

Interactive comment on “Estimating temporal and spatial variation of ocean surface $p\text{CO}_2$ in the North Pacific using a Self Organizing Map neural network technique” by S. Nakaoka et al.

Anonymous Referee #2

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This paper presents maps of $p\text{CO}_2$ in the North Pacific on a $0.25^\circ \times 0.25^\circ$ grid from 2002 to 2008 using a self-organizing map neural network based on the technique already applied in the North Atlantic by Telszewski et al. (2009). The technique to produce the maps is thoroughly described. The maps are compared to the LDEO climatology and the distribution of $p\text{CO}_2^{\text{sea}}$ anomalies in winter 2003 and 2008 shows the contrasts between El Niño and La Niña years. It is not so easy to see how well the two methods compare. It would be better to show maps of differences for the comparison between the two methods. One interesting aspect of the NN is the possibility to produce high resolution maps. However, the fine scale features should be validated with observed data to make sure they really correspond to oceanic conditions. The

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paper tends to focus more on the technique and lacks some scientific interpretation of the maps. Including salinity as a parameter for the NN should be based on physical processes occurring in this region but it seems it was only introduced to improve the statistics: “The reason why inclusion of SSS improved the $p\text{CO}_2^{\text{sea}}$ estimate is unclear”. Also, one objective of the paper is to estimate temporal variations but there is no discussion of any temporal trends.

More specific comments:

p. 4577-4578 The North Pacific definition should be clarified and consistent throughout the manuscript. First, we read that it includes the subarctic and subtropical gyres. Then, “the North Pacific is characterized as a high nutrient, low chlorophyll region at high latitudes and as a low-nutrient, low chlorophyll region at low latitudes. I guess this refers to the subtropical North Pacific as, later on, the subarctic North Pacific is an upwelling area with high biological productivity. “The subarctic North Pacific is an upwelling area”: specify the location of the upwelling.

p. 4578 “there are quite large temporal and spatial variations of $p\text{CO}_2^{\text{sea}}$, the regional characteristics of which are generally understood from the LDEO climatology”: this is a vague statement; it should be made more explicit by describing the characteristics.

“Takamura et al. (2010) used MLR to reconstruct $p\text{CO}_2^{\text{sea}}$ distributions as a function of SST and SSS from 1999 to 2006 (25°N to 40°N , 120°W to 150°W , 140°E to 170°E). They resolve regional differences in secular increasing trends, however their MLR technique could not be applied to spatial mapping”: what is the meaning of the last sentence? Takamura et al. applied their MLR to map the region: 25°N to 40°N , 120°W to 150°W , 140°E to 170°E . Some information (measurements made, time range) about the station KNOT should be given as it is used in the work.

Stephens et al., 1995 and Landrum et al., 1996 also mapped $p\text{CO}_2^{\text{sea}}$ in the North Pacific. How do their works compare with the NN maps? Can we detect any $p\text{CO}_2^{\text{sea}}$ trend?

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2.1 Methods of pCO₂sea estimation

p. 4579 The biological activity is important in spring and summer in the subarctic North Pacific but the chlorophyll and pCO₂sea do not have the same time constants as low pCO₂sea will persist after a bloom of phytoplankton due to the slow CO₂ exchange with the atmosphere. How is this taken into account in the SOM? “The use of SSS in this study is consistent with the suggestion by Telszewski et al. (2009)”: the mapping of Telszewski et al. is for the North Atlantic, why would the suggestion, made for the North Atlantic, be valid for the North Pacific?

p. 4580 “We presented the change of the pCO₂sea distribution in response to the ENSO events”: what is the mechanism for the link between ENSO and pCO₂ for the region 10oN-60oN? How far north will ENSO affect pCO₂?

2.2 Training data set (SST, MLD, CHL, SSS)

Why are the in-situ data corresponding to the pCO₂sea not used to train the SOM? There might be some differences between the satellite datasets and the in-situ values. “The parameters are gridded onto a frequency of one per day”: does it mean that daily maps are obtained from 2002 to 2008? What is the temporal resolution of the SOM?

2.3. pCO₂sea datasets for labelling

p. 4583 It would be clearer to separate the presentation of the pCO₂ dataset from the method of labelling. “. . .accompanied by supplementary values of observed atmospheric and oceanic parameters”: are they SST, MLD, CHL, SSS? The parameters should be listed or the sentence should be removed as it does not provide any information.

2.6 Reconstructing pCO₂sea distributions in winter at high latitudes

Is there any difference in the subtropical region between the SOM with and without CHL? Is the role of CHL limited to the subarctic region in spring and summer?

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2.7.2 Improvement in the NN scheme

p. 4587 “The reason why inclusion of SSS improved the pCO₂sea estimate is unclear”: what is the salinity range in the North Pacific? Where are the most important salinity variations? p. 4588 Adding or subtracting a trend is not an improvement in the NN scheme, it is another term of equation 1.

3.1 Mapping of seven-year averaged monthly pCO₂sea distributions

The comparison between the climatology and the SOM would be easier to see by plotting the map of the differences. “the resolution of the SOM is much higher and the results more precisely resolve some oceanic features”: this should be demonstrated and supported by some data.

3.2. Reproducibility of temporal pCO₂sea variations

Why there are so few observed data at the time-series station KNOT?

3.3 Difference of pCO₂sea distributions during ENSO events

“The patterns of SST anomalies in Fig. 9 are typical of El Niño and La Niña winters”: what is meant by “typical”? “The pCO₂sea anomaly related to ENSO events is easily discernible”: there should be a description of the patterns and some explanation of the mechanisms explaining the patterns. What is the extent of the influence of El Niño?

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