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DELL'UNIVERSITÀ E DELLA RICERCA

Conferenza nazionale sulla ricerca in Antartide
Roma 20-21 ottobre 2015, Accademia Nazionale dei Lincei

Southern Ocean and sea ice in a warming world

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Outline

- Southern Ocean and sea ice
- Attività italiane *(elenco non esaustivo, …)*
- Tematiche attuali
- Iniziative internazionali
- Quale futuro

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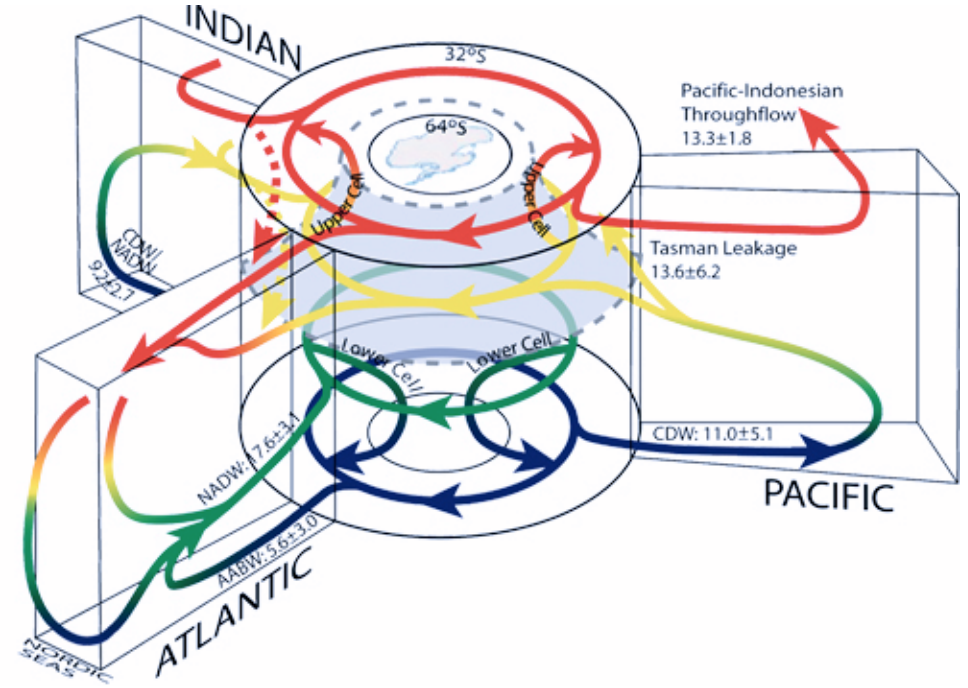
Southern Ocean and sea ice in a warming world

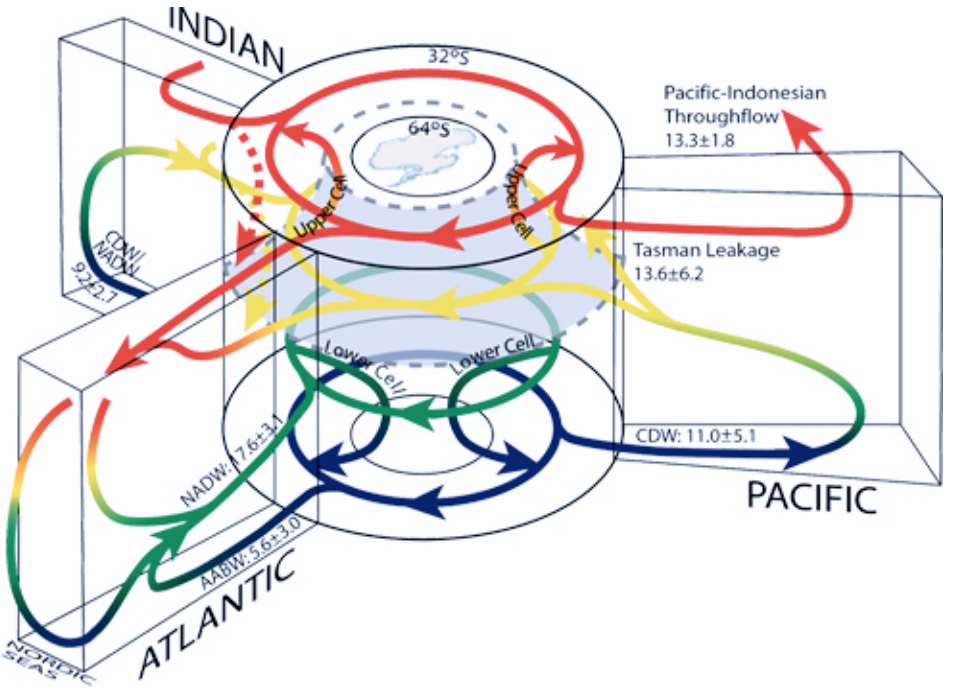
As a result of the unique geography of the Southern Ocean, the region has a profound influence on the global ocean circulation and the Earth's climate. The Southern Ocean provides the principal connections between the Earth's ocean basins, and controls the connection between the deep and upper layers of the global overturning circulation, thereby regulating the capacity of the ocean to store and transport heat, carbon and other properties that influence climate and global biogeochemical cycles.



The standard oceanographic definition of the Southern Ocean as the waters between the Subtropical Front and the Antarctic continent. This is a broader definition than used in some policy contexts, but reflects the circumpolar continuity of the waters of this oceanic domain and the strong scientific connections between them.

Southern Ocean and sea ice in a warming world

The upwelling branch of the overturning circulation in the Southern Ocean returns carbon and nutrients to the surface layer, while the downwelling branches transport heat, carbon and other properties into the ocean interior. The balance between upwelling and release of CO_2 versus uptake of carbon into the ocean interior determines the strength of the Southern Ocean sink of CO_2.



The Southern Ocean contributes more to the ocean storage of the excess heat and carbon added to the Earth-atmosphere system by human activities than any other latitudinal band. About 40% of the total global ocean inventory of anthropogenic carbon dioxide is found south of 30°S, whilst export of nutrients by the upper limb of the overturning circulation ultimately supports 75% of the global ocean primary production north of 30°S.

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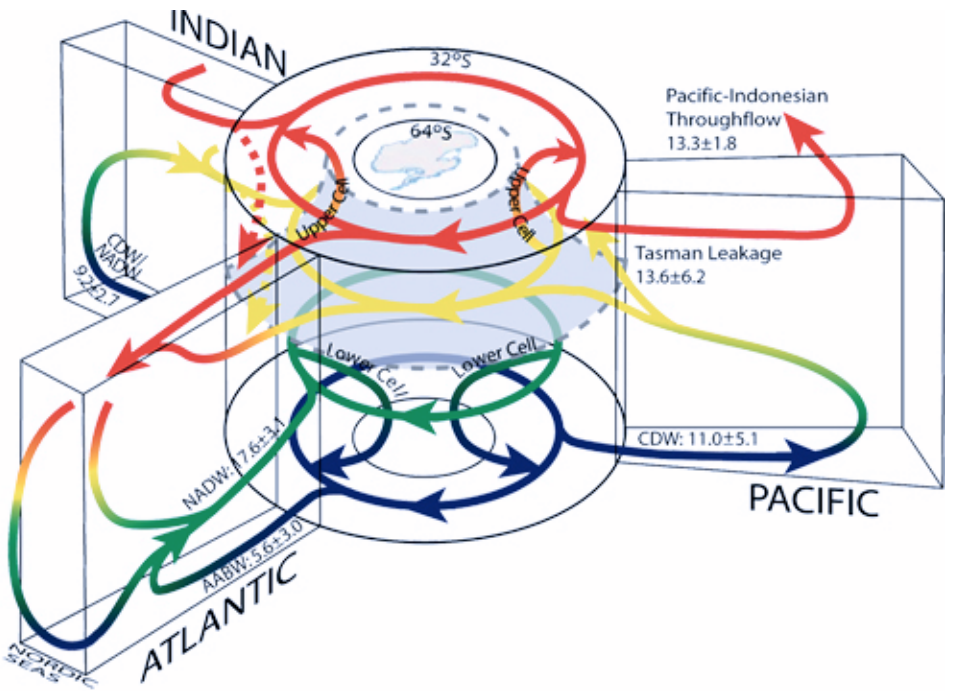
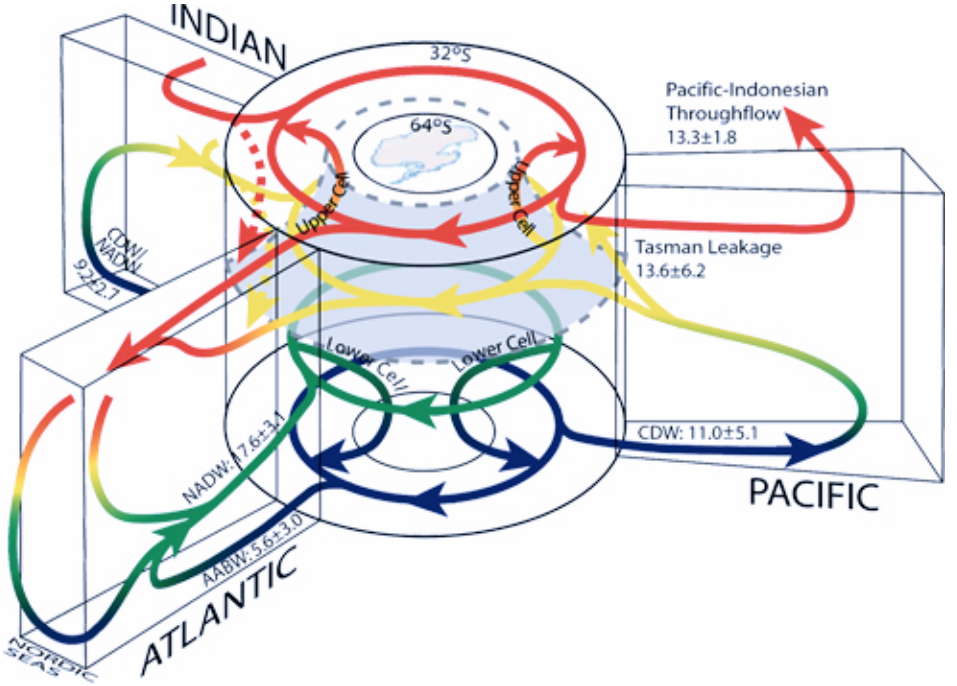
Climate and sea-level rise are influences strongly by ocean-cryosphere interactions in the Southern Ocean. Changes in sea-ice extent or volume result in changes in the Earth's albedo, water mass formation rates, and air-sea exchange of gases such as CO_2, and affect oceanic organisms from microbes to whales through physiological changes and changes to their habitats. Melting of floating glacial ice by warm ocean waters influences the high-latitude freshwater budget and stratification, and may affect the stability of the Antarctic Ice Sheet and the rate at which glacial ice flows to the sea.



Given the central role that the Southern Ocean plays in the global climate system, any changes in the region will have global consequences.

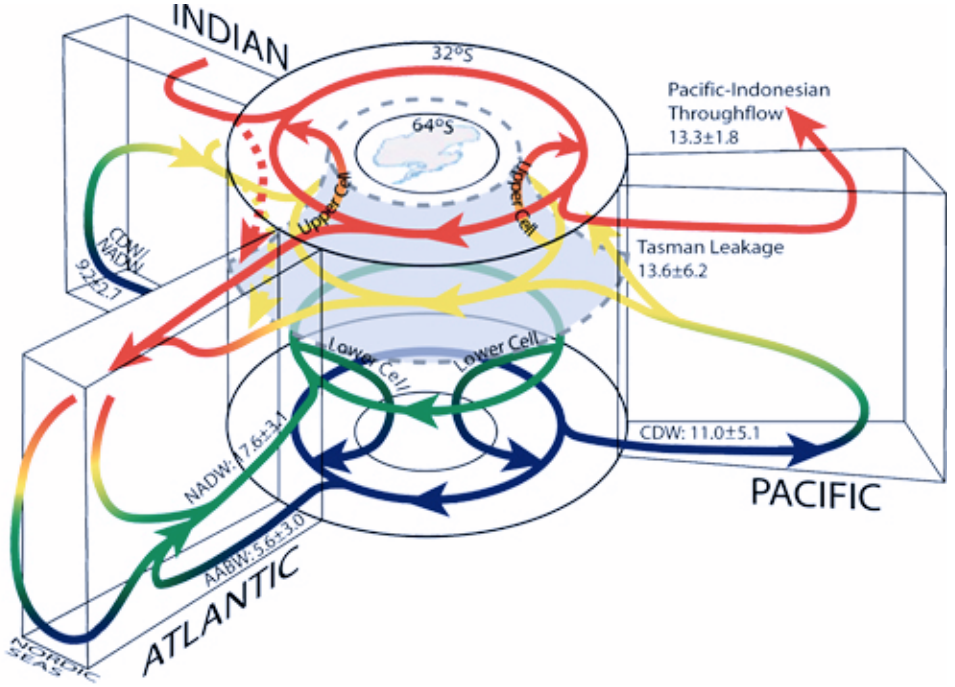
The Southern Ocean is changing

Changes in the physical and biogeochemical state of the Southern Ocean are already underway. The circumpolar southern Ocean is warming more rapidly, and to greater depth, than the global ocean average. The upper layers have freshened and widespread warming of the Antarctic Bottom Water has been observed.



Since 1992, the satellite altimeter record shows an overall increase in sea level, with strong regional trends. Changes in sea ice extent are showing strong regional trends, with large increases in the Ross Sea sector compared to large decreases west of the Antarctic Peninsula. The uptake of CO_2 by the ocean is changing its chemical balance, increasing the acidity and reducing the concentration of carbonate ion. The response of the Southern Ocean food web to changes in ocean chemistry remains largely unknown.

The Southern Ocean is changing



The Southern Ocean food web is characterised by a keystone species, Antarctic krill (*Euphausia suberba*), and this heavy dependence on a single species and the uniqueness of the Southern Ocean food webs and biogeochemical cycles make the system potentially vulnerable to climate variability and change.

There is evidence of changes in other components of the Southern Ocean food web, from phytoplankton to penguins and seals, however lack of long-term observations makes it difficult to assess long-term trends.

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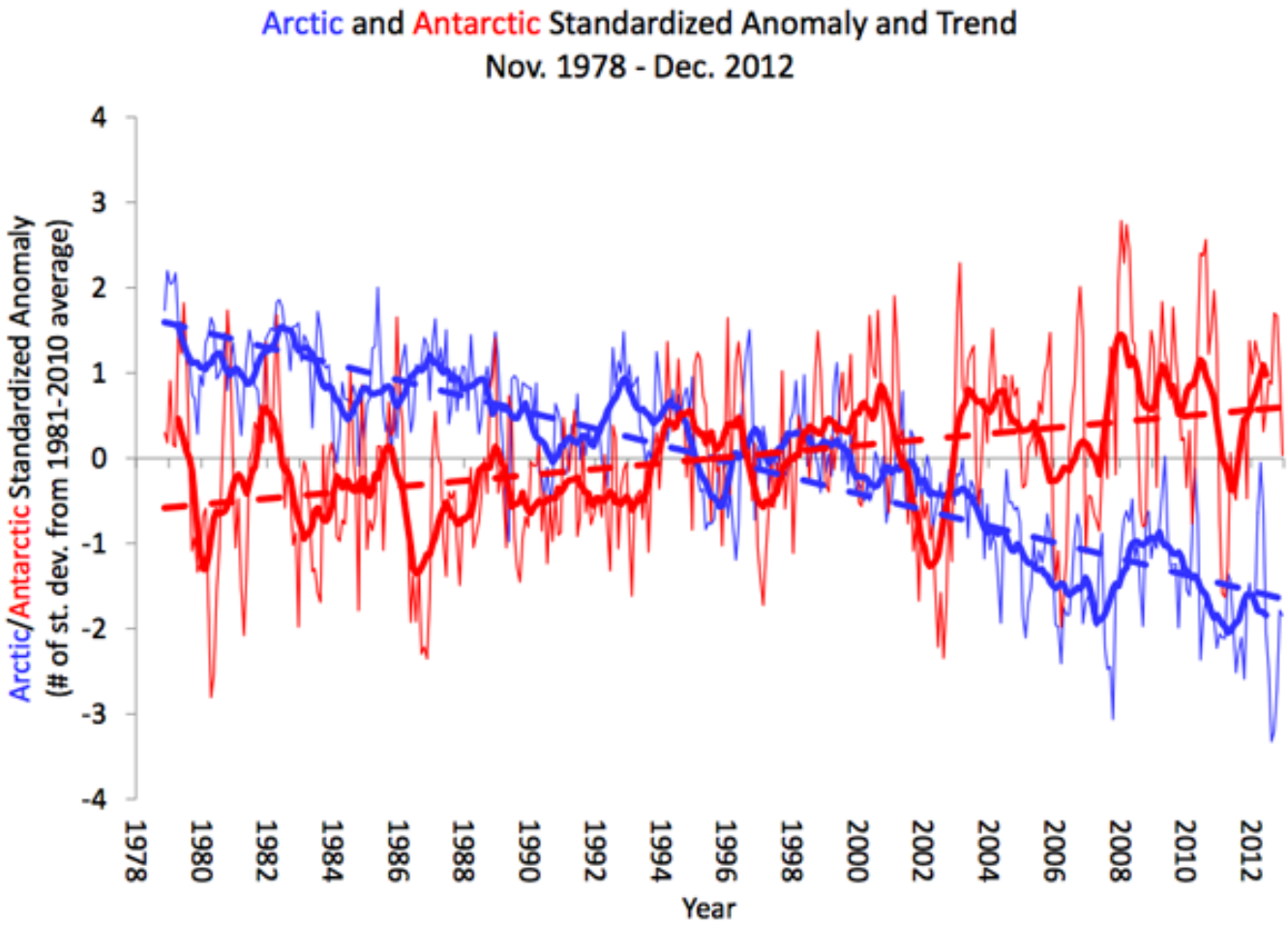
Southern Ocean and sea ice in a warming world

SEA ICE

Antarctic sea ice is one of the most variable features of the Earth system. It reaches its maximum extent of 20 million km^2 in September and recedes to its minimum extent of 4 million km^2 in February.



Arctic and Antarctic Sea Ice Extent Anomalies, 1979-2012: Arctic sea ice extent underwent a strong decline from 1979 to 2012, but Antarctic sea ice underwent a slight increase, although some regions of the Antarctic experienced strong declining trends in sea ice extent.

XXX anni di attività italiane nell'Oceano Meridionale

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Fino alla IV spedizione le navi erano principalmente utilizzate per il trasporto di materiale, strumenti, carburante e personale nonché come nave appoggio per il personale alla costruenda base a BTN (**POLAR QUEEN** I, II e III spedizione; **FINPOLARIS** II e III spedizione; **BARKEN** IV e V spedizione).

Polar Queen

Barken

Durante la V e VI spedizione venne utilizzata per la prima volta una imbarcazione dedicata alle attività oceanografiche **(CARIBOO** 1989-90 e 1990-91).

Cariboo

La V spedizione vede anche il varo del mezzo minore **Malippo**, per le ricerche marine costiere, tuttora operante a MZS.

Malippo

A partire dalla VI spedizione (1990-91) viene noleggiata la nave (**ITALICA**). In occasione della X spedizione (1994-95) viene ristrutturata per ospitare i necessari laboratori scientifici e da quel momento rimane praticamente l'unico mezzo per le ricerche oceanografiche (ma anche per il trasporto di carburante, materiale e personale tecnico-scientifico ….).

Italica

OGS-Explora svolge dal 1987-88 diverse missioni prevalentemente di geofisica marina in aeree periantartiche e antartiche.

OGS-Explora

In pillole…

Nei primi anni le ricerche italiane oceanografiche hanno interessato esclusivamente l'area marina di Baia di Terra Nova.

Durante la V e VI spedizione (*Cariboo, 1989-90 e 1990-91*) le ricerche sono state estese prevalentemente al settore occidentale del Mare di Ross.

Dalla X spedizione (*Italica, 1994-95*) l'area indagata è stata allargata anche ai settori orientali ma rimane sostanzialmente confinata nel Mare di Ross.

Le ricerche in altre aree sono state effettuate con navi straniere e/o non polari, o in regime di "*ship opportunity*".

XXX anni di ricerche italiane nell'Oceano Meridionale

(breve sintesi necessariamente incompleta e non esaustiva)

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CLIMA - Climatic Long-term Interactions for Mass-balance in Antarctica *(varie edizioni)*

CLIMA project was the main Italian contribution to Antarctic **physical oceanography** (including air-sea interactions and marine ecology) during 1993-2009, it involved Universities, C.N.R. & other research institutes.

Main interest areas:

1. Pacific Sector of the Southern Ocean (ACC)
2. Ross Sea continental shelf and slope
3. Terra Nova Bay polynya

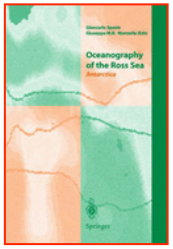
…after 2009

SOChiC – Southern Ocean Chokepoints, Italian Contribution

T-REx – TerraNovaBay Research Experiment

PolarDove - Deep Ocean Ventilation

Collaboration with: Columbia University (USA), University of Cape Town (South Africa), CSIRO (Australia), University of Brest (France), NIWA (New Zealand)



Oceanography of the Ross Sea: Antarctica. 1999 (Springer) G.Spezie,G.Manzella

Antarctic Science. 2003. Vol. 15, 1

Deep Sea Research Part II: Topical Studies in Oceanography
Volume 56, Issues 13-14, Pages 775-894 (June 2009)
Southern Ocean Shelf Slope Exchange
Edited by A. L. Gordon, A. Bergamasco, and L.Padman

The1st SCAR Antarctic and Southern Ocean Science Horizon Scan - Final List of Questions: Southern Ocean and sea ice in a warming world

12. Will changes in the Southern Ocean result in feedbacks that accelerate or slow the pace of climate change?
13. Why are the properties and volume of Antarctic Bottom Water changing, and what are the consequences for global ocean circulation and climate?
14. How does Southern Ocean circulation, including exchange with lower latitudes, respond to climate forcing?
15. What processes and feedbacks drive changes in the mass, properties and distribution of Antarctic sea ice?
22. How will climate change affect the physical and biological uptake of CO_2 by the Southern Ocean? (Cross-cuts "Antarctic Life")
23. How will changes in freshwater inputs affect ocean circulation and ecosystem processes? (Cross-cuts "Antarctic Life")

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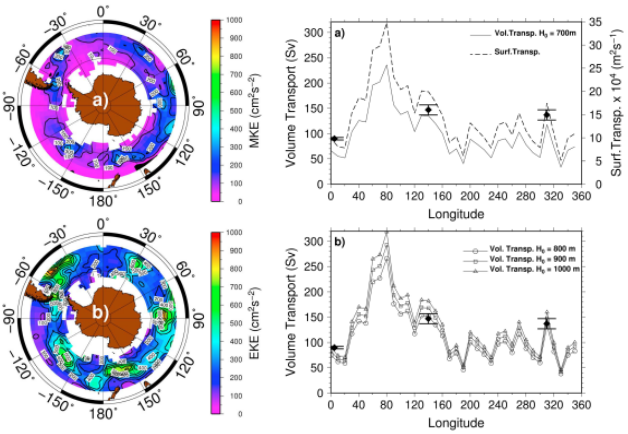
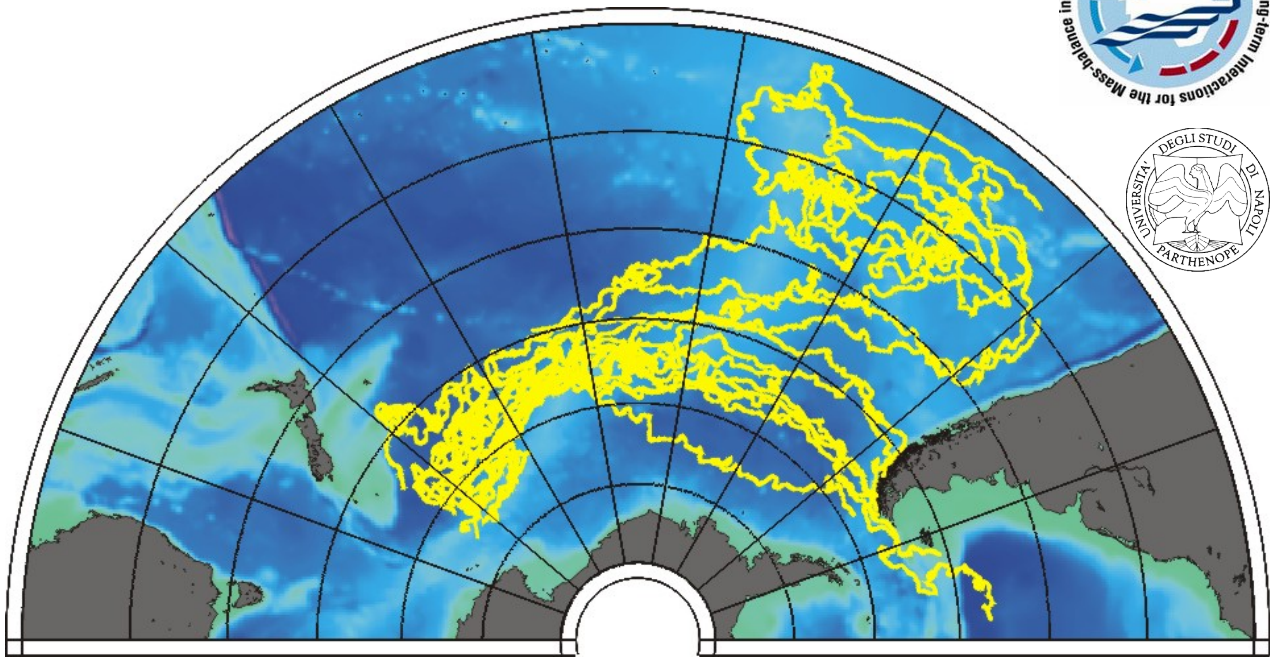
Southern Ocean and sea ice in a warming world

Antarctic Circumpolar Current - Lagrangian view (drifters and floats)

New Zealand – Ross Sea chokepoint: ship opportunity !!





Falco, Zambianchi, JGR 2011

The Italian contribution to drifter population in the SO started in 1994 by the CLIMA project and it is now improved using also Argo floats by the MORSea "Marine Observatory" (PNRA) and ARGO-ITALY projects.

http://morsea.uniparthenope.it

http://argoitaly.ogs.trieste.it

Antarctic Circumpolar Current - Lagrangian view (drifters and floats)

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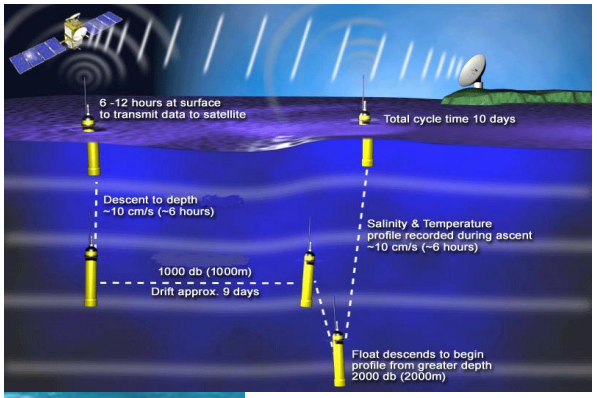
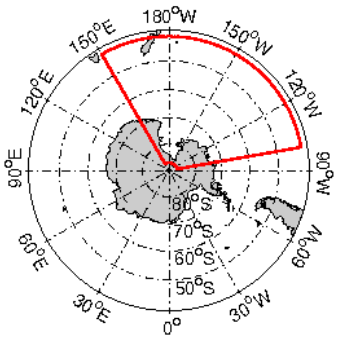
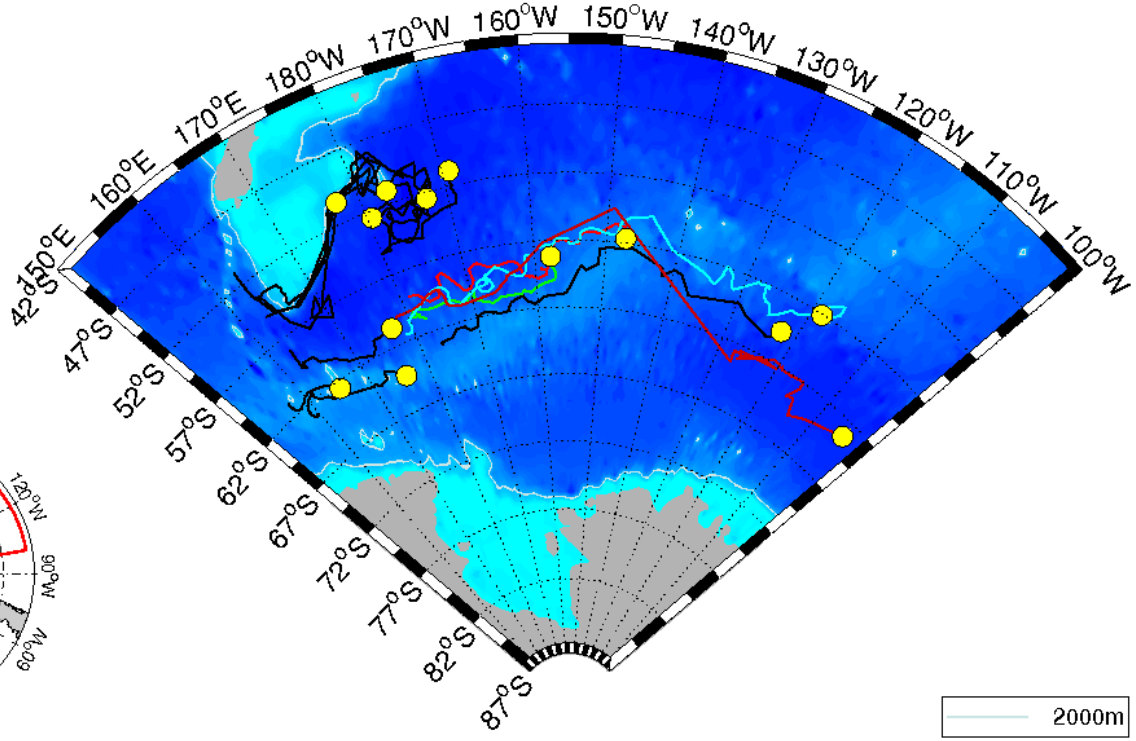
LAST UPDATE 18–Oct–2015







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Southern Ocean and sea ice in a warming world

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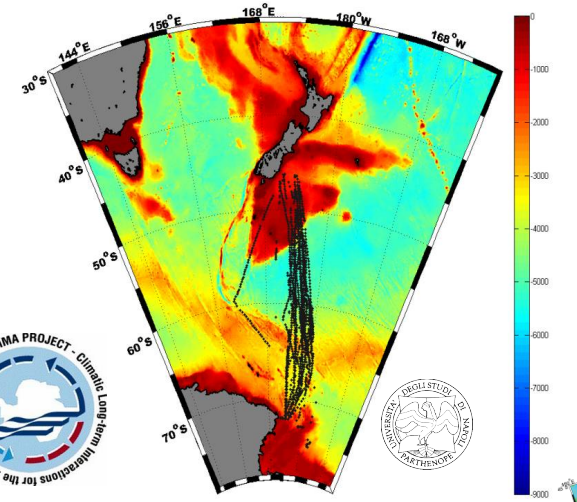
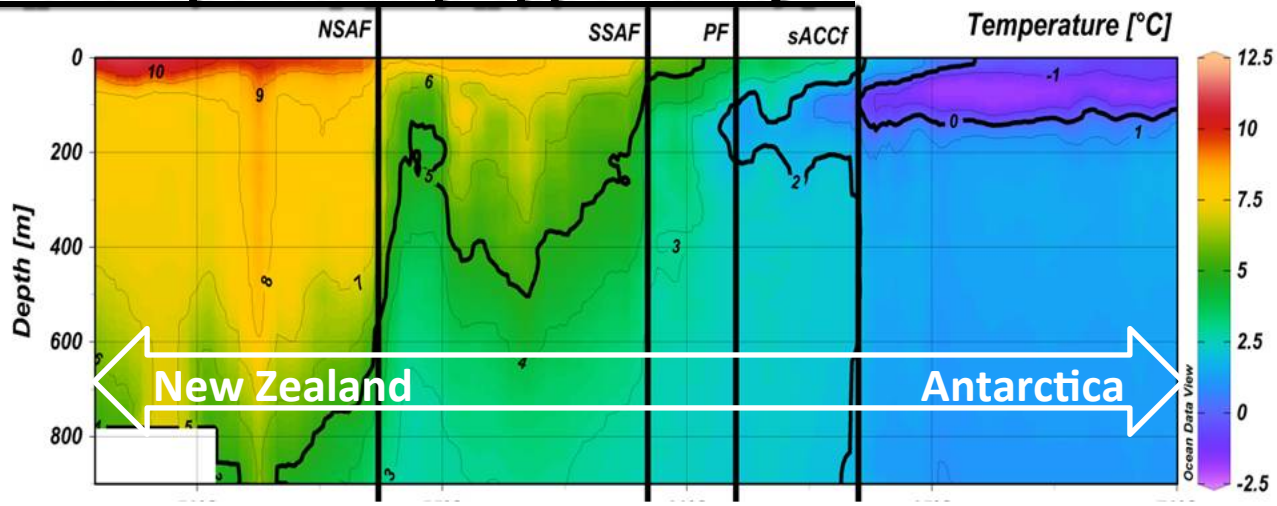
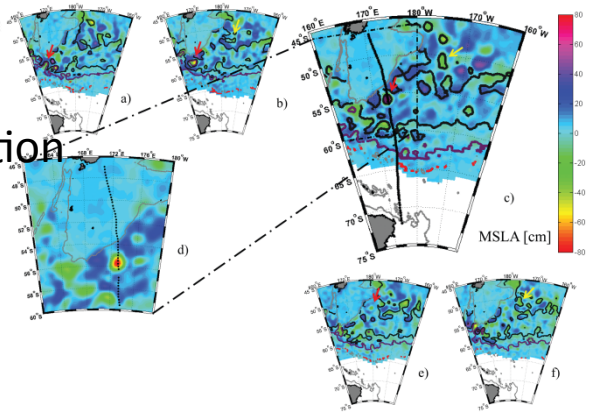
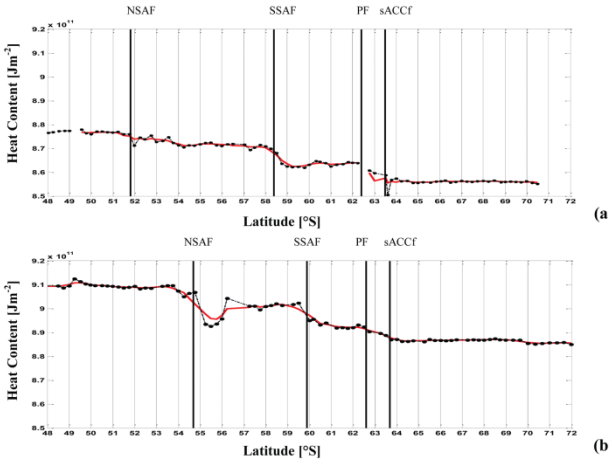




SOChIC – Southern Ocean Chokepoints, Italian Contribution





Cotroneo, Budillon, Fusco, Spezie DSR 2013

MORSea

http://morsea.uniparthenope.it

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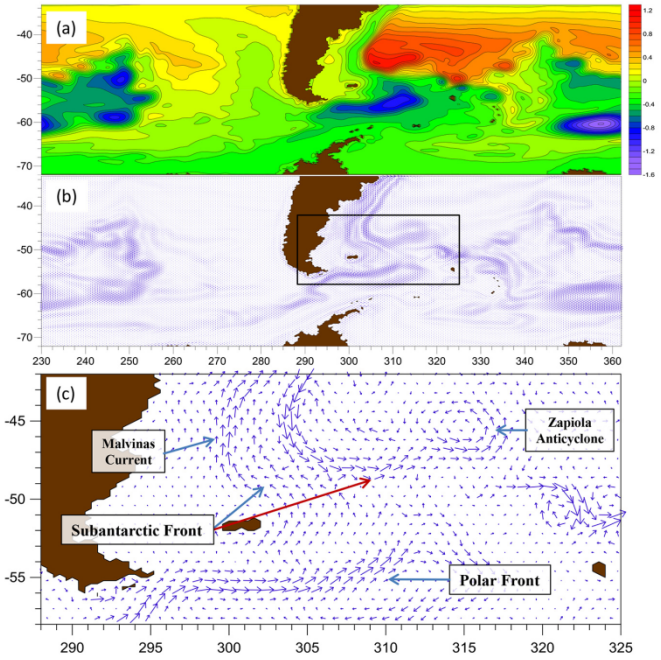
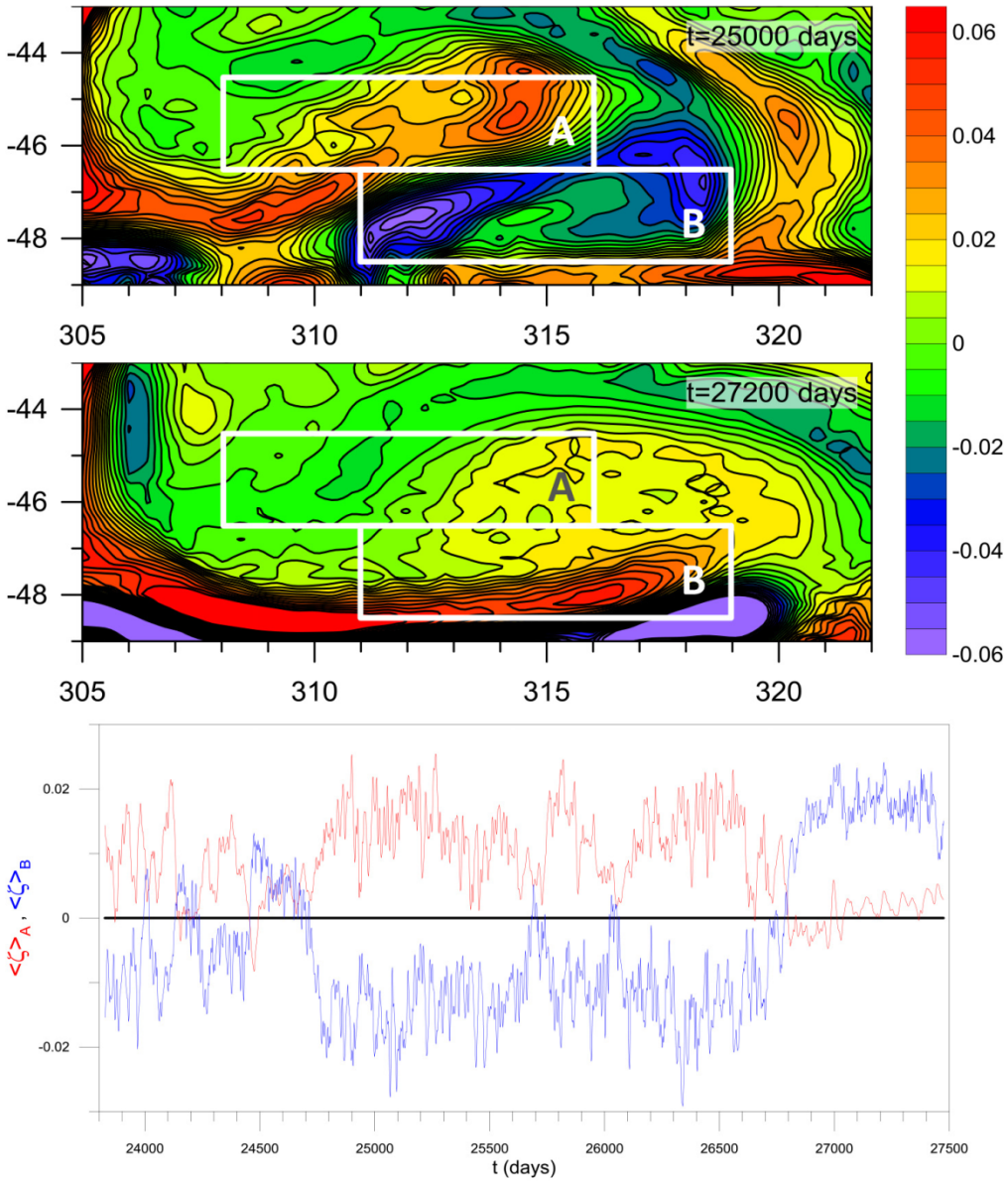
Southern Ocean and sea ice in a warming world

Numerical studies on the ACC dynamics

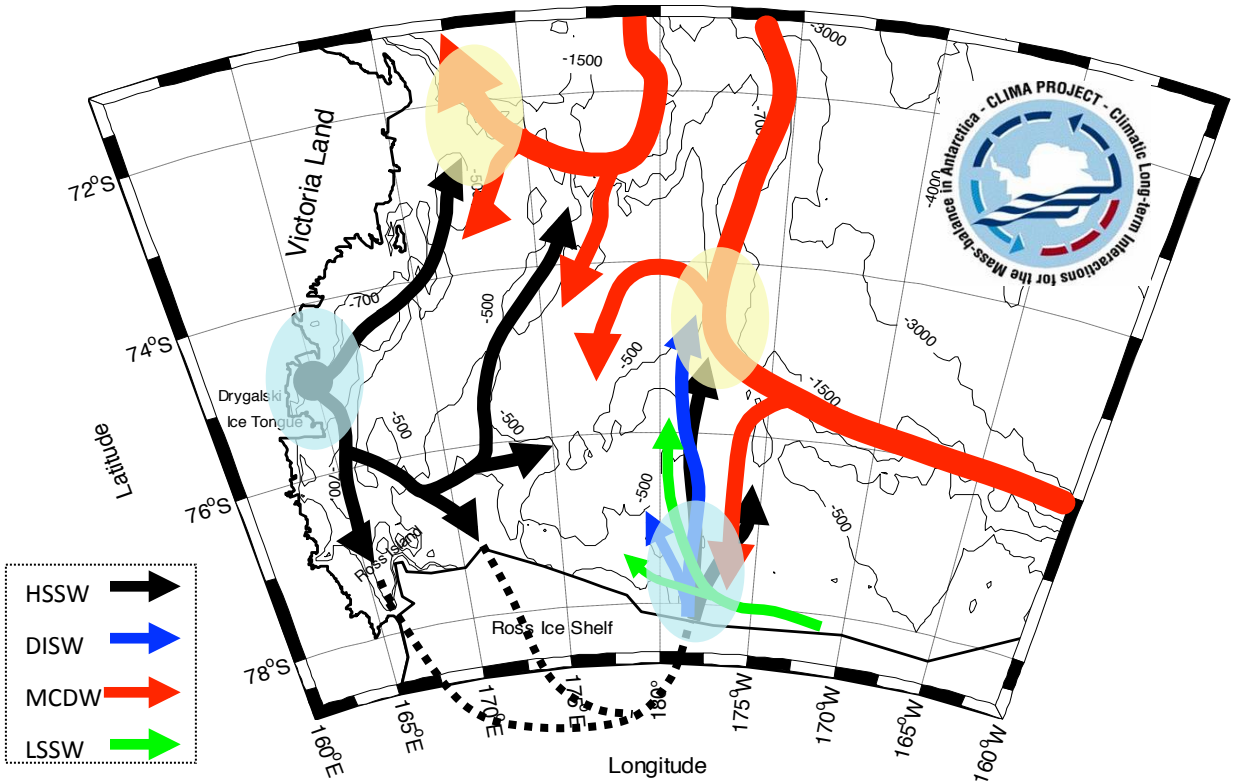
Intrinsic variability of the Antarctic Circumpolar Current system:
low- and high-frequency fluctuations of the Argentine Basin flow





Sgubin, Pierini, Dijkstra Ocean Science 2014

This activity led to the construction of the first interpretative model of the shelf water formation, spreading and circulation in the Ross Sea.



From Budillon et al., AS. 2003

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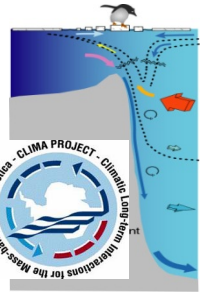
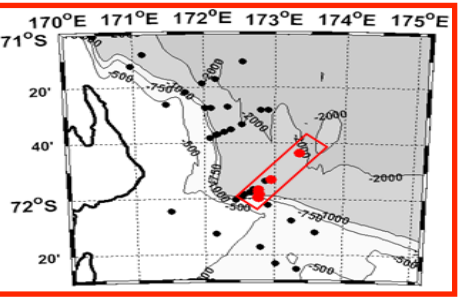
Southern Ocean and sea ice in a warming world

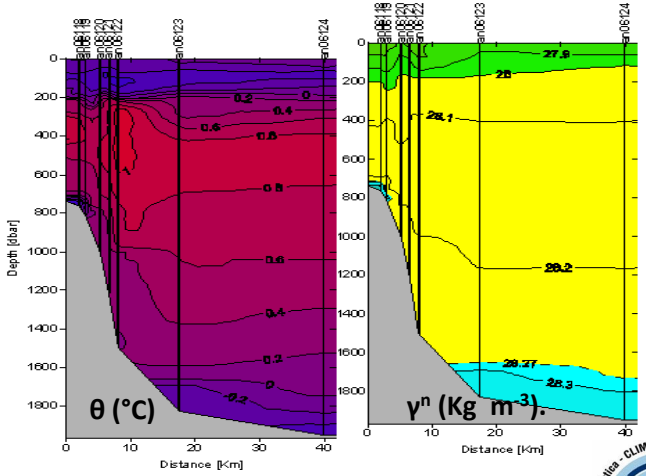
Antarctic Slope Front (ASF) - Experimental evidence of the shelf water outflow from the continental shelf

- Less stable at the DT allowing frequent inflow of relatively warm CDW over the shelf.
- More stable at the GCT preventing intrusion of CDW in the intermediate layers.



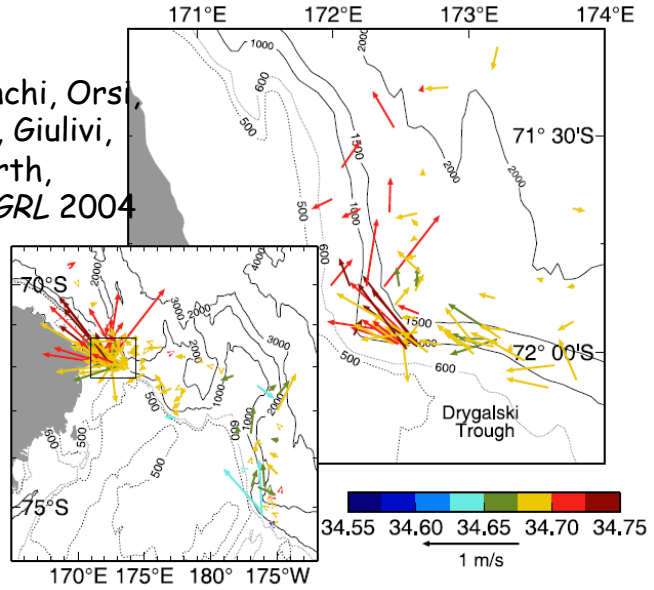
Drygalski Trough



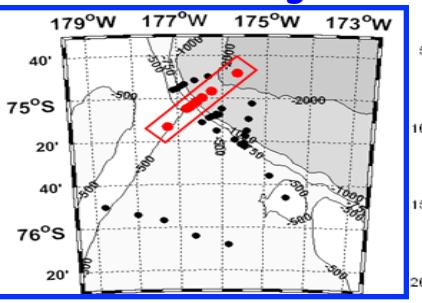


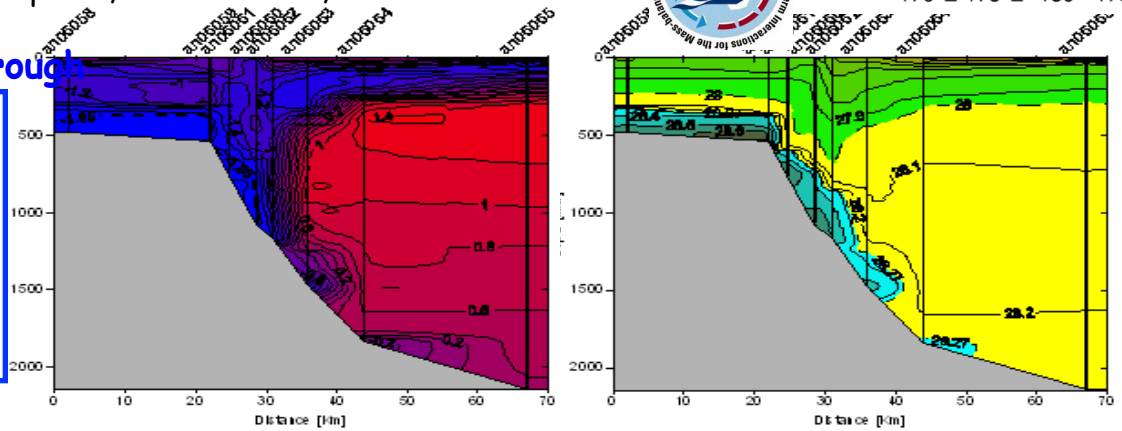
Budillon Castagno, Aliani, Spezie, Padman et al., JGR 2011

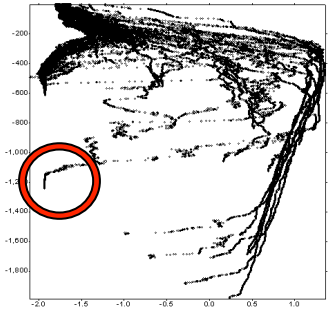
Gordon, Zambianchi, Orsi, Visbeck, Giulivi, Whitworth, Spezie *GRL* 2004



Glomar Challenger Trough

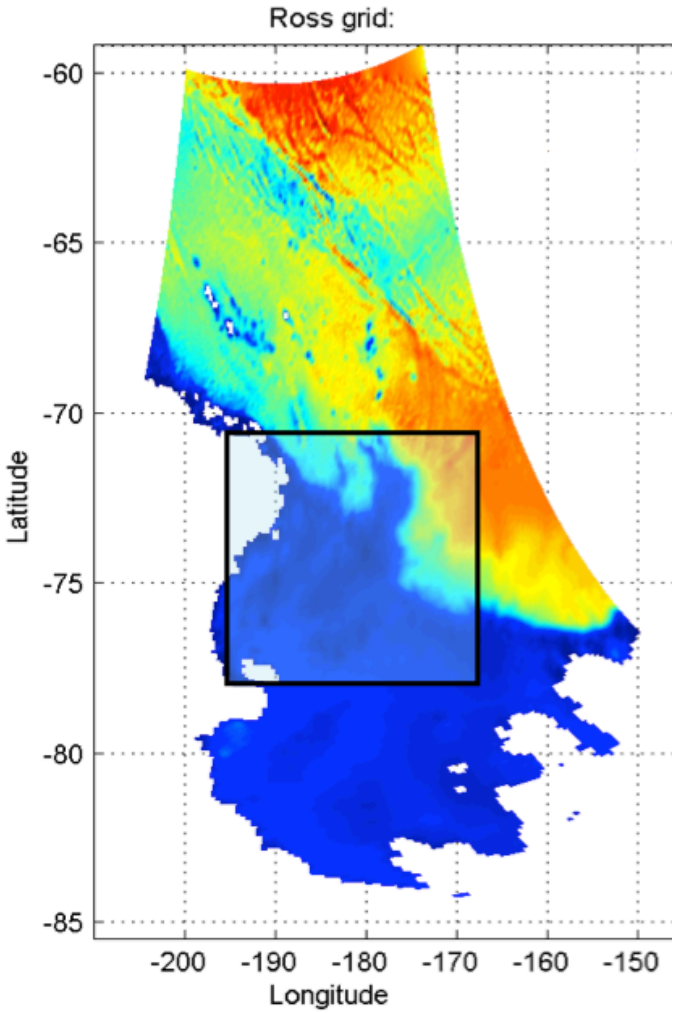


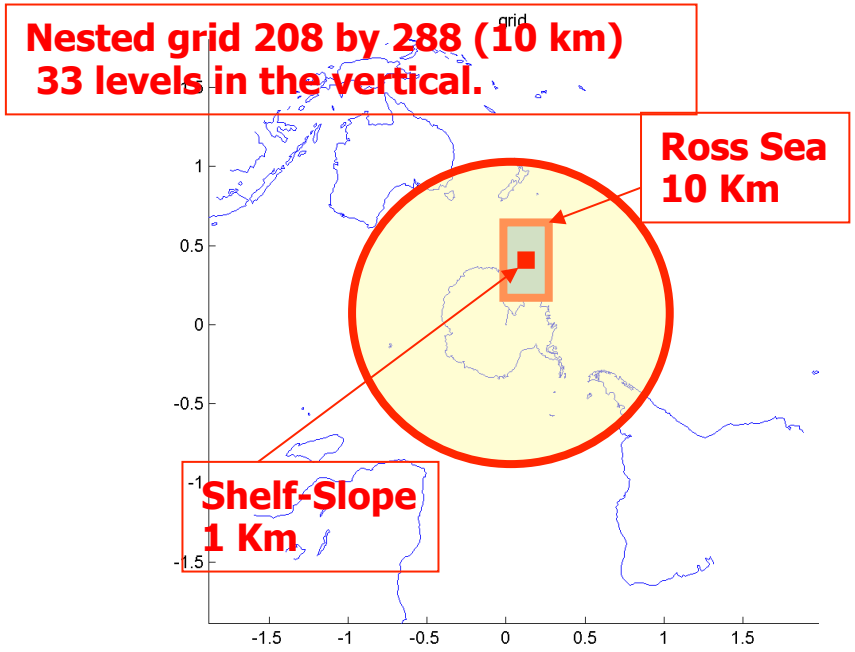




Bergamasco, Defendi, Zambianchi, Spezie. JMS 2002

Bottom layer density - Numerical studies





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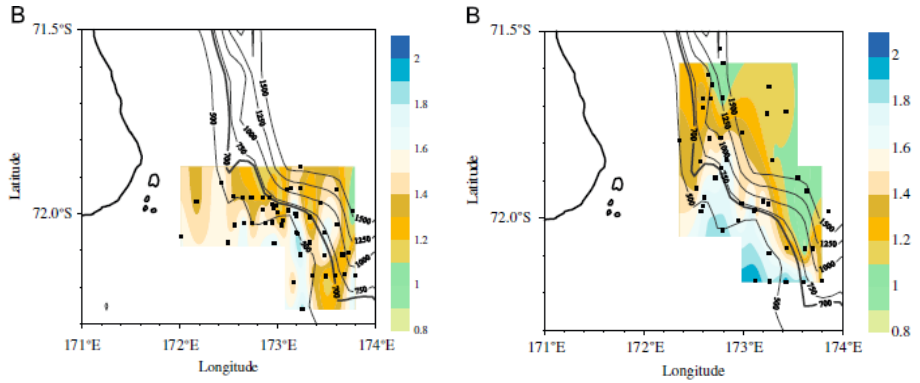
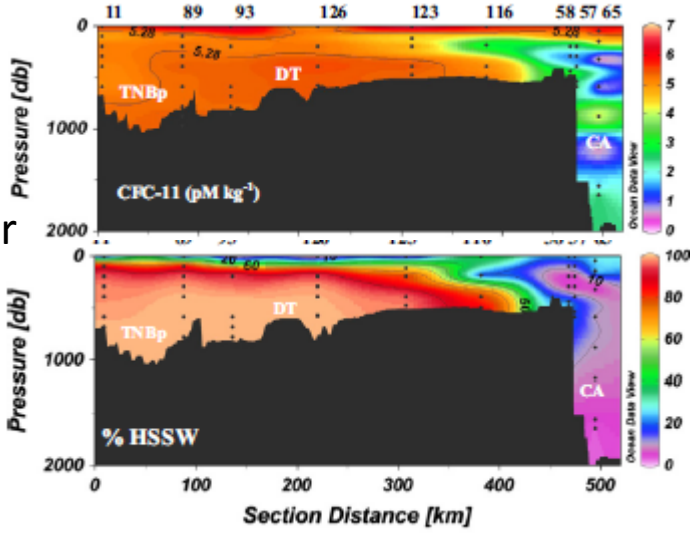
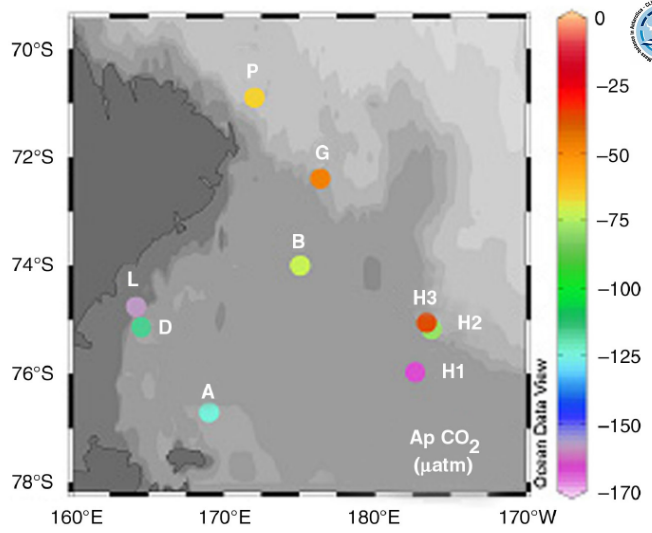
The variability in the chemical properties of the deep water masses in the Western Ross Sea



1. The estimated volume of the overflowing new Antarctic Bottom Water (AABW) and the associated export of O_2 and nutrient in 1998 (left) and in 2003 (right).
(Rivaro et al., DSRI, 2010)



2. The CFCs data revealed the extent of that newly ventilated HSSW produced in the Western Ross Sea participating in AABW production and suggested this water had a longer residence time on the shelf than the past.
(Rivaro et al., DSRI, 2015)

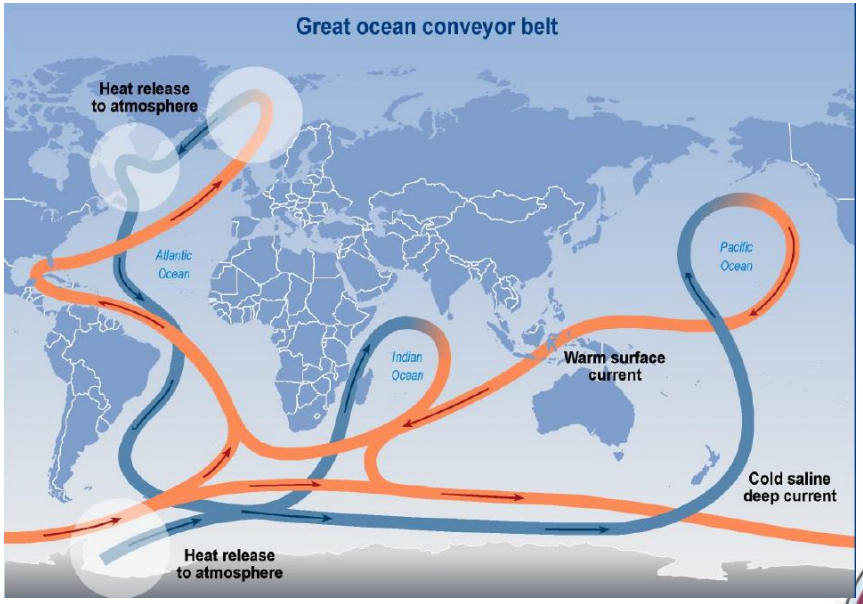


& **T-REx** projects

3. During summer the Ross Sea is a sink for atmospheric CO_2 with a large variability depending on biological and physical forcing.
4. The water column contains anthropogenic CO_2: the maximum values are associated to the HSSW and the minimum to the old CDW, consistent with CFCs data.
(Rivaro et al, Polar Research, 2014; Sandrini et al., AS 2007)

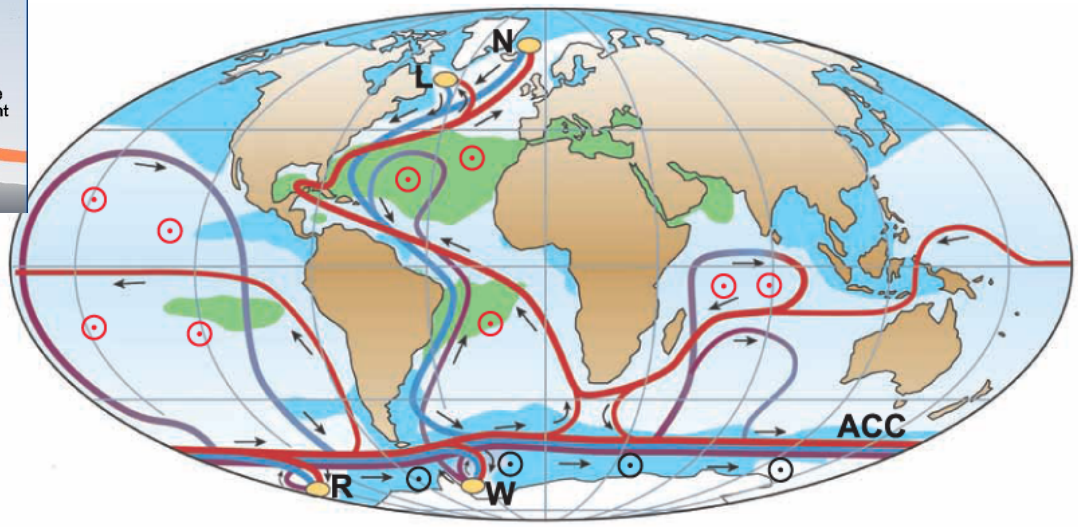
pCO_2 (pCO_{2SW}–pCO_{2air}) (µatm) calculated at the surface respect to a 382 ppm pCO_{2air}.

La Conveyor Belt – trova la differenza … ☺

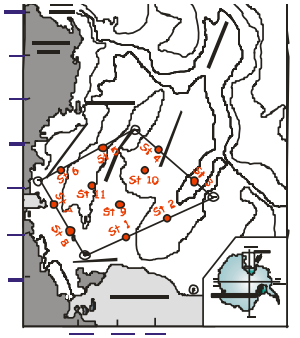


1987

2002



Projects: BIOSESO I & II, ABIOCLEAR



MAIN CONCERNS:

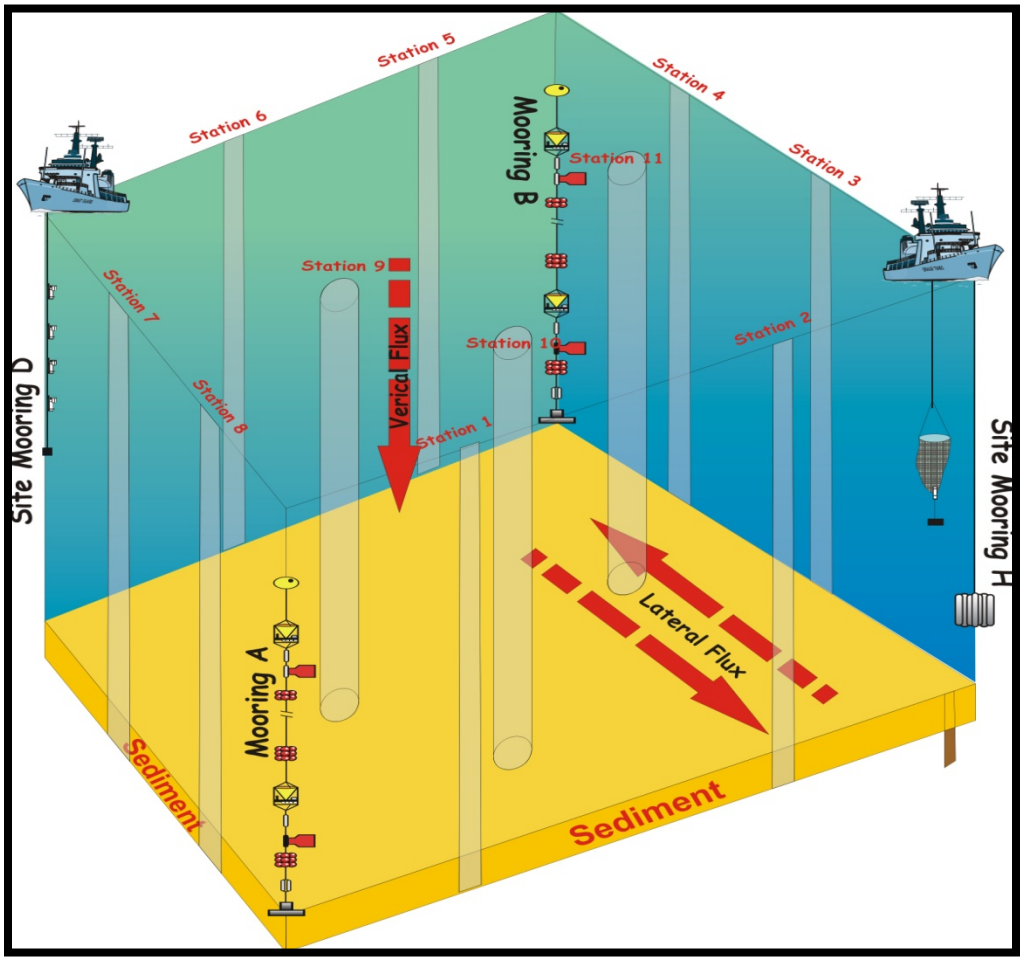
-Links between nutrient organication and OM export,

-Mechanisms governing transfer and degradation of the surface organic matter;

-Environmental parameters affecting space and temporal distribution of diatoms and forams;

-Implementation of an ecological model in significant sites

-Reconstruction of climatic variability



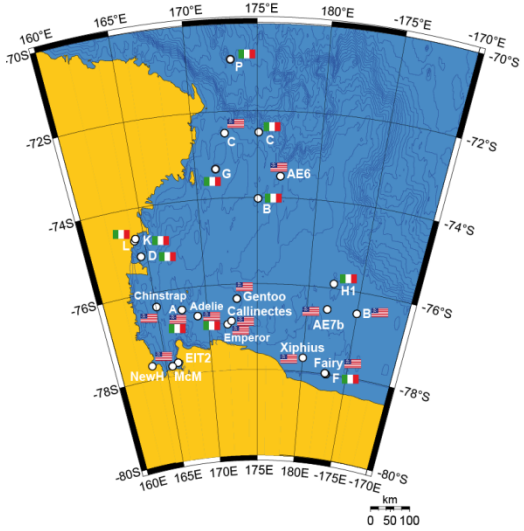
The1st SCAR Antarctic and Southern Ocean Science Horizon Scan - Final List of Questions: Southern Ocean and sea ice in a warming world

17. How has Antarctic sea ice extent and volume varied over decadal to millennial time scales?
21. How did the Antarctic cryosphere and the Southern Ocean contribute to glacial-interglacial cycles? (Cross-cuts "Antarctic Ice Sheet")
22. How will climate change affect the physical and biological uptake of CO_2 by the Southern Ocean? (Cross-cuts "Antarctic Life")

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

Particle fluxes in the Ross Sea: a 25-year synthesis

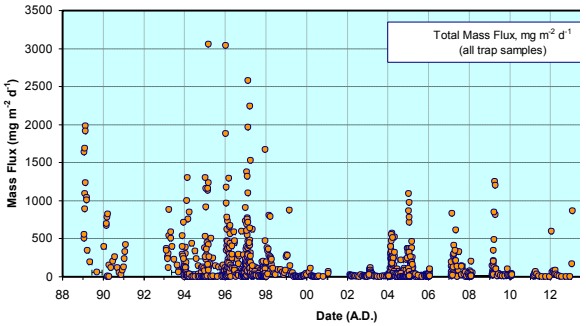


~1000 sediment trap samples, collected from 23 Italian or US sites

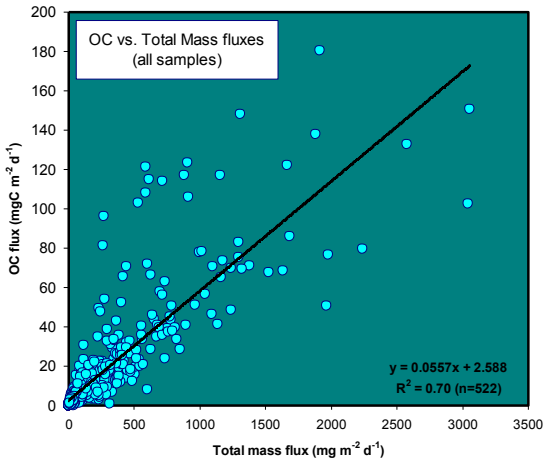
High seasonal variability (peaks in late-spring-summer)

Large lag between periods of high biological productivity and high flux events (secondary peaks in April-May)

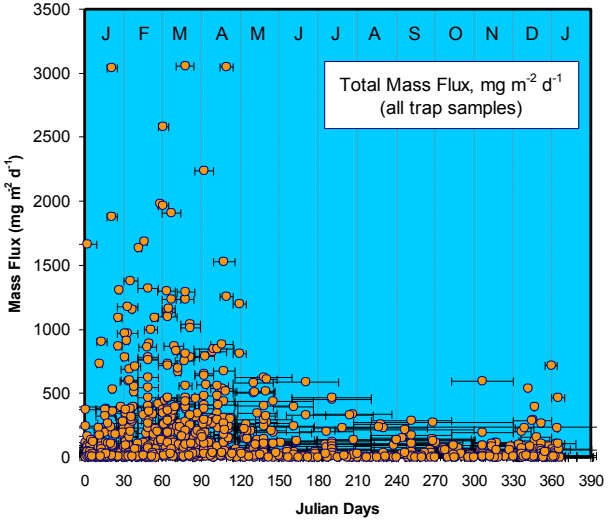
To do: Process cruises in early autumn to elucidate what process controls this variability and how OC is vertically transported



Temporal TMFs peaked between 1996 and 1998; then a decreasing trend. A true feature or just an artefact?

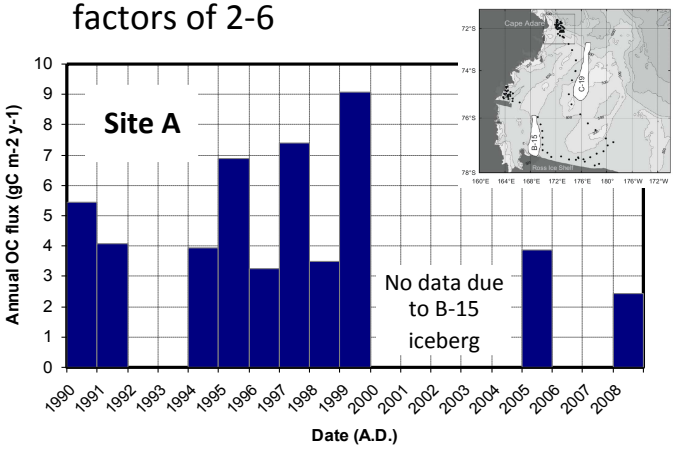


OC and TMF well correlated suggesting that biological debris dominates particle fluxes



Langone et al., 2015

Annual C fluxes vary year by year by factors of 2-6



Site A **is** the most representative site of the Ross Sea to monitor temporal variations and long-term trends

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

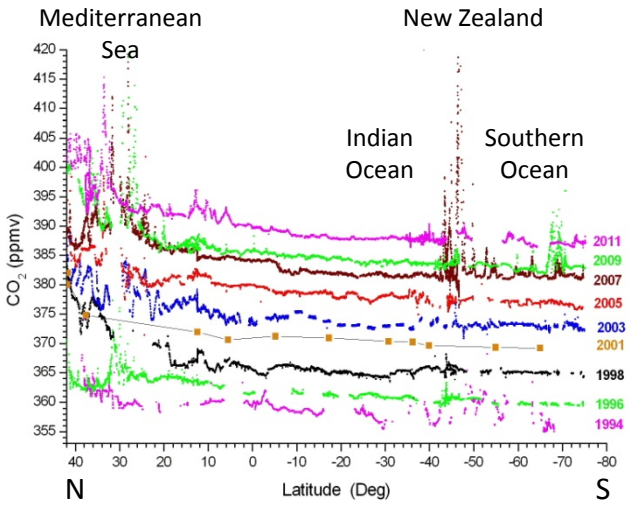
Southern Ocean and sea ice in a warming world

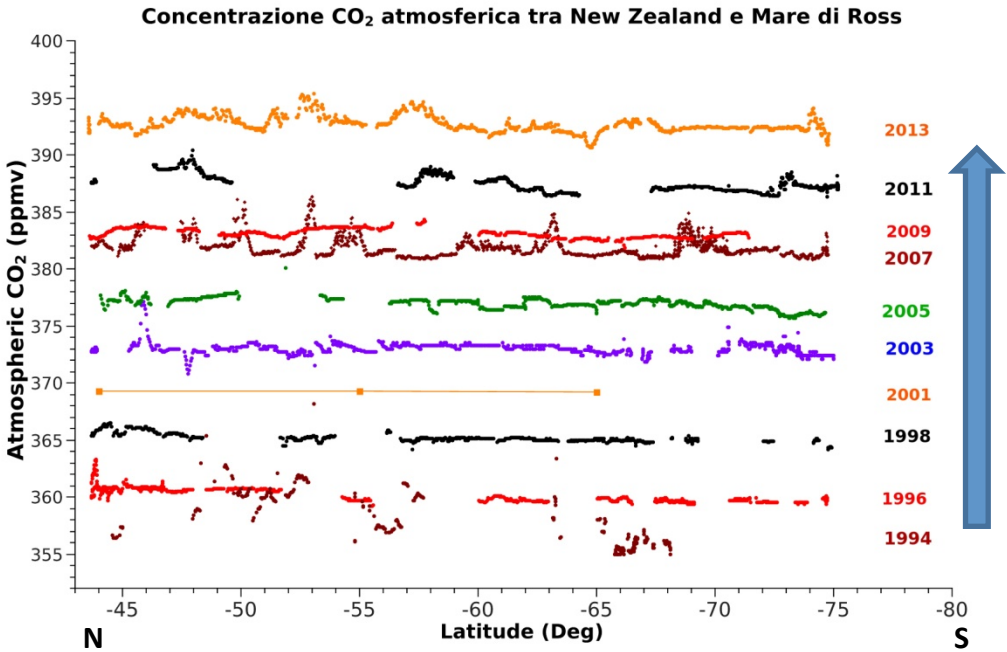
Atmospheric CO_2 measurements in remote oceanic and Antarctic areas (Mediterranean Sea to the Southern Ocean)

Continuous measurements of the CO_2 concentration carried out a bi-annual frequency from 1994 between Italy and Antarctica (Lenaz et al., 2000; Langone et al., 2007; Longinelli et al., 2001, 2005, 2007, 2010, 2012, 2013)

Maximum concentrations and variability recorded in the Mediterranean Sea, but long-term increases clearly observed also in scarcely-populated areas in the Indian and Southern Oceans

Results highlight a global interannual growth-rate of CO_2 of ca. 1.7 ppm yr^{-1}.

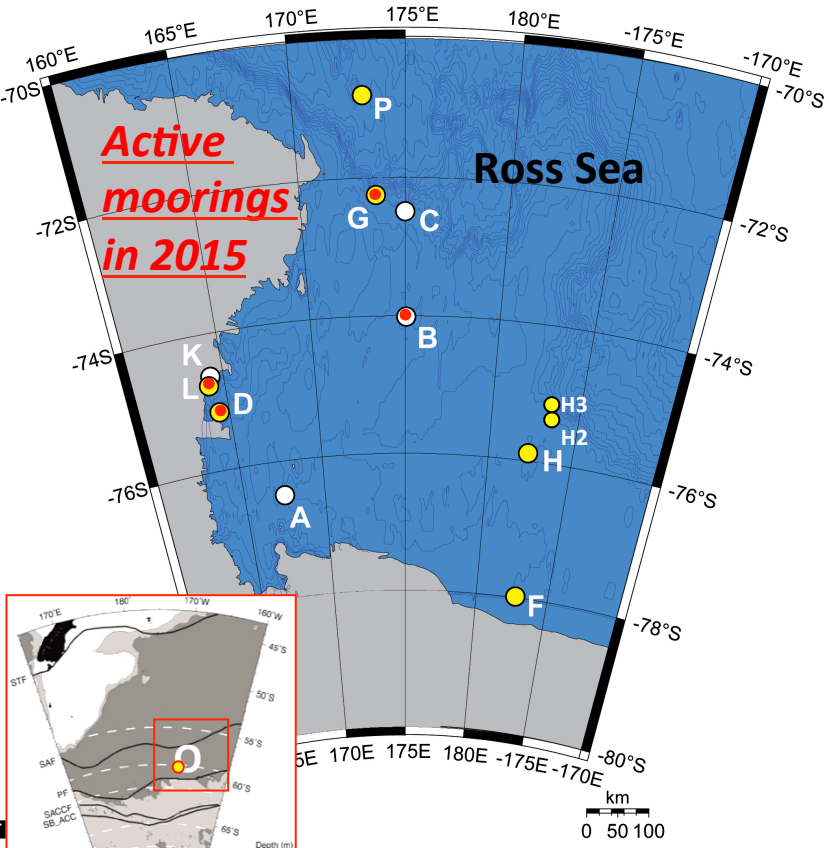




Courtesy of Langone et al., 2015

Italian moorings in the Ross Sea (we need time series!!!)

Long time-series of oceanographic parameters (T, S, V, Torbidity, Sediment Traps, ….) collected by several projects from 1994 (mainly: CLIMA I-V, Bioseso e Abioclear) and in **MORSea** after 2009.



A -> 1990-2008
B -> 1995-present
C -> 1995
D -> 1995-present
F -> 1994-98
G -> 2003-present
H1 -> 1995-2008
H2 -> 2002-05
H3 -> 2005-10
K -> 1996-97
L -> 1998-present
O -> 1999
P -> 2006-07

MORSea

Marine Observatory in the Ross Sea

http://morsea.uniparthenope.it/

Consiglio Nazionale delle Ricerche

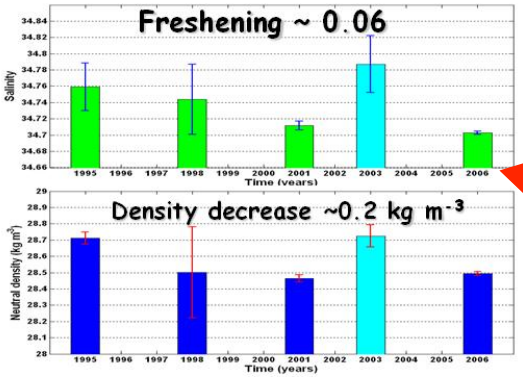
DISTAV Dipartimento di Scienze della Terra, dell'Ambiente e della Vita – Università degli Studi di Genova

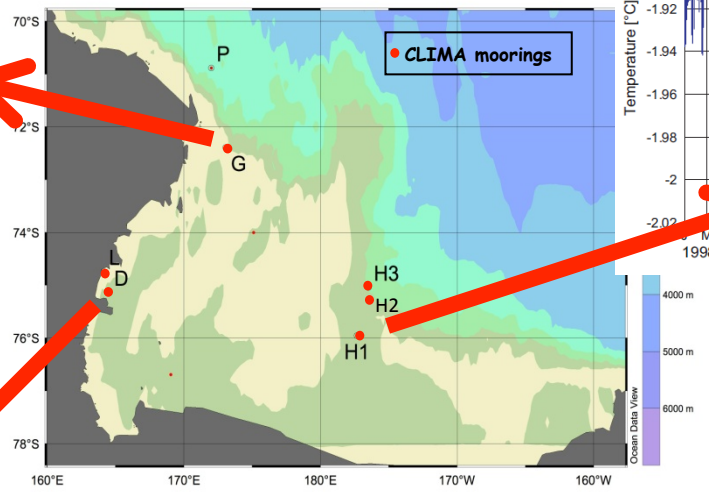
MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

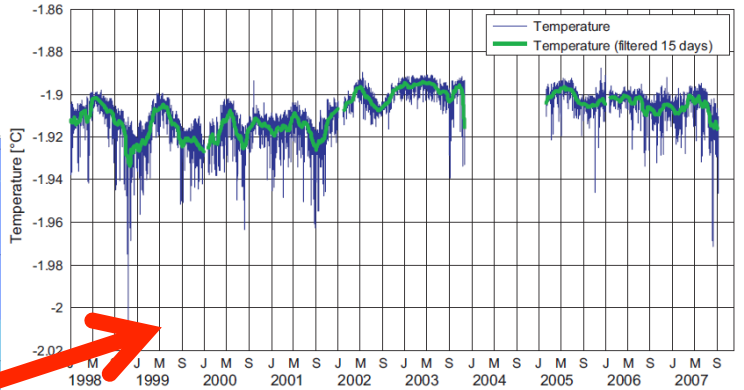
Southern Ocean and sea ice in a warming world

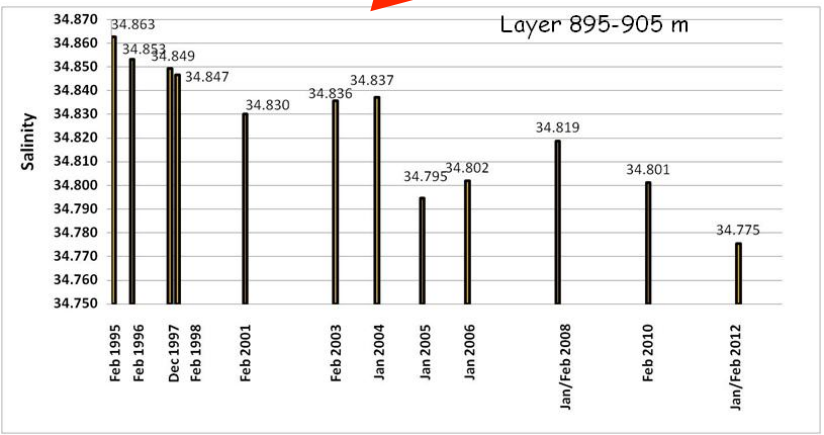
& **T-REx** projects

Trends in the Ross Sea









ISW warming at the continental shelf break.

HSSW freshening in the Terra Nova Bay polynya and at the continental shelf break.

Freshening and warming of the Ross Sea AABW (Rintoul, 2009)

after
Budillon & Spezie A.S. 2001
Fusco et al., CSR 2009
Budillon et al., JGR 2011

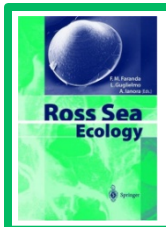
MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

ROSSMIZE - Ross Sea Marginal Ice Zone Ecology

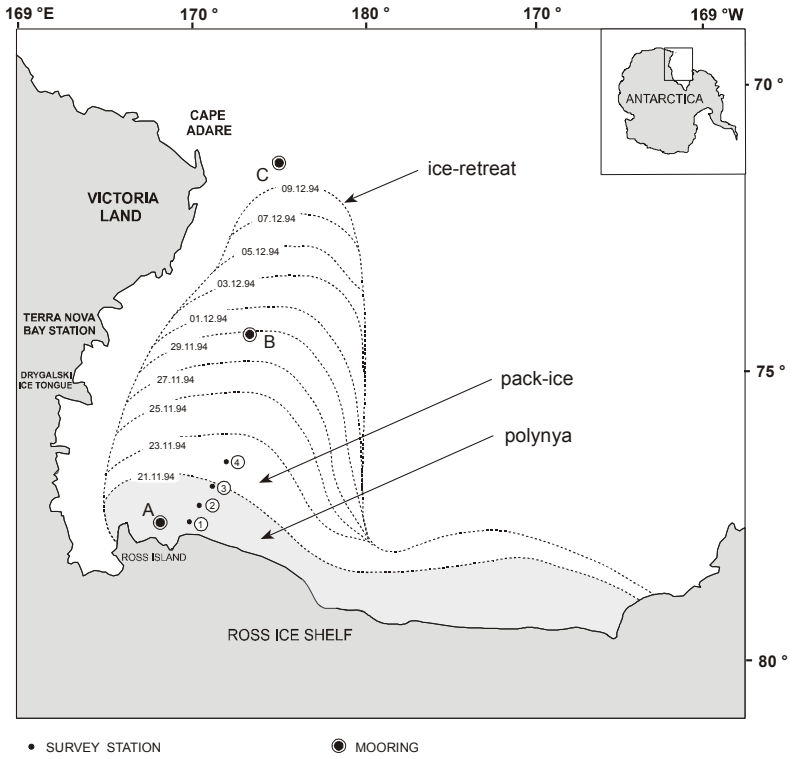
ROSSMIZE Project investigated patterns and drivers of production of the Ross Sea during the sea ice melting process (1994-95).

Study areas: a wide stretch of the western sector of the Ross Sea (71°56′ to 76°30′S; 170°-180°W).

Objective: it represent one of the first oceanographic cruises ever carried out in the Ross Sea during the austral spring. It was focused on nutrient distribution and dynamics, new and regenerated production, role of mesozooplankton, krill and top predators in controlling primary production, biochemical composition and fate of particulate organic matter, biogenic flux in the water column, biogenic sedimentation and seafloor bioturbation.

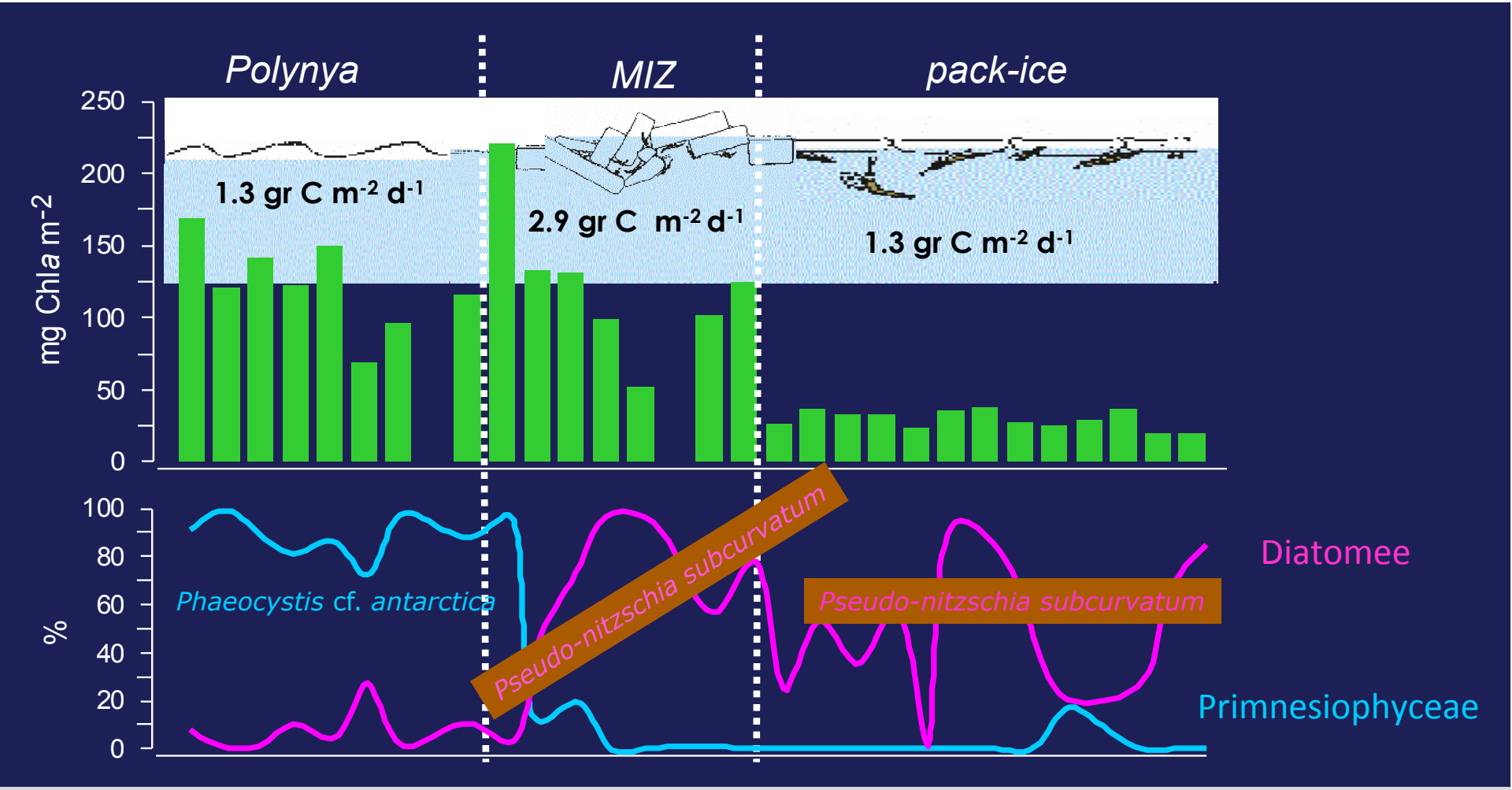


Ross Sea Ecology: Italiantartide Expeditions (1987-1995), 2000 (Springer) F.M. Faranda, L. Guglielmo, A. Ianora



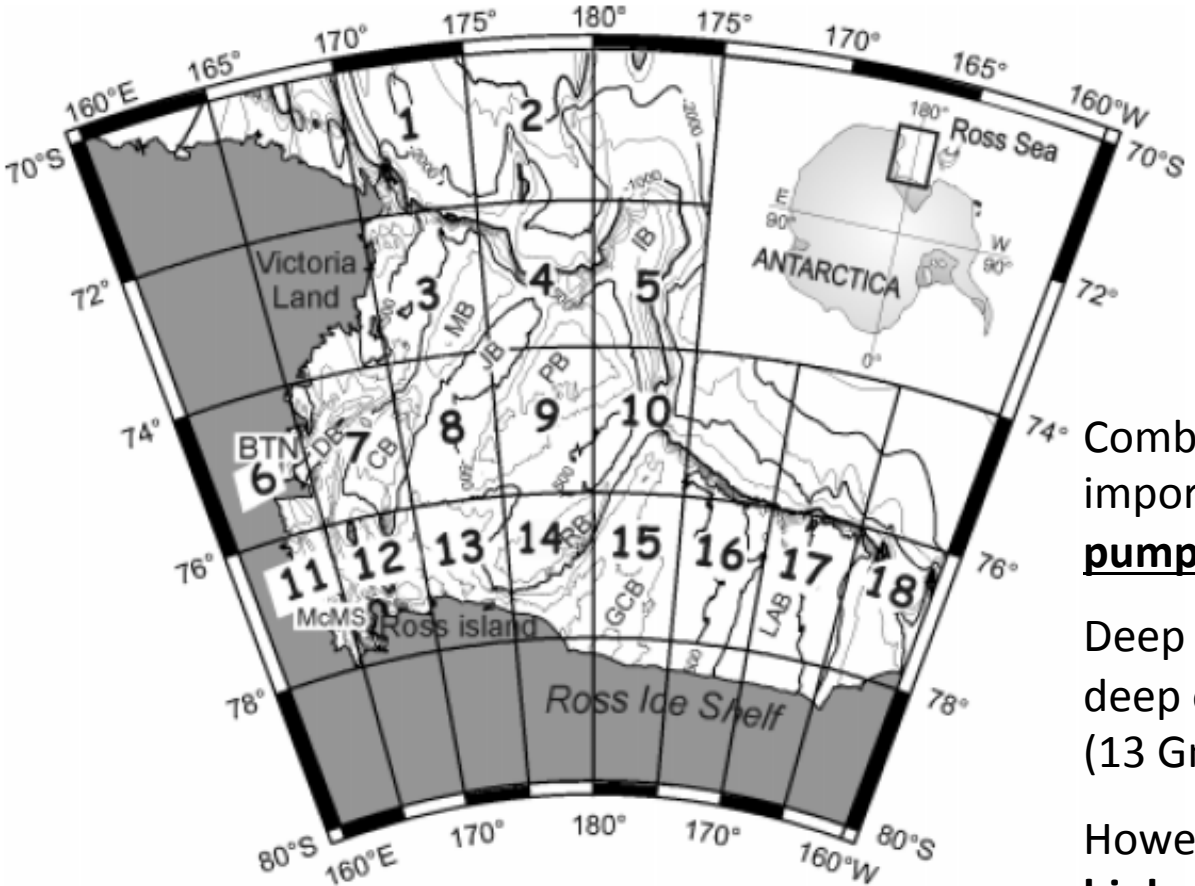
MINISTERO DELL'ISTRUZIONE,
DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

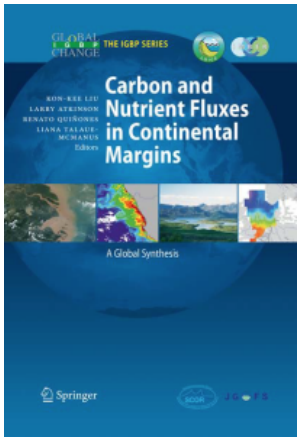


Carrada *et al.*, 2000; Saggiomo *et al.*, 1998, 2000

A very nice example of a collaborative synthesis (CLIMA, Bioseso, Abioclear, Rossmize)



The Ross Sea (3.1 10^5 km^2) produces 53,6 10^6 tons C (November-February). Average 102 $gC\ m^2\ h^{-1}$



Catalano et al., (2010) **in Carbon and Nutrient Fluxes in Continental Margins: A Global Synthesis** (Springer) k.-K. Liu et al.

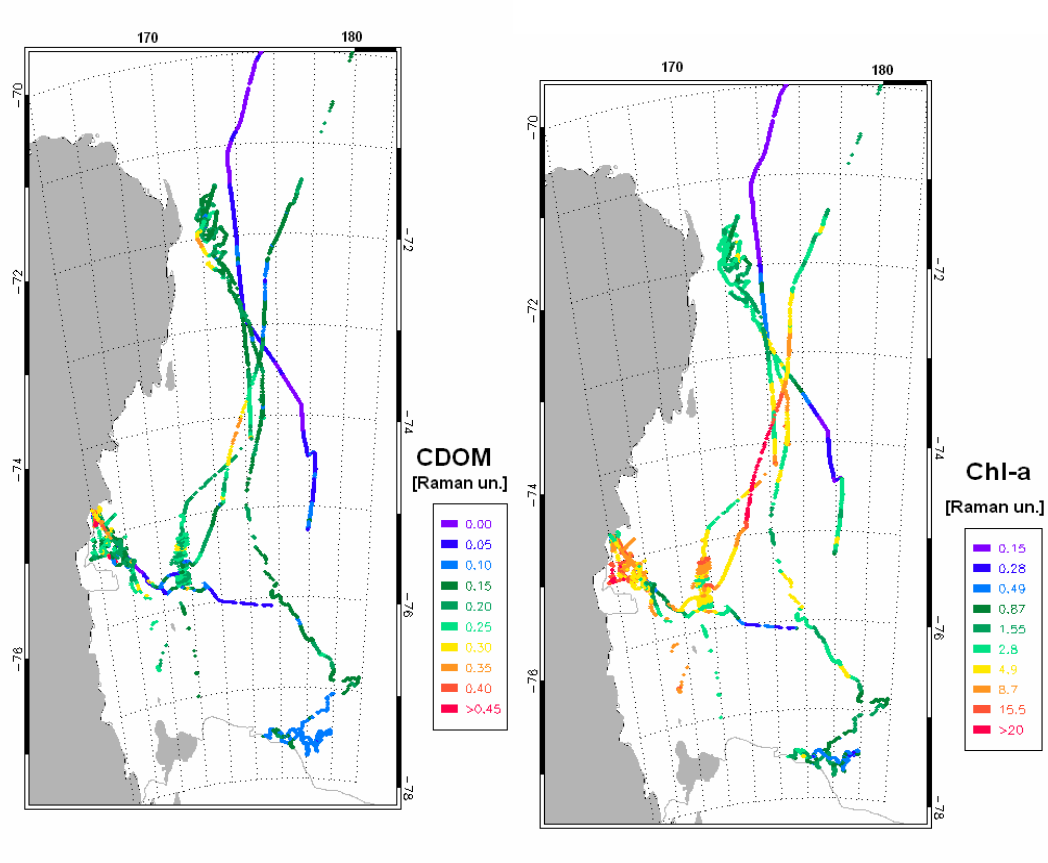
Combining results elucidated the importance of the **continental shelf pump**

Deep layer releases carbon to the deep ocean as DIC (937 Gmol), DOC (13 Gmol) and POC (7 Gmol)

However, during summer the **biological pump** (vertical exchanges) is one order of magnitude higher than the continental shelf pump

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

ARES - Active and passive remote sensing of the Southern Ocean for the monitoring of the biological parameters



XVIII Antarctic campaign 2002-2003

UO: ENEA – Frascati – Palucci A.
Lidar fluorosensor–SeaWiFS, MODIS or MERIS satellite frames–AVHRR, ASAR satellite frames –Data merging and analysis

UO: UNIV-Florence – Lazzara L.
Irradiance, Inherent Optical properties, absorption and scattering, Pigments, PAM Variable fluorescence

Fantoni et al., 2010 *JOAM; Fiorani et al., 2006 EARSeL; Barbini et al., 2006 JOAM.*

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

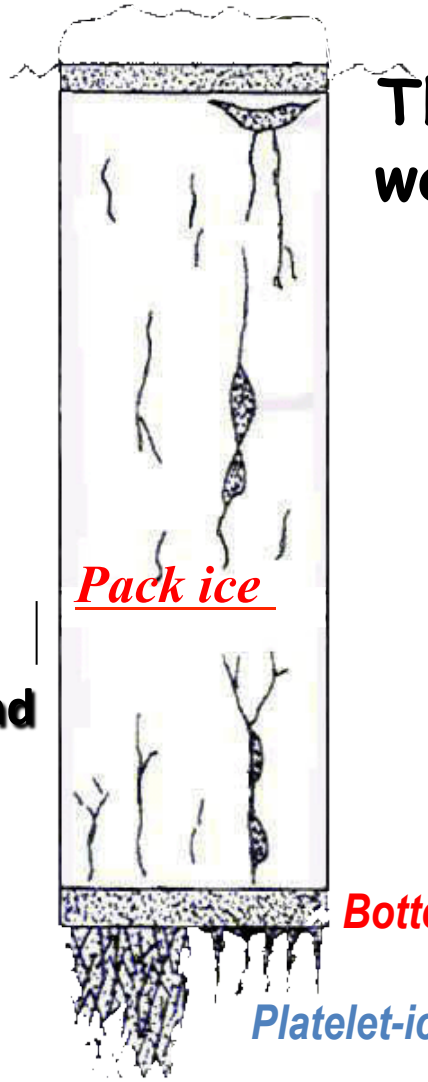
Southern Ocean and sea ice in a warming world

1997 – PIPEX, Pack Ice Plankton Experiment
Short-term temporal changes in sea ice productivity and microbial processes

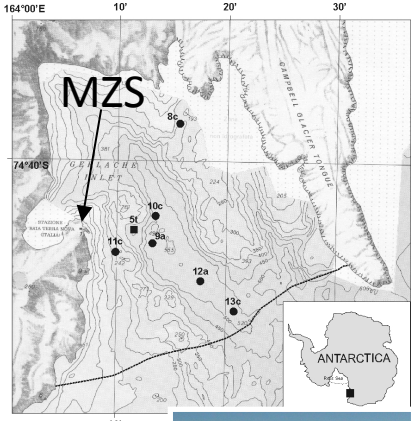
1999 – PIED, Pack Ice Ecosystem Dynamics
Links between the sea ice and the water column and relationships between sea ice primary productivity and the microbial loop

2004 – SEAROWS, Sea Ice Ecology in the Ross and Weddell Seas
Linkages between structure and dynamics of the sea ice system

2010 – SICaf, Sea Ice Carbon Flux
Assessment of factors limiting biological production, carrying capacity and available resources in different Antarctic sea ice ecosystems (Ross and Weddell Seas)

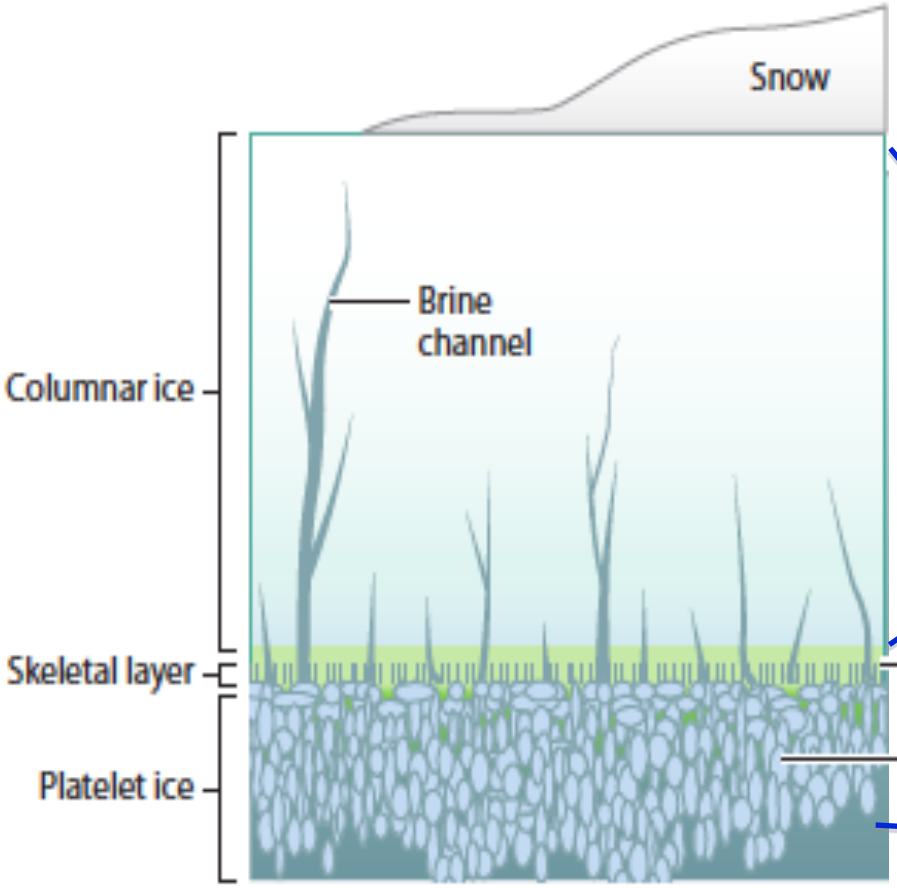


The "sympagic world" at TNB



Living in the "sympagic world"

Microalgal Community of land fast-ice: **benthic species on the bottom**



Planktonic diatoms

Fragilariopsis curta
Fragilariopsis rhombica
Fragilariopsis sublinearis
Thalassiosira gracilis
Thalassiosira lentiginosa

Benthic diatoms

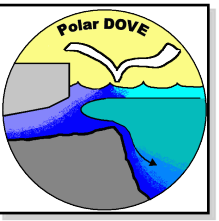
Chaetoceros spp
Fragilariopsis cylindrus

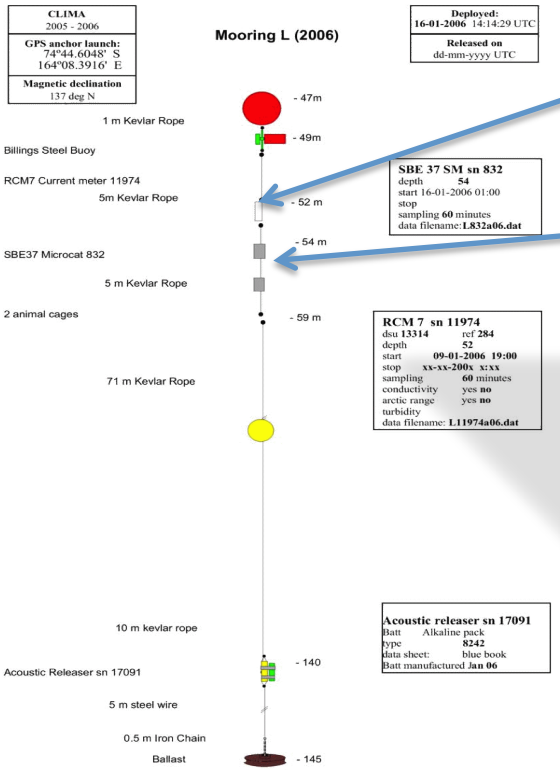
Entomoneis cfr. kufferathii
Nitzschia stellata
Pinnularia quadrataerea
Gomphonema kamtschatikum

[Guglielmo et al., 2000; Saggiomo M. *et al.*, in press]

PolarDOVE Experiment

"Calibrazione" fisica di proxy biologici





Mooring L, BTN:

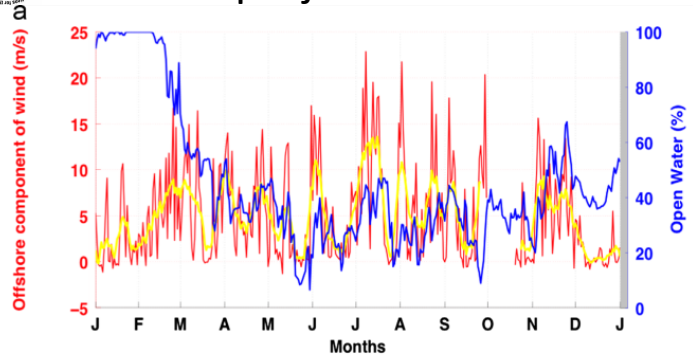
- **74°44.604' S, 164°08,391' E, max depth 145m**
- **period : 16-1-2006, 31-1-2007**
- **-52 m RCM7, -54 m CTD**
- **-54 : -59 m, 2 Cages**

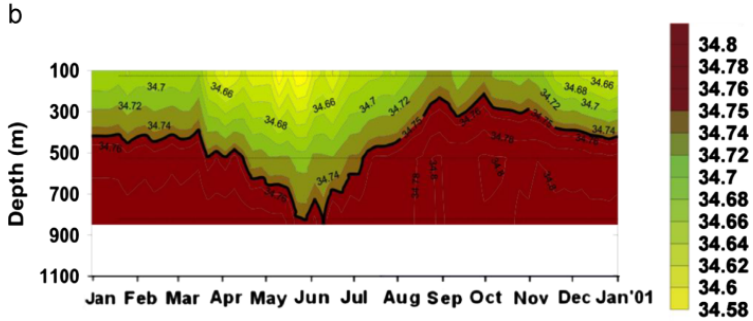
  with 60 living specimens of A. Colbecki

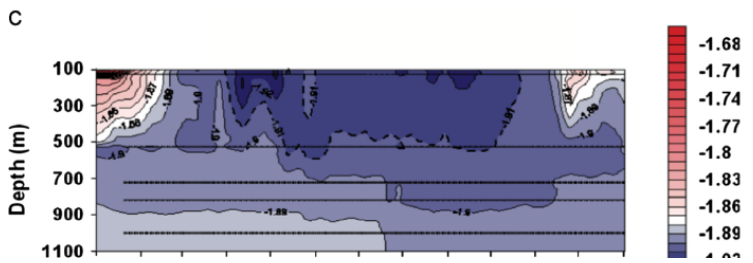
Please cite this article as: Trevisiol, A., et al., Antarctic seawater temperature evaluation based on stable isotope measurements on *Adamussium colbecki* shells: kinetic effects ..., J. Mar. Syst. (2012), http://dx.doi.org/10.1016/j.jmarsys.2012.10.012

Atmosphere – Ice – Ocean interactions at Terra Nova Bay

& **T-REx** projects







Rusciano, Budillon, Fusco, Spezie. CSR, 2013

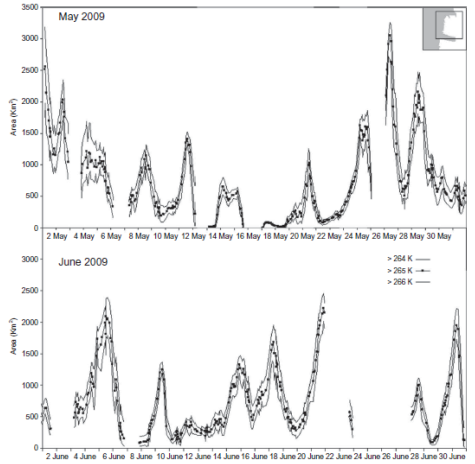
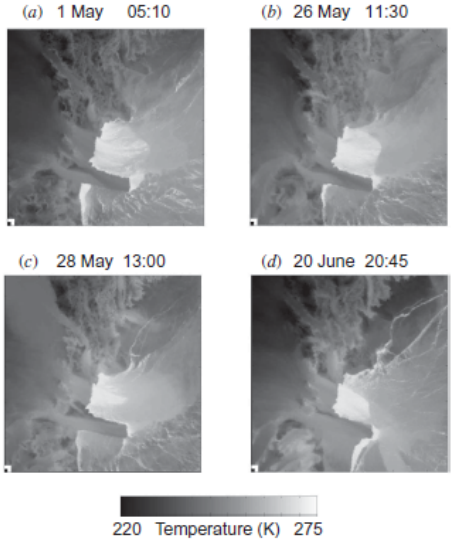
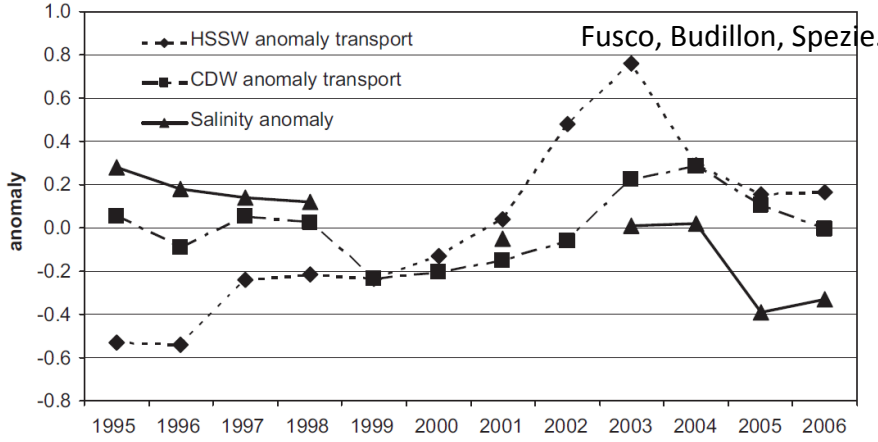


Figure 7. Estimates of the polynya area extracted from the IST sequence by using thermal thresholds between 264 and 266 K.



Ciappa, Budillon. IJRS 2013



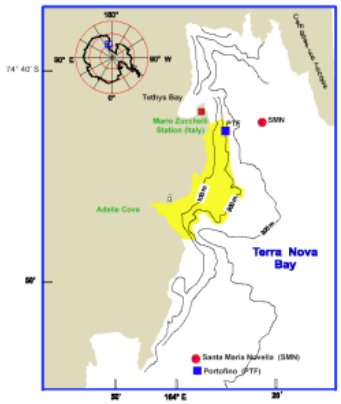
Fusco, Budillon, Spezie. CSR 2009

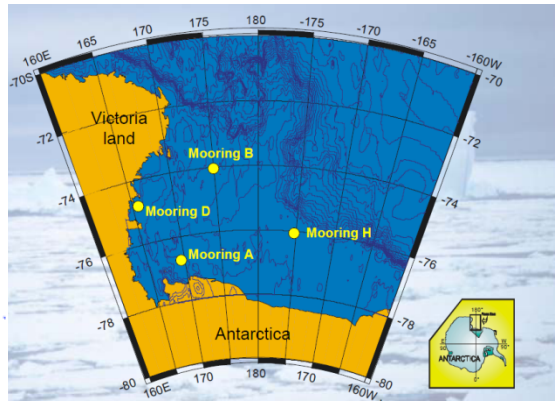
Fig. 6. HSSW anomaly transport referred to a mean value of 1.2 Sv for the period 1995–2006 in TNB polynya; CDW anomaly transport referred to an average value of 3.0 Sv for the period 1995–2006 in the Ross Sea continental shelf; salinity anomaly (CTD data) referred to an average value of 34.835 for the period 1995–2006.

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

From 2006, the Ross Sea is an Antarctic site of LTER-Italy, (Long Term Ecological Research)



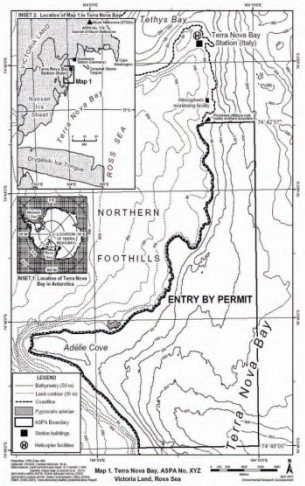


Defined two macro-areas:

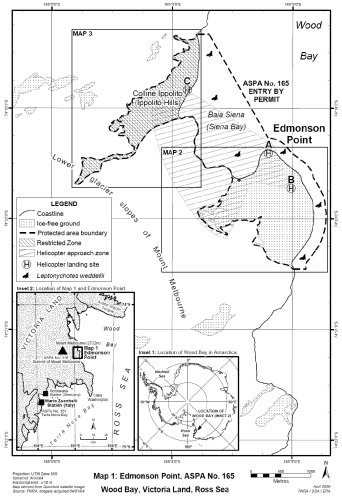
- Marine Observatory of Terra Nova Bay (MOA-BTN)
- Offshore, 4 mooring sites,

Acquisition of long time series measurements on:
Atmospherci parameters, sea ice, physics, chemistry, ecology and biogeochemistry of the water column, vertical particulate fluxes, sediment characteristics and benthic ecosystems

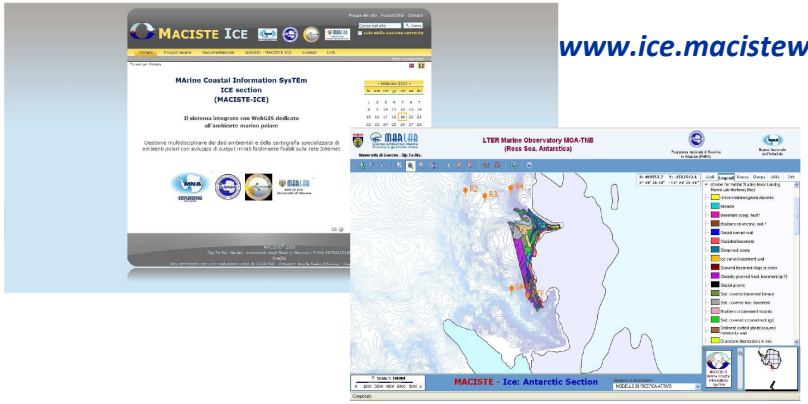
Italy contributed to define 2 Antarctic Specially Protected Areas (ASPA) by SCAR



TNB, ASPA n.161



WOOD BAY, ASPA n.165



www.ice.macisteweb.com

MArine Coastal Information SysTEm
(MACISTE-ICE)

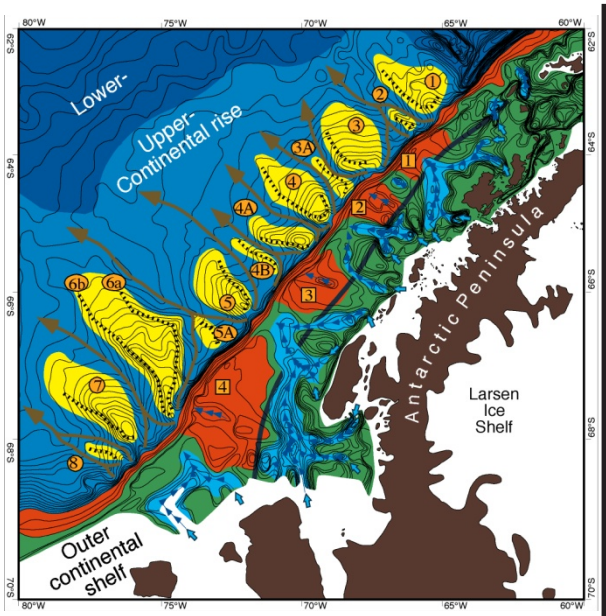
The1st SCAR Antarctic and Southern Ocean Science Horizon Scan - Final List of Questions: Southern Ocean and sea ice in a warming world

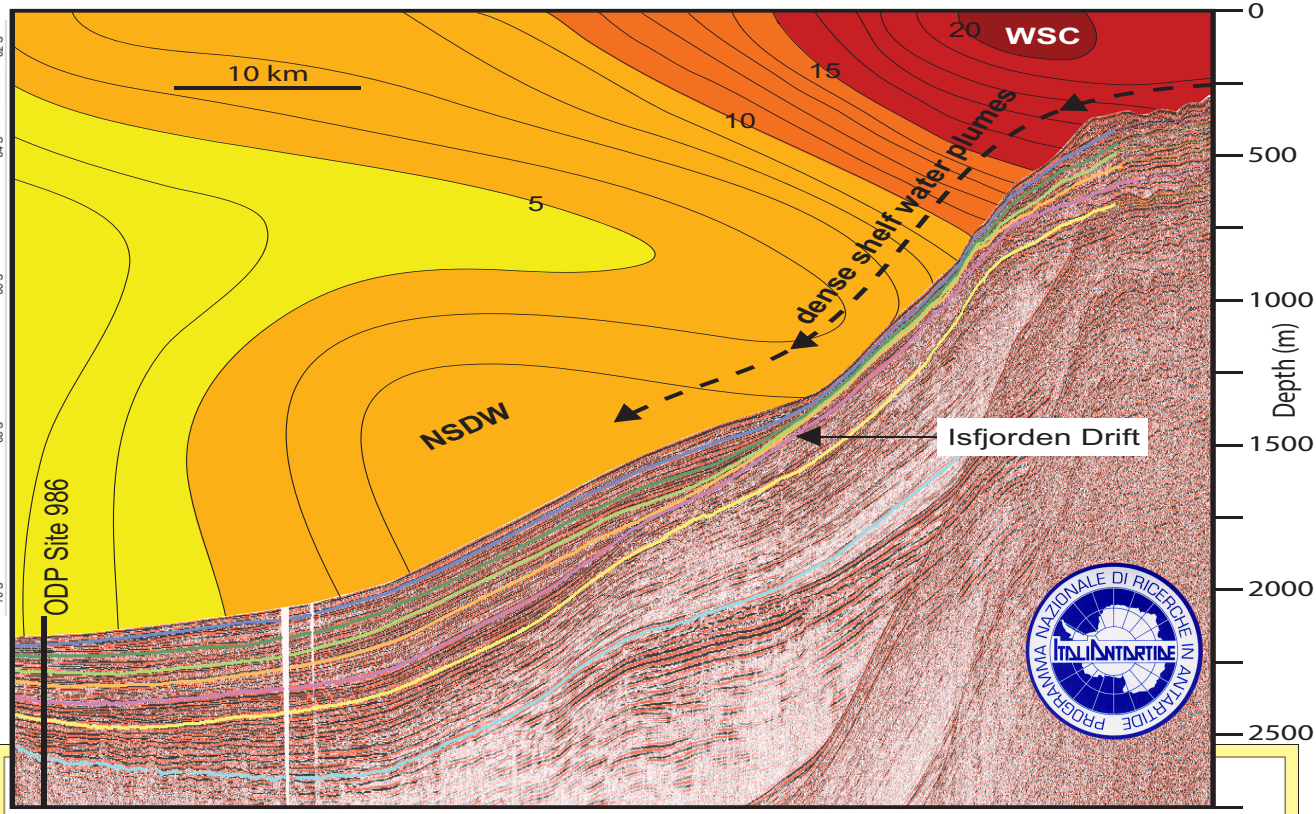
22. How will climate change affect the physical and biological uptake of CO_2 by the Southern Ocean? (Cross-cuts "Antarctic Life")
23. How will changes in freshwater inputs affect ocean circulation and ecosystem processes? (Cross-cuts "Antarctic Life")

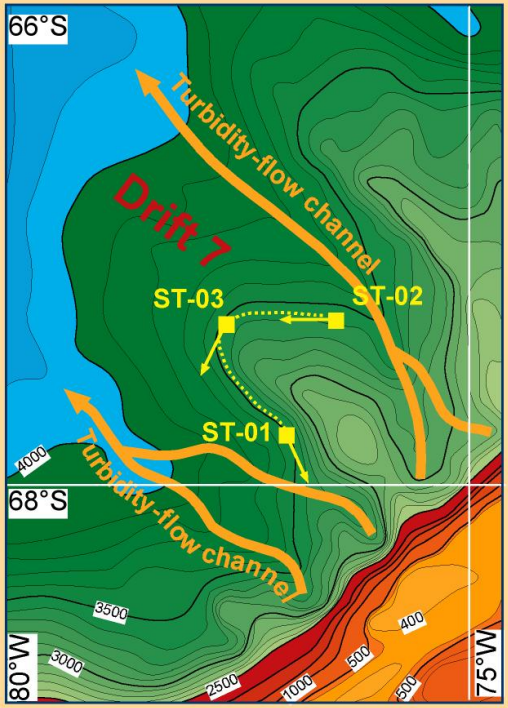
&

60. What are the impacts of changing seasonality and transitional events on Antarctic and Southern Ocean marine ecology, biogeochemistry, and energy flow?
65. What will key marine species tell us about trophic interactions and their oceanographic drivers such as future shifts in frontal dynamics and stratification?

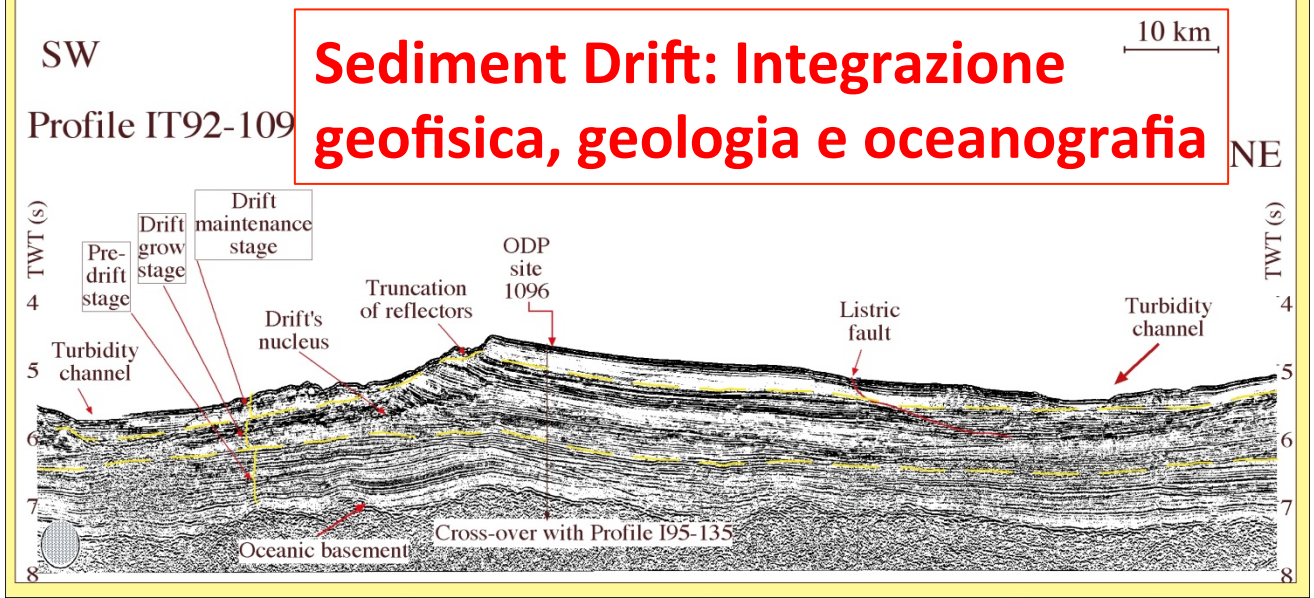
Cambiando scala temporale……





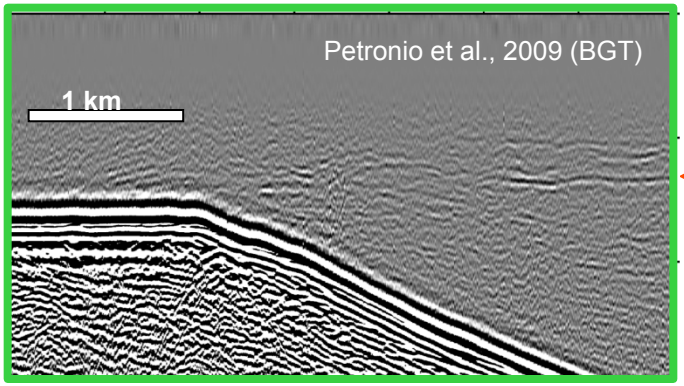


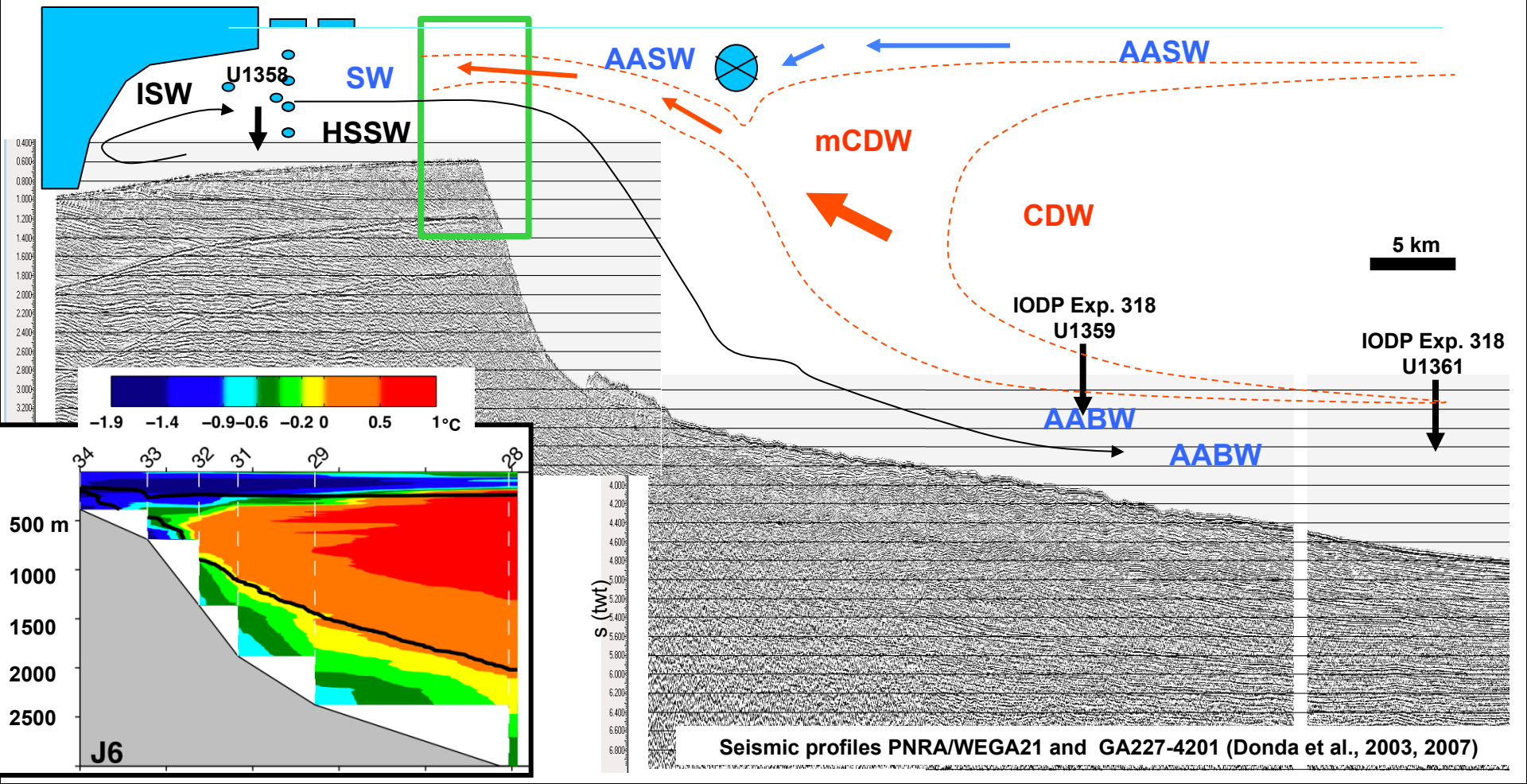
Sediment Drift: Integrazione geofisica, geologia e oceanografia



Oceanografia Sismica

AASW Antarctic Along Slope Water
AABW Circum Antarctic Bottow Water
HSSW High Salinity Shelf Water
ISW Ice Shelf Water
SW Shelf Water
CDW Circum Antarctic Deep Water
mCDW modified Circum Antarctic Deep Water





Seismic profiles PNRA/WEGA21 and GA227-4201 (Donda et al., 2003, 2007)

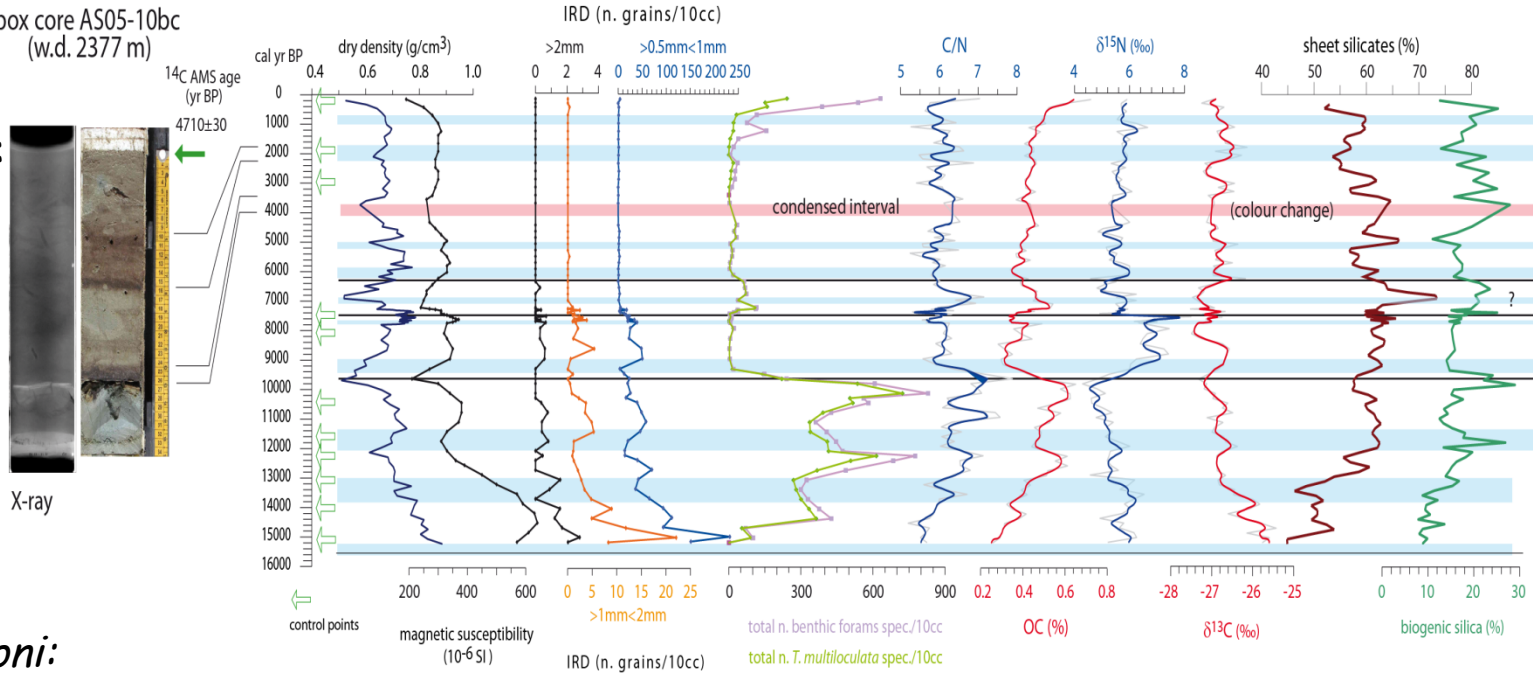
13. Why were the properties and volume of Antarctic Bottom Water changing, and what were the consequences for global ocean circulation and climate?

16.How did changes in iceberg numbers and size distribution affect Antarctica and the Southern Ocean?

Bottom water I e II: Variabilità temporale della produzione di acqua densa di piattaforma durante l'Olocene, MIS5 e MIS7

Area di interesse: Mare di Ross

Intervallo stratigrafico: 0-250.000 anni.



Principali conclusioni:

1) due eventi tra 15-10 e 7.5-7 cal kyr BP marcano un cambiamento principale nella colonna d'acqua, ossia un aumento della disponibilità di nutrienti, probabilmente a causa di una maggiore efficienza di risalita della parte più superficiale della Circumpolar Deep Water;
2) Durante gli interglaciali 7.5 e 5.5 (240 e 125 ky c.a.) e condizioni di alta produttività superficiale e rapida ritirata del ghiaccio marino.

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

The1st SCAR Antarctic and Southern Ocean Science Horizon Scan - Final List of Questions: Southern Ocean and sea ice in a warming world

13. Why are the properties and volume of Antarctic Bottom Water changing, and what are the consequences for global ocean circulation and climate?
14. How does Southern Ocean circulation, including exchange with lower latitudes, respond to climate forcing?
16. How do changes in iceberg numbers and size distribution affect Antarctica and the Southern Ocean?
17. How has Antarctic sea ice extent and volume varied over decadal to millennial time scales?
19. How do changes in sea ice extent, seasonality and properties affect Antarctic atmospheric and oceanic circulation? (Cross-cuts "Antarctic Atmosphere")
20. How do extreme events affect the Antarctic cryosphere and Southern Ocean? (Cross-cuts "Antarctic Ice Sheet")
21. How did the Antarctic cryosphere and the Southern Ocean contribute to glacial-interglacial cycles? (Cross-cuts "Antarctic Ice Sheet")
22. How will climate change affect the physical and biological uptake of CO_2 by the Southern Ocean? (Cross-cuts "Antarctic Life")

Bando 2013, progetti "*ongoing*"

SIGLA	TEMATICA	
DEEPROSSS 2013/AN1.01	Funzionamento degli ecosistemi profondi nel Mare di Ross: nuove prospettive sul ruolo dei processi di ventilazione su diversità e metabolismo microbici	***ITALICA***
PANACEA 2013/AN2.02	The role of frazil and PANcake ice in the mass and energy budgets of the AntarctiC sEA ice cover	***ITALICA***
HOLOFERNE 2013/A2.03	Fluttuazioni climatiche oloceniche a scala sub-millenaria registrate in sequenze sedimentary espanse del Mare di Ross	***ITALICA***
EchoSurvey 2013/AN1.02	Lo stato delle specie chiave dell'ecosistema pelagico del Mare di Ross: cambiamenti dell'abbondanza e della distribuzione spaziale nel tempo e in relazione alle condizioni ambientali	***ITALICA***
RoME 2013/AN2.04	ROss Sea Mesoscale Experiment	***ITALICA***
CEFA 2013/AZ1.06	Funzionamento degli ecosistemi costieri un un Oceano Antartico in cambiamento (CEFA)	***MZS***
SIAMO 2013/AZ1.07	Sea-ice associated methylated osmolytes: biogenesis and contribution to oceanic methane production	***MZS***
2013/AZ1.16	Analisi delle dinamiche del benthos antartico su stazioni fisse di rilevamento e mediante tecniche non distruttive	***MZS***
RAISE 2013/AZ1.18	RAISE - Ricerche integrate sulla ecologia dell'AntarctIc Silverfish nel MarE di Ross	***MZS***
GEOSMART 2013/AZ2.06	Firme geochimiche nel sistema carbonatico marino Antartico: presente, passato e implicazioni per il futuro	***MKS***

Iniziative e collaborazioni internazionali

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Southern Ocean and sea ice in a warming world

The WCRP Mission is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. The two overarching objectives of the WCRP are:

- to determine the predictability of climate; and
- to determine the effect of human activities on climate

Core projects

Climate and Cryosphere

Understanding the changing cryosphere and its climate connections

Climate and Ocean - Variability, Predictability, and Change

To observe, understand and model the hydrological cycle and energy fluxes in the Earth's atmosphere and at the surface.

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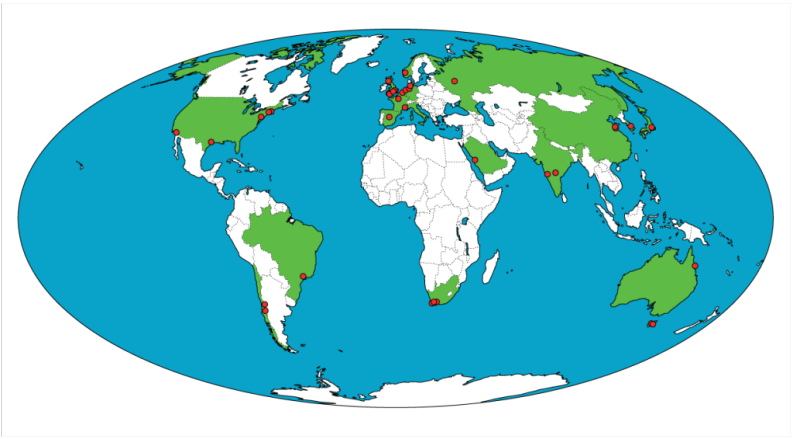
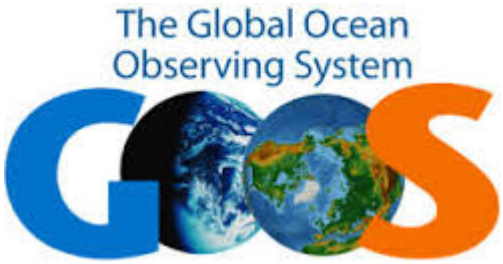
Southern Ocean and sea ice in a warming world



The Partnership for Observation of the Global Oceans, POGO, is a forum created in 1999 by directors and leaders of major oceanographic institutions around the world to promote global oceanography. Of particular focus is the implementation of an international and integrated global ocean observing system. POGO is a partnership of institutions involved in oceanographic observations, scientific research, operational services, education and training. POGO has 38 member institutes, including several consortia, from 19 different countries, and works closely with other international and regional programmes and organisations.



GOOS is a permanent global system for observations, modelling and analysis of marine and ocean variables to support operational ocean services worldwide. GOOS provides accurate descriptions of the present state of the oceans, including living resources; continuous forecasts of the future conditions of the sea for as far ahead as possible, and the basis for forecasts of climate change.

Activities:

- Hydrography
- Argo Profiling Floats
- Drifting Buoys
- Global Sea Level Observing System (GLOSS)
- Ocean Tracking Network
- Continuous Plankton Recorder

MINISTERO DELL'ISTRUZIONE,
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Southern Ocean and sea ice in a warming world

SOUTHERN OCEAN OBSERVING SYSTEM

FACILITATING AND ENHANCING GLOBAL SOUTHERN OCEAN OBSERVATIONS

SOOS è il principale programma scientifico internazionale promosso dallo SCAR e dallo SCOR e sostenuto anche dal WCRP.

SOOS evidenzia la necessità di integrare dati storici, ripetere ed implementare osservazioni in situ, utilizzare strumenti per rilievi su ampia scala, costruire e mantenere serie complete di dati che coprano lunghi intervalli temporali.

www.soos.aq

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

FACILITATING AND ENHANCING GLOBAL SOUTHERN OCEAN OBSERVATIONS

The Southern Ocean research community has identified 6 overarching challenges (Themes) that the SOOS will address:

Theme 1: The role of the Southern Ocean in the planet's heat and freshwater balance
Theme 2: The stability of the Southern Ocean overturning circulation
Theme 3: The role of the ocean in the stability of the Antarctic Ice Sheet and its future contribution to sea-level rise
Theme 4: The future and consequences of Southern Ocean carbon uptake
Theme 5: The future of Antarctic sea ice
Theme 6: Impacts of global change on Southern Ocean ecosystems

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Southern Ocean and sea ice in a warming world

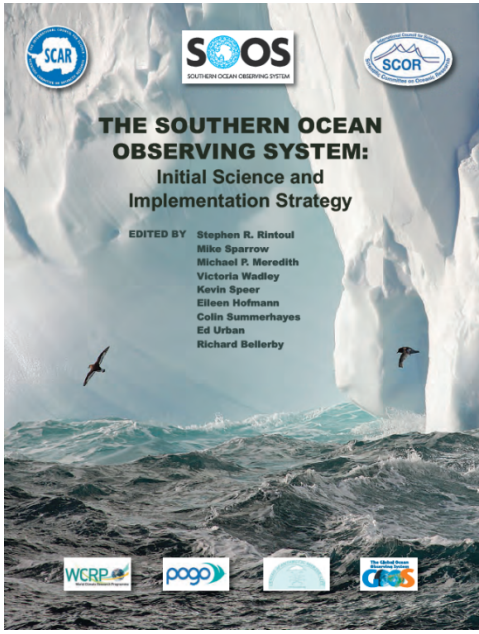
SOOS SOUTHERN OCEAN OBSERVING SYSTEM

FACILITATING AND ENHANCING GLOBAL SOUTHERN OCEAN OBSERVATIONS

ACTIVITIES

Air-Sea Fluxes
Satellite Data
Essential Variables
Ecosystem Variables
Under Ice Observations

The SOOS "Initial Science and Implementation Strategy" outlines the scientific rationale and strategy for the SOOS and identifies the next steps towards implementation.



http://www.soos.aq/science

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICER

Southern Ocean and sea ice in a warming world

Ross Sea
Variabilità stagionale/inter-annuale del ghiaccio marino nelle aree di polynya
Influenza della produzione di ghiaccio marino sulla formazione delle masse di acqua dense

Ross Sea
Miglioramento ed innovazione della rete di osservazione del ghiaccio marino e delle interazioni oceano-atmosfera;
utilizzo di veicoli autonomi sottomarini per il

Ross Sea & environments
Serie temporali di dati oceanografici in relazione alla variabilità climatica. Processi implicati nella formazione e nella ridistribuzione delle Antarctic Bottom Water che agiscono ascala locale e che influenzano la scala globale.

ACC
Dinamica a mesoscala e sub-mesoscala e inter
fisica-biologia lungo la corrente circumpolare
Antartica: analisi della variabilità stagionale e interannuale della dinamica, impatto su produttività biologica e classi fitoplanctoniche, ruolo dei forzanti atmosferici e dei cambiamenti climatici

Southern Ocean & Ross Sea

Southern Ocean
Lo studio dell'albedo del ghiaccio marino e i meccanismi di feedback ad esso collegati.

Ross Sea
Acidificazione/sorgente e/o pozzo CO2;

Riflessioni finali (1)
Risorse logistiche e strumentali

La ricerca oceanografica è svolta – soprattutto in aree polari - con mezzi e apparecchiature ad alto tasso tecnologico che però hanno una veloce obsolescenza.

La strumentazione oceanografica in dotazione al PNRA, tranne piccole eccezioni, risale al 1994 (CTD, correntometri, sganciatori, verricelli, ….) e nella maggioranza dei casi mancano strumenti di rispetto.

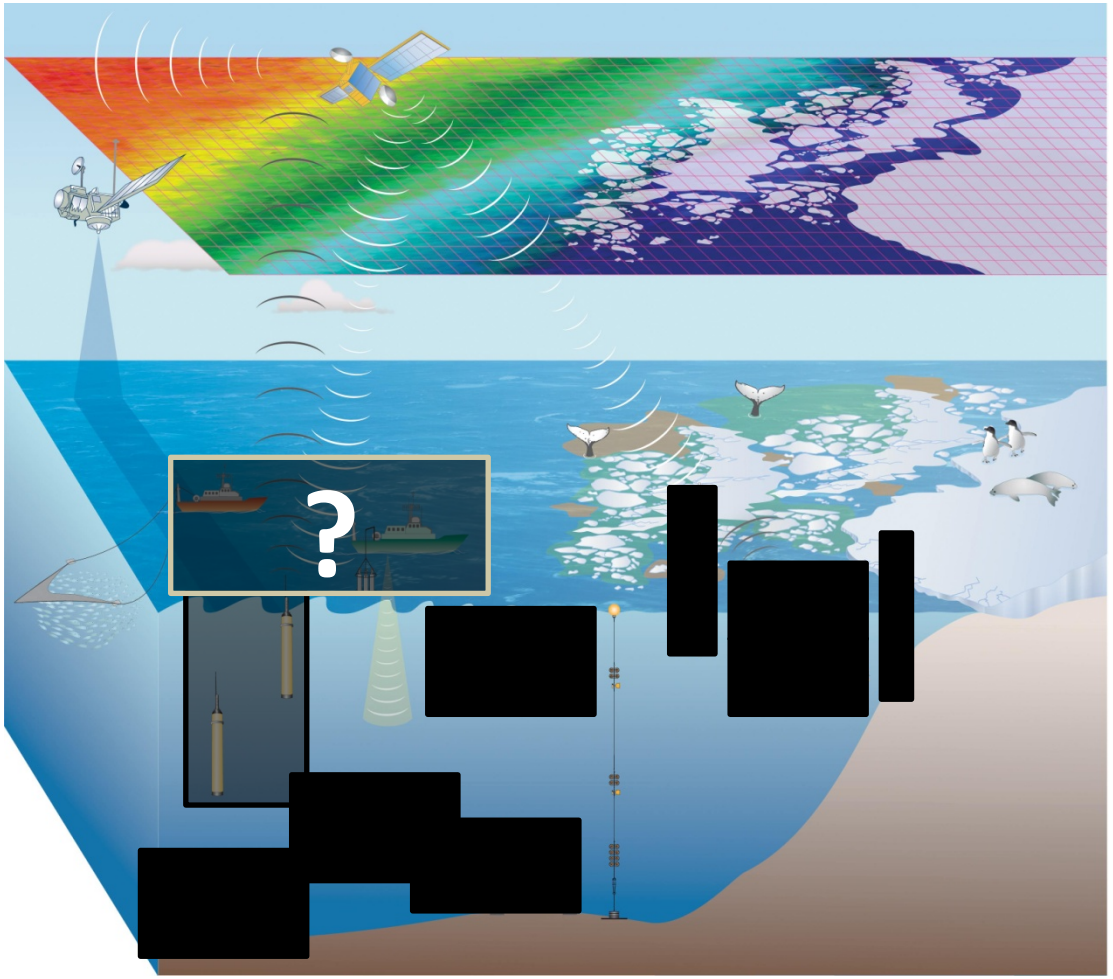
La nave ITALICA - dove si è svolta la ricerca oceanografica del PNRA negli ultimi 20 anni - sarà utilizzabile non oltre la XXXII spedizione (2016-17). Anche i mezzi minori di MZS hanno necessità di importanti interventi e/o sostituzioni.

OCCORRE DEFINIRE UN PIANO DI AMMODERNAMENTO DELLA STRUMENTAZIONE E DELLE RISORSE NAVALI CON LE QUALI EFFETTUARE LE RICERCHE OCEANOGRAFICHE PER I PROSSIMI 15-20 ANNI.

Riflessioni finali (2) - risorse logistiche e strumentali

Le osservazioni marine secondo il SOOS

L'attuale sistema osservativo del PNRA



Riflessioni finali (3):
Continuità delle ricerche e delle osservazioni

L'esperienza di questo 20nnio ha evidenziato che le condizioni essenziali per ottenere risultati significativi sono l'adeguatezza e la continuità del finanziamento; senza di esse è impossibile la pianificazione pluriennale e di conseguenza lo sviluppo delle collaborazioni internazionali.

La continuità delle osservazioni ha consentito di mettere in luce fenomenologie e trend climatici che adesso sono sotto l'attenzione della comunità scientifica internazionale.

OCCORRE SALVAGUARDARE QUESTO PATRIMONIO DI CONOSCENZE E DI CREDIBILITA' ACQUISITA NEL CONTESTO INTERNAZIONALE

GRAZIE PER L'ATTENZIONE

Arrivederci al W2 per l'approfondimento