

## CLIVAR/CliC/SCAR Southern Ocean Region Panel SORP-11: Sept. 17-18, 2016

### National activities report

Country Italy

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#### A. Recent and ongoing activities

Does your country have a national committee tasked with oversight of Southern Ocean climate science?

YES (Italy has a Scientific Committee for Antarctic Research, or CSNA. The CSNA has identified a series of scientific themes, among which climate, paleoclimate, climate change, atmosphere and ocean are clearly identified)

What major activities have been carried out in the last several years or are in progress now? Contact information for the projects would be useful.

##### 1. Observational

In the last few years, marine research in the Southern Ocean and in the Ross Sea has been accomplished from the R/V *Italica*, the R/S *Agulhas II* or from other ships in the framework of scientific collaboration programmes. In the last three years:

- Summer 2016/17 R/V *Italica* (Italy)
- Summer 2016/17 R/S *Agulhas II* (South Africa)
- Summer 2015/16 R/V *Italica* (Italy)
- Summer 2015/16 R/S *Agulhas II* (South Africa)
- Summer 2014/15 R/V *Araon* (South Korea)
- Summer 2013/14 R/V *Italica* (Italy)

Measurements carried out mainly comprehend:

Expendable probe observations:

Italian scientists have been continuing a long-term (over 20 year) XBT and XCTD deployment plan along the route New Zealand – Ross Sea. These measurements represent the recurrent observations of the Antarctic Circumpolar Current recommended by the Southern Ocean Observing System (SOOS). In Figure 1 we show a map of all XBT launches carried out by the Italian Program for Antarctic Research on the transect, starting in 1994 through 2017.

Moreover, in the framework of the MOMA project (Multiplatform Observations and Monitoring in a sector of the ACC) and in cooperation with the South African National Antarctic Programme, XBT launches have been conducted from the R/V *Agulhas II* during the austral summer 2016/17, as shown in Figures 2a and 2b. These measurements were collected along the NOAA AX 25 high resolution XBT monitoring line ([http://www.aoml.noaa.gov/phod/hdenxbt/ax\\_home.php?ax=25](http://www.aoml.noaa.gov/phod/hdenxbt/ax_home.php?ax=25)), repeated since 2004.

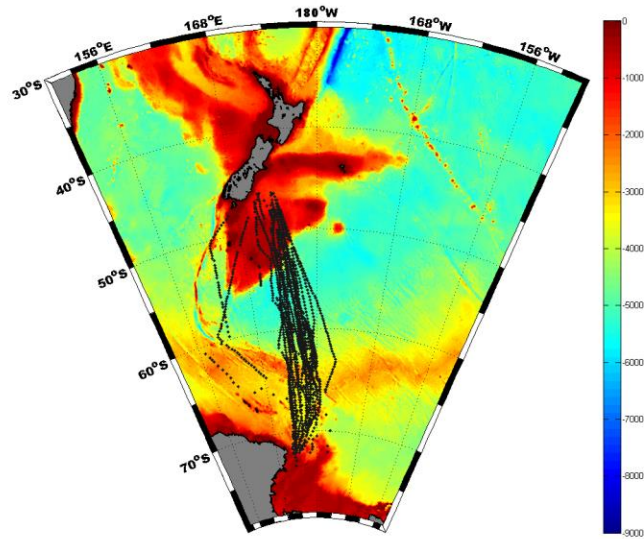
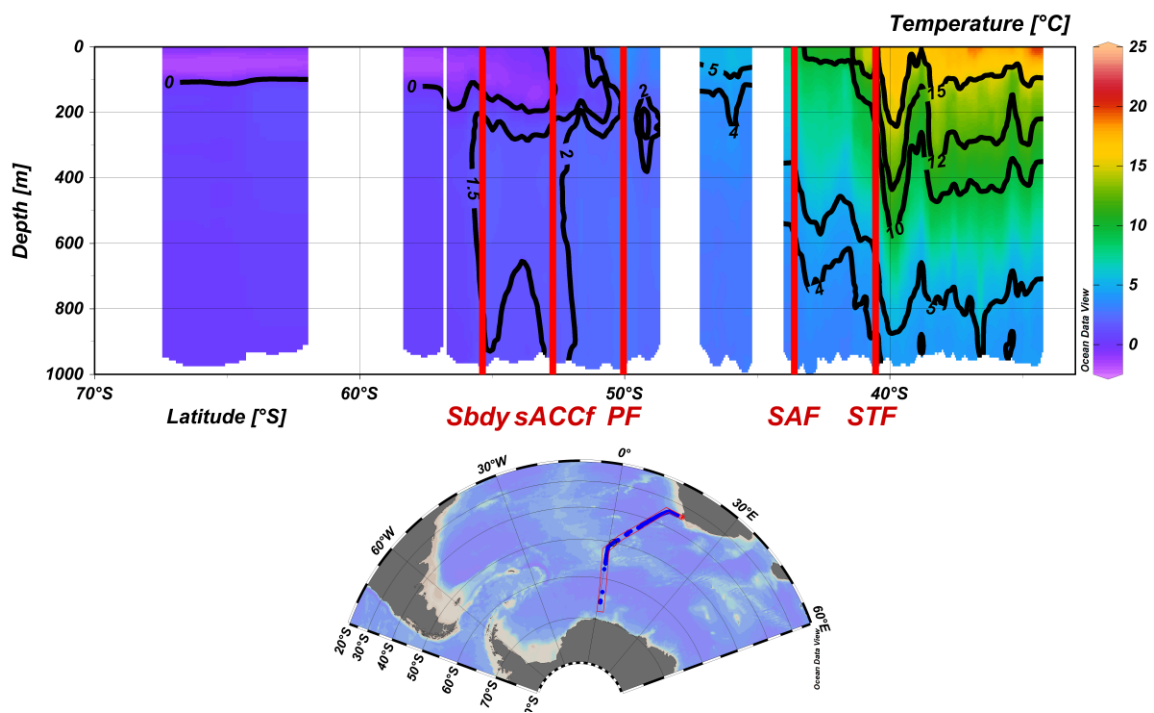
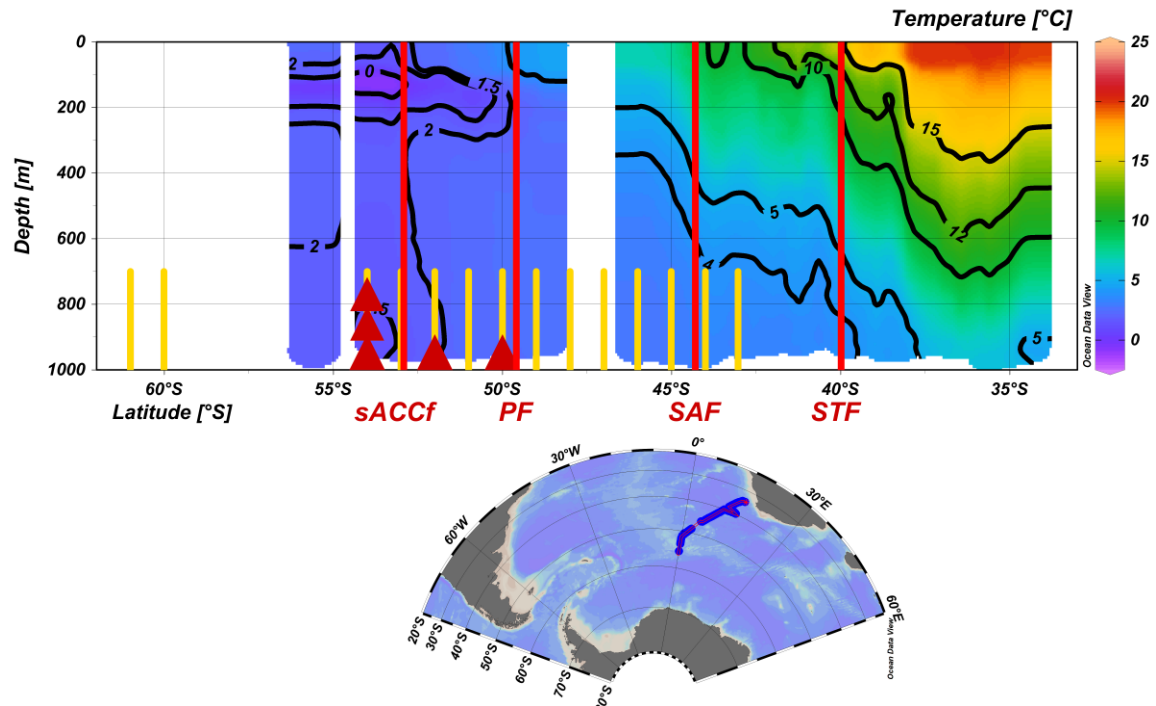


Figure 1: map of XBT launches carried out by the Italian Program for Antarctic Research on the transect New Zealand – Ross Sea, starting in 1994 through 2017





Figures 2a,b: Map of XBT launches jointly carried out in the austral summer of 2016/17 by the Italian Program for Antarctic Research and the South African National Antarctic Programme along the route South Africa – Antarctica. Upper panels show the temperature section across the ACC from Cape Town to Antarctica in December 2016. Lower panels show the temperature section and the position of drifter (yellow line) and float (red triangles) deployments from Antarctica to Cape Town in January 2017. The position of the main ACC fronts is also indicated by red lines.

#### Moorings:

The Italian National Programme for Antarctic Research maintains a network of moorings in the Ross Sea within the MORSea – Marine Observatory in the Ross Sea Programme. Currently, 4 moorings are present (B, D, G, L), equipped with a suite of currentmeters, sediment traps, CTD units, turbidimeters (see Figure 3)

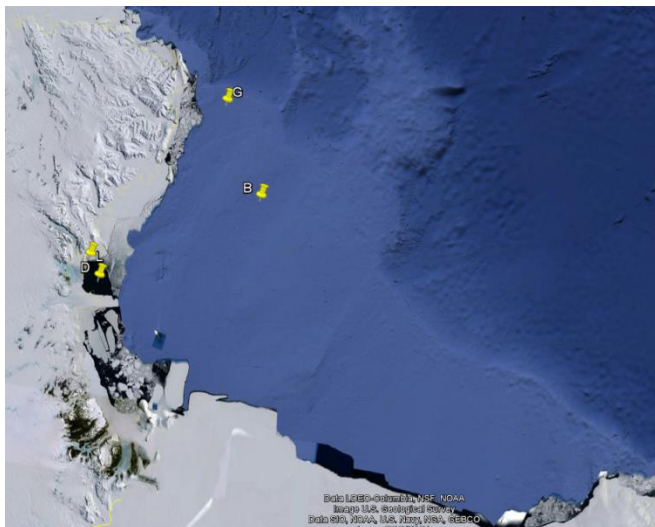


Figure 3: Map of B, D, G and L mooring locations as deployed in early 2017.

Lagrangian measurements:

Thanks to synergy with, and funding from, the ARGO-Italy programme, SVP near-surface drifters and ARGO floats have been regularly deployed on the route from New Zealand to the Ross Sea and back (A) and from South Africa to Antarctica and back (B).

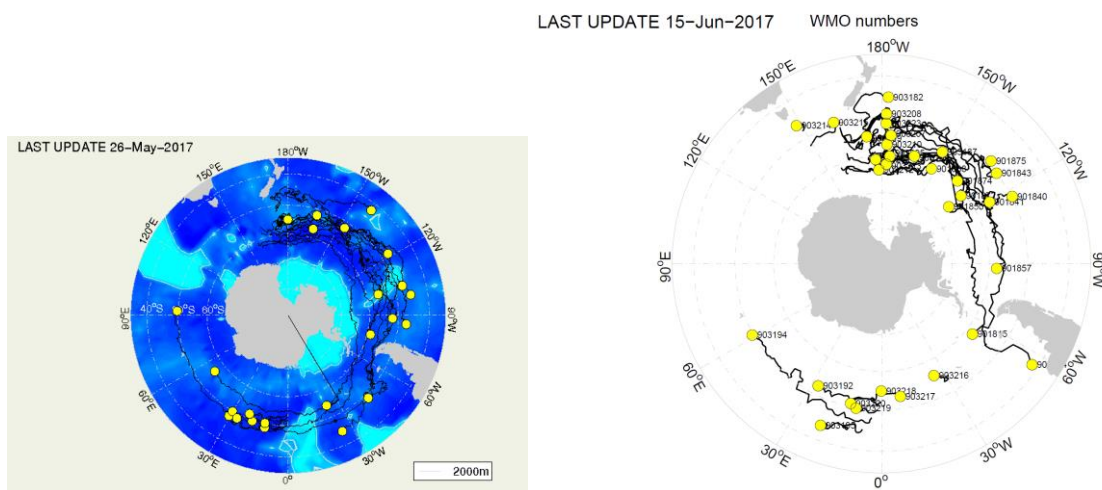


Figure 4: trajectories of floats and drifters deployed so far in the Pacific Sector of the Southern Ocean

In the last few years, Lagrangian instrument deployments amounted to:

- A) 10 floats and 10 drifters in Summer 2014/15 from the R/V Araon
- A) 10 floats and 10 drifters in Summer 2015/16 from the R/V Italice
- B) 5 floats in Summer 2015/16 from the R/V Agulhas II

- A) 10 floats and 10 drifters in Summer 2016/17 from the R/V Italice
- B) 5 floats and 16 drifters in Summer 2016/17 from the R/V Agulhas II

Underway measurements:

Surface temperature and salinity as well as meteorological parameters have been routinely measured along ship tracks during the R/V Italice cruises. In addition to the New Zealand-Ross Sea transect, these measurements have also been carried out in the Ross Sea, as shown as an example in Figure 5.

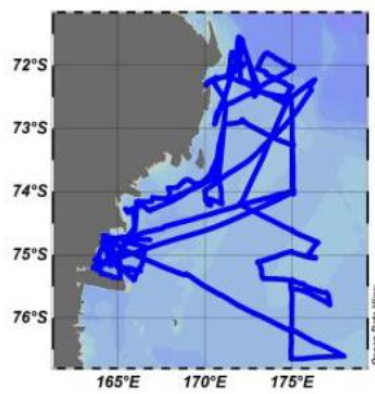


Figure 5 – R/V Italice route in the Ross Sea, along which continuous measurements of sea surface temperature and salinity were carried out in the summer 2016/2017

Hydrology:

The Italian Program for Antarctic Research has been performing hydrological measurements over the whole water column for the last 20 years and more (Figure 6 shows a composite of all CTD casts performed since 1995). This was also done during the cruise carried out in the austral summer 2016/17, and the relative hydrological network is shown in Figure 7.

## CTD casts

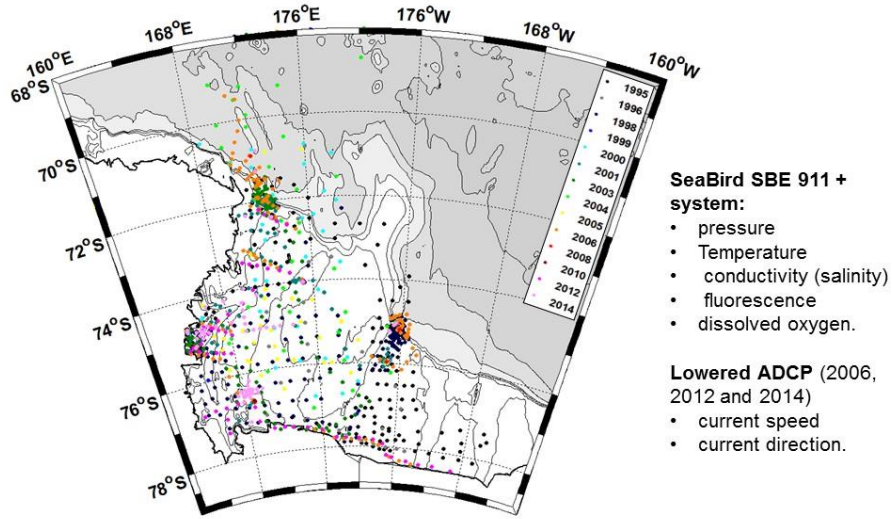


Figure 6 – locations and measurement type of all CTD casts performed since 1995 in the Ross Sea by the Italian Program for Antarctic Research.

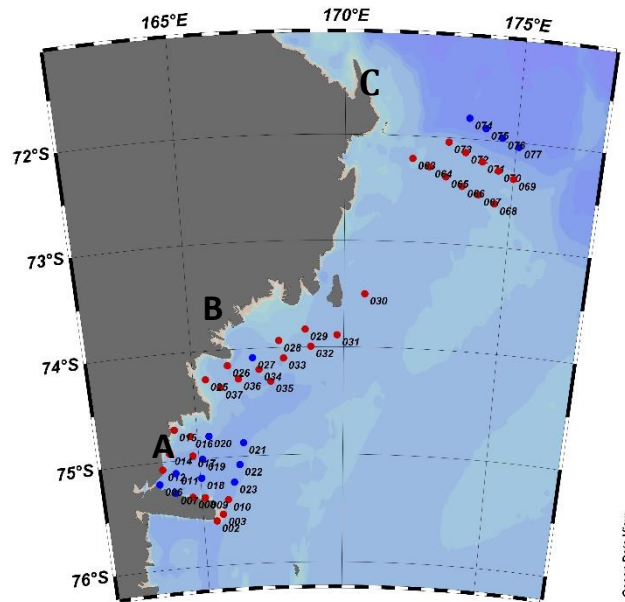


Figure 7 - Map of CTD casts performed in the Ross Sea by the Italian Program for Antarctic Research in the summer 2016/2017



## 2. Modeling

### 2a - Circulation

In recent years a customized version of the Princeton Ocean Model has been implemented in a sector of the Southern Ocean ranging from 90°E to 250°E in longitude (with periodic boundary conditions at the western and eastern boundaries) and from 80°S to 30°S (solid boundaries North and South, with free slip boundary conditions). Its horizontal resolution 0.18°, with 14 sigma vertical layers.

The latest version of the model has a realistic initial stratification, surface forcing based on ½° ECMWF ERA-Interim data. Initial 3D temperature and salinity conditions have been drawn from the Southern Ocean database (SODB, <http://wocesootlas.tamu.edu/>). Figure 8 shows surface elevation and current over the whole domain relative to the 20<sup>th</sup> day of simulation with ECMWF surface heat fluxes.

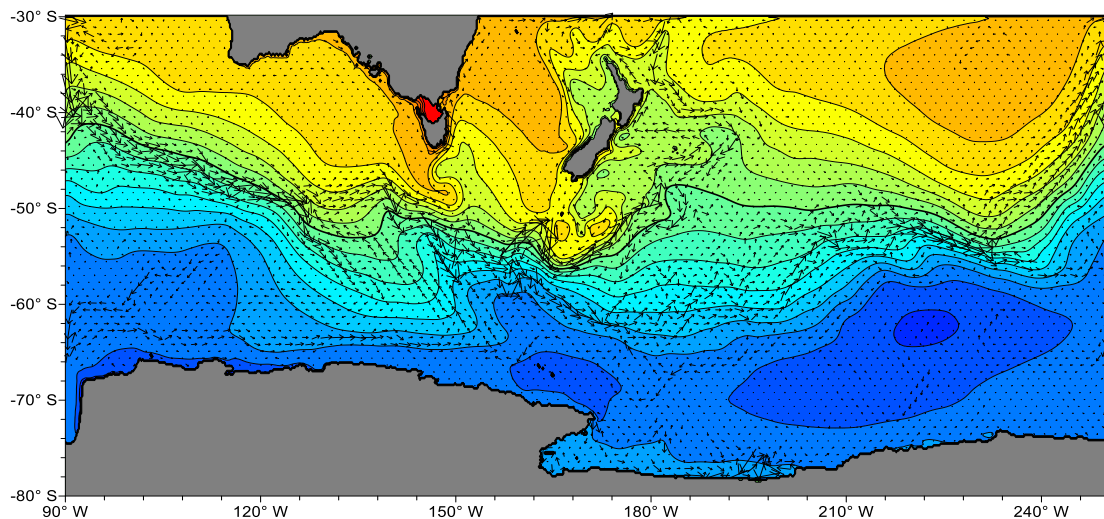


Figure 8: surface elevation and current field over the whole domain relative to the 20<sup>th</sup> day of simulation with ECMWF surface heat fluxes.

### 2b – Ice dynamics

A coupled sea ice–ocean model has been developed to simulate the seasonal cycle of sea ice formation and export in the Terra Nova Bay polynya. The sea ice model accounts for both thermal and mechanical ice processes. The oceanic circulation is described by a one-and-a-half layer, reduced gravity model. The model is forced by a combination of Era Interim reanalysis and in-situ data from automatic weather stations, and also by a climatological oceanic dataset developed from in situ hydrographic observations. The model resolves fairly accurately the sea ice drift and sea ice production rates in the TNB polynya, leading to realistic polynya extent estimates. The model-derived polynya

extent has been validated by comparing the modelled sea ice concentration against MODIS high resolution satellite images.

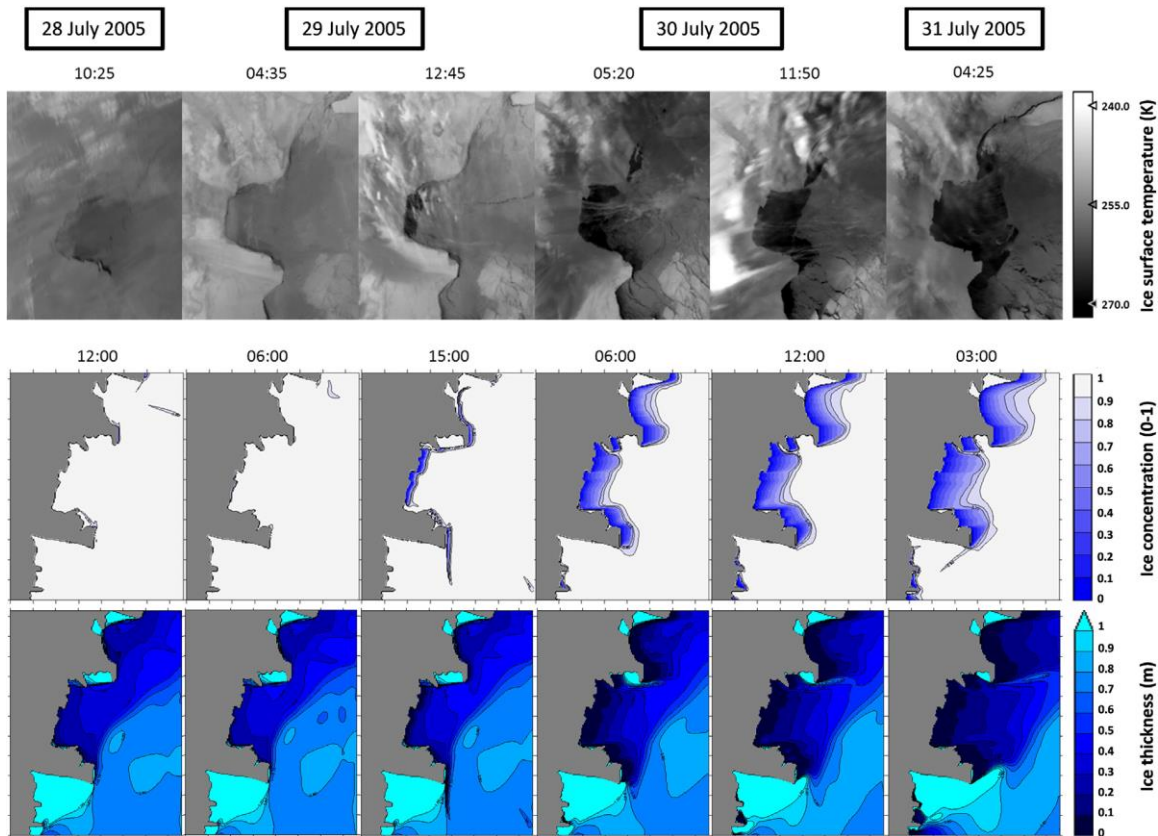


Figure 9: validation of the sea-ice model: MODIS scenes (top) and the modelled sea ice concentration and thickness maps (bottom) displaying the polynya evolution on 28th – 31st July 2005 (from Sansiviero et al., 2016)

## B. Planned activities

What major activities are planned or likely to occur during the next several years? Contact information for the projects would be useful.

### 1. Observational

Plans for observational activities are set for the austral summer 2017/18. They will be carried out from the South African R/V Agulhas II during the second cruise of the MOMA project. In particular, XBT launches, as well as 5 float and 10 drifter deployments will be performed from the ship on the route from South Africa to Antarctica, while the possibility of an additional route is being investigated-



As to hydrology, CTD, LADCP, turbulence profiles as well as biological measurements will be carried out in the Ross Sea in the framework of the Celeber project, funded by the Italian Program for Antarctic Research.

For the next austral summer 2017/18, in cooperation with the American programme, two Italian Scientist will be on board of the R/V Palmer to support oceanographic investigation in the Ross Sea.

## 2. Modeling

The existing, limited domain Princeton Ocean Model will be extended to the whole circumpolar Southern Ocean, limited only in latitude from 80°S to 30°S, same horizontal and vertical resolution as above. Ice modelling will be further carried out as well.

### **C. Editorial activities**

Further information regarding the Italian (and non-Italian) research effort specifically on the Ross Sea can be found in the special issue of the Journal of Marine Systems (Volume 166, Pages 1-196, February 2017) on “Mesoscale and high-frequency variability in the Ross Sea”, whose associate editors are Dennis J. McGillicuddy, Jr., Giorgio Budillon and Adam Kustka.