I - Executive Summary

This summary, initiated during the workshop meeting, was synthesized thereafter by Miroslav Gačić and Michèle Barbier upon the basis of further inputs received from all participants, in particular Katrin Schroeder, Mokhtar Guerfi, Toste Tanhua and Nurit Kress.

Frédéric Briand, Monograph Series Editor, reviewed and edited the entire volume. Valérie Gollino was responsible for the final layout and physical production.

1. Introduction

Over the last three decades a number of Basin-wide studies have revealed dramatic and faster than expected changes in the hydrography and biogeochemistry of both Eastern and the Western Mediterranean sub-basins (see syntheses in CIESM, 2009; 2000). As long-term variability in the ocean is, most often, revealed through studying the variability of the basin-wide circulation - and more specifically the changes of the overturning circulation cell - there is a growing need to document changes in the Mediterranean Sea over the entire water column and in different regions, in order to relate them to sea level variations and climatic variations.

In opening the meeting, Frédéric Briand, Director General of the Mediterranean Science Commission, remarked how effective Miroslav Gačić, Chair of the Committee on Climate and the Ocean, had been in persuading him to convene a workshop on such issues. The eighteen scientists (see list at end of volume) gathered here at the invitation of CIESM on the charming, secluded Brac Island would have all the time and latitude necessary to seriously discuss the possible design and implementation of a coordinated program for repeated basin-wide oceanographic surveys in the Mediterranean. Before inviting Dr Gačić to detail the specific objectives of this exploratory seminar, Dr Briand expressed his gratitude to the Director of the Institute of Oceanography and Fisheries (Split), Dr Ivona Marasović, and especially to her assistant Ana Marušič, for allowing this meeting to take place in Supetar in the best possible logistic conditions.

Miroslav Gačić reminded all present that the Global Ocean Ship-based Hydrographic Investigations Programme Initiative (GO-SHIP) had been recently set up as the international response to support and coordinate a system of repeat cruises in the world's oceans (see GO-SHIP White paper[1], OceanObs-09 conference, Venice, 2009[2]). The GO-SHIP plan defines an observational system which, on roughly decadal time-scales, conducts a number of repeat hydrographic lines in all ocean basins (see Tanhua, this volume). The GO-SHIP document specifies a number of core-parameters to be measured and defines protocols and data-policy for the surveys. As part of the GO-SHIP initiative, the WOCE hydrographic manual was revised and a new set of guides of best practices for several common measurements are now accessible on the GO-SHIP website.

[1] The GO-SHIP white paper available at the GO-SHIP website: http://www.go-ship.org/
[2] The Ocean Obs white papers are available at: http://www.oceanobs09.net/proceedings/cwp/index.php

With increasing societal demand for predictions of climate change impacts on the environment and ecosystems, e.g., temperature, sea level rise, occurrence of catastrophic weather events (flash floods, hurricanes, droughts, etc.), the time had come to formulate a possible Mediterranean component - a Med-SHIP Programme - to GO-SHIP. Due to its semi-enclosed nature, the Mediterranean Sea affects the climate of the surrounding land areas, in ways without analogs in other regions of the world. The complex land-sea distribution of the Basin has a strong effect on the atmospheric circulation and its seafloor keeps records of past climate evolution. The analysis of the complex Mediterranean Sea processes and evolution is an essential step to understand the regional environment and climate.

The bathymetry of the Mediterranean Sea is composed of several sub-basins separated by straits and channels with depths ranging from a few hundred meters to more than 4,000 m. This makes this sea very sensitive to atmospheric forcing and resulting changes in seawater characteristics can reach rapidly the deep waters. *In situ* meteorological observations and data time-series are long and spatially dense enough to enable some documentation of longer-term changes, by testing and validating models (see Lionello, this volume). While recent findings indicate that Mediterranean water masses have steadily become saltier and warmer in the last decades at all depths and everywhere in the basin (CIESM HydroChanges papers http://www.ciesm.org/marine/programs/hydrochanges.htm), with rates of change varying from one sub-basin to another, the oceanographic observational system, both here and in the world ocean, is lagging much behind the meteorological system. As a result *in situ* basin-wide data are very scarce; in fact the first basin-wide surveys in the eastern Mediterranean were carried out only in the mid-1980s. Now is the time to fill such gaps.

In the Mediterranean Sea, intense but mostly localized oceanographic campaigns are being carried out within the framework of different national and international projects. The methodology used differs among the projects. Moreover new monitoring technologies such as gliders and mooring are being progressively implemented in coastal ocean observatories (Tintoré *et al.*, this volume). However, there is a lack of a unified international platform that would, similarly to GO-SHIP, coordinate the observational network in order to avoid duplications and assure sufficient coverage in time and space. The GO-SHIP approach and methodology should be applied but adapted to the Mediterranean sea that is characterized by smaller spatial and shorter temporal scales of the circulation features compared to the global ocean (see Taupier-Letage, this volume). Such a programme should also develop data syntheses products and facilitate the interpretation of hydrographic data in partnership with national, regional, and global research programmes. Thus, there is a need to establish a permanent international body, preferably under the umbrella of CIESM, which will facilitate exchange of information on national initiatives in the Mediterranean ship-borne surveys both at basin and sub-basin scales.

Subsequently, a more formal organization is envisaged that would become part of the global GO-SHIP Programme: Med-SHIP which shall promote cooperative repeat hydrographic surveys, optimize national shiptime resources, enable merging and interpretation of collected data and encourage scientists from different countries to join and cooperate during all stages, from sampling to data analysis and interpretation. In this executive summary, we present a series of recommendations for the implementation of Mediterranean basin-wide ship borne repeated surveys: the Med-SHIP Programme.

2. The Mediterranean Sea and its specificity

2.1 The Mediterranean circulation and variability

The Mediterranean Sea is a semi-enclosed marginal sea that communicates with the world ocean through the narrow and shallow Strait of Gibraltar. The Mediterranean circulation is characterized by a variability at different spatial and temporal scales, determined by a complicated bathymetry and variable spatial scales of atmospheric forcing. Basin-wide flow, as a part of the upper circulation cell driven by the negative freshwater and heat balance, is characterized by an eastward surface flow of the relatively fresh Atlantic Water (AW). Generally, this surface current shows energetic meandering, baroclinic instabilities and mesoscale activities. In the Western basin, the main process is the continuous formation of meanders and mesoscale eddies along the North

African Current. According to POEM results and other *in situ* studies (Robinson *et al.*, 2001; Malanotte-Rizzoli *et al.,* 1999), the Eastern Mediterranean, in addition to the strong mesoscale activity, is characterized by a jet of AW entering the basin and crossing the Ionian Sea. On its way toward Israeli's coast it continues meandering between several bottom-trapped or wind-driven quasi-permanent or recurrent gyres. The Levantine Intermediate Water (LIW) is formed in the area of the Rhodes Cyclonic Gyre through the vertical convection reaching intermediate depths (Hayes and Zodiatis, this volume; Özsoy and Aydoğdu, this volume). This water then in a return westward pathway reaches the Gibraltar Strait and represents the main component of the exiting Mediterranean waters. Another proposed scheme of the Eastern Mediterranean surface circulation (Taupier-Letage, 2008; Millot and Gerin, 2010) suggests that the flow pattern is mainly characterized by travelling eddies and vortices that strongly interact with the general circulation along the African coast and divert AW offshore. In the same way, mesoscale eddies entrain intermediate and deep waters deflecting them from their pathway (Millot and Taupier-Letage, 2005a).
The implementation of GO-SHIP like surveys would provide additional *in situ* data and thus a better insight into the circulation pattern in the Eastern Mediterranean, its variability and the biogeochemical properties of the Mediterranean contributing to the understanding of processes and structures.

The deep circulation cell of the Mediterranean is driven by the dense water formation processes that take place in both the Western and in the Eastern Mediterranean. In the Western Mediterranean the dense water is formed in the Gulf of Lion, facilitated by the presence of the salty LIW and generated by the cold air outbreaks associated with the Mistral events in an area of cyclonic circulation. In the Eastern Mediterranean the main dense water formation source is the Southern Adriatic, in an area characterized by the presence of the bottom-trapped basin-wide cyclonic gyre. Again the presence of the saltier waters of the Levantine origin in the intermediate layer facilitates the vertical convection, which takes place during violent air-sea heat loss events associated with the Bora (Northeasterly wind) episodes. Recent results have revealed that during the last decade alternatively the dense water was formed in the Aegean and substituted the Adriatic (Roether *et al*., 2007). This phenomenon, named the Eastern Mediterranean Transient (EMT) (see CIESM, 2000) suggests that the mean circulation in the Mediterranean is subject to sudden changes revealing also that the time scale of the deep circulation cell is much shorter than previously thought. Recent studies showed pronounced decadal inversions in the North Ionian Gyre (NIG) that are important in determining thermohaline properties of the Adriatic as well as the pre-conditioning for the EMT. Inversions of the North Ionian Gyre are responsible for the out-of-phase behaviour of the Adriatic and Aegean as the dense water formation sites (Civitarese and Gačić, this volume) (see Figure 1).

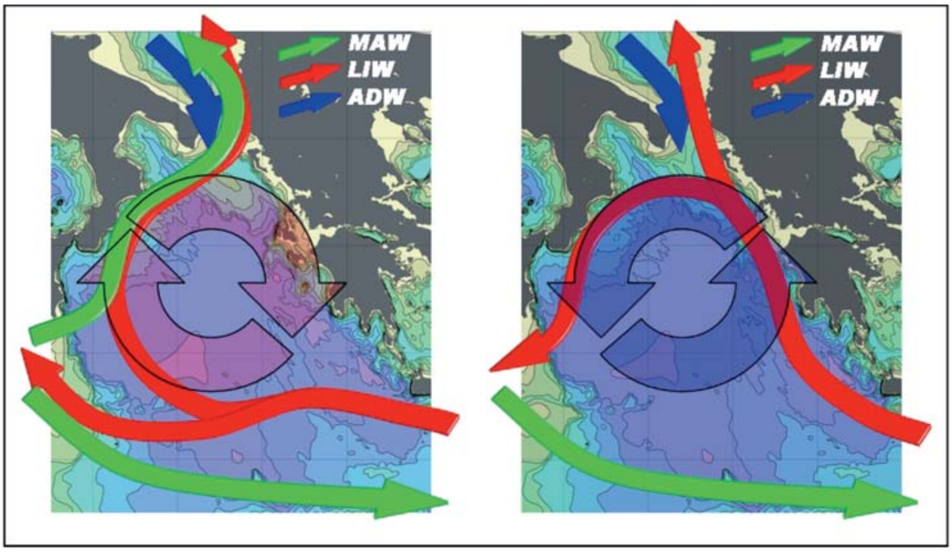

Figure 1. Example of Mediterranean complexity: circulation schemes of the two Ionian horizontal modes (Adriatic-Ionian Bi-Modal Oscillating System - BiOS) and pathways of the principal water masses after Civitarese and Gačić, this volume.

Recently, a significant warming and salinification of the whole water column in the western Mediterranean has been observed and several studies have revealed the abundant formation of a new warmer and saltier WMDW during winters 2004-2005 and 2005-2006 (Schroeder *et al.*, 2006; 2008a; 2010a; Font *et al.*, 2007). The bulk of the new WMDW, in the abyssal plain of the western Mediterranean Sea, showed temperatures of 12.85°–12.88°C and salinities of 38.455–38.473 below 2,000 m depth (Schroeder *et al.*, 2008a). Between 2004 and 2008 the new WMDW occupied a layer which reached hundreds of meters thick, with total increases of salinity and temperature of about $\Delta S = 0.024$ and $\Delta\theta = 0.042°C$, respectively, near the bottom (see profiles in Figure 2). By October 2008 the new deep water had been found everywhere in the western basin below 2,000 m depth, with the exception of the Tyrrhenian subbasin (Schroeder *et al.*, 2009). Furthermore, it has been uplifted toward the Alboran subbasin, where in 2008 it was detected along the Moroccan continental slope at depths <1,000 m. The magnitude of the replacement of the old deep water by the new deep water is clearly evident in the vertical profiles shown in Figure 2. This event has been called the Western Mediterranean Transition (WMT, CIESM, 2009).

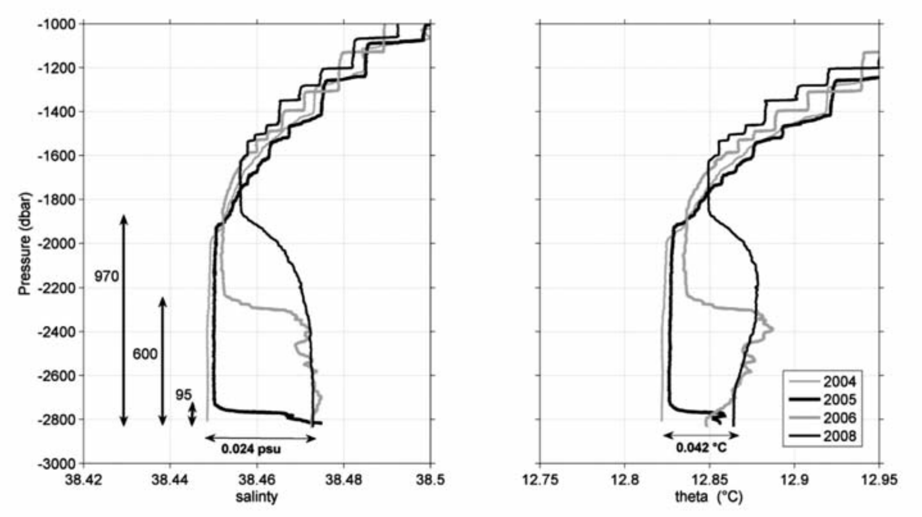

Figure 2. Vertical profiles of (left) salinity and (right) potential temperature measured at an example station in the Algerian basin (5°E, 38°N) in October 2004 (shaded thin), June 2005 (bold line), October 2006 (shaded bold line) and November 2008 (thin line). Vertical arrows indicate the thickness of the new Western Mediterranean Deep Water (WMDW) layer in the different years. Horizontal arrows indicate total salinity and temperature increase at the bottom between 2004 and 2008. From Schroeder *et al.* (2010a).

Long-term changes of the circulation pattern, especially in the Western Mediterranean, show indications of the relationship with the global scale teleconnections pattern.

Property exchange and interaction between shelf and open sea in the Mediterranean are very important and in general have been shown to take place via mesoscale eddies and, very efficiently, via bottom water sinking through canyons (Salat *et al.*, 2010).

2.2 Biogeochemical properties of the Mediterranean

Nitrate and oxygen distribution in the Mediterranean

The Mediterranean is considered an oligotrophic area. Generally, surface waters in the Mediterranean are depleted in nutrients and the thickness of this depleted layer increases eastwards from about 10 m in the Gulf of Lion to more than 100 m in the Levantine basin, more or less as nitracline and thermocline depths (Pujo-Pay *et al.*, 2011). Large phytoplankton blooms are geographically well localized and mainly associated with the physical forcing (dense water formation areas and/or cyclonic circulation pattern). In addition, important phytoplankton biomass densities are located in the Alboran anticyclonic gyres and near the coast adjacent to river mouths (D'Ortenzio and Ribera-d'Alcalà, 2009). The depth distribution of the chemical parameters in the Eastern Mediterranean changed following the EMT and continues to change through its relaxation and the re-establishment of the Adriatic as the deep water source. During the EMT the Cretan Sea

Overflow water (CSOW), that was warmer, saltier, more oxygenated and with lower nutrient concentrations than the Adriatic Deep Water (ADW) uplifted the older ADW and created a mid-depth layer with minimum oxygen (Min_{Ox}) and maximum nutrients (Max_{Nut}) in the Levantine basin and Cretan sea (Kress *et al.,* 2003). The CSOW, first noticed in the vicinity of Crete near its source, propagated initially towards the western Ionian and later towards the Levantine basin, uplifting the Min_{Ox}/Max_{Nut} layer from 1,250 m to 950 m and 750 m in the Levantine and Ionian basin, respectively, between 1995 and 2001. In 2008, this layer was centered at ca. 900 m depth in the Levantine basin, more emphasized in the eastern part and eroded towards the west. In the easternmost part of the Levantine basin, one of the last regions to be influenced by the EMT (Roether *et al.,* 2007), the CSOW was already in place in 2002, as reflected by the Min_{Ox}/Max_{Nut} at mid depth, and higher oxygen and lower nitrate concentration close to the bottom (see Kress *et al.*, this volume). Between 2002 and 2010, the Min_{Ox} vertical span narrowed and the influx of more oxygenated waters (the new, younger ADW) was more evident. The concentration of nitrate at the Max_{Nut} increased with time and shallowed (Figure 3).

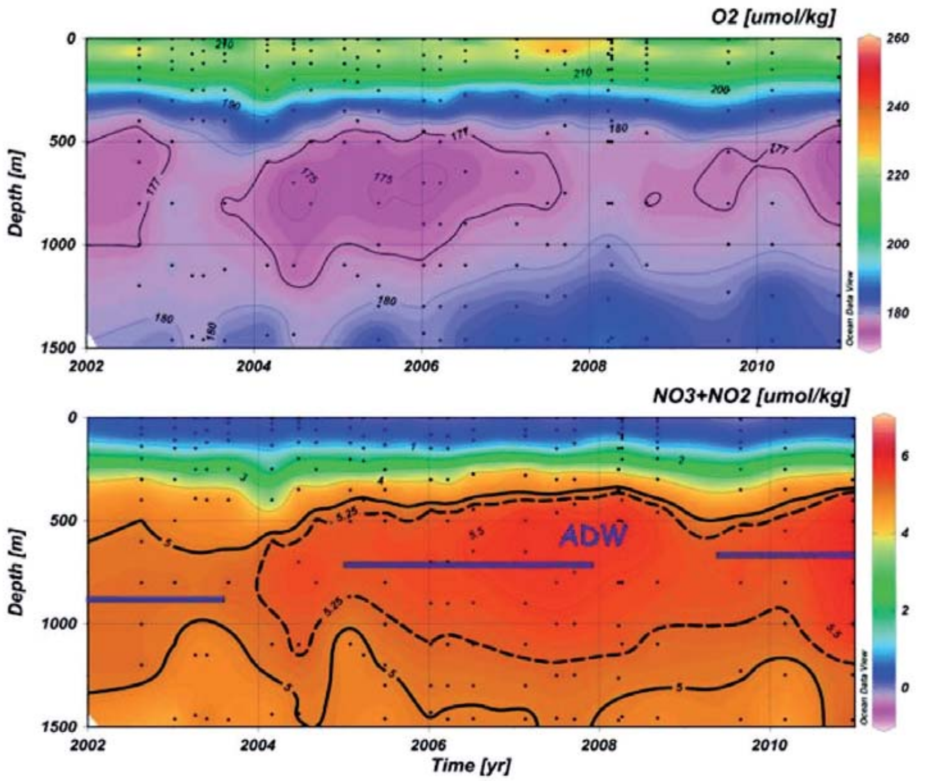

Figure 3. Temporal depth evolution of dissolved oxygen and nitrate at a station located at 33N, 34,5E. The blue line in the lower panel indicates the change in position and concentration of the maximal concentration of nitrate, corresponding to the ADW.

Carbonate system in the Mediterranean

There are only few observations of the carbonate system in the Mediterranean Sea, making it difficult to draw any conclusions on the temporal variability of the inorganic carbon at this stage. However, a recent 2011 survey repeated measurements of Dissolved Inorganic Carbon (DIC) in the Eastern Mediterranean, and a significant increase in normalized DIC (i.e. corrected to a common salinity) could be detected in the period between 2001 and 2011. However, when corrections are made for the remineralization of organic matter using changes in oxygen, only a small and mostly insignificant increase in DIC is observed. For the deepest layer in the southwest Ionian Sea a significant increase in respiration corrected DIC is noted: this is a consequence of recently formed ADW.

The Mediterranean does hold large amounts of anthropogenic carbon as a consequence of the high buffer factor and the active ventilation (Schneider *et al*., 2010). With the assumption that the anthropogenic carbon (C_{ant}) behaves like an inert gas, its distribution can be calculated with the "transit time distribution" (TTD) method from observations of transient tracers. Figure 5 shows the C_{ant} concentrations calculated from the TTD method for 2001 and 2011 for a zonal section in the Eastern Mediterranean Sea. An increase of C_{ant} calculated with the TTD method is equivalent to active ventilation. Figure 5 shows the signal of active ventilation in the western Ionian Sea, whereas the Cant concentration in the deeper layer of the Levantine Basin is very similar in 2001 and 2011, indicating a slowdown of deep ventilation in this area. This is consistent with the direct observations of changes in respiration corrected DIC (Figure 4). Figures 4 and 5 demonstrate the value of repeat observations of transient tracers and DIC in the Mediterranean Sea.

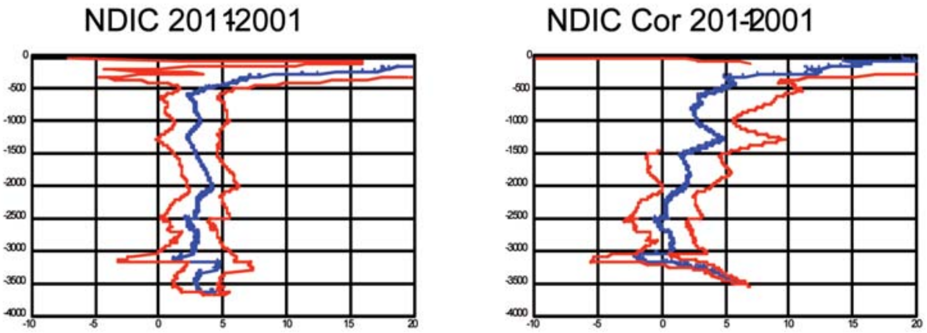

Figure 4. Changes in Dissolved Inorganic Carbon (DIC) between 2001 and 2011 in the Eastern Mediterranean Sea. Left panel shows changes in salinity corrected DIC, and the right panel a correction for respiration (from Alvarez, pers. comm.).

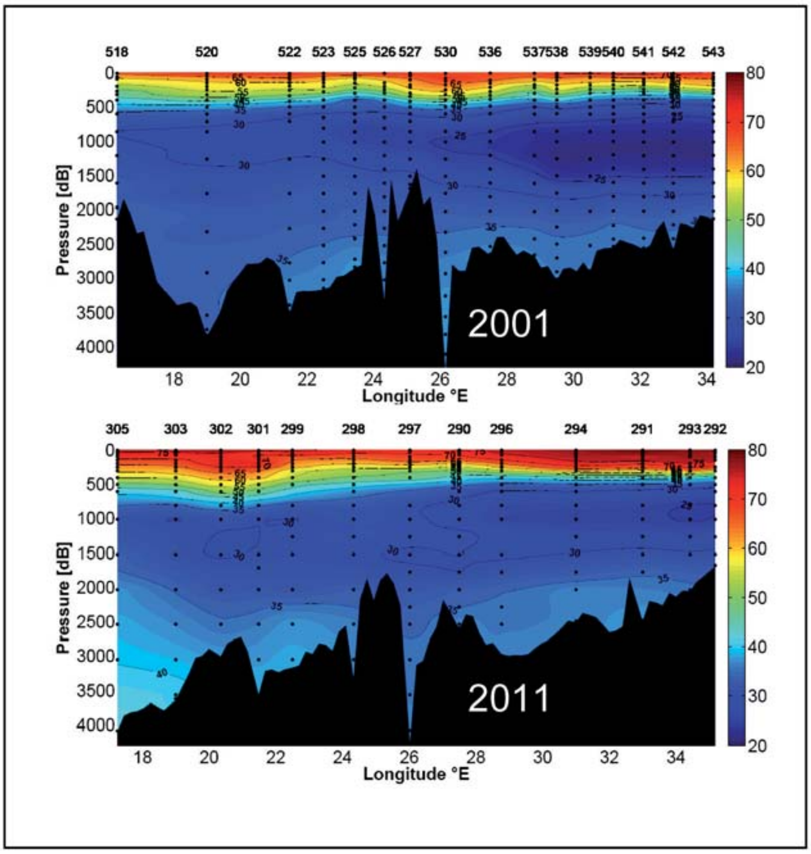

Figure 5. Anthropogenic carbon in the Eastern Mediterranean Sea in 2001 (top panel) and 2011 (bottom panel) calculated with the TTD method from observations of CFC-12 and SF6 (Stöven, 2011).

3. Objectives and significance of the Med-SHIP Programme

The Med-SHIP Programme aims at documenting and understanding the physical and biogeochemical water property distributions, their long term variations, and drivers at decadal and sub-decadal scales within the Mediterranean Sea, including physical and biogeochemical properties.

The specific objectives of this programme are to:

- Determine the long term variability and controls of water mass properties;
- Determine changes in circulation patterns and ventilation rates;
- Determine the variability of natural and anthropogenic carbon, and other biogeochemical properties;
- Reduce uncertainty in the heat, freshwater and property budgets, and sea-level;
- Augment the historical database of full water column observations necessary for understanding the Mediterranean Sea variability on multiple timescales and for numerical model evaluation.

The strength of the Med-SHIP Programme is in the long term, repeated, sustainable basin-wide surveys, that will complement the more frequent but localized studies. It shall include systematic long-term measurements, further optimize ship-time resources, integrate data collection, analysis, interpretation and management including dissemination through central coordination and governance. The implementation of such coordinated surveys would provide further insight into the circulation pattern, its variability and the associated changes in the biogeochemical properties of the Mediterranean.

4. Recommendations for the implementation of the Med-SHIP Programme

In order to address the complexity and the main scales/processes occurring in the Mediterranean Sea, recommendations are presented here for an efficient Med-SHIP Programme. The survey should consist of three components:

- Basin-wide half decadal (sub-decadal) zonal surveys;
- Cross-basin (north-south) transect at two-three years intervals;
- Higher frequency surveys using different platforms (e.g. ships gliders and floats mainly) at sub-basin and the mesoscale in order to follow the variability of structures/processes that influence the basin scale circulation and THC.

As reported by Tanhua (this volume) and Taupier-Letage (this volume), it is reasonable to suggest that a somewhat more intense observational programme is needed in the Mediterranean compared to the world ocean programme (GO-SHIP). The zonal transect, repeated on a low-frequency basis and including the full suite of the GO-SHIP core parameters, would allow to assess long-term variations of heat and freshwater budgets (and their steric influence on sea-level) and to compute basin-wide inventories of natural and anthropogenic carbon in the Mediterranean, with a focus on its deeper layers, being less subject to small (time/space) scale variability. But, the Mediterranean is a coastal ocean with open ocean characteristics (Tintoré *et al.,* this volume; Robinson *et al*., 2001), where the circulation is not driven by basin scale forcings, but by intense, variable and diverse subbasin forcings. With this in mind the high-frequency repetition of subbasin, meridional transect, including a subset of the GO-SHIP core parameters, is essential to capture the observed degrees of variability.

In addition, an integration of all other important on-going programmes will provide higher spatial and temporal resolution than the one set up by ordinary Med-SHIP cruises. More specifically, remotely sensed data will be essential for resolving smaller scale features. In addition, the HydroChanges network of moored CTDs sponsored by CIESM as well as the installation of low-cost autonomous thermosalinometers on ships of opportunity will allow the monitoring at high temporal resolution (~weekly) of the temperature and salinity of the sea surface, and provide a synoptic picture at basin scale (see Taupier-Letage, this volume).

4.1 Basin wide (sub-decadal) surveys – Recommendations for full water column ship-based long term observations in the Mediterranean Sea

Two types of repeated hydrographic surveys shall be envisaged, further combined with other platforms, specifically with gliders, for studies of mesoscale variability:

- High-frequency lines (3 years), generally North-South;

- Low-frequency line (6 years), East-West hydrographic transect.

• Recommendations on transects –

Backbone activities will mainly be carried out at these two types of transects which shall be integrated with existing sampling at higher spatial and temporal resolution.
The optimal surveys are drafted on the map below.

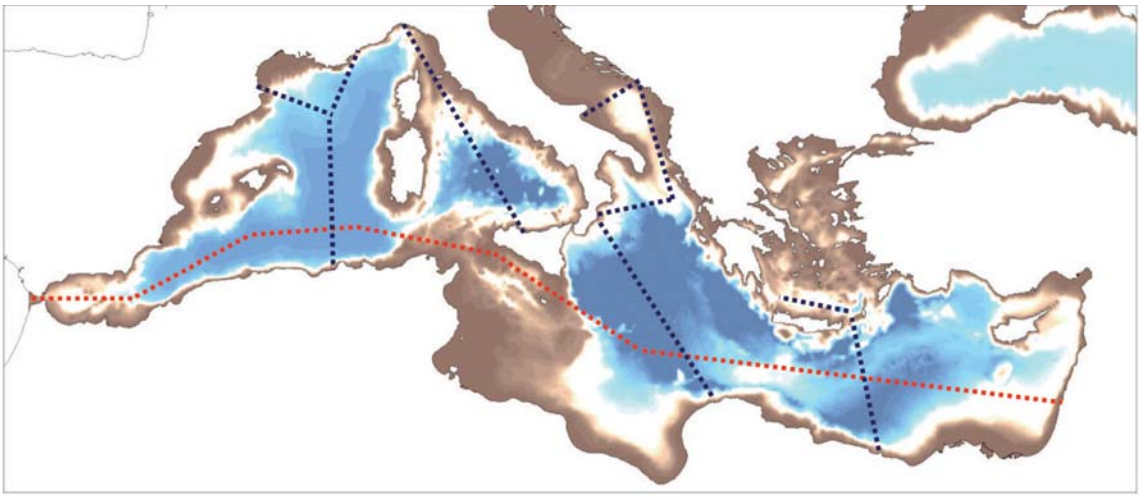

Figure 6. Proposed Med-SHIP survey transects with north-south high-frequency lines (every 3 years) in blue, and east-west low-frequency line (every 6 years) in red.

It is recommended that spacing between stations should be 30 nm but reduced to 10 nm in the vicinity of sharp bathymetry. Full chemistry stations should be designed at least every 60 nm but adapted in sharp bathymetry areas. The preferred period for sampling would be in August-October. The surveys shall include the entire water column since the deep Mediterranean circulation is strongly impacted by processes that take part in the upper part of the water column and thus cannot be excluded in this study. Note that all of the lines are designed to reoccupy long-term monitored stations and cruises, both deep stations (GEOSECS, SESAME (Adios, Haifa), DYFAMED, etc.), coastal monitoring stations or ship of opportunity tracks.

• Recommendations on key parameters measurements – *In situ* continuous profiles core measurements should include temperature, salinity, pressure, dissolved oxygen and fluorescence. Refraction and Photosynthetically Active Radiation (PAR) are recommended.

Water column sampling at designated stations should include the full chemistry of:

- Dissolved oxygen;

- Inorganic nutrients (phosphate, nitrate, nitrite (separately if possible and if not nitrate+nitrite and silicate). Measurements to nanomolar levels are recommended for the upper water column;

- CO_2 variables (preferred are measurements of alkalinity and total inorganic carbon, measurements of pH is an alternative);

- Transient tracers such as CFCs, SF_6.

Additional recommended variables are organic carbon, nitrogen and phosphorous, chlorophyll *a*, HLPC pigments, flow cytometry.

Stations should be complemented by underway sampling measurements:

- Meteorological variables;
- Thermosalinograph;
- Aerosols;
- *In situ* underway CO_2 measurements;
- Fluorometer;
- Hull-mounted ADCP for current profiles.

4.2 Sub basin/mesoscale survey – Recommendation for high frequency sub-basin surveys

Zonal backbone basin-wide transects will add on existing activities as well as on small scale national surveys. Specific attention will be paid to the integration of glider data and data collected during both high-frequency lines and the low-frequency east-west hydrographic transect. Especially, the incorporation of gliders should be an important contribution to the Med-SHIP initiative. Data collected during the two types of cruises will also be integrated with measurements from all available platforms.

• Recommendations for key process study areas for understanding the variability of water masses, ventilation and impact on basin-wide circulation –

To document the effects of deep and intermediate waters (DW and IW) on circulation and biogeochemical variability at basin and sub-basin scale, the study of the following key sub-basins/processes is recommended:

- BIOS/EMT as an example of Mediterranean complexity in the Ionian Sea/Otranto Strait and Cretan passage (anticyclonic mode: AW enters Adriatic increasing buoyancy cyclonic mode: the AW feeds directly the Levantine and the Aegean). Study of the impact on the ecosystem and biochemical features.
- Cretan Sea.
- Levantine eddies/gyres: Rhodes, Mersa Matruh, Cyprus, Shikmona.
- Sicily Strait and Sardinia section.
- Southern Gulf of Lion / Eastern Menorca (towards Sardinia).
- Balearic Sea and channels (related to identification of presence of 'deep' 600 m WIW eddies and their relation to blocking of surface and intermediate waters flow). This area allows the assessment of impact on the ecosystem: for example the Bluefin tuna (*Thunnus thynnus*) spawns, each summer, south of the Balearic Islands, in proximity to the AAW/MW convergences.

• Recommendations for key areas for understanding mesoscale variability and impact on the general circulation –

For intense meandering current and baroclinic instabilities that modify the general circulation, the study of the following key areas is recommended:

- Alborán Sea / Algerian current;
- Asia Minor current.

For weak sub-basin circulation and strong mesoscale impact on general circulation, the study of the following key areas is recommended:

- Balearic Sea;
- Levantine eddies.

5. Data management, sharing and products development

Data management is likely to be the most challenging issue for the Med-SHIP Programme, in view of the richness of the data already harvested in different areas of the Basin (see Table 1) and with due consideration to the important data divide between the North and South of the Mediterranean. The deployment of new monitoring technologies [gliders, AUV's, etc.] is allowing a high resolution sampling in the north, while the south part of the basin is under sampled (see Tintoré *et al.*, this volume).

Table 1. List of Mediterranean areas, observing tools and variables under current monitoring.

Location	Monitored Area/ Process	Tools	Parameters / variables
Western Mediterranean	Gibraltar strait	Deep CTD mooring CIESM Hydrochanges Program	Temperature, salinity, current
	Balearic sea	Gliders,	Temperature salinity
		Mooring buoys	
		Radar	Surface currents
		ARGO profilers /surface drifters	Current, temperature
		RADMED time series CTD	pH, TA (*pCO2 to come*)
	Gulf of Lion	Deep CTD mooring CIESM Hydrochanges Program	Temperature, salinity, current
		buoys DYFAMED	
		Buoys (W1-M3A)	TA, pH (*pCO2 to come*)
	Corsica channel	Mooring buoys	Temperature, salinity
	Tyrrhenian sea	CTD casts	Temperature, salinity
	Sardinian channel	Deep CTD mooring CIESM Hydrochanges	Temperature, salinity, current
	Transect Marseille-Malta	Autonomous CTD on ship of opportunity (CIESM PartnerSHIPS)	Sea surface Temperature salinity
Eastern Mediterranean (Adriatic sea)	Gulf of Trieste	Surveys at Paloma site	pH, TA, biogeochemical variables
	Northern and central Adriatic	CTD + sampling survey	Temperature, salinity nutrients, disolved Oxygen
		Deep CTD mooring CIESM Hydrochanges	Temperature, salinity
	Southern Adriatic sea	Buoys (E2-M3A)	Temperature, salinity pCO2
Sicily strait		Mooring buoys	Temperature, salinity
		Deep CTD mooring CIESM Hydrochanges	
Eastern Mediterranean	Cretan sea/	Deep CTD mooring CIESM Hydrochanges	Temperature, salinity,
		M3A Buoy	pH , pCO2 (in the near future)
	(Bosphorus strait/ Marmara sea)	Ship survey - CTD cast	Temperature, salinity
	Mersa Matruh gyre	CTD +sampling survey	Temperature, salinity nutrients, dissolved Oxygen
	Cyprus eddy and Shikmona gyre	Gliders	Conductivity, Temperature, disolved oxygen, chla fluorescence, optical backscatter
	Eastern Levantine	CTD + sampling survey (CYCOFOS Buoy)	Temperature, salinity, dissolved Oxygen
	Haifa section	About 3 times a year 6 stations from Haifa westwards to 1700 m depth station Oceanographic campaigns	Temperature, salinity, pressure, dissolved oxygen, fluorescence, refraction, dissolved oxygen, inorganic nutrients (phosphate, nitrate, nitrite and silicate, total N and total P, TOC, chl a.
Western, Central and Eastern Mediterranean		MedArgo floats[1]	Current, vertical profile for temperature and some biochemical properties

[1] MedArgo float (updated position of argofloats available at http://nettuno.ogs.trieste.it/sire/medargo/active/index.php)

The general strategy proposed here is built upon the IODE/IOC/UNESCO model, with a central data assembly center, playing also the role of a communication and coordination center, as the backbone of the new regional Ocean Data infrastructure, linked to a well established ODN (Ocean Data Network), by a strong cooperation and coordination with National Oceanographic Data Committees (NODCSs). This strategy moves toward a basin-wide data capability, sharing capacity, and data management standards.

A task team shall be created to propose ways and solutions to improve technology and data policies, to release data in a more timely manner; to coordinate with other international programmes, and to propose a mechanism for products development and data synthesis (see Guerfi, this volume).

5.1 The data management and sharing policy

The data management is designed on a distributed model, where National Oceanographic Data Committees maintain control of their data resources, and are responsible for data collection, analysis, documentation, quality control (QC) archiving, and ii) the data assembly center is responsible for data merging, online dissemination and documentation, etc. The strategy of the ODN model is built to develop and improve national, sub-regional and regional capacities, with the involvement, cooperation and coordination with all hydrographic stakeholders.

The Med-SHIP panel recommends that the data-release guideline of the GO-SHIP Programme should be adopted to be in harmony with the global programme as following:

- Preliminary dataset released within 6 weeks;
- 6 months for final physical data;
- One year for final data of all other variables.

While for some countries, where frameworks for data sharing are well established, the strategy and the guidelines proposed for the global GO-SHIP Programme could be adopted without constraint, meaning quick data release, real-time or near-real time and a broader coverage - more variables exchanged (CTD, SST, salinity, etc.). Principles, to produce scientific products on a shorter time scale, should be respected-. In other Mediterranean countries, governments are still considering publicly-funded research data either as secret or as commercial commodities, so the absence of a clear policy and legislative framework at the national level can seriously disturb the effective implementation of the basin-wide data sharing objectives.

5.2 Existing data management centre/infrastructure

During the last decade, many projects/programmes related to oceanographic data and information management in the Mediterranean were conducted. These projects were both for research and/or specifically devoted to oceanographic data and information management. They allowed the establishment of a pan-Mediterranean network of data centers and specialized marine institutions. They cover in particular the European countries, with a basin-wide aspiration. They permitted the development of several oceanographic and marine metadata directories for the Mediterranean, established data format, data management quality control and standards for interconnecting the data centers, enabling the provision of integrated online access to comprehensive sets of multi-disciplinary, *in situ* and remote sensing marine data, metadata and products.

The most recent and important initiatives are:

MyOcean, the Ocean Monitoring and Forecasting component of the GMES (Global Monitoring for Environment and Security) Marine Core Service. It provides the users with the main variables needed to depict the ocean state: temperature, salinity, currents, sea level, ice coverage and thickness, or primary ecosystem characteristics.

EMODNet (European Marine Observation and Data Network) which is actually in a pilot phase and has a portal that provide users with hydrographic data collated for a number of Mediterranean regions.

SeaDataNet which is a Pan-European infrastructure for managing, indexing and providing access to ocean and marine data sets and data products, from more than 35 National Oceanographic Data

Centers (NODCs) and international organizations (IOC/UNESCO, ICES, EU-JRC) from European and Mediterranean countries.

5.3 Recommendations

Series of recommendations have been made on all aspects of data management/data sharing policy, based on the Mediterranean context summarized below:

- The creation of a data management/data policy working group to assess the development and operation of an integrated Mediterranean hydrographic network by;
  - Identifying gaps in data sharing policies, data managements practices, legal frameworks for a sustained basin-wide hydrographic programme;
  - Assessing the data management infrastructure in terms of data gathering, data management, etc.
- Establishing the link with other international programmes that already implemented infrastructure for marine and ocean data management that provide users with harmonized services, products, standards and tools - SeaDataNet, MyOcean, and EMODNet-.

6. Coordination and governance

The efficient execution of the repeat multidisciplinary international hydrographic surveys as a part of the future Med-SHIP Programme needs an overall coordination, especially to ensure that links are strong between ongoing cruises, ship surveys under national and international programmes, high frequency measurements profiles, upcoming projects, financial aspects, data analysis and integration.

Some desirable components of an efficient Med-SHIP Programme are mapped in the Figure 7 below.

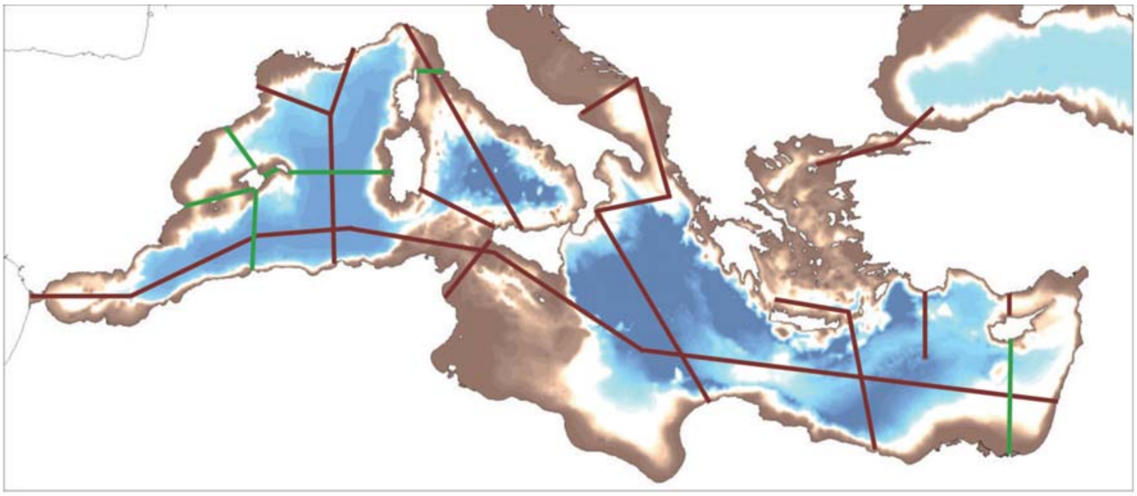

Figure 7. Desirable grid of repeated oceanographic surveys, including ship cruises (in brown) and gliders (in green).

Considering the large number of ongoing and up-coming activities including oceanographic campaigns, monitoring programmes at the national, regional or international level, the Med-SHIP Programme requires already in this phase some coordination.

More specifically the following organizational aspects should be addressed: preparation of a Memorandum of Understanding between the countries and CIESM regarding data sharing policies; data management development; coordination with existing data centers coordination with GO SHIP initiative; inventory of available resources and capabilities as well as national/international programmes (current and upcoming); design and implementation of a training programme for capacity building including trials; administrative management and dissemination of the programme; development and update of web pages dedicated to the Med-SHIP Programme on CIESM web site; coordination with large international ongoing operational oceanography activities

(MOON, MYOCEAN, etc.); preparation of the Med-SHIP Special session during the next CIESM Congress (2013) dedicated to the 2011 ship campaigns results.

In addition, scientific aspects for such a programme should be considered: synthesis of relevant scientific questions and the scientific rationale of the programme; standardization of protocols (Methodology of measurements) following GO-SHIP standards, adapted to the Mediterranean; appropriate data analysis and integration; proper presentation of scientific results and application of the publication policy; data use policy, etc.; integration of complementary/multidisciplinary data related to biogeochemistry and climate science (e.g. satellite data; precipitation records); integration to modelling and observational studies (see Rixen, this volume); synergies with modelling efforts to focus observations when and where they have the largest impact on reducing uncertainties.