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TITLE: Nutrient dynamics in Amazon shelf waters: results from AMASSEDS

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ABSTRACT:

Four hydrographic cruises were conducted on the Amazon shelf as part of the AMASSEDS field program. During each cruise, approximately 55 stations were occupied and nutrients, as well as other hydrographic parameters, were measured. The results of this time series sampling program indicate that the nutrient concentrations in the riverine end-member (silicate = 144 ?mol kg?1, phosphate = 0.7 ?mol kg?1, nitrate = 16 ?mol kg?1, ammonium = 0.4 ?mol kg?1, and urea = 0.9 ?mol kg?1) remain relatively constant, despite a two-fold seasonal variation in river water discharge rate. Of the major nutrients (nitrate, phosphate, ammonium and silicate), nitrate shows the greatest seasonal change in riverine end-member concentration with a high value (23 ?mol kg?1) during the March cruise (rising river discharge) and a low value (12 ?mol kg?1) during the November cruise (falling river discharge). Nitrate is the dominant nutrient form of inorganic nitrogen throughout most of the river/ocean mixing zone, however, in the outershelf area, where nitrate has been depleted by biological production, this nutrient occurs at concentrations comparable to the other nitrogen species (ammonium, nitrite and urea), which are at levels < 1 ?mol kg?1. Nearshore, high turbidity inhibits phytoplankton production because of light limitation, whereas on the outershelf, nitrate appears to be limiting growth more than silicate or phosphate. Nutrient uptake was observed during all four cruises, however, nearly all of this production must be regenerated in shelf bottom waters, because very little of the biogenic materials are buried in the seabed (silicate burial <4% of flux to algal blooms; ?10% burial of biologically available inorganic nitrogen reaching the river/ocean mixing zone; and <3% burial of phosphate flux to shelf environment). Clearly the Amazon shelf is not an efficient nutrient trap. Initial estimates of primary production on the Amazon shelf suggest that algal blooms are sustained by regeneration to a large extent (up to 83%, 69% and 59% for N, P and Si, respectively) as well as by riverine and upwelled sources. Nutrient budget calculations have been used to establish the dominant external source of nutrients to the algal blooms occurring on the outer shelf. Based on flux core measurements, diffusive nutrient fluxes from Amazon shelf sediments are very low relative to riverine supply rates (silicate flux out = 1.3% of riverine flux, the nitrate plus ammonium flux is essentially zero, and the phosphate seabed flux shows removal of ?2% of the riverine flux). Inventories of naturally occurring210Pb were used to estimate the onshore flow of subsurface water onto the Amazon shelf. The radiochemical data indicate that the flux of water onto the shelf may be as much as five to ten times greater than the annual flow of the Amazon River. The nutrient flux from this shoreward movement of ocean water (originating at a depth of 60?100 m water depth) accounts for about 80% of the externally supplied ammonium, 52% of the externally supplied phosphate, 38% of the externally supplied nitrate, and 17% of the externally supplied silicate reaching the outer shelf, with the remainder of the nutrient fluxes coming from the river. Therefore, the outershelf algal blooms are supported to a significant extent by the shoreward flux of nutrients from offshore, subsurface waters.

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