Responses to the reviewers

Title: Improving model performance of ecosystem carbon cycle by integrating soil erosion related processes

Dear Editor,

We are grateful for the reviewers for the time and effort that they have taken to review our manuscript. We have addressed all the comments and made the suggested revisions for the manuscript. According to the instructions presented in your decision letter, we uploaded the file of the revision notes, revision (changes marked), revised manuscript.

Appended to this letter is our point-by-point response to the comments. The comments are reproduced (in black) and our responses are given directly afterward in a different color (in red). All the lines in our responses refer to the new line numbers. “Additional revisions” are placed at the end of the comments from reviewer.

We believe that the quality of the manuscript has been greatly improved after following the reviewers’ suggestions.

If there is any question, please feel free to contact me.

Yours sincerely,

Wensi Ma

Reviewer #1:

1. evaporation (ET) (the average r is) is what?

Response:

Thanks for your comments. In the revised manuscript, we have added the concrete value as follows: *"evaporation (ET) (the average r is 0.76)"* in **line 17**.

2、Soil nutrients 39 are lost with runoff and sediment, this sentence is replicated.

Response:

Thanks for your comments. In the revised manuscript, we have changed the sentence as follows: "*Under the influence of long-term soil erosion, the nutrient-rich topsoil layer is gradually denuded and the soil nutrients are lost to runoff and sediment, which leading to a decrease in soil fertility and thus reducing the erosion resistance of the soil."* The revised part is shown in **Line 39-41**.

3、etc isn't a meteorological data, Please identify all meteorological data included.

Response:

Thanks for your comments. In the revised manuscript, we have added theall meteorological data as follows: *"The meteorological data include wind speed, relative humidity, pressure, radiation, daily maximum temperature, daily minimum temperature, daily average temperature, precipitation."* The revised part is shown in **Line 86-88**.

4、In the soil module, where to find?

Response:

Thanks for your comments. The IBIS model consists of five modules: land surface module, vegetation dynamics, vegetation phenology, subterranean carbon and nitrogen cycling, and soil geochemistry (Fig 2). The soil module is soil physical processes, which in land surface module.

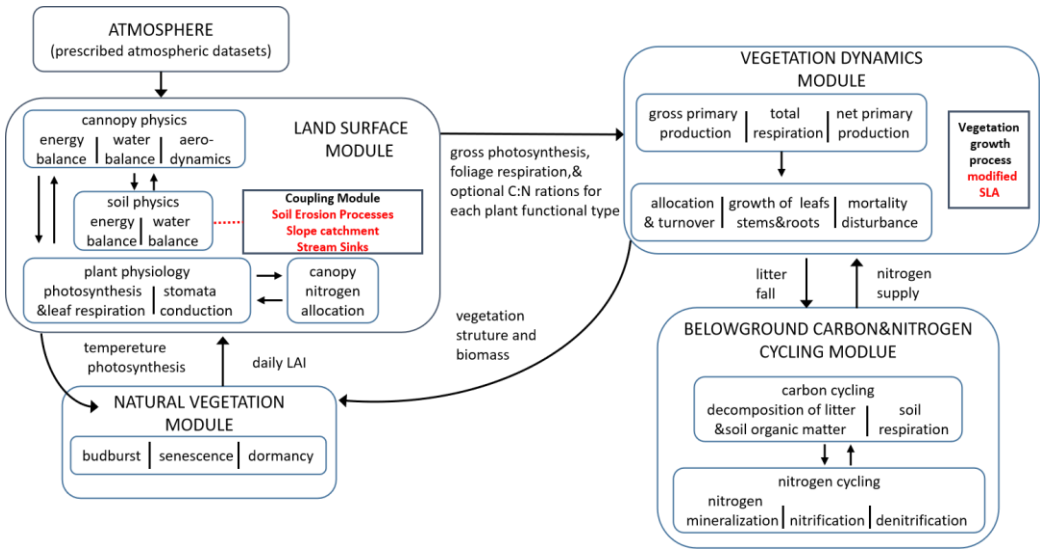

Fig 2. Modeling framework and improvement modules (refer to [35])

5、soil water content is calculated using the Richard equation References??

Response:

Thanks for your comments. We have added reference sources for all formulas, the formulas from the IBIS model description paper as follow:

"Foley, J. A., Prentice, I. C., Ramankutty, N., Levis, S., Pollard, D., Sitch, S., Haxeltine, A. An integrated biosphere model of land surface processes, terrestrial carbon balance, and vegetation dynamics. Global biogeochemical cycles, 1996,10(4), 603-628."

In the revised manuscript, we have added the reference sources as follows: *"To simulate the soil hydrothermal regime, we calculate the soil temperature, the water content, and the ice content of a given soil layer [20], Using the heat diffusion equation [20], The GPP calculation [20], This threshold day forms the basis of the leaf area index (LAI) calculations [20]"* in **line 120, 134, 150**.

6、These formulas created by the authors? If not, where are the bibliographic references?

Response:

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7、 In the phenological module, it is assumed that deciduous plants begin to germinate in winter when the growth of a particular plant functional type exceeds a certain threshold. Who defined and when?

Response:

Thanks for your comments. Botta et al focus on the prediction of spatial patterns of the climatological onset date of leaf growth for the decade 1983-1993. It examines the possibility of extrapolating existing local models of leaf onset date to the global scale.

Nevertheless, they define the unified model by retaining the model that best reproduced the spatial distribution of leaf onset dates for each biome. The main spatial patterns of leaf onset date are well simulated. They assumed that deciduous plants begin to germinate in winter when the growth of a particular plant functional type exceeds a certain threshold. This threshold is defined by the day when two conditions are met: 1) the average temperature (Avt10) is greater than 5° C for 10 consecutive days and 2) at least 100 days have experienced temperature increases greater than 0° C (GDD_0). When Avt10 is less than 5° C, the vegetation enters the withered yellow period. The IBIS model is an application of this rule-based formulation to describe the winter and dry season defoliation behavior of some specific plant functional types.

Specific references are as follows:

Botta, A. , Viovy, N. , Ciais, P. , Friedlingstein, P. , & Monfray, P. A global prognostic scheme of leaf onset using satellite data. Global Change Biology, 2000,6(7), 709-725.

8、 I didn't see any reference to this figure in the text.

Response: Thanks for your comments. The reference to this figure in the text as follow: *"The IBIS model consists of five modules: land surface processes, vegetation dynamics, vegetation phenology, subterranean carbon and nitrogen cycling, and soil geochemistry (Fig 2)."* in **Line 99-101**.

9、 Fig. 2. modeling framework and improvement modules should capital letter.

Response: Thanks for your comments. In the revised manuscript, we have changed the sentence as follow: *"Fig 2. Modeling framework and improvement modules (refer to [35])"* **in line 175.**

10、4.2 Parameter sensitivity should be about results and not about discussion?

Response:

Thanks for your comments. In the revised manuscript, we have divided the discussion 4.2 Parameter sensitivity into the result *3.4* Parameter sensitivity *Parameter sensitivity* and discussion 4.2 Parameters affecting simulation results.

"3.4 Parameter sensitivity

As shown in Table 6, the simulation results are most sensitive to changes in the Z0m.

For the cropland, a 20% increase in the Z_{0m} decreased ST and NEE by 26.68% and 18.25%, respectively, and increased SW, ET, and Re by 86.43%, 42.71%, and 38.07%, respectively. Therefore, the accuracy of the input parameters plays an important role in the simulation results. While the +20% change in the SLA value resulted in a moderate NPP increase of 5%-8%, the sensitivity of NEE to SLA is much higher than that of NPP."

"4.2 Parameters affecting simulation results

Soil water content and ET are greatly affected by the dynamic roughness, which reflects the weakening effect of different ground surface characteristics on the wind speed [43]. The vegetation characteristics and the wind speed cannot be ignored in sparsely vegetated areas. Z0m is negatively correlated with wind speed, and wind speed is positively correlated with ET [50]. An increase in the Z_{0m} parameter represents a decrease in the wind speed, which in turn leads to a reduction in the ET value.

SLA values can directly affect the efficiency of vegetation in capturing light and CO_2[49]. Higher SLA values means that plants usually have higher productivity values, and that plants with lower specific leaf area values experience more efficient photosynthesis in limited resource conditions [51]. SLA is involved in the area-based biochemical parameterization of photosynthetic enzyme concentrations linking LAI to NPP and provides structural parameters linking leaf carbon distribution to LAI [44,52]."

The revised part is shown in **Line 272-282, 333-345**.