

## ***Interactive comment on “A scheme for calculating soil moisture content by using routine weather data” by K. Z. Shang et al.***

**K. Z. Shang et al.**

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reply to the Interactive comment of Referee 1

Question 1: Intuitively, ground vegetation cover plays an important role in modulating soil moisture and also the formation of sand storm. In the derived equation, I didn't see the explicit role of vegetation. Can the authors explain this? Answer65306; Indeed, ground vegetation cover plays an important role in preserving soil moisture and also the formation of sand storm. On a settled station, the routine weather elements and the soil moisture change obviously daily, but the ground vegetation cover change very small in half month (even a month), so it can be seen as constant in a short range. In equation (23) that we have established for calculating soil moisture:  $S = A + BX$ , A is the background soil moisture content when no rain for a long time, and B is the response factor of soil moisture to precipitation. A and B for the 79 stations are not the

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same. Because the ground vegetation cover is positive to soil moisture preserving, and reduce the response of soil moisture to precipitation, so A is higher and B is lower in the station where ground vegetation cover is more, otherwise, A is lower and B is higher in the station where ground vegetation cover is lower. According to the regression analysis for the 79 stations, A is positive related to longitude, cloud cover, and negative related to annual average temperature. This is accord with the distribution of ground vegetation cover, cloud cover, and annual average temperature in northern China. B is negative related to longitude, this means that the responsibility of soil moisture to precipitation become weak with the increase of ground vegetation cover. Therefore, the influence of ground vegetation cover on soil moisture is implied in equation (23).

Question 2: The soil moisture scheme is established based upon 79 stations. But the validation is only conducted at 7 stations which seems not very convincing. On the other hand, from the operational point, for sand-storm forecast, I assume spring/early summer soil moisture is very important. Thus, a comparison between calculated soil moisture time series to those of observations are highly desirable.

Answer65306;We agree to the opinion of the reviewer . But the problem we encountered is the available soil moisture data we can obtain are only at 79 stations of China from 1980 to 2002. We have used the data for establishing the soil moisture calculation scheme. The soil moisture data at the 79 stations from 01/01/2003 to now are not proofed by National Meteorological Center of China yet and can't be used by public. The data to have been used from 7 stations in the paper have been proofed by Gansu Meteorological Information Center of China and are available, which are not included within the data from the 79 stations from 1980 to 2002. In addition, the 7 stations are located in the geography center of China and are representative. Therefore, we think that, the validation has reasonable meaning.

Question 3: The calculation scheme is for irregular observational points, the authors should explain how the results then were transfered to the regular model grids, e.g., via interpolation etc. Then how such transformation will affect the results.

Question 5: Observations are not always handy, while numerical model outputs are easy to get. What's the prospect to use model outputs or hybrid forcing (a combination of model outputs and obs.) to derive soil moisture in the scheme instead of using observations only. This may be easier to implement as there is no to worry about missing data or lacking of observations. Also, in a changing climate, the relationship can change too. Using model outputs may help to resolve this problem. Can the authors comment on this aspect?

Answers about question 3 and question 565306; Though the calculation scheme is established by using irregular observational points' data, it only reveals the relationship between ground soil moisture and meteorological elements. So, we think that the scheme also can be used to calculate the ground soil moisture for regular points. For calculating soil moisture at regular grids, there are two ways to realize the purpose. One way is calculating soil moisture in irregular observational points, then interpolating the value to the regular grids. This way may bring evident errors in the area where meteorological station is rare. Another way is interpolating meteorological elements in irregular observational points to the regular grids, then calculating soil moisture in regular grids. If we merely use the meteorological elements in irregular observational points, this way also bring evident errors in the area where meteorological station is rare. As reviewer mentioned, the combination of model outputs and observational data by assimilation, to obtain the meteorological elements of precipitation, air temperature, air relative humidity, wind velocity, and cloud cover in the regular grids, to derive soil moisture will be a good idea. We try to do it.

Question 4: Almost all current numeric models have soil hydrology scheme that will calculate spatial-temporal-varying soil moisture. In addition, there are many land surface schemes too. Then, it would be very interesting to see, compared to some of them (e.g., reanalysis soil moisture or offline model simulated soil moisture), how much improvements this method can produce in estimating soil moisture and forecasting sand-storm in the retrospective sense. A reason for this is that such products (e.g., reanaly-

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sis soil moisture) is routinely updated through the assimilation system. Answers : We agree with the reviewer, and will try to compare soil moisture calculated by this scheme with soil moisture calculated by some numerical model.

Question 6: The authors should check the reference in the paper and review the introduction more carefully. E.g, P3, "In most numerical models, soil moisture content in China is treated as a constant ...". This shouldn't be the case. Almost all GCMs, though differing in the treatment of land surface hydrology, treat soil moisture as a time-dependent variable. This can be easily seen by looking at the recent IPCC AR4 models. Also P3, "Entin et al., 1999" is not about calculation soil moisture content. Also P3, "But this type needs real-time soil moisture content data of multiple layers as initial values and thus can not be used widely". This is definitely not true. Although true soil moisture initial conditions are hard to obtain, there are many spin-up methods available to reduce if not complete remove the effects of unrealistic initial conditions. P4 Line 2 "This type is good for drought monitoring and the climatic evaluation of soil moisture, but not so good for daily soil moisture content retrieval". The authors should explain why as not all readers have the necessary background. Answer: We have checked the reference in the paper and will revise the introduction.

Question 7: The application part, when comparing the forecasting result, the authors should explain in more detail of Figure 4 to demonstrate that soil moisture from their scheme help to improve the forecasting.

Answer: From 18 to 20/03/2002, a strong dust storm event occurred in northern China. Figure 4 shows the actual dust storm distribution with the simulated dust concentration distribution by using two kinds of different soil moisture schemes at 20/03/2002, 03:00UTC. It can be seen clearly that the actual sand-dust weather occurred in South-east Mongolia, middle and east of Inner Mongolia, northern China and the Big Bent of Yellow River, the maximum stronger center of dust storm occurred in the middle of the boundary of China- Mongolia, the second stronger center occurred in the Big Bent of Yellow River. The simulated dust concentration distribution output by the DOFS, with

soil moisture content input as shown in Fig. 2, shows that the maximum stronger sand-dust center is in Western Inner Mongolia, the second stronger sand-dust center is in the Big Bent of Yellow River and the middle of the boundary of China- Mongolia(Fig. 4a). The simulated dust concentration distribution output by the DOFS, but with soil moisture content input calculated according to our scheme as shown in Fig. 3 show that the maximum stronger sand-dust center is the middle of the boundary of China-Mongolia, the second and stronger sand-dust center is in the Big Bent of Yellow River and Western Inner Mongolia ( Fig. 4b). In a word , the distribution of simulated dust concentration shown in Fig.4 (b) is much closer to the observed intensity distribution of the dust event than that shown in Fig.4a. Particularly, the two simulated dust storm centers shown in Fig.4 (b) are much closer to the actually observed ones. The above results show that the forecasting accuracy of the DOFS can be clearly improved by using our scheme.

Question 8: With respect to conclusions part, Conclusion 1 seems ungrounded or at least is not the results of this paper. This has to be done by. e.g., looking at auto-correlation between sm and P. Additional contents are needed to support (3) and (4) [refer 1-5,7].

Answer: Conclusion(1) can be derived from the calculated result(Fig. 1b) that, the correlation coefficient between ground soil moisture and the ratio of precipitation to evaporation is maximum when the ratio non-linearly summed up to 16 days.

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 7451, 2007.

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