Comparison of two global sea surface temperature data sets

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1. Introduction

A Bulk formula is one of general methods to estimate global surface turbulent heat flux (THF). To calculate surface turbulent heat fluxes using bulk algorithms the following input variables are required; sea surface temperature (SST), surface wind, surface air temperature and specific humidity. In the present study, we compared two kinds of global SST data, Center for Atmospheric and Oceanic Studies (CAOS) and Reynolds SST data. Moreover, we evaluated both SST data with buoy data. In addition, we investigated about the difference of ocean surface THF by using two different global SST data.

2. Data

2.1 Global SST data sets.

The Reynolds SST analysis (Reynolds et al., 2002) are based on a blending of in situ observations and satellite infrared measurements from the Advanced Very High Resolution Radiometer (AVHRR). The Reynolds SST analysis consist of weekly averages on a global 1°latitude×longitude grid and are obtained from a optimum interpolation (OI) that uses correlation length scales of approximately 900km zonally and 600km meridionally, respectively. The CAOS SST analysis are based on a blending of various satellite instruments (e.g., AVHRR, TMI and AMSR-E). Figure 1 shows the SST observing satellite used in this product. They include a microwave sensor such as TMI and AMSR-E those are available under almost all cloudy conditions (as well as clear). The CAOS SST analysis is provided as daily average on a global 0.1°latitude×longitude grid and are obtained from 3D OI that uses correlation length scale of 180km zonally , 140km meridionally and 2 days.

In this study, we used two SST data sets during 1995-2004. To unify spatial /temporal resolutions of two SST data sets, Reynolds SST data are changed from weekly to daily data by a linear interpolation, while CAOS SST data are simply averaged from 0.1°grid to 1°grid.

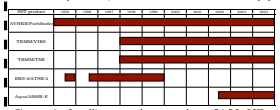

Figure 1. Satellite used to produce CAOS SST products.

2.2 Buoy data.

In this study we used SST data observed by various buoys, sixty-five TAO/TRITON buoys in the tropical Pacific Ocean, three JMA buoys around Japan and one KEO buoy in the Kuroshio Extension region, for evaluation of Reynolds and CAOS SST data. Location of buoys used in this study is shown in Figure 2. All buoy SST data are compared with Reynolds and CAOS data after being averaged into daily-mean values.

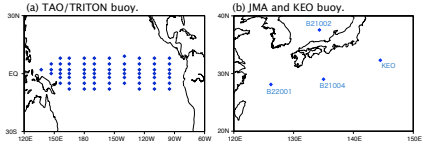

Figure 2. Location of buoys used in this study.

3. Results

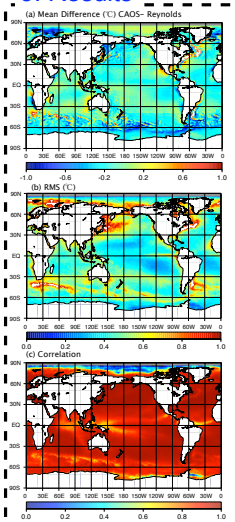

Figure 3. Mean difference (CAOS-Reynolds), rms difference and correlation between the CAOS SST and the Reynolds SST for 1995 -2004.

3-1. Comparison of two global sst data sets.

The mean difference (CAOS-Reynolds), rms difference and correlation between the CAOS SST and the Reynolds SST for 1995-2004 are shown in Figs. 3. In regions of strong SST gradients, such as the Kuroshio Extension in the North Pacific, the Gulf Stream in the northwest Atlantic, and in several regions of the Southern Ocean, the mean difference and rms difference exceed 1℃. The negative difference appears in regions of the Antarctic circumpolar current in the Pacific Ocean and Atlantic Ocean. The large rms difference shows at high-latitude Northern Oceans and equator Eastern Pacific Ocean. While correlation is high in all rounds, that is low in equatorial area (in particular correlation in equator Western Pacific Ocean is lower than other regions).

Figure 4 shows the CAOS SST gradient field for the period of 1995-2004. Strong SST gradients areas correspond to the regions of large mean and rms differences shown in Fig. 3. As an example, time-series of two SST products in the Gulf Stream region is shown in Figure 5.

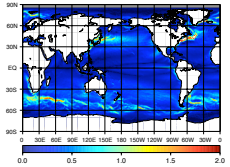

Figure 4. CAOS SST gradient (℃) for the period of 1995-2004.

From this figure 5, high- frequency variability can be found in CAOS SST, but cannot be found in Reynolds SST. In addition, we can see remarkable SST rises more than 5℃ in CAOS SST. This SST rise may be related to the movement of SST front there.

3-2. Evaluation of two global sst data sets.

Figure 6 and Table 1 show scatter-plots and statistics between all buoy data and two SST products. Accuracy of two SST products is fairly close. However, it should be noted that TAO/TRITO and JMA buoy data are assimilated into Reynolds SST product. It is important that despite those buoy data are not assimilated into CAOS SST, CAOS SST' shows similar accuracy to Reynolds SST even at buoy points.

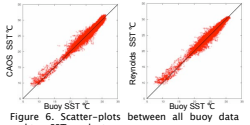

Figure 6. Scatter-plots between all buoy data and two SST products.

As an example, Figure 7 shows spectral density of CAOS SST, Reynolds SST and in situ SST for JMA (B21004) buoy. The spectral density of CAOS SST is close to that of in situ SST. On the other hand, in spite of that the Reynolds SST consist of weekly averages, the spectral density of Reynolds SST for the time scale of longer than one week is smaller than that of CAOS SST and in situ SST.

3-3. Impact for turbulent heat flux.

The mean difference (CAOS-Reynolds), rms difference of Latent Heat Flux (LHF) derived from CAOS SST and Reynolds SST for 2000 are shown in Figs 8 . In regions of strong SST gradients (regions of large differences between two SST products), the mean difference and rms difference extend 30(W/m²), 50(W/m²). (in particular, in region of Gulf Stream exceed this values.) Moreover, because of LHF are large in less of SST gradients area such as eastern shore of Australia, the mean difference and rms difference also large in this region.

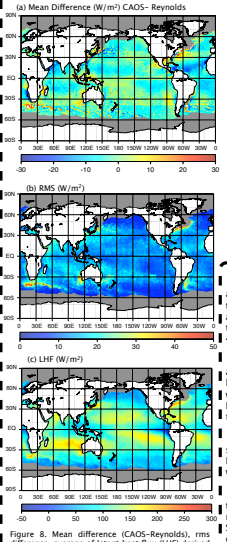

Figure 8. Mean difference (CAOS-Reynolds), rms difference, average of latent heat flux (LHF) derived from CAOS SST and Reynolds SST for 2000.

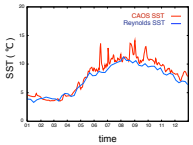

Figure 5. Time-series of two SST products in the Gulf Stream region (45.5W,49.5N).

Table 1. Statistics between all buoy data and two SST products.

	CAOS SST	Reynolds SST
Bias ℃	-0.1	0.01
RMS ℃	0.49	0.43
Cor	0.98	0.99

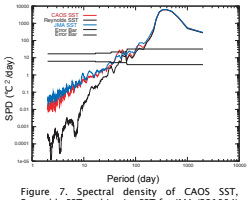

Figure 7. Spectral density of CAOS SST, Reynolds SST and in situ SST for JMA (B21004) buoy.

The difference of LHF derived from CAOS SST and Reynolds SST in the Kuroshio Extension region (34°N~40°N : 144°E~150°E), where we can find large LHF difference , is shown in Fig 9. We can see large differences more than 80(W/m²) in winter.

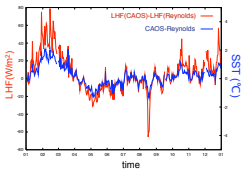

Figure 9. Difference of LHF derived from CAOS SST and Reynolds SST in the Kuroshio Extension region (34°N~40°N : 144°E~150°E).

4.Summary

- In the regions of strong horizontal SST gradients such as the Kuroshio Extension and the Gulf Stream regions, the mean and rms differences between CAOS Reynolds are considerably large. For example, difference between two SST products indicate more than 5℃ at 45.5W,49.5N in the Gulf Stream region.
- Comparison between buoy data and two SST products, accuracy of two SST products is fairly close. However, buoy SST data are assimilated into Reynolds SST data, while this are not assimilated into CAOS data. Therefore, It is considered that accuracy of CAOS SST is similar to that of Reynolds SST at buoy location.
- The spectral density of CAOS SST is close to that of in situ SST. On the other hand, the spectral density of Reynolds SST even for the time scale of longer than one week is smaller than that of CAOS SST and in situ SST.
- The mean and RMS differences of LHF derived from two SST products are more than 30(W/m²) and 50(W/m²), respectively, in the Kuroshio Extension and the Gulf Stream regions. Moreover, the mean and RMS differences are also large east of Australia.