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Interactive comment on "Surface transport of DOC acts as a trophic link among Mediterranean sub-basins" *by* Chiara Santinelli et al.

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The authors use data from a 6-station hydrographic section off the SW coast of Italy in the Tyrrhenian Sea to state that surface advection of Atlantic sourced water plays a crucial role in shaping DOC distribution in the Sea. This makes sense, of course, and is pretty obvious.

Even if we agree with the referee that it is quite obvious that dissolved organic carbon (DOC) is transported, as many other tracers, by water, we believe that: (1) the importance of this process is overlooked in the literature and in the models, which generally focus on local primary production and (2) compared to internal production, the relative weight of external DOC input is noteworthy and needs to be correctly quantified, es-

pecially because it certainly occurs at larger scale in the open ocean (see below). It is well known that lateral advection affects the spatial distribution of dissolved substances in the ocean; however, very few works have been devoted to study and quantify this process for DOC which, in oligotrophic environments, account for the largest fraction of utilizable reduced carbon (e.g., Santana-Falcón et al., 2016; Wu et al., 2015; Hansell et al. 1997). Our study addresses this process for the first time in the Mediterranean Sea and shows that horizontal transport of DOC into the Tyrrhenian Sea is of the same order of magnitude, or even larger, than the in-situ DOC production. The small size of the Mediterranean Sea allows for short transfer times which, in turn, favors the preservation of the DOC stock produced elsewhere. However, this transfer may be important also in other regions of the oceans. In this scenario surface advection may set up, via horizontal transfer, a sort of compensation among regions with different trophic regimes, smoothing trophic gradients. We believe that understanding these transport processes is a crucial and preliminary step to understand and quantify all the other processes (biological, chemical, geological) that influence DOC distribution on a variety of timescales.

What I would find more interesting, if the authors agree, is the following set of processes: 1. DOC-enriched Atlantic Water is transported into the Tyrrhenian Sea where, in the net, it continues to escape remineralization while in the surface layer (as evidenced by the absence of change in concentrations or stock during summer).

We suspect that DOC remineralization is reduced in summer, as also proposed by Santinelli et al., (PiO, 119, 68-77, 2013), but, as we clarify in the text: "Even if DOC concentration does not change, DOC turnover can occur either by (1) advected DOC is consumed and replaced by DOC released within the basin or coming from external sources or (2) removal of DOC released within the basin or coming from external sources and aging of the advected DOC."

2. It is then mineralized in support of upper mesopelagic microbes once winter overturn occurs. In this model, the DOM supporting the mesopelagic microbes is imported from

outside the Tyrrhenian Sea, a story that is a bit more novel and defensible than the one presented in the paper. This story remains consistent with the Conclusions of the manuscript.

We thank the referee for this suggestion. The DOC redistributed by mixing in the fall-winter period feeds the mesopelagic microbes and we find an interesting hypothesis that the mesopelagic communities can use the DOC coming from outside the Tyrrhenian Sea instead of the surface communities. In addition, fall-winter is the time when the Tyrrhenian circulation 're-opens' thus restoring a significant exchange with the Ligurian sea; a fraction of the surface DOC can therefore be exported northward contributing to the large amount of DOC exported to depth by deep convection, feeding the deep water microbes in the Western Mediterranean Sea (see Santinelli et al., 2010; Christensen, J. P.et al. GBCycles, 3(4), 315-335, 1989). On the other hand we do not agree with the fact the showing that the DOC supporting the mesopelagic microbes is imported from outside the Tyrrhenian Sea, would be a story a bit more novel and defensible that the fact that advection represents an important and overlooked source of DOC to the Tyrrhenian Sea and that it can fuel the microbial loop in the surface layer. We can rework the discussion including this hypothesis.

Mechanism 1 for explaining the distribution of DOC concentrations: The authors write that "the anticyclone may determine dynamical regions where DOC can accumulate" But DOC doesn't "accumulate" by physical means, except for modest concentration by evaporation. Instead, DOC "accumulates" by biological processes. So I agree that the circulation will dictate where the DOC is present (in terms of elevated concentrations), but I do not understand how fluid trajectory controls "accumulation". The authors similarly wrote that "DOC is a passive tracer on the temporal scale of months; as such, its concentration can be strongly affected by the geometry of the advecting velocity field." This does not seem correct to me; the geometry will control distributions (which we see via concentrations), but it will not control (through alteration) concentration directly. The authors then direct the reader to Fig 5, where we see that the higher concen-

trations of DOC during August are at the ends of the section, where the authors see strong negative values of lambda. They say "strongly negative values of lambda {are} where the areal concentration can increase". Again, I do not see where stretching or broadening the trajectories of the surface flow (as lambda indexes) will actually change concentrations of DOC. Narrowing the flow of a specific water will reduce the spatial extent of the associated DOC (just as a river's spatial extent varies between broad and narrow sections along its path), but I do not see it changing concentrations in that flow. Perhaps I do not adequately understand the writing in this section. If so, the authors need to improve the clarity.

The referee is absolutely right for what concerns the DOC concentration in each small water parcel. By local accumulation here we refer to the concentration of DOC, over a spatial scale encompassing the velocity field at meso/large-scale. On such scales, DOC, considered as a passive tracer, can be redistributed depending on the geometry of the advecting velocity field, and can thus locally increase in a specific area, even if the water concentration does not increase. The problem of quantifying local changes of passive tracer concentration in a stationary or weakly changing flow is a classical problem of geophysical fluid dynamics, which has been revisited in Haller-Iacono (2003), where new quantitative measures of these effects (e.g., the "lambda parameter") have been introduced. In other words, we states that the DOC spatial maxima observed do not result only by local production but by the geometry of the flow. We will better clarify this concept in the revised version.

Mechanism 1 for shaping the horizontal distribution of DOC is explained in a long paragraph, but Mechanism 2 is not further addressed at all.

We explained mechanism 1 more in depth since it is more difficult to be understood and introduces a new idea. We think that Mechanism 2 is pretty easy to understand and without further data it cannot be tested.

As for Section 3.5 "DOC annual cycle" 5/30: "DOC likely due to biological production

resulting from the phytoplankton blooms in the Algerian Basin." There isn't really a way to know if the DOC was produced there, or somewhere further up stream, such as in the North Atlantic itself. The authors should tell us if the DOC entering the Med Sea from the Atlantic is lower/higher/equal that present in AW present in the TYR; if higher, then a source in the Med Sea is required.

DOC concentration in the AW close to the Gibraltar Strait is highly variable, but lower than in the Tyrrhenian Sea: 60 $\pm$ 4 μM in April 1998 (Dafner et al., 2001), 51-54 μM in September 1999 (Santinelli et al., 2013), and 50-60 μM in May/June 2007. So yes, DOC in the AW core is lower when it enters the Med Sea than in the Tyr Sea, suggesting that it is enriched in DOC during its route. We can add this information in the revised manuscript.

Specific Comments Page/Line 1/7: "flux. . .into the basin." It looks like the flux of DOM is out of the Algerian Basin and into the Tyrrhenian Sea, not into the basin (unless basin refers to TYR).

Yes, the basin refers to the TYS (this is the acronym we have used for the Tyrrhenian Sea), we will clarify.

1/18: I suspect that Copin-Montegut and Avril 1993 would like to be recognized for their work in the Med as well.

We will add the reference

3/15: what makes the cyclonic winds in the TYS "global"? I suggest deleting the word.

We have used the word "global" to indicate that the large-scale wind stress is cyclonic over most of the TYS; this can be seen, for example, in Figure 2 of Iacono et al. (2013). This global wind stress drives the cyclonic circulation along the Italian coast, from Sicily to the Corsica Channel, which is one of the distinctive features of the winter-spring dynamics. If less confusing we can replace "global" by "basin-scale"

4/18: The Algerian Current is mentioned for the first time here, but not mentioned in

the description of the system's circulation.

The description of the main pattern of circulation, including the Algerian Current, will be added at the end of the introduction or in a specific section.

5/12: "to the northwest and south-southeast". It looks like the section runs from the NE to the SW, not NW to SW, and that is where the green colors under the section are located.

The referee is right, we apologize for the mistake.

6/2: The term "the basin" has been used a few times in the text, but I'm not sure if this refers to the Algerian Basin or the basin holding the TYR. The authors need to be clear and consistent on that.

OK, we will clarify.

6/10: what is the "global cyclonic cell"? Should "washing" be "flushing"?

As for the "global cyclonic cell", see answer to 3/15. Yes, flushing is more appropriate. We will correct the sentence.

6/19: why is there a ? in parentheses?

This is a typo. The ? will be removed.

Figures Figure 1: The arrows in Figure 1 used to identify straits are hard to see since they are black, as are the underlying current vectors.

Ok

Also, I suggest that "ADT" be spelled out in the caption; I found myself having to look it up in the text to remember what it meant.

Ok

The values for lat and long should include 'degree' symbols so that the reader knows

what the values refer to.

Ok

The caption needs to indicate which months were averaged for the winter and summer conditions.

Winter refers to January-March, and summer to July-September. We will clarify this in the caption.

Figure 3: I cannot make out the velocity vectors in 1a, so I don't know which what the vectors are pointing.

Ok, we will make a new figure with a bigger panel devoted to the circulation.

Units are not given for the vectors.

There is a reference arrow in the upper part of the figure that corresponds to 0.5 m/s.

In 3d, I wonder how well observed salinity matches with the modeled salinity shown in the plot.

Comparing the salinity section (model) and the T-S diagram, where the depths of the observations are marked by red numbers, one can see that there is good correspondence between the model and measured values.

Figure 4: too many words in the caption are capitalized.

Ok

What is "multi satellite"?

Multi-satellite means that the daily maps are obtained merging measurements made by different satellites.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-418/bg-2018-418-AC1-

supplement.pdf

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-418, 2018.