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Biogeosciences Discussions

Interactive comment on "Net sea-air CO_2 flux uncertainties in the Bay of Biscay based on the choice of wind speed products and gas transfer parameterizations" *by* P. Otero et al.

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First at all, we are grateful for your review and we really appreciate your careful reading of the manuscript. You state that this work is potentially interesting, however you suggest that "the present manuscript is not suitable for publication in Biogeosciences". From our point of view, this work deserves publication in this scientific journal, after a revision of some aspects that we will clarify below.

Your main disappointment concerns with the combination of different wind speed products (U) and different gas transfer coefficients (k). We agree with you when you refer to Section 6.1 of Takahashi et al. (2009) to highlight that, if a specific scale factor is

used to compute the gas transfer velocity as previous step to compute CO2 fluxes. Then the same wind product in the original study should only be used. We are aware that there is a dependence of the air-sea CO2 fluxes on the uncertainties of the wind speed products and the spatial and temporal resolution of the wind fields. Naegler et al. (2006) went deep into this issue re-assessing gas exchange scaling parameters for the Wanninkhof's parameterization (Table 1; Naegler et al., 2006) in order to correct the quadratic differences among wind fields (in situ measurements, satellite observations, climatology and reanalysis products...). As example, they obtained an overestimation of the QuikSCAT winds of around 30% in comparison to the global annual mean of the NCEP wind speed. However this correction roughly appears inconsistent with the CO2 flux variability described in the Bay of Biscay. Using the Wanninkhof's parameterization as well, our results showed an overestimation of 16% of the fluxes estimated from QuikSCAT dataset. However, we suspect that if it would be possible to make the estimation, the normalization presented by Naegler et al. (2006) would lead to different results in coastal environments.

The high topographic variability of the continental margins are poorly represented by the terrain data models of the weather reanalysis models (e.g. NCEP-1 and NCEP-2) avoiding the correct estimation of land-sea interaction mechanisms. Continental margins also have particular impacts due to its spatial heterogeneity on the satellite wind observations (QuikSCAT and CCMP). In any case, coastline has an important impact on the wind speed measurements (Otero et al., 2008) in spite of being better represented by the new generation reanalysis models (ERA-Interim; Carvalho et al., 2012).

Precisely our main goal is evaluate the annual mean CO2 fluxes estimated in an arbitrary coastal region from five different wind speed data sets in order to going deep into the analyze of the uncertainty and variability of the coastal CO2 fluxes. In this sense, this effort is an useful case study of the discrepancy among coastal wind products, especially, when many of the articles computing CO2 fluxes in coastal regimes do not take into account the recommendations described in Naegler et al. (2006).

Even the only scaling of air-sea CO2 fluxes in different continental margins (Cheng and Borges, 2009; Laurelle et al., 2010) do not take this into consideration in spite of showing large CO2 outgassing/uptake. Moreover, this analysis also gives an idea of the disagreement of using regional wind products (HIRLAM-AEMet...) as do biogeochemistry modellers in coastal regions and that cannot be evaluated following Naegler et al. (2006).

Therefore we will modify the manuscript to clarify the necessary correct selection of a wind speed product and the gas transfer parameterization. However we will keep the original analysis from the combination of gas transfer algorithms and different wind speed products.

1. The use of the Liss and Merlivat (1986) parameterization will be clarified in the revision. So, the previous paragraph:

" ... the main uncertainty remains in the estimation of the transfer velocity k which is, for its part, dependent on wind speed. there is not still consensus as to what is the adequate relatonship of k with de wind speed. .Various studies assume a linear {Liss, 1986 #248}, quadratic {Wanninkhof, 1992 #251}{Nightingale, 2000 #252}{Ho, 2006 #250}{Sweeney, 2007 #253} or cubic {Wanninkhof, 1999 #259}"

was replaced by this one:

"... the main uncertainty remains in the estimation of the transfer velocity k which is, for its part, dependent on wind speed. So, there is not still consensus as to what is the adequate relationship of k with de wind speed. Liss & Merlivat (1986) assumed three linear segments of gas transfer with different wind regimes from experiments in wind-wave tanks. Various studies suggested a quadratic dependence between gas transfer and wind speed, such as, Wanninkhof (1992) from the global bomb 14C inventory (Broecker et al. 1985) and Sweeney et al (2007) using more recent estimates

of the carbon bomb radiocarbon inventory (Naegler and Levin, 2006). Nightingale et al (2000b) also computed a quadratic parameterization of the gas transfer velocity from field studies in coastal regions. Unlike these studies, McGillis et al (2001) described a gas transfer velocity controlled by breaking waves parameterized by cubic expression."

2. The equations of gas transfer velocity will be included.

3. The analysis of the temporal and spatial variations in pCO2 will be expanded in Section 3.3.

4. The value of 57% corresponding to the explained variability of the CO2 fluxes at long-term scale by the changes in the gas transfer velocity was estimated by Padin et al. (2009).

5. Comments of Fig.1 and Fig.4 have already been applied (see supplementary material to this response).

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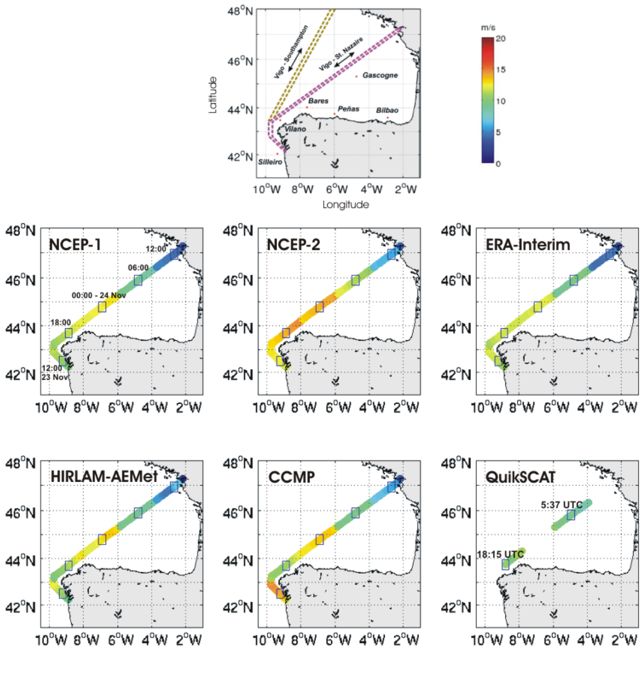

Fig. 1. New Figure 1

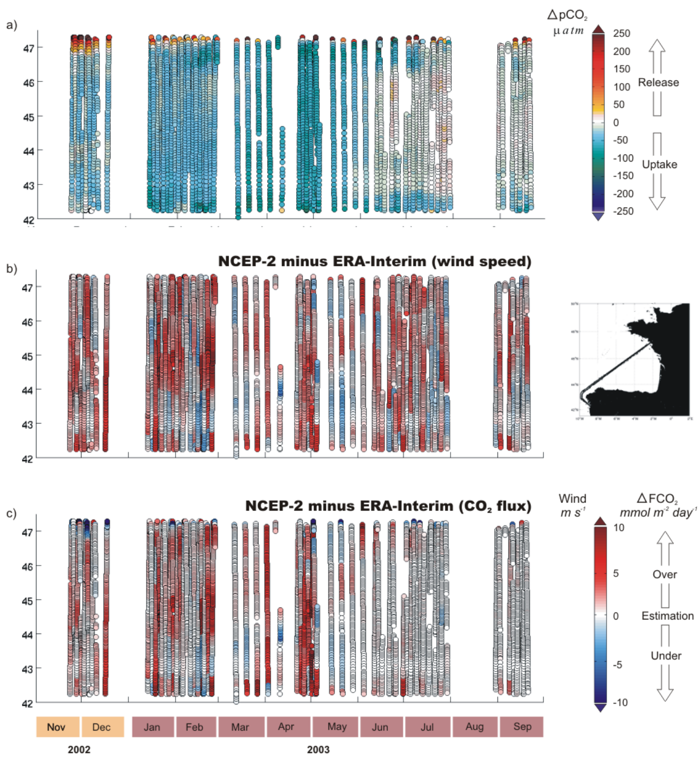

Fig. 2. New Figure 4