Abstract:
The most critical environmental problems of the day involve the effects of climate change and the supply of sufficient quantities of safe water for a growing population. Society expects scientists to analyze such complex problems and to provide rigorous, defensible, and accurate quantitative representations of these environmental systems. Mechanistic models are the gold standard for helping scientists meet these societal demands. To be of maximum utility, environmental models must represent systems in a tractable fashion with adequate fidelity and accuracy for the intended use. Our group considers the modeling of porous medium systems, which bear upon climate change as well as critical water supply and protection problems. We provide the typical mechanistic modeling approach, summarize deficiencies in current models, and present approaches to overcome these deficiencies. A variety of examples are considered in this seminar to illustrate the advances made in this field. First, how the methods developed can be used to describe density-dependent flow in a porous medium system, such as occurs in coastal regions. Second, the case of two-fluid-phase flow is considered, which is critical for applications such as carbon sequestration, petroleum production, and environmental remediation. Finally, the importance of advances in approximation methods to enable more accurate simulation is discussed.