# SS116-11915 PARTICLE FLUX DYNAMICS IN THE GULF OF MAINE BENTHIC NEPHELOID LAYER AND IMPLICATIONS FOR CARBON CYCLING ON THE MARGIN

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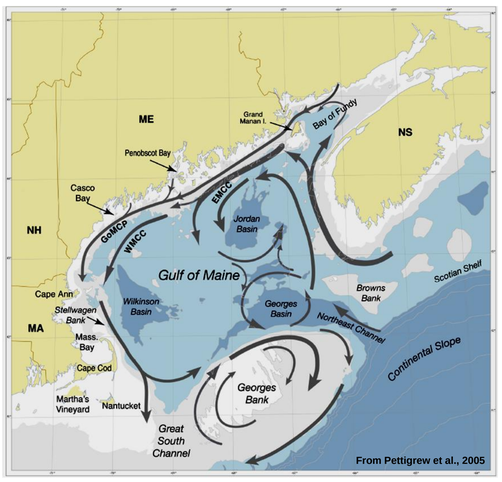
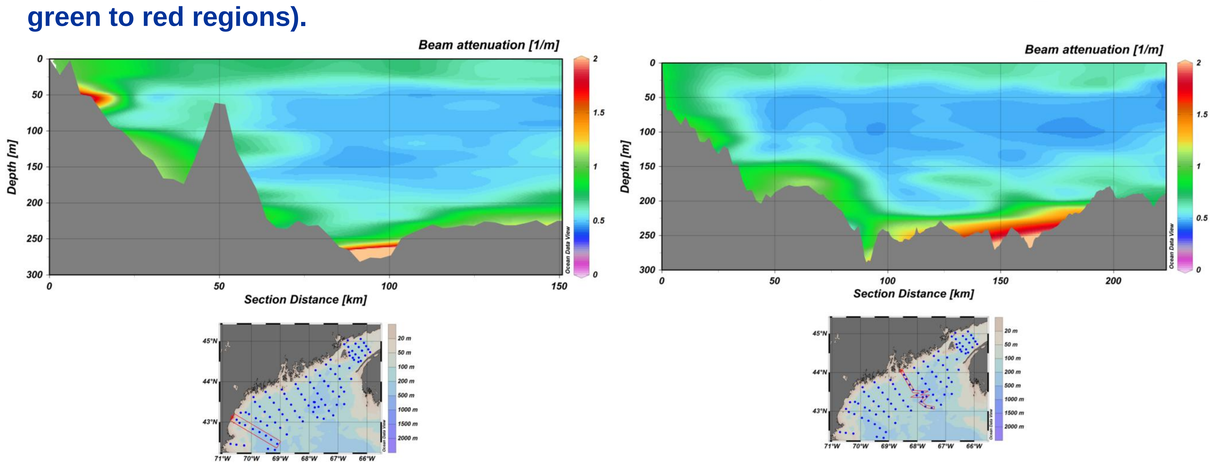
On continental margins, carbon production and flux are highly elevated compared with the adjacent interior ocean. Carbon accumulation in shelf sediments is a function of the relatively short residence time of sinking, carbon-rich particles in the shallow shelf water column, coupled with processes of lateral advection and resuspension. Margin benthic nepheloid layers (BNLs) are common and easily identified as high particle density zones in which particle matter is supplied via seasonal export from the overlying water column and resuspension of underlying sediments. In regions where BNLs are maintained by strong tidal and sub-tidal flow, they may be thick, persist throughout the year and display elevated biological activity. It is suggested that such BNLs represent geochemical transformation layers, potentially modulating the balance between carbon remineralization, benthic delivery and offshore transport. We present data from the Gulf of Maine/Bay of Fundy documenting pervasive BNLs of 20-50 m thickness and their relationship to local topography and current flow. Multi-year, biogeochemical particle fluxes measured with time-series sediment traps deployed within and above the gulf's BNLs provide evidence of organic and inorganic carbon remineralization dynamics.

**1. Background**: Recent NOAA/ECOHAB-funded programs in the Gulf of Maine (GoM) have included research components examining the dynamics and biogeochemistry of BNLs (Pilskaln et al., 2012, 2013) to assess their potential impact on organic and inorganic carbon cycling, as well as their role in distributing particle matter within the shelf-slope system. Here we present a subset of the results from optical and physical examinations of GoM BNLs and from time-series, sediment trap flux studies.

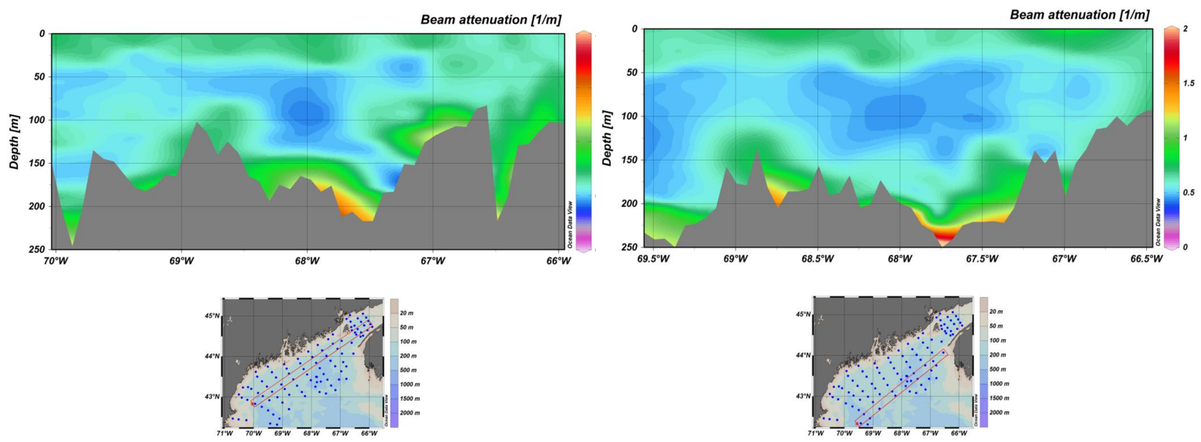


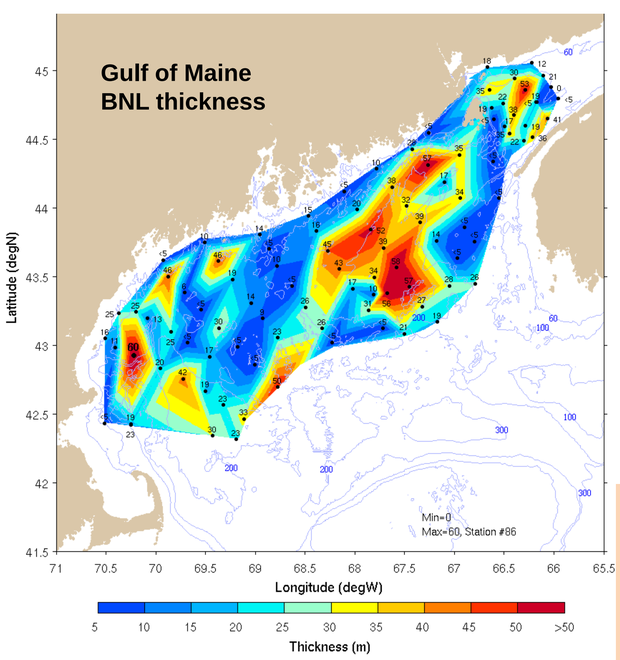

**2. BNL thickness and extent**:

Below: Two onshore-offshore transects of beam-c from October 2004 CTD/transmissometer profiles, 99 stations. Gulf of Maine; transect shown in each panel is denoted by red rectangle on associated station map; left side of panel is inshore, right is offshore. Extensive, abundant and often thick BNLs are represented by beam-c values $\geq$ 0.8 $m^{-1}$(lime green to red regions).




Two panels below: Representative southwest to northeast (left to right) contoured beam-c sections across Gulf of Maine,, 2004. Topographic control and focusing of BNLs is evident, as well as BNL connections between the Bay of Fundy, the Maine Coastal Current and the south-central region of the gulf (Pilskaln et al., 2013).



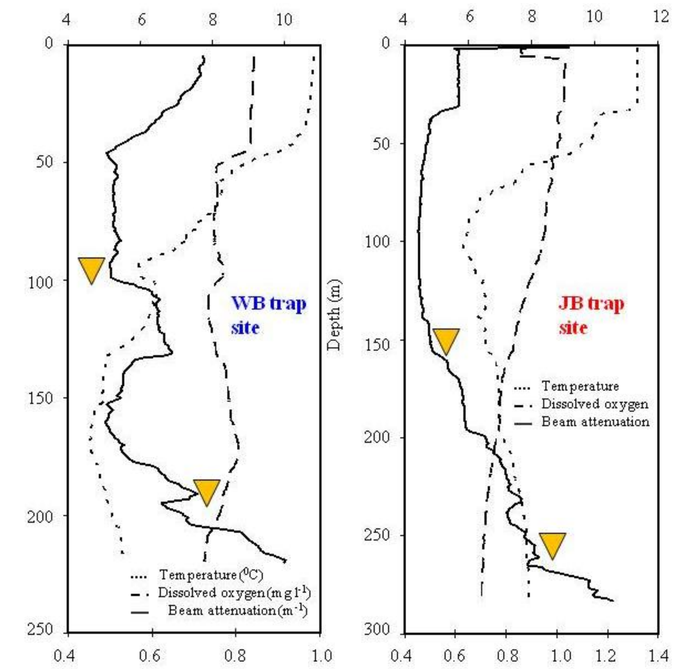

**LEFT: Gulf-wide BNL map (2004)**: Thickest BNLs of 30-50+ m in deep basins, eastern Gulf and Bay of Fundy; thinner BNLs across shallow ledges and in western Gulf.

**Particle resuspension energy and thick BNL maintenance in deep-waters**: Flow speed and direction measurements in the basin BNLs indicates that tidal flows of 10-15 cm $sec^{-1}$ dominate near-bottom energies with subtidal flows being substantially less (Pilskaln et al., 2012, 2013).

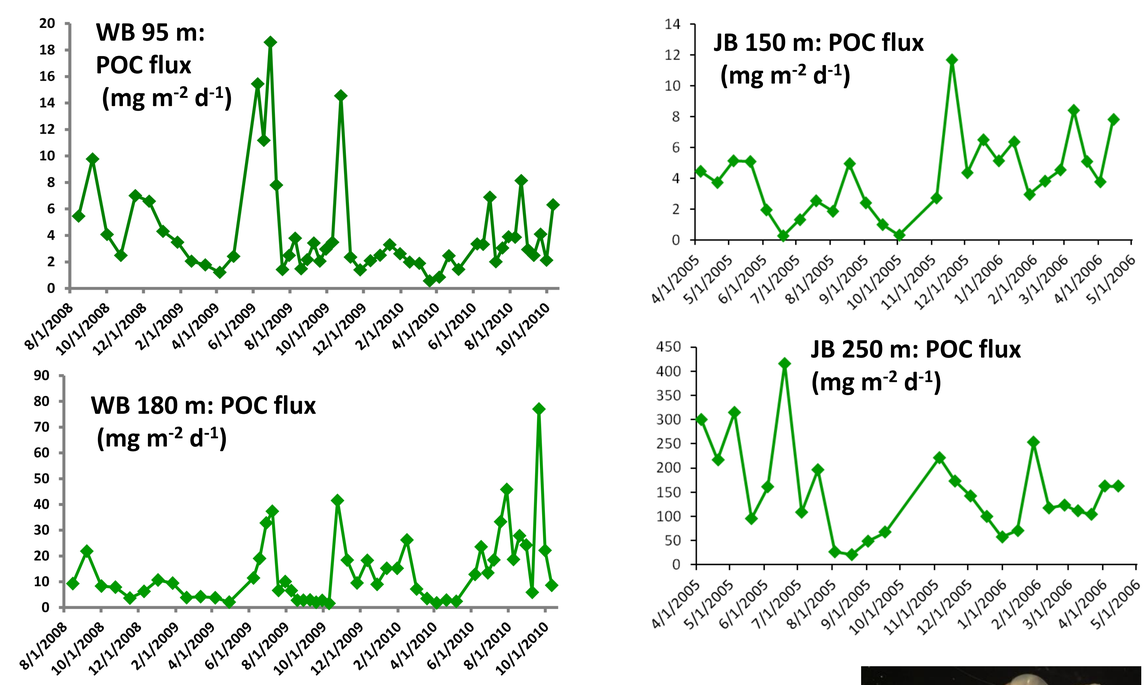
**3. Time-series trap measurements**:

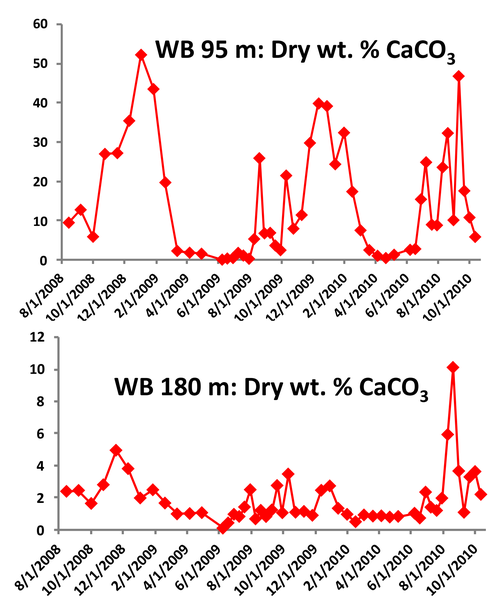
McLane 13-cup (pre-poisoned) traps were deployed above and within BNLs, as identified by beam attenuation profiles (RIGHT PANELS), in the deep western (Wilkinson Basin-WB) and eastern (Jordan Basin-JB) gulf; separate deployments and years.

**Several-fold to >1 order of magnitude greater total mass, POC (SHOWN BELOW) and lithogenic fluxes is observed in the BNLs compared to overlying, lower particle abundance waters** (Pilskaln al., 2012; Hayashi, unpubl. PhD thesis).




**4. POC-rich BNLs:** Effective delivery of planktonic-derived POC to underlying BNLs is reflected by seasonal peaks in POC fluxes measured above and within the BNLs (PLOTS BELOW). Highly elevated, deep-BNL POC has a moderately low organic C:N molar ratio (8-9) and is composed of a mix of fresh, planktonic detritus and more refractory, older, sediment-bound carbon (Hayashi, unpubl. PhD thesis; Hwang et al., in prep.).




**5. $CaCO_3$ dissolution in BNLs**:

**LEFT**: Data from the 2-year Wilkinson Basin trap collections shows dissolution loss of sinking $CaCO_3$ between sub-euphotic depths and the BNL.

~10-fold decrease in $CaCO_3$ content of sinking particles collected in pH-buffered trap cups is observed in late fall-winter when flux of empty aragonite pteropod shells is maximal at 95 m (left).


**ABOVE**: Planktonic pteropod *Limacina retroversa* shells (~1 mm), abundant in Gulf of Maine water column and sediment trap samples above BNLs. Recent documentation of low omega-aragonite (<1.5) in gulf BNLs indicates acidification on shallow, productive shelves (Wang et al., 2013; Salisbury, Pilskaln and Vandemark, unpubl.).

**6. Summary**:

*BNLs are extensive and pervasive throughout Gulf of Maine.

*Geochemical data reveals BNL composition to be a seasonally variable mix of planktonic material and resuspended sediments.

*Clear evidence of labile POC input to BNLs as well as $CaCO_3$ dissolution occurring in the BNLs.

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