Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AOS25-06 Room:203 Time:May 19 15:30-15:45

Model simulation of plankton bloom driven by riverine inputs of nutrient and fresh water in coastal regions

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Rivers transport nutrients and suspended sediment matter (SSM) as well as fresh water from land to coastal regions, where biological productivity is high. The buoyancy by fresh water forms horizontal anticyclonic gyres (Kubokawa, 1991; McCreary et al., 1997; Yankovsky, 2000; Magome and Isobe, 2003) and vertical estuary circulations (Rattray and Hansen, 1962), which affect the variation of biological production such as plankton bloom.

We developed an ocean general circulation model (OGCM) including a simple ecosystem model, to investigate the three-dimensional and temporal changes in phytoplankton bloom caused by riverine input such as flooding.

Distribution patterns of nutrients and phytoplankton are significantly different from that of fresh water. The high concentration of phytoplankton shifts downstream (right-hand side from river mouth) to upstream regions (left-hand side). The shift that occurs is categorized by the different nitrate origins: (1) river-originated nitrate in the downstream region, (2) subsurface-originated nitrate in the upstream region, transported by upwelling associated with vertical estuary circulation and horizontal anticyclonic gyre, and (3) regenerated nitrate in the upstream region.

High concentration of SSM supplied from river shades sunlight and reduces phytoplankton photosynthesis efficiency. Net primary production is lower than that without flooding, until around ten days after the high SSM discharge. After SSM is removed from sea water, phytoplankton increase with the shift from downstream to upstream, and the plankton bloom is delayed.

Keywords: coastal ocean, biogeochemical cycles, 3-D modeling, riverine input, nutrient supply, phytoplankton bloom