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Numerical assessment of atmospherically promoted seawater phytoplankton production: Significance of wet deposition events of nitrogen compounds

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The atmospheric input of macronutrients often has been claimed to be missing element to explain anomalies in primary production. The haze events (arising from forest fires modulated by El Nino events) that have plagued South East Asia (SEA) are likely to affect atmospheric fluxes of nutrients and other pollutants into aquatic systems. Atmospheric deposition in Singapore and surrounding countries appears to provide significant fluxes of nutrients of environmental concern and to play an important role in the coastal eutrophication. In this study, an attempt has been carried out to evaluate the percentage change of inorganic nitrogen (N) in the coastal water column due to biologically available nitrogen from atmospheric wet deposition (WD). During wet periods the removals of gaseous and particle-sorbed compounds dominate other depositional processes. Because precipitation is intermittent and a local phenomenon; it is crucial to consider its spatial and temporal variability. The direct atmospheric flux of inorganic nitrogen into coastal waters with WD was quantified (estimated 3.92 g/m2/year) using field monitoring. A numerical 3D water quality model NEUTRO has been developed to describe the dynamics of nutrients and plankton in coastal waters in response to nutrients loads, including atmospheric depositions from spatially distributed sources. NEUTRO was utilized to estimate the additional N contribution by WD to coastal water and to evaluate the potential of atmospherically deposited N by stimulating the phytoplankton production in nutrient-depleted conditions. To understand relative importance of atmospheric (vertical) fluxes in the region as com-

pared with lateral (horizontal) fluxes via open ocean boundaries, the model was ran for three cases, considering: (a) flux of nutrients from lateral boundaries only; (b) atmospheric fluxes only; and (c) combination of fluxes from the ocean and atmosphere. The concentration of nitrate nitrogen at open boundary, due to atmospheric wet deposition and initial seawater concentration were 0.02 mg/l, 1.835 mg/l and 0 mg/l respectively. Computations show that atmospheric fluxes may account for up to 10-15% of total mass of nitrate nitrogen in water column, which might be a relatively significant contribution into regional eutrophication in nutrient-depleted condition. Since atmospheric conditions vary significantly at hourly and daily scale, we explored the potential of episodic extreme events to stimulate phytoplankton blooms. The events were estimated to deliver up to 8.96 mg/l of TN, representing a phytoplankton stock of 1.69 mg Chl/l. The nitrogen inputs from atmospheric deposition to the surface were modeled to investigate the significance of these fluxes for generating blooms in SEA. The results obtained from this comprehensive study will be presented and discussed.