Introduction of J-OFURO latent heat Flux Version2

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Abstract

Japanese Ocean Flux Data Sets with Use of Remote Sensing Observations (J-OFURO) includes global ocean surface heat flux data derived from satellite data and are used in many studies related to air-sea interaction. Recently latent heat flux data version 2 was constructed in J-OFURO. In version 2 many points are improved compared with version 1. A bulk algorithm used for estimation of latent heat flux is changed from Kondo (1975) to COASRE 3.0(Fairall et al., 2005). We basically need sea surface temperature (SST), specific humidity and wind speed data for estimation of latent heat flux. In version 1 we used NCEP reanalysis data (Reynolds and Smith, 1994) as SST data. However, the temporal resolution of the data is weekly and considerably low. Recently there are many kinds of global SST data because we can obtain SST data using a microwave radiometer sensor such as TRMM/MI and Aqua/AMSR-E. Therefore, we compared many SST products and determined to use Merged satellite and in situ data Global Daily (MGD) SST provided by Japan Meteorological Agency. Since we use wind speed and specific humidity data derived from one DMSP/SSMI sensor in J-OFURO, we obtain two data at most one day. Therefore, there may be large sampling errors for the daily-mean value. In order to escape this problem, multi-satellite data are used in version 2. As a result we could improve temporal resolution from 3-days mean value in version 1 to daily-mean value in version 2. Also we used an Optimum Interpolation method to estimate wind speed and specific humidity data instead of a simple mean method. Finally the data period is extended to1989-2004.

In this presentation we will introduce latent heat flux data version 2 in J-OFURO and comparison results with other surface latent heat flux data such as GSSTF2 and HOAPS etc. Moreover, we will present validation results by using buoy data.

1. Introduction

The ocean actively exchanges heat, water and momentum with the atmosphere at the ocean surface. The exchanged heat, water and momentum are transported by general ocean and atmospheric circulations on a global scale. Since the exchange and transport processes play important roles in the global climate, the estimation of the fluxes between the atmosphere and the ocean and those transports by the ocean and atmospheric circulations are very important for understanding the mechanism of the global climate. However, it is difficult to globally estimate the fluxes and transports by using *in situ* observation data such as ship observation data because they are extremely sparse in time and space. However, we can obtain considerably homogeneous data with high resolution using analysis and satellite data. Therefore, it is considered that analysis and satellite data are suitable for obtaining accurate globally covered fluxes between the ocean and the atmosphere.

We have constructed ocean surface flux data sets mainly using mainly satellite data. The data set named Japanese Ocean Flux data sets with Use of Remote sensing Observations (J-OFURO) has been provided to scientists since 2002 (Kubota et al., 2002) and has been used in many research studies. Recently, new surface heat flux data sets have been constructed in J-OFURO, thereby upgrading it to version 2 (J-OFURO2).). In the following, the differences between J-OFURO1 and J-OFURO2 associated with latent heat flux are described in section 2, and the comparison results with buoy data and characteristics of J-OFURO2 latent heat flux are shown in section 3. Finally some conclusions are given in section 4.

2.DIFFERENCES BETWEEN J-OFURO1 AND J-OFURO2

Version 2 has many improvements over version 1 for the estimation of turbulent heat fluxes. There are three major differences between the latent heat flux (LHF) values of J-OFURO1 and 2. First, multisatellite data are used in J-OFURO2, while data from only one DMSP-SSM/I sensor has been used for the estimation of turbulent heat fluxes in J-OFURO1. This is based on the results provided by Tomita and Kubota (2007), who demonstrated a remarkable reduction in the sampling error by using multisatellite data, particularly, in regions with large daily variability. In J-OFURO2, we have used all available SSM/Is (F08-F15), ERS1/2, QuikSCAT, AMSR-E and TMI for the estimation of daily wind speeds. In J-OFURO2, we could recognize that the usage of multisatellite data is quite effective, even if bias adjustments are not applied to each sensor. Figure 1 shows the time variation of wind speeds observed by the Kuroshio extension Observatory (KEO) buoy and satellites. If only one satellite is used, the time series shows many gaps, resulting in less accurate observations. On the other hand, with multisatellite data, there are no gaps in the time series, and the accuracy is considerably higher, as shown in Fig. 1b. Because various data are merged by an optimum interpolation method (Kako and Kubota, 2006) into daily mean data with a spatial resolution of 1°. However, only available SSMIs (F08-F15) are used for estimation of air specific humidity at present because it is not easy to estimate accurate air specific humidity using AMSR-E or TMI data still now. This is a future issue for the construction of J-OFURO3.

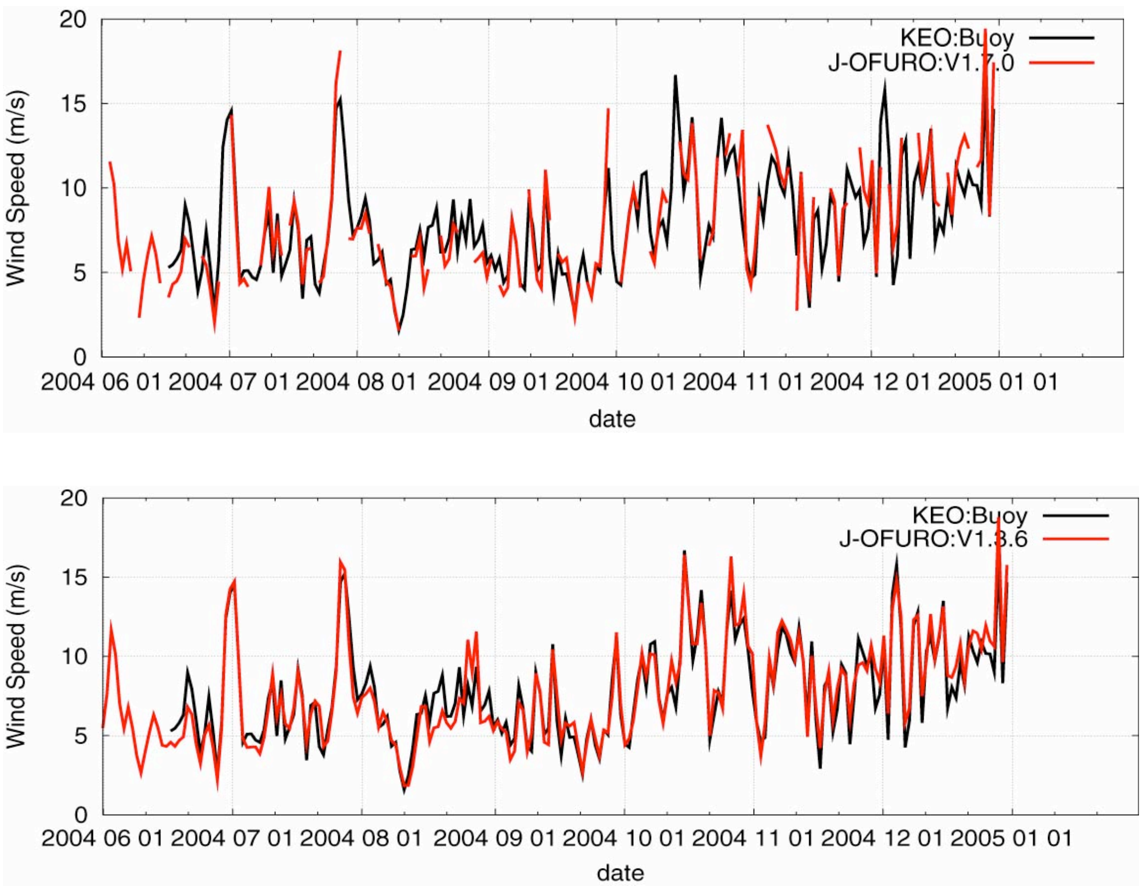

***Figure 1.* Time variation of wind speed data observed by KEO buoy and derived from (a). single satellite (DMSP/SSMI, F10) and (b). multi-satellite (DMSP/SSMI F13,14 and 15, Aqua/AMSR-E and QSCAT) data.**

Second, we changed gridded sea surface temperature (SST) data from Reynolds OI SST data (Reynolds and Smith, 1994; Reynolds et al., 2002) to Merged satellite and in-situ data Global Daily (MGD) SST data provided by JMA. This change is based on the results of Iwasaki et al. (2007), wherein five types of global SST products are compared and evaluated. The MGD SST data set has been constructed by using IR SSTs (NOAA/AVHRR), Microwave SSTs (Aqua/AMSR-E) and *in-situ* data (Kurihara et al., 2006). Subsequently, the bulk formula suggested by Kondo (1975) was also changed to COARE 3.0 (Fairall et al., 2003). However, warm layer and cool skin effects are not included in J-OFURO2. Hence, the estimation method for the sensible heat flux (SHF) has been drastically changed. In J-OFURO1, we use a method proposed by Kubota and Mitsumori (1997) for calculating the SHF by multiplying the LHF by the climatological Bowen ratio derived from the ECMWF data. However, in J-OFURO2, the SHF is estimated from COARE 3.0 using our merged wind speed, MGD SST data and NRA1 air temperature data. Finally, the temporal resolution is improved from a 3-day mean to a daily mean. Moreover, the data period is extended from 1992–2000 to 1988–2005. The radiation data in J-OFURO1 covers the region of the eastern Indian Ocean and the western and central Pacific Ocean between 60°N and 60°S, 80°E and 160°W because we use only the Japanese geostationary satellite for the estimation of radiation flux. However, in many cases, scientists require global flux data. Therefore, we provide the global net heat flux data, which is estimated by our turbulent heat flux data and ISCCP radiation data, in J-OFURO2. However, we have estimated the upward longwave radiation by using the MGD SST data.

3. COMPARISON RESULTS WITH BUOY DATA

We have compared the J-OFURO2 latent heat flux with the *in situ* latent heat flux data observed by the KEO buoy. In June 2004, the KEO buoy was deployed in the Kuroshio Extension recirculation gyre at 144.6°E, 32.4°N by NOAA/PMEL to monitor air-sea heat, moisture and momentum fluxes and upper-ocean temperature and salinity. Figure 2 shows the time variation of the J-OFURO2 and KEO LHF data from June 2004 to November 2005. The J-OFRO2 LHF follows is in good agreement with the KEO LHF. The bias and the root-mean-square (RMS) error for a daily mean value of the J-OFURO2 latent heat flux are 7 W m^{-2} and 42 W m^{-2}, respectively. Kubota et al. (2007) showed that the bias and RMS error values for the NRA1 latent heat flux are 38 and 48 W m^{-2}, respectively. Therefore, the J-OFURO2 latent heat flux may be more accurate than the NRA1 latent heat flux. On the other hand, the bias and RMS values of the J-OFURO2 sensible heat flux are 0.2 and 10.8 W m^{-2}, respectively. Since these values for NRA1 are 9 and 20 W m^{-2}, respectively (Kubota et al.,2007), the J-OFURO2 SHF is considerably more accurate than the NRA1 data, as shown in Fig. 3.

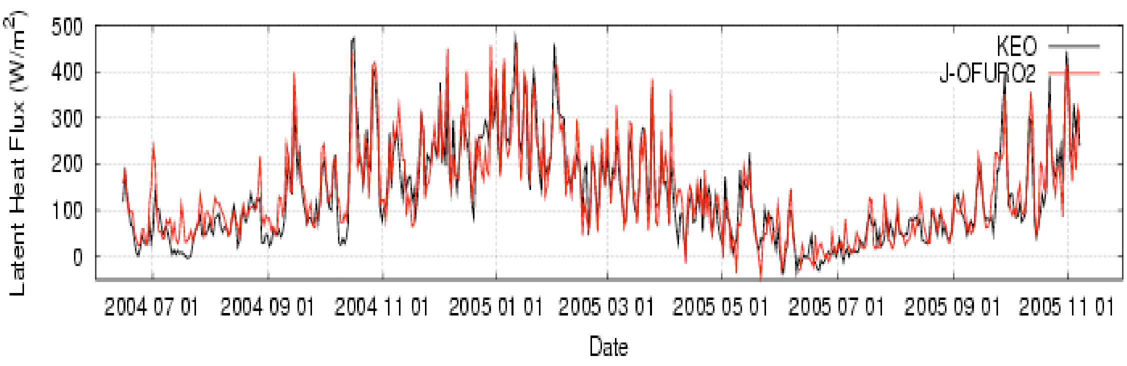

Figure 2. **Time variation of LHF of J-OFURO2 and observed by KEO buoy.**

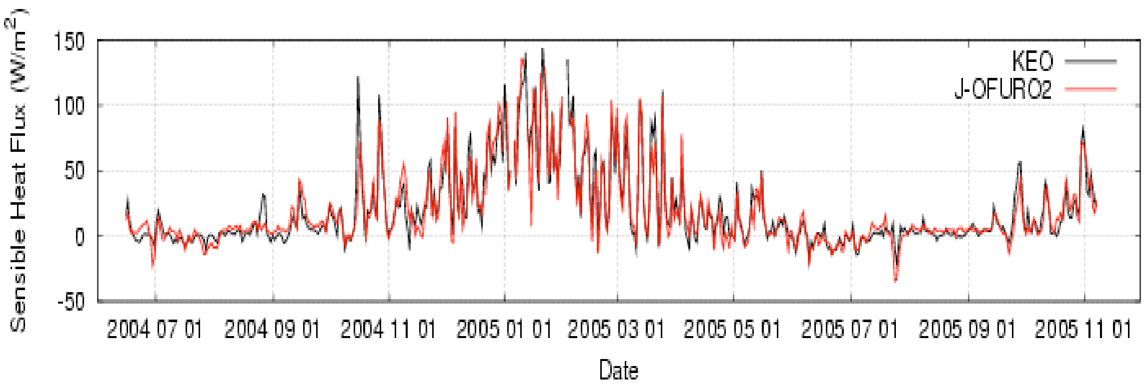

Figure 3. **Same figure as Fig,.1 except SHF.**

4. AIR-SEA INTERACTION

It is well known that many famous many warm eddies exist in the Kuroshio and Kuroshio Extension regions. Interestingly, we can find a fine-scaled distribution of latent heat flux associated with that of the sea surface anomaly observed by the TOPES/Poseidon altimeter (Fig. 4). Such characteristics cannot be found in other latent heat flux fields such as J-OFURO1, OAflux and ERA40. This feature suggests that the ocean plays an active role in the atmosphere over the warm eddies. As mentioned earlier, the use of multisatellite data improves the accuracy of turbulent heat fluxes. Moreover, the use of multisatellite data contributes to the representation of the fine structure of heat fluxes over the Kuroshio/Kuroshio Extension Regions.

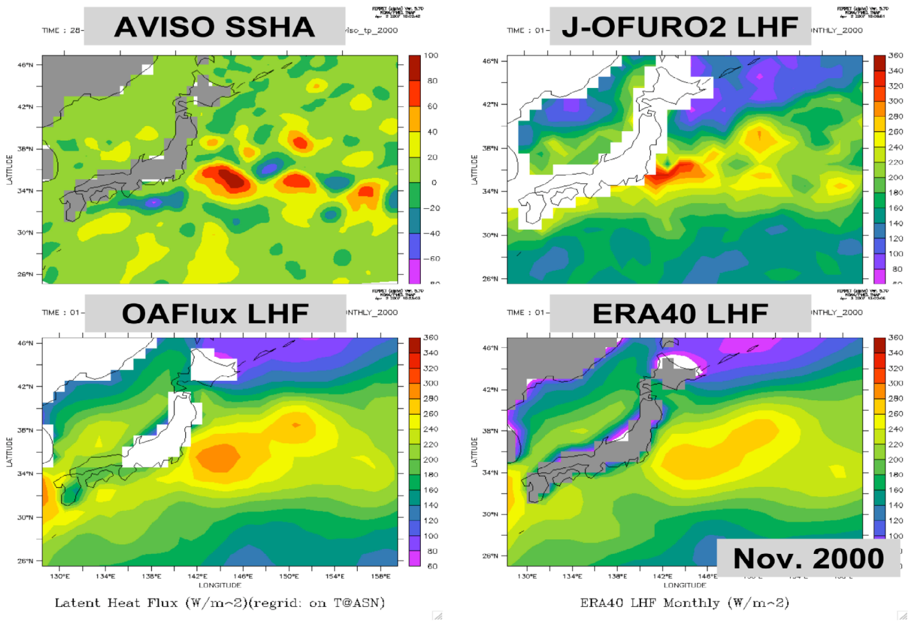

Figure 4. **Sea surface height anomaly derived from TOPEX/POSEIDON and latent heat flux by J-OFURO2, OAflux and ERA40 in the Kuroshio and Kuroshio Extension regions**

5.CONCLUSION

We constructed new surface heat flux products, J-OFURO Version 2. Many points are improved in Version 2 compared with the version 1 fro estimation of turbulent heat fluxes. The temporal resolution is changed from 3-daye mean to daily-mean value. The data period is from 1988 to 2005. While a bulk formula by Kondo(1975) was used in the version 1, COARE 3.0 (Fairall et al., 2003) is used in the version 2. It is most important to use mult-satellite data in the version 2 for estimation of turbulent heat fluxes. We carried out comparison of J-OFURO 2 turbulent heat fluxes with KEO buoy data. Both of the bias and RMS error are small compared with the results with NRA data. It is concluded that use of multi-satellite data can improve accuracy of turbulent heat fluxes. Moreover, it is suggested that J-OFURO 2 latent heat flux may reproduce fine structure of air-sea interaction using multi-satellite data. J-OFURO2 data is available for scientific use and can be freely obtained from the website http:// J-OFURO2_index.htm.

ACKNOWLEDGMENT:

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