Understanding the complexity of Earth’s dynamic systems is notoriously difficult due to limited knowledge of process mechanics, feedback mechanisms, systems couplings, and the inherent scale-dependent nature of polygenetic landscape evolution. Geospatial data and information technologies can be effectively utilized to investigate complex systems by characterizing and mapping landscape biophysical properties that govern processes, and are required in numerical modeling and validation efforts. Unfortunately, numerous challenges related to conceptual representation, spatial analysis, mapping, empiricism, computation, parameterization schemes and spatial modeling approaches require new information extraction and synthesis capabilities to facilitate knowledge discovery. This talk presents numerous examples of multidisciplinary geographic research where advances in geographic information science and technology have been used to understand dynamic systems including: 1) The radiation-transfer cascade in mountain environments and the limitations associated with anisotropic-reflectance-correction of multi-spectral satellite imagery; 2) Climate-glacier dynamics in the Himalaya and assessing glacier-state and the sensitivity of glaciers to climate change; and 3) Mountain geodynamics in active orogens and the characterization and mapping of surface process regimes and crustal deformation zones. Characterization, mapping and simulation results are presented to demonstrate the need for mathematical formalization of scientific concepts that incorporate spatial and temporal dimensions.

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