A new look at ocean carbon remineralization for estimating deepwater sequestration

The "biological carbon pump" causes carbon sequestration in deep waters by downward transfer of organic matter, mostly as particles. This mechanism depends to a great extent on the uptake of CO2 by marine plankton in surface waters and subsequent sinking of particulate organic carbon (POC) through the water column. Most of the sinking POC is remineralized during its downward transit, and modest changes in remineralization have substantial feedback on atmospheric CO2 concentrations, but little is known about global variability in remineralization. Here we assess this variability based on modern underwater particle imaging combined with field POC flux data and discuss the potential sources of variations. We show a significant relationship between remineralization and the size structure of the phytoplankton assemblage. We obtain the first regionalized estimates of remineralization in biogeochemical provinces, where these estimates range between -50 and +100% of the commonly used globally uniform remineralization value. We apply the regionalized values to satellite-derived estimates of upper ocean POC export to calculate regionalized and ocean-wide deep carbon fluxes and sequestration. The resulting value of global organic carbon sequestration at 2000m is 0.33PgCyr-1, and 0.72PgCyr-1 at the depth of the top of the permanent pycnocline, which is up to 3 times higher than the value resulting from the commonly used approach based on uniform remineralization and constant sequestration depth. These results stress that variable remineralization and sequestration depth should be used to model ocean carbon sequestration and feedback on the atmosphere.

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