

Interactive comment on “Factors controlling pCO₂ variability in the eastern Gulf of Cádiz (SW Iberian Península)” by Dolores Jiménez-López et al.

Anonymous Referee #3

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The authors investigate factors controlling pCO₂ variations in the Gulf of Cadiz. They use high quality data from 8 cruises incorporating underway data of pCO₂, SSS, SST, and wind speed as well as discrete data for pH, AOU, and nutrients taken along three repeat transects during the cruises. They present spatiotemporal distributions of the underway data, the cruise averages of the discrete data, and the seasonal changes of the computed air-sea CO₂ flux. The authors then discuss the factors influencing the pCO₂ variability. Specifically, they quantify thermal/non-thermal controls of pCO₂. They conclude that temperature and biological activity are the two principal factors that explain the temporal variability of pCO₂. They also point out that continental inputs and mixing with water originating from warm ocean currents influence the spatial variability of pCO₂.

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The work is OK structured, includes original research based on high quality data, and suits for publication in this journal. However, there are several things that need improvements and/or clarification and I recommend major revision.

General comments: 1- The main subject of the study is the controls of pCO₂ variations. The authors correctly write “In addition to influence of temperature, the spatiotemporal distribution of pCO₂ in surface seawater is affected by the biological utilization of CO₂, the vertical and lateral transport, the sea-air exchange of CO₂ and terrestrial inputs.” However, they do not quantify the relative importance of these controls in their data although there are published methods for such quantification (e.g. Olsen et al 2008). Specifically, the importance of fresh water input and air-sea exchange need to be quantified. This should be feasible since they have seasonal data of two parameters of the CO₂-system in addition to SST, SSS, and nutrients. 2- The readability of the manuscript need to be improved. For instance, the study area is quite small, but quite complicated in terms of processes and interactions. Hence, there are a lot of names used in the manuscript (e.g. Gulf of Cadiz Current; AZORES Current; Guadalquivir River; Bay of Cádiz; Cape San Vicente), but locations of these are not shown anywhere in the manuscript. Including these names in the maps/figures would enhance the readability of the manuscript. It is also my opinion that it would be much easier to read the paper if the authors present results in seasonal maps (they do that for CO₂ flux in Fig. 10) and then discuss the controls of pCO₂ changes between seasons and places.

Specific comments: Line 19, “On the other side” do you mean “on the other hand?” Line 48, after “all other organisms” please add “which increases the concentration of inorganic carbon” Line 50 “generate uncertainty” please replace with “is not clearly defined” Lines 62-65 I do not understand the sentences between “Finally, the inner..” and “. . .towards offshore (Walsh 1991).” Line 193, “T values were significantly different among all cruises (p < 0.05)” why is this important result to mention? Line 96-97 “Spatially T tended to increase from coastal to offshore areas” during all seasons? or

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during winter? Lines 211 – 215. I do not understand. Do you mean that both underway and discrete data are shown in Fig 2B? if so please clarify this in the caption and explain more about the reasons for differences between different data. Line 238 “TF presented the highest mean concentration for the whole study ($0.77 \pm 0.76 \mu\text{mol L}^{-1}$).” I notice that given the mean PO₄ of 0.28 this mean NO₃ is much less than what is expected from Redfield, is this typical for the area? Lines 283 – 291, please state the uncertainty of the implied pCO₂ growth. Please elaborate why you believe the excess pCO₂ growth (over the atmospheric growth) is caused by continental input. Lines 300 – 3005, can the reason for difference pCO₂ over different depth ranges be due to different TA/DIC ratios in the FW influenced areas and those offshore? Line 321, in which form is the CO₂ input? Lines 333 - 334, How pCO₂ increase can be computed from only F? or do you make more assumptions? Lines 335 – 342, you mention that upwelling systems can be influencing the distribution of pCO₂ in the Gulf of Cadiz. BUT do you have any evidence for such influence in your data? If not why do you mention it here?

Figures: Figure 1: show important currents and places mentioned in the text. Figures 2, 3, 5, 6, and 7. Clarify in the caption whether both underway and discrete data are used.

Reference: Olsen, A. et al. (2008), Sea-surface CO₂ fugacity in the subpolar North Atlantic, *Biogeosciences*, 5, 535-547, doi:10.5194/bg-5-535-2008.

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