Exploring interactions between deep scattering layers and large-scale bathymetric features

Contact Information
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Willing to Attend Workshop? Yes
Target Name(s): Continental slopes, canyons, and Mid Atlantic Ridge
Geographic Area(s) of Interest within the North Atlantic Ocean (Indicate all that apply)
Northwest, North Central, Northeast, Southwest
Relevant Subject Area(s) (Indicate all that apply)
Biology, Geology, Physical Oceanography, Other - Water column processes
Description of Topic or Region Recommended for Exploration
Brief Overview of Area or Feature
We are interested in the interactions between several large-scale bathymetric features (e.g., continental slope, submarine canyons, mid-oceanic ridge, seamounts) and the mesopelagic community (i.e. nekton and zooplankton), and in particular, we seek to use water column acoustic scattering data to measure deep scattering layers to better understand the processes that structure the vertical migration patterns of deep-sea organisms along a latitudinal gradient. Our primary request is for additional cross-shelf transects to be done over a 24-48 hour period (to capture migration events as well as day/night distributions) at a wide variety of latitudes (e.g., North Atlantic to at least the Caribbean) to increase the amount of available data regarding the movements of these features with respect to various bathymetries.

Brief Summary of Current State of Knowledge
The mesopelagic (200-1000 m) zone's spatial extent is approximately 60% of the area of the planet and constitutes nearly 20% of the volume of the world's oceans. The continental shelf margins bound the mesopelagic zone, abruptly transitioning into deeply sloping habitats leading to the abyssal plane. Mid-oceanic ridges also extend into the depths where migrating mesopelagics can interact with the benthic communities. The mesopelagic biological community is highly diverse consisting of fishes, crustaceans, cephalopods and gelatinous zooplankton, and aggregates in Deep Scattering Layers (DSL) that undergo daily vertical migration (DVM), transiting hundreds of meters between the meso- and epi-pelagic zones. These communities play a critical role in trophic pathways of the oceanic realm (Sutton 2013), and form one of the few connections between surface and abyssal waters. While migrating DSLs are ubiquitous across oceans, the patterns observed in DSLs are highly variable (Klevjer et al. 2016). Less well understood is the within basin variation, and in particular, how DSLs behave when encountering bathymetric features (Fig1).

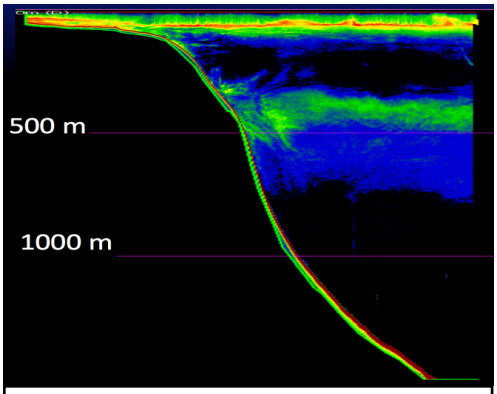

Figure 1. Example of DSLs detected at 38 kHz interacting with the continental shelf/slope at night in the Gulf of Mexico (Boswell unpub.

DSLs near a boundary can migrate both vertically and laterally (Fig 1) which can transfer carbon on or off shore as well as higher/lower in the water column with direct linkages between the migrating mesopelagic and the shelf communities. This vertical and lateral connectivity has important life-history and trophic implications, with direct consequences for material (i.e., carbon) flux in the ocean.

Rationale for Future Exploration
Recent estimates of the global mesopelagic fish biomass may be 10x greater than previously estimated (Irigoien et al., 2014, Proud et al. 2017). Given that many of these fish participate in

DVM (Klevjer et al. 2016), the potential for fish alone to play a substantial role in active carbon transport in the World's oceans is immense (Davison et al. 2013).

There are few existing data sets that have broadband water column backscatter data providing multiple cross-shelf transects that capture the day-transition-night distribution and movement of the DSLs. The NOPP-funded ADEON program has suitable data at seven sites (ranging from VA to Northern FL) that were conducted in November 2017 and June 2018 (with another cruise scheduled for Nov 2018). There may be some additional data from NOAA NEFSC/SEFSC survey (such as AMAPPS), however these cruises do not focus on the shelf-break region and do not repeat transect lines over a 1-2 day period so they are not suitable for characterizing the diel movements at a particular location.

While not the focus of study, an evolving threat to the world's oceans is the impact of seafloor mining with potential to disrupt biological and ecological processes (Boschen et al. 2013). In particular, mid-oceanic ridges are known to contain an abundance of highly-valuable deposits (Hannington et al. 2011). Concerns of the associated sediment plumes within the water column hold unknow implications towards the mesopelagic community and in particular for those performing diel migrations and comprising the DSLs. More extensive datasets described herein will provide a working model on understanding broad-scale patterns in mesopelagic communities.

References

Boschen, R.E., Rowden, A.A., Clark, M.R. and Gardner, J.P.A., 2013. Mining of deep-sea seafloor massive sulfides: a review of the deposits, their benthic communities, impacts from mining, regulatory frameworks and management strategies. Ocean & coastal management, 8:54-67.

Davison, P.C., Checkley Jr, D.M., Koslow, J.A. and Barlow, J., 2013. Carbon export mediated by mesopelagic fishes in the northeast Pacific Ocean. Progress in Oceanography, 116:14-30.

Hannington, M. Jamieson, J., Monecke, T., Petersen, S., Beaulieu, S. 2011. The abundance of seafloor massive sulfide deposits Geology, 39:1155-1158.

Irigoien, X., Klevjer, T.A., Røstad, A., Martinez, U., Boyra, G., Acuña, J.L., Bode, A., Echevarria, F., González-Gordillo, J.I., Hernandez-Leon, S. and Agusti, S., 2014. Large mesopelagic fish biomass and trophic efficiency in the open ocean. Nature communications, 5, p.ncomms4271

Klevjer, T.A., Irigoien, X., Røstad, A., Fraile-Nuez, E., Benítez-Barrios, V.M. and Kaartvedt, S., 2016. Large scale patterns in vertical distribution and behaviour of mesopelagic scattering layers. Scientific reports, 6, p.19873.

Proud, R., Cox, M.J. and Brierley, A.S., 2017. Biogeography of the global ocean's mesopelagic zone. Current Biology, 27:113-119.

Sutton, T.T. 2013. Vertical ecology of the pelagic ocean: Classical patterns and new perspectives. Journal of Fish Biology 83:1508–1527.

Relevant Partnerships

Colleagues associated with existing deep sea programs have indicated interest in participating directly in this program: ***Joseph D. Warren***, Stony Brook University, associated with ADEON, DEEPSEARCH, and DEEPEND; ***Tracey T. Sutton***, College of Natural Sciences and Oceanography, Nova Southeastern University, associated with DEEPEND and DEEP SEARCH; Michael Vecchione, NOAA NMFS, assocated with DEEPEND; ***J. Christopher Taylor***: NOAA National Ocean Service; ***Ciaran O'Donnell***: Marine Institute, Ireland, associated with AORA; ***Nils Olav Handegard***: IMR, Norway, associated with MESOPP; ***Rudy Kloser***: CSIRO, Australia, associated with MESOPP.