Simulated 21st century's increase in oceanic suboxia by CO_2-enhanced biotic carbon export

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Using a model of global climate, ocean circulation and biogeochemical cycling, experimental findings of a pCO_2-sensitive increase in biotic carbon-to-nitrogen (C:N) drawdown and of pCO_2-senstive changes in nitrogen fixation and diazotroph composition are extrapolated to the global ocean. For a simulation run from the onset of the industrial revolution until A.D. 2100 under a ``business-as-usual'' scenario for anthropogenic CO_2 emissions, the model predicts a negative feedback on atmospheric CO_2 levels that represents a small alteration of the anthropogenic perturbation of the carbon cycle. Changes in simulated nitrogen fixation remain relatively small on decadal and longer timescales because of negative feedbacks mediated by inorganic nutrient inventories. Still, the model results reveal a dramatic 50% increase in the suboxic water volume by the end of this century in response to the respiration of excess organic carbon formed at higher CO_2 levels. This is a significant expansion of the marine “dead zones” with severe implications not only for all higher life forms, but also for oxygen-sensitive nutrient recycling and hence for oceanic nutrient inventories.

Geochemical proxies for paleoprecipitation and drought from Lake Tahoe cores: California and Nevada, USA

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Sediment cores from >400 m water depth in Lake Tahoe reveal a long-term history of suspension fallout interspersed with turbidites generated by severe storms and associated hyperpycnal currents over the last 7000 years. Relative to fine-grained ‘background’ sediments, the majority of Tahoe turbidites exhibit coincident trends of increased mean grain size, increased magnetic susceptibility, decreased TOC, higher $\delta^{13}C_{org}$ and variable C/N. The shift in $\delta^{13}C_{org}$ toward higher values within turbidites is interpreted to record the input of soil organic matter within runoff from the watershed triggered by high-intensity storms.

Tahoe turbidites tend to occur in clusters, separated by intervals of fine-grained mud, suggesting a changing frequency of severe storms and potentially long-term paleoprecipitation levels. To test our hypothesis that turbidite frequency records paleoprecipitation levels, we compared the timing of our correlated Tahoe sediment record with published paleoclimatic proxies for 1) elsewhere in the Tahoe basin, 2) lakes in the western Great Basin whose level is directly related to runoff from the Sierra Nevada, and 3) the San Francisco bay estuary. The reasonable degree of temporal overlap suggests that apparent trends in severe storm frequency recorded by clusters of turbidites provides a measure of millennial-scale regional paleoprecipitation and drought. We recognize an extended phase of dryness and a near absence of major storms between ~3000 and ~700 cal yr B.P. in the Tahoe watershed, partly coincident with the Medieval Climate Anomaly and two mega-droughts previously recognized in other climate records.