Transport of Agricultural Chemicals: Mass Budget Approach

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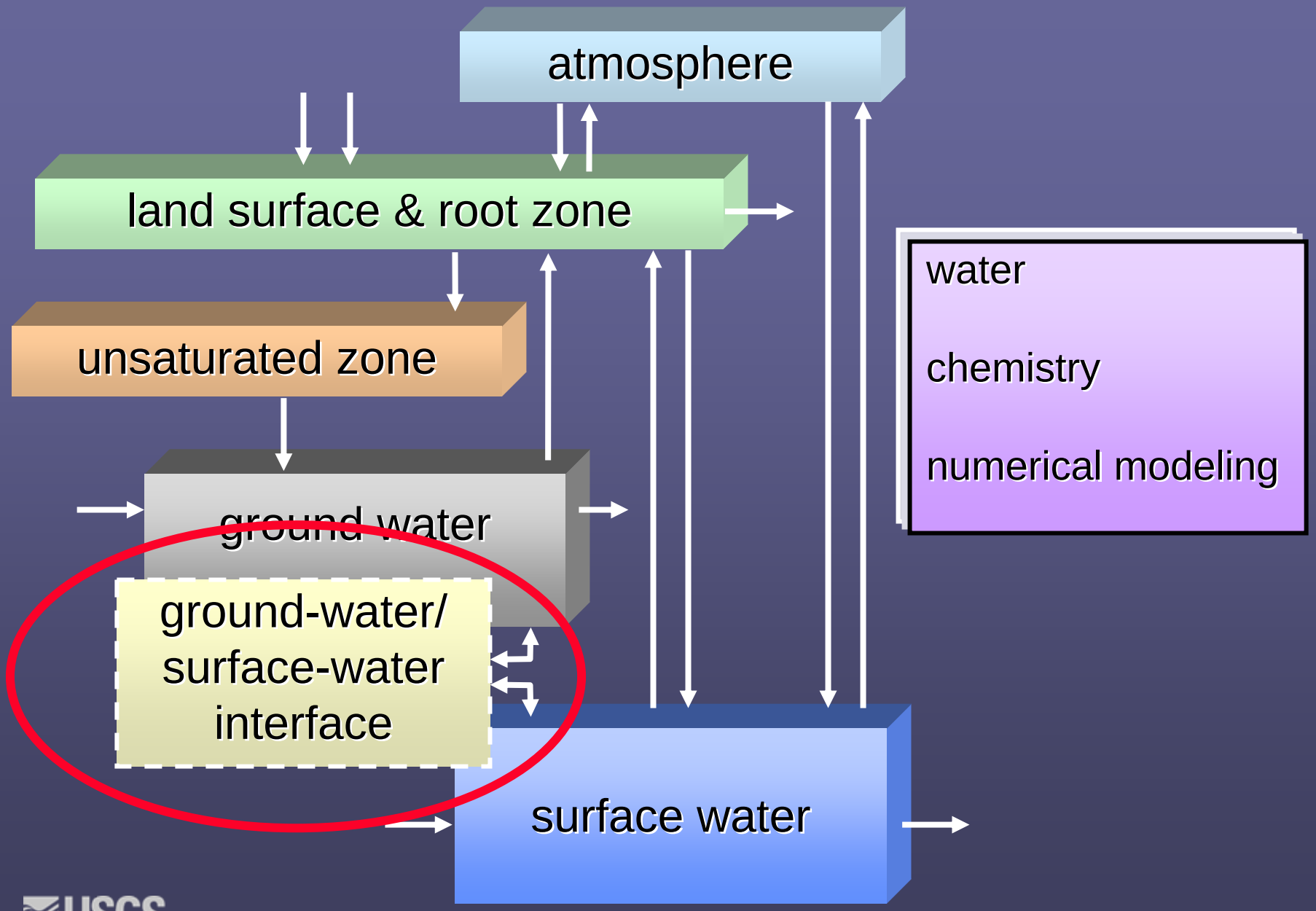

atmosphere
land surface & root zone
unsaturated zone
ground water
ground-water/
surface-water
interface
surface water
water
chemistry
numerical modeling

key points . . .

agricultural chemical transport is complex

***BUT*. . .**

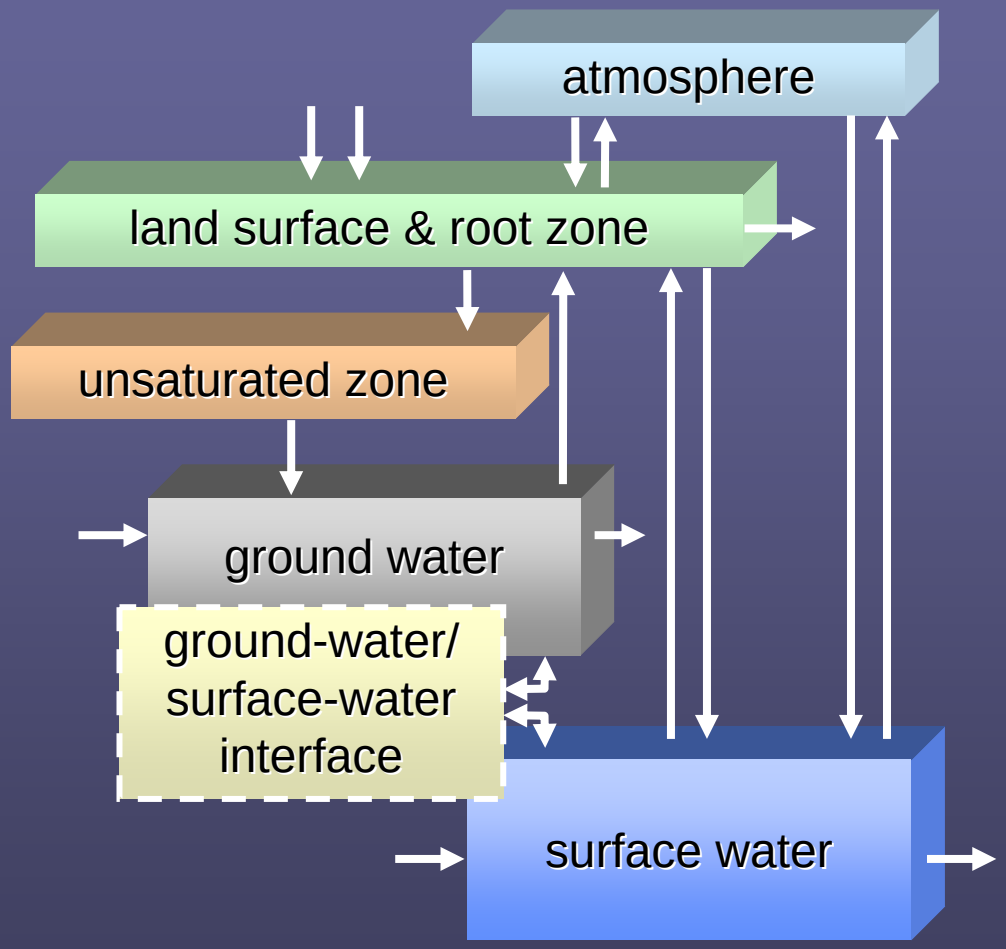
available information can be a “gold mine”

a whole-watershed approach is greater than the sum of its parts

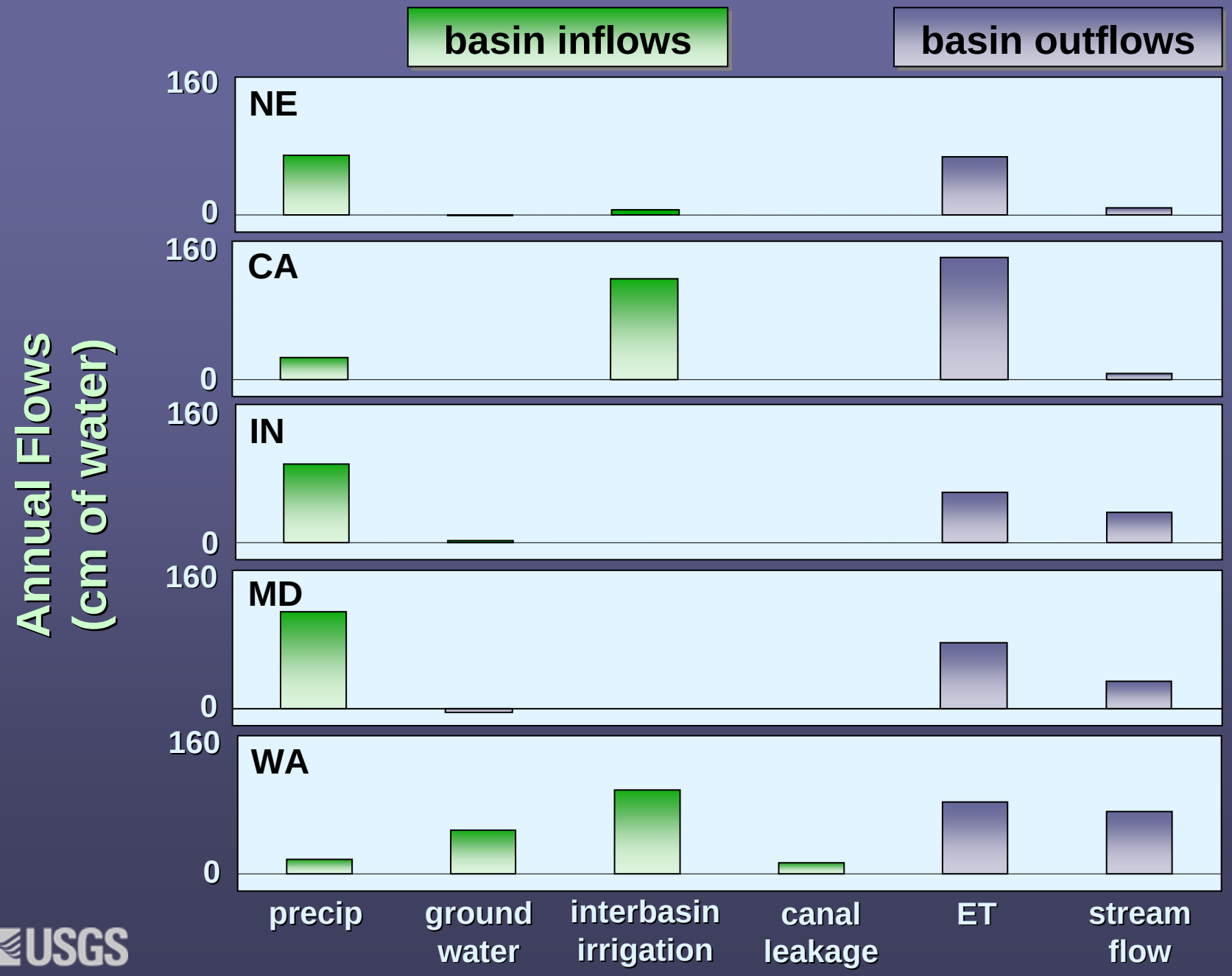
USGS

water data

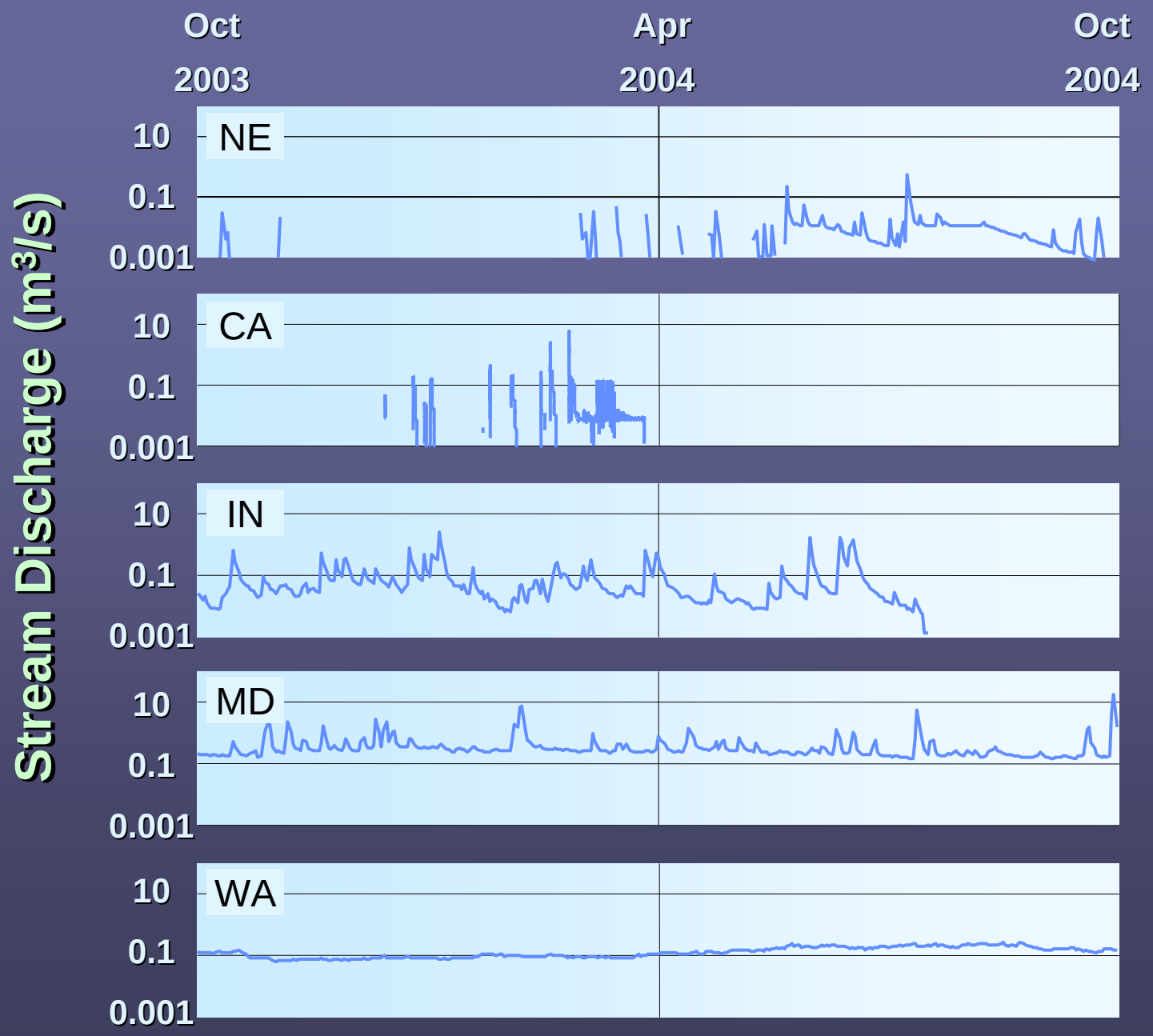
- precipitation
- evapotranspiration
- irrigation
- soil moisture
- ground-water levels
- streamflow

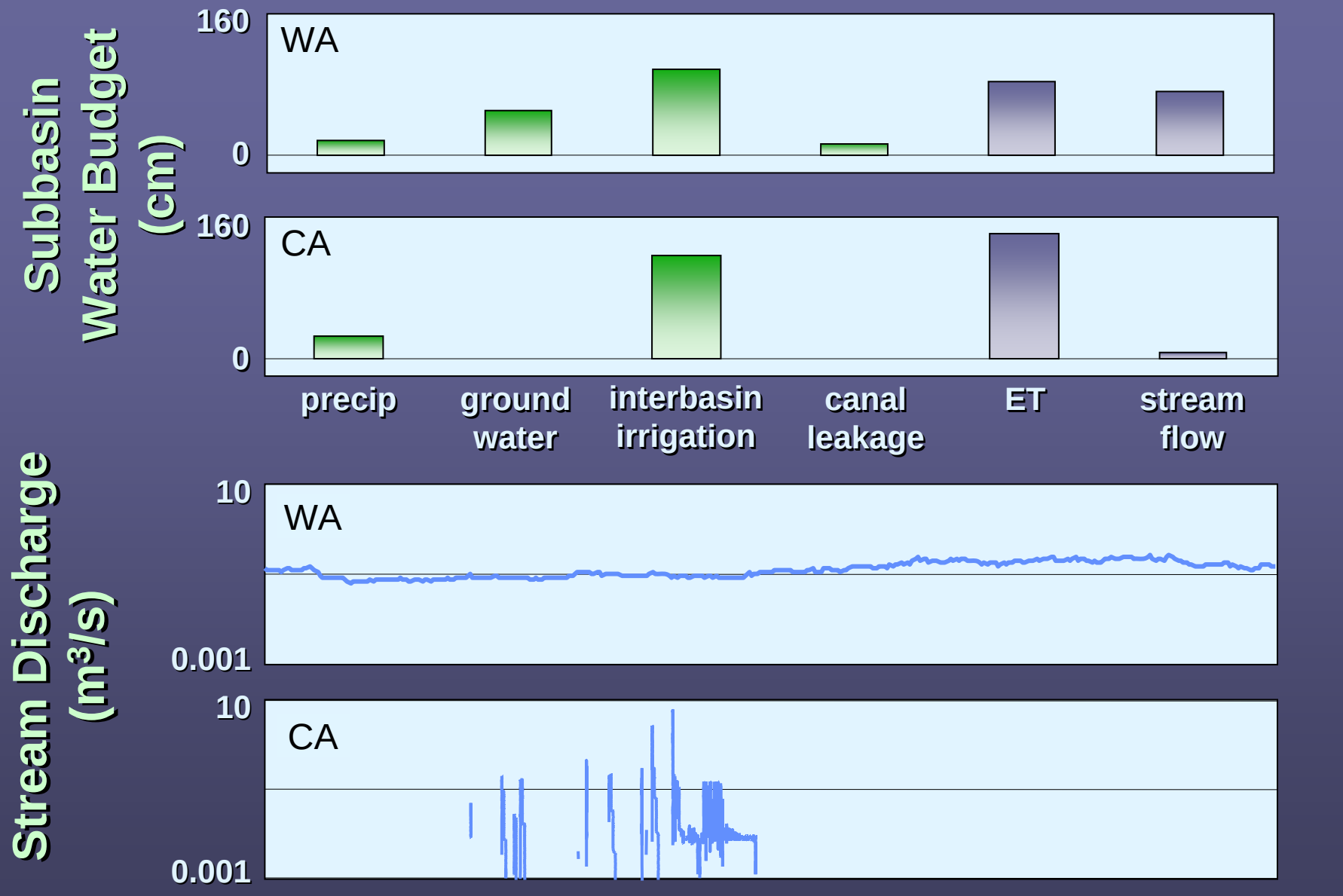


USGS


basin inflows
basin outflows
Annual Flows
(cm of water)
160
0
NE
CA
IN
MD
WA
precip
ground water
interbasin irrigation
canal leakage
ET
stream flow

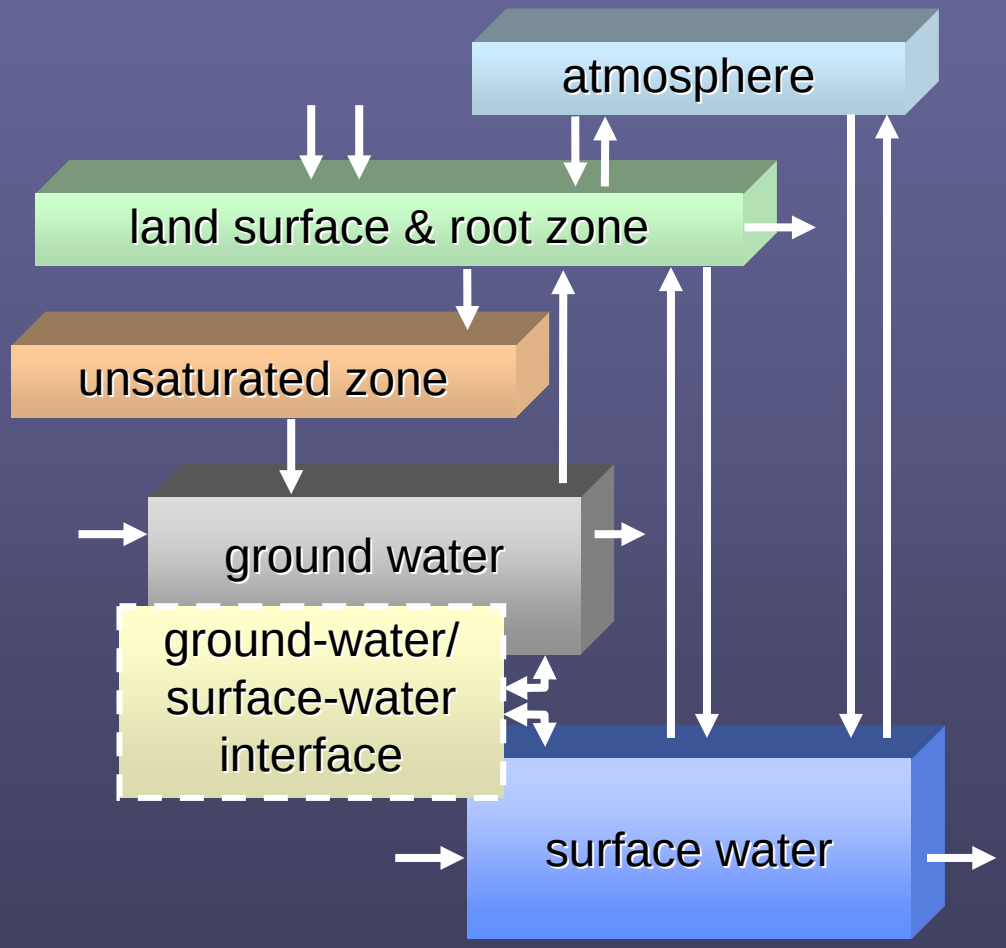
USGS


Oct
2003
Apr
2004
Oct
2004
Stream Discharge (m³/s)
NE
CA
IN
MD
WA
10
0.1
0.001


Subbasin Water Budget (cm)
160
0
WA
160
0
CA
precip
ground water
interbasin irrigation
canal leakage
ET
stream flow
Stream Discharge (m^3/s)
10
0.001
WA
10
0.001
CA
Oct 2003
Oct 2004

water & solids chemistry data

- field parameters
- nutrients
- major ions
- DOC
- pesticides & products
- suspended sediment
- age dating analytes
- isotopes (N & O)

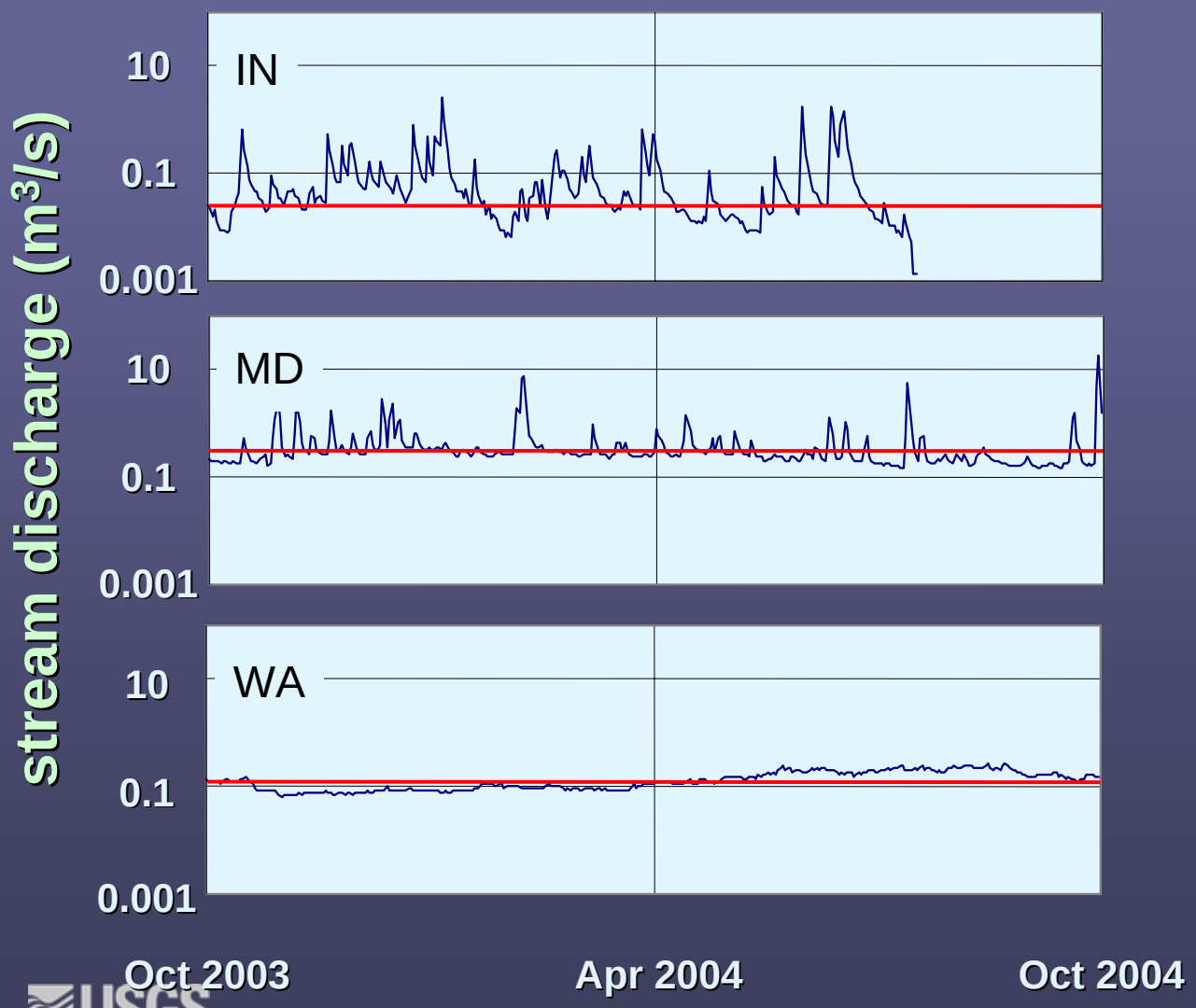


USGS

Nitrate + Nitrite, filtered (mM)
IN
MD
WA
100
1
0.01
precip & irrigation
unsaturated zone
ground water
streambed
overland flow
tile drains
surface water

USGS

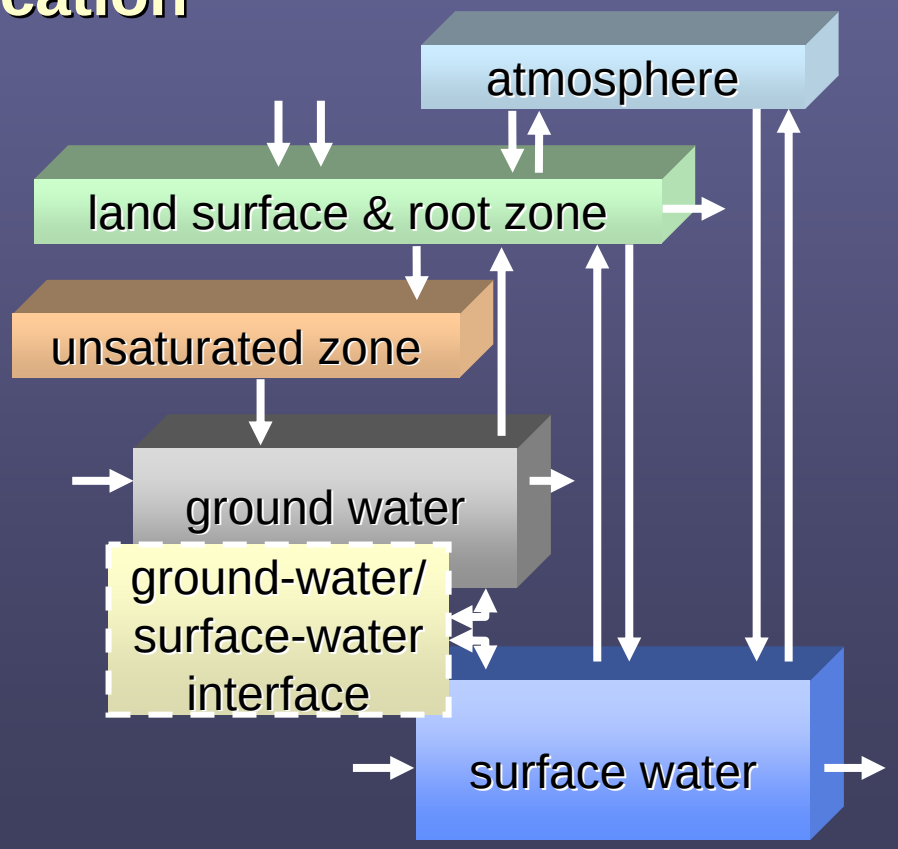
nitrate load relative to median flow



95 %	5 %
70 %	30 %
50 %	50 %

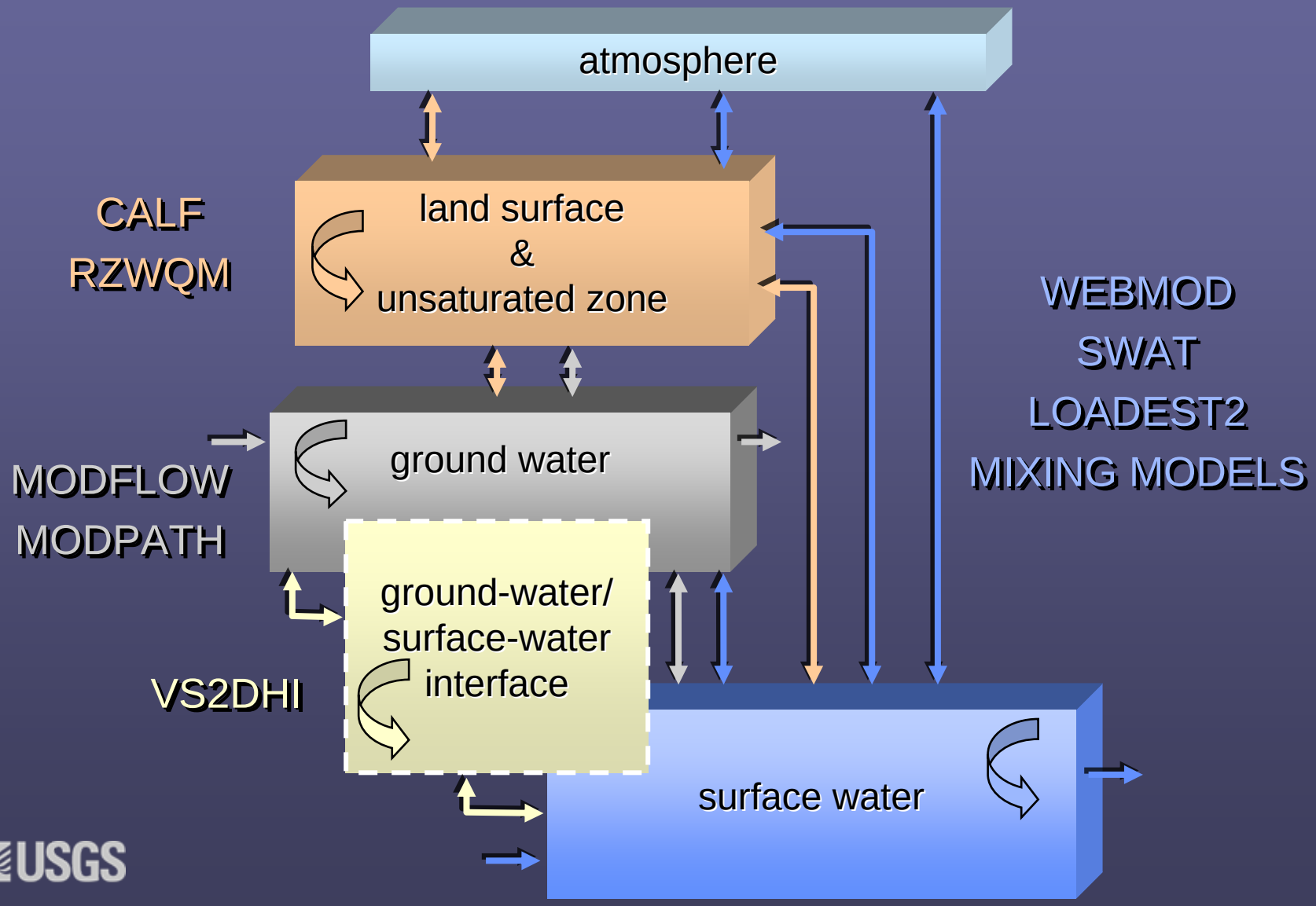
supplementary data for modeling

- agricultural chemical application
- crops
- soils
- aquifer solids



USGS

modeling



USGS

mixing models

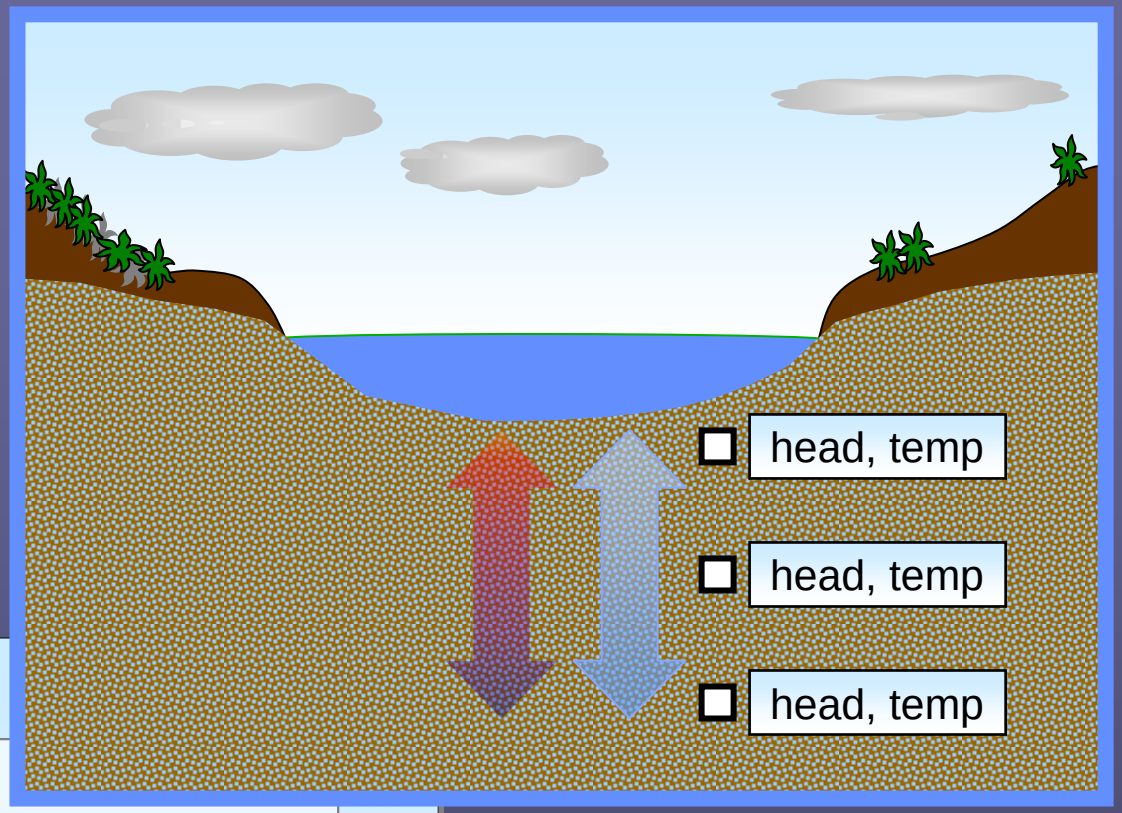
$$Q_{\text{tile drain}} = Q_{\text{soil water}} + Q_{\text{macropore flow}}$$

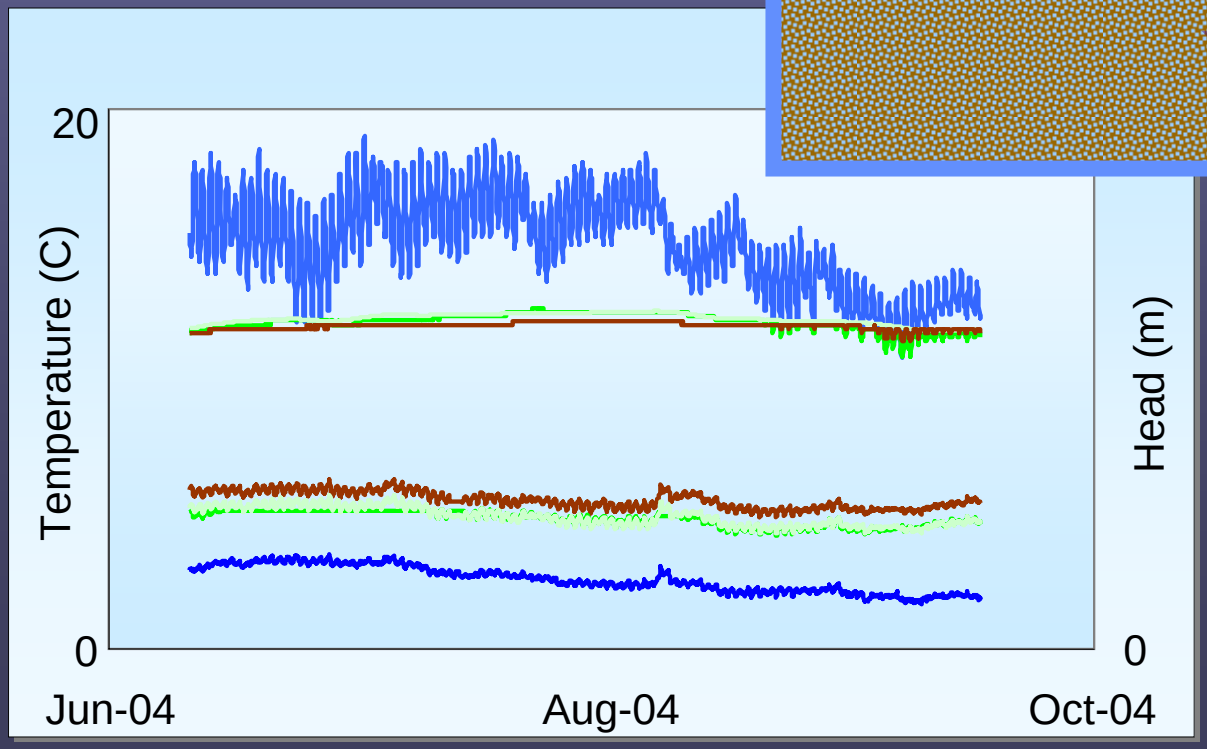
$$[Q\ C]_{\text{tile drain}} = [Q\ C]_{\text{soil water}} + [Q\ C]_{\text{macropore flow}}$$

soil water + macropore flow = tile drain

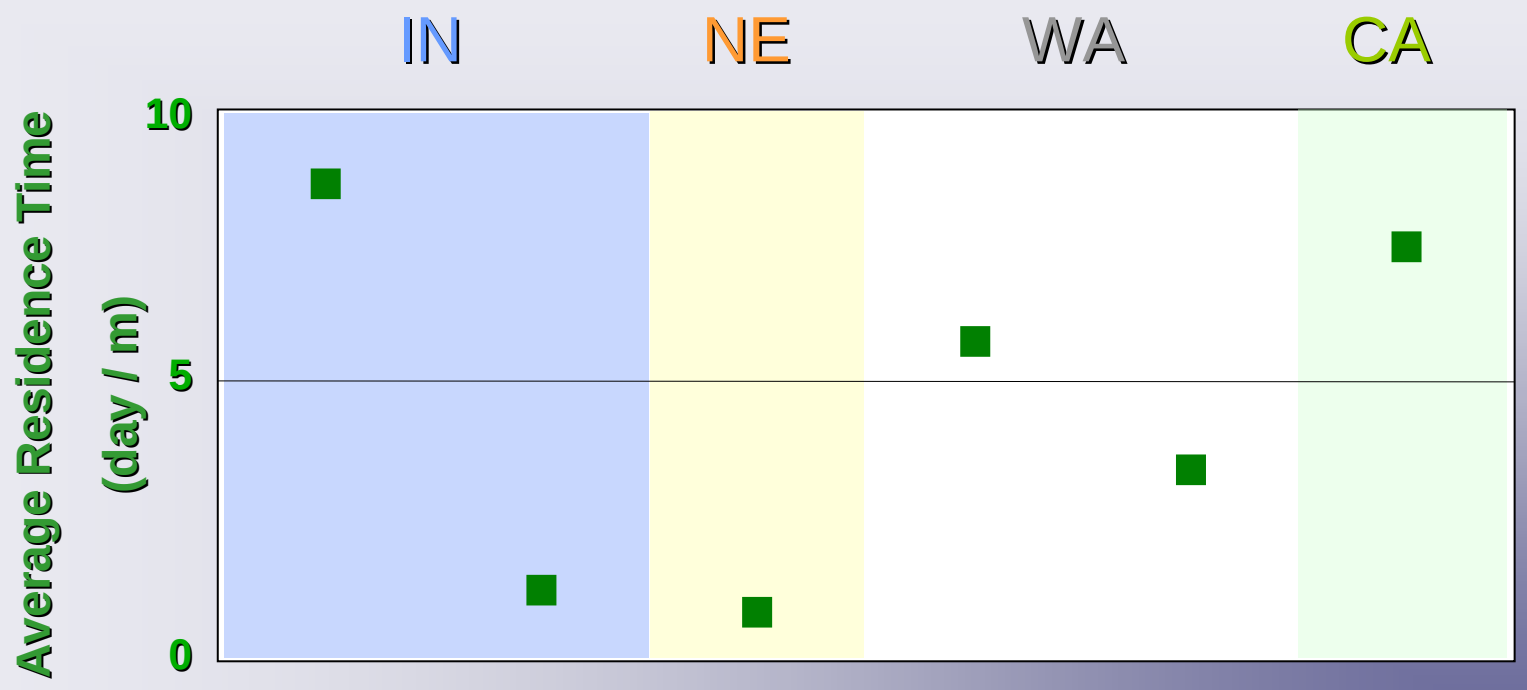
USGS

streambed heat-transport modeling



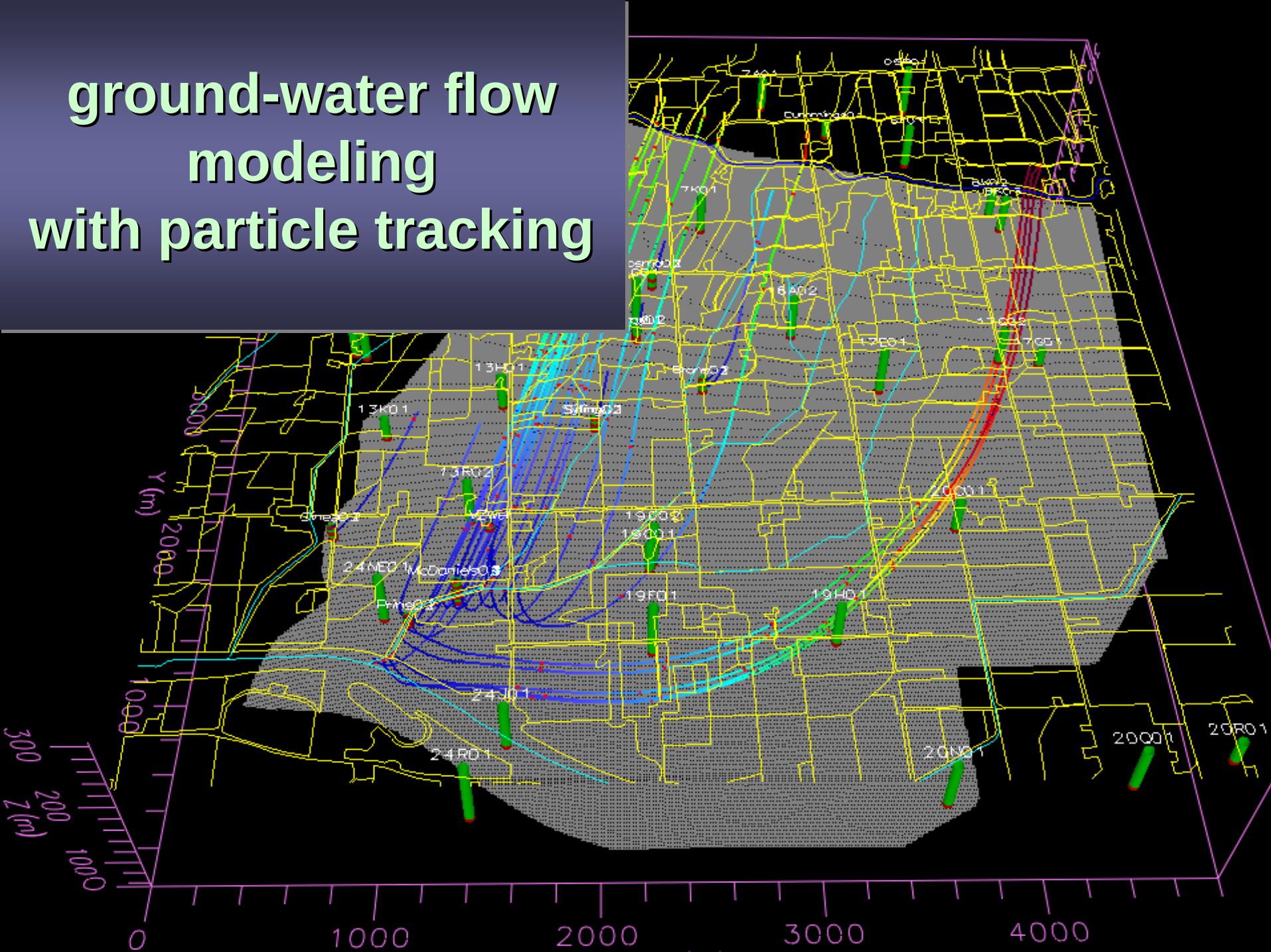


estimates of residence times within the streambed based on heat-transport modeling

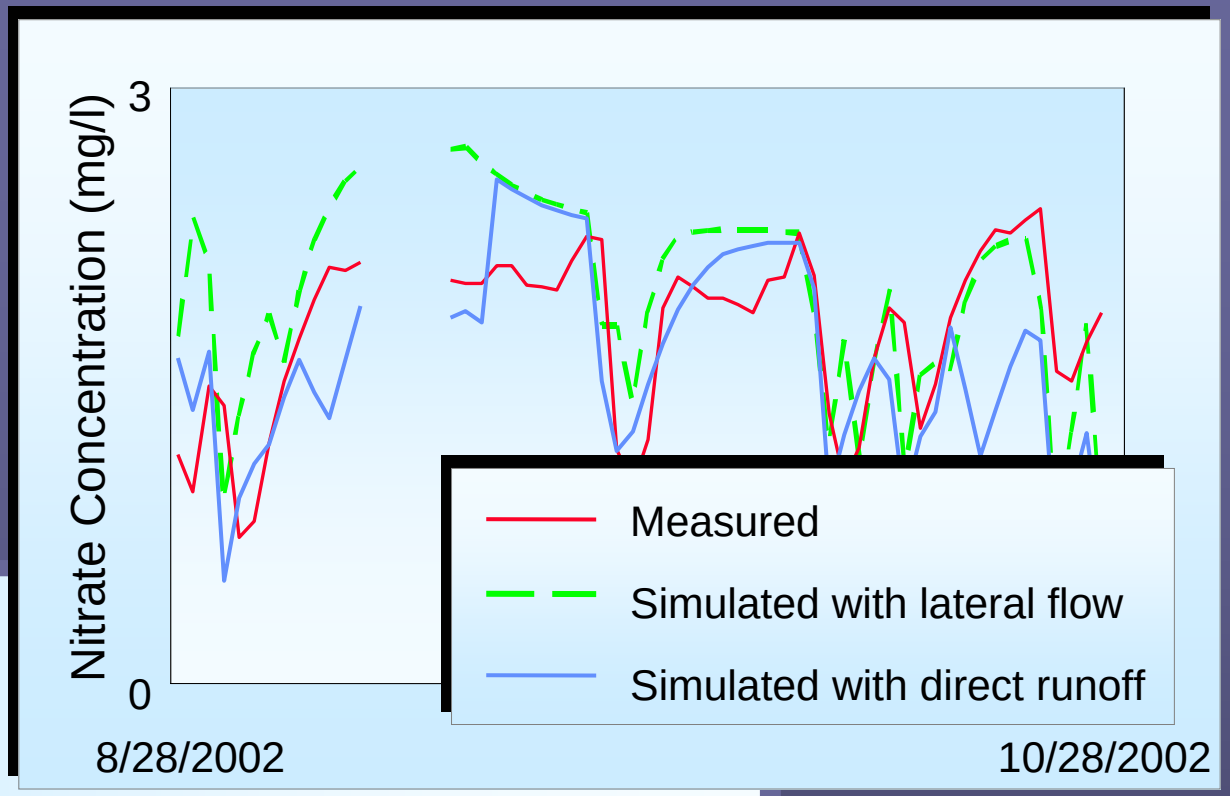


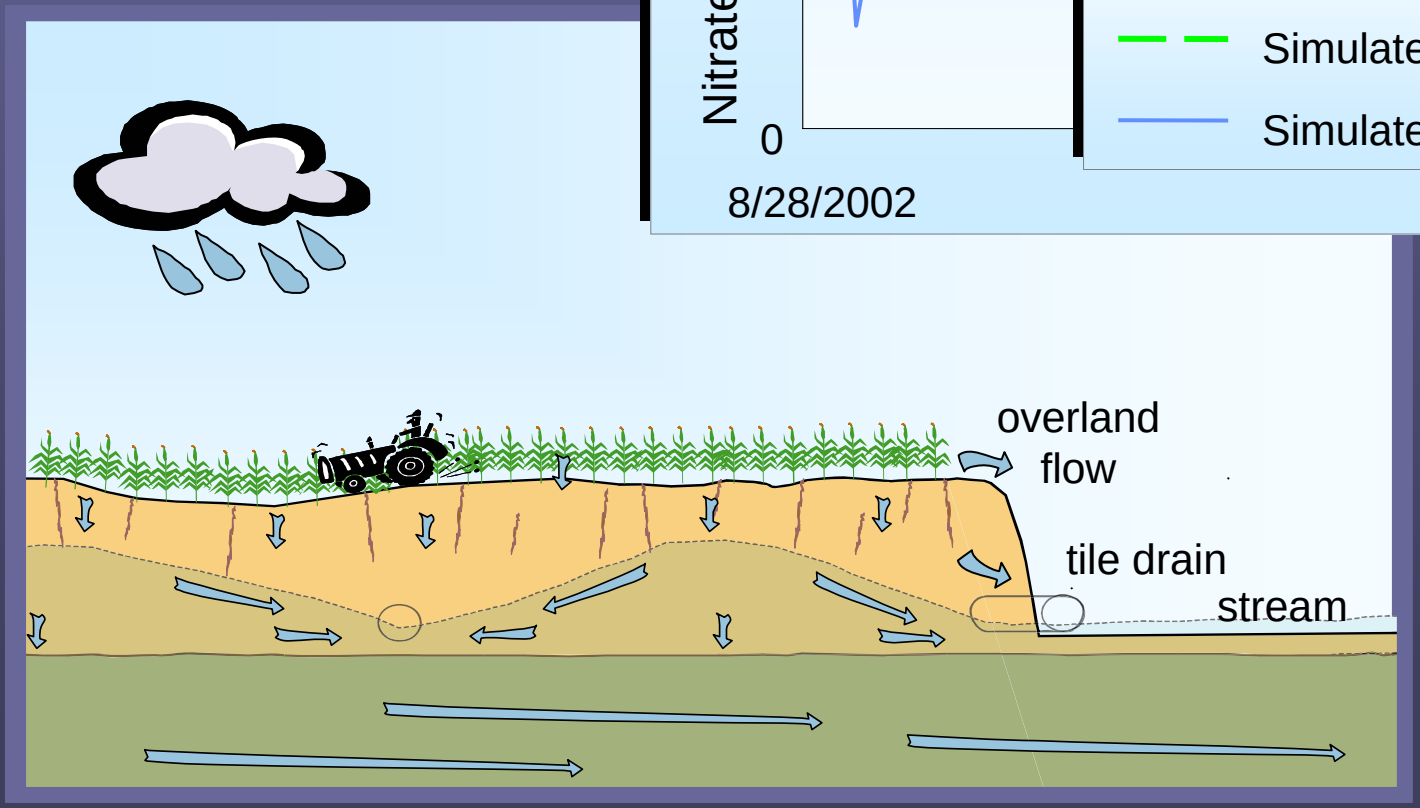
USGS

ground-water flow modeling with particle tracking

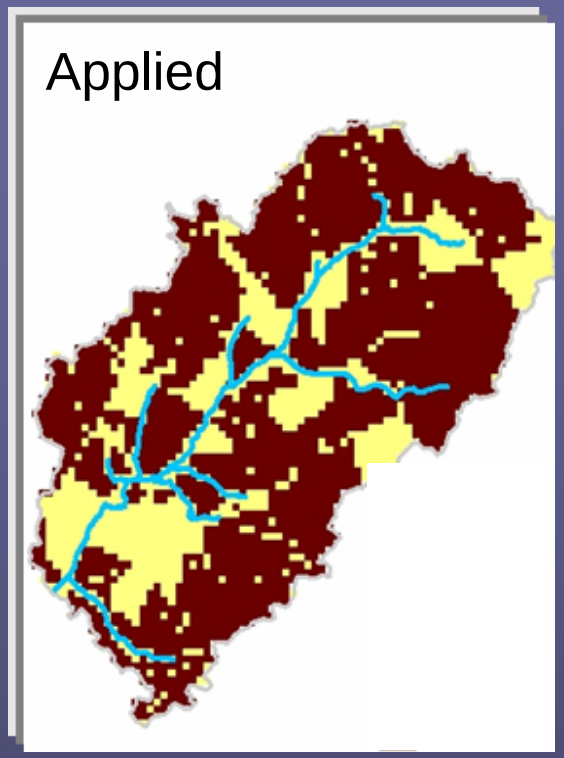


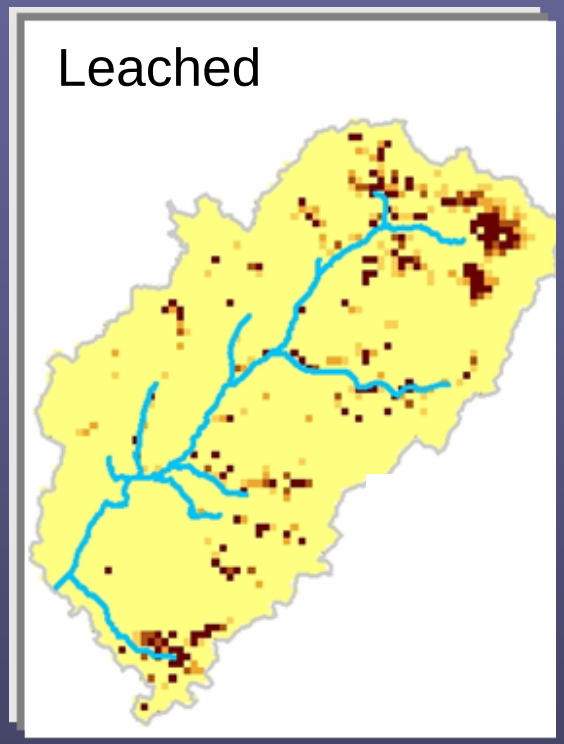
rainfall-runoff modeling

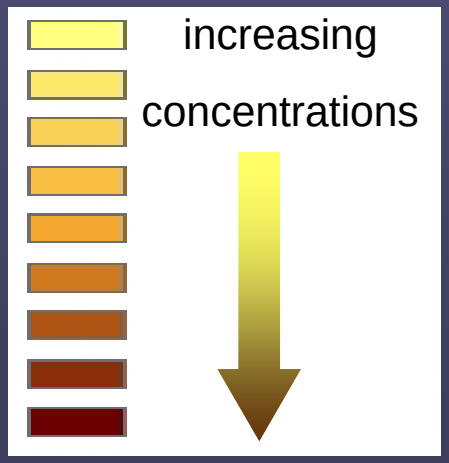




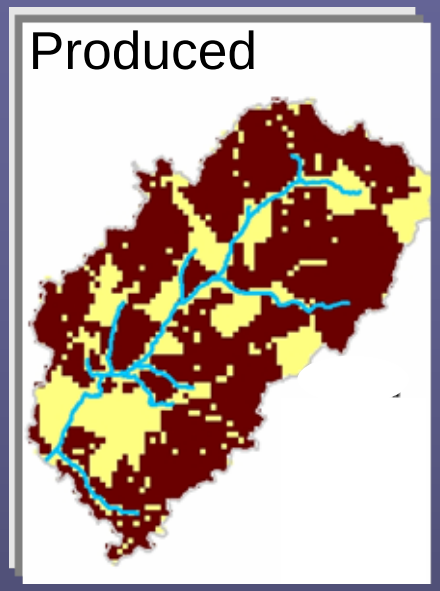
metolachlor in the unsaturated zone

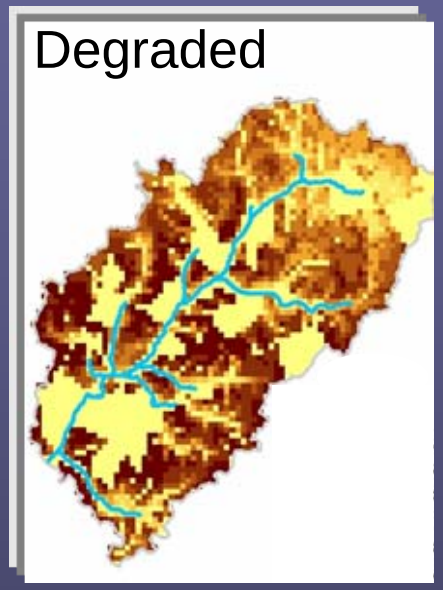


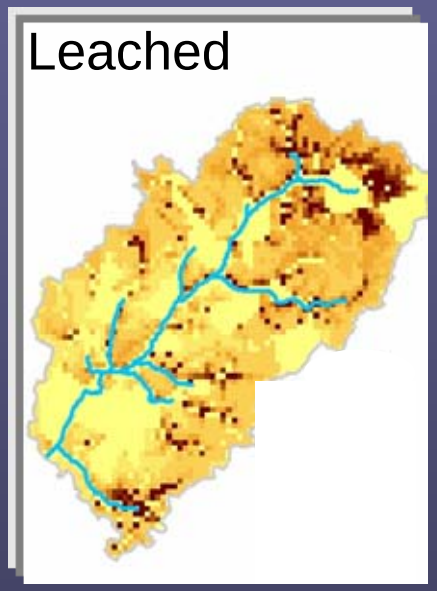


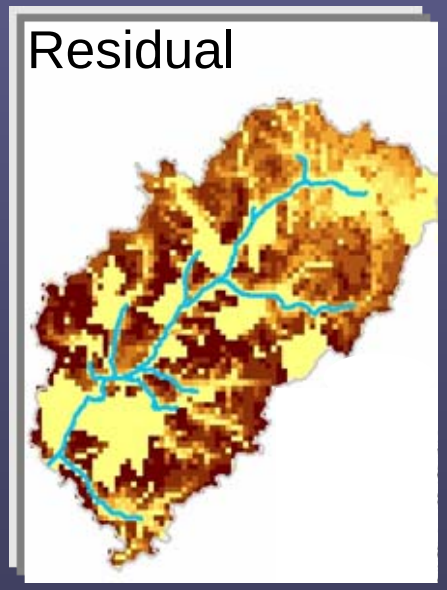


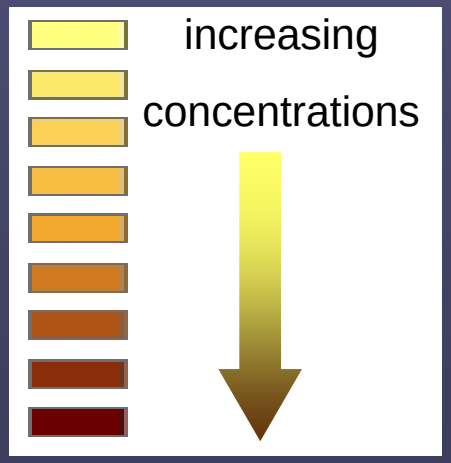
metolachlor ethane sulfonic acid in the unsaturated zone



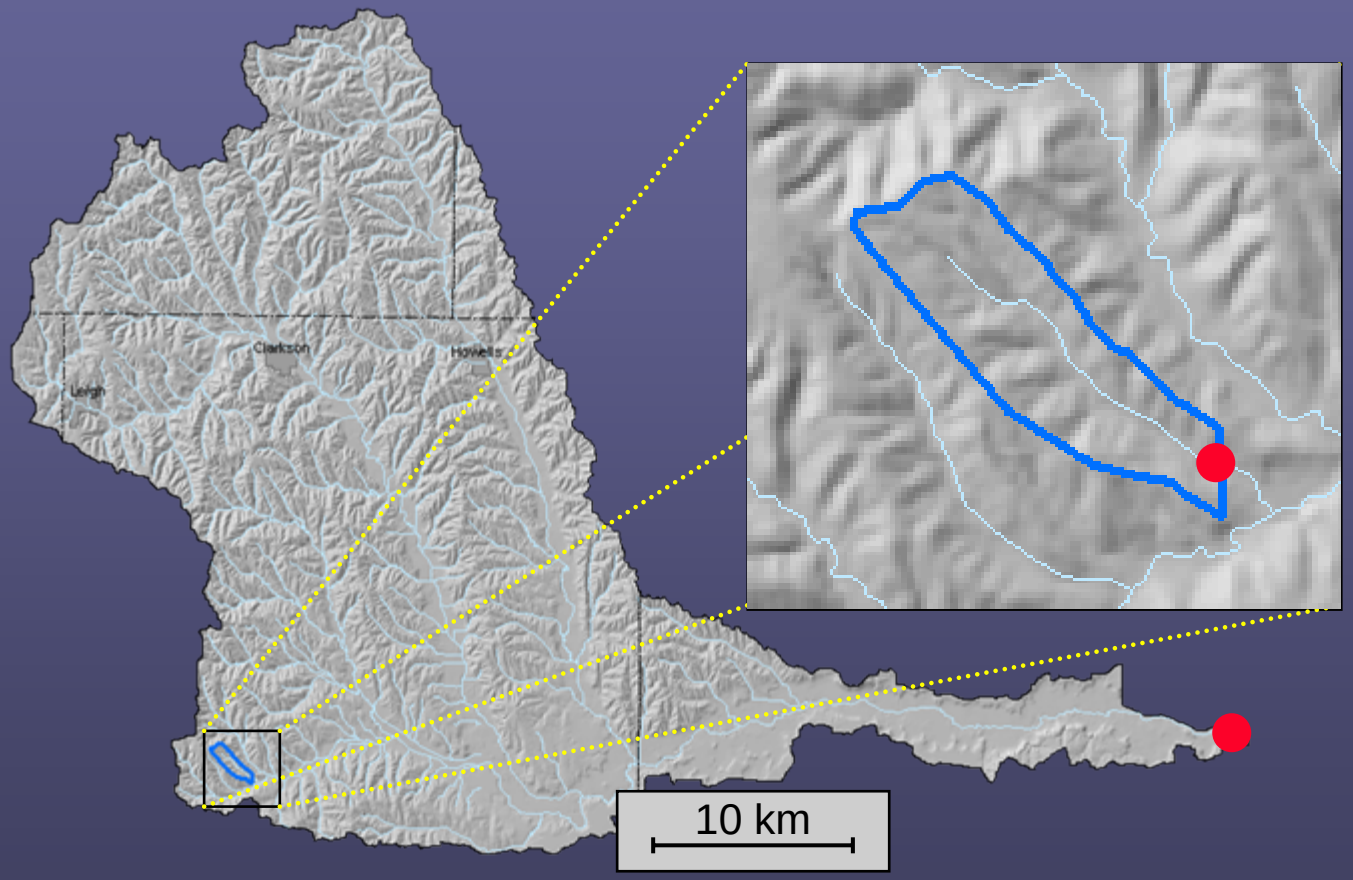




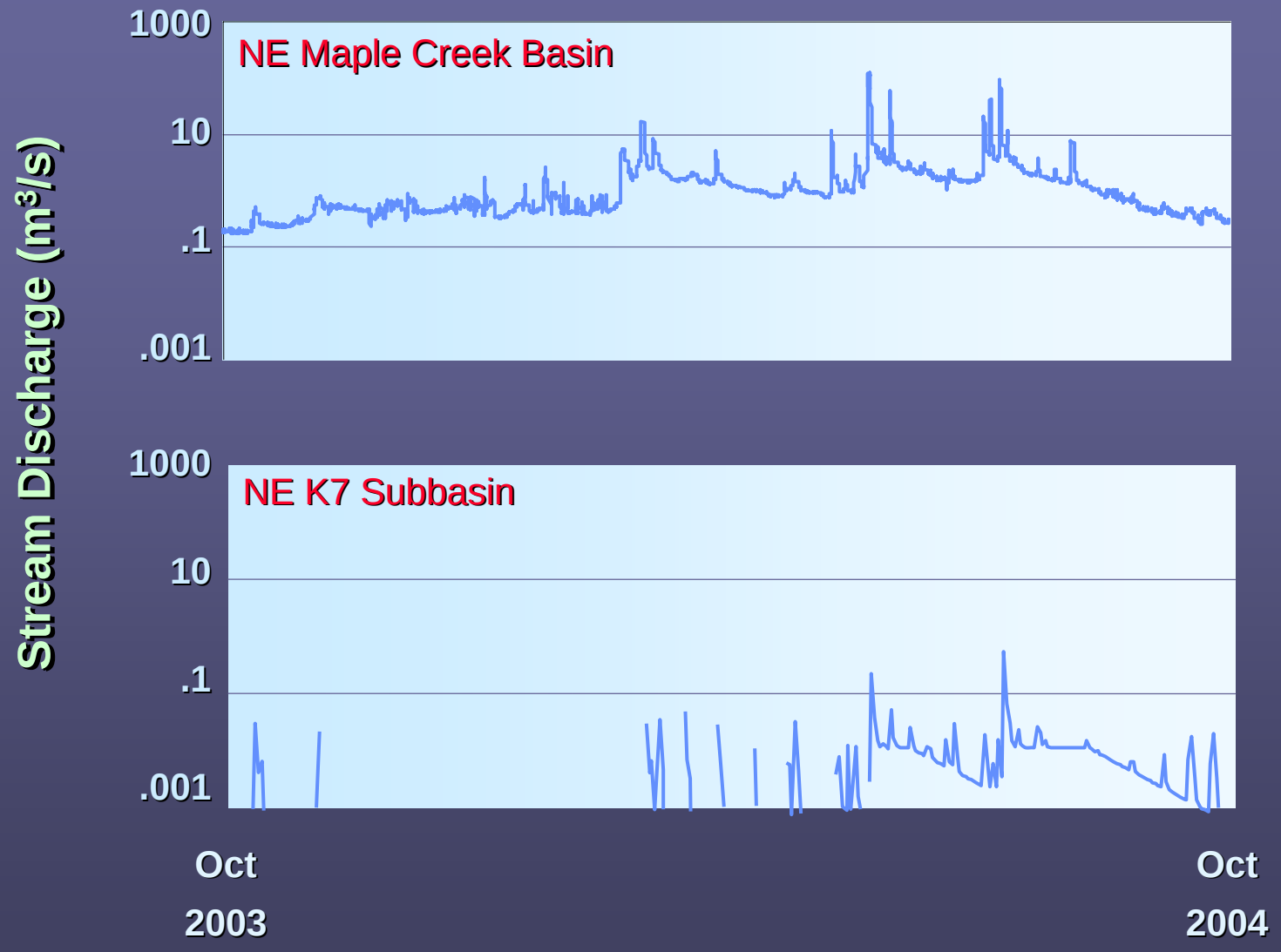




scaling is *not* straightforward

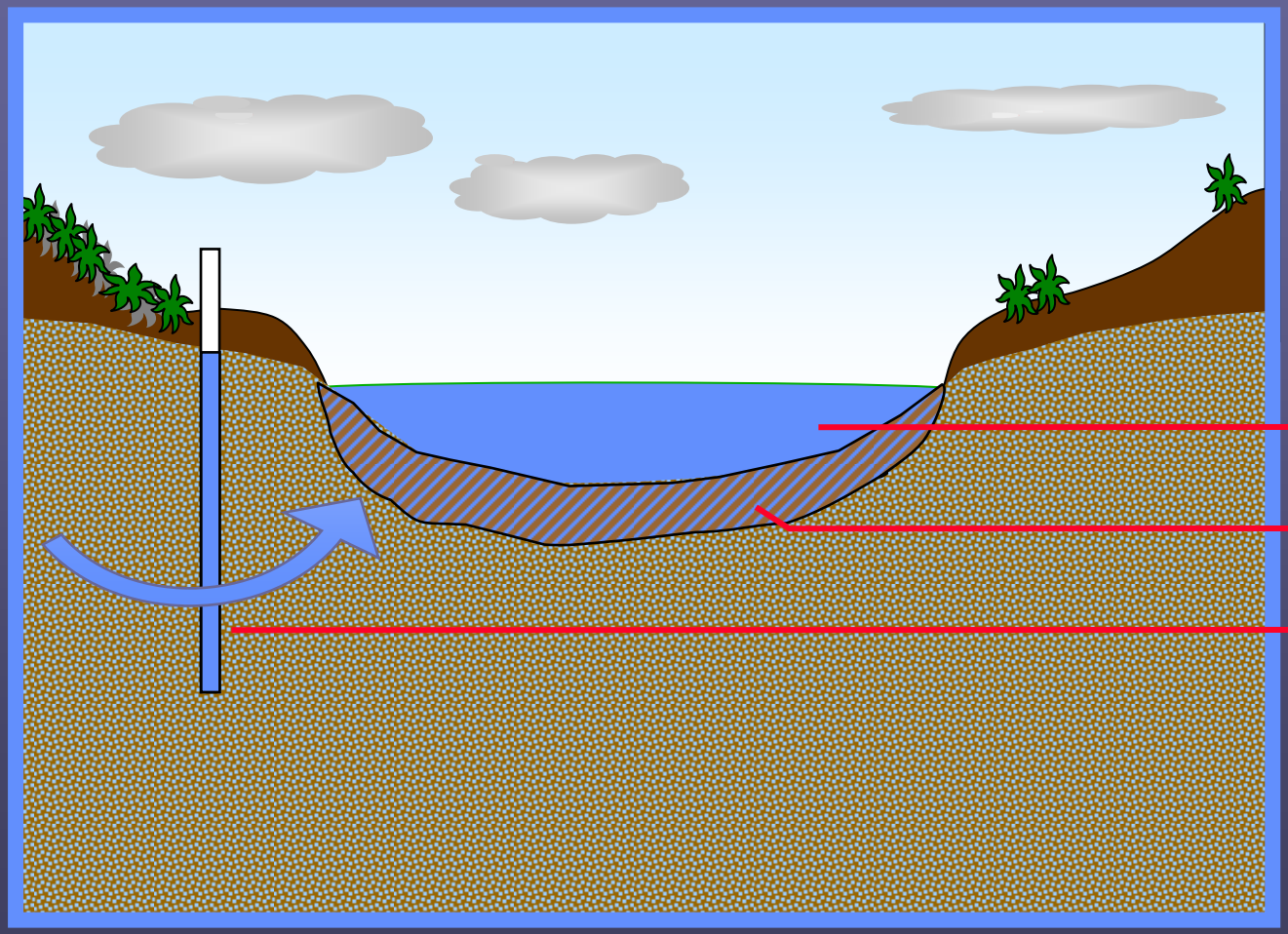


USGS


Stream Discharge (m³/s)
1000
10
.1
.001
NE Maple Creek Basin
1000
10
.1
.001
NE K7 Subbasin
Oct
2003
Oct
2004

USGS

multi-compartment sampling can reveal misconceptions



nitrate

mg/L

~ 5

< 1

~ 5

USGS

summary. . .

agricultural chemical transport is complex

***BUT*. . .**

available information can be a “gold mine”

USGS

. . . summary

conceptual modeling with available data

rigorous multi-compartment numerical modeling

A whole-watershed approach is greater than the sum of its parts

USGS

USGS