



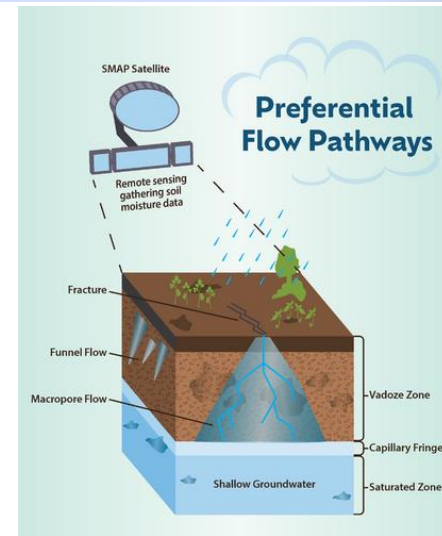
Characterizing large-scale preferential flow across Continental United States



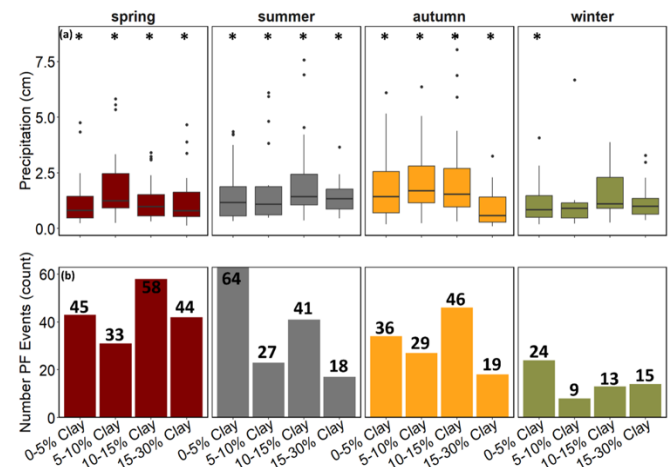
Problem: Understanding large-scale preferential flow (PF) is crucial for groundwater management, yet surface soil heterogeneity and observational limitations hinder progress. Existing models struggle to capture the rapid infiltration dynamics that influence soil moisture and shallow groundwater fluctuations.

Finding: A machine-learning-based random forest model achieved 98% accuracy in predicting large-scale PF events, integrating remote sensing and physics-based data. Seasonal variations significantly impact PF, with spring showing the highest frequency of events, particularly in clay-rich soils.

Impact: These findings improve water resource management by refining groundwater recharge predictions and identifying areas vulnerable to contamination. A data-driven approach leveraging SMAP soil moisture data provides a scalable tool for land and water conservation efforts.



A schematic of preferential flow to shallow groundwater



Number of preferential flow events from 2019 to 2022 categorized by season and clay percentage for the study sites