Many of the complex physical processes relevant for compositional multi-phase flow in porous media are well understood at the pore-scale level. In order to study CO₂ storage in subsurface formations, however, it is not feasible to perform simulations at these small scales directly and effective models for multi-phase flow description at Darcy scale are needed. Unfortunately, in many cases it is not clear how the micro-scale knowledge can rigorously be translated into consistent macroscopic equations. Here, we present a new methodology, which provides a link between Lagrangian statistics of phase particle evolution and Darcy scale dynamics. Unlike in finite-volume methods, the evolution of Lagrangian particles representing small fluid phase volumes is modeled. Each particle has a state vector consisting of its position, velocity, fluid phase information and possibly other properties like individual velocities, the properties are modeled via-stochastic methods, the evolution of Lagrangian particles represents evolution and Darcy scale dynamics. Unlike in finite-volume methods, the evolution of Lagrangian particles representing small fluid phase volumes is modeled. Each particle has a state vector consisting of its position, velocity, fluid phase information and possibly other properties like individual velocities, the properties are modeled via-stochastic methods, the evolution of Lagrangian particles represents evolution and Darcy scale dynamics. Unlike in finite-volume methods, the evolution of Lagrangian particles representing small fluid phase volumes is modeled. Each particle has a state vector consisting of its position, velocity, fluid phase information and possibly other properties like individual velocities, the properties are modeled via-stochastic methods, the evolution of Lagrangian particles represents evolution and Darcy scale dynamics. Unlike in finite-volume methods, the evolution of Lagrangian particles representing small fluid phase volumes is modeled. Each particle has a state vector consisting of its position, velocity, fluid phase information and possibly other properties like individual velocities, the properties are modeled via-stochastic methods, the evolution of Lagrangian particles represents evolution and Darcy scale dynamics. Unlike in finite-volume methods, the evolution of Lagrangian particles representing small fluid phase volumes is modeled. Each particle has a state vector consisting of its position, velocity, fluid phase information and possibly other properties like individual velocities, the properties are modeled via-stochastic methods, the evolution of Lagrangian particles represents evolution and Darcy scale dynamics.