

## Final project report

<i>Project ID</i>	2004/8.01
<i>Title</i>	CANOPO, the role of the Atlantic sector of the Southern Ocean in CO <sub>2</sub> sequestration
<i>Principal investigator</i>	Vincenzo Artale
<i>Institution</i>	ENEA
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<i>Duration</i>	3 years
<i>Assigned funding</i>	120.000,00 Euro

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### Activities and results

During the project three oceanographic cruises were performed on board of the Argentinean ice breaker "Almirante Irizar" in the three austral winters 2004-2005, 2005-2006 e 2006-2007. XBT and XCTD data were collected on the Drake Strait, the Weddell Sea and between the northern tip of the Antarctica Peninsula and the Orcadas Islands. Totally during the three cruises were collected 451 temperature profiles with XBT and 35 profiles of temperature and salinity with XCTD probes. All the logistic was in charge of the Argentinean Navy, the "Instituto Antartico Argentino" (IAA) and the Direccion Nacional del Antartico Direccion National Antartica (DNA).

The main aim of the project was the study of the variability of the Mixed Layer and the estimate of the heat content on the first 700 m of the water column, and the large scale representation of the surface and subsurface structure of the ACC.

Data from the Weddell sea were used to estimate the changes in temperature of the Warm Deep Water (WDW). Data from the Drake Passage were used to estimate the baroclinic transport, using WOCE section on the same area to infer statistical relation between temperatures and salinities.

3D OGCM models were used to study by means of Lagrangian diagnostics the water mass transformations on the Southern Ocean and their interannual variability. In particular the representation of the downwelling-upwelling cycle was reconstructed positioning particles on the water formation area and integrating them till the moment they resurface.

The bio geochemical model PISCES was used to study the relative role of the biological and physical pump in the Southern Ocean with the aim of understanding the main mechanism of the CO<sub>2</sub> sequestration.

During the project was elaborated an experimental methodology useful to estimate the ML depth by means vertical profiles of temperature and salinity, using also data from CANOPO cruises.

Finally, was investigated the role of the coherent structures, peculiar of the 2D geostrophic turbulence, on the ACC dynamics analyzing historical Lagrangian Data.

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### Products

#### A – papers in scientific magazines

- 1) Denaro F. M., De Stefano G., Iudicone D. and Botte V., A finite volume dynamic large-eddy simulation method for buoyancy driven turbulent geophysical flows, *Ocean Modelling*, 17: 199-218, 2007.
- 2) Rupolo, V. 2007: A Lagrangian based approach for determining trajectories Taxonomy and Turbulence regimes. *J. of Phys. Oceanogr.* Vol. 37 1584-1609
- 3) Iudicone D., Rodgers K.B., Schopp R., Madec G., An Exchange Window for the Injection of Antarctic Intermediate Water into the South Pacific. *Journal of Physical Oceanography*, 37: 31-49, 2007.
- 4) Almandoz G., G. Ferreyra, I. Schloss, A. I. Dogliotti, V. Rupolo, F. Papparazzo, J. L. Esteves, M. E. Ferrario; 2007: Distribution and ecology of Pseudo-nitzschia species in the Weddell Sea (Antarctica). *Polar Biology* doi 10.1007/s00300-007-0369-9
- 5) Iudicone D., G. Madec and T. J. McDougall, 2008: Water-mass transformations in a neutral density framework and

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- the key role of light penetration. *Journal of Physical Oceanography*, pp.1357–1376, 2008.
- Iudicone D., G. Madec, B. Blanke and S. Speich, The role of Southern Ocean surface forcings and mixing in the global conveyor. *Journal of Physical Oceanography*. 1377–1400, 2008.
  - Iudicone D., S. Speich, G. Madec, B. Blanke, The global Conveyor Belt from a Southern Ocean perspective, *Journal of Physical Oceanography*. pp 1401–1425, 2008.
  - Fusco G., Cotroneo Y., Budillon G., Spezie G. 2008: "METEOROLOGICAL FIELDS IN THE SOUTHERN OCEAN AND ROSS SEA REGION AND THEIR RELATIONSHIP TO SOUTHERN AND ANTARCTIC OSCILLATION". *Journal of Marine Systems*. In press.

### B – book chapters

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### C - proceedings of international conferences

- Busdraghi F., F. Vivier, C. de Boyer Montégut, and D. Iudicone. Seasonal variations of the mixed layer and heat storage in the Southern Ocean based on recent hydrographic observations. Ocean Surface Topography Science Team Meeting, Florida, USA. 2004 (poster).
- de Boyer Montégut, C., G. Madec, A. S. Fischer, A. Lazar, and D. Iudicone. A global mixed layer depth climatology based on individual profiles. First CLIVAR international conference, Baltimore, USA. 2004 (poster)
- de Boyer Montégut, C., G. Madec, A. S. Fischer, A. Lazar, and D. Iudicone. A global mixed layer depth climatology based on individual profiles. EGU meeting, Nice, France. 2004 (poster)
- de Boyer Montégut, C., G. Madec, A. S. Fischer, A. Lazar, and D. Iudicone. A global mixed layer depth climatology based on individual profiles. AGU Ocean Science meeting, Portland, USA. 2004 (poster)
- Denaro, F.M.; De Stefano, G.; Iudicone, D. ; D'Ambrosio, A.; Botte, V., Large eddy simulation of the marine surface boundary layer during the spring phytoplankton bloom: preliminary results, EGU, Wien, Austria, 2005.
- Iudicone, D.; Rodgers, K.; Schopp, R.; Madec, G. An exchange window for the Antarctic Intermediate Water injection into the South Pacific, EGU, Wien, Austria, 2005.
- Iudicone, D.; Madec, G., Diagnosing water transformation in neutral density space and the key role of light penetration in the ocean, EGU, Wien, Austria, 2005.
- Iudicone, D.; Speich, S.; Madec, G.; Dutay, J.C.; Blanke, B., The role of the Southern Ocean in the global conveyor: Eulerian and Lagrangian analysis of an ice-ocean model, EGU, Wien, Austria, 2005.
- Dutay, J-C; Madec, G; Jean-Baptiste, P; IUDICONE, D ; Rodgers, K, Using natural helium-3 and 14C simulations to study the impact of the geothermal heating and vertical mixing parameterization on ORCA ocean general circulation model's deep circulation, EGU, Wien, Austria, 2005.
- F. Busdraghi, F. Vivier, D. Iudicone, Changes in the large-scale mixed layer properties in the Southern Ocean based on recent hydrographic observations and a simple mixed-layer model., Argo meeting, Venice, Italy, 2006.
- G.Fusco, Y.Cotroneo, G.Budillon, G.Spezie "EOF ANALYSIS OF METEOROLOGICAL FIELDS IN THE SOUTHERN OCEAN AND THEIR RELATIONSHIP TO SOUTHERN AND ANTARCTIC OSCILLATION". European Geosciences Union General Assembly. Vienna, Austria, 15 – 20 April 2007.
- Rupolo V , Artale V., Balestrini C., Bianchi A., Budillon G., Busdraghi F., Charo M., De Alteris A.,Iudicone D., Ochoa H., Ruiz Pino D., Schloss I., Ulrich A.: "CANOPO Project: Vertical profiles of temperature in the Weddell Sea", International Union of Geodesy and Geophysics, Perugia 2-13 Luglio 2007.
- Busdraghi, F.; Vivier, F.; Iudicone, D., Variations of the mixed layer and heat storage in the Southern Ocean based on recent hydrographic observations (solicited), EGU, Wien, Austria, 2008.
- Vivier, F.; Iudicone, D.; Busdraghi, F.; Park, Y.-H., Analysis of a decade SST anomalies in the Southern Ocean: role of surface fluxes, lateral advection, and vertical processes (solicited), EGU, Wien, Austria, 2008.
- T.Peluso,, G.Budillon, G.Fusco, D.Iudicone, MIXED LAYER VARIABILITY AND ITS RELATION TO ICE COVER AND DISTRIBUTION OF CHLOROPHYLL-A IN WEDDELL SEA (SOUTHERN OCEAN). Effects of Climate Change on the World's Ocean – International Symposium. Gijon, Spain, 2008.
- G.Fusco, Y.Cotroneo, G.Budillon, G.Spezie. "SURFACE HEAT FLUXES AND GLOBAL CLIMATE VARIABILITY IN THE ROSS AND WEDDELL SEAS".Biennial SCAR Meeting, 87-12 July, San Petersburg, Russia.

### D – proceedings of national meetings and conferences

- A.De Alteris, V.Rupolo, V.Artale, G.Budillon. "ANALISI PRELIMINARE DEI DATI XBT E XCTD RACCOLTI NEL MARE DI WEDDELL DURANTE LA CAMPAGNA CANOPO 2006". XVII Congresso dell'Associazione Italiana di Oceanologia e Limnologia; Napoli 3-7 luglio 2006.
- T.Peluso,, G.Budillon, F.Busdraghi, D.Iudicone: "Uno studio del mixed layer nel settore Atlantico dell'Oceano Meridionale" XVII Congresso dell'Associazione italiana di Oceanologia e Limnologia AIOL, Napoli 3-7 luglio 2006, Castel dell'Ovo, Poster Session.
- Y.Cotroneo, G.Fusco, G. Budillon, G.Spezie. "TEMPORAL AND SPATIAL VARIABILITY OF THE METEOROLOGICAL FIELDS IN ANTARCTICA". XVII Congresso dell'Associazione Italiana di Oceanologia e Limnologia; Napoli 3-7 luglio 2006.
- A.De Alteris, V.Rupolo, V.Artale, G.Budillon. "CARATTERISTICHE IDRODINAMICHE DELLE PRINCIPALI MASSE D'ACQUA E STRUTTURE OSSERVATE NEL MARE DI WEDDELL (PROGETTO CANOPO 2006)". Quinto convegno del

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- CoNISMa, Viareggio (ITALY), 14-18 November 2006.
- 5) T.Peluso, G.Fusco, G.Budillon. "ANALISI DEI FLUSSI DI CALORE ALL'INTERFACCIA ARIA-MARE-GHIACCIO NEL MARE DI WEDDELL". Quinto convegno del CoNISMa, Viareggio (ITALY), 14-18 November 2006.
  - 6) Rupolo V.: "Analisi di dati di profili di temperatura e salinità nel Mare di Weddell." Convegno Nazionale di Fisica della Terra Fluida e problematiche affini. Poster; Ischia 11-15 Luglio 2007
  - 7) G.Fusco, T.Peluso, G.Aulicino, G.Budillon. "IMPLEMENTAZIONE DI UN ALGORITMO PER LA STIMA DELLO SPESSORE DEL GHIACCIO DA MISURE TELERILEVATE". Convegno Nazionale di Fisica della Terra Fluida e Problematiche Affini, Ischia 11-15 Giugno 2007.
  - 8) T.Peluso, G.Budillon, F.Busdraghi, D.Iudicone. "ASPETTI SPERIMENTALI E MODELLISTICI DELLA VARIABILITA' DEL MIXED LAYER NEL SETTORE ATLANTICO DELL'OCEANO MERIDIONALE". Convegno Nazionale di Fisica della Terra Fluida e Problematiche Affini, Ischia 11-15 Giugno 2007.
  - 9) Y. Cotroneo, G. Fusco, G. Budillon, G. Spezie.: "VARIABILITÀ METEOROLOGICA DELL'OCEANO MERIDIONALE IN RELAZIONE ALLE SOUTHERN ED ANTARCTIC OSCILLATION". Convegno Nazionale di Fisica della Terra Fluida e Problematiche Affini, Ischia 11-15 Giugno 2007.
  - 10) G.Fusco, G.Budillon, Y.Cotroneo, T.Peluso, G.Spezie. "INTERAZIONI ARIA-MARE-GHIACCIO E VARIABILITÀ CLIMATICA DELLE AREE ANTARTICHE". Congresso congiunto AIOL-SitE, Ancona 17-20 settembre 2007.

### E – thematic maps

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### F – patents, prototypes and data bases

### G – exhibits, organization of conferences, editing and similar

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### H - formation (PhD thesis, research fellowships, etc.)

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### Research units

#### 1) ENEA, Roma Italy:

V. Artale	Researcher	ENEA
S. Calmanti	Researcher	ENEA
S. Marullo	Researcher	ENEA
V. Rupolo	Researcher	ENEA
R. Santoleri	Researcher	CNR-ISAC

#### 2) Stazione Zoologica 'A. Dohrn', Napoli, Italy:

Daniele Iudicone	Researcher	SZN
Maurizio Ribera D'Alcala'	Researcher	SZN
Vincenzo Saggiomo	Researcher	SZN

#### 3) Università 'La Parthenope' DISAM, Napoli, Italy:

G. Budillon	Professor	Univ. PARTHENOPE
M. De Stefano	Technician	Univ. PARTHENOPE
A. De Alteris	Technician	Univ. PARTHENOPE
A. Di Prospero	Researcher	Univ. PARTHENOPE
A. Finga	Researcher	Univ. PARTHENOPE
G. Fusco	Researcher	ENEA - Univ. di Napoli PARTHENOPE

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**Date: 06-08-09**

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