Model study of the palaeoceanography of the Miocene Mediterranean Sea and Paratethys; Preliminary results

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1. INTRODUCTION

Using the Mediterranean version of the Modular Ocean Model Array (MOMA: Web, 1996), the purpose of this pilot study is to construct an Early/Middle Miocene model setup that may serve as a starting point for subsequent work. This includes a Burdigalian (about 20 Ma) bathymetry and idealized (present-day) atmospheric forcing. The model will be used to investigate the effect of the basin geometry and, in particular, gateway geometry, on marine circulation.

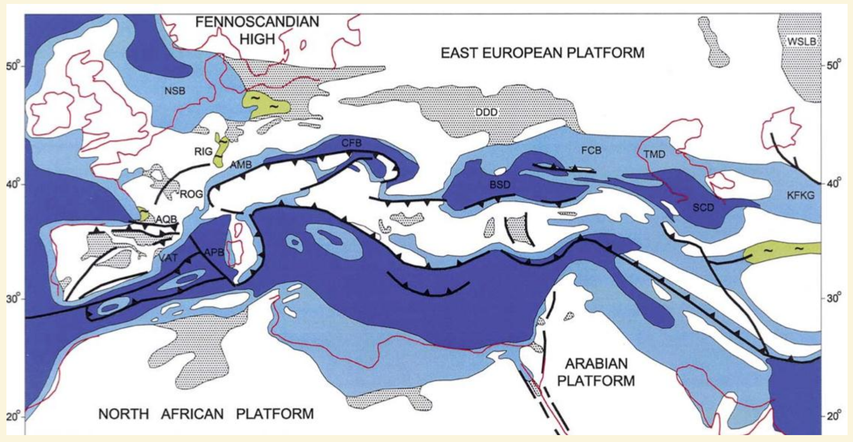
2. MODEL SETUP

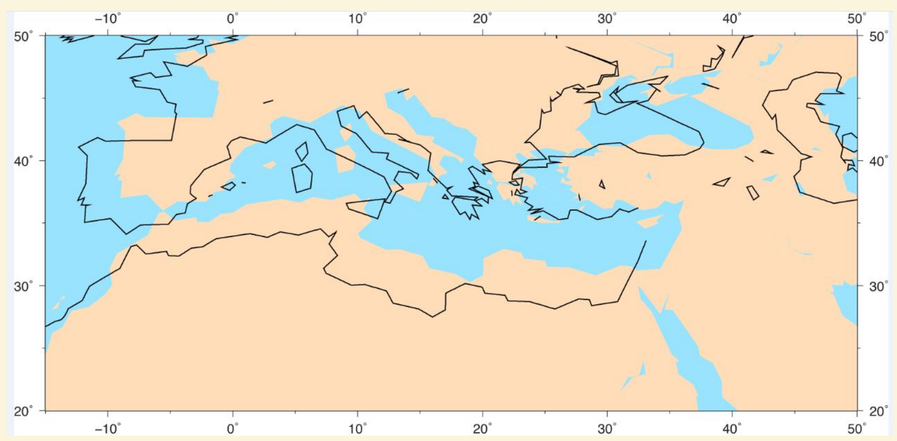
In order to be able to isolate the effect of basin shape, the present forcing was also applied to the Miocene situation. More specifically, the surface heat flux was accomplished by a two-hour relaxation of the sea surface temperature to a value that varies with latitude (based on present-day observed values; Micheels *et al*., 2006). Finally, the net evaporation was idealized to a constant and uniform value equal to 0.5 m/yr. The model resolution is 0.25 by 0.25 and includes 19 vertical levels.

At the westernmost region of the models, an "Atlantic box" was implemented. This represents the Atlantic inflow into the Mediterranean basin by means of the restoration of the salinity and temperature fields to prescribed values. In a next step, a similar box will be introduced to simulate the Indian Ocean.

3. BURDIGALIAN SETTINGS

Combining the Burdigalian palaeogeographic map from the Peri-Tethys Atlas with the absolute position of the main units reconstructed on the basis of a recent compilation of rotation poles (Müller *et al.,* 2008), the two-levels palaeobathymetry shown below was built. In this case, the shallow and deep levels were set to 200 and 3000 meters depth.





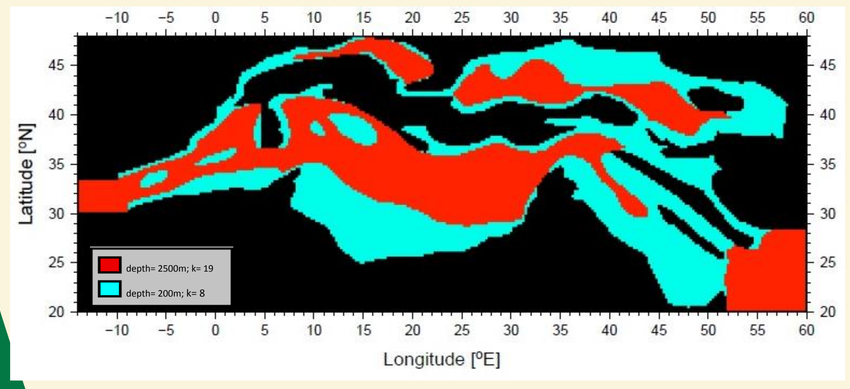


Fig. 1. a) Top: modified Burdigalian palaeogeographic map (Peri-Tethys Atlas).
b) Center: reconstructed absolute position of the coasts of Africa and Europe at 20Ma (black lines) relative to present.
c) Bottom: Miocene two-levels bathymetry.

To prevent instabilities of the model due to the strong gradients in depth in the two-levels Miocene bathymetry, the introduction of a continental slope similar to that in the present-day Calabrian region (Tessarolo *et al.,* 2008) was found to be required Fig.2) .

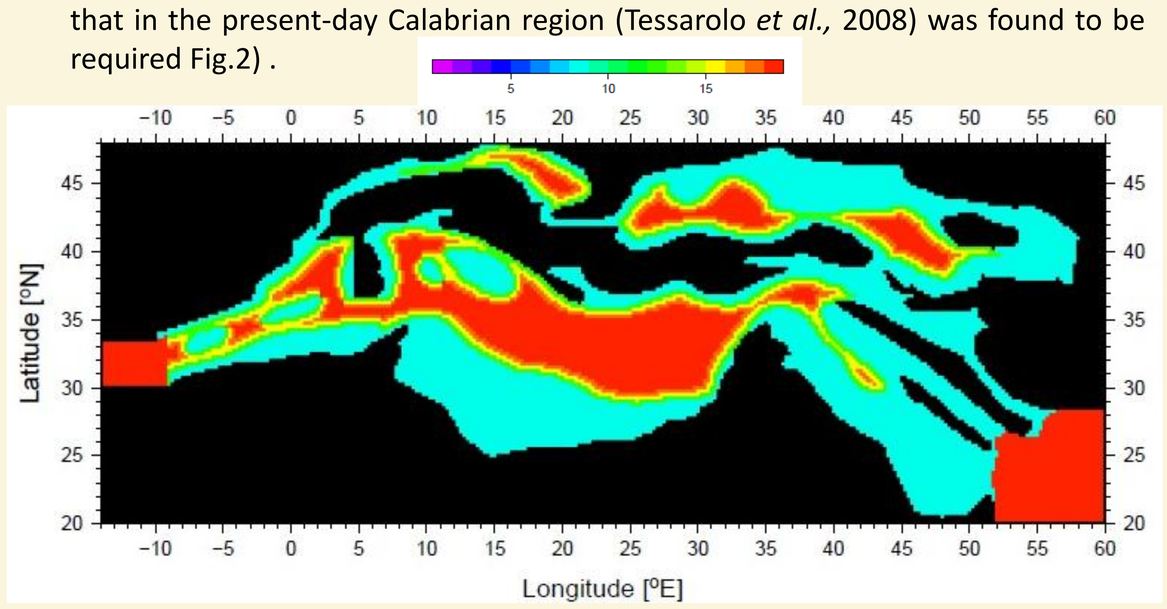


Fig.2. Burdigalian smooth bathymetry.

4. PRESENT-DAY SETTINGS

To be able to assess the role of the uncertainties inherent to the Miocene bathymetry, it was decided to simplify the present-day bathymetry into two vertical levels also. The results thus obtained can be compared to those found with a realistic present-day bathymetry and observations.

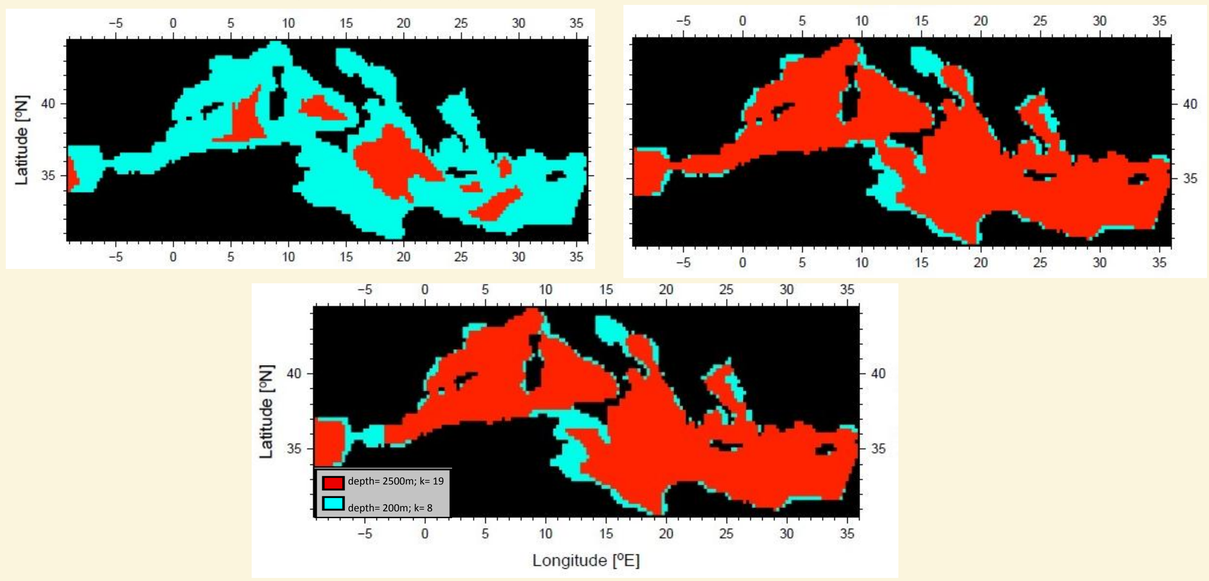


Fig.3. Present-day simplified two-levels bathymetries.

Fig.4. shows the zonal overturning streamfunction for the realistic and simplified (deep shelves and shallow straits) Mediterranean basins. It can be appreciated that they reproduce a similar circulation pattern, but cells tend to extend deeper in the simplified case.

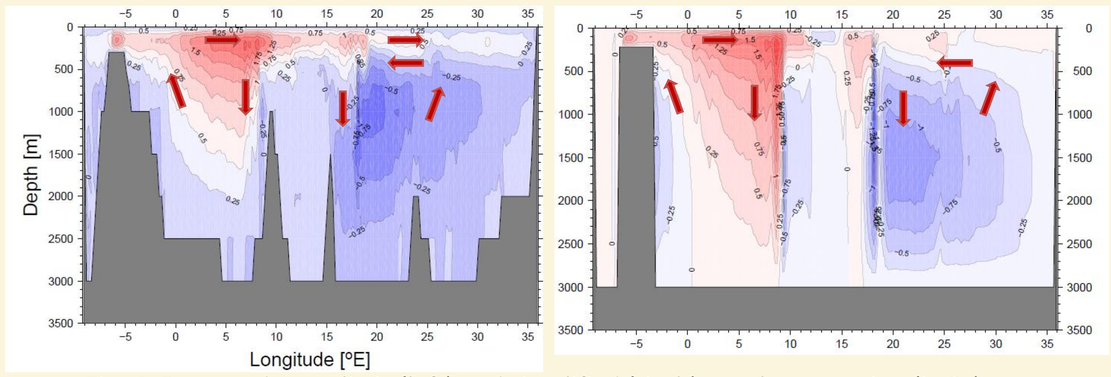


Fig. 4. Present-day realistic (left) and simplified (rigth) zonal overturning (in Sv).

5. OUTLOOK

- The analysis of the present-day bathymetry provides insight of uncertainties in the Miocene bathymetry.
- On-going work focuses on the improvement of the Miocene setup. Particularly, the next step will be to introduce a representation of the Indian Ocean.
- The main objective of this project to assess the response of the Mediterranean circulation to depth and with of the Tethys Seaway.

6. ACKNOWLEDGEMENTS

A. de la Vara acknowledges financial support from NWO. Computational resources were provided by ISES.

Meulenkam & Sissingh, Palaeo-3, 196, 209-228, 2003; Micheels *et al.,* Palaeo-3, 238, 399–423, 2006 ; Müller *et al*., G-cubed, 9 (4), 2008; Tessarolo *et al*., Chemistry and Ecology, 24 (S1) , 225-242, 2008; Webb, Compu.Gesoci., 22, 569-578, 1996.