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Global modeling of soil evaporation efficiency for a chosen soil type

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One way of reproducing the dynamics of a system is by deriving a set of differential, difference or discrete equations directly from observational time series. A method for obtaining such a system is the global modeling technique [1]. The approach is here applied to the dynamics of soil evaporative efficiency (SEE), defined as the ratio of actual to potential evaporation. SEE is an interesting variable to study since it is directly linked to soil evaporation (LE) which plays an important role in the water cycle and since it can be easily derived from satellite measurements. One goal of the present work is to get a semi-empirical parameter that could account for the variety of the SEE dynamical behaviors resulting from different soil properties. Before trying to obtain such a semi-empirical parameter with the global modeling technique, it is first necessary to prove that this technique can be applied to the dynamics of SEE without any a priori information. The global modeling technique is thus applied here to a synthetic series of SEE, reconstructed from the TEC (Transfert Eau Chaleur) model [2]. It is found that an autonomous chaotic model can be retrieved for the dynamics of SEE. The obtained model is four-dimensional and exhibits a complex behavior. The comparison of the original and the model phase portraits shows a very good consistency that proves that the original dynamical behavior is well described by the model. To evaluate the model accuracy, the forecasting error growth is estimated. To get a robust estimate of this error growth, the forecasting error is computed for prediction horizons of 0 to 9 hours, starting from different initial conditions and statistics of the error growth are thus performed. Results show that, for a maximum error level of 40% of the signal variance, the horizon of predictability is close to 3 hours, approximately one third of the diurnal part of day. These results are interesting for various reasons. To the best of our knowledge, it is the very first time that a chaotic model is obtained for the SEE. It also shows that the SEE dynamics can be approximated by a low-dimensional autonomous model. From a theoretical point of view, it is also interesting to note that only very few low-dimensional models could be directly obtained for environmental dynamics, and that four-dimensional models are even rarer. Since a model could be obtained for the SEE, it can be expected, now, to adapt the global modeling technique and to apply it to a range of different soil conditions in order to get a global model that would account for the variability of soil properties.

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