Improving the representation of lateral flow in E3SM land model

Sub-grid heterogeneity of landscape and its associated lateral flow have important implications for water, energy, and carbon cycles; however, they are not explicitly considered in E3SM land model (ELM). To address this challenge, we coupled a hybrid-3D hillslope hydrological model, namely h3d, with ELM. Using 1-D vertical and pseudo-2D lateral components, h3d can solve hydrological responses at hillslope scale with high computational efficiency.

We employed the hillslope width function and soil thickness to depict the sub-grid heterogeneity of landscape (i.e. hillslope width, length, and depth to bedrock). We then designed a multi-soil column structure under the ELM land unit to couple with h3d. Sub-grid water table variation and lateral flow are solved for each soil column by h3d. We carried out global simulations and examined the results at both global and major basin scales. Preliminary results show that, comparing with the default ELM, the new lateral flow scheme has almost the same computational efficacy, and it is able to produce comparable results at ELM grid level. Meanwhile, the new scheme can produce different water and energy states at sub-grid level which alters important land processes.