A 7.5-YEAR DATASET OF SSM/I-DERIVED SURFACE TURBULENT FLUXES OVER GLOBAL OCEANS

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1. INTRODUCTION

The global air-sea turbulent fluxes are needed for driving ocean models and validating coupled ocean-atmosphere global models. Chou et al. (1995, 1997) developed a method to retrieve surface air humidity from the radiances measured by the Special Sensor Microwave/Imager (SSM/I). Using both SSM/I-retrieved surface wind and air humidity, they computed daily turbulent fluxes over global oceans with a stability-dependent bulk scheme. Based on Chou et al. (1997), we have produced Version 1 of **G**oddard **S**atellite-Based **S**urface **T**urbulent **F**luxes (GSSTF) dataset from the SSM/I data and other data. It provides daily- and monthly-mean surface turbulent fluxes and some relevant parameters over global oceans for individual F8, F10, and F11 satellites covering the period July 1987-December 1994. It also provides 1988-94 annual- and monthly-mean climatologies of the same variables, using only F8 and F11 satellite data. It has a spatial resolution of 2.0°x2.5° lat-long and is archived at the NASA/GSFC DAAC (http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/hydrology/hd_main.html). The purpose of this paper is to present an updated assessment of the GSSTF 1.0 dataset.

2. DATA

The data sets used to derived turbulent fluxes are: 1) the SSM/I total precipitable water and 10-m wind speeds of Wentz (1994), 2) precipitable water in the lowest 500-m bottom-layer (W_B), 3) weekly mean sea surface temperature (SST) analyses of the National Centers for Environmental Prediction (NCEP), 4) 0Z and 12Z analyses of SST-T_{2m} (2-m temperatures) of the European Centre for Medium-Range Weather Forecasts (ECMWF), and 5) SSM/I 10-m wind directions of Atlas (1996). The W_B is estimated from the SSM/I antenna temperatures of Wentz (1993) using the method of Schulz et al. (1993). Daily mean SSTs for computing latent heat fluxes (LHF) are interpolated from the weekly means of Reynolds and Smith (1994). The 1990-93 annual-mean (and 1988-94 seasonal-mean) turbulent fluxes and input variables are derived from the F8 and F11 SSM/Is, which have slightly better data quality than the F10 SSM/I.

3. RESULTS

The retrieved surface air humidity is found to be generally accurate as validated against the collocated radiosonde observations over global oceans during February and August 1988 and the entire annual cycle of 1993. However, the retrieved surface air humidity (thus LHF) is slightly more accurate for F11 than for F10. In addition, there are significant regional differences of surface air humidity and LHF between the two satellites. This may be due to the morning orbital drift of the F10 satellite. Thus we only use F8 and F11 results to compute annual- and monthly-mean climatologies in the GSSTF 1.0 dataset. The retrieved daily wind stress and latent heat flux retrieved from the F10 and F11 SSM/Is show useful accuracy as verified against those of the RV Moana Wave and IMET buoy measured in the western Pacific warm pool during the COARE IOP. The1988-94 seasonal-mean wind stress, LHF, wind speed and sea-air humidity difference (not shown), derived from monthly climatologies of the GSSTF 1.0 dataset, have reasonable patterns related to seasonal variations of the atmospheric general circulation and are consistent with previous studies.

To assess regional biases of the retrieved fluxes, the 1990-1993 untuned results (referred to as UWM/COADS) of da Silva et al. (1994) are used. The 1990-93 annual mean turbulent fluxes, derived from F8 and F11 SSM/I data (Fig. 1), are compared with those of UWM/COADS

(Fig. 2). The SSM/I-minus-UWM/COADS differences of turbulent fluxes for 1990-93 are shown in Fig. 3, while those of the relevant parameters are shown in Fig. 4. The patterns of the 1990-93 annual-mean turbulent fluxes and relevant parameters (not shown) are generally in good agreement between SSM/I and UWM/COADS. The retrieved wind speed is generally within ± 1 m s^{-1} of UWM/COADS, but is weaker by ~1-2 m s^{-1} in the northern extratropical oceans. Da Silva et al. (1994) most likely underestimated anemometer heights (Kent and Taylor 1997), which could overestimate wind speeds particularly over high-wind regions of the northern extratropical oceans. The retrieved wind stress is generally within $\pm$ 0.02 N m^{-2} of UWM/COADS, except for the ocean south of 40°S. The results indicate that the wind directions in the extratropical oceans are steadier for SSM/I than for UWM/COADS.

Compared to UWM/COADS, the retrieved LHF and sea-air humidity difference (Q_S-Q_{20m}) are generally larger with significant differences in the trade wind zones and southern oceans (up to~40-60 W m^{-2} and ~ 1-1.5 g kg^{-1}). The difference in surface air humidity (Q_{20m}) between the two datasets is primarily responsible for these discrepancies. The Q_{20m} difference is believed to be mainly caused by higher UWM/COADS Q_{20m} arising from overestimation of dew point temperatures and from extrapolation of observed high Q_{20m} southward into data-void regions south of 40°S. For some stations in the trade wind regions and southern extratropical oceans, the retrieved surface air humidity compares well with the collocated radiosonde observations but its 1990-93 mean values are significantly smaller than those of UWM/COADS. The comparison with the measurements at the SW buoy of the Subduction experiment (Moyer and Weller 1997) also suggests the COADS Q_{20m} to be overestimated. This is consistent with some previous findings that ships overestimated dew point temperatures (Isemer and Hasse 1987; da Silva et al. 1994; Chou et al. 1997; Josey et al. 1999). Averaged over global oceans, the retrieved 1990-93 annual-mean LHF and Q_S-Q_{20m} are larger than UWM/COADS by 23.5 W m^{-2} and 0.55 g kg^{-1}, respectively. This result is consistent with previous studies that the latent heat fluxes based on ship measurements might be systematically underestimated (Oberhuber 1988; da Silva et al. 1994; Chou et al. 1997; Josey et al. 1999). The retrieved sensible heat flux (SHF) is generally within ± 5 W m^{-2} of UWM/COADS, except for some areas in the extratropics, where the differences in wind speed have large impact on SHF differences. The GSSTF 1.0 dataset derived from SSM/I is useful for climate studies, forcing of ocean models, and validation of coupled ocean-atmosphere global models.

4. REFERENCES

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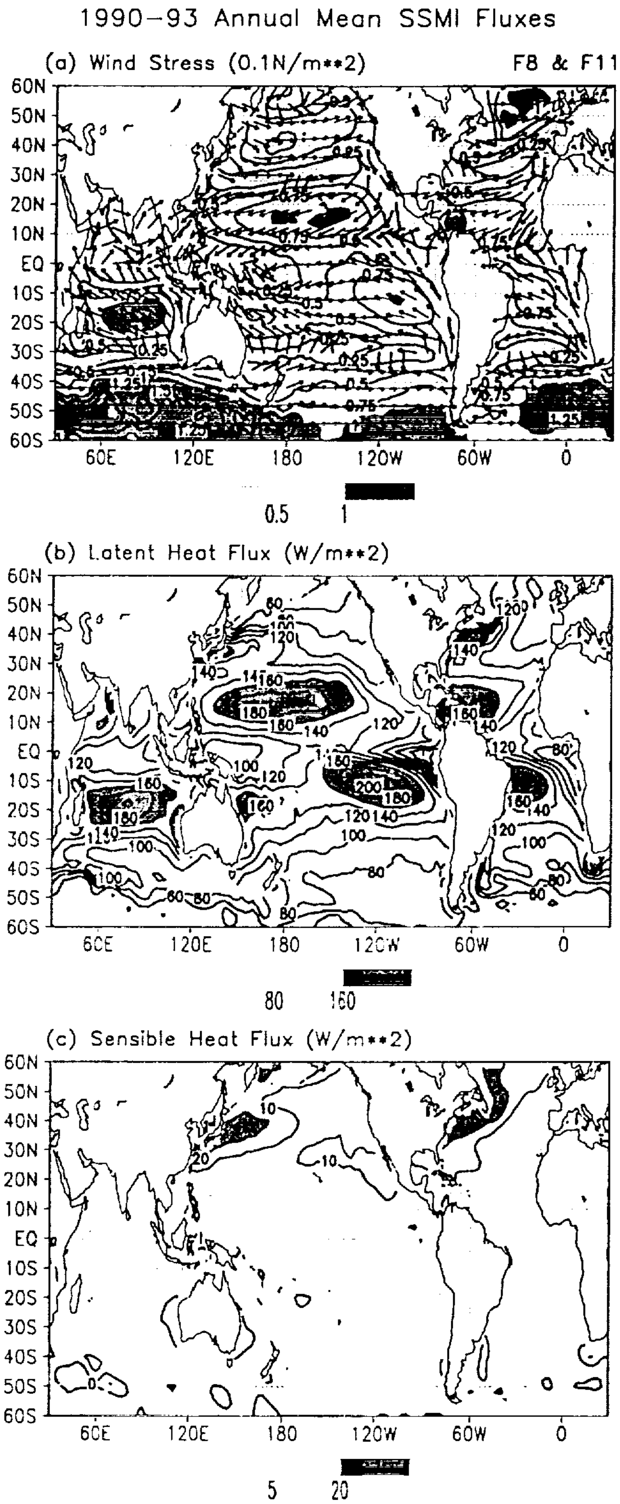

Figure 1 – Annual mean (a) wind stress, (b) latent heat flux, and (c) sensible heat flux, derived from F8 and F11 SSM/I data during 1990–93. Arrows indicate wind stress directions.

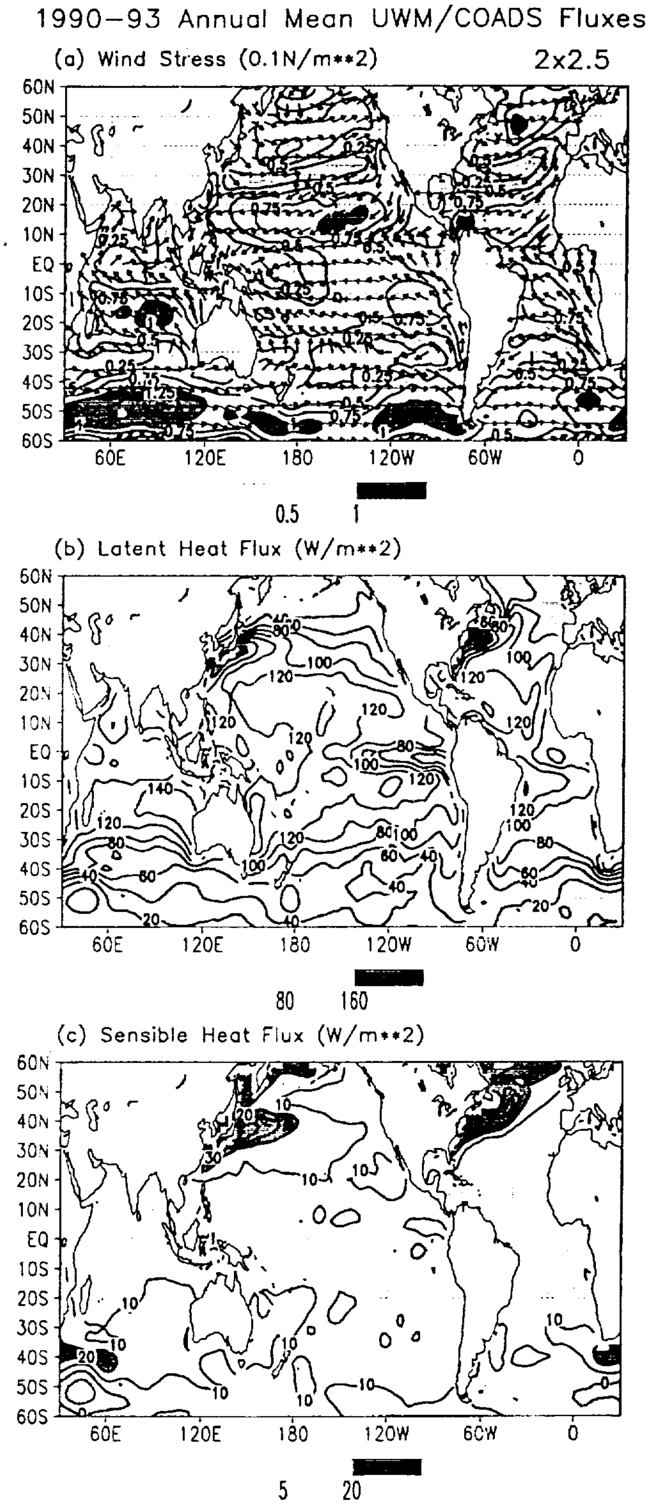

Figure 2 – Same as Fig. 1, except for UWM/COADS.

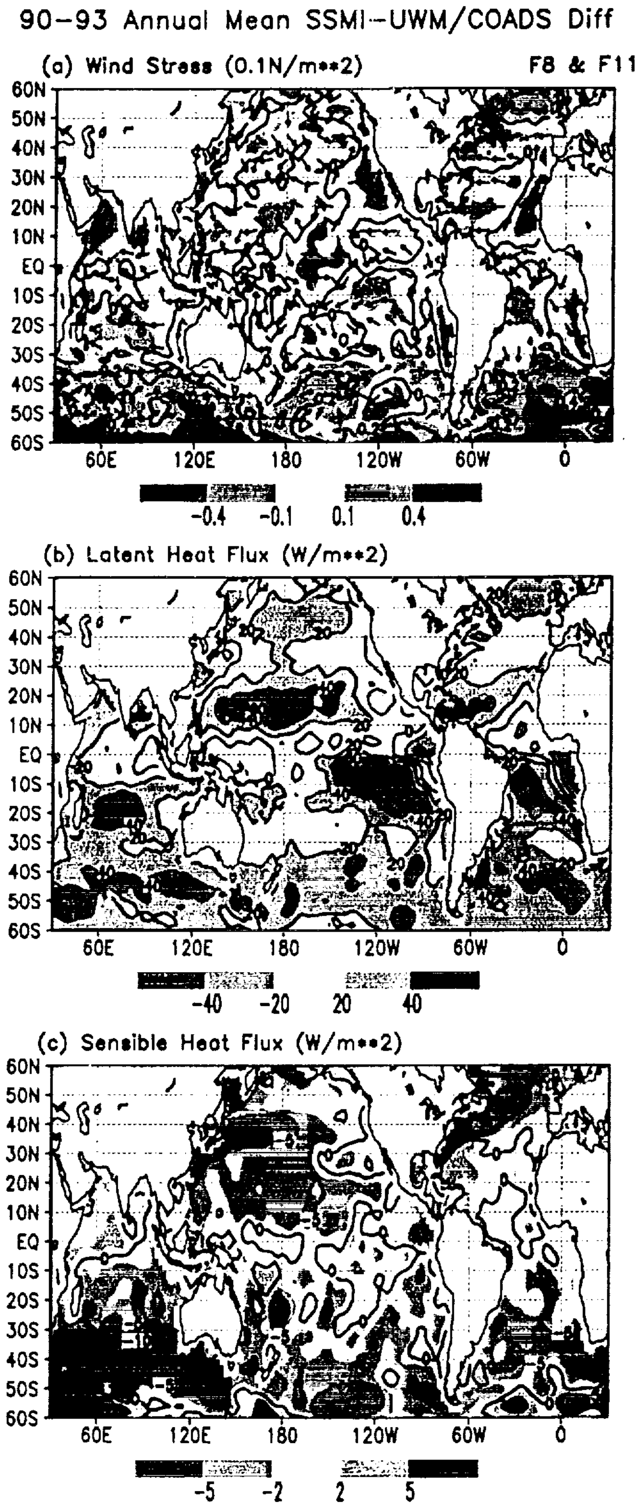

Figure 3 – SSM/I-minus-UWM/COADS differences of (a) wind stress, (b) latent heat flux, and (c) sensible heat flux for 1990–93. Arrows indicate wind stress difference directions.

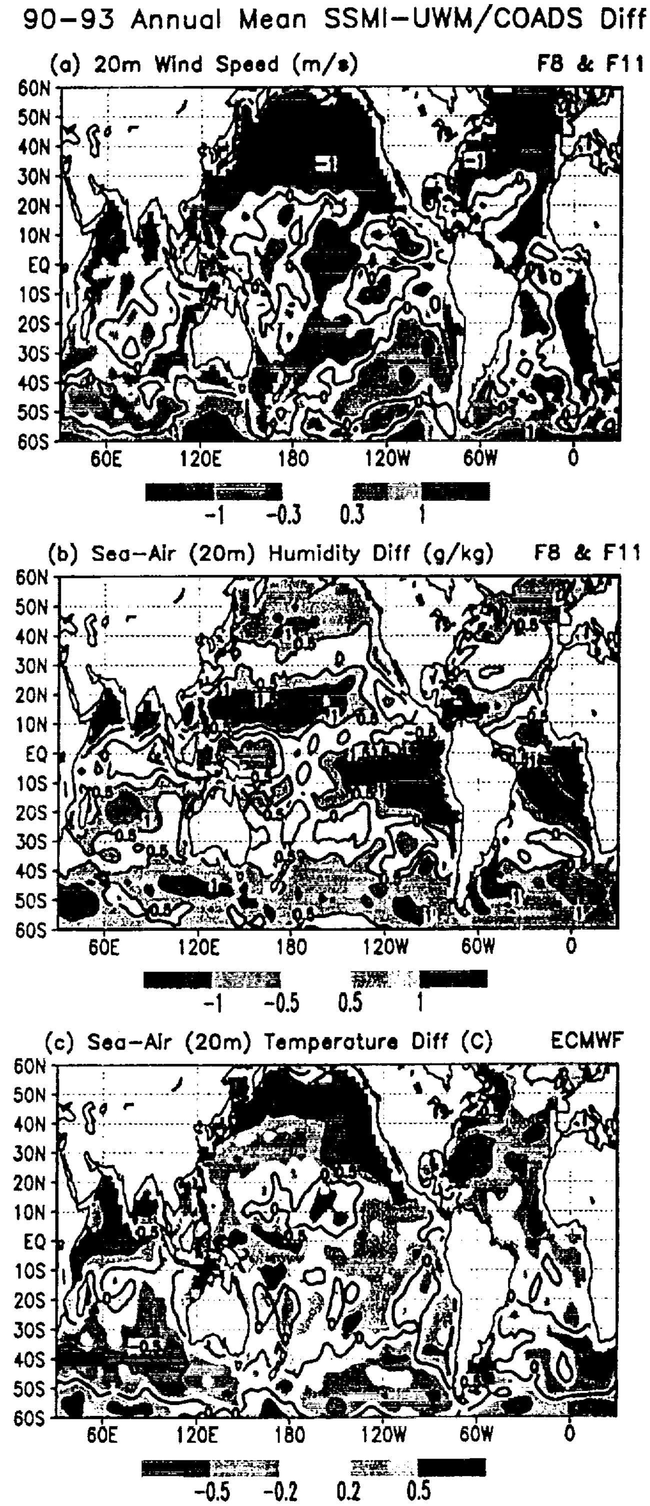

Figure 4 – SSM/I-minus-UWM/COADS differences of (a) wind speed, (b) sea-air humidity difference, and (c) sea-air temperature difference at the 20-m level for 1990–93.