*Thesis proposal: Riesna Audh*

**Physical and biogeochemical processes in the Antarctic Marginal Ice Zone: observations and modelling**

*To be added: Introduction on the processes occurring in the Marginal Ice Zone and their implications for the Southern Ocean dynamics (Less than a page, to be taken from Riesna’s Honours project)*

The sea ice environment in the Marginal Ice Zone (MIZ) of the Southern Ocean is characterized by a combination of pancake ice, frazil ice and more consolidated ice conditions. The process of pancake ice formation usually occurs at the very boundary with the open ocean, but also in the interior of the MIZ, as recently observed during a South African winter cruise in July 2017. The semi-consolidated state of the surface covered ocean is the result of the action of strong air-sea interactions and waves. Pancake ice is therefore shaped by the typical thermodynamic processes occurring at the interface with the atmosphere and the ocean, but also by the action of waves and surface washing. Ice growth leads to the entrapment of nutrients and biological components in the sea ice, which may develop into a sympagic community and eventually bloom. However, very little is known about the internal vertical structure of pancake ice, the distribution of biogeochemical constituents and the biogeochemical cycling that occurs both within the ice and between the ice and underlying ocean. Data from the SA Agulhas II 2017 winter cruise are available to obtain an initial understanding of the concentration and gross distribution of nutrients and phytoplankton in the growing pancake ice. These data will be combined with numerical modelling with the main objective of explaining the processes leading to the accumulation of chemical and biological components in the MIZ and their evolution as the ice season advances. A model for sea-ice biogeochemistry has been proposed by Tedesco et al. (2009, 2010), and can be expanded to include features that are specific to the Antarctic pancake ice field.

The thesis work will focus on the following aspects:

1. Analysis of the existing literature concerning physical and biogeochemical conditions of the Antarctic MIZ, with special attention on non-summer conditions
2. Extension of a numerical model of sea-ice thermodynamics and biogeochemistry originally developed by Tedesco et al. (2009, 2010) to incorporate the specific features of pancake ice as described by Doble et al. (2003)
3. Characterization of the biogeochemistry (nutrients and chlorophyll) in winter pancake ice using samples collected during the winter cruises
4. Simulation of sea-ice biogeochemistry equilibria during the freezing season and validation of the model results with the available data. Prognostic simulation of the evolution of sea-ice nutrients and algae along the seasonal pathway determined by means of the ice-tethered buoys deployed during the cruise.

**References**

Doble, M., M. Coon, and P. Wadhams (2003), Pancake ice formation in the Weddell Sea, J. Geophys. Res., 108(C7), doi:10.1029/2002JC001373.

Tedesco, L., M. Vichi, J. Haapala, and T. Stipa (2009), An enhanced sea-ice thermodynamic model applied to the Baltic Sea, Boreal Environmental Research, 14, 68–80.

Tedesco, L., M. Vichi, J. Haapala, and T. Stipa (2010), A dynamic biologically-active layer for numerical studies of the sea ice ecosystem, Ocean Modelling, 35, 89–104.