

Terra Nova Bay Research Experiment (T-REx)

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3. Project Description

The Ross Sea is a key region for the formation of AABW (Antarctic Bottom Water) and for the ventilation processes of deep layers of the Southern Ocean which are essentially related to the presence of free-ice areas also during the winter (polynyas). In the Ross Sea, most of the processes involving in the formation of AABW has as its starting point the presence of the High Salinity Shelf Water (HSSW) formed by the salinization of the waters of circumpolar origin, the increase in salinity is substantially realized in the areas of polynya (like that in the Terra Nova Bay - TNB) during the formation of sea ice. The polynya of TNB is believed to be the most important source of HSSW in the Ross Sea, thus it plays a key role in the modification of the thermohaline structure with important implications for global-scale thermohaline circulation.

We proposed a coordinated study to identify the mechanisms and the critical aspects responsible for the water masses formation, modification and diffusion in the TNB polynya, which plays a key role in the climatic context. To this end it is proposed to carry out and coordinate measurements of different types and critically analyze the oceanographic time series previously acquired.

- I. *CTD/LADCP Measurements*: Field measurements of the three-dimensional of mass field and dynamics in the polynya and along the Drygalski Basin will be carried out to characterize the local water masses, to define the flow and the horizontal transport of mass, and the chemical properties (CO₂ and CFC).
- II. *Time Series - MOORING and AWS*: Since the austral summer 1994/95 and 1997/98 respectively Italian moorings "D" and "L" have been positioned in the polynya area collecting thermohaline and current data that will be analyzed and correlated with measurement collected by the Italian mooring "G" in the northern sector, with the remote sensing data (see section III), and with the atmospheric forcing (in particular the radiative and turbulent flows)using Wavelet analysis and EOF approaches.

- III. *Remote Sensing Data*: The main purpose is to investigate the variability in the extent of the TNB polynya by 1 km resolution satellite data (MODIS) related to the atmospheric forcing (radiative and turbulent flows). Estimation of the polynya extent will be carried on according to a preliminary comparison with COSMO SkyMed SAR data available "HugeRegion" area (collected during the pre-operational testing of the COSMO system). Through this comparison we identify suitable thermal thresholds to discriminate (pixel by pixel) the presence or absence of sea ice crucial for the definition of polynya size itself.
- IV. *ARGO Measurements*: ARGO floats will be used in the TNB polynya to measure the vertical and horizontal thermohaline gradients in the surface and subsurface layers.
- V. *Ice Mass Balance Buoys*: The study of mass balance of ice and its temperature are crucial for understanding the processes occurring in polar areas and particularly in those of polynya. The use of Ice Mass Balance Arrays (IMBA) is optimal in this type of study: the IMB consists of an array of thermistors, which are lowered into holes in the ice and return information on temperature and indirectly on the type of medium in which they are. This activity will be performed in collaboration with the Scottish Association for Marine Science (SAMS - UK).

4. Project Timeline

Start Date: 2010

End Date: 2013

5. Key Project Deliverables

- Understanding the variability of atmospheric forcing (wind, radiative and turbulent flows) in modulating the magnitude of the polynya.
- Determine the role of the thermohaline field as a pre-conditioning in the formation of ice and HSSW.
- Determine the evolution of thermohaline characteristics of the HSSW under the atmospheric forcing at the sub-synoptic to that year scale.
- Define the physical characteristics of sea ice in the polynya in different environmental conditions.
- Determine the spatial and temporal characteristics of the surface mixed layer in the polynya.
- Determine the role of the polynya in the capture of CO₂ and in the export to the continental margin.

6. Funding

100.000 euro for science (logistic needs are covered by the Italian National Program for Antarctic Research – PNRA).

7. Linkages With Other Programmes

Collaborative activity with

NIWA (Craig Stevens)

Scottish Association for Marine Science (SAMS)

ARGO-Italy (Pierre Poulain, OGS)

