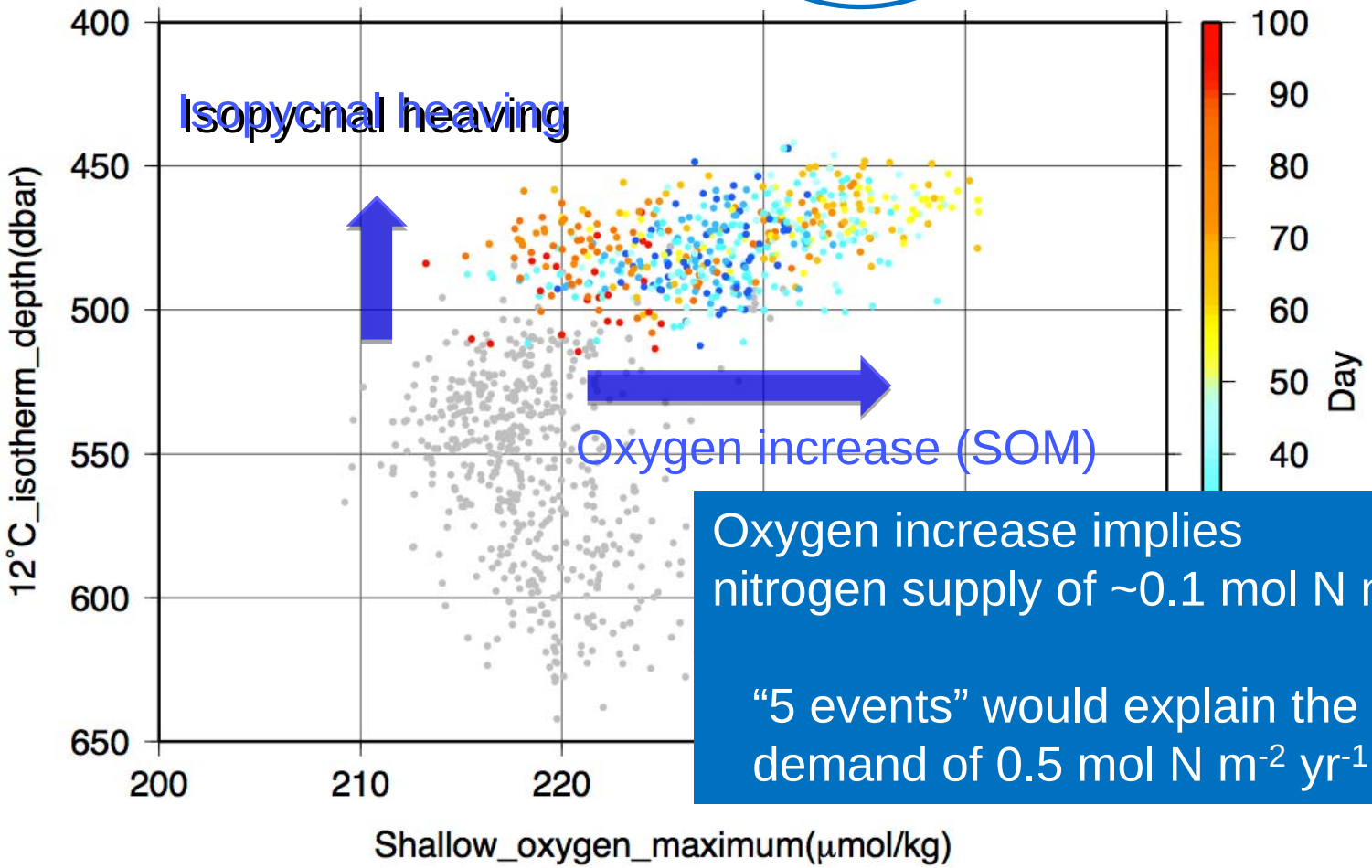
All floats:

12ºC isotherm representing main thermocline



Oxygen increase at SOM associated with passage of cyclonic eddy

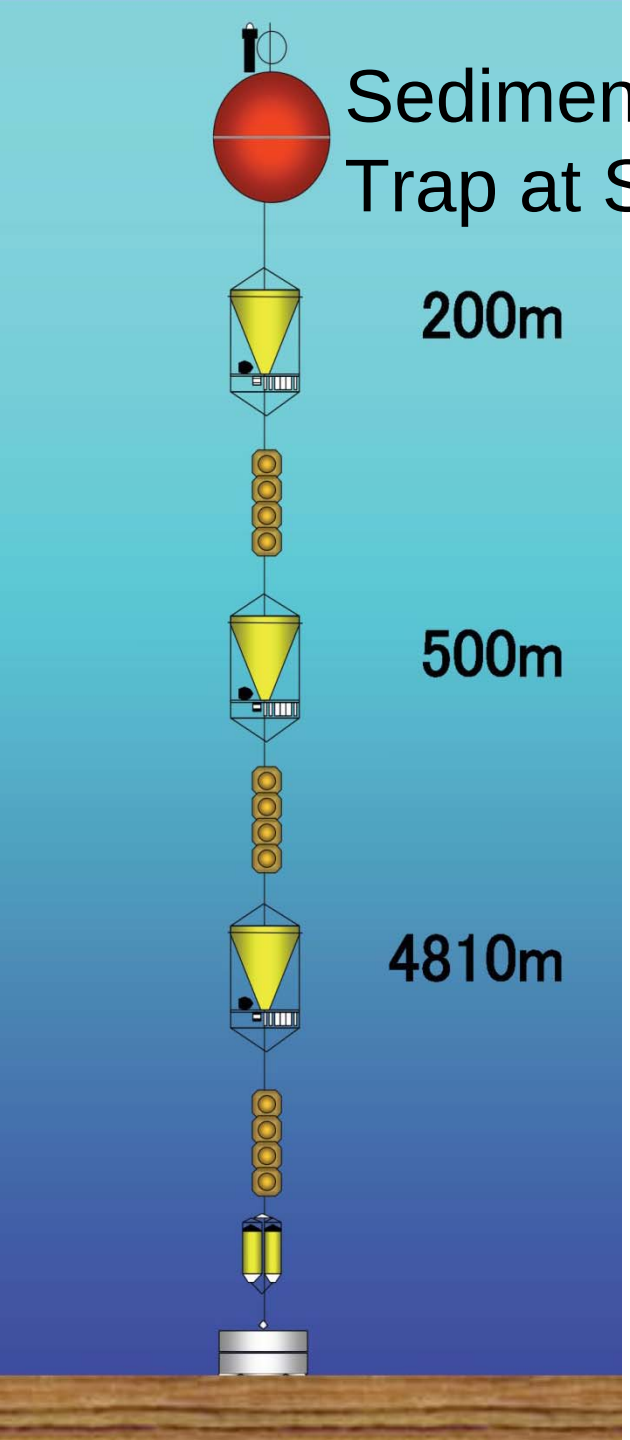


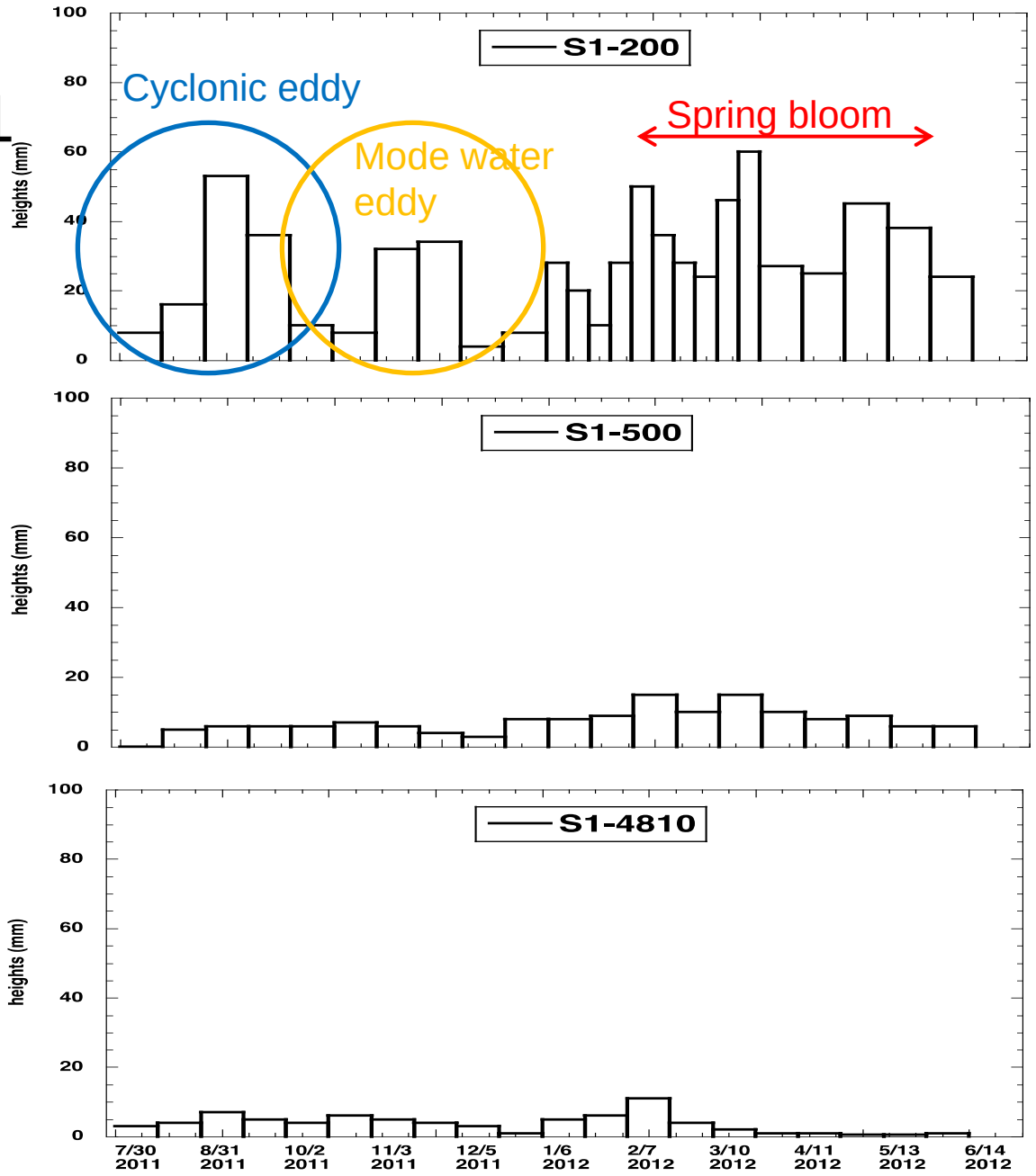


Oxygen increase implies nitrogen supply of ~0.1 mol N m^{-2}

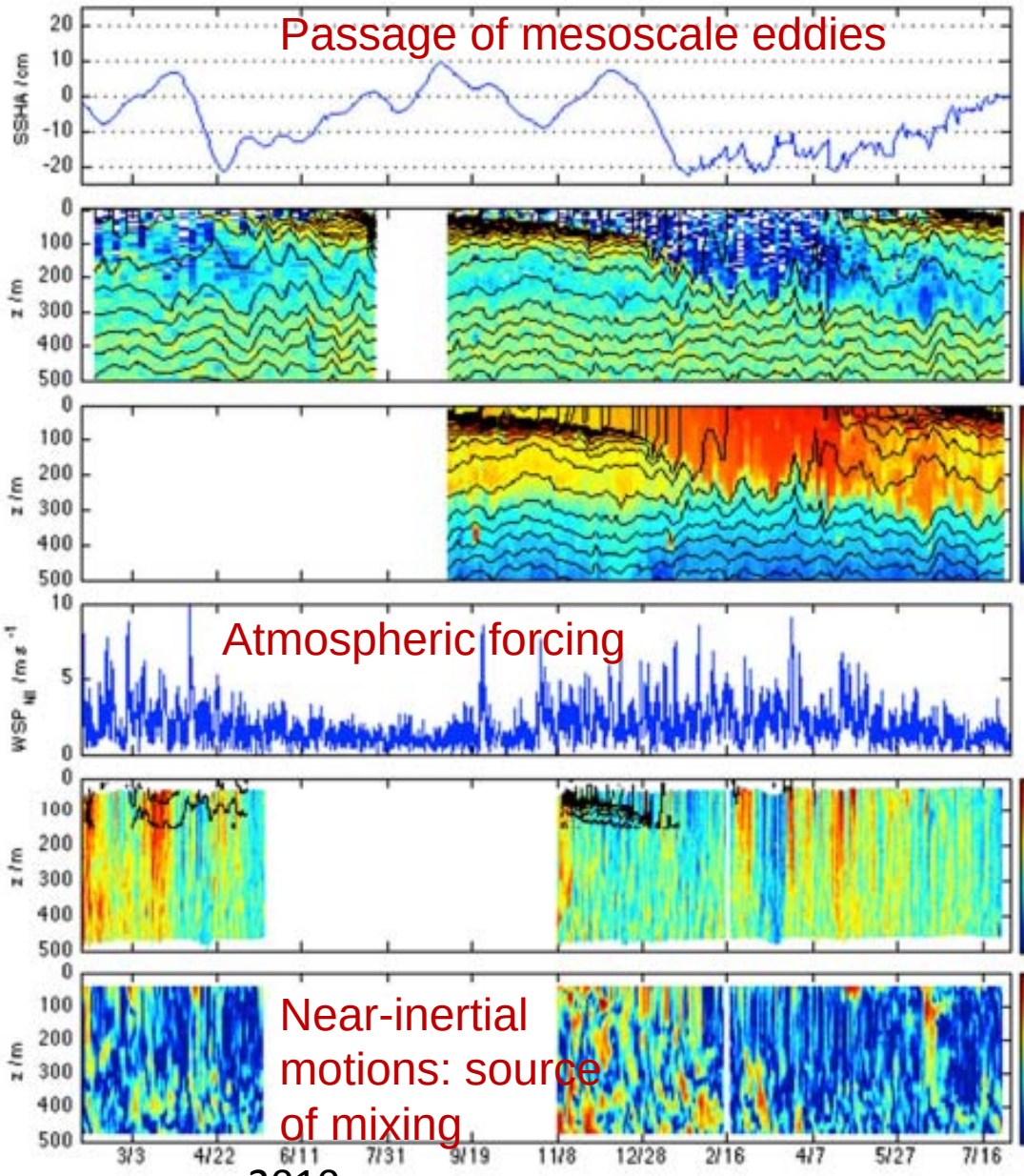
"5 events" would explain the annual demand of 0.5 mol N m^{-2} yr^{-1}.

Sediment Trap at S1

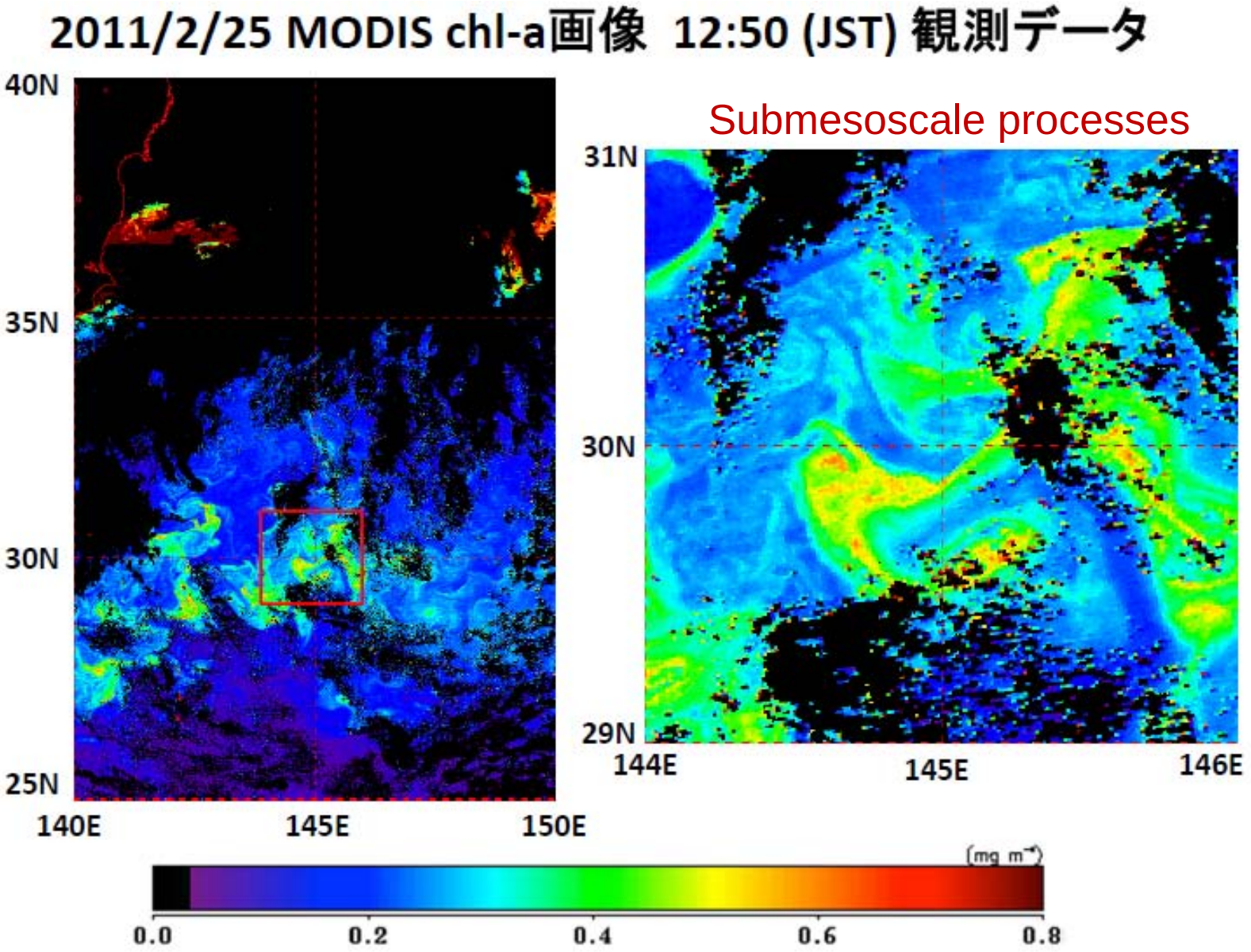




Time series at S1: Physical processes and blooming

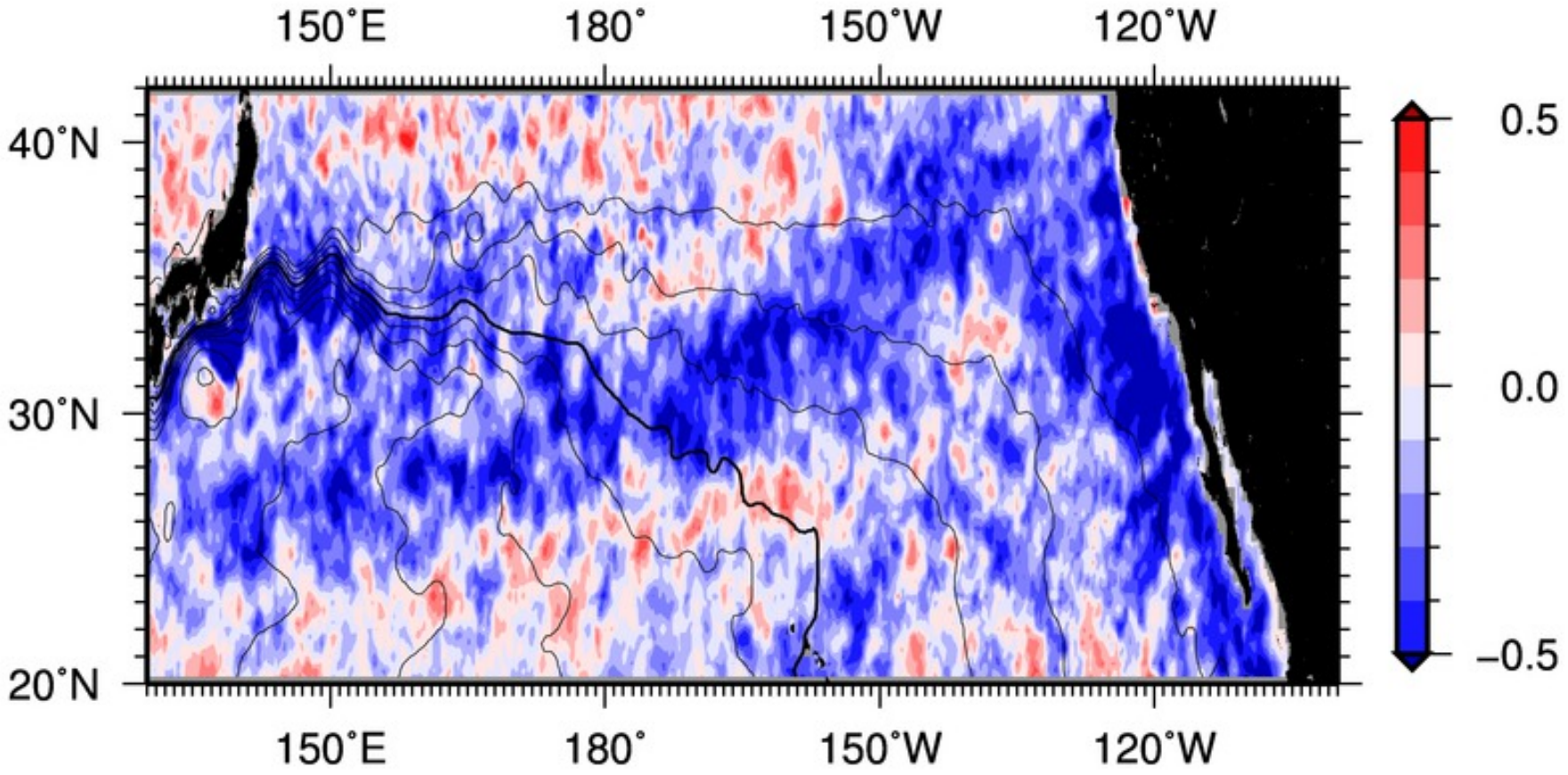


Daily image with 1º resolution: Physical processes and blooming

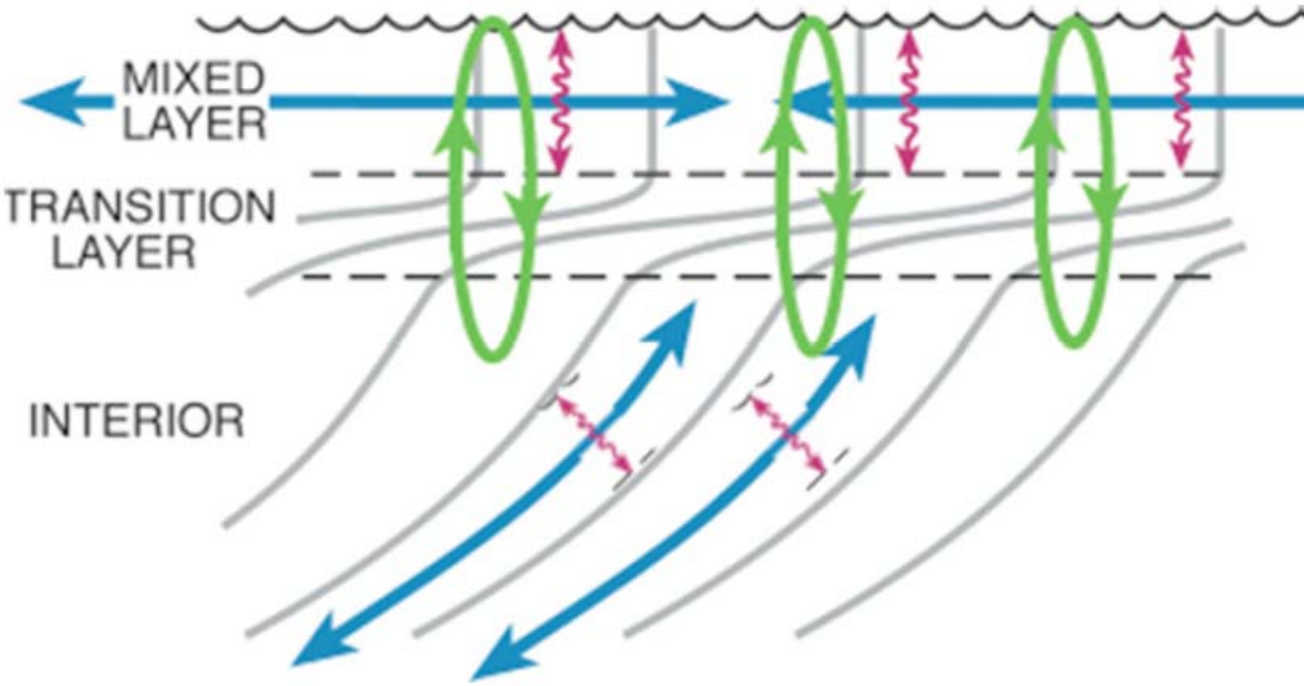


Correlation between SSHA (T < 300 days) vs Chl.a

April-June



Physical processes affecting vertical flux and biogeochemical processes



Mesoscale **100～500km**

Submesoscale **1～100km**

Mixing **～1km**

By R. Ferrari (MIT)

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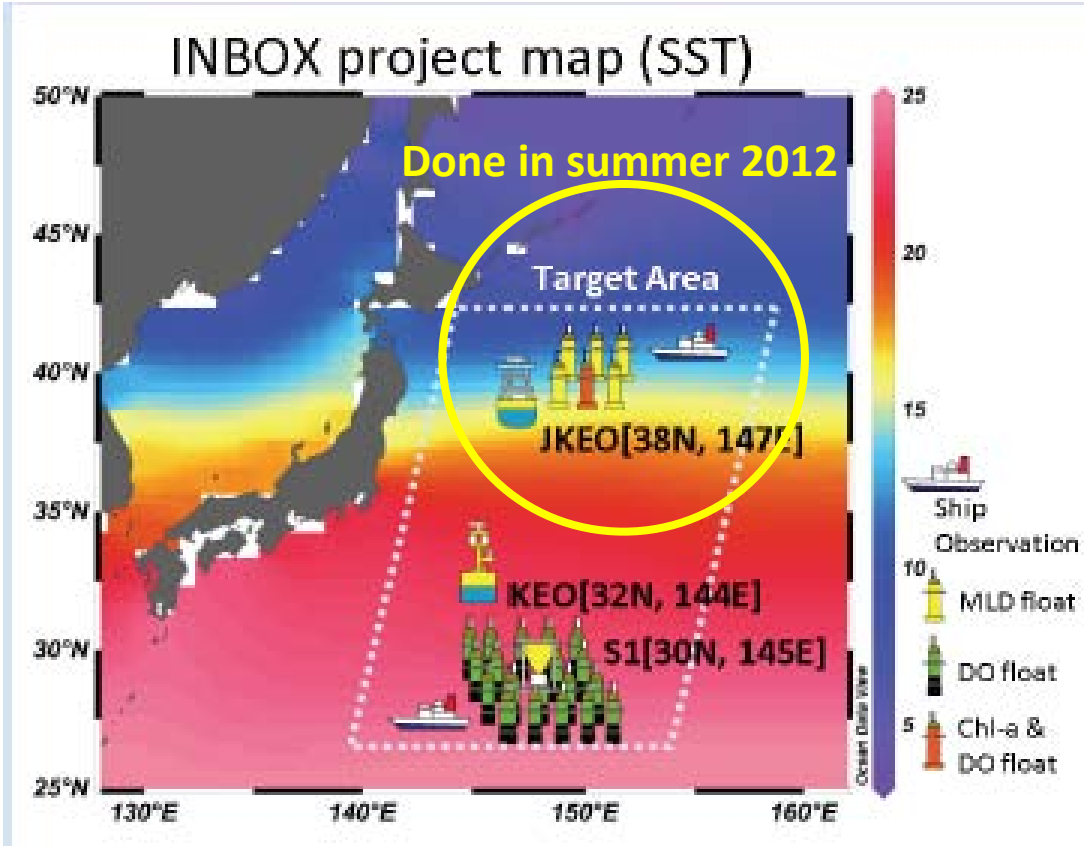
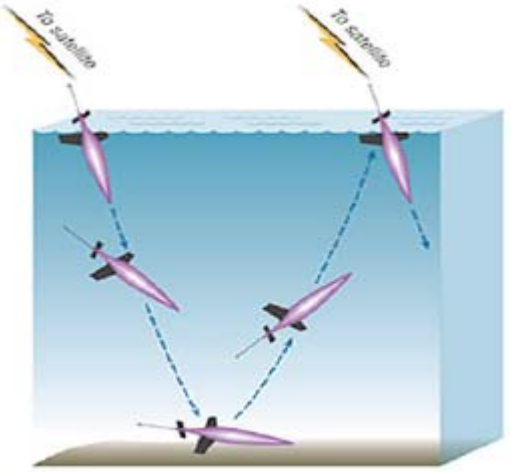
near-future expansion of observations





glider

EM-APEX

Summary

- INBOX: objectives
  - “Eddy-resolving” physical-biogeochemical data
  - BGC impacts of mesoscale physics
  - Physical understanding through biogechemistry
  - Information for BGC observing system design
- Quick look at the data from INBOX
  - Enhanced primary production associated with eddy passage
    - Quantification underway using DO and sediment trap data
  - Various physical processes related to blooming
    - Near-inertia motion causing mixing, storm events, …
  - Impacts of mesosclae eddy on air-sea flux of CO_2
- Future expansion of experiments
  - Submesoscale phenomena…
  - Mixing…
  - Gliders, EM-APEX…