PCHES: PROGRAM ON COUPLED HUMAN AND EARTH SYSTEMS

The Program on Coupled Human and Earth Systems (PCHES) is a leading contributor in a broad community effort to create new, state-of-the-art, integrated modeling frameworks that will drive advances in the quantitative understanding of coupled energy, water, and land systems.

These systems frequently interact in complex and poorly understood ways—all with significant implications for:

- Reliability of electric power supply;
- Food security;
- Economic productivity;
- International trade;
- Changing populations and demographics;
- Resource acquisition and utilization; and
- The resilience of communities and critical infrastructure to natural hazards.

Supported by the U.S. Department of Energy (DOE), PCHES brings together an interdisciplinary research team that is building the knowledge and deep analytic foundations for this research while fostering innovation in the emerging field of MultiSector Dynamics (MSD).

RESEARCH FOCUS AREAS

PCHES research spans three major focus areas that explore, analyze, and test complementary approaches to the modeling and analysis of complex multisector systems, including the many and varied influences and stressors that govern their behaviors.

1. Addressing questions of the impacts of extreme events on the energy-water-land system and associated adaptation options: This requires capturing the frequency, intensity, and impacts of extreme weather events, as well as to understanding the infrastructure needs for adaptation to these events. The research team's approach involves coupling and testing various fine-scale process models (water balance, power system, and agricultural impact models), most recently with a simplified gridded economic model of the United States.

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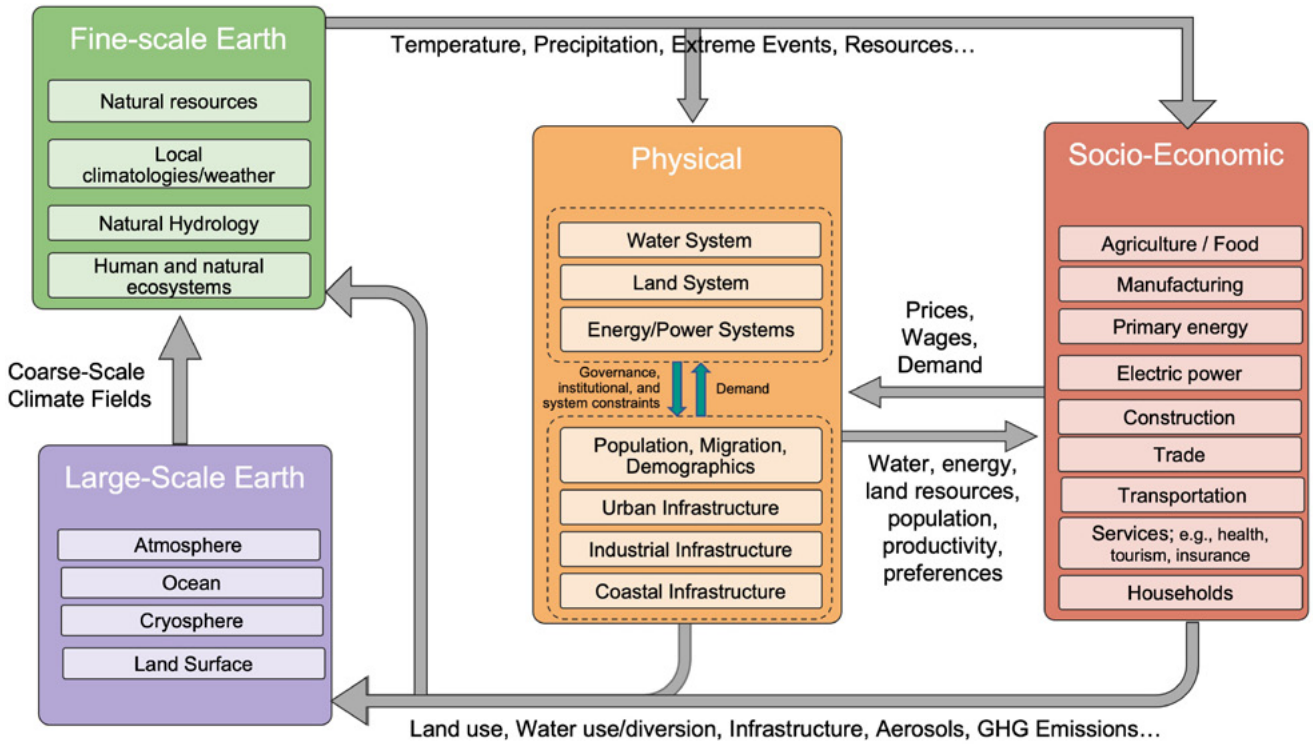
2. Governance, institutional, and system constraints: Each is expected to play an important role in the evolution of regional economies and physical landscapes. The research team is presently examining the use of fine-scale process models (water balance, power system) coupled with a detailed, multi-sector economic model of the Western United States, the latter acting as the coordinating mechanism between the fine-scale physical models and the function of markets under these constraints.
3. Earth system variability and change: This can result in a chain of cascading and sometimes adverse impacts on coupled land, energy, and water systems. The research team is evaluating strategies for examining these cascades and is developing a combined physical-econometric framework to analyze potential risks at global scales, where direct coupling of detailed process models is typically infeasible. This approach emphasizes the development of large-scale statistical and process emulators that can be directly incorporated into a global MSD framework.

SCIENCE QUESTIONS

Beyond the systems interactions research encompassed within the three main focus areas, PCHES supports advances in fundamental methodologies that crosscut and underpin these focus areas. This methodological research seeks answers to questions such as:

- How skillful are current empirical-statistical downscaling tools in their representation of decision-relevant information (e.g., modes and tails of relevant probability density functions or the spatio-temporal correlation structure) on regional to local scales?
- What are the inherent trade-offs between downscaling and emulation strategies (e.g., statistical emulators



Components of an integrated framework for modeling coupled energy-water-land systems dynamic.

based on observational data versus mechanistic/ process emulators based on model ensembles) for generating climate, weather patterns, and extreme event information for multisector dynamics?

- What are the driving mechanisms and projected magnitudes of future changes in the frequency, duration, and intensity of weather extremes, including intense rainfall events, heat waves, floods, and droughts? And how do these vary across spatial and temporal scales?
- What are new and innovative tools and methods for uncertainty characterization in integrated energy, land, and water systems analysis?

All of these efforts are coordinated across a diverse, multi-institutional research team that intersects with many additional networks of informal collaborators around the globe. Leadership, engagement, and coordination within this network of networks is a key program component spanning all PCHES research activities.

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