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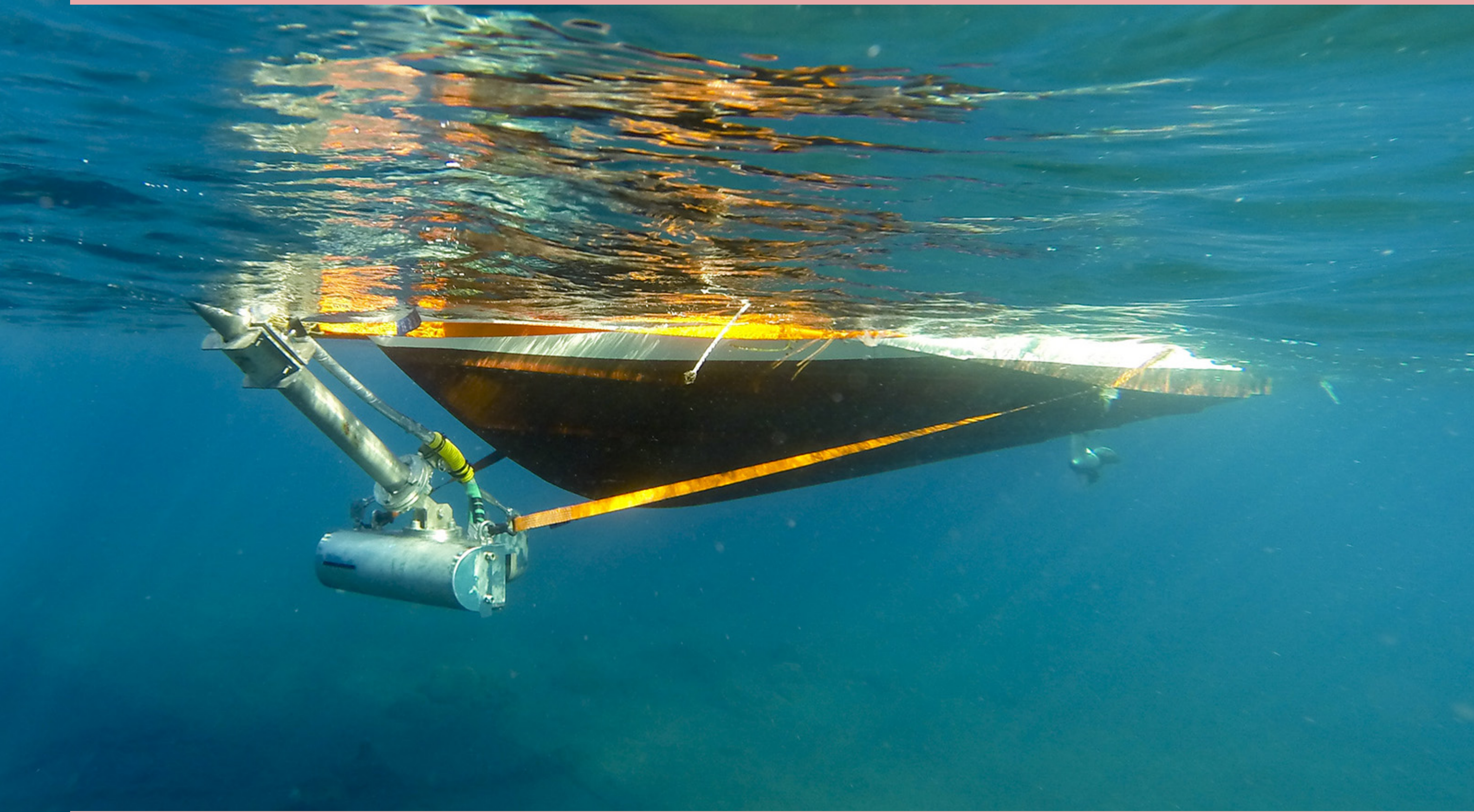

MISCELLANEA INGV

Abstracts Volume

Giornate INGV sull'ambiente marino
INGV Workshop on Marine Environment

Rome, 26th | 27th June 2019

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ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

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Cover Multibeam sensor munted on the INGV vessel for bathymetric surveys at Lipari island (Italy) | *In copertina Sensore multibeam installato su una imbarcazione INGV per rilievi batimetrici a Lipari* (©INGV)

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Preface

On 26 and 27 June, 2019, the Environment Department of Istituto Nazionale di Geofisica e Vulcanologia (INGV) organized a first internal workshop dedicated to the scientific and technological research on the marine environment. This volume contains the extended abstracts of the presentations given in the workshop.

INGV promotes the development of research, observational infrastructures and services related to the marine environment in the broad sense for a variety of stakeholders. These activities, mostly carried out within the framework of the Environment Department, are dispersed in different Sections of INGV, involving various groups of researchers, technologists, technicians and project managers.

The workshop aim was to present the state-of-the-art of the activities around the marine environment and promote the exchange of knowledge, ideas and expertise among colleagues. More than 60 INGV scientists attended the workshop with a lively interest and active participation to constructive debates.

This volume includes 35 extended abstracts grouped three categories: (1) Research, (2) Infrastructures and (3) Services for the Society.

The *Research* Section has 23 abstracts on topics ranging from fluid geochemistry of natural marine emissions in both volcanic, hydrothermal and sedimentary settings, crustal structures and imaging, the evolution of the physical state of the Mediterranean, observed sea level trends and future projections, paleoclimate reconstructions and proxies for the occurrence of paleo-tsunami.

The *Infrastructures* Section includes 6 abstracts presenting the state of the art and the perspectives of INGV research facilities, the development of original devices and techniques for the monitoring of a variety of physical phenomena in the Mediterranean environment, with specific attention on areas of active volcanism and tectonics, as well as the management of specific databases.

The *Services for the Society* Section also includes 6 abstracts related to original experimental devices developed for security in harbor environments, as well as to operational oceanography and to third mission initiatives aimed to raise public awareness toward environmental pollution and marine sciences.

The large variety of the topics presented and the relatively high number of attendees respect to the youthfulness and limited dimension of the marine environmental research area at INGV compared to its traditional disciplines, is an incitement to promote further this kind of initiatives based on in-person discussion and mutual update.

We take the opportunity to express our thankfulness to all the attendees.

The Workshop Organisation Committee
Leonardo Sagnotti, Laura Beranzoli, Cinzia Caruso, Sergio Guardato, Simona Simoncelli

River runoff and Dardanelles Strait implementations in the Mediterranean Sea numerical modelling system

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Introduction

This contribution aims at presenting the numerical model developments recently implemented in an eddy-resolving Mediterranean Sea modelling system based on the Ocean General Circulation Model (OGCM) NEMO (Nucleus for European Modelling, [Madec et al., 2017]. In this implementation the model has a horizontal resolution of 1/24° and it is resolved over 141 z vertical levels [Clementi et al., 2017]. The developments are related to the implementation of an increased number of freshwater river outlets and to the improvement of the Dardanelles Strait representation in the numerical modelling system.

River runoff implementation

The river runoffs in the starting version of the Mediterranean Sea numerical system are implemented as Surface Boundary Conditions (SBC), meaning that freshwater input is added through the top model cells where the river mouths are defined. In addition to the volume flux, which represents the river discharge measured at gauge stations and usually available as monthly climatologies, specific values of salinity have been associated to the river inputs.
Two numerical experiments have been performed in order to evaluate the impact of an increased number of freshwater inputs (see Figure 1) on the thermohaline properties of the Mediterranean Sea and on its circulation structures: 7 rivers have been implemented (green dots in Figure 1) in the first experiment (simrs_v1), while 32 additional rivers (red dots in Figure 1) have been included in the second experiment (simrs_v2). The newly added rivers were those around the basin presenting a mean annual discharge larger than 50 m^3/s over the period 2000–2010 according to the climatological values derived from the PERSEUS project (http://www.perseus-net.eu).
Numerical results have been compared with respect to in situ observations (Argo floats, XBTs and gliders) showing that the temperature error is almost the same in both experiments, being approximately 0.65°C in the surface layer, 0.95°C in the thermocline (30-60m) and decreasing down to 0.2°C at largest depths. Experiment simrs_v2 shows an improvement in the salinity skill at Mediterranean Sea basin scale from the sea surface down to 60m depth. On the contrary, a worsening can be noticed from 60m down to 300m depth. Finally, results are very similar from 300m down to 2000m depth, as shown by the Root Mean Square Error values (RMSE) of Salinity, presented in Table 1. The salinity skill scores varies also among the different sub-regions of the Mediterranean Sea. In particular, simrs_v2 shows better performances in the Adriatic Sea than simrs_v1 above 30m depth, while it shows worse performances below 30m depth.

Depth range [m]	Salinity RMSE simrs_v1 [PSU]	Salinity RMSE simrs_v2 [PSU]	Salinity RMSE increase/decrease [%]
0-10	0.36	0.33	-9
10-30	0.34	0.31	-9
30-60	0.32	0.31	-3
60-100	0.29	0.30	+3
100-150	0.24	0.25	+4
150-300	0.13	0.14	+7
300-600	0.09	0.09	0
600-1000	0.05	0.05	0
1000-2000	0.03	0.03	0

Table 1 Root Mean Square Error (RMSE) of salinity for experiments simrs_v1 and simrs_v2 (columns two and three, respectively), and RMSE percentage increase/decrease for salinity (column four) in experiment simrs_v2 with respect to simrs_v1. Statistics consider the whole Mediterranean Sea basin.

Further tests would be needed in order to improve the accuracy of the thermohaline properties, for example by implementing estuary box models to better represent the salinity at the river mouth [Verri et al., 2019] or through a better calibration of the vertical mixing parameterization at river outlets.

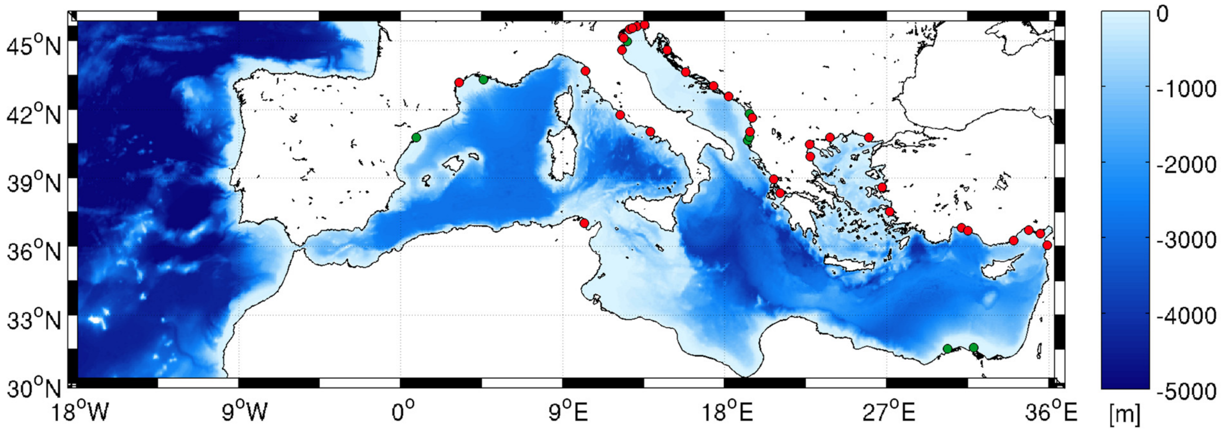

Figure 1 Model domain, bottom topography and location of river inputs: green dots represent the 7 river sources included in both experiment simrs_v1 and simrs_v2, red dots represent the 32 additional rivers implemented in experiment simrs_v2.

The Dardanelles Strait implementation

The second model upgrade consists of a modified implementation of the Dardanelles Strait, a narrow strait connecting the Mediterranean Sea and the Black Sea through the Marmara Sea. The improvement brought the implementation of the Dardanelles from a Surface Boundary

Condition (SBC) to a Lateral Open Boundary Condition (LOBC). In the SBC case, the Dardanelles system is parameterized like a river where monthly climatological values of salinity and volume flux are imposed [Kourafalou and Barbopoulos, 2003].

In the LOBC case, salinity, temperature, volume flux and sea surface height are partially provided as daily values of the CMEMS GLO-MFC system (Global Ocean Monitoring and Forecasting Center, GLO-MFC, in the framework of the Copernicus Marine Service, CMEMS, http://marine.copernicus.eu/) and partially as daily climatologies from the Turkish Straits System (TSS) box model [Maderich et al., 2015]. Specifically, barotropic and baroclinic velocities are computed from the TSS box model volume flux, while the sea surface height and the temperature fields are provided by the CMEMS GLO-MFC. The TSS box model provides the salinity fields for the upper layers of the Dardanelles Strait (from the surface down to 13m depth), while for the deepest layers (from 13m depth down to the bottom) a constant value of 38.6 PSU is used.

Numerical experiments have been set up to evaluate the performance of the new system with the Dardanelles Strait implemented as LOBC (expB) with respect to the previous implementation (expA) and the ability in reproducing temperature and salinity fields, in particular in the Aegean Sea area. ExpB shows a quite significant improvement of surface salinity above 10m depth with an error reduction from 0.65 to 0.55 PSU, whereas the salinity skill scores are comparable going deeper. Concerning temperature, expB presents a general improvement with respect to expA along the whole water column in the Aegean Sea with an error reduction of about 7.5%, without considering the depth range between 1000 and 2000m, where the number of available observations is very low.

The BSW outflow from the Dardanelles Strait has been significantly modified by the new implementation, which affects also the circulation of the North Aegean Sea, as shown in Figure 2 after two years of integration.

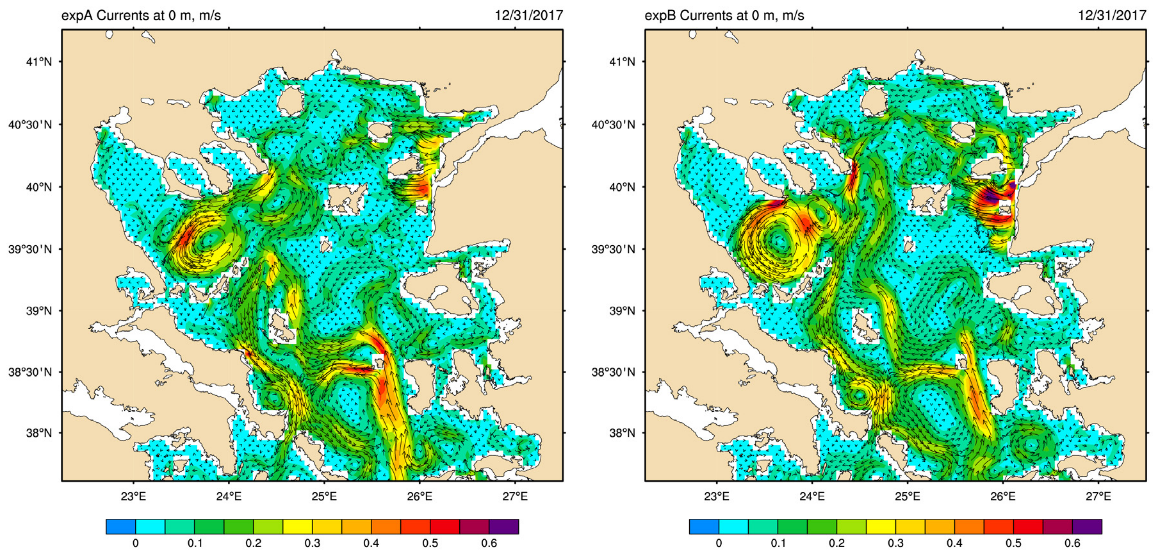

Figure 2 Surface currents for expA (left panel) and expB (right panel) for the 31st of December 2017, after two years of integration for both the experiments.

Conclusions

The comparison of modelled and observed salinity shows an improvement of the model skill at the surface thanks to the increase of the number of rivers in the model implementation, while a slight increase of the error is found at greater depths.

Finally, the introduction of the Dardanelles Strait as a Lateral Open Boundary Condition resulted in a significant improvement in representing the thermohaline properties of the surrounding area.

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