Development of a high resolution regional coupled ocean-atmosphere model for seasonal prediction and climate studies at IC3

Mahesh Shinde\textsuperscript{1,2}, Jordi Isern and Xavier Rodo
1. Catalan Institute of Climate Sciences, Barcelona, Spain
2. Indian Institute of Tropical Meteorology, Pune, India
contact: mshinde@ic3.cat

The Catalan institute for climate sciences (IC3) was established in July 2008 with the main goal of evaluating, understanding and predicting climate variability and change and their impact at both global and regional (Mediterranean) scales. IC3’s main scientific goals are (1) To increase the understanding of the past and present climate including variability and change. (2) To improve the quantification of the forces causing climate change and variability. (3) To reduce uncertainty in predictions. (4) To develop a regional coupled climate model for seasonal prediction in the Mediterranean. (www.ic3.cat)

Abstract: One of our first objectives is to develop a high resolution coupled ocean-atmosphere model for the Mediterranean area. To this end we’ve started to work on the ocean component of the system that will provide the high resolution Surface Temperature (SST). We are currently building a configuration of the ROMS code able to reasonably resolve the Mediterranean mesoscales. Our current configuration has a horizontal spatial resolution of 1/16º by 1/16º (~6 km) and 72 uneven vertical levels, does not include the Black Sea and has an Atlantic Box that extends until 20°W. For the initial tests we are using COADS monthly climatologies with a spin up of 10 years although we plan to use forcing fields from the ECMWF. Presently, there are not available observations of ocean dynamics (velocity and vorticity fields) at such high spatial resolutions for validating the model. Therefore, we have developed a system to recover the 2D surface velocity field at spatial resolutions of the order of 10 km from a single SST image based on our previous work on Surface Quasi-Geostrophic dynamics. We are currently validating this approach using ADCP measurements and drifting buoys observations.

Objective:
(1) To implement, run and calibrate ROMS for Mediterranean. (2) Application of ROMS to get high resolution SSTs and to study oceanic process in Mediterranean.
(3) To implement and run pacemaker experiments to provide seasonal prediction coupled with ROMS.
(4) To develop reliable seasonal prediction modeling system in Mediterranean. (5) To study teleconnections between Mediterranean and Indian regimes.

Data and Methodology:
(1) Grid: 1/16 deg resolution with 72 vertical levels, Etopo-2 bathymetry used.

(a) Parameters used: (a) theta_b=0.0, (b) theta_s=5.4 (c) h=10.0

(2) Clim & Ini data: Levitus monthly climatology.

(3) Forcing: COADS monthly climatological forcing for initial simulation. This forcing will then be replaced by ECMWF and also with high resolution coupled model output.

Observational Work: The dynamics resolved by our grid (O(5km)) is higher than the quantitative observations provided by existing observing systems, e.g. the velocity field obtained from along track altimetric measurements (~30-50 km) and altimetric maps (~100 km). This fact has pushed us to investigate alternative approaches to recover the 2D velocity field at resolutions higher than those obtained from altimeters and closer to the resolution of our grid. To this end we have developed a methodology based on the Surface Quasi-Geostrophic equations to recover high resolution velocity fields from a single SST image. Figure 1 shows the qualitative comparison between the velocities derived from an SST images (notice that only some vectors are plotted), velocities measured using ship-mounted ADCP and the geostrophic velocities estimated from SeaSoar measurements. Figure 2 shows the scatter plot between velocities derived from SST using the SQG approach and ADCP measured velocities.

Fig. 1

Fig. 2

HPC facility: The High Performance Computing Facility at IC3 is formed by a 384 core cluster with Infiniband connection, 8.81 Tb of RAM, 55 Tb of disk capacity and a backup capacity of 97 Tb (Tapes). The cluster is composed by a Sun Blade 6048 Chassis with 48 blade servers (Sun Microsystems X6270) with 2 Intel Xeon (Nehalem) processors at 2.26GHz each, a SAS disk of 07.2 Tb, a SATA disk with 48 Tb and a Sun StorageTek SL500 tape storing system.

References: