Impact of mesoscale eddies on spring bloom initiation in the Japan Sea

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Mesoscale eddies play an important role in the ocean primary production and biogeochemical processes and induce large spatial and temporal variability of near surface chlorophyll-a concentration (CHL). In particular, they are known to impact on the temporal variation of mixed layer depth (MLD), which is important for biological processes such as phytoplankton spring bloom phenomenon, a recurring phenomenon observed in temperate seas that results in large increase in phytoplankton abundance in springtime. In this study we investigated the influence of mesoscale eddies on timing of spring bloom initiation in the Yamato Basin region (133-139º E and 35-39.5º N), Japan Sea, in a period spanning 2002-2011. We identified mesoscale eddies based on geometric characteristic of satellite estimated geostrophic velocity around eddies (Nencioli et al., 2010). Eddy region was defined based sea level anomaly (SLA) data as the outmost closed contour of SLA enclosing identified centre (Chelton et al., 2011). CHL from winter (January) to early summer (June) was used to capture the spring bloom event. We also used in-situ profiles of temperature-salinity data within eddy region to estimate the MLD on individual profiles as the density change of 0.03 kg m^{-3} from surface reference level (10 m). Results showed that bloom was initiated early in cyclonic eddies (CEs) with shallow MLD (mostly < 100 m) compared to anticyclonic eddies (AEs) in which it was initiated despite the deeper MLD (> 100 m). From the examination of net heat flux (Q_0) within eddies we found that the onset of spring bloom in CEs occurred while large heat loss to the atmosphere was being observed, whereas in AEs it was observed close to the commencement of positive Q_0. This suggested that in AEs relaxation of turbulent mixing was important for bloom to start, whereas in CEs, because of shallower MLD, improved light condition for phytoplankton growth within the turbulent layer was reached earlier, thus triggering the bloom.

Keywords: Mesoscale eddies, mixed layer depth, phytoplankton, spring bloom

