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Pursuing the method of multiple working hypotheses to understand differences in process-based snow models

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When faced with the complex and interdisciplinary challenge of building process-based land models, different modelers make different decisions at different points in the model development process. These modeling decisions are generally based on several considerations, including fidelity (e.g., what approaches faithfully simulate observed processes), complexity (e.g., which processes should be represented explicitly), practicality (e.g., what is the computational cost of the model simulations; are there sufficient resources to implement the desired modeling concepts), and data availability (e.g., is there sufficient data to force and evaluate models). Consequently the research community, comprising modelers of diverse background, experience, and modeling philosophy, has amassed a wide range of models, which differ in almost every aspect of their conceptualization and implementation. Model comparison studies have been undertaken to explore model differences, but have not been able to meaningfully attribute inter-model differences in predictive ability to individual model components because there are often too many structural and implementation differences among the different models considered. As a consequence, model comparison studies to date have provided limited insight into the causes of differences in model behavior, and model development has often relied on the inspiration and experience of individual modelers rather than on a systematic analysis of model shortcomings.

This presentation will summarize the use of "multiple-hypothesis" modeling frameworks to understand differences in process-based snow models. Multiple-hypothesis frameworks define a master modeling template, and include a a wide variety of process parameterizations and spatial configurations that are used in existing models. Such frameworks provide the capability to decompose complex models into the individual decisions that are made as part of model development, and evaluate each decision in isolation. It is hence possible to attribute differences in system-scale model predictions to individual modeling decisions, providing scope to mimic the behavior of existing models, understand why models differ, characterize model uncertainty, and identify productive pathways to model improvement. Results will be presented applying multiple hypothesis frameworks to snow model comparison projects, including PILPS, SnowMIP, and the upcoming ESM-SnowMIP project.