

Mixed layer depth & chlorophyll a



Sachi Itoh, et al* (AORI, The University of Tokyo)

1. Hypotheses for phytoplankton bloom

✓ Critical Depth Hypothesis (CDH; Sverdrup, 1953)

- Bloom initiation occurs in spring
- Caused by increase in light availability above the threshold, mainly through mixed layer shoaling

✓ Disturbance-Recovery Hypothesis (DRH; Behrenfeld and Boss, 2014)

- Bloom initiates in winter when mixed layer is deep;
- Caused by decrease in grazing pressure through decreasing prey/predator encounter rates
- Analyses based on areal **biomass** [m^{-2}] instead of **concentration** [m^{-3}] in the North Atlantic

Question

- Mixed layer and phytoplankton in the NW Pacific?
- Bloom mechanism: CDH, DRH or others?

2. Profiling float observations in the Kuroshio-Oyashio Extension region (KOER)

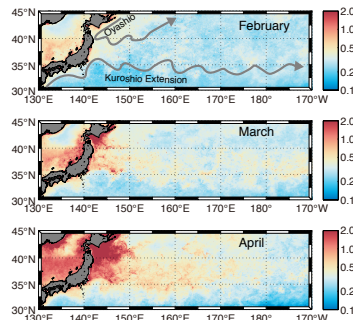


Fig. 1. Monthly sea surface chl a [mg m^{-3}] in the KOER

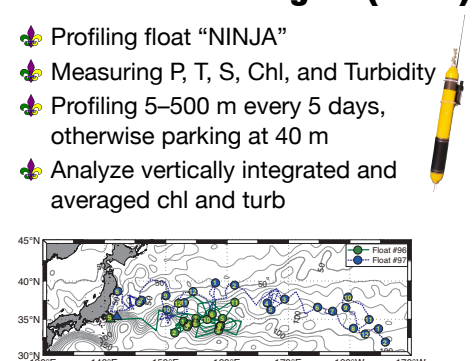


Fig. 2. Float positions at a 5-day interval

3. Fluctuations from winter to spring

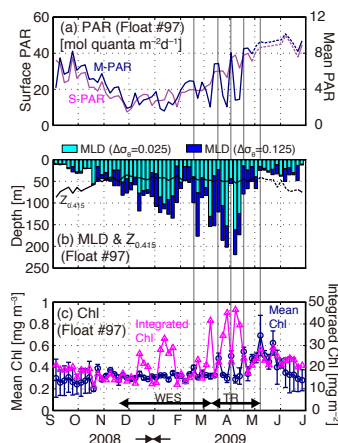


Fig. 3.

- (a) light intensity
- (b) Mixed layer depth (MLD) and $Z_{0.415}$ (depth of irradiance limit)
- (c) mean and integrated chlorophyll a within PLD (either MLD or $Z_{0.415}$, whichever is deeper).

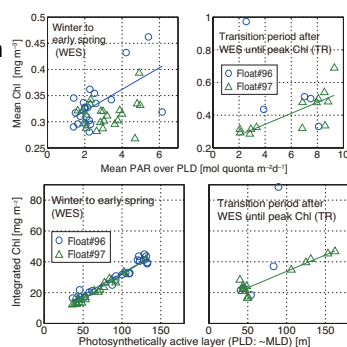
WES: Winter to early spring period
TR: Transition period after WES until the spring bloom

4. Correlation analysis

Fig. 4.

Relationships between mean PAR and mean chl a (upper), and PLD and integrated chl a (lower), for periods of WES (left) and TR (right).

- Similar results for turbidity (particle backscatter)



5. Phytoplankton responses to MLD fluctuations

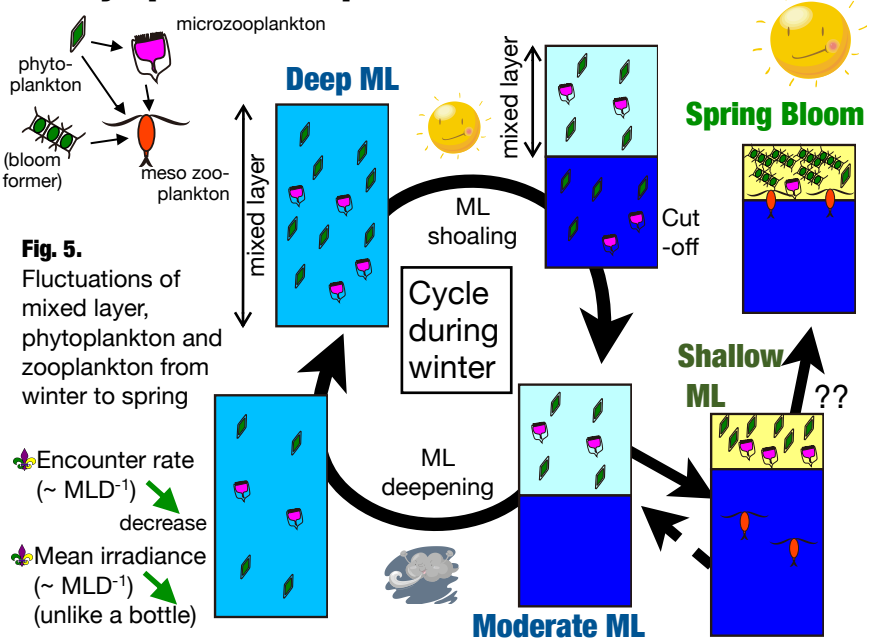


Fig. 5. Fluctuations of mixed layer, phytoplankton and zooplankton from winter to spring

- Encounter rate ($\sim \text{MLD}^{-1}$) decrease
- Mean irradiance ($\sim \text{MLD}^{-1}$) (unlike a bottle)

6. CDH or DRH?

- Phytoplankton biomass increased in winter when MLD was deep. (**consistent with DRH**)
- Deepening of MLD would decrease irradiance similarly to encounter rates, which likely compensate each other. (**opposed to DRH**)
- Positive responses of mean chlorophyll a to MLD shoaling events were observed (**consistent with CDH**)

Both production-driven (e.g., **CDH**) and loss-driven (e.g., **DRH**) processes are responsible for phytoplankton bloom in the Kuroshio-Oyashio Extension region

*Author list

S. Itoh, I. Yasuda, H. Saito, A. Tsuda and K. Komatsu

Contact information: itohsach@aori.u-tokyo.ac.jp

Full title: Mixed layer depth and chlorophyll a: profiling float observations in the Kuroshio-Oyashio Extension region

[adapted from Itoh et al. (2015, Journal of Marine Systems, doi:10.1016/j.jmarsys.2015.06.004)]

Open access to Itoh et al. (2015): <http://www.sciencedirect.com/science/article/pii/S0924796315001141>

