

HEAT FLUXES AND RECENT THERMOHALINE CHANGES IN THE ROSS SEA.

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In order to investigate the atmospheric forcing variability at different spatial and temporal scales, firstly this work analyse the surface heat budget of the continental Ross Sea using ERA40 re-analyses and operational analysis provided by ECMWF (European Centre for Medium-Range Weather Forecasts) for the period 1958-2005, inferring also the year mean Circumpolar Deep Water (CDW) flow needed to compensate the heat loss from the sea to the atmosphere. Secondly, we focused on the surface heat budget of the TNB polynya evaluating consequently the ice and High Salinity Shelf Water (HSSW) production. Thirdly, we analysed the measured thermohaline changes in the water column of TNB and close the north-eastern continental slope where the shelf waters interact with the CDW ventilating the deep ocean.

The yearly mean heat loss reaches its maximum in 1989 (-130 Wm⁻²) and its minimum (-86 Wm⁻²) in 1980. A mean value for the entire period is -103 Wm⁻², with a standard deviation of about 9 Wm⁻². In a steady state, the yearly mean heat loss, from the sea to the atmosphere, must be compensated by the heat carried by the incoming (warmer) waters and mixing processes. The CDW provides the major source of heat (and salt) in this region: the net flow needed to preserve the annual surface heat budget ranges between 2.5 Sv ÷ 3.8 Sv.

We estimated also the surface heat budget for the TNB polynya finding behaviour comparable to the one obtained for the whole Ross Sea, with a maximum heat loss (about -180 Wm⁻²) in the 1989 while the minimum heat loss occurs in 1996 with a value of -58 Wm⁻². Assuming that the estimated yearly heat loss reflects the average conditions, it is possible to assess the annual ice production which is needed to balance the deficit at the surface. The ice thickness production computed during the period 1958-2002 ranges between 11 m (1996) and 22 m (1989) (per surface unit) with a mean value of 18 m and a standard deviation of about 2 m.

Moreover, because of their dependence on total ice production, it is possible to calculate the total production of salt and HSSW. Our results suggest that the HSSW production switches to the lowest values during the middle 90's (minimum during 1995-1996).

The decrease in HSSW production can have modified also the thermohaline characteristics of the Western Ross Sea as we detected from the analysis of the hydrological casts collected in the TNB area and close to Cape Adare between 1995 and 2006. In TNB the temperature does not reveal any clear trend, contrarily the salinity shows an evident freshening from 1995 up to 2001 while during the following two years we observed a small increases in salinity. The last data confirm a freshening trend. These results are consistent with the estimated HSSW production variability which shows a slight increase at the beginning of the new century.

The variability of HSSW should produce temporal changes also in the characteristics of the bottom water formed at the continental shelf break. We speculate on the possibility of a recent modification on the volume production of RSBW (Ross Sea Bottom Water) in the Western sector as a consequence of the decrease of the HSSW production in TNB. Actually our data set shows a freshening ($\Delta S \approx -0.1$) of the deep layers close to the shelf break at Cape Adare where the mixing between the MCDW and the HSSW takes place to form the RSBW. Only the cruise performed during the austral summer 2002/03 showed an increase in salinity in the bottom layer consistent with the estimated increase in the HSSW production in TNB during the previous years. The high values observed during that cruise, which overcome the values measured in 1994/95, may be explained by as high production of HSSW in TNB and a minor mixing with the MCDW in Cape Adare region. The data collected during the last cruise during the austral summer 2005/06 in this area confirm a freshening of the HSSW.

The overall scenario clearly indicates how the Ross Sea is still far from a steady state and it is very sensitive to the atmospheric changes even if a possible role played by the CDW freshening can be also assumed. A remark concern the substantial role played by the Terra Nova Bay polynya in regulating the characteristics of the shelf waters, at least in the western sector, which mix at the continental shelf break ventilating the deep ocean.

Finally we stress the relevance to monitor the thermohaline characteristics along the Drygalski Basin which represents a sort of intermediate reservoir and the primarily path followed by the shelf waters to reach the shelf break.