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Coupling PFLOTRAN into E3SM through a Collaboration between the CMDV and Ngee Arctic Projects

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Microbially-explicit soil biogeochemistry (BGC) models are thought to be more biologically realistic than conventional models, and improved model structures can potentially better represent field- and lab-scale observations. The microbe-enabled BGC module will be implemented in the PFLOTRAN-BGC framework, which has been developed under the Ngee- Arctic project. PFLOTRAN can solve a system of nonlinear partial differential equations describing multi-phase, multi-component and multi-scale 3-D flow and reactive-transport in porous media. We have developed a generic interface in the Energy Exascale Earth System Model (E3SM) through the CMDV project. The interface facilitates the coupling of PFLOTRAN into the E3SM Land Model (ELM). The development of this interface is to enable flexible and fast development and evaluation of soil BGC modules and their coupling to various thermal- hydrology (TH) and aboveground vegetation modules. The interface includes a generic data- structure to pass data between submodels (i.e., vegetation, TH and BGC) and allows users to select a specific submodel from multiple options (e.g., ELM-BGC or PFLOTRAN-BGC for BGC). We evaluate ELM-PFLOTRAN and compare it to the original ELM and observations at a field site near Barrow (recently renamed Utqiagvik), AK. The ELM-PFLOTRAN simulations (e.g., GPP, LAI, and total soil organic carbon) were improved by modifying the nitrogen (N) uptake profile with N fixation profile (representing root distribution). Without this improvement, there is not enough N in ELM-PFLOTRAN to support plant growth and accumulation of SOM during model spin-up. Further coupling of PFLOTRAN-TH into ELM is underway and the coupled PFLOTRAN TH-BGC will be tested at both point and regional scales.