**Physics-informed Machine Learning for Uncertainty Quantification in E3SM Land Model**

**Khachik Sargsyan1, Cosmin Safta1, Vishagan Ratnaswamy1, Daniel Ricciuto2**

1 Sandia National Laboratories, Livermore, CA

2 Oak Ridge National Laboratory, Oak Ridge, TN

The focus of this work is approximating Energy Exascale Earth System Model (E3SM) Land Model (ELM) dynamics with neural networks (NNs). Building such surrogates for ELM is necessary to enable ensemble-intensive studies such as parameter estimation, uncertainty quantification, and optimal experimental design.

Due to the temporal nature of the model, the surrogate is constructed with a recurrent NN architecture with long-short term memory units. The architecture is then adjusted with a hierarchical structure informed by the known relationships between the various inputs, state variables, and QoIs. The resulting NN surrogate mimics the physical relationships between the underlying processes and provides a natural structure for temporal evolution. Using this surrogate, we then perform global sensitivity analysis to identify the most influential input parameters for dimensionality reduction and Bayesian model calibration when observational data is provided.