SATELLITE-DERIVED SENSIBLE HEAT FLUX OVER THE OCEAN

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ABSTRACT:

Though sensible heat flux is one of heat flux components, it is generally considered that the importance is low compared with other components because of the small value. Actually sensible heat flux over the tropical ocean is extremely small, less than 10 W/m^2. However, it should be noted that sensible heat flux in boreal winter over the western boundary current regions is considerably large, about 100 W/m^2, and not neglected. In this study we carry out intercomparison of various global sensible heat flux data including not only satellite-derived data but also reanalysis data in order to clarify the characteristics of those data.

KEY WORDS: Satellite data, ,Sensible heat flux, Reanalysis data, Sea surface temperature

1. INTRODUCTION

Heat transfer at the sea surface plays an important role in linking the ocean and the atmosphere. Therefore, monitoring of the heat transfer between the ocean and the atmosphere is crucial for understanding a global climate system. The heat transfer has four components, i.e. shortwave radiation, longwave radiation, latent heat flux and sensible heat flux. Generally, longwave radiation, latent heat flux and sensible heat flux transfer heat energy from the ocean to the atmosphere. Since sensible heat flux is generally small compared with other components in low- and middle-latitudes, it is considered to be often negligible. Therefore, there are few studies to estimate sensible heat flux. However, sensible heat flux is considerably large in boreal winter over the western boundary current r such as Kuroshio and Gulf Stream.

Recently global sensible heat flux data are derived from three kinds of observation data. First one is based on in situ data such as buoy and ship data. Second data set is basically derived from general atmospheric circulation model. However, observation data are assimilated into the model. These kinds of data are called as reanalysis data, and NRA or ERA data are examples of reanalysis data. Third one is satellite-derived data such as the Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data (HOAPS), Goddard satellite-Based Surface Turbulent Fluxes (GSSTF), and Japanese Ocean Flux Data Sets by Use of Remote Sensing Observations (J-OFURO).

In the present study, intercomparison of various data sets of monthly sensible heat flux is carried out. The compared data sets are HOAPS2, GSSTF2, J-OFURO, J-OFURO2, ERA (the European Centre for Medium Range Weather Forecasting Reanalysis) 40, NRA1 (NCEP/NCAR Reanalysis), and NRA1 adjusted data. NRA1 adjusted data are estimated using NRA surface meteorological parameters and an appropriate bulk flux algorithm (Moore and Renfrew, 2002).

2. DATA

In the present study, intercomparison of various data sets of monthly latent heat flux is carried out. The compared data sets are HOAPS2, GSSTF2, J-OFURO, J-OFURO2, ERA40, NRA1 and NRA adjusted data. HOAPS, GSSTF and J-OFURO are all satellite-derived data sets. In order to estimate latent heat flux using a bulk formula, one needs three physical parameters, i.e., wind speed, sea surface temperature (SST), and specific humidity. However, it should be noted that a bulk formula is not used in J-OFURO. Kubota and Mitsumori (1997) proposed a method to calculate sensible heat flux by multiplying latent heat flux by the Bowen ratio. In J-OFURO the same method is adopted (Kubota et al., 2002). All data are transformed into monthly data with 1-deg. grid spacing for intercomparison in the present study. The intercomparison is carried out for the period from 1992 to 2000 for all the datasets.

3. RESULTS

Figure 1 shows distribution of mean sensible heat flux for each data set. Though the qualitative feature is similar, the value is different depending on a data set. For example, NRA1 shows the largest value in Kuroshio and Gulf Stream regions as Moore and Renfrew (2002) pointed out, while HOAPS2 gives the smallest value there. Most data sets show about 40 W/m2 for these regions. GSSTF2 gives large values in the southern hemisphere compared with other data sets. Also NRA1 and J-OFURO2 shows large values south of Africa. On the other hand, small values are found in the tropical regions for all data sets.

Standard deviation fields are shown in Fig.2. Large values are also found in the western boundary current regions similar to mean fields for all data sets. NRA1

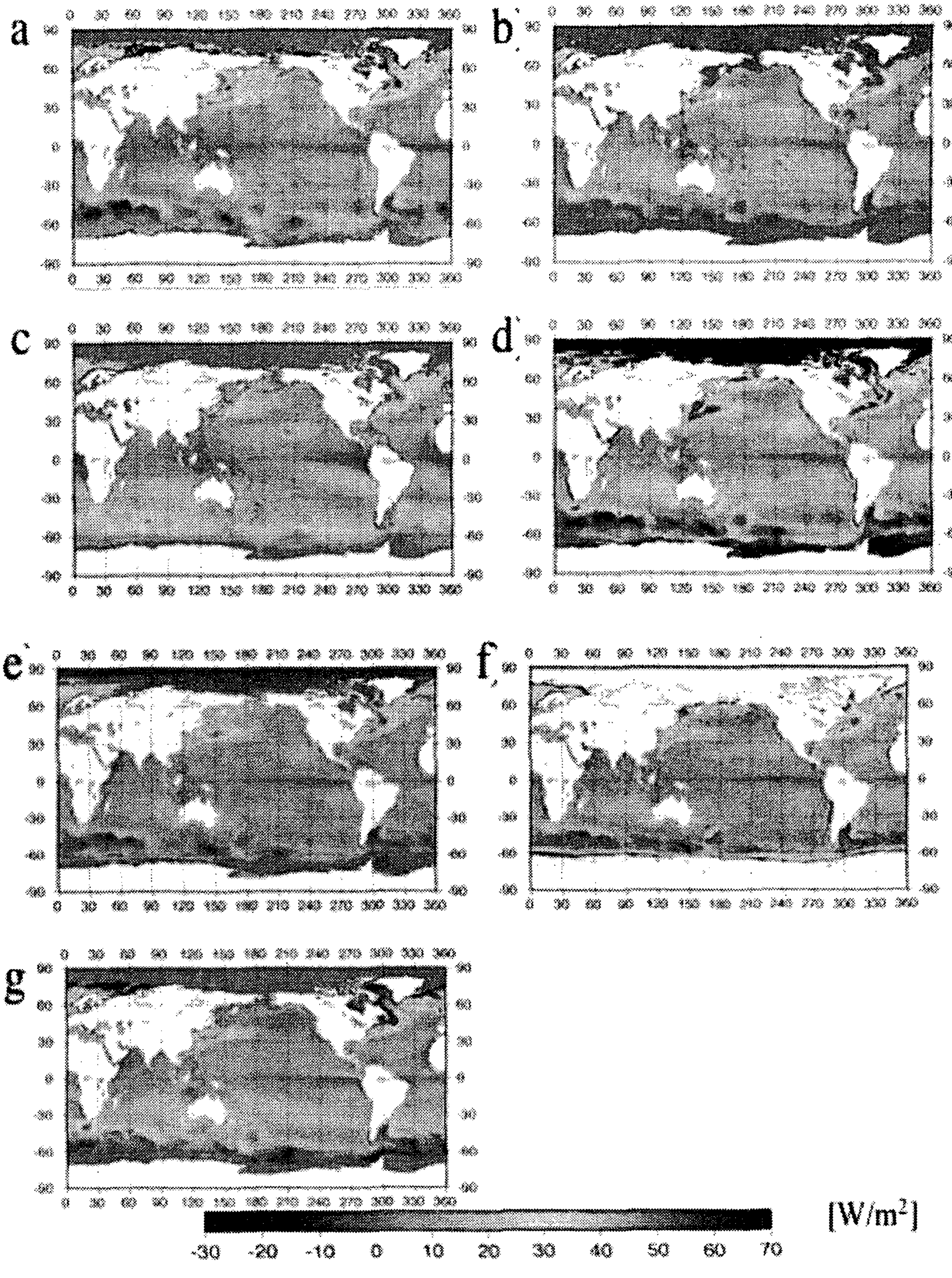

Figure 1. Average fields of sensible heat flux for the period of 1992-2000. a. J-OFURO , b.GSSTF2 , c.HOAPS2 , d.NRA1 , e.ERA40, f. NRA1 adjusted, and g. J-OFURO2

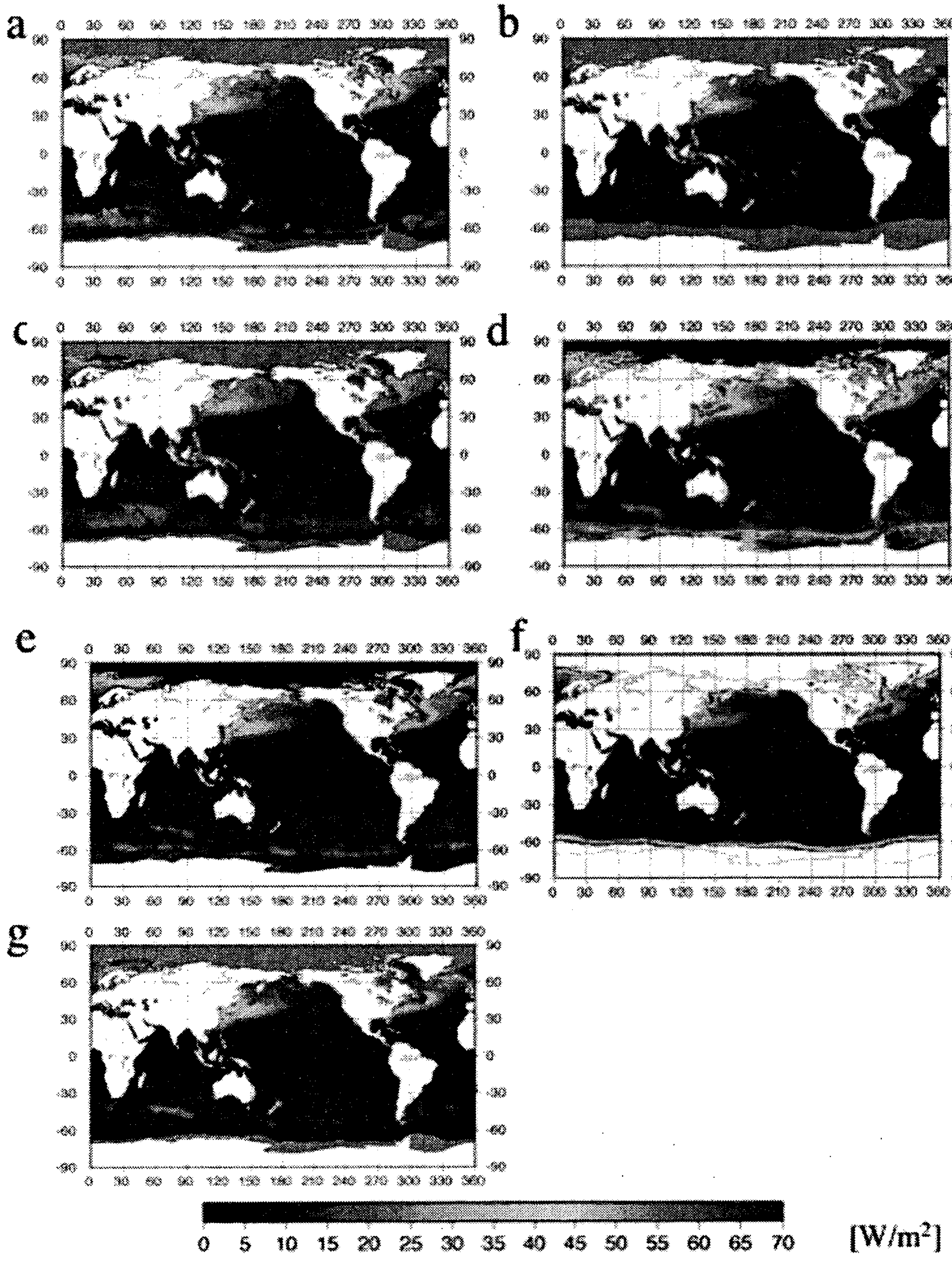

Figure 2. Standard deviation of sensible heat flux for the period of 1992-2000. a. J-OFURO , b.GSSTF2 , c.HOAPS2 , d.NRA1, e.ERA40, f. NRA1 adjusted, and g. J-OFURO2

gives largest values, more than 65 W/m2, while other data sets gives 30-45 W/m2 there. NRA1 adjusted data shows the smallest variability in the western boundary current regions. Generally the standard deviation is considerably small in other regions.

Figure 3 shows meridional distribution for mean sensible heat flux. The difference between data sets is relatively small. However, HOAPS2 shows a curios feature of large values south of 45°S. Probably the positive values are related to the algorithm that is used to estimate air temperature. Also NRA1 shows large values in mid-latitudes. These large values are strongly related to the overestimation in boreal winters shown in Fig.4.

4. Conclusions

Results from comparison of sensible heat flux for J-OFURO. J-OFURO2, HOAPS2, GSSTF2, ERA40, NRA1 and NRA1 adjusted data were presented. Time and space resolutions for data used are one month and 1 deg. by 1 deg., respectively. The general features of distribution for mean values and standard deviations ace similar. However, there are several regions quantitative differences can be found. For example, NRA1 shows large values in the western boundary current regions compared with other data sets. Also NRA1 shows smaller values in high-latitudes of southern hemisphere, while HOAPS2 shows large values there. NAR1 also generally shows large temporal variability, in particular in the western boundary current regions. This overestimation affects the meridional profile of sensible heat flux.

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Acknowledgments

This research was partly supported by Japan Aerospace Exploration Agency and the Category 7 of MEXT RR2002 Project for Sustainable Coexistence of Human, Nature and the Earth.

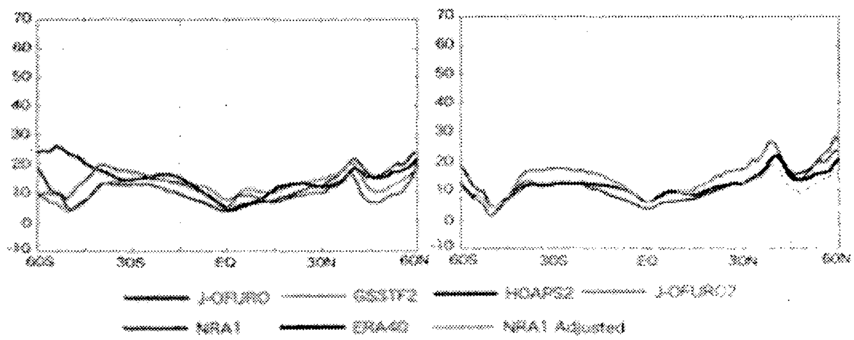

Figure 3. Meridional profile of zonal-averaged sensible heat flux.

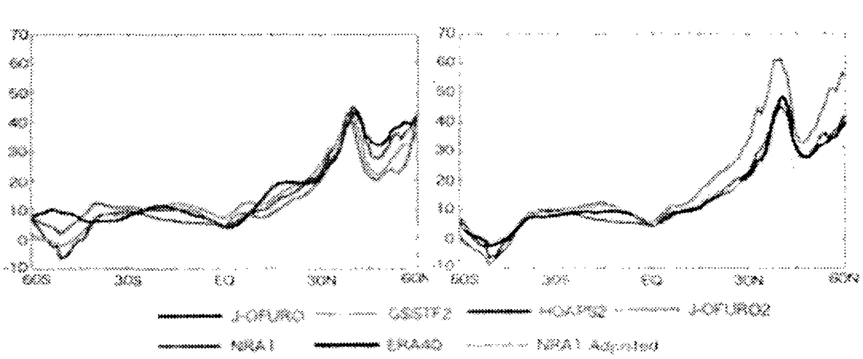

Figure 4. Meridional profile of zonal-average sensible heat flux in winter.