The two-faced Marginal Sea Ice Zone: A physical characterization and the link to biology

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INTRODUCTION

The marginal sea ice zone (MIZ) is a very dynamic and active area. In addition, the MIZ is biologically important due to an intense primary production bloom, which is an important carbon source for the marine food web. Here we present data collected in the Antarctic MIZ during a ship-based expedition to the Eastern Weddell Sea. The work aims to characterize the physical environment of the MIZ and identify the possible environmental drivers of ecological processes.

1. SAMPLING

Sea ice surveys were conducted with a Surface and Under Ice Trawl (SUIT). The SUIT is designed to sample under-ice fauna and is equipped with a sensor array (Fig. 1) to measure the environmental properties: sea surface salinity, temperature, chl-α, under-ice spectral radiation, ice thickness, ice roughness and sea-ice algae content. In total, 6 profiles of ca. 2 km were collected in the MIZ in December 2014 (eastern transect, shown in Fig. 2) and January 2015 (western transect, shown in Fig. 3).

2. SEA-SURFACE PROPERTIES

Along-profile variability in sea surface properties (Fig. 4) is large. Figure 5 shows that the western stations have higher mean temperature, this agrees with the advanced melting stage as seen in the ice concentration (Fig. 3). Lower, but not significantly different, Chl-α concentration in surface sea water was registered in the western stations (Fig. 6).

3. SEA-ICE PROPERTIES

A clear separation between eastern and western stations is seen in all sea-ice properties. The ice is thicker (Fig. 7) in the western stations, and has more ridges (Fig. 8), detected as in Castellani et al. (2015). This is reflected in the light available under the ice (Fig. 9). Sea-ice algae (Fig. 10), retrieved as in Melbourne-Thomas et al. (2015), are more abundant in the eastern stations.

4. SUIT CATCH

The variability found in sea surface and sea-ice properties is reflected in the species abundances and composition (Fig. 13 and 14). Species diversity also differs between transects. Krill Euphausia superba, Thysanoessa macrura, and the amphipod Eusirus microcarus were abundant in the western stations, the amphipod Eirusus laticeps in the eastern ones.

CONCLUSION

- Sea-ice physical properties in the Antarctic MIZ can vary drastically, showing two completely different environmental regimes
- The structure of under-ice communities clearly follows the strong contrast in sea-ice properties
- The general knowledge of the MIZ as a very productive area is, in half of the case studies presented here, not confirmed
- High abundances of Antarctic krill were associated with thick deformed ice and low Chl-α in both sea ice and water, indicating that krill distribution under sea ice reflects other traits of the environment than food availability, such as predator avoidance
- Low Chl-α in surface water and sea ice could, on the other hand, be a consequence of grazing