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Parallel Computing for Module-based Computational Experiment: A Case Study of Carbon Decomposition using ELM Modules

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Many large-scale scientific applications play an important role in improving and exploring our daily life. However, it is often very expensive to maintain those codes, and even more difficult to quantify and evaluate on specific function's effect due to the lower-level program construction and the codes' complexity. Based on previous work on functional unit testing, we developed a data driven parallel computing framework to facilitate module-based computational experiment. By adopting parallel data-driven pipeline and fast IO network, our model achieved a good performance on ORNL's leadership computing facilities. In this research, we extracted key functions from the E3SM land model (ELM) that represent the carbon decomposition process. Then, we compared the performance of the de-composition reaction network within the ELM using data collected from the long-term intersite decomposition experiment team (LIDET). The decomposition submodel is the convergent trophic cascade (CTC) used in a number of studies in the Community Land Model. Since CTC was evaluated using LIDET data previously, therefore, in this study, we first verified that in the LIDET study using our standalone module does not introduce unrealistic feedbacks between the simulated litter bags and vegetation growth. Then we used the standalone CTC submodel to investigate (1) the impacts of default settings of litter decomposition parameters, and (2) the influence of nitrogen limitation, and the temporal variability of its limitation, on litter decomposition.