An overview of the Antarctic polynyas and their impact on deep water production

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Polynyas are areas that remain ice-free during the polar winter. They can show a mixed sensible and latent heat character. In particular in this work we would like to focus on latent heat polynyas. The latent heat mechanism is characterised by the rapid removal of ice, which is forming close to the coast, by strong katabatic winds blowing from the continent. Sensible heat polynyas, on the other hand, arise through the upwelling of warmer water which melts the sea ice cover and prevents further ice growth. The two processes described are not mutually exclusive, so that every polynya can present a mixed character.

Latent heat polynyas play a fundamental role in dense water production. The large difference in temperature between air and water leads to a strong heat loss from the sea surface, which freezes almost immediately, activating a positive feedback.

The ice production rate increases dramatically, leading to a large release of brine in the column of water underneath strongly modifying its structure. The densest water mass of the Southern Ocean is Antarctic Bottom Water (AABW), and is formed in polynya regions. In this work we investigate the behaviour of the Prydz bay, Mertz glacier, Pine Island, Ross Sea, and Terra Nova Bay polynyas.

A steady-state ice flux model is applied to each polynya in order to have a time series of its extent. ECMWF data are used as an input to the model. Satellite images, either SSM/I or SAR, when possible, are used in order to validate the results.

The model gives an estimate of the polynya areas, the ice production, the heat fluxes and the salt produced corresponding to the calculated ice production rate.

For each polynya an estimate on the deep water production is given. For the Ross Sea and Terra Nova Bay polynyas hydrological data is available to compare with model results. The Terra Nova Bay polynya is known to produce about 10% of the total deep water production of the Ross Sea. An estimate of the HSSW (High Salinity Shelf Water) produced within this polynya reaches 1 Sv. Results are presented for AABW formation within the Mertz glacier, Pine Island and Prydz Bay polynya.