

Interactive comment on “A Study of the hydrographic conditions in the Adriatic Sea from numerical modelling and direct observations (2000–2008)” by P. Oddo and A. Guarnieri

Anonymous Referee #1

Received and published: 17 May 2011

General comments

This paper presents an important aspect of the oceanography of the Adriatic Sea. The relevant scientific questions addressed are within the scope of OS. The title clearly reflects the contents of the paper.

The model set up is appropriate with suitable horizontal resolution.

Nevertheless, in the text there are some vague conclusions, which are not supported by convenient analysis, or figures, they are not based on valid assumptions and they

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are not clearly outlined. In some cases the results are not sufficient to support the interpretations and conclusions and some statements regarding data shown in figures are not obvious and concise for the reader.

Common terminology is not followed. For example the term “event” is not always preceded by the same characterization (it is either cooling/warming event, or seasonally defined (e.g. summer2003), or yearly defined (2001 event) or just referred to as event).

General statements about the model performance without proper validation of the model with the observations should be avoided.

In some cases it is not clear if the authors discuss model results or observational data.

The conclusions paragraph is too long, with too many details on results already discussed inside the manuscript.

Specific comments

Abstract A summary of the model deficiencies should be included. 1. Introduction In the introduction, there is no reference on the evaporation and precipitation rates of the basin, the Otranto Strait regime, the definition of MLIW, although all these parameters and features are thoroughly examined in the paragraph where the model results are discussed. 2. Model description 3. Data and methods → It would be more convenient to use this name instead of results and discussion for the first 30 lines of section 3. 4. Results and discussion 4.1 Heat and water fluxes It would be helpful to estimate the mean annual heat budget at least for the Adriatic basin and include it in figure 2. Explain what kind of time series are presented in figure 2 : monthly means? p.574, lines 16-17 : “The autumn and winter cooling exhibits a strong inter-annually variability mainly due to the latent heat flux component of the surface heat balance” This conclusion is not supported by a figure. At least you should mention that, if a figure of the heat budget components is not possible to be introduced. p.574, lines 17-22 : “Thus.....heat fluxes”. This conclusion is somewhat arbitrary and definitely not clearly

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stated and not supported by the analysis of the results. Moreover what is written about summer 2003, is not obvious in figure 2. At least you could refer to the actual value of the “significant larger than climatology” summer heat flux of the year 2003. p.574, lines 23-26 : “The mean annual heat budget ..basin” Are you referring to the surface heat budget ? If yes again the conclusion about the overall heat budget of the basin is arbitrary, vague and it is not supported by any analysis of the model results. p.575, line 14-15 : How do you define seasons of the year? Autumn → November ,December??? Please clarify p.575,lines 27-28 and p.576 line 1: “With the sole. . .heat losses” This is a very confusing sentence. Are you referring to the annual heat flux at the strait?? Are you referring to all the year or only to winters? Are you referring to the all the years 2000-2008? For example 2007 net heat flux in Otranto strait seems to be negative. p.575, line 5: “large heat anomalies , not as large as in other periods” ???? → how large, which are the other periods→ please be accurate and concise p.575,lines 5-6: “the extended length of this episode has largely affected the thermohaline characteristics of the basin” How? From page 575 line 14 to page 576 line 17, this part of heat and water fluxes paragraph is very confusing! I think it should be rewritten using a common structure. For example, describe the major cool or warm events first during autumn - winters and then during summers, and in a separate paragraph the advective heat flux in the Otranto strait. Do not go back and forth from cooling seasons to warming seasons. Keep the same methodology for all the sections p.576, line 23-24 : “ Starting . . . seasons” It is not clear if you refer to the evaporation rate or the heat flux. Moreover your statement is not accurate. From the figure 4 it seems that during autumn-winter 2006-2007 the evaporation rate anomaly is negative. p.577, line 1-5: Please use references to support your statements Figure 5 : Please clarify that this diagram is derived using model results.

4.2 Temperature and salinity characteristics p.578 line 14-16: “However ..a longer period” How do you justify this statement? p.580, line 29 “2007 event”→ define the event, define the season, use a common way to describe the “events” in this and previous paragraph. p.581,lines 11-12: The difference between . . .mixing” if you refer to the

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model results, please write it. p.581,lines 3-8: “ The successive . . .2004” How do you know/justify that statement? What are the “normal values”? p.583, line 17: “This missing . . . mixing” or it could happen the opposite! This is not a justification, but a possibility about the positive model bias. p.583, line 25-26: “However. . .simulations” This is not true, observations of the years 2002 and 2003 have very different values from those the model results as you mention later in the text. Please avoid such general statements. p.584, line 9-11: “Thus . . . following years” This is not a valid assumption and it can not be an accepted validation for the model. p. 584, line 12-13: The increase. . . August 2006 cruise” You have only 5 points in 9 years to compare with the model results, out of which at least 3 (2002,2003, Jan 2006 1st) have very different value, so you can not argue that the sole exception is 2006. 4.3 Dense waters The calculated formation/dissipation rate on a daily basis is very interesting and gives important information. But how do the authors use this indicator and how do they estimate the formation rate of dense waters from this indicator? They only mention and compare with other calculations the “seasonal” formation rate which is not shown.

You mention the term “ formation velocity”. What does it mean? Do you refer to the duration of the process? Mantziafou and Lascaratos 2008 has shown that the amplitude of the interannual variability of the deep water formation in the Adriatic basin is not proportional to the mean winter buoyancy loss but it is highly dependent on the high frequency variability of the atmospheric forcing over the area under convection. Also Mertens and Schott (1998) have shown for the DWF processes in the Northwestern Mediterranean, that the longer the time period over which the buoyancy loss is distributed, namely when the buoyancy loss events are not frequent, the more important is the effect of lateral buoyancy fluxes. These fluxes disturb the local balance by bringing more stratified water at the surface and thus preventing convection, or reducing the rate of the mixed-layer-depth development. You can use such information to justify why “the formation velocity” and the relative DW volume formed is different from year to year.

Mertens, C., Schott, F., 1998. Interannual variability of deep convection in the north-western Mediterranean. *Journal of Physical Oceanography*, 28, 1410–1424

p. 587 line 14 : “ and consequently ... values” The way it is written it gives the impression that the increasing salinity , increases the temperature. Please rephrase.

p.588, line 18 : You can refer to Mantziafou and Lascaratos 2004 who have shown the existence of “memory” in the Adriatic basin and have concluded that the DWF rates in the basin depend not only on the heat forcing of the present year but on the time history of the heat forcing as well.

The paper of “ Manca B.B., Civitarese G., Klein B., and Ribera d’Alcalà M. (2004), Dense water formation in the Southern Adriatic Sea Associated with variations of the thermohaline circulation in the Ionian Sea during 2001-2002, *Rapp. Comm. int. Mer Médit.*, 37, 122.) could be included in the references. The authors could possibly find important information on deep water formation process in Adriatic basin for 2001-2002 to refer to.

Climatologically, dense water locally formed in Southern Adriatic has σ_θ lower than 29.2 That is another reason for the low formation rates calculated in most of the years of investigated period, which I think it should be mentioned. Details on DW formation in 2006-2008 should be transferred from the last section (summary and conclusions) here.

5. Summary and conclusions This section should be shortened and rewritten. There is no need for so many details already mentioned in other sections of the manuscript. Write only substantial conclusions. The deficiency of the simulation of MLIW intrusion is not mentioned.

Technical corrections 1. In my view, it would be more convenient to use the following paragraph structure 1.Introduction 2. Model Description 3. Data and methods (instead of results and discussion) 4. Results and discussion 4.1 Heat and water fluxes 4.2

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Temperature and salinity characteristics 4.3 Dense water mass formation 5. Summary and conclusions

2.In all figures with time series write what kind of time series you present?. Mean monthly values? Mean daily? 3. Use present and not past tense 4.When you refer to data, it would be helpful to mention the color used for each cruise in a parenthesis so as to help the reader. 5.Use values instead of adjectives like : significant larger than , ...to describe the magnitude of a flux, parameter etc. 6. In Figure 1 a) in T-S diagrams use colors for different cruises data as in the Adriatic map b) Is the model grid rectangular? Use a similar to fig2. From Oddo et al. 2005 figure to show the two different grids 7. Please refer to the color of the CTD data cruise everytime (e.g. August 2006 (cyan)). It would be very helpful to the reader. Typing errors Abstract: investigated period or period under investigation. Introduction : Page 567 line 5 : The river runoff → start a new paragraph page 570 line 18 → this is later Model description: page 573 line 2 : a horizontally averaged density is subtracted before computing the baroclinic integrals. Heat and water fluxes : page 575, line 5 : who instead of which Page 576, line 20 : evaporation rate Page 577, line 13: MLIW is absent Temperature and salinity characteristics Page 578, line 14: almost 3 instead of 2/3 Page 578, line 15: short intervals of strong Page 581, line 27: it is interesting to note that this anomalous.. Page 582, line 21: excessive vertical mixing

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