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Integrating observations and models to elucidate the seasonal evolution of land-atmosphere coupling and its subsequent impacts on ground temperatures.

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Our objective is to better understand the principal controls that drive land-atmosphere coupling and the evolution of subsurface temperature regimes. We adopt an approach that seeks to integrate observational evidence and modeling studies to provide a parsimonious description of the governing dynamics at and below the ground surface. We begin with a general discussion of air and ground temperature relationships using site-specific observations in tundra, forest, cropland, and grassland settings, spanning arctic to mid-latitudes. We specifically consider vegetation and cryogenic effects on seasonal and inter-annual timescales, and illustrate some basic patterns in air and ground temperature relationships and in the evolution of subsurface temperatures. These general observational patterns lay the foundation for the development of a simple land-interface model (SLIM) for studying land-atmosphere dynamics and subsurface thermodynamics. We present several experiments using a SLIM to demonstrate: 1) that subsurface thermal memory can play an important role in evolving surface and subsurface temperatures; 2) that the responses of subsurface temperature regimes are dependent on the relative frequency spectra in surface temperature and land-surface coupling changes; and 3) that the location of a lower-boundary condition in subsurface temperature simulations can induce large errors at specific frequencies of change. In addition to addressing several assumptions of borehole paleoclimatology, these modeling experiments have particular implications for simulations of subsurface temperatures in Global Circulation Models.