

## ***Interactive comment on “DINCAE 1.0: a convolutional neural network with error estimates to reconstruct sea surface temperature satellite observations” by Alexander Barth et al.***

**Alexander Barth et al.**

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**We would like to thank the reviewer for carefully reading the manuscript and providing comments to the manuscript and to the figures in particular to improve their clarity. We hope that our reply below answers the questions and comments by the reviewer in an adequate manner. Our response is in bold-face.**

General Comments: This is a good work. The author develops a new reconstruction methodology based on neural network with the structure of a convolutional autoencoder. In this manuscript, the author uses the cross-validation and field comparison

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to prove the performance of DINCAE in SST reconstruction is better than DINEOF from some statistical results, such as RMSE and standard deviation. I also use the DINCAE1.0 released on GitHub by author to fill gapped chlorophyll satellite images in another sea area and achieved satisfactory results. The first reviewer put forward very meaningful comments, which promotes the improvement of this manuscript. I think there are still some place to improve.

DINCAE is based on neural network, therefore its trained model can be saved and used to predict the other independent missing data. Considering the time parameter of DINCAE input is "days in year", the trained model should be able to fill the data for other years. I think this is one of the biggest different between DINCAE and DINEOF, but is not mentioned in this manuscript.

Many of the colorbar labels are incomplete or uninformative.

**We have added to all captions that the temperature and its standard deviation are in degrees Celsius and improved the caption for figure 3 (numbering of the original manuscript; figure 4 for the revised manuscript) as explained below.**

**We also clarified that the day of the year is not used by DINEOF by adding the following:**

**It should be noted that DINEOF does not use the day of the year of each satellite image, but it uses a temporal filter which increases the temporal coherence of the reconstruction (Alvera-Azcárate et al., 2009).**

Page 7 line 1: Manuscript gives the size of complete dataset is 8 x 112 x 112 x 5266. But, I think "Scaled SST anomalies and inverse of error variance of the previous day" in the input parameters list (page 6 line 20) means two parameters and the size of complete dataset should be 10 x 112 x 112 x 5266.

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Thank you for pointing this out. This is now corrected. See also my reply to reviewer 1 from 17 December 2019.

Page 9 Equation 8: lacks a left bracket.

**This is equation (8) from the original manuscript. We do not see where there is a missing bracket.**

$$p(y_{ij}|\hat{y}_{ij}, \hat{\sigma}_{ij}) = \frac{1}{\sqrt{2\pi\hat{\sigma}_{ij}^2}} \exp\left(-\frac{(y_{ij} - \hat{y}_{ij})^2}{2\hat{\sigma}_{ij}^2}\right) \quad (1)$$

**But we noticed a bracket-issue in equation (5) on page 8 which we corrected.**

Page 11 line 1: Calculation efficiency is an important index to evaluate the reconstruction algorithm. The manuscript gives "Training this network for 1000 epochs takes 32hours on a GeForce GTX 1080 and Intel Core i7-7700 with the neural network library tensorflow (Abadi et al., 2015)". I am also interesting on how many hours spent by DINEOF.

**The original version of DINCAE took indeed 32 hours to make 1000 epochs, but after restructuring the code (and some update of system libraries and drivers, like the NVIDIA kernel driver), the version now published on github uses only 4.5 hours. These differences are indeed quite significant, but we are not able to tell which change caused this difference in runtime (the results are still the same). As a comparison, DINEOF uses 15 hours on an Intel Core i7-3930K CPU. Note also that the i7-3930K (used by DINEOF) was first released in 2011 and the i7-7700 (used by DINCAE) was released in 2017. DINCAE used thus a more modern CPU than DINEOF and the runtimes are not directly comparable. The manuscript is updated accordingly.**

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Page 12. Figure 3: What is the colorbar meaning? Please adding some information about colorbar in figure or the caption under figure.

**In the manuscript we mentioned: "The color represents the estimated expected error standard deviation of the reconstruction" but we agree that it is more readable if this information is also placed in the caption. In the revised manuscript, this information is now also added to the caption. We thank the reviewer for pointing this out.**

Page16 line 5: The comparison between the measured data and the reconstructed data is the most persuasive validation method. I suggest adding the number of measured points, which can be more convincing.

**I assume that the reviewer refers here to the in situ measurements (as the number of validation data points measured by the satellite is already mentioned in the manuscript). For the in situ data, there are 774 surface observations. We agree that this is a useful information for the reader and it has been added to the manuscript.**

Page18. Figure 7: The standard deviation of reconstructed SST by DINCAE and DINEOF along the southern coast of France and Corsica is larger than that of original SST. Why? The unit and label of colorbar are not given.

**Near the coast there are much fewer observations than in the open ocean. We can illustrate this by comparing two different locations: the nearshore location at 8.0641°E and 43.9243°N with a standard deviation of 0.85 °C (around the seasonal cycle and the original SST) and the offshore location 8.0641°E and 43.0454°N, same longitude but different latitude with a standard deviation of 1.20 °C. There are about 9 times more data in the offshore location than in the**

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nearshore location (3037 versus 346). Also the data available in the nearshore is not evenly distributed around the different years (see the attached histograms) while the distribution is quite even for the offshore location. When the seasonal mean is computed from the available data it is thus biased towards the years where most data are available which results in a low standard deviation. Per definition, the data from DINCAE and DINEOF are complete time series and such distribution bias is not present.

The figure's caption now includes the units (degrees Celsius).

## References

Alvera-Azcárate, A., Barth, A., Sirjacobs, D., and Beckers, J.-M.: Enhancing temporal correlations in EOF expansions for the reconstruction of missing data using DINEOF, *Ocean Science*, 5, 475–485, <https://doi.org/10.5194/os-5-475-2009>, <http://www.ocean-sci.net/5/475/2009/>, 2009.

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-128>, 2019.

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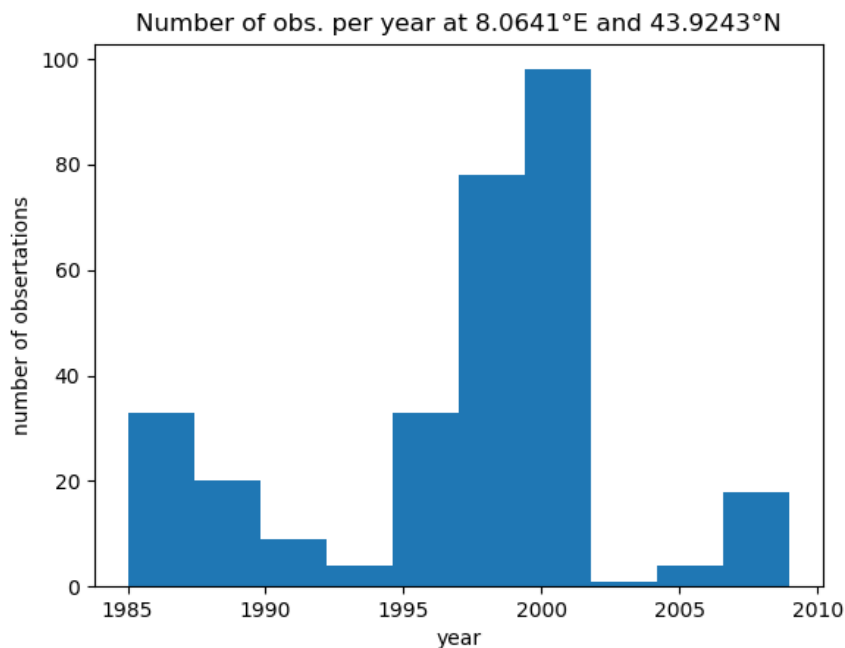
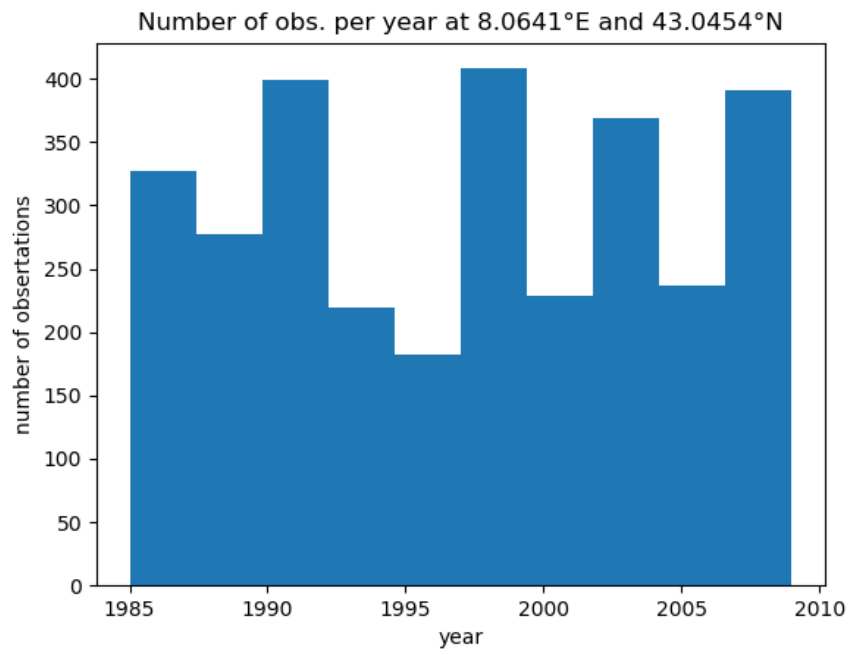


Fig. 1. Data histogram per year for a nearshore location

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**Fig. 2.** Data histogram per year for a offshore location