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Ocean2ice: Processes and variability of ocean heat transport toward ice shelves in the Amundsen Sea Embayment

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Eberhard Fahrbach was an inspiration to me, as well as a colleague and friend. He had great insight into the physics on the continental shelf and slope of Antarctica. He taught me the importance of the Antarctic Slope Current and of shelf-edge exchange processes for providing heat to melt the ice shelves. This presentation is dedicated to him.

Here we present the first results of the Ocean2ice field campaign in the Amundsen Sea in January-March 2014. The Amundsen Sea hosts some of the most rapidly retreating ice shelves in Antarctica such as Pine Island Glacier. This field campaign is designed to understand the processes by which ocean heat is delivered from the open ocean to the continental shelf, and by which that heat is then modified across the continental shelf en route for the Amundsen Sea ice shelves. The processes to be studied include the Antarctic Slope Undercurrent, coastally trapped waves, wind-driven upwelling, bottom Ekman layers, diapycnal mixing and topographic steering. The influence of mixing of inflowing warm Circumpolar Deep Water with glacial meltwater, and of atmosphere-ocean-ice interaction, are of particular interest.

We will present the hydrographic sections (temperature, salinity, dissolved oxygen, current velocity and microstructure) at the Amundsen Sea shelf break and along and across troughs towards the ice shelves from a variety of ship-based and autonomous platforms. Initial calculations of quasi-heat fluxes will be discussed, as well as the modifications of water masses across the slope and shelf using their temperature, salinity, and dissolved oxygen characteristics. We will compare the observations with historical hydrographic sections from the region since 1994, and with our understanding of the circulation from numerical modelling.

A high resolution limited area model of the Amundsen sea faithfully reproduces key features of the historically-observed circulation. The warm Circumpolar Deep Water arriving at the ice front originates from two shelf-edge troughs; these inflows merge close to the shelf break, forming a single inflow of warm water. At interannual to decadal time scales, fluxes of Circumpolar Deep Water in each of these shelf-edge depressions are well correlated with CDW fluxes at the ice front, and with the modelled glacial melt rate. The time series of these quantities is dominated by decadal variability, originating from atmospheric surface forcing and correlated with the Southern Annular Mode (SAM). Analysis of the along-trough overturning streamfunction reveals a strong overturning cell, the strength of which is closely related to the modelled glacial melt. EOF analysis of the depth of the 0.5ºC isotherm indicates that the leading mode of variability is a shelf-wide deepening of the thermocline, which is strongest in the south-western part of Pine Island Trough.