A study on open-ended intercomparison of terrestrial carbon cycle model

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The simulation of terrestrial carbon cycle model is an important means to estimate and predict the distribution pattern and change trend of carbon budgets at different scales. With the development of the terrestrial carbon cycle model, its types become more and more diverse and the mechanism become more and more complex. The intercomparison of terrestrial carbon cycle model has become a hot and difficult point in current research. A number of terrestrial carbon cycle model intercomparison projects have been carried out internationally, and some research institutes have released some open source comparison tools. However, the intercomparison of terrestrial carbon cycle model still faces some problems, mainly reflected in the fairness, openness, reproducibility and reusability of the comparison solution, the intercomparison of terrestrial carbon cycle model still require further research.

**[Document Title]**

Aiming to compare the terrestrial carbon cycle model openly in the network environment, this paper closely follows the two difficulties in the comparison process, including the fairness, openness, reproducibility and reusability of the intercomparison solution. This paper takes the service componentization as the entry point, specifically including terrestrial carbon cycle model resources, data resources and comparison method resources. The open-ended intercomparison solution is driven by the scientific workflow engine, and realized by the integrated scheduling of model resources, data resources and comparison method resources. This paper provides a new idea for the intercomparison of terrestrial carbon cycle model.

The main research contents and results are as follows.

1. The construction of an open-ended intercomparison system architecture for the terrestrial carbon cycle model. Aiming to compare the terrestrial carbon cycle model open-endedly, this paper designed a fair, open, shareable and reuseable comparison solution, which divide the comparison process as three tiers, “comparison topic”, “comparison project” and “comparison task”. As the terrestrial carbon cycle model and data are developed and updated continuously, this paper designed a distributed intercomparison system architecture with high scalability, flexibility and stability, in this architecture we support the access of new model and dataset.
2. The service componentization of the comparison resources the terrestrial carbon cycle. This paper summarized and designed a universal process of servitization of terrestrial carbon cycle model, data and comparison methods, including the analysis of heterogeneity, the structured description and expression, encapsulation, deployment and finally release. Through this process, local terrestrial carbon cycle model, data and comparison methods are transformed web-services. Among them, data services include spatial information service like WMS/WCS/WFS, data upload and data download services, data refactor services. Model services include IBIS, Biome-BGC and LPJ services. Comparison services include visual comparison services and statistical comparison services. Those service componentization give a guaranty to the scalability of the comparison system, and could provide public and transparent comparison resources.
3. The construction of intercomparison engine to terrestrial carbon cycle model. In order to implement the resource scheduling, task distribution and execution among model services, data services and comparison service, this paper designed a scientific workflow engine, with which achieved the open-ended comparison of the terrestrial carbon cycle model.

This paper designed a fare, open, reproducible and reusable terrestrial carbon cycle model intercomparison system, and provided a new idea for the intercomparison of terrestrial carbon cycle model.

**Keywords:** Terrestrial carbon cycle model, Model comparison, Web service, Service integration