PICES 2010
S15 MONITOR Topic Session
Development and use of ocean observing and forecasting systems in coastal and marine management
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Profiling floats as tools for biogeochemical and biological monitoring

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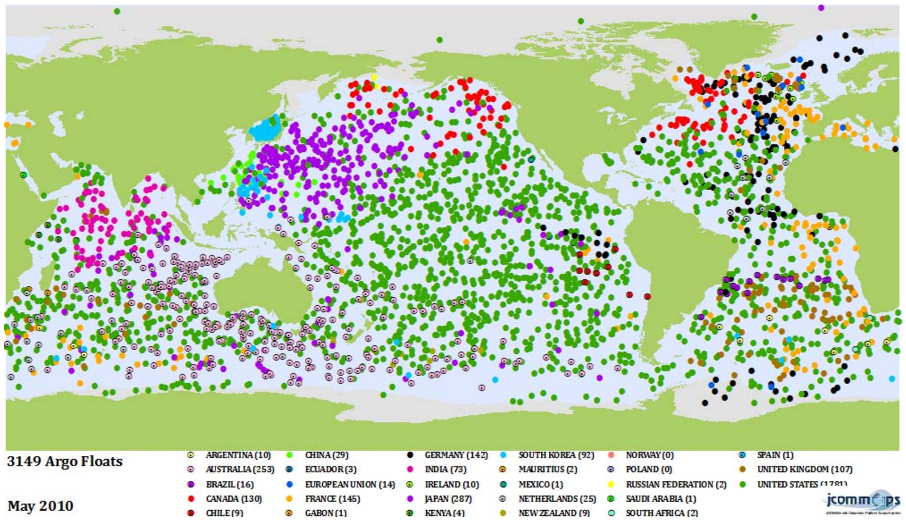
Outline

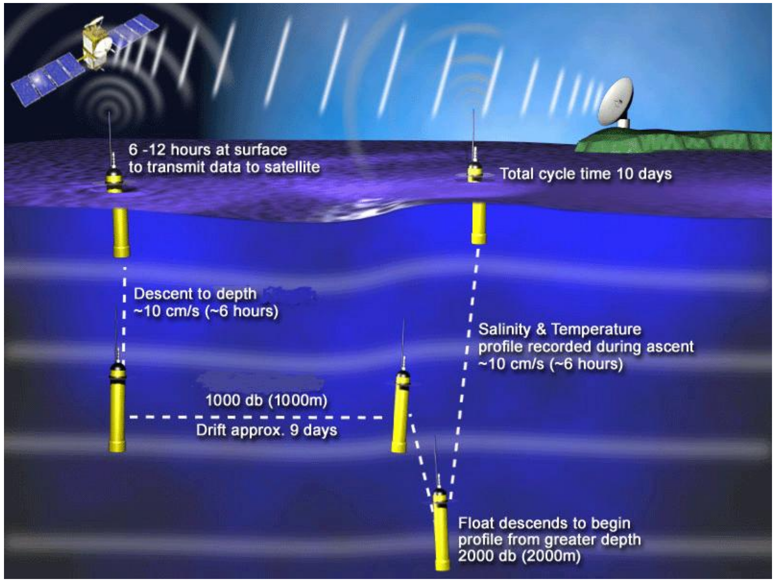
- OceanObs'09 Community White Paper by IOCCG
  - Comprehensive recommendations for profiling float observation for biogeochemical and ecosystem studies
- Example of interdisciplinary (physical-biogeochemical-biological) science topics emerging from profiling float observations
  - Summertime subsurface primary production in the subtropical gyre [Sukigara et al.,submitted]
- Remarks on challenges and approaches

After (or because of) Argo's initial success, expectations for its expansions have increased…



"3000 float array" achieved in 2007

-T/S measurement for upper 2000 m
-10 day cycle
-$3^o \times 3^o$ average spacing



Iridium telemetry allows high-resolution (1-2 dbar), multi-parameter data transmission and two-way communication.

New generations of chemical, optical and biological sensors have been developed.

Community White Paper prepared by IOCCG

"*Bio-optical profiling floats as new observational tools for biogeochemical and ecosystem studies: Potential synergies with ocean color remote sensing*" (Claustre and co-authors: International Ocean Color Coordinating Group –Bio-Argo Working Group)

Three types of floats:

1. "Bio-Argo" float

- To provide the biogeochemical community with an unprecedented amount of vertical profiles of (real-time) key biogeochemical and bio-optical variables.
- 20% of the Argo array (600 floats) with capacity to measure Chl*a* and POC
- ~1.5 M$/year & one person in each of GDACs plus...

2. Carbon-float
   - dedicated to process studies aiming at investigating key stocks and fluxes involved in the carbon cycle
   - 20-40 floats (POC, PIC, NCP) with adaptive sampling in key and undersampled areas for 5-year term
   - 1-2 M$ (floats plus sensors and devices)
3. Val-float
   - dedicated to the validation of ocean-color algorithms
   - 20-40 float (multispectral radiometers, ~10 cm vertical scale) in various trophic oceanic regimes, acquiring one matchup every 3-4 days for 2 years
   - 0.4-0.8 M$/year (incl. recovery of 25% of the array) & two persons (deployment, data treatment, QC)

Significant synergetic capabilities of these arrays:

- Extending remotely-detected signal to the ocean interior
  - Bio-Argo, Carbon- and Val- floats would yearly acquire about 20,000, 3,000 and 3,000 profiles of bio-variables (= more than 1000 days of ship-based acquisition)
    - => refining and/or establishing the algorithms for vertical distribution from surface values
- Producing long-term coherent database
  - Development of QC procedure ensuring data quality over a long term is required to address climate-relevant issues.
  - This is the key for the scientific success of a bio-optical float array and its synergetic combination with ocean color remote sensing and modeling.

Challenges for developing Bio-GC float arrays

- Additional sensors beyond T,S increase EEZ sensitivities and reduce chances for international consensus on global deployment.
- Bio-GC-Argo presents difficult technology development problems.
  - Besides sensor technologies, many technical issues for the data stream should be solved, including establishing naming conventions, metadata and technical information for the new variables as well as a quality control pathway
  - Bio-GC-Argo may be manpower-limited (sensor and data quality expertise).

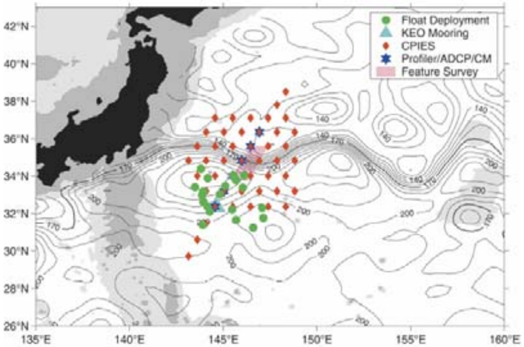
Understanding and enthusiasm of the community for the values are essential to overcome these difficulties.

Specific scientific issues will be key drivers.

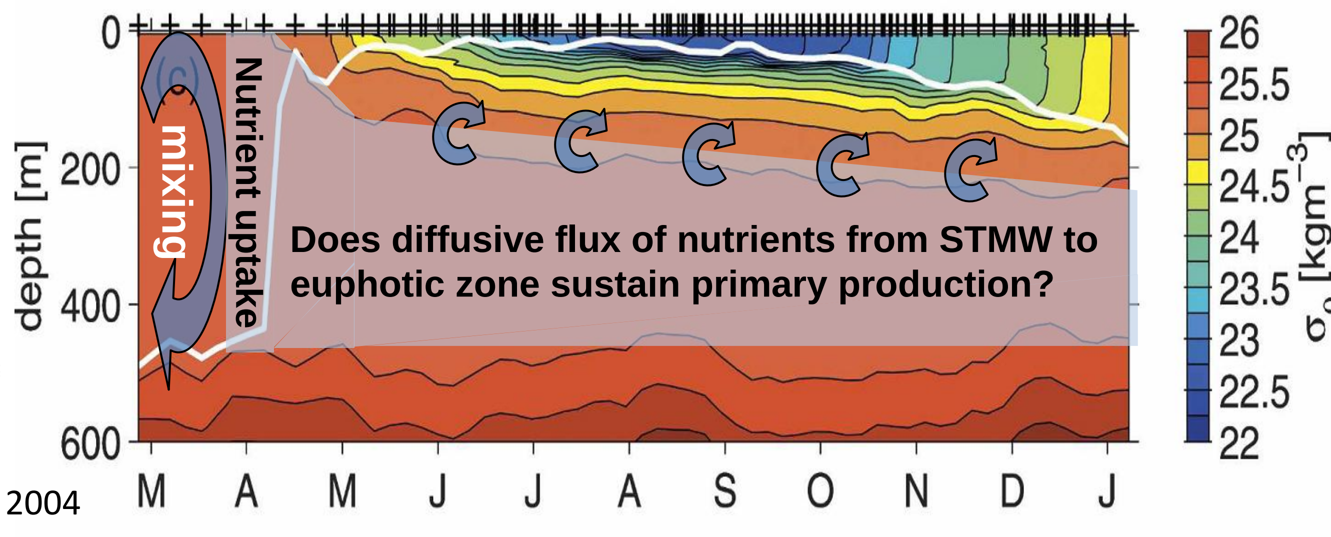
Two examples of interdisciplinary science topics emerging from profiling float observations.

Example: Subsurface primary production [1/6]

Intensive float deployment (KESS)



May-June 2004



Rapid erosion of Subtropical Mode Water (STMW) from the top

⇒ Large diapynal diffusiveity (**2-5 x 10^{-4} m^2s^{-1}**) was estimated based on potential vorticity budget (Qiu et al. 2006).

Physical and biogeochemical observations, using a profiling float, was conducted to examine the vertical diffusivity near the top of the STMW and associated subsurface primary production.

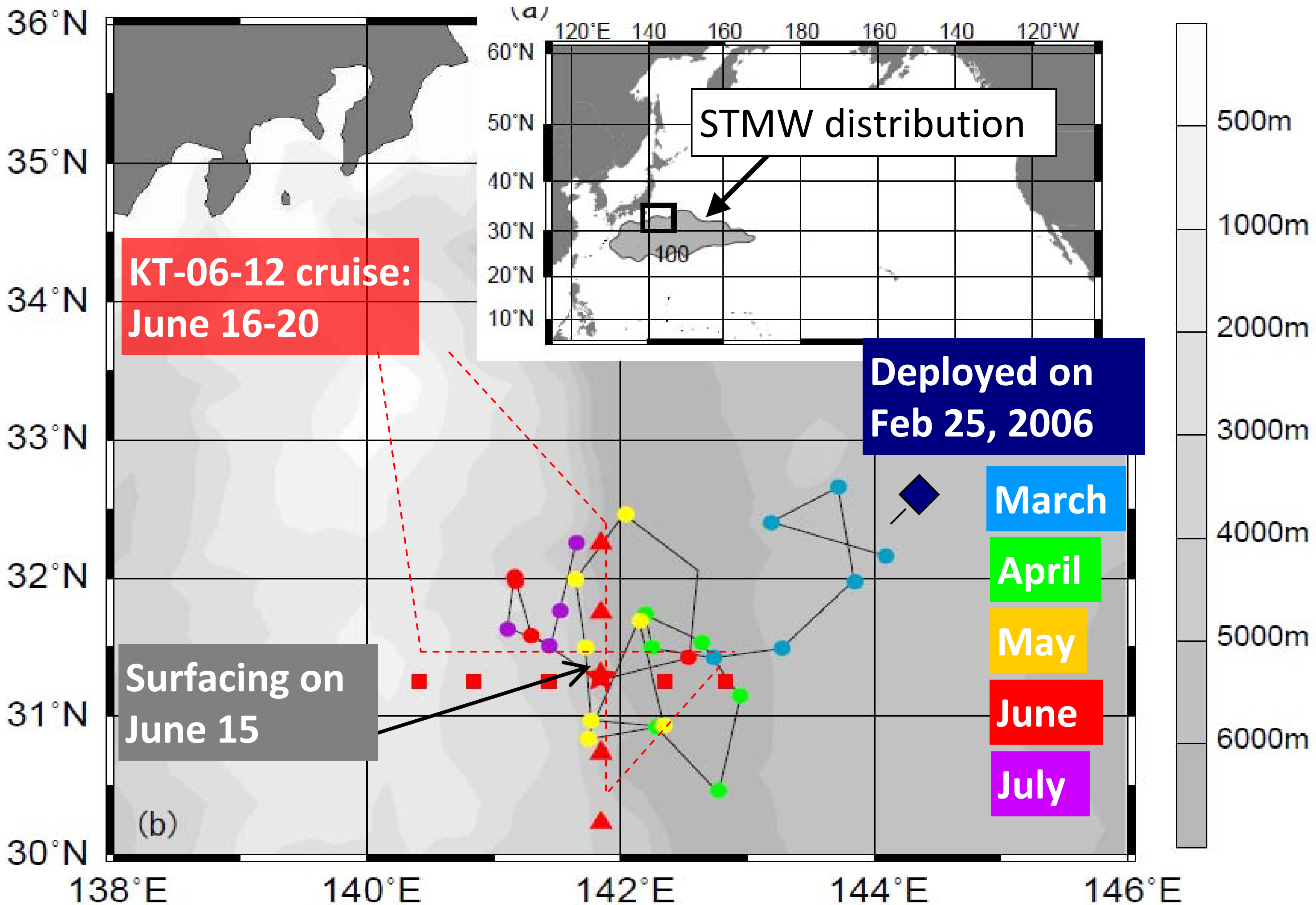
Example: Subsurface primary production [2/6]

APEX float

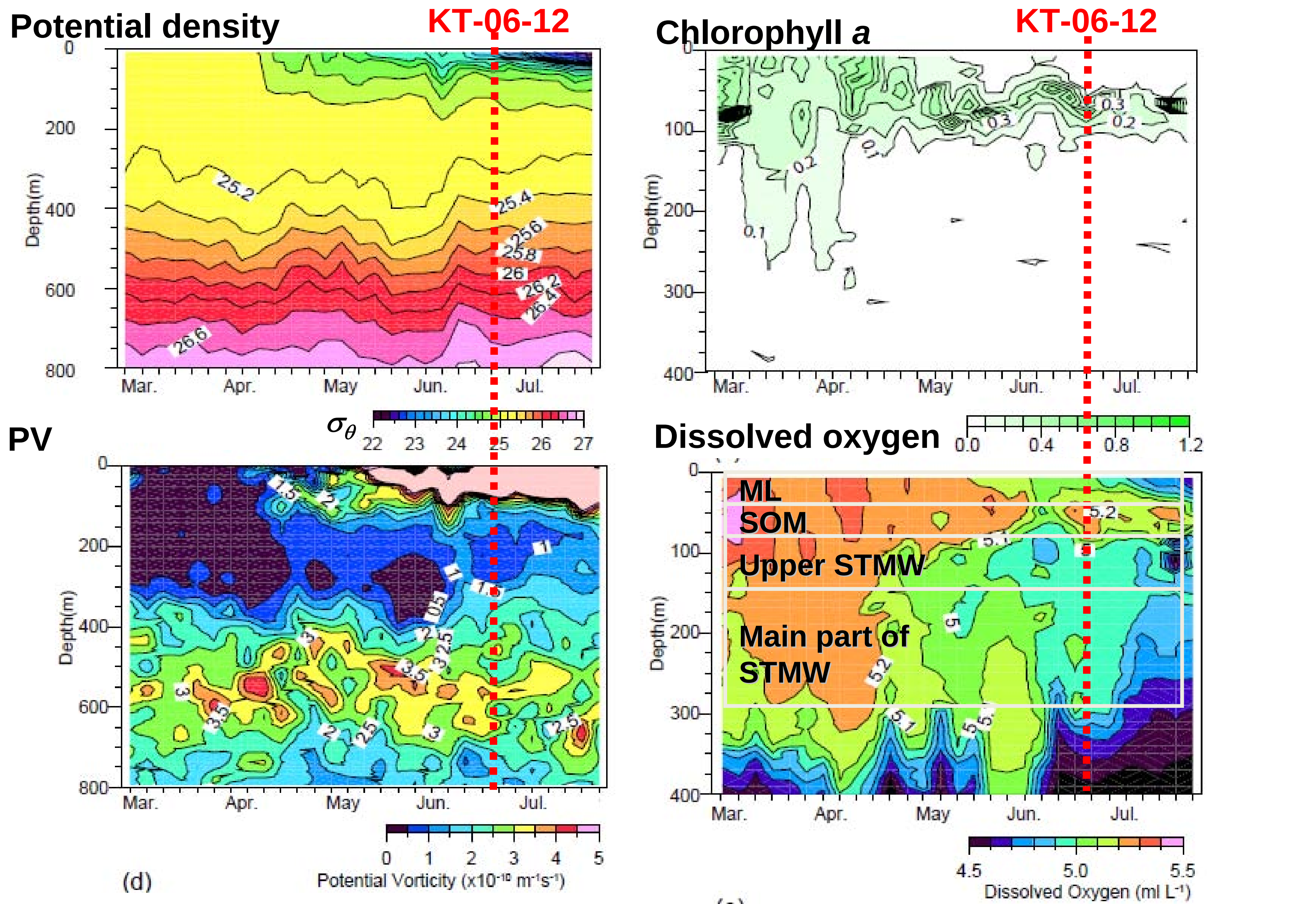
+ **DO sensor** (SBE43F)
+ **fluorometer** (Wetlabs FLNTU)

- Profiling every 5 days
- Drifting & profiling depth: 1000 db
- Measuring each 5 db for 0-200 db
  each 10 db for 200-400 db
  each 20 db for 400-1000 db
- Deployed at 32º21'N,144º35'E in the STMW formation area on Feb 25, 2006.

Example: Subsurface primary production [3/6]

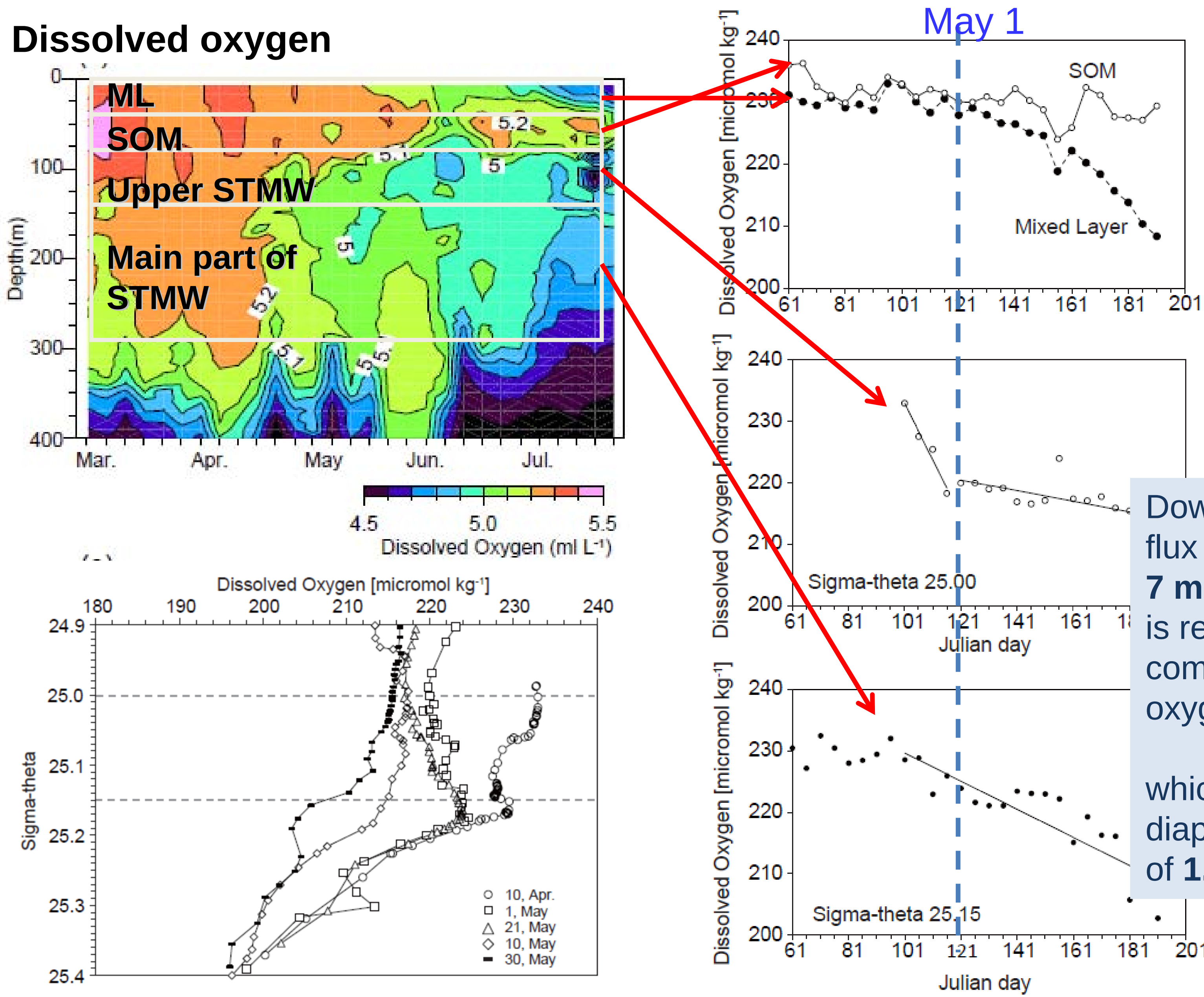


Example: Subsurface primary production [4/6]



Example 1: Subsurface primary production [5/6]

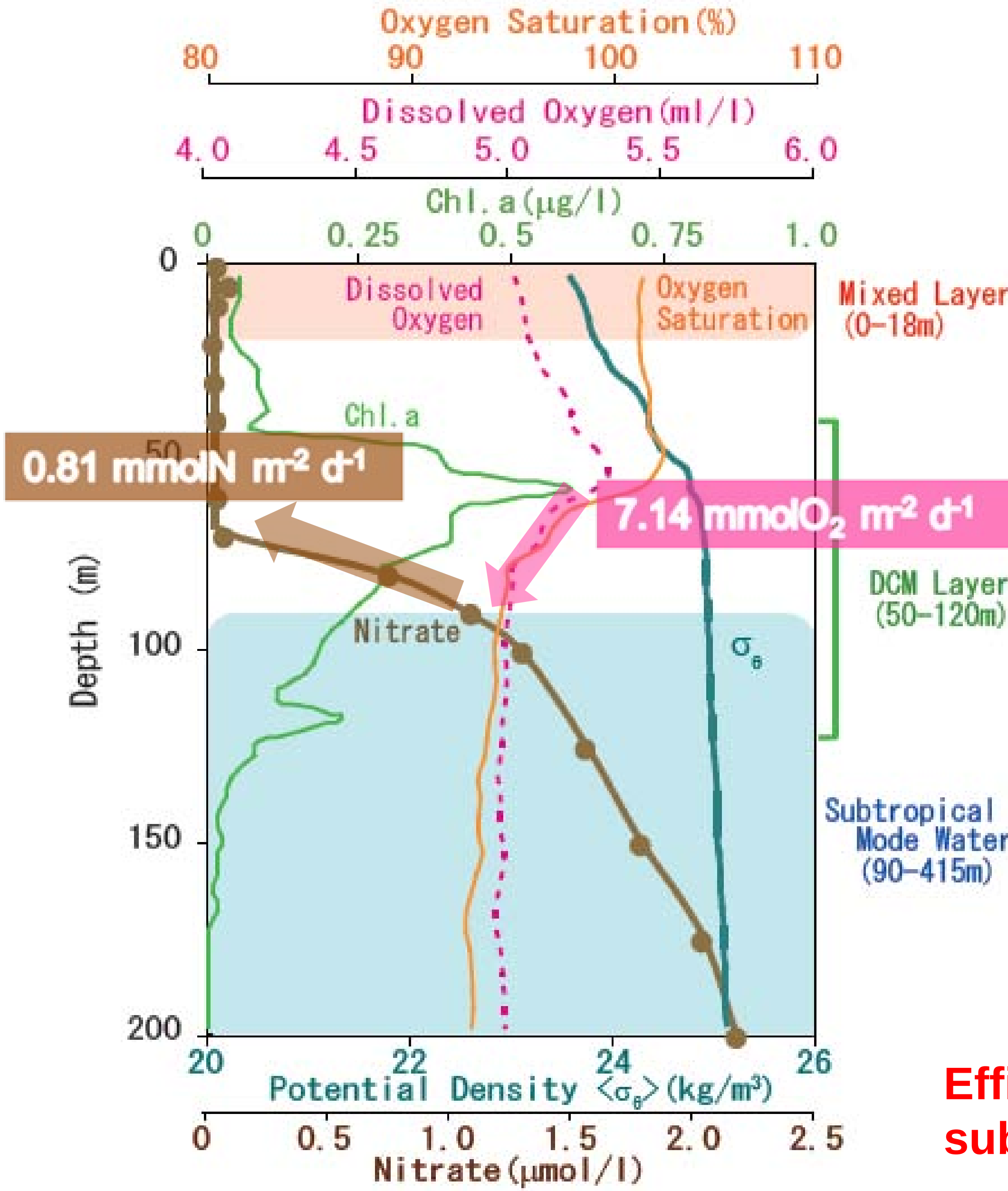
Dissolved oxygen



Downward oxygen flux of **7 mmolO$_2$ m^{-2} d^{-1}** is required to compensate the oxygen consumption,

which implies diapycnal diffusivity of **1.7 x 10^{-4} m^{-2} s^{-1}**.

Example: Subsurface primary production [6/6]



When large diapycnal diffusivity near the upper boundary of STMW (~**1.7 x 10^{-4} m^{-2} s^{-1}**) is assumed…

O_2/N (= **8.8**) is close to the Redfield ration (= **9.4**, Anderson, 1995).

Subsurface net community production (NCP) from May to July is estimated to be **5.3 mmolC m^{-2} d^{-1}** .

Efficient mechanism to support subtropical new production

Remarks on challenges and approaches

- Bio-GC float arrays will be much more revolutionary than the original Argo.
  - Totally new types of data (spatial & temporal coverage, vertical resolution, accompanying physical info, …)
  - Enormous challenges (technical, legal, political, …)
- Multiple approaches and their synergy will be essential.
  - A variety of difficulties
  - Many dedicated individuals and groups are needed.
  - Regional/scientific-issue-driven approaches will be useful in parallel with global approaches (e.g. IOCCG).
  - The synergy of those efforts are essential.

PICES and PICES countries will have key roles in promoting and coordinating relevant activities for developing Bio-GC float arrays.