Verification of JRA-25 Land Surface with CEOP Data

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INTRODUCTION

Land surface data of Coordinated Enhanced Observing Period (CEOP: Koike T., 2004) includes not only observed basic meteorological elements of surface air temperature, surface air humidity and precipitation but also radiative fluxes, soil moisture, ground surface temperature, soil temperature, and sensible and latent heat fluxes at land surface over the world-wide CEOP observation points. Therefore, it is indicated that the CEOP data is quite important for the verification and development of modeled land surface. In this study, the CEOP observational data is used for the verification of JRA-25 (Onogi et al., 2007) land surface data at the CEOP points.

DATA AND METHODS

The land surface data of the JRA-25 with the horizontal resolution of 1.125 degree is compared with those at the four CEOP locations named as the Lindenberg in Germany (14.12°E,52.17°N), the Southern Great Plain in USA (97.88°W,36.45°N), the Eastern Siberia Tundra in Russia (128.75°E,71.62°N) and the Chao Phraya River in Thailand (99.47°E,18.40°N) for the period of 2002-2003. For the Southern Great Plain, the CEOP data at three sites of Byron, Lamont, Ringwood are used except that radiative fluxes are not observed at Byron. These data and information of observation sites are obtained from one of the CEOP web sites (http://www.eol.ucar.edu/projects/ceop/dm/). To compare annual and seasonal cycles and intra-seasonal variability, all data are five-day-running-averaged.

RESULS

Figure 1 shows the time-sequences of five-day averaged surface air temperature of the CEOP observation at (a) Lindenberg, (b) Southern Great Plains, (c) Eastern Siberia Tundra and (d) Chao Phraya River with those at the corresponding nearest grid points of JRA-25 datasets (each thick line). Figure 2 is the same as Fig.1 except for surface air relative humidity. The five-day averaged surface air temperature and relative humidity of the JRA-25 correspond to those of the CEOP observation quite well except some periods.

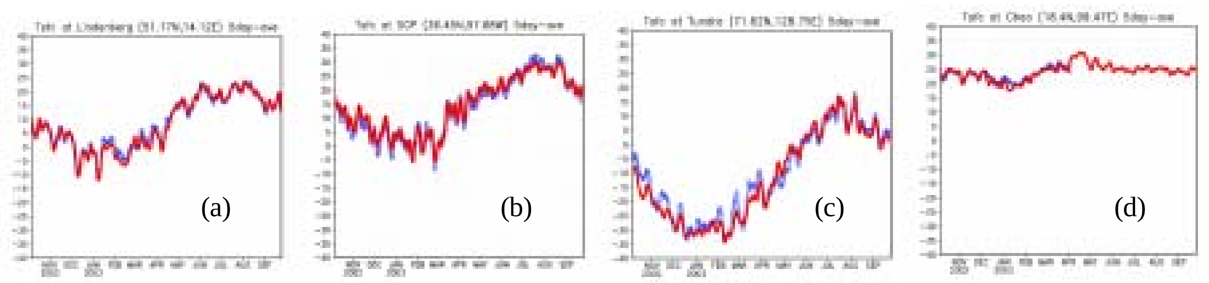

Figure 1 Time sequences of five-day averaged surface air temperature from 6 Oct. 2002 to 25 Sep. 2003 from the JRA-25 (red or black line) and the CEOP observation (blue, green, purple or grey line) at the four CEOP observation sites of (a) Lindenberg, (b) Southern Great Plains, (c) Eastern Siberia Tundra and (d) Chao Phraya River. Vertical range is from -40 to 40 degrees centigrade.

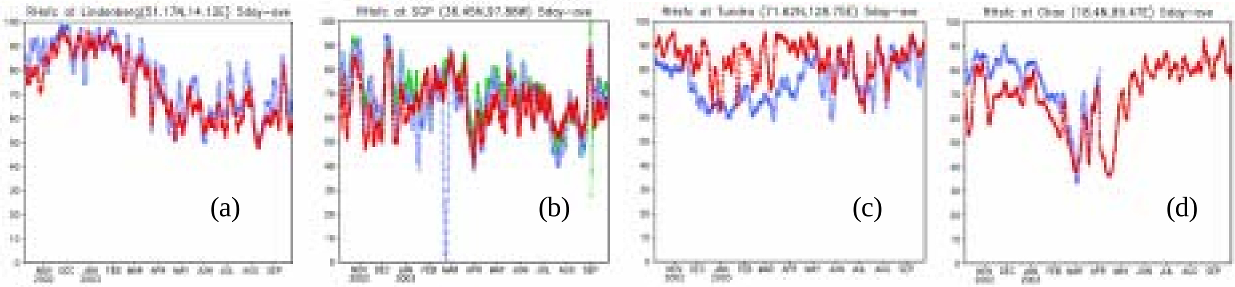

Figure 2 Time sequences of five-day averaged surface air relative humidity from 6 Oct. 2002 to 25 Sep. 2003 from the JRA-25 (a red or black line) and the CEOP observation (blue, green, purple or grey lines) at the four CEOP observation of (a) Lindenberg, (b) Byron, Lamont, Ringwood of Southern Great Plains, (c) Eastern Siberia Tundra and (d) Chao Phraya River. Vertical range is from 0 to 100 %.

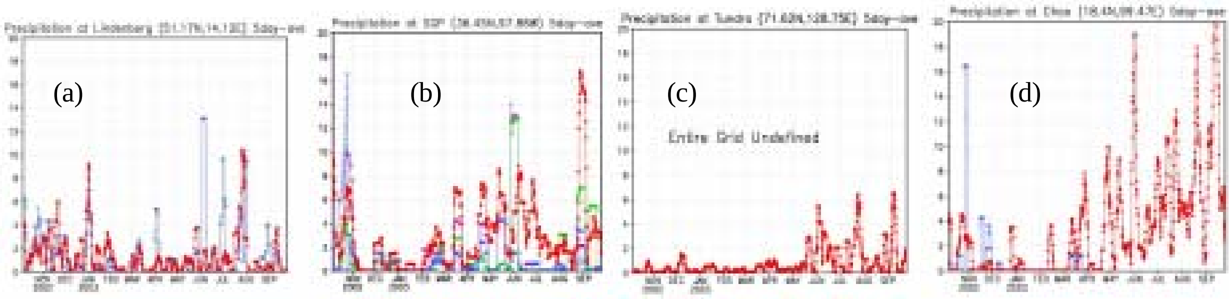

Figure 3 Same as Fig.2 except for precipitation. Vertical range is from 0 to 20 mm/day.

Figure 3 is the same as Fig.2 except for precipitation. Data from three observation sites of Byron, Lamont, Ringwood are shown in (b) the CEOP Southern Great Plains. From those data, uncertainty caused by locality of precipitation occurrence may be estimated. The relationship between JRA-25 and CEOP precipitation tends to be relatively good in the mid-latitude wintertime of (a) Lindenberg and (b) Southern Great Plain than in the tropics of (d) Chao Phraya River or the mid-latitude summertime probably due to less local convective precipitation.

Downward shortwave radiative fluxes of the JRA-25 (Fig. 4) show the similar short-term (intra-seasonal) variability to those of the CEOP, but the JRA-25 fluxes are systematically large in magnitude through seasonal cycles. These characteristics are common at the four CEOP observations. Therefore, it is strongly suggested that the differences may be due to less cloudiness simulation by the JRA-25 model over land. Less cloudiness of the JRA-25 is also suggested in the comparison of downward longwave radiative fluxes between JRA-25 and CEOP (Fig.5): the JRA-25 downward longwave radiative fluxes tend to be less than those of the CEOP commonly at the four observations systematically.

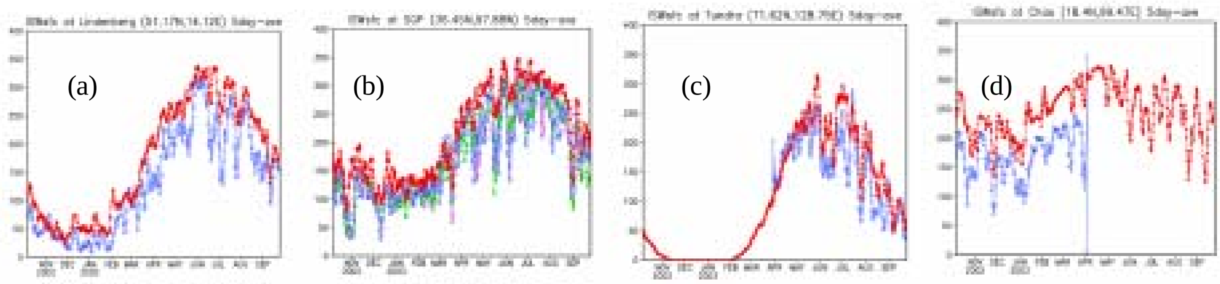

Figure 4 Same as Fig.3 except for downward shortwave radiative flux. Vertical range is from 0 to 400 W/m^2.

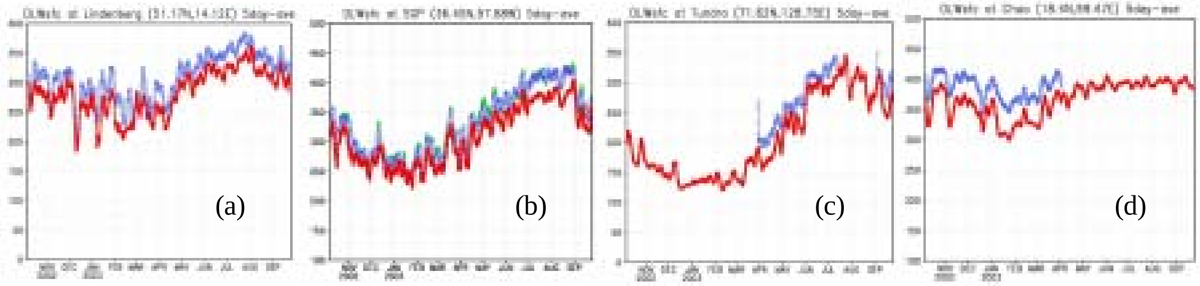

Figure 5 Time sequences of five-day averaged surface downward radiative flux from 6 Oct. 2002 to 25 Sep. 2003 from the JRA-25 (a red or black line) and the CEOP observation (blue, green, purple or grey lines) at the four CEOP observation of (a) Lindenberg, (b) Byron, Lamont, Ringwood of Southern Great Plains, (c) Eastern Siberia Tundra and (d) Chao Phraya River. Vertical range is from 0 to 400 W/m^2.

For surface albedo at the four observations, the CEOP and the JRA-25 well correspond each other for summertime but not during wintertime (Fig.6). The former fact indicates that a value for bare surface albedo is properly given in the JRA-25 model. The wintertime differences in northern areas are due to appearance of snow cover on ground surface, the difference in dry season of Chao Phraya River is unknown though. The albedo of CEOP seems to change with time from a bare-surface albedo to a high value of snow, depending on the existence or not of snow. The model albedo of JRA-25 varies moderately. It looks that some snow cover is left through wintertime even in Lindenberg and Southern Great Plains for JRA-25.

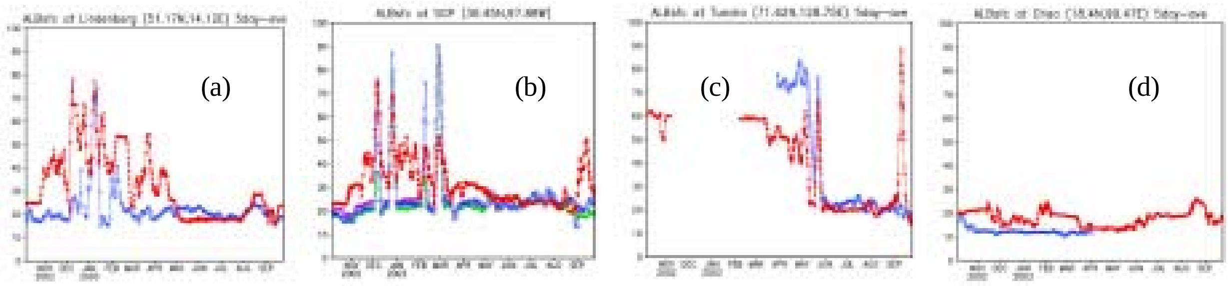

Figure 6 Same as Fig.5 except for shortwave surface albedo. Vertical range is from 0 to 100%.

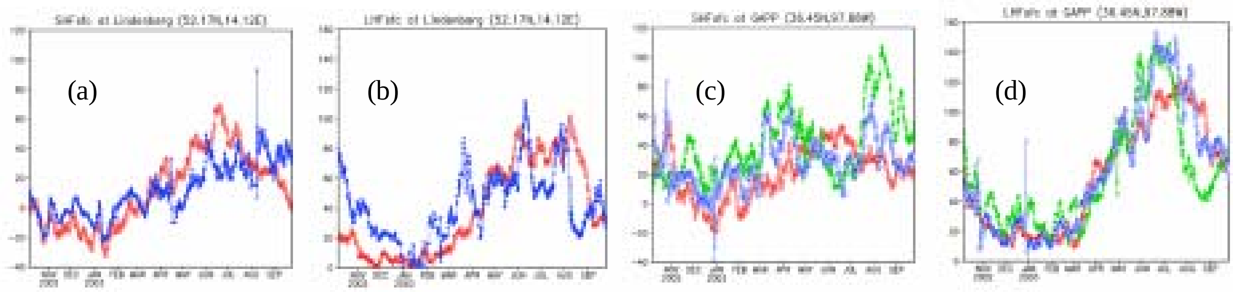

Figure 7 Time sequences of five-day averaged surface (a) sensible and (b) latent fluxes from 6 Oct. 2002 to 25 Sep. 2003 from the JRA-25 (a red or black line) and the CEOP observation (a blue or grey line) at Lindenberg. (c) and (d) are sensible and latent heat fluxes the JRA-25 (a red or black line) and the CEOP observation (blue, green or grey lines) at Lamont and Ringwood of Southern Great Plains. Vertical range is from 0 to 120 W/m^2.

Variability of sensible and latent heat fluxes of the JRA-25 are not well related to those of the CEOP observation at Lindenberg and Southern Plain (Fig.7) as compared with the cases of radiative fluxes. Some similarities between CEOP and JRA-25 are found in the respect of their seasonal change. For the CEOP observation of Southern Great Plaines, annual change of sensible heat flux in Fig.7c is small but that of latent heat flux in Fig.7d is relatively large. For Lindenberg, annual change of sensible and latent heat fluxes in (a) and (b) respectively is almost comparable in magnitude. The differences are probably explained by the fact that more solar energy is available for surface evaporation in summertime at the Southern Great Plaines sites located south as compared with Lindenberg. This climatology seems to be reproduced in the seasonal change of the JRA-25 sensible and latent heat fluxes.

Short-term or intra-seasonal variability in sensible and latent heat fluxes of JRA-25 are rather different from those of CEOP observation. This may partially come from the characteristics of these elements which may vary from local place to place. Actually, it seems that sensible heat fluxes are not coherently varied with time even at two sites of the Southern Great Plain CEOP observation (Fig.7) within the same single JRA-25 grid. This is the case for latent heat fluxes. However, even when the discrepancy of sensible and latent heat fluxes between the two observational sites of Lamont and Ringwood is considered as uncertainty or inconsistency on the model-grid scale at the Southern Great Plaines, it is difficult to conclude that the discrepancy in the temporal variability of sensible and latent heat fluxes between JRA-25 and CEOP is attributed all to the locality of those fluxes.

SUMMARY

This study demonstrates that the CEOP observation is quite useful for the verification of JRA-25. The comparison with the Southern Great Plains observation indicates that observational data at more than one site within a single model grid are generally quite helpful for meaningful comparisons between model and in-situ observation. Although much attention is also paid to locality of elements, the comparison between CEOP and JRA-25 helps identify the characteristics of the JRA-25 model and datasets for various elements. Quality of JRA-25 land surface data depends on elements and time-scale.

For uniformly distributed elements, the five-day averaged JRA-25 grid values are comparable to the CEOP point observation. Surface temperature and surface relative humidity are included in those elements. Precipitation and radiative fluxes at surface of JRA-25 are also reproduced similarly to the CEOP observation, but with less consistency. It is suggested that the occurrence of clouds having two aspects of precipitation and radiation are local phenomena especially in summertime in addition to the fact that those are strongly depending on the model physical processes. Soil moisture may belong to these types of elements since soil moisture is closely related to precipitation. It is found that short-term variability of sensible and latent fluxes show less similarity between JRA-25 and CEOP observation, their climatological changes have some common features between JRA-25 and CEOP though. It seems that strong locality of these elements is not enough to explain the discrepancy between JRA-25 and CEOP for these elements.

REFERENCES

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