Comparison of EBBR and SiB2 Model Sensible and Latent Heat Flux Values

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Introduction

A fundamental requirement for a general circulation model (GCM) is the specification of the lower boundary condition, including heat transfer by turbulence. Because of the variety of surface types within a GCM grid cell, it is not obvious how to obtain an accurate measure of the flux through the lower boundary from flux measurements that can be made at only a few locations. We used the Simple Biosphere model (SiB2 [Sellers et al. 1996]) driven by interpolated surface observations and applied it to each of 50 x 58 grid points covering the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) to represent the spatial variability of surface heat fluxes. We were then able to address key issues by (1) comparing averaged fluxes from the Energy Balance Bowen Ratio (EBBR) stations with average SiB2 fluxes for the site; (2) comparing average SiB2 fluxes from the grid points nearest the EBBR stations with the site-wide SiB2 flux; and (3) examining the SiB2 fluxes near the EBBR sites for systematic local flux variability.

Two fundamental questions that must be addressed, therefore, are:

- How well can sensible and latent heat fluxes be modeled or measured?
- How representative of the entire SGP CART is the average flux that occurs at the EBBR locations?

Correspondence Between Model and Data

To explore how well SiB2 can represent measured fluxes at a particular location, we compared SiB2 output with the EBBR station at the CART Central Facility. In general, we provide conditions to SiB2 that are most appropriate for each 6.25 km x 6.25 km grid area to which its computations apply. For this comparison, however, SiB2 was tuned to represent conditions in the immediate vicinity of the EBBR station at the Central Facility. The results shown in Figure 1 are encouraging. Each

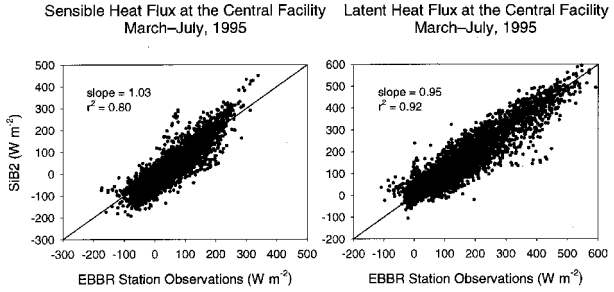

Figure 1. Heat flux comparison between the Central Facility's EBBR station with SiB2 tuned to represent the conditions in the immediate vicinity of that EBBR station.

point represents a half-hour average during the period March–July 1995. Overall, the SiB2 calculations explain 80% of the variance in the EBBR sensible heat flux measurements and more than 90% of the variance in the latent heat flux measurements.

The agreement between SiB2 and the EBBR measurements is more sporadic when the comparison is made over the site as a whole. Figure 2 shows time series of the average over all 2900 grid points of sensible heat flux computed by SiB2 together with the average sensible heat flux from all ten EBBR stations during July 1995. There are periods of very good agreement and periods of relatively poor agreement. Figure 3 shows that the same is true for latent heat fluxes. Noting the good results of Figure 1, we suspect that this result is at least in part a reflection of how well the EBBR station fluxes are representative of the larger 6.25 km x 6 km grid area within which they are located.

Representativeness of the EBBR Sites

To investigate the degree to which flux measurements at a small number of locations may represent the average flux over the SGP CART as a whole, we compared the SiB2 site average with SiB2 calculations for individual grid areas

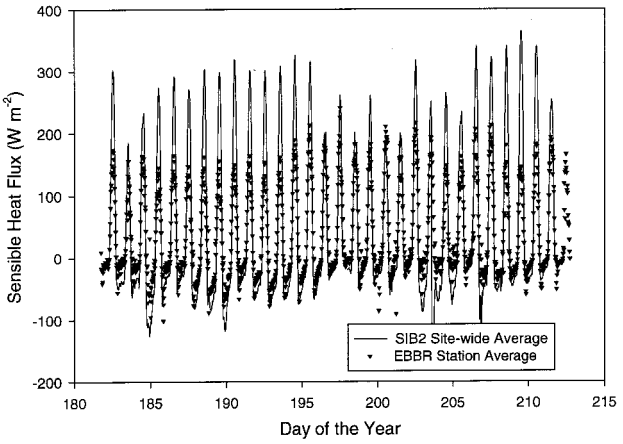

Figure 2. July 1995 time series of average sensible heat fluxes for all of the SGP CART grid point as modeled by SiB2 and for the measurements from the ten EBBR stations.

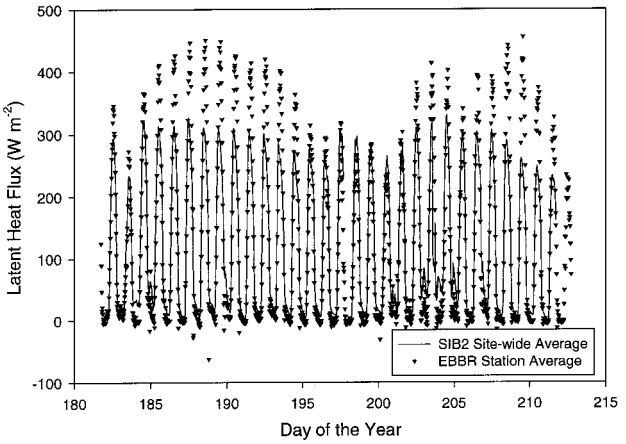

Figure 3. July 1995 time series of average latent heat fluxes for all of the SGP CART grid point as modeled by SiB2 and for the measurements from the ten EBBR stations.

containing the EBBR stations. Figure 4 shows a comparison of sensible heat fluxes between the site average and the grid points near the Central Facility and Elk Falls. It is clear that during July 1995 there was greater sensible heat flux than the site average at the Central Facility and less than the site average at Elk Falls. However, when heat fluxes from the grid areas containing these two sites and the other eight are

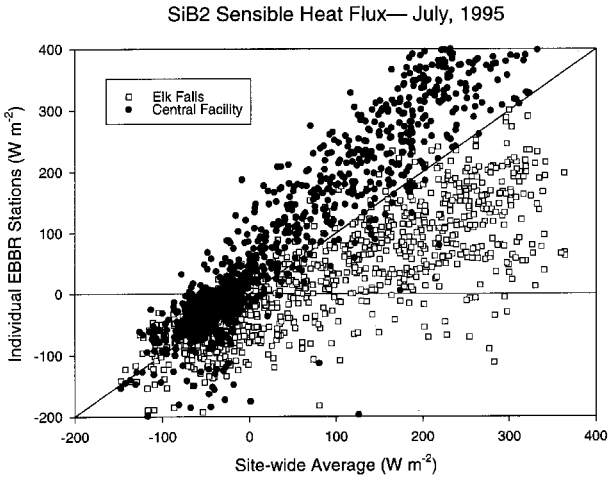

Figure 4. SiB2 sensible heat fluxes for two near-EBBR grid points compared with the SiB2 site-wide average.

averaged, the result is very close to the site average of all 2900 grid points. Figure 5 shows the result for sensible heat flux, where more than 99% of the variance in the site average is explained by the average of fluxes from the ten EBBR grid points. Figure 6 shows that the result is essentially the same for latent heat flux.

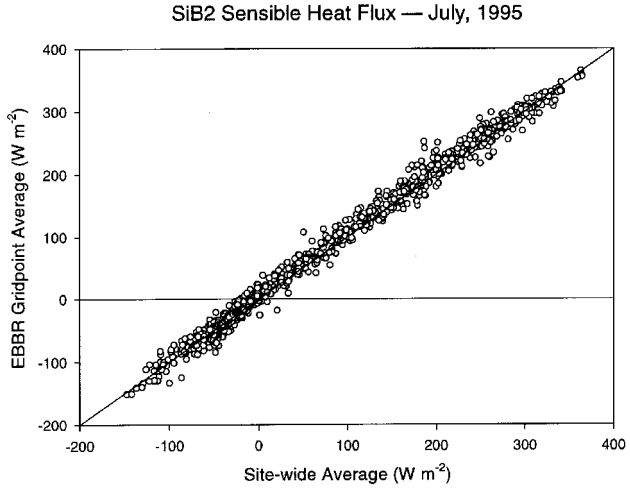

Figure 5. Comparison of the average sensible heat fluxes from the 10 SiB2 grid points closest to the ten EBBR stations with the average from all 50x58 SiB2 grid points spanning the CART.

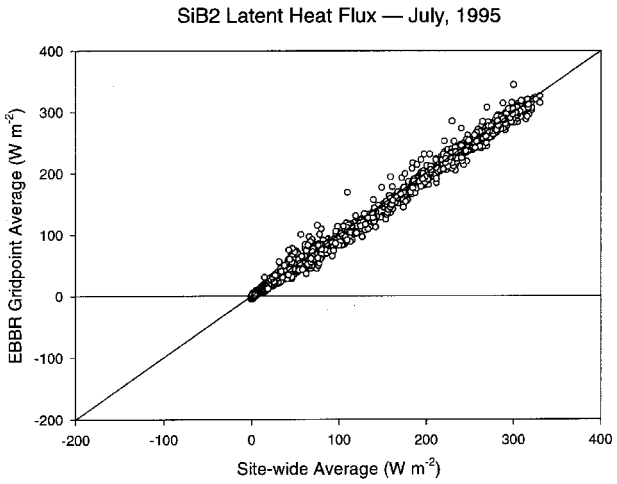

Figure 6. Comparison of the average latent heat fluxes from the ten SiB2 grid points closest to the 10 EBBR stations with the average from all 50x58 SiB2 grid points spanning the CART.

Summary and Conclusions

We have presented three fundamental results in this paper:

- There are periods of both good and poor agreement between the site-wide SiB2 and the EBBR average heat fluxes at the SGP CART.
- Fluxes modeled by SiB2 at the 10 EBBR locations, taken together, well represent the modeled heat fluxes averaged over all 2900 grid points of the CART.
- SiB2, when tuned for conditions in the immediate vicinity of an EBBR station, shows good long-term agreement with the measurements, although short-term departures (<weeks) need further refinement.

The primary unresolved issue is one of representativeness of individual flux measurements. There is a pattern of larger latent and smaller sensible heat fluxes measured by the EBBR stations than diagnosed by SiB2. This may be because the pasture locations of the EBBR stations are not representative of a 6.25 km x 6.25 km area corresponding to a SiB2 grid point. This is supported by the good long-term agreement found when SiB2 was tuned to reflect the conditions in the immediate vicinity of one EBBR station.

Reference

Sellers, P. J., D. A. Randall, G. J. Collatz, J. A. Berry, C. B. Field, D. A. Dazlich, C. Zhang, G. D. Collelo, and L. Bounoua, 1996: A revised land surface parameterization (SiB2) for atmospheric GCMs. Part I: model formulation. *J. Climate*, **9**, 676–705.