Dear Editor,

we are very satisfied of the positive comments given by the two reviewers. Indeed, we would like to make a few changes to the manuscripts in order to incorporate the last minor suggestions of reviewer#2 as detailed in the following table.

Many thanks
Gianpiero and coauthors

REVIEWER #2 SUGGESTIONs	AUTHOR’s RESPONSES
accepted subject to minor revisions The authors have responded thoroughly and comprehensive to the comments by the reviewers. I do however have two comments; the first is more technical and should be easy to correct, the second one might need a little more work.	Thanks for the positive comments
Table 3 gives the regression coefficients for the TA/sal relation for the whole Med as annual average and for each season. However Figure 4 shows clearly that the S/TA relation is very different for different sub basins. This is fine, but I find it difficult to decipher which of the relations in Figure 4 is for which area. Please either make a not in the plot, or add to table 3 (preferred). Maybe I misunderstand the table, and the regression is made without the Aegean and Adriatic data, which are both very different. Either way, more explanations to the table/figure are required.	Thanks for the suggestion. The Figure 4 has been redrawn; equations have been inserted in colored boxes. The color of boxes is the same of that one of the corresponding regression line. This should enhance the readability of the figure. Further, the caption has been modified in order to give more explanations about the data used for each regression. New figure and caption are reported below.
Section 3.4: This section is new although this was discussed also in the original submission. Also figures 7 and 8 are new. I do have problems with the conclusions in section 3.4	We acknowledge that calcifiers might play an important role in alkalinity dynamics. However, quantitative information about their real impact is poorly available for the Mediterranean Sea.

regarding the biological effects on the variability of alkalinity (I should have noticed this in the first submission, but was alerted by the new figures, I guess). In the Mediterranean surface layer (i.e. the mixed layer) there is almost no nutrients present, so that rapid biological uptake of nutrients (i.e. of almost nothing) cannot really affect the alkalinity so much. This part of the results looks strange to me. Even more so since it is known that the Mediterranean Sea has a dominance of calcifiers, such as coccolitophores (e.g. Oviedo et al., 2015). Formation of calcite/aragonite shells would tend to reduce alkalinity of seawater, and when/if these shells sink out of the surface layer represent a sink of alkalinity. Is this considered in the model? Rereading section 2.1. makes we wonder if calcium carbonate formation by phytoplankton is considered. Please confirm what is done. I would expect (from an educated guess) that the alkalinity flux due to calcium carbonate formation would vastly exceed that of inorganic nutrient utilization in the surface, but I might be wrong. I would like to see some discussion/explanation on this. Sorry that I did not notice first time around.	Although some studies about abundances of calcifiers in the whole Mediterranean basin are now becoming available (as in Oviedo et al., 2015, but also Siokou-Frangou et al 2010), many required information are lacking in order to include a calcifying phytoplankton functional type and a parameterization of CaCO3 cycle in biogeochemical models of the Mediterranean Sea. Very little is known about the biomass of the calcifiers (to be used for initial conditions and boundaries), their dynamics (to be used for setting their rate of calcification and their contribution to the total primary production), and their functional responses (parameterization forms and parameter values of equations) to the specific environmental forcing in the Mediterranean Sea. Further, a specific parameterization of the rate of dissolution of calcium carbonate during sinking should be required for the Mediterranean Sea. Nevertheless, using available information, we have computed an off-line and rough estimate of the potential impact of the processes of precipitation/dissolution of CaCO3 to the rate of change of alkalinity (i.e. Fig. 7 of our manuscript). Using the following information: 1) the vertical profile of primary production of our model run (see details in Lazzari et al., 2012), 2) the ratio of the inorganic carbon fixation for calcification to the total carbon fixation (calcification + photosynthesis) equals to 5% (which is a mean value respect to those reported in global studies and models: Poulton et al., 2007; Jim et al., 2006; Moore et al.,

2004; Greeg and Casey, 2007);

3) the conversion factor of 2 (each mole CaCO3 precipitated equals to – moles of alkalinity, and the opposite for the dissolution of CaCO3 (WolfGladrow et al., 2007)
4) the estimate that 80% of CaCO3 is dissolved within the first 700 m of the water column (which is a rough estimate considering Jansen et al., 2007; Stavrakakis et al., 2013);

we estimated that the rate of change of alkalinity for biological processes would have an extra term of up to -0.008 mmol ALK m-3 d-1 for the first 200m of the water column and an extra term of about +0.004 mmolALK m-3 d-1 for the layer 200-700m

Therefore, given the facts that most of the reported information and estimates are given for other sites than the Mediterranean Sea, the level of speculation is high, we prefer to not explicitly include this process in our model and results at this stage, since a model of calcifiers in the Mediterranean sea would deserve a specific study. Indeed, to acknowledge the importance of this aspect we have added the following sentence in the discussion part of the section 3.4:

> "Precipitation and dissolution of calcium carbonate should also be considered in the alkalinity biological equation. However, this process is poorly quantified for the Mediterranean Sea (only sparse measures of calcifiers abundances are available Siokou-Frangou et al 2010; Oviedo et al., 2015) so it was not possible to include it in the model. Nevertheless, an estimate derived by combining information from global studies and models (Poulton et al., 2007; Gregg and Casey, 2007; Jansen et al., 2002), data on sedimentation (Stavrakakis et al., 2013) and our results would indicate extra terms of the alkalinity budget up to -0.007 mmol m^{-3} d^{-1} in the upper part of the water column and up to about +0.004 mmol m^{-3} d^{-1} for the intermediate layer."

The appropriate references have been added to the reference list.

Reference used in this answer:

Gregg, W. W., & Casey, N. W. (2007). Modeling coccolithophores in the global oceans. *Deep Sea Research Part II: Topical Studies in Oceanography*, *54*(5), 447-477.

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Jin, X., Gruber, N., Dunne, J. P., Sarmiento, J. L., & Armstrong, R. A. (2006). Diagnosing the contribution of phytoplankton functional groups to the production and export of particulate organic carbon, CaCO3, and opal from global nutrient and alkalinity distributions. *Global Biogeochemical Cycles*, *20*(2).

Lazzari, P., Solidoro, C., Ibello, V., Salon, S., Teruzzi, A., Béranger, K., Colella, S., and Crise, A.: Seasonal and inter-annual variability of plankton chlorophyll and primary production in the Mediterranean Sea: a modelling approach, Biogeosciences, 9, 217–233, doi:10.5194/bg-9- 217-2012, 2012.

Moore, J.K., S.C. Doney, and K. Lindsay, 2004. Upper ocean dynamics and iron cycling in a global three-dimensional model. Global Biogeochemical Cycles 18: doi:1020/2004GB002220.

Oviedo, A., Ziveri, P., Álvarez, M., and Tanhua, T.: Is coccolithophore distribution in the Mediterranean Sea related to seawater carbonate chemistry?, Ocean Sci., 11, 13-32, 10.5194/os-11-13-2015, 2015.

Poulton, A. J., Adey, T. R., Balch, W. M., & Holligan, P. M. (2007). Relating coccolithophore calcification rates to phytoplankton community dynamics: regional differences and implications for carbon export. *Deep Sea Research Part II: Topical Studies in Oceanography*, *54*(5), 538-557.

Siokou-Frangou, Ioanna, Urania Christaki, M. G. Mazzocchi, Marina Montresor, M. Ribera d'Alcalá, Dolors Vaqué, and A. Zingone. "Plankton in the open Mediterranean Sea: a review." Biogeosciences 7, no. 5 (2010): 1543-1586.

Stavrakakis, S., Gogou, A., Krasakopoulou, E., Karageorgis, A. P., Kontoyiannis, H., Rousakis, G., ... & Lykousis, V. (2013). Downward fluxes of sinking particulate matter in the deep Ionian Sea (NESTOR site), eastern Mediterranean: seasonal and interannual variability. *Biogeosciences*, *10*(11), 7235-7254.

Wolf-Gladrow, D. A., Zeebe, R. E., Klaas, C., Körtzinger, A., and Dickson, A. G.: Total alkalinity: the explicit conservative expression and its application to biogeochemical processes, Mar. Chem., 106, 287–300, 2007

New Figure 4 and caption:

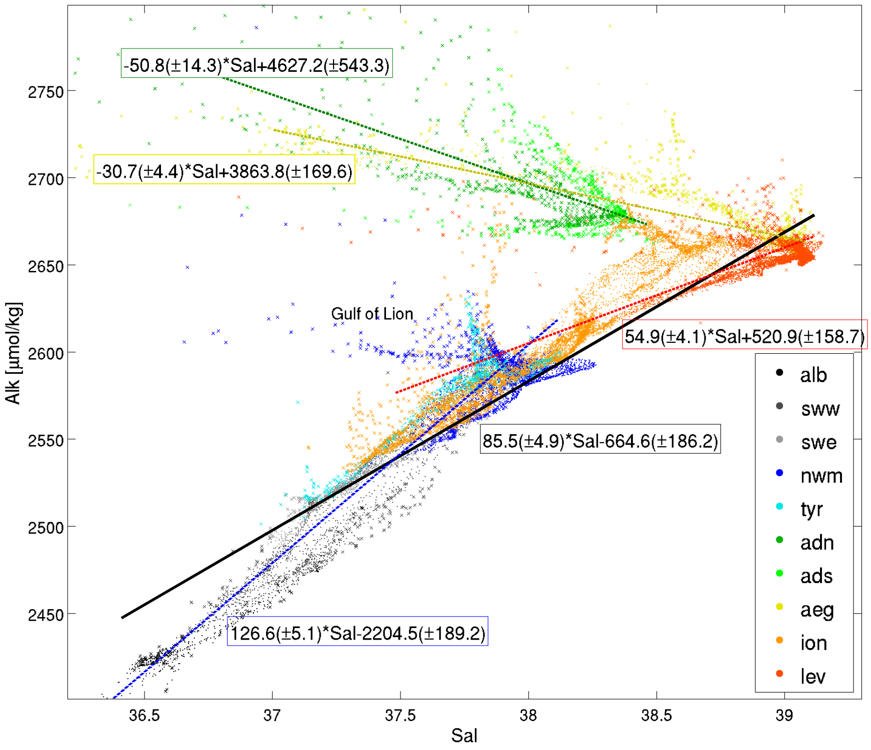

Figure 4. Regressions between salinity and alkalinity at the surface. Colored points belong to the different sub-basins of Fig. 1. Regression for the whole Mediterranean Sea is shown as a black solid line, and the equation is reported in the black box (95 % confidence intervals of the coefficients are in brackets; $p < 0.001$; R2 = 0.91; RMSD = 18.8). The regression uses data from the alb, sww, swe, tyr, ion, lev sub-basins with depths greater than 200 m. Sub-basin regressions are computed for the Adriatic sea (green box and line; data from adn and ads; R2 = 0.45, RMSD = 32.0), the Aegean Sea (yellow box and line, data from aeg; R2 = 0.77, RMSD = 9.3), the western Mediterranean Sea (blue box and line; data from alb, sww, swe, tyr with depths greater than 200 m; R2 = 0.95, RMSD = 11.6) and the eastern Mediterranean Sea (red box and line; data from ion and lev with depths greater than 200 m; R2 = 0.74, RMSD = 13.8).