Interactive comment on "Feasibility of reconstructing the basin–scale sea surface partial pressure of carbon dioxide from sparse in situ observations over the South China Sea" by Guizhi Wang et al.

Anonymous Referee #1
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The subject is important but the manuscript suffers from two major flaws. Fortunately, both could be amended.

My major concern is the reliability of the result. The manuscript gave a rate of pCO2 increase of 2.38 uatm/yr, which is very high. Unfortunately, no uncertainty was given. Judged by the large scatter of the data (Fig. 8a) the standard deviation of the rate must be very large. Note other studies, for instance, that of Lui et al. (2020, Transient carbonate chemistry in the expanded Kuroshio region, in Changing Asia Pacific Marginal Seas, pp 307-320) gave a much lower increasing rate of only 0.8 uatm/yr at the SEATS station. I fully recognize that different sampling locations, sampling periods, and sampling frequency could contribute to large differences in the results. Yet, exactly because of this the result must be qualified and compared with other studies. In addition, there ought to be other independent checks of the pCO2 data generated by the satellite chlorophyll data. There is an abundance of alkalinity, DIC, and pH data in various parts of the South China Sea, especially at SEATS. It would be relatively easy to generate pCO2 from these data to check model-derived pCO2.

Response: Thank you for your comments and input.

First, we have quantified the uncertainty of our rate of increase as 2.4 ± 0.8 µtam/yr, where 0.8 µtam/yr is the standard error of the rate. See Figure R1.

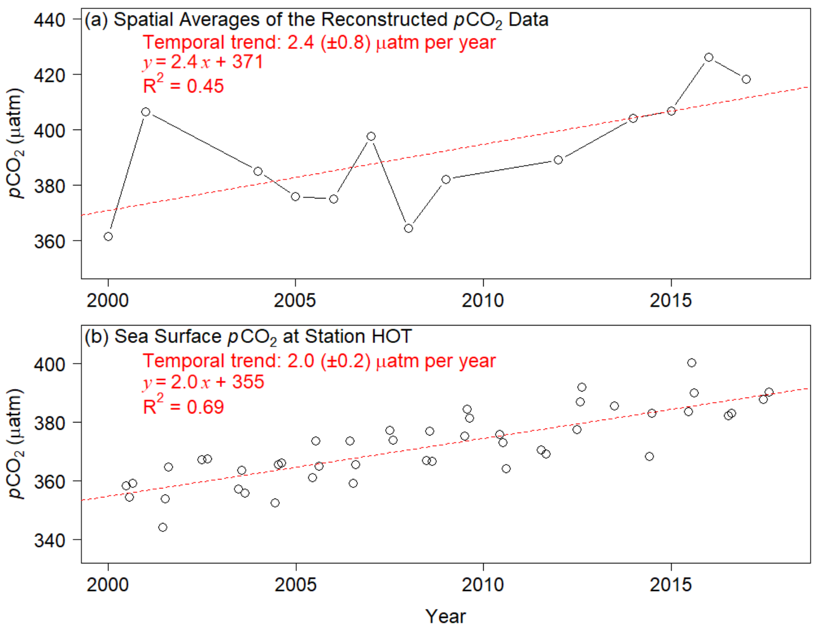

Figure R1: (a) Time series and linear trend of the spatial averages of the reconstructed summer pCO_2 data in the period of 2000–2017; (b) Summer sea surface pCO_2 at Station HOT in 2000–2017 adapted from Dore et al. (2009).

Second, the rate in Lui et al. (2020) of 0.8 μatm/yr is for the period of 1998-2006 and was calculated based on the data of spring, summer, fall, and winter. The reason for their much slower rate might be due to the peak pCO_2 value approximately 405 μatm in 1999, as shown in Fig. 16.7 in their paper. This peak value at an earlier time forced a lower rate. We re-calculated the rate using their summer-only data from the year of 2000, which is the beginning year of our data, to the year of 2006, we obtained a rate of 2.5±1.0 μatm/yr, which is almost the same as our rate of 2.4±0.8 μatm/yr.

Third, regarding the question about independent checks for the remote-sensing derived pCO_2 estimates, we have compared our observed underway pCO_2 with the remote-sensing derived estimates as a quality check. See Figure R2 and Table R1. In general, most of the remote-sensing derived pCO_2 overestimate the sea surface pCO_2 by no more than 50 μatm. The root-mean-square-errors (RMSE) between the remote-sensing derived pCO_2 and the observed underway pCO_2 fall in the range of 12.8-89.0 μatm.

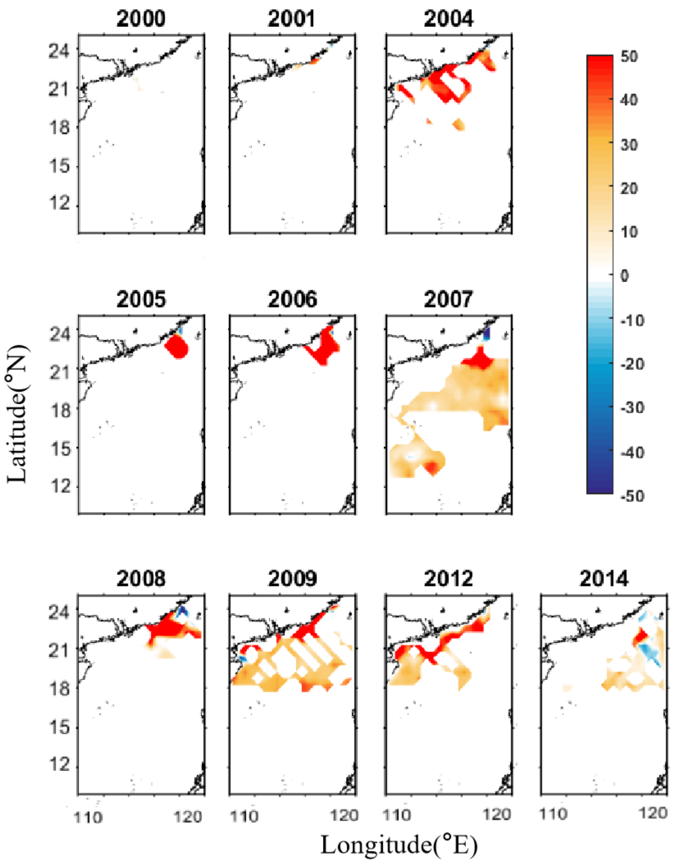

Figure R2: The difference between the remote-sensing derived pCO_2 estimates and the observed underway pCO_2 data in years 2000, 2001, 2004-2009, 2012 and 2014 (unit: μatm).

Table R1: The RMSE between the remote-sensing derived pCO_2 estimates and the observed underway pCO_2 data (unit: μatm).

Year	2000	2001	2004	2005	2006	2007	2008	2009	2012	2014
RMSE	12.8	20.2	47.9	65.7	89.0	25.1	43.8	36.8	30.7	24.2

Fourth, we have used the pCO_2 data calculated from alkalinity and DIC data observed at Station SEATS and nearby stations from Liu et al. (2020) and our own database to check the reconstructed pCO_2. See Figure R3. The temporal pattern of the reconstructed data is basically consistent with that of the pCO_2 data calculated from the observed alkalinity and DIC data. The difference between the reconstructed data and those calculated from observed data falls within ±10.2 μatm and the relative error is within ±2.1%. This comparison between the reconstructed data and an independent dataset calculated from observed data around Station SEATS indicates that our reconstruction is reliable.

We will include a description of the calculation and the observed data used in the calculation in the revised data section of the paper.

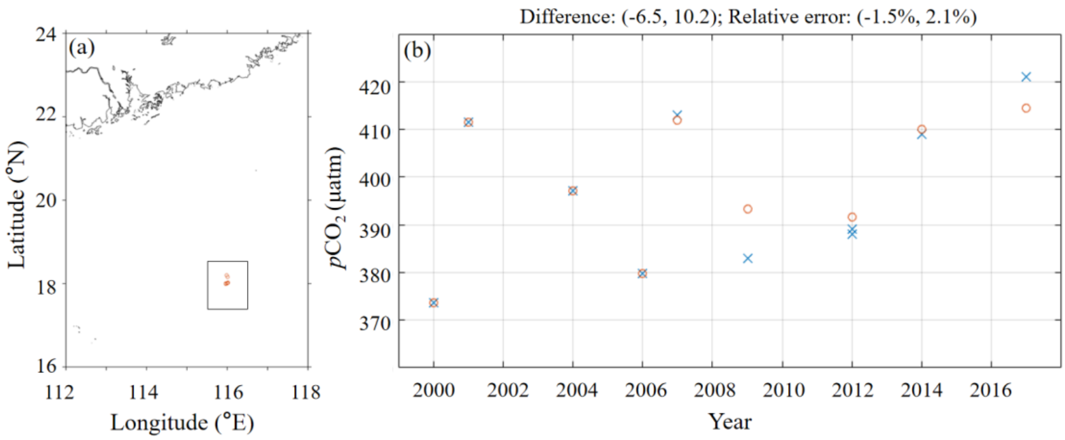

Figure R3: The comparison between the pCO_2 calculated from the observed total alkalinity and DIC and those from our reconstruction around Station SEATS (18 °N, 116 °E). (a) Locations of the observation stations and the area where the reconstructed pCO_2 was selected for comparison. The red circles are observation stations and the black rectangle indicates the area where the reconstructed data are used in comparison, (b) The comparison between the pCO_2 data calculated from the observed DIC and total alkalinity and those from our reconstruction. Red circles represent the reconstructed data and the blue crosses represent the pCO_2 calculated from the observed total alkalinity and DIC. The difference is pCO_{2R} - pCO_{2C}, where pCO_{2R} is the reconstructed pCO_2 and pCO_{2C} is calculated from the observations, and the relative error is $(pCO_{2R}-pCO_{2C})/pCO_{2C}\times100\%$.

My second major concern is the coverage of the data. The manuscript covers data from only 13 years, and in most years the region covered was very small. In fact, none of the cruise tracks covers the southern South China Sea. It seems that the authors used only their own data but why not include other people's data as well? For instance, the open-access SOCAT database covers tracks in the southern South China Sea. One minor issue is that the title does not reflect correctly that only summer data were covered.

Response: The word 'summer' will be added before 'basin-scale' in the title. Our method allows us to include any group's data if they are available.

As for the data temporal coverage, to our knowledge the underway summer pCO_2 data are available by this date only for 13 years. A pCO_2 dataset calculated from observed total alkalinity and DIC is present for June 2010 in the northern South China sea in Guo et al. (2015). We have considered this dataset. However, we are still examining an outlier of the dataset. When the outlier and consistency issues of this dataset are resolved, we may include their data in our future reconstruction. Of course, we will also include any group's data when they become available. Observed data from other groups are published either at one or two buoys or stations, e.g., Liu et al. (2020) and Yu et al. (2020) or in other seasons, e.g., Xu et al. (2016). However, the data at one or two buoys or stations cannot provide a spatial coverage needed for the reconstruction. Although the SOCAT database has tracks in the southern South China Sea, it does not have summer data for the region. We plan to make reconstruction in other seasons in the future and we will then include these data.

As for the spatial coverage, the poor coverage of observed data in the South China Sea, especially in the southern South China Sea, is exactly the main reason for us to make the reconstruction. The purpose of our work is to reconstruct a complete pCO_2 field in the South China Sea.

References

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