NOTES AND CORRESPONDENCE

Comments on ''Use of Midlatitude Soil Moisture and Meteorological Observations to Validate Soil Moisture Simulations with Biosphere and Bucket Models''

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Robock et al. (1995) discussed simulations using SSiB (Xue et. al. 1991), which is a simplified version of the Simple Biosphere (SiB) model (Sellers et al. 1986). In this evaluation of the performance of SSiB, Russian soil moisture data (Vinnikov and Yeserkepova 1991) were used. Robock et al. (1995) reported two major problems: 1) failure to reproduce the soil moisture peak related to the spring snowmelt and 2) substantial differences in the magnitude of the seasonal variations and the annual-mean values for some stations, even though the phase of the annual cycle was reasonable. Robock et al. give the impression that there is something incorrect about the basic model formulation. In this note we will show that the problems highlighted by Robock et al. can be ameliorated by correctly assigning the surface properties and by correctly partitioning the snowmelt between runoff and infiltration for frozen soil.

We have analyzed the problems. It seems that the first problem was caused by improper partitioning of snowmelt into infiltration and runoff when the soil surface was below freezing. A simple improvement was made to correct the first problem. In a revised version of the snow submodel, the partitioning of snowmelt into runoff and infiltration is based upon both surface and deep soil temperatures. This revised scheme allows for a progressive reduction in soil hydraulic conductivity as the soil freezes (Sellers et al. 1996) and has been used in SiB-type models since 1993.

The second problem was caused by erroneous assignments of the soil properties in the model. In the station simulations of Robock et al. (1995) the standard GCM-scale soil properties over Russia were used for all six Russian sites due to a lack of soil data. Soil characteristics can vary widely, even over short distances (Wetzel and Chang 1987; Peck et al. 1977). In particular, the soil conductivity can vary by a few orders of magnitude over relatively short distances. Therefore, the values used for GCM grid boxes may not be representative of the soil type at a station. In light of this consideration, we readjusted the soil property values for the six Russian sites in a recent study (Xue et al. 1996). This readjustment was based on our study of the sensitivity of SSiB to soil hydraulic properties in soil moisture simulations (for more details see Xue et al. 1996). Results with the new snow submodel and the new soil parameters for the top 100 cm at two Russian stations are shown in Fig. 1. The model was integrated for 6 yr, and the results in Fig. 1 were the average of the last 5-yr integration as performed by Robock et al. (1995). The results from old simulations are also depicted for comparison. Results for other stations and for 50-cm soil depths are similar.

Table 1 lists the rms errors of soil water content from the old and new simulations, as well as the soil prop-

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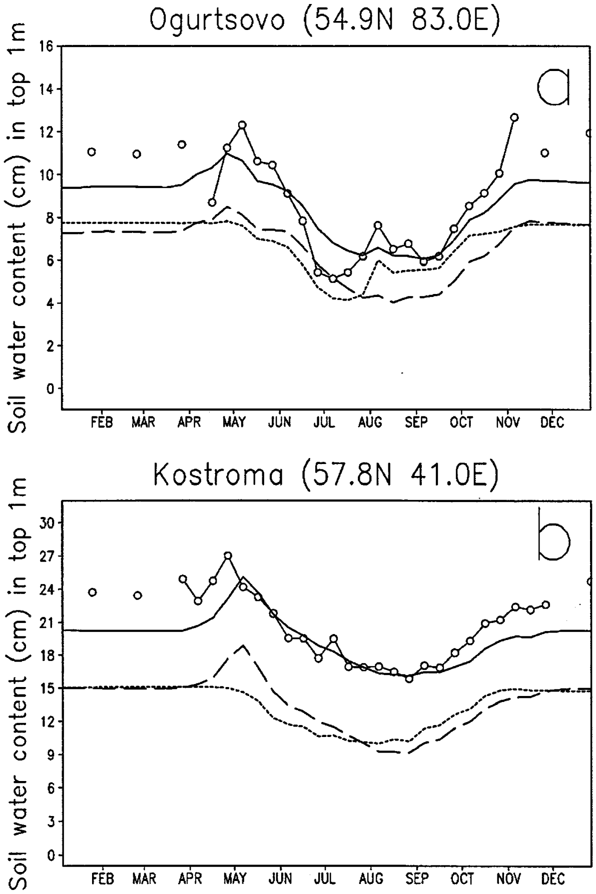

FIG. 1. Results of simulated soil moisture as compared to observations for (a) Ogurtsoro station in top 1 m and (b) Kostroma station in top 1 m. Open circle is observation; solid line is new results; dotted line is old results; and dashed line is new snow submodel with old soil properties.

TABLE 1. Soil properties for the Russian data and simulated rms errors (cm).

Stations	k_s	B	C_1	rms* (1-m layer/ 50-cm layer) Old	New
Khabarovsk	0.000001	11.12	4.8	13.8/8.9	11.9/7.9
Kostroma	0.000001	11.12	4.8	7.9/6.3	2.2/3.0
Ogurtsovo	0.000001	11.12	6.4	2.7/3.1	1.3/1.0
Tulun	0.00002	11.12	5.8	3.2/2.8	1.7/1.4
Uralsk	0.00002	7.12	6.4	1.7/1.7	1.1/0.9
Yershov	0.0002	7.12	6.4	2.6/1.8	2.2/1.8

* Units are cm; k_s is 0.00002; B is 7.12; and C_1 is 5.8 in the old tests.

erties used for these simulations. The soil properties include the hydraulic conductivity at saturation K_S, the sorption parameter B, and the logarithm of soil water potential at wilting point C_1. The simulated rms errors are reduced substantially and are now very close to the observational error of about 1 cm for the 1-m soil layer. For most stations, the reduction of the rms error is about 30%–50%. Figure 1 shows clear soil moisture peaks in the new simulations in spring. The new simulated annual cycle of soil moisture is much closer to that observed, especially between late spring and early fall. The results with old soil parameters and the new snow submodel are also shown in Fig. 1 for comparison.

These results have several implications. First, the intercomparison with field measurements provided valuable information for improving the snow submodel after the snow melting problem was revealed. Second, the need for an objective method of scaling from a single site to a larger scale, such as a GCM grid box, has been identified as a consequence of the sensitivity of the results to soil properties. Our new simulation shows that the use of proper parameter values is crucial for simulations at a single site. The GCM grid box values of soil properties are within the range of the station values; however, the differences between GCM grid boxes and the corresponding stations could be quite large (Table 1). Caution must be exercised in applying the parameter values from a small scale to a large scale, or vice versa. Although the SSiB and similar models undoubtedly should be improved, these results show that the problems presented in Robock et al.'s paper can be largely addressed by assigning appropriate values for the local surface properties, rather than questioning the formulation of the basic model structure. The new simulations clearly demonstrate that the improper assignment of the soil properties was the major problem in previous simulations.

Soil moisture is an important quantity in land surface modeling, but simulation of surface fluxes may not be very sensitive to the exact value of the soil moisture. Ultimately, the performance of SSiB, or any similar land surface parameterization scheme (LSP), must be judged by its ability to reproduce time series of large-scale surface–atmosphere fluxes, and surface runoff and drainage, rather than soil moisture profiles at a few small-scale sites, which are not good indicators of the hydrologic budget by themselves. Unfortunately, there was no such complete set of measurements available in the Russian dataset. However, more comprehensive examinations for the performance of different LSPs have been conducted in recent PILPS intercomparisons using other observational data, including the discussion on persistence of soil moisture memory in different models questioned in Robock et al. (1997) (e.g., Yang et al. 1995; Shao and Henderson-Sellers 1996; Chen et al. 1997). Readers should refer to these studies for further insights. The purpose of this comment is not to make a comparison between the bucket model and a biosphere model. However, we believe that according to the discussion above, since there were no observational data to provide soil and vegetation information required by the surface models or information on other surface water components and fluxes measurement in the Russian dataset, the conclusions drawn in Robock et al. (1995) cannot be considered definitive.

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