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Gaussian or Non-Gaussian? A Comparison between the EnKF and the EnPAT inverse modeling methods

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The Ensemble Kalman Filter (EnKF) has been commonly used to assimilate real time dynamic data into geologic models over the past decade. Despite its various advantages such as computational efficiency and capability to handle multiple sources of uncertainty, the EnKF cannot be used to update model that are characterized by curvilinear geometries such as fluvial deposits where the permeable channels play a crucial role in the prediction of solute transport. It is well-known that the EnKF performs optimally for multi-Gaussian distributed fields, basically because it uses two-point statistics (i.e. covariances) in the analysis process, which fully characterizes a multi-Gaussian distribution. We developed a novel inverse modeling method Ensemble PATtern matching (EnPAT), as an alternative to EnKF, which shows a significant potential for conditioning models for channelized aquifers to dynamic data. EnPAT is an evolution of EnKF, replacing, in the analysis step, two-point statistics with multiple-point statistics. The advantages of the EnPAT reside in its capability to honor geologic structures as well as measured static and dynamic data. In this work, the performance of classical EnKF and EnPAT are compared for modeling a synthetic channelized aquifer. The results show that EnPAT yields better prediction of transport characteristics than EnKF. Issues such as uncertainty of multiple variables and measurement errors, during practical implementation of EnPAT will be discussed.