Transit Time Distributions of Evapotranspiration

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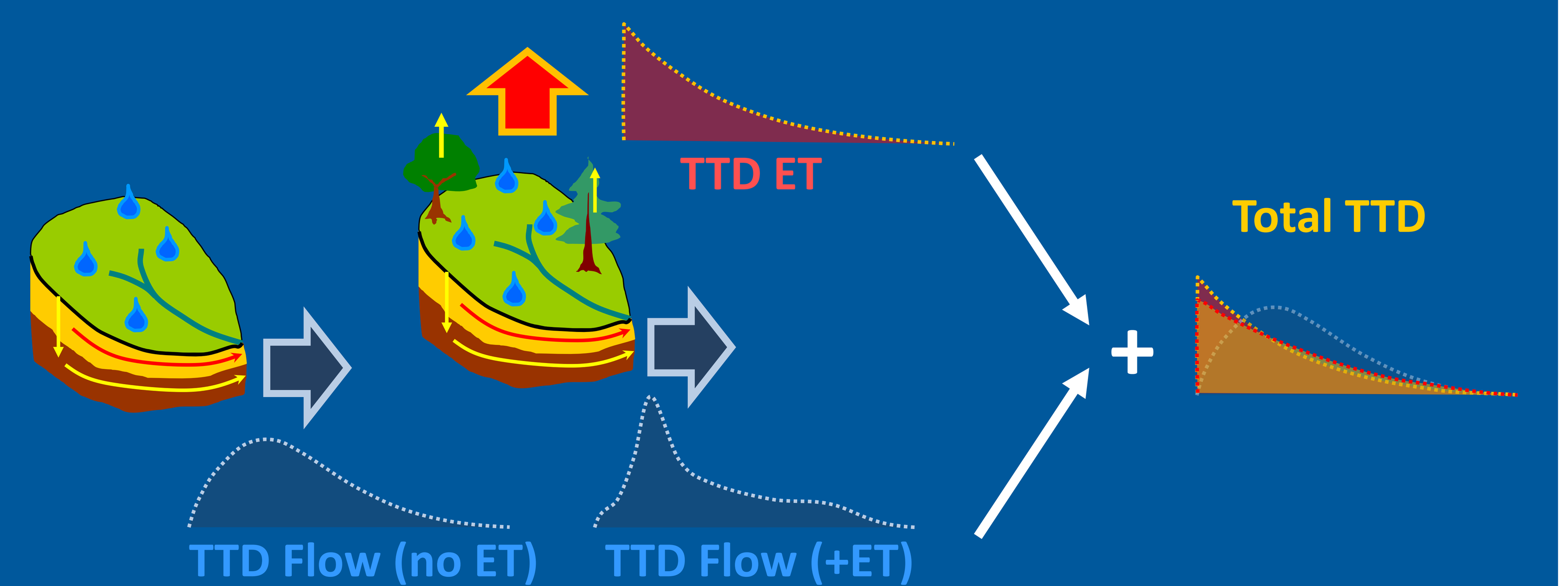
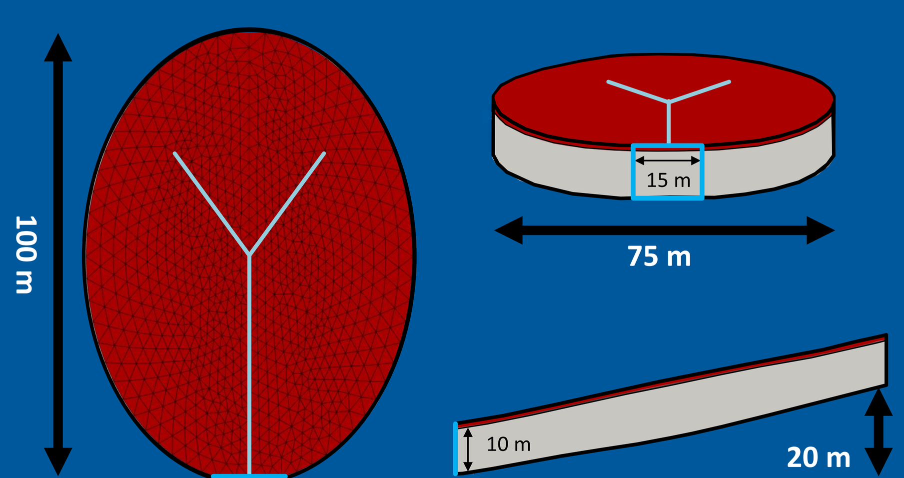
Motivation

- How do transit time distributions of ET look like?
- How do they change over time with hydrologic conditions?
- How do they change in space with catchment properties?
- How do they influence TTDs of flow?

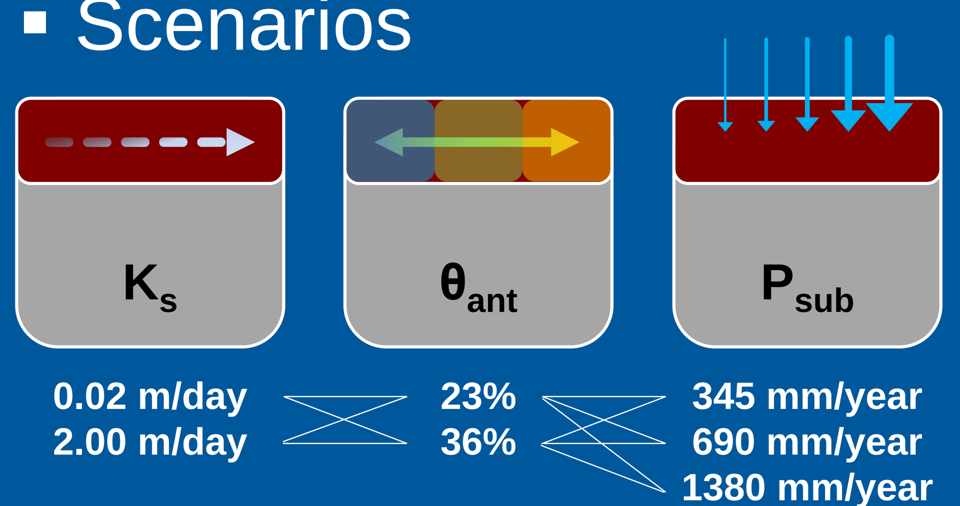


Approach

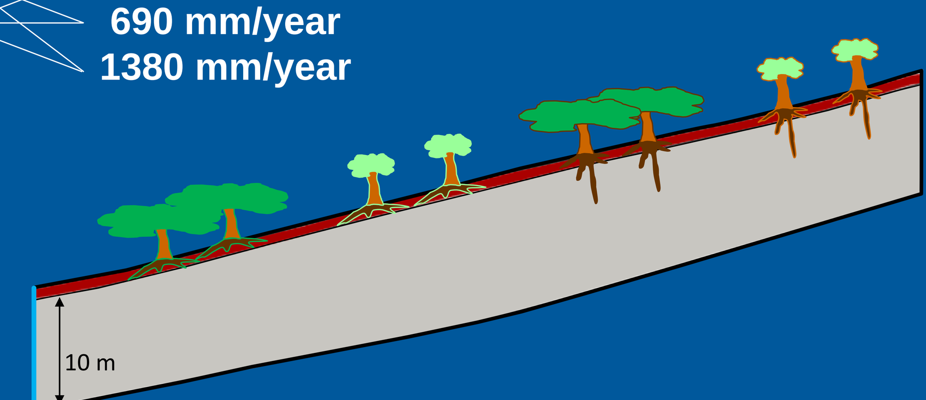
- virtual experiment with HydroGeoSphere
- 10 m of bedrock with low hydraulic conductivity
- on top soil layer with higher conductivity
- 3D
- physically-based
- spatially-distributed
- matrix flow



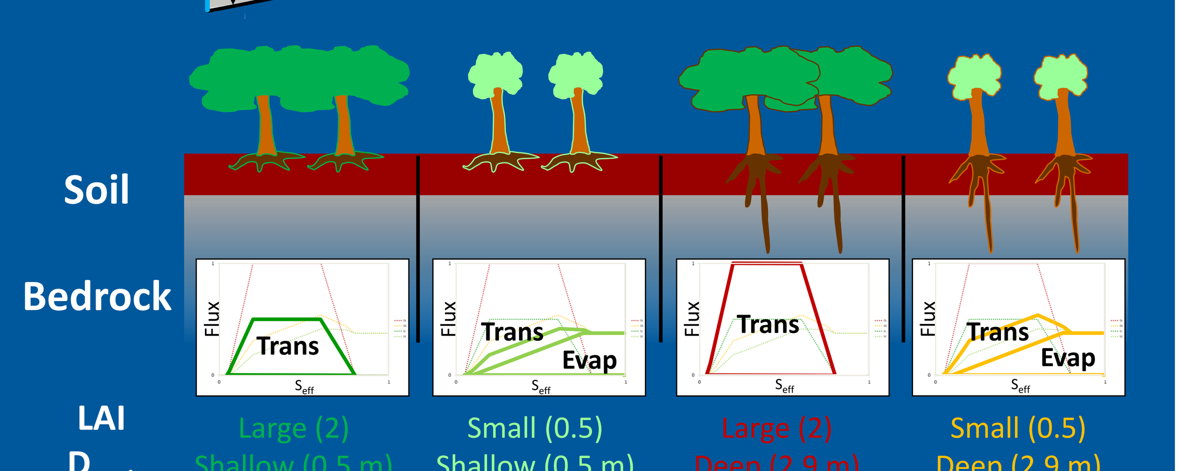
Scenarios



- changing catchment and climate properties

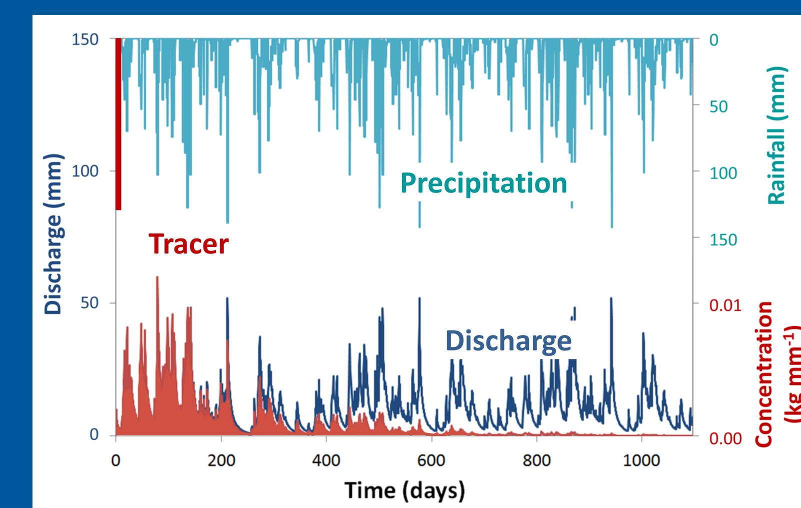


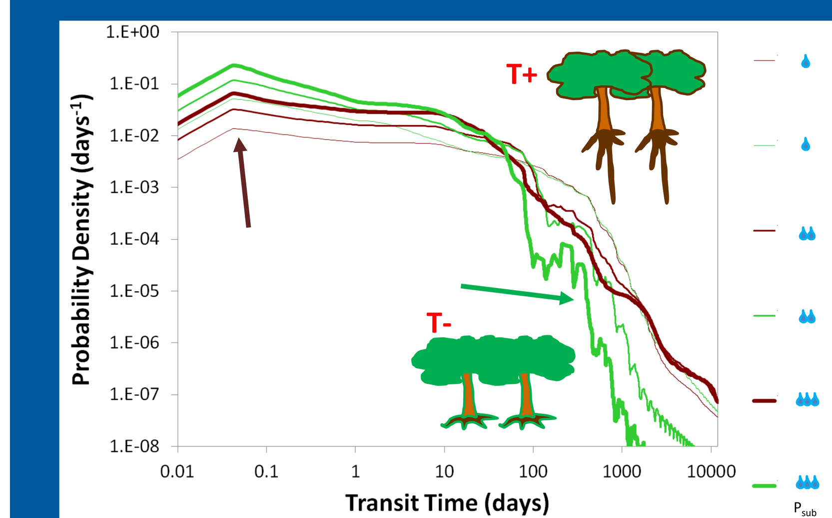
- adding vegetation
- different leaf area indices
- different rooting depths

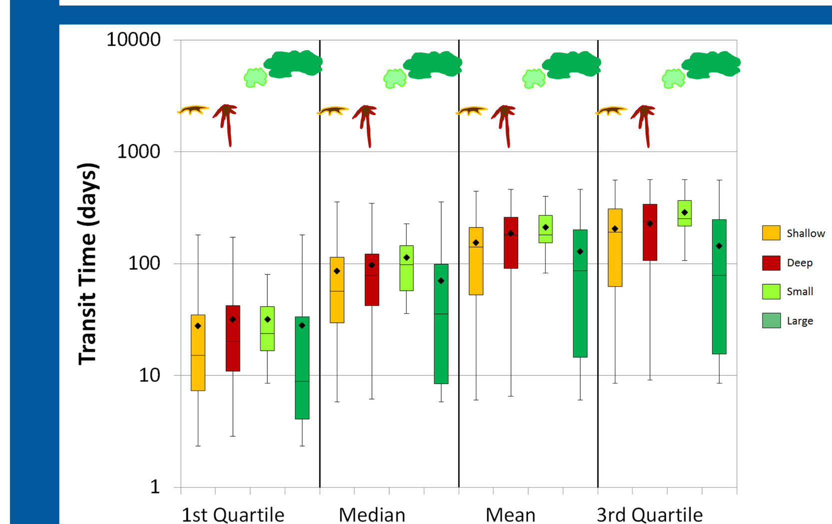


Input

- tracer application from time t=0 to t=1 h
- afterwards natural precipitation time series
- one year repeated 32 times
- normalized tracer breakthrough curve:
- TTD





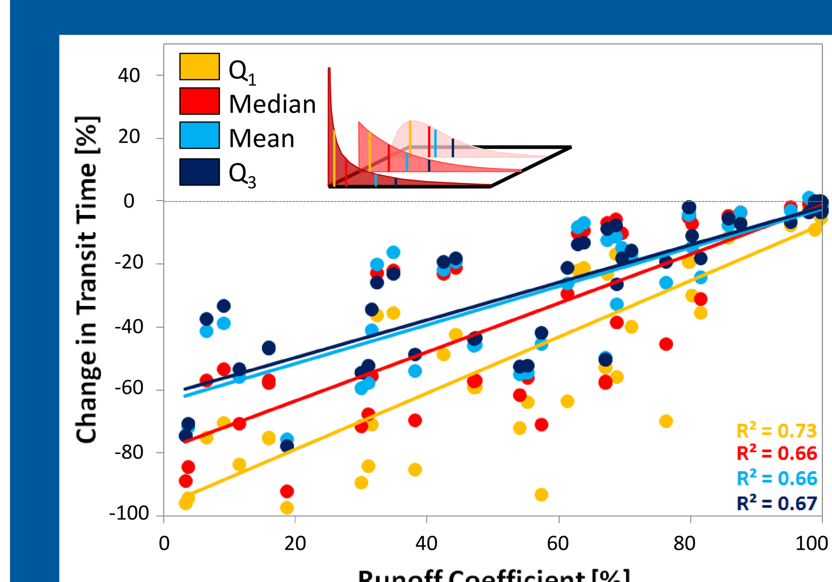


Results: Evapotranspiration

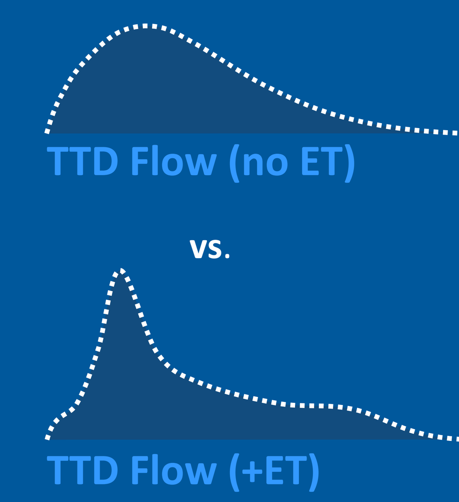
- longer TTs for scenarios with deeper roots
- shorter TTs for scenarios with shallower roots
- longest TTs and smallest variation for scenarios with small LAI
- shortest TTs and largest variation for scenarios with large LAI

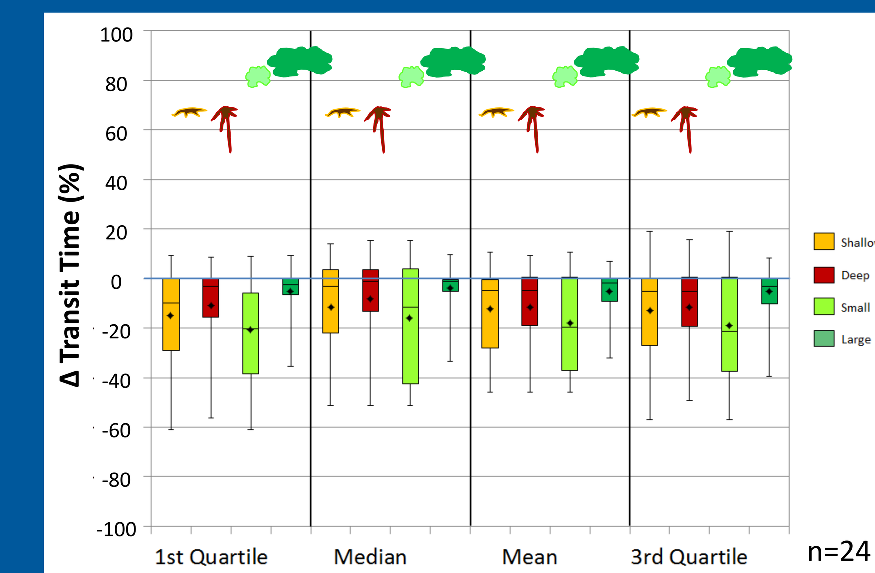
Results: Flow

- the stronger the evapotranspiration, the more it influences the TTDs of flow
- increase of young water fraction
- Increase of irregularity



- transit times of flow decrease with decreasing runoff coefficients

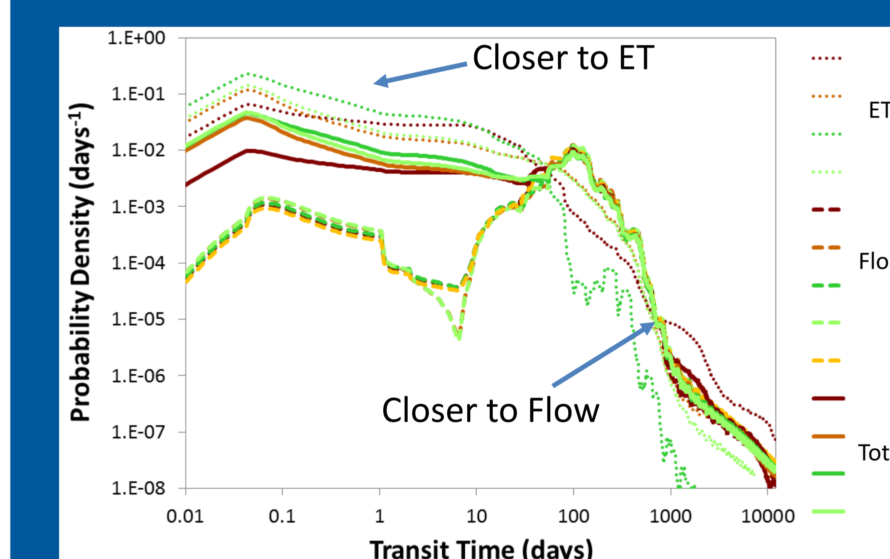


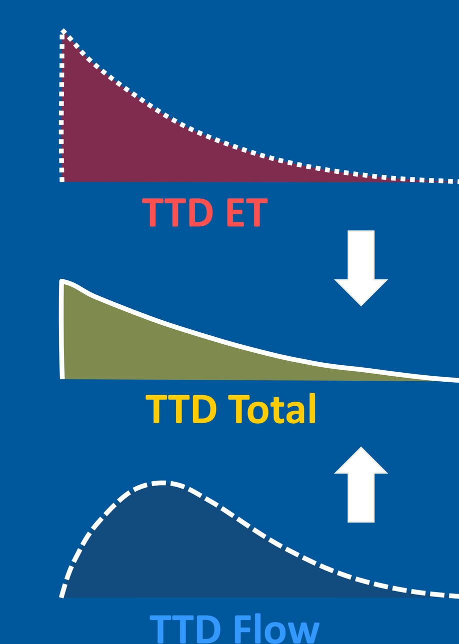


- TTs become shortest if LAI is small (i.e. more soil evaporation)
- least influence if LAI is large

Results: Total

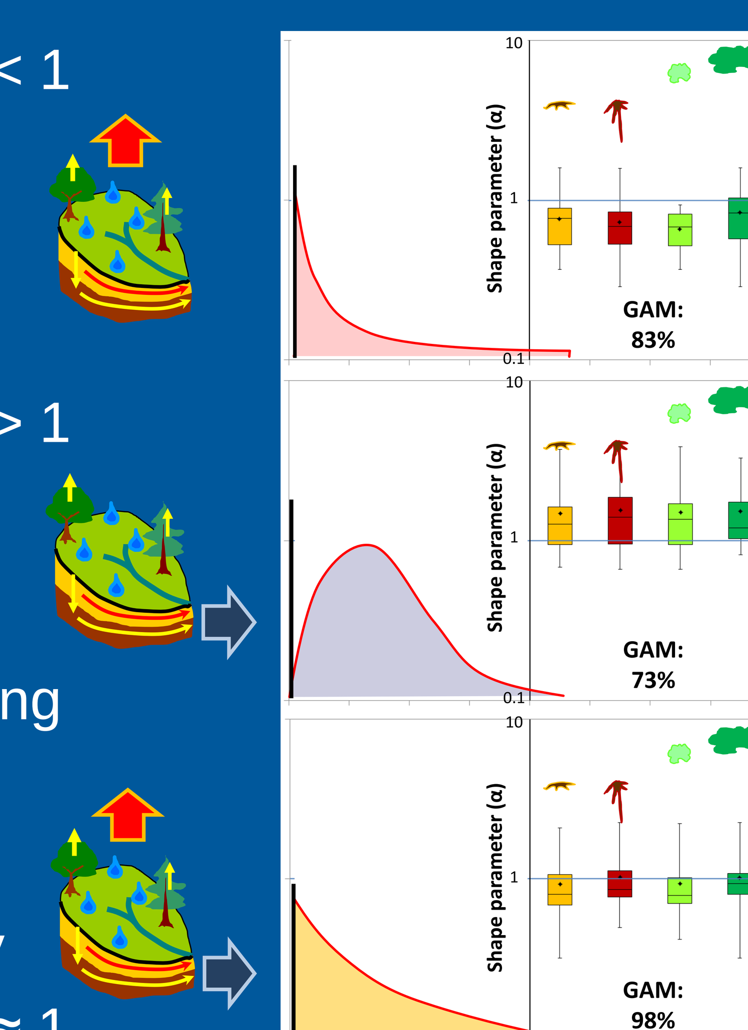
- total TTDs initially more similar to ET TTDs
- later more similar to Flow TTDs





Summary

- **TTDs of ET:**
- vary moderately with rooting depth and leaf area index
- are mostly faster than TTDs of flow
- shapes fit predominantly Gamma distributions with α < 1
- **TTDs of Flow:**
- ET shortens TTs of flow
- shapes fit predominantly Gamma distributions with α > 1
- **Total TTDs:**
- faster ET compensates for slower subsurface flow making total TTDs more similar to each other
- shapes fit almost exclusively Gamma distributions with α ≈ 1



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