RESULTS OF THE FIRST MEDITERRANEAN MODELS EVALUATION EXPERIMENT MEDMEX E.U. Concerted Action (MAS2-CT94-0107)

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Abstract

The present paper will summarize the results of the first MEDMEX experiment, in which 5 general circulation models were applied to simulate the seasonal cycle in the Mediterranean. The intercomparison was designed so as to impose identical resolutions and forcing functions on the models, aiming at eliminating interpretation problems due to different forcings. The models participating in the intercomparison are two versions of the MOM model, the GHER model, OPA and POM model, whose results are compared.

Key-words: circulation models

Setup of the coarse resolution experiment

Individual descriptions of the models applied to the Mediterranean can be found in the report, but the implementation caracteristics for the intercomparison are given in figure 1.

The first MEDMEX modelling experiment was set up to study the behaviour of the models when forced by the classical perpetual year approach, repeating each year the atmospheric data of a monthly averaged atmosphere, including sea surface relaxation of temperature and salinity towards climatological monthly means. The participating models were set up as indicated in figures 1 and described in [1]. Horizontal resolution was identical in all models (1/4) and 31 vertical degrees of freedom were allowed.

	GHER	LODYC CETIIS OPA	IMGA-CNR MOM	UA POM	UIB MOM
Grid	C	C	B	C	B
Advection	TVD	Centered in Time and space	Centered in time and space	Centered	Centered in time and space
Turbulence	k	k	constant vertical diffusion at 0.3 cm^2/s for tracers and 10 cm^2/s for momentum	k, l (Mellor-Yamada)	constant vertical diffusion at 1 cm^2/s for tracers and for momentum
Pressure treatment	free surface, mode splitting	rigid lid, streamfunction formulation	rigid lid, streamfunction formulation	free surface, mode splitting	rigid lid, streamfunction formulation
Horizontal diffusion	Laplacian in model coordinates 300 m^2/s for u 90 m^2/s for T,S	Bi-Laplacian in model coordinates [illegible]=8 10^{10} m^4/s for u [illegible]=8 10^{10} m^4/s for T,S	Bi-Laplacian in model coordinates [illegible]=5 10^{10} m^4/s for u [illegible]=2 10^{10} m^4/s for T,S	Smagorinsky formulation, with [illegible]=0.20	Laplacian in model coordinates 6000 m^2/s for u 100 m^2/s for T,S Now 400 m^2/s for u 400 m^2/s for T,S
Time stepping	One time step method: barotropic 60 s baroclinic 3600 s	baroclinic: 3600 s	Mixed centered finite difference and Euler: 1200 s	Leapfrog method: barotropic 40s baroclinic 4320s	Leapfrog method baroclinic 10000s

Figure 1 : Model specifications

Data preparation and modelling experiment setup

For the purpose of the perpetual year run, the ECMWF wind stress data were averaged to obtain monthly mean wind stress values, as explained in the first MEDMEX report [1]. The sea surface fields of temperature and salinity were taken from the MED4 data base described in [2] and found on the WWW http://modb.oce.ulg.ac.be/. Similarly, initial conditions and boundary conditions for the Atlantic box were taken from this data base. The whole modelling setup and data set is accessible through http://modb.oce.ulg.ac.be/MEDMEX

Model Results

Here we will only give a flavour of the results which were obtained during the intercomparison by showing circulation pattern and some globale analysis of drift trends. Results were obtained by simulating 15 years of the perpetual forcing. A first feature is that the horizontal variability is very different when comparing one model to the others: UIB and CETIIS show the lowest variability of the five models. IMGA and UA have high variability of which UA has a lower signal. This general trend is readily observed on most horizontal sections and can be attributed to the horizontal diffusion coefficients and numerical diffusion of the advection scheme. Generally all models reproduce the main large scale features of the surface circulation, with differences in local representations: For exemple:

• the UIB model produces no Alboran gyre, neither does the other MOM or POM, while CETIIS and GHER produce small Alboran gyres ;

• all models are showing an Algerian current detached to the north, but in the GHER model this feature is always very strong and a recirculation is seen at the African coast ;

• each model shows a westward flow in the Ligurian basin, with a northern current which is partly formed by the flow through the Corsican channel ;

• Gulf of Syrthe: All models produce an anticylone except UIB ;

• IMGA presents a big cyclone in the southern Ionian. CETIIS an UIB produce a weaker cyclone, whereas UA and GHER also show a cyclonic gyre but with some meanders and some additional small scale anticyclones. These smaller gyres are probably controlled by horizontal diffusion, since a run by IMGA with lower diffusion also produced these features, while a run of GHER with higher diffusion eliminated them.

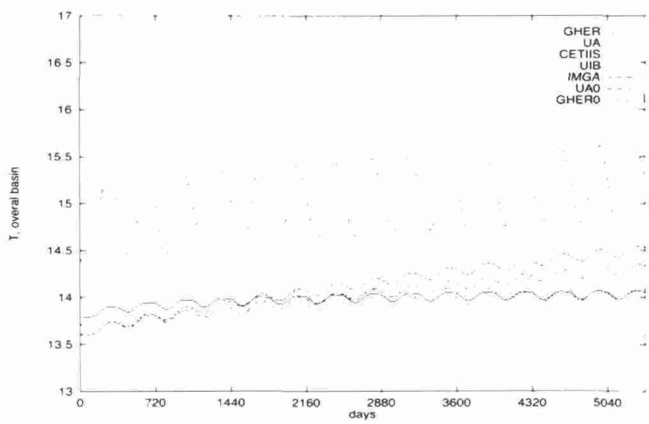

Figure 2: Average temperature

• the Southern Adriatic cyclonic circulation is present in all models.

• the Rhode gyre is present and bifurcation east and west of Cyprus is represented in all models.

• the Antalia anticyclone is represented by GHER and UA very well, in the other models only weakly.

Though the large scale circulation patterns and even some strait transports are similar, the hydrographic structure in the models showed some drift tendencies, due to the monthly averaged forcing, inadequate to form correct water masses. These drifts, though unphysical, can nevertheless be compared and we show as an exemple some volume transports, basin averaged temperatures and diagnosed air-sea interactions.

Conclusion after the first experiment

Forcing with monthly mean averages and a low relaxation is surely not appropriate to form correctly the water masses in the Gulf of Lions and the Levantine basin . This deficency of the modelling setup limits of course the physical realism of the simulation results, but at least the model drifts and beaviours are simular. To eliminate drifts, more complex air-sea interactions are needed and hopefully, the results obtained by using daily air-sea fluxes rather then monthly averaged wind-stress and relaxation fields will be available at the conference. At the time being, current conclusions can be summarised as follows:

• Models give similar response concerning Strait transports and their seasonal cycle, general heat budgets, salt budgets and drifts, overall circulation in surface and deep layers and spectra of the time evolution of diagnosed fluxes of salt and heat at the air-sea interface (due to the relaxation towards linearly time-interpolated SST and SSS data) ;

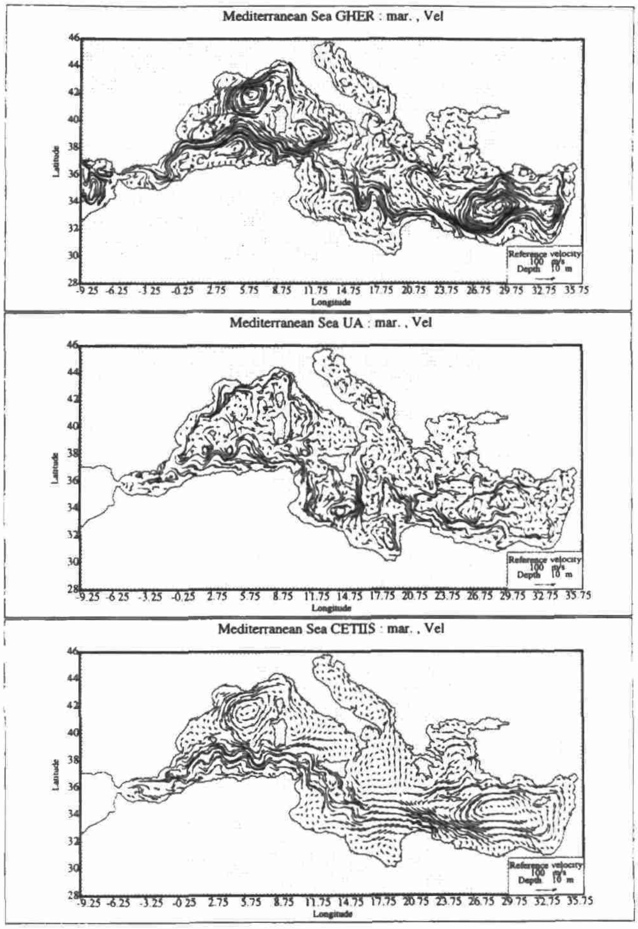

Figure 3: Velocity fields March Average

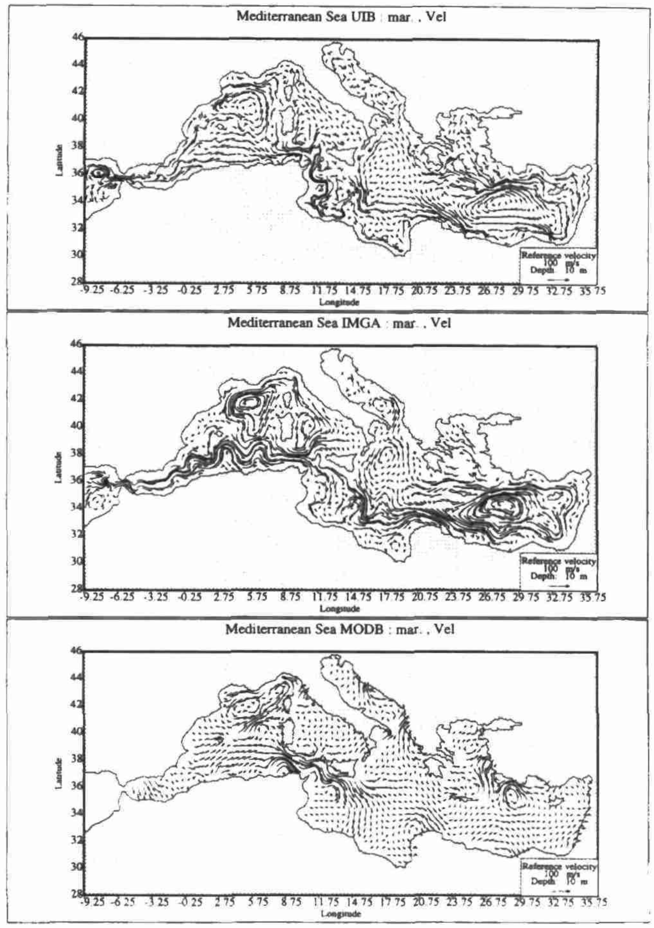

Figure 4: Velocity fields March Average (cont.)

• They differ in the representation of their hydrographic structures, different subbasin and small scale feature representation, high frequency signals in strait fluxes and specific sub-basin drifts ;

• Model behaviour depend on modellers skill as much as on models (model is here understood as the mathematical model and its computer implementations, without specified parameters) ;

• Though the oceanographic relevance of the experiment is not optimal (due to the forcing), at least the models exhibit a similar drift, and we know how to correct it ;

• Additional calibrations of models (strait adaptations, vertical diffusion and modified surface relaxation) could improve "realistic" behaviour, as shown by some additional simulations of some partners ;

• Most of the differences in the hydrographic structures can be explained by the different vertical diffusion parameterisation ;

• No model performs clearly better then the others, some give a better signal of the variability, some conserve deep water caracteristics better etc. and no real outlyers are visible, except a strong drift in UIB-MOM (and "noisy" UA) ;

• Though intercomparison is possible and very helpfull in calibrating and correcting, a real benchmarking and skill assessment was not possible, a classical drawback of most intercomparison projects, because quantification of comparison results is only possible on integral quantities, due to the lack of appropriate knowledge of adequate methodologies. For qualitative comparison and improving of models behaviour, vertical sections proved to be the most effective, in conjunction with the used of the MODB MED4 data base.

References

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[2] P. Brasseur, J.M. Brankart, R. Schoenauen, and J.-M. Beckers. Seasonal temperature and salinity fields in the Mediterranean Sea: Climatological analyses of an historical data set. *Deep Sea Research*, 43:159-192, 1996.