EGU2020-183
https://doi.org/10.5194/egusphere-egu2020-183
EGU General Assembly 2020

Listening to the Oceans - Effective Techniques for Acoustic Imaging of Oceanic Structure

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Sub-mesoscale variability in the ocean is poorly understood. The challenge is to observe oceanic thermohaline structures on sufficiently fine space and time scales. One promising approach is seismic oceanography, which applies acoustic reflection techniques to image temperature and salinity gradients within the water column. Here, we present three acoustic oceanographic datasets showing different survey methods and assess their advantages and disadvantages.

Firstly, seismic images from a 2D seismic survey in the Sub-Antarctic southwest Atlantic Ocean are shown. The study site is located northeast of Drake Passage, through which Pacific and Antarctic waters flow to merge with those from the Atlantic, making it a key confluence region. The data show detailed images of sub-mesoscale structures in the upper ocean. Future work will make use of coincident XBT measurements to invert the acoustic data and create detailed 2D maps of temperature distribution.

The second dataset contains samples from a 3D seismic survey in the narrowest part of the Mozambique Channel, which is affected by eddies and changes in transport direction and volume. It acts as a pacemaker for the Agulhas Current system, which plays an important role in global heat transport. The dataset, courtesy of Schlumberger Ltd, combines a high signal to noise ratio with a dense data grid, where locations are sampled several times over several days. These data were used to create time lapse images of the area, providing an invaluable insight into the variabilities in the Mozambique Channel.

Despite a lot of advantages, seismic surveys are generally expensive and lack mobility and versatility. Therefore, another acoustic dataset using a hull-mounted EK80 scientific echo sounder, as part of the ICEBERGS project, is presented as a cheaper and more readily available alternative. Images from the West Antarctic Peninsula show thermohaline structures recorded along the actively de-glaciating margin, contributing to the understanding of underlying physical processes that modulate the flux of oceanic heat to the Antarctic cryosphere, and how and where glacial meltwater is discharged, transported and modified. Furthermore, recording and processing

difficulties are discussed.

Lastly, acoustic forward modelling work is discussed, which will wrap up the analysis of the methods presented earlier. Based on the three datasets, the use of different acoustic sources will be forward modelled. Through this ideal sources of different sizes and configurations for seismic oceanography can be analysed. Is it feasible to use acoustic sources small enough to be attached to autonomous vehicles, in order to overcome the current difficulties in extracting temporal variability of oceanic fine structure?