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Estimation of the Rates of Particle Aggregation and Disaggregation in the Mesopelagic Zone of the Eastern North Pacific

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The processes of particle aggregation and disaggregation are of paramount importance for ocean biogeochemical cycles. Particle aggregation leads to a transfer of particulate material and of their chemical constituents into large size fractions that can settle rapidly through the water column, thereby contributing to the ocean biological pump. In contrast, particle disaggregation redistributes material into smaller size classes and places limits on the size of the largest aggregates. In spite of their preeminent importance for ocean biogeochemistry, rates of particle (dis)aggregation in the ocean cannot be measured directly and are notoriously difficult to constrain. Indeed, current estimates obtained in a variety of oceanographic environments range over several orders of magnitude and suffer from appreciable uncertainties.

The goal of the Export Processes in the Ocean from Remote Sensing (EXPORTS) program is to develop a predictive understanding of the export and fate of global ocean net primary production for present and future climates. As part of this program, an extensive oceanographic campaign took place in summer 2018 in the Gulf of Alaska, during which various measuring and sampling platforms including a large-volume filtration (LVF) system have been deployed at different depths in the euphotic and mesopelagic zones at stations centered around a drifting Lagrangian float. Here we present the status of our ongoing effort to estimate the rates of particle (dis)aggregation in the mesopelagic zone of EXPORTS stations based on concomitant measurements of the concentration of particulate organic carbon (POC), lithogenic elements (Al and Ti), and thorium-234 (a naturally-occurring particle-reactive radionuclide), in different size fractions sampled from LVF and bottles. The rates of particle (dis)aggregation, as well as remineralization and sinking, are estimated from the quantitative combination of this diverse dataset with a simplified model of the cycling of POC, Al, Ti, and Th-234 in the upper water column using a least-squares procedure that accounts for both data and model errors. Rate estimates and their errors obtained at different stations and at different depths in the upper 500 m are presented and discussed in the context of independent measurements bearing on the mesopelagic ecosystem of the eastern North Pacific.