Contribution ID : **256** Type : **Poster**

A benthic-pelagic nitrogen budget for the continental margin of the Peruvian oxygen minimum zone

Nitrogen (N) loss in oxygen minimum zones (OMZ) accounts for around one-third of global fixed N loss and plays a critical role in the oceanic N inventory. Expanding OMZs in tropical oceans may intensify N loss, reduce primary production, and thereby decrease oceanic CO_2 uptake. However, major uncertainties exist regarding the transport pathways of nutrients and the magnitude of N-loss in OMZs. In this study, a comprehensive data set from the continental margin of the Peruvian OMZ is used to evaluate benthic-pelagic dissolved inorganic N budgets and to investigate the dominant nutrient transport mechanisms. The data set was collected during a 4-week process study in austral summer 2013 along 12°S and consists of velocity time series from moorings, turbulence measurements, CTD/O2 profiles, nutrient and N2 gas concentration profiles, and benthic nutrient fluxes measured in situ by landers. Resulting sinks and sources allow net N-losses to be determined and compared to the flux divergences of an excess N2 gas budget. On the anoxic shelf, nearstagnant circulation and elevated turbulence due to internal waves resulted in a dominant nutrient transport mechanism via diapycnal mixing. Nutrient fluxes due to vertical advection (i.e. upwelling) were insignificant.Enhanced sediment release of ammonium (NH4) and diapycnal flux convergences of nitrate (NO3) and nitrite (NO2) resulted in a net N-loss of 220 nmol L-1 d-1. This agrees with the divergence of excess N2 fluxes. Benthic NH4 release accounts for about 50% of N-loss, most likely due to coupling with annamox in the water column. On the upper continental slope, N-loss occurred primarily in the near-bottom region of the water column. Here, diapycnal NO3 fluxes and isopycnal eddy and advective fluxes provide NO3 for sedimentary uptake and NO2 production by NO3 reduction. Combining water column NO3 and NO2 flux imbalances with sedimentary NH4 release resulted in an N-loss of 23 nmol L-1 d-1. Again, N-loss of similar magnitude was obtained from an excess N2 budget. The study indicates that water-column NH4 sources play only a minor role for N cycling processes along the continental margin of Peru. Results also highlight diapycnal mixing as a key transport mechanism providing nutrients for benthic uptake.

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Track Classification : 10 Biogeochemical Cycles: Feedbacks and Interactions