Modeled Water Ages of the Hydrologic Cycle

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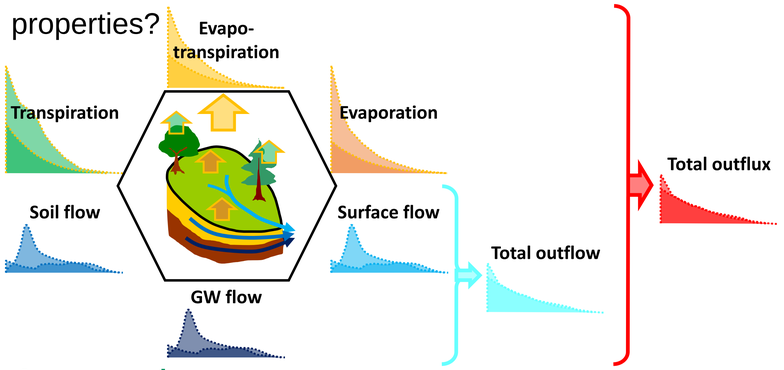
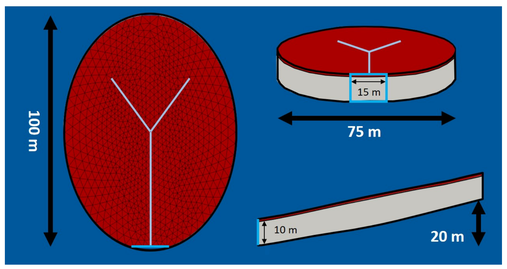
Motivation

- How do water ages differ between different fluxes?
- How do they change over time with hydrologic conditions?
- How do they change in space with catchment and climate properties?



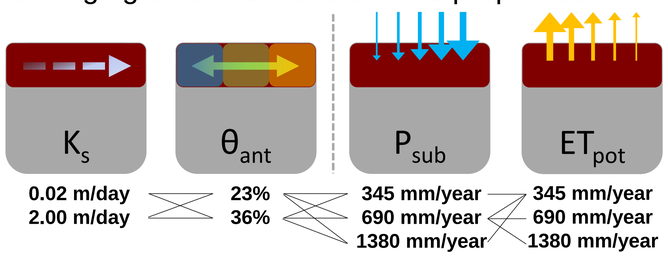
Approach

- 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

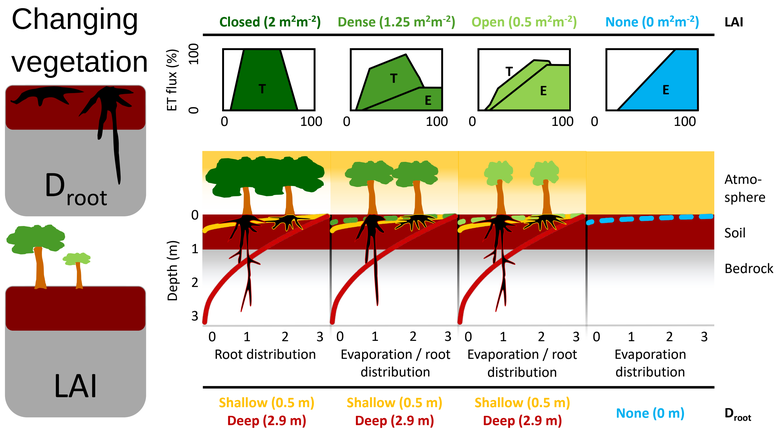


Scenarios

- Changing catchment and climate properties

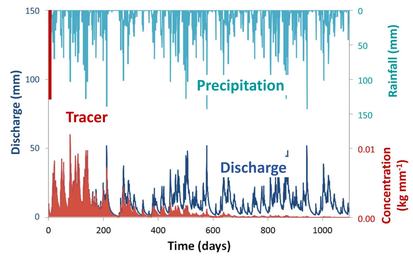


- Changing vegetation

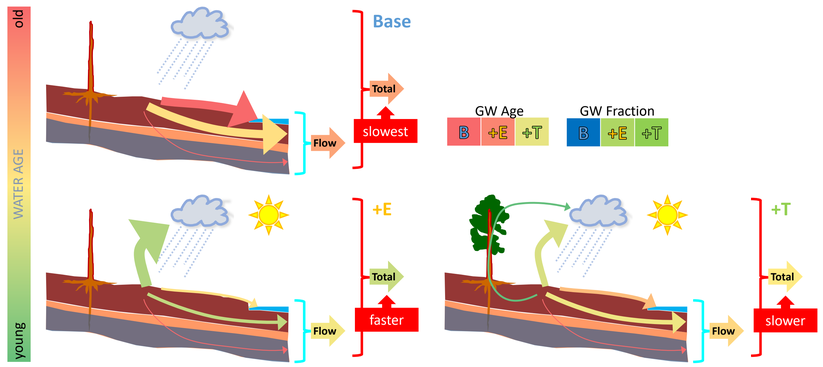


Input

- Tracer application from time t=0 to t=1 h
- Afterwards natural precipitation time series
- One year repeated 32 times
- Normalized tracer breakthrough curve:
- Transit time distribution

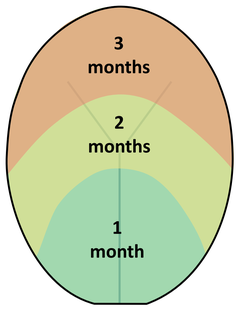


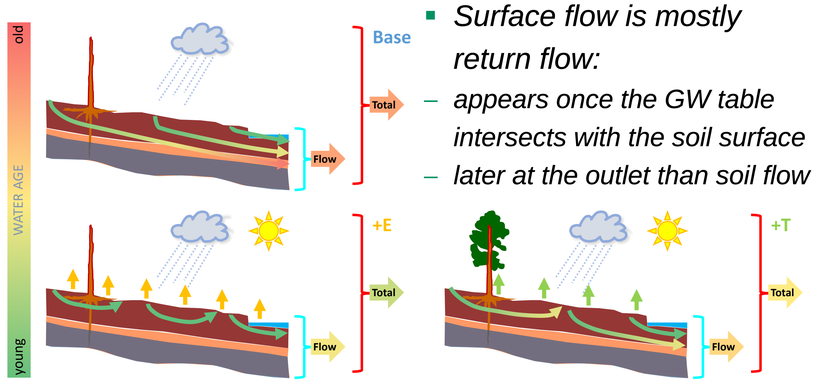
Results: Processes



- Evaporation accelerates the hydrologic cycle
- Vegetation decelerates the hydrologic cycle
- Surface flow is generally older than soil flow
- Evaporation is generally younger than flow
- Transpiration is generally younger than evaporation

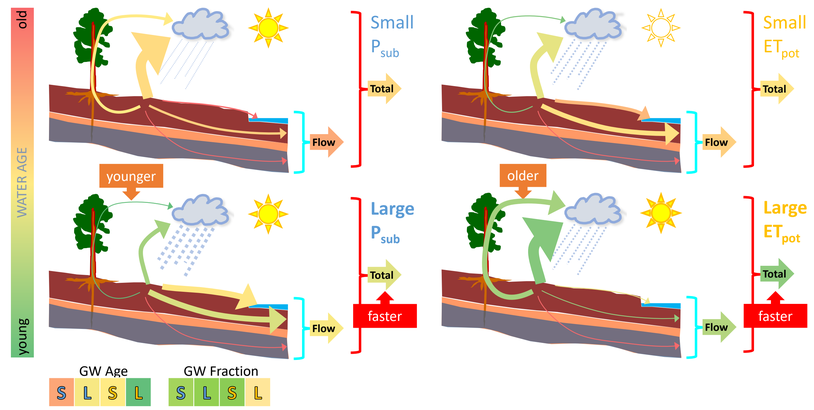
- *Water entering the catchment farther away from the outlet:*
  - *takes longer to reach the outlet*
  - *is more likely to be turned into evaporation or transpiration*
- *Less old soil water reaches the outlet if there is more extraction from the soil*



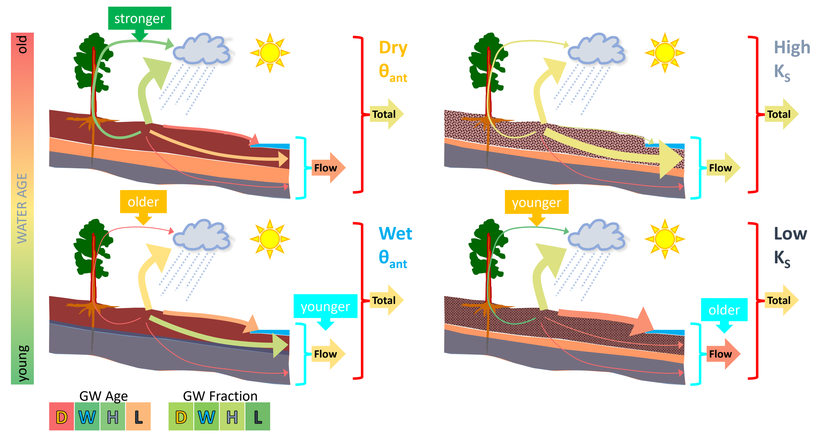


- *Surface flow is mostly return flow:*
  - *appears once the GW table intersects with the soil surface*
  - *later at the outlet than soil flow*

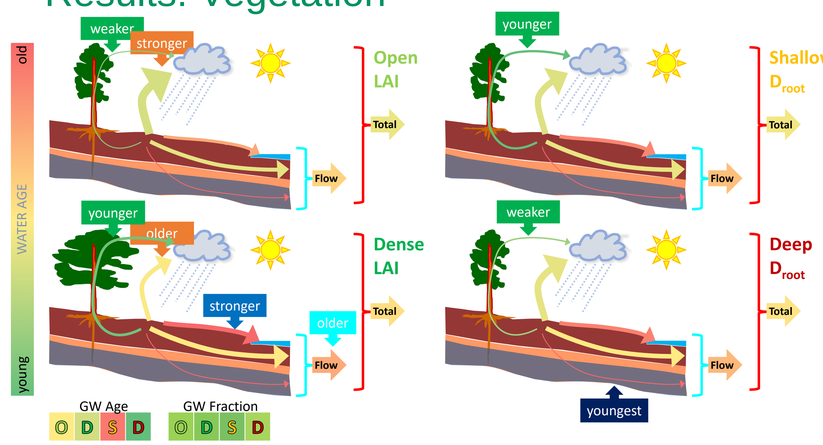
Results: Climate



Results: Catchment



Results: Vegetation



Conclusion

- Water ages are controlled by a **complex interplay** of:
  - dominant flow paths
  - dominant source areas
  - water storage within the catchment
  - physical catchment properties
  - climate forcing
  - ecohydrology

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