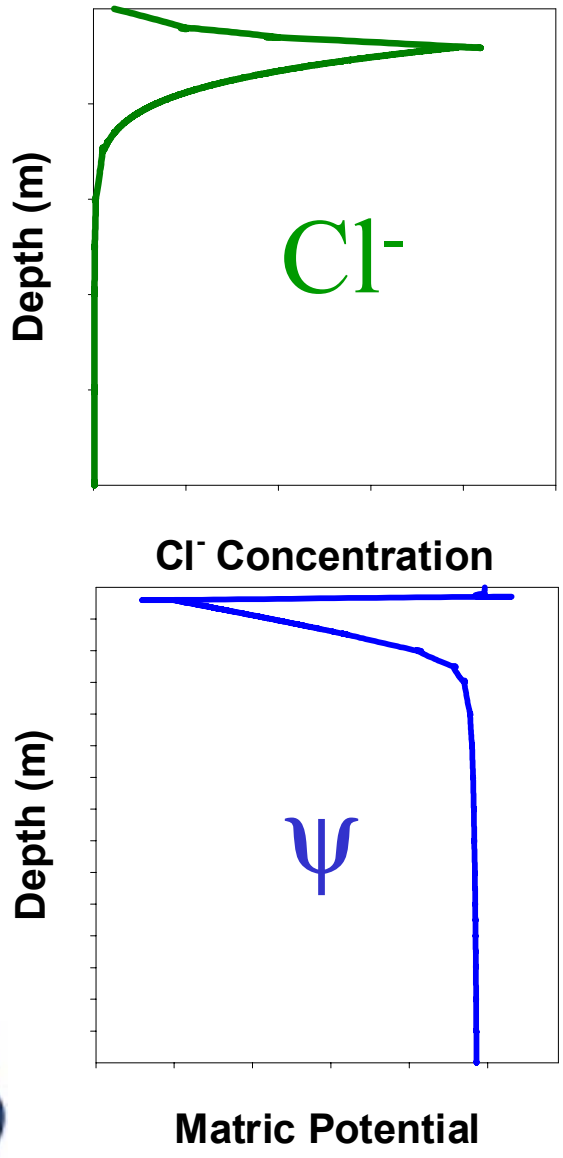
Moisture Fluxes in Deep Semiarid Vadose Zones

Michelle A. Walvoord
Dr. Fred M. Phillips, Mitchell A. Plummer

New Mexico Institute of Mining and Technology

Dr. Andrew W. Wolfsberg, LANL

Introduction



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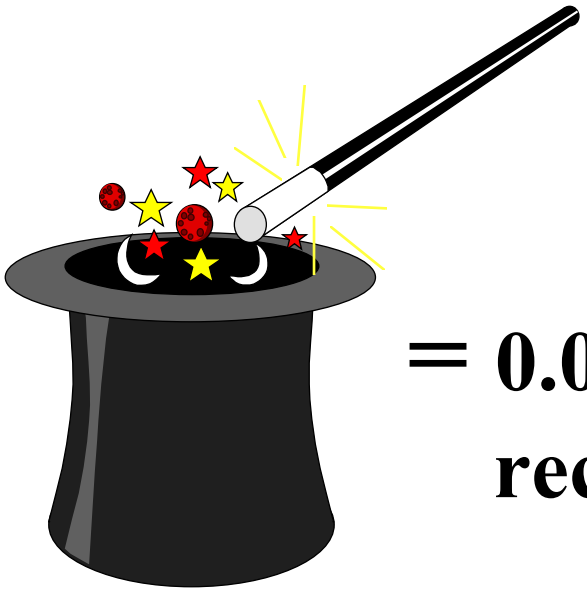
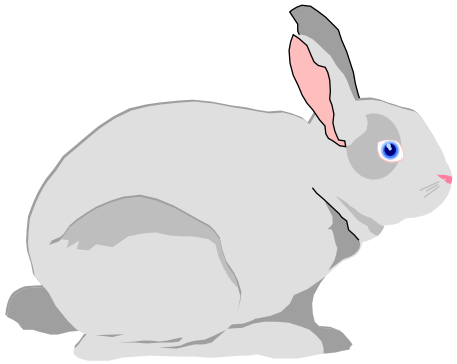


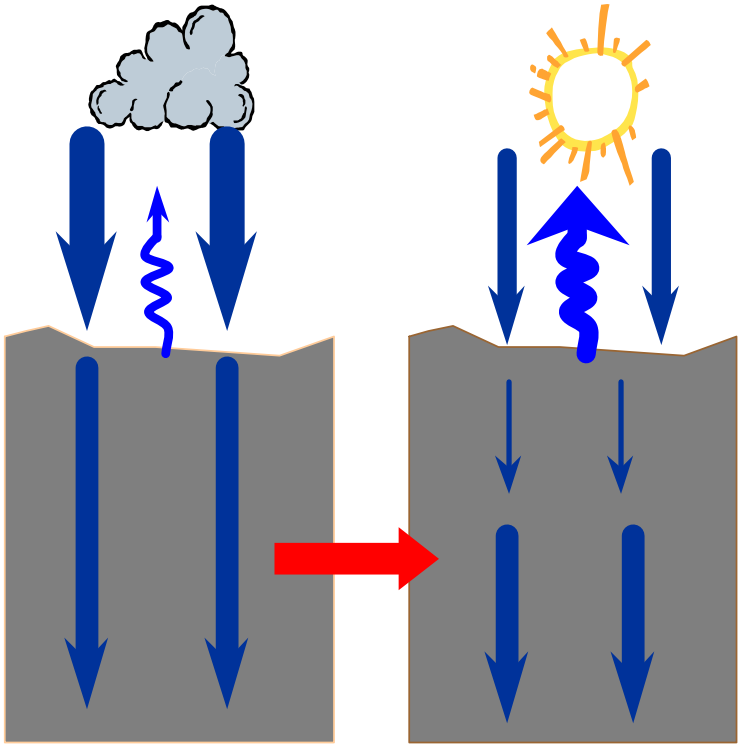
= 0.02 mm/yr recharge



Conceptual Model Comparison

Reduced recharge hypothesis

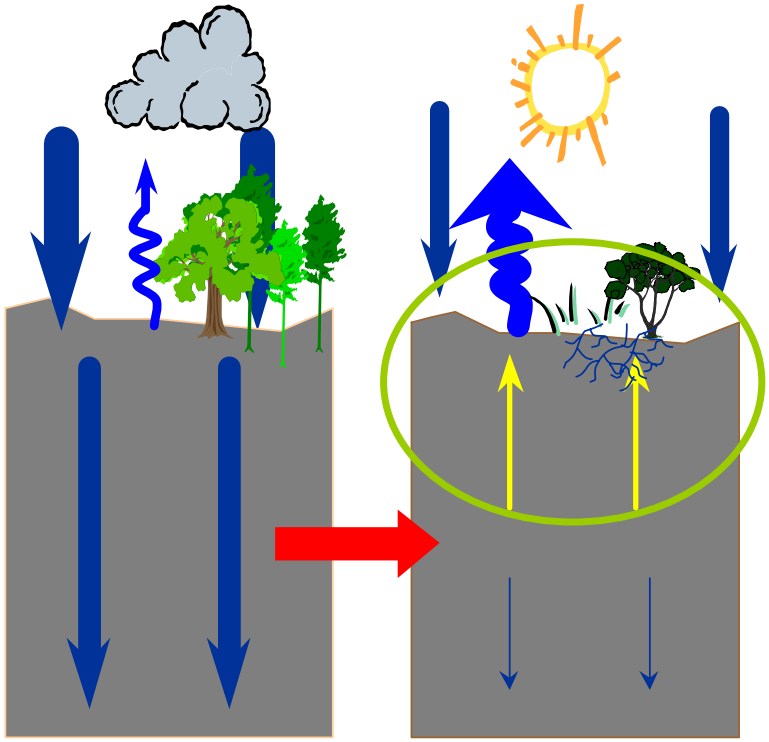
below r.z. net moisture fluxes
ALWAYS downward



Humid Climate → Arid Climate

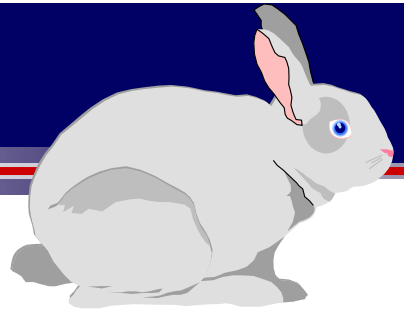
Net flux reversal hypothesis

xeric vegetation maintains net
upward moisture fluxes



Mesic Vegetation → Xeric Vegetation

The Rabbit

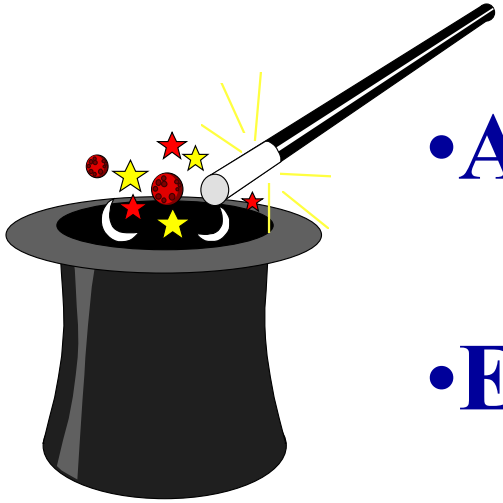


Numerical modeling results supported our new conceptual model : flux-reversal hypothesis.

Gravity-driven liquid flow does not completely describe deep vadose zone hydrodynamics.

Recharge through inter-drainage areas of semiarid basins is extremely low. Previous reported values are overestimates.

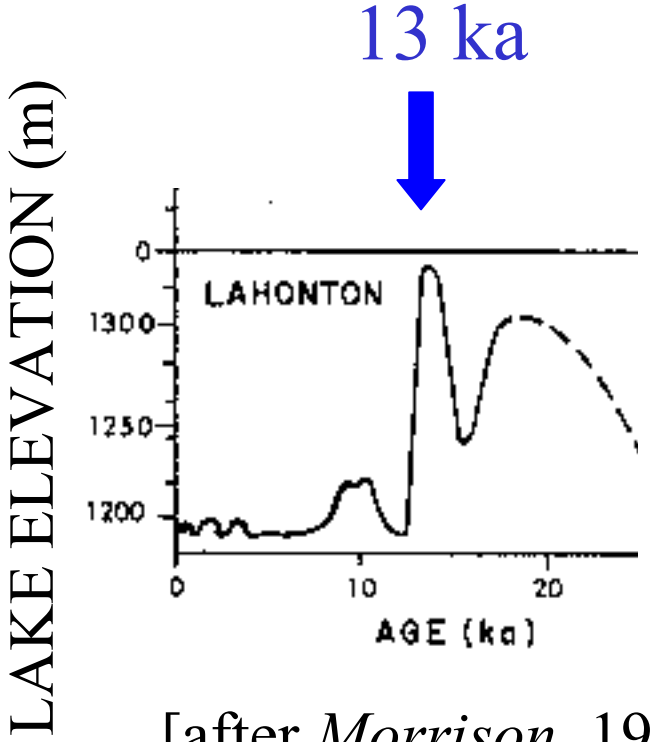
What's in the Hat?



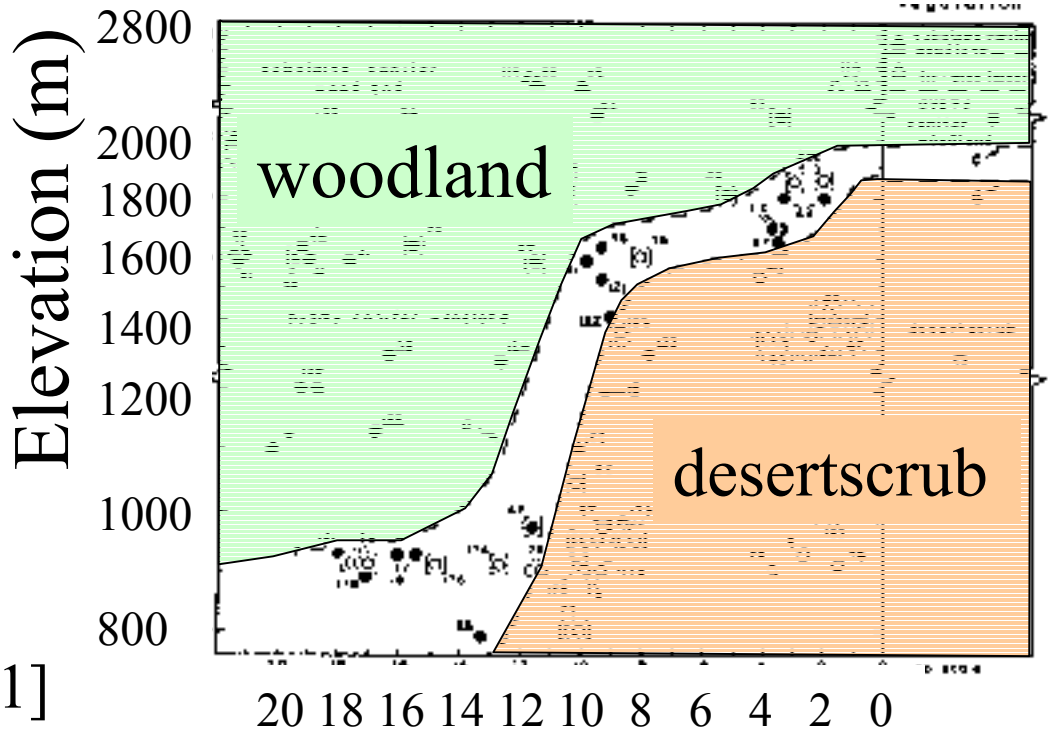
- **ASSUMPTIONS**
- **ELEMENTS - EXPRESSIONS**
- **MANIFESTATIONS - What are the characteristics of the flow regime under the new conceptual model?**
- **LIMITATIONS - Remaining ??**

Climate/ Vegetation Transition

Paleolake Levels and Paleovegetation: Great Basin, NV



[after *Morrison*, 1991]



[after *Spaulding*, 1990]

Simulations Using FEHM

Initial conditions:

10 mm yr^{-1} downward water flux

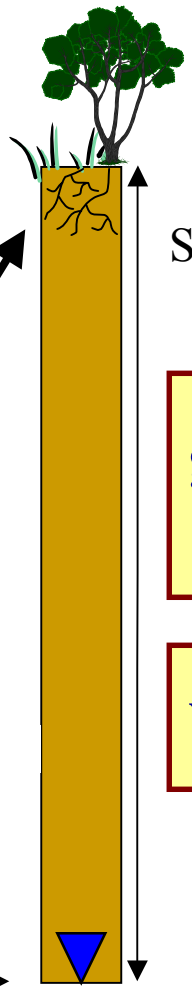
10 mg L^{-1} uniform Cl- conc.

Boundary conditions:

–Cl- deposition at the surface = 100 mg m^{-2} yr^{-1}

Ψ = -4 MPa at the base of the root zone (PLANTS SUCK CONDITION)

water table, P_{atm}



SINK

geothermal grad = 35 °C/km

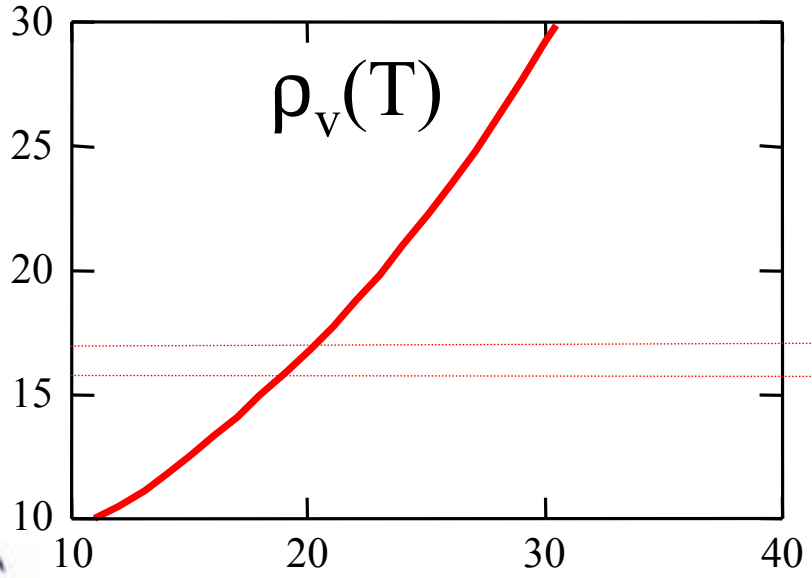
vapor transport

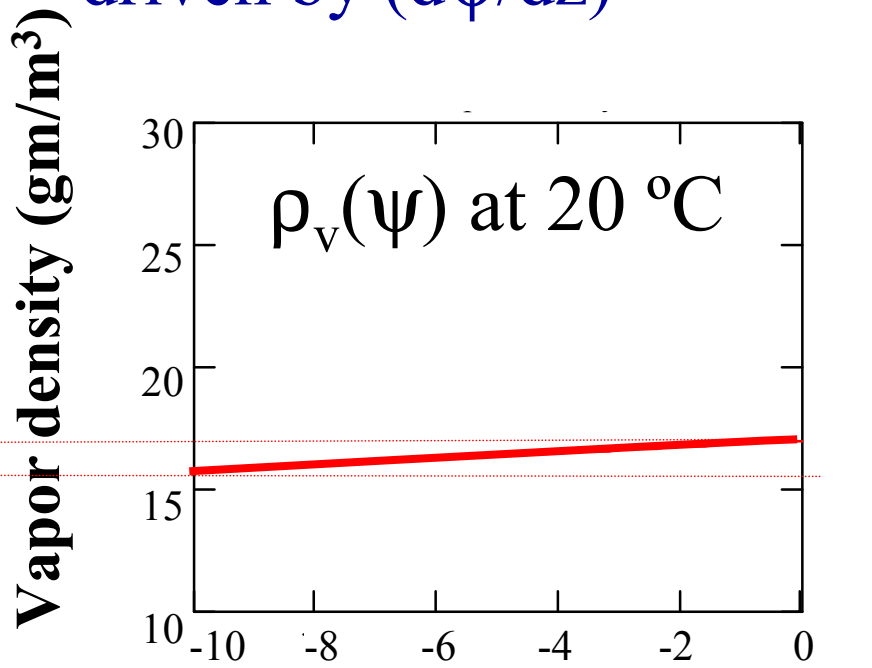
Vapor Transport

$$q_v = -Da\left[\frac{\partial \rho_v}{\partial \psi}\frac{d\psi}{dz} + b\frac{\partial \rho_v}{\partial T}\frac{dT}{dz}\right]$$

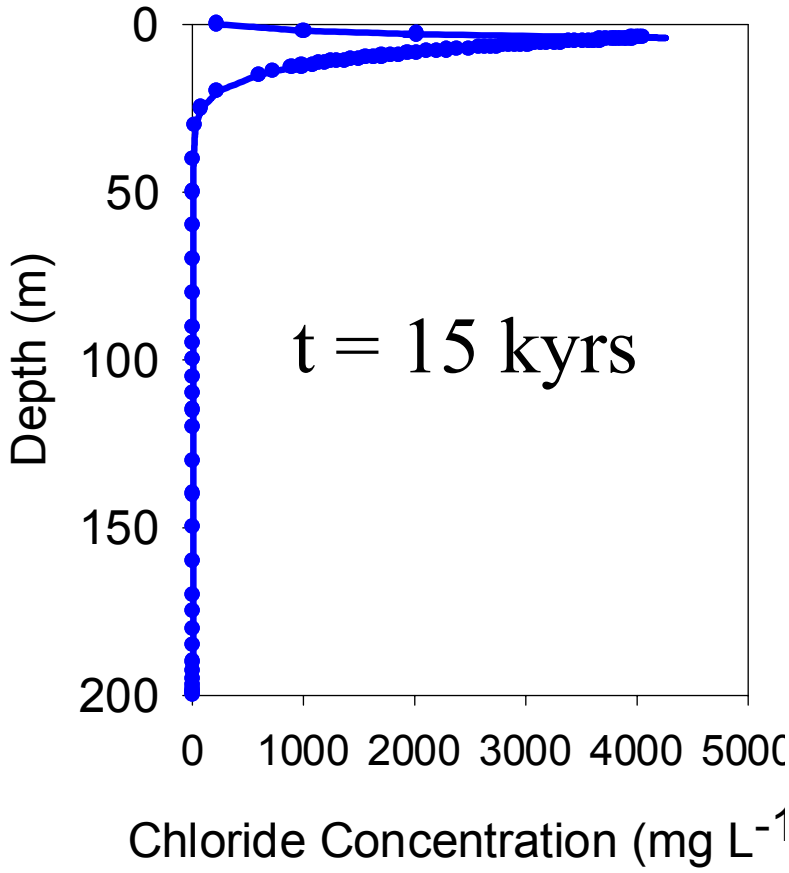
Thermal Vapor Flux: driven by (dT/dz)

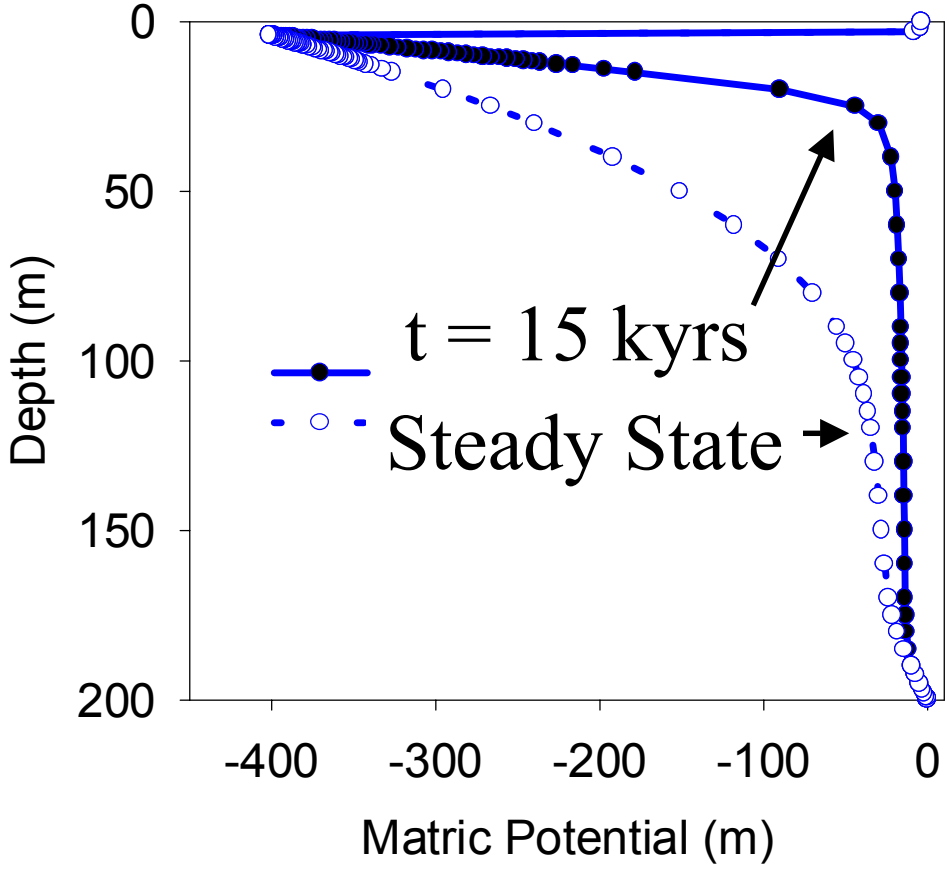
Isothermal Vapor Flux: driven by (dψ/dz)



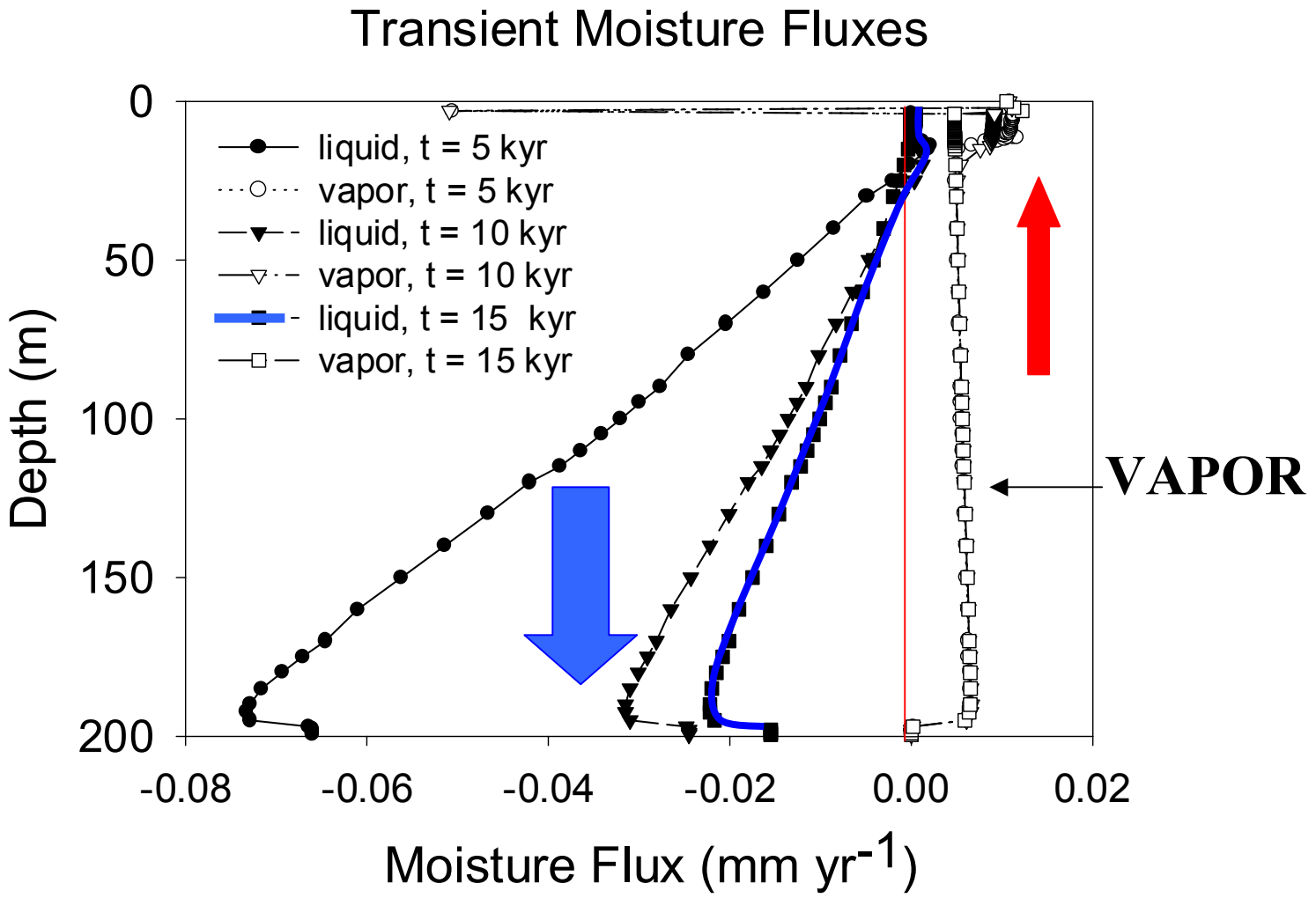


Matching Modeled ψ and Cl- Profiles to Observed Data

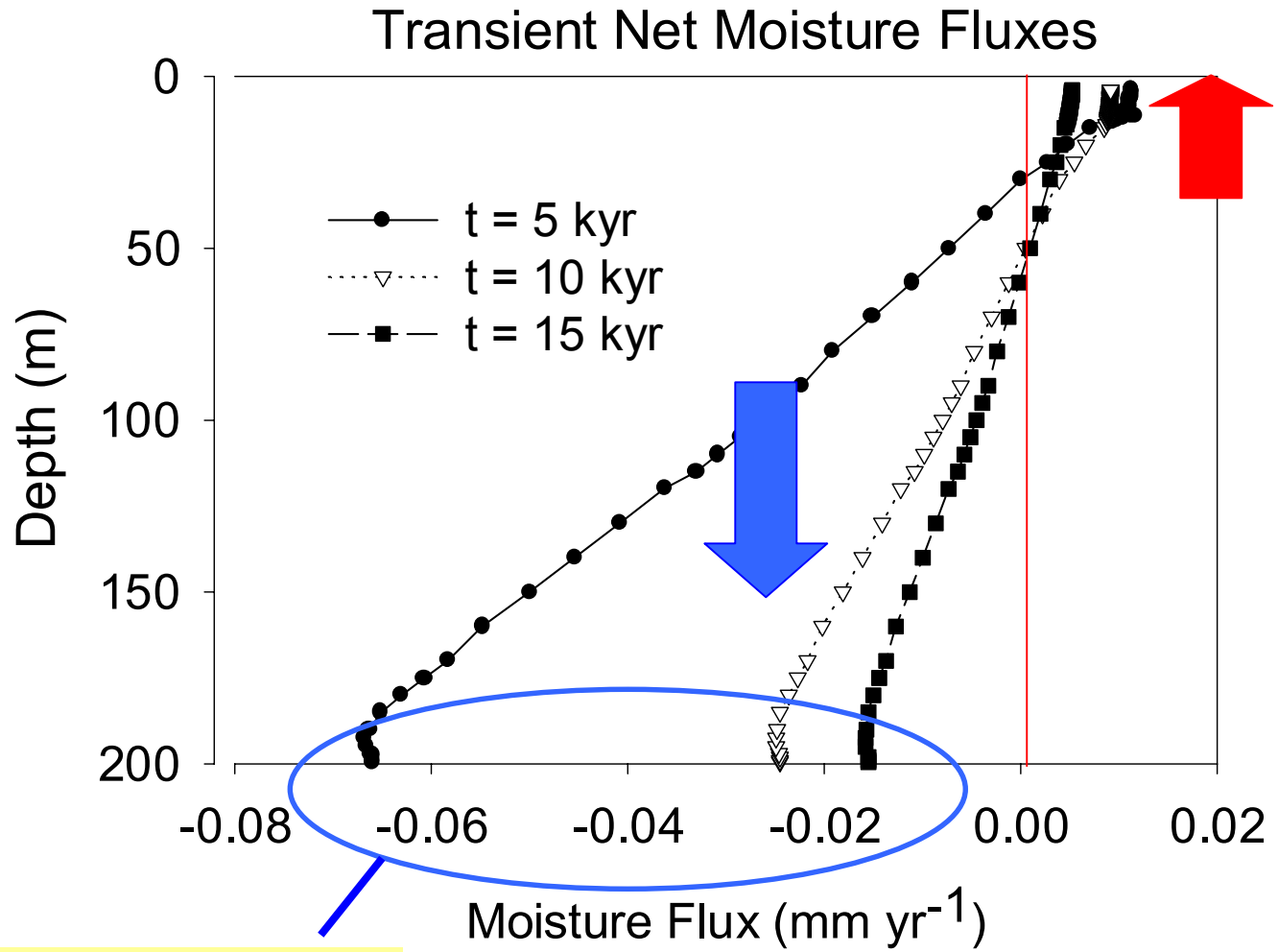




Liquid and Vapor Fluxes

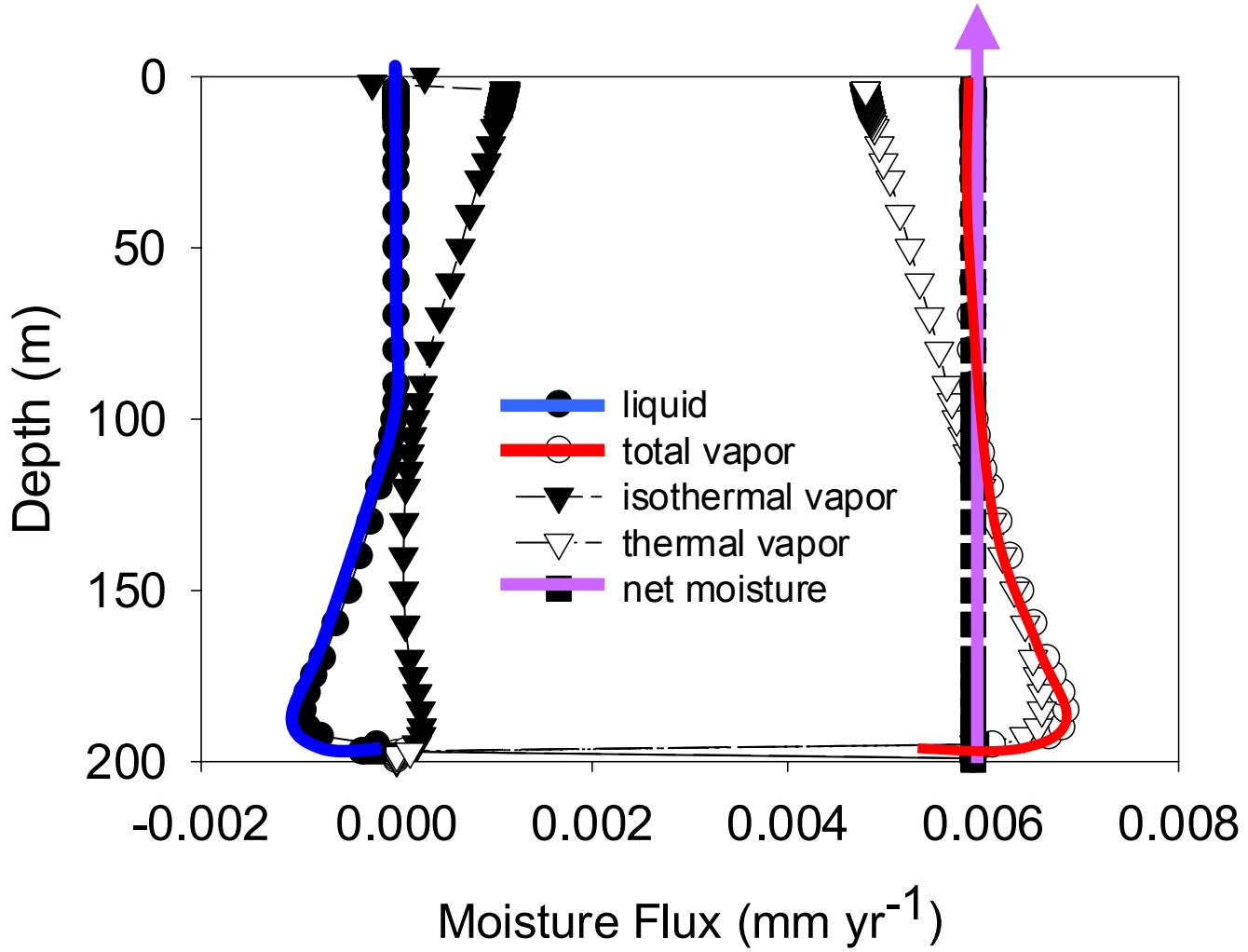


Net Moisture Fluxes

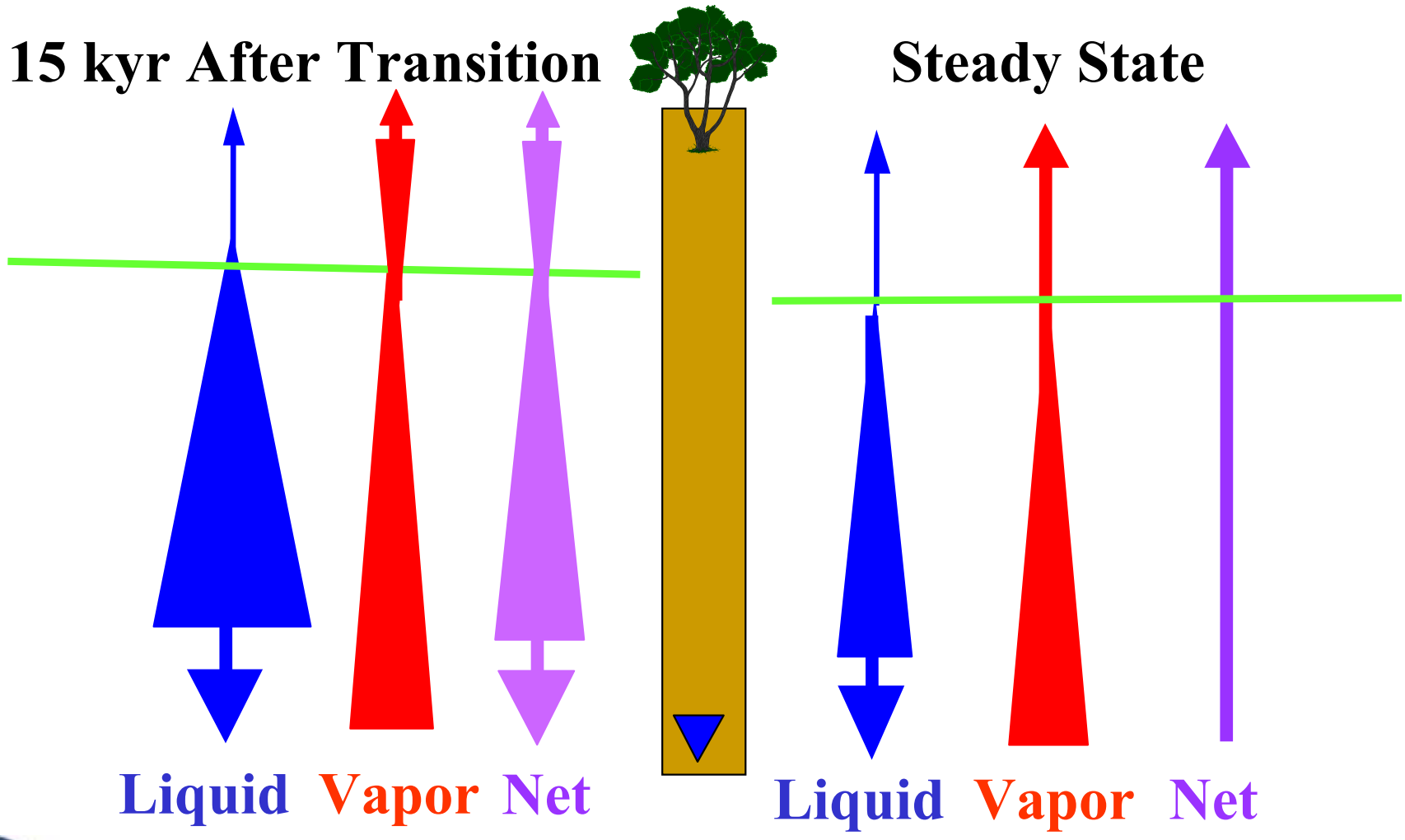


RECHARGE

Steady-State Moisture Fluxes



Moisture Fluxes



Limitations - Remaining Qs?

1-D Flow Assumption: neglects lateral flow

"Plants Suck" Sink: over-simplification of near-surface processes

Time/Data Intensive: many site-specific inputs required to numerically reproduce measured ψ and Cl^- vadose zone profiles

Conclusions

Numerical simulations of a new conceptual model of vadose zone hydrodynamics reproduce typical observed ψ and Cl- profiles.

Recharge through thick vadose zones in interdrainage semiarid basins is ~ negligible.

The contribution of vapor transport to the overall moisture flux regime becomes increasingly important as steady state is approached.