Intercode Comparisons for Simulating the Water Balance of Engineered Covers in Semiarid Regions

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OBJECTIVE

- Compare the performance of 7 different codes for simulating the water balance of near surface soils in hot and cold deserts
- Codes: HELP, HYDRUS-1D, SHAW, SoilCover, SWIM, UNSATH, and VS2DTI
- Monitoring data:
  - Chihuahuan desert in Texas
  - Snake River Plain in Idaho
- Sites nonvegetated and subjected to natural and enhanced precipitation

Talk Outline

- Code attributes, input, and output
- Site descriptions: Texas and Idaho
- Simulation results:
  - Texas
  - Idaho
- Summary
- Current Studies

ATTRIBUTES OF CODES

- Dimensionality: VS2DTI, 2D; HELP, quasi-2D; all others, 1D
- Runoff: HELP, SCS Curve No.; others, precip. - infil.
- Subsurface flow: HELP, storage routing approach; other codes, Richards' equation
- GUI: HELP, HYDRUS-1D, SoilCover, UNSATH, VS2DTI

Model Input and Output

- Initial conditions: θ(z) (HELP); h(z) other codes
- Constitutive equations: h(θ)
  - van Genuchten: HYDRUS, SWIM, UNSAT-H, and VS2DTI
  - Brooks & Corey: HELP; Campbell: SHAW
- Boundary conditions:
  - z = 0 m: P(t), T(t), RH(t), U(t), net radiation (t),T_{dew}(t) ---PET
  - z = 2 - 3 m: unit gradient or seepage face
- Model output:
  - runoff(t), evaporation(t), storage(t), drainage (t)

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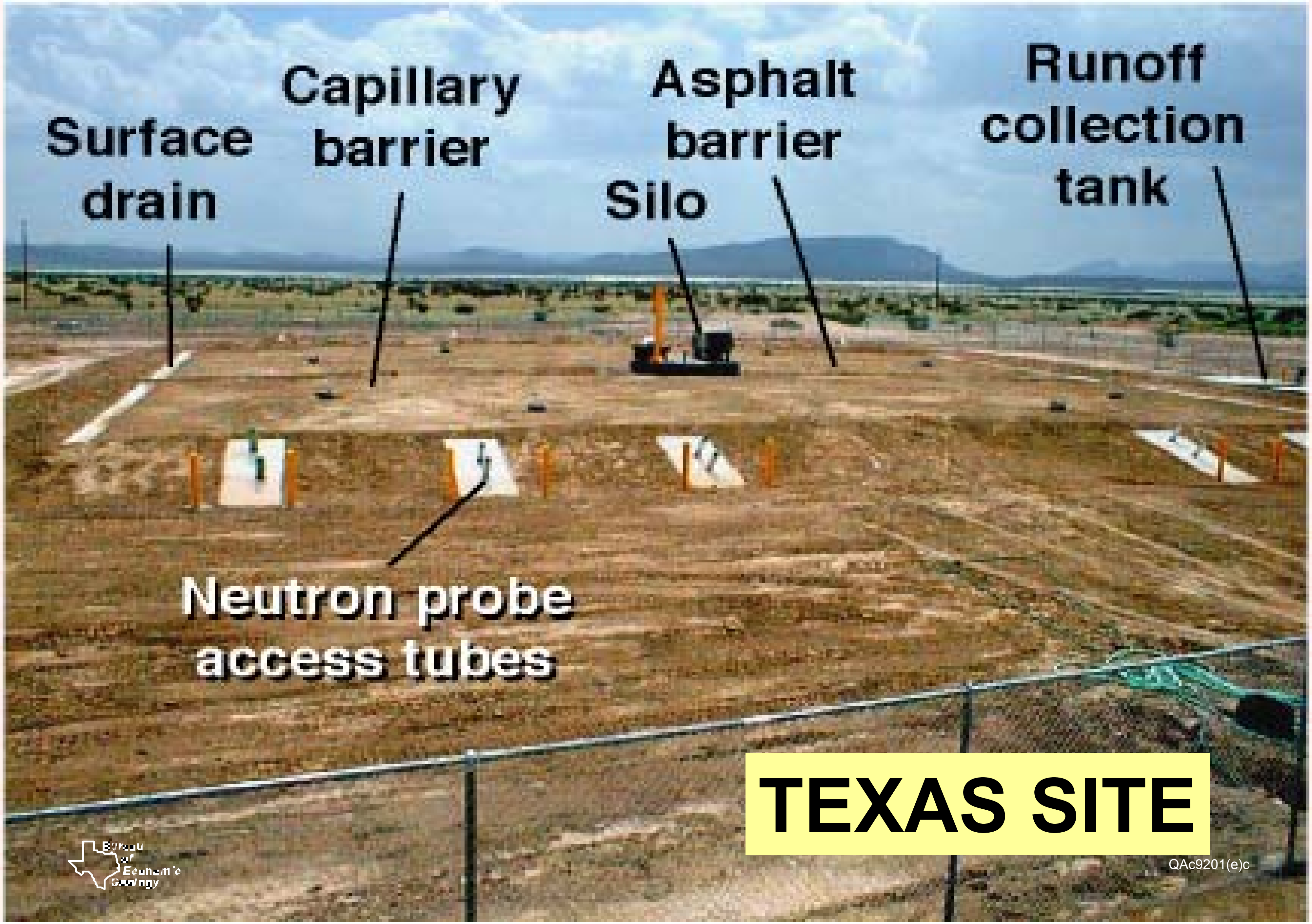
Surface drain
Capillary barrier
Asphalt barrier
Silo
Runoff collection tank
Neutron probe access tubes
TEXAS SITE
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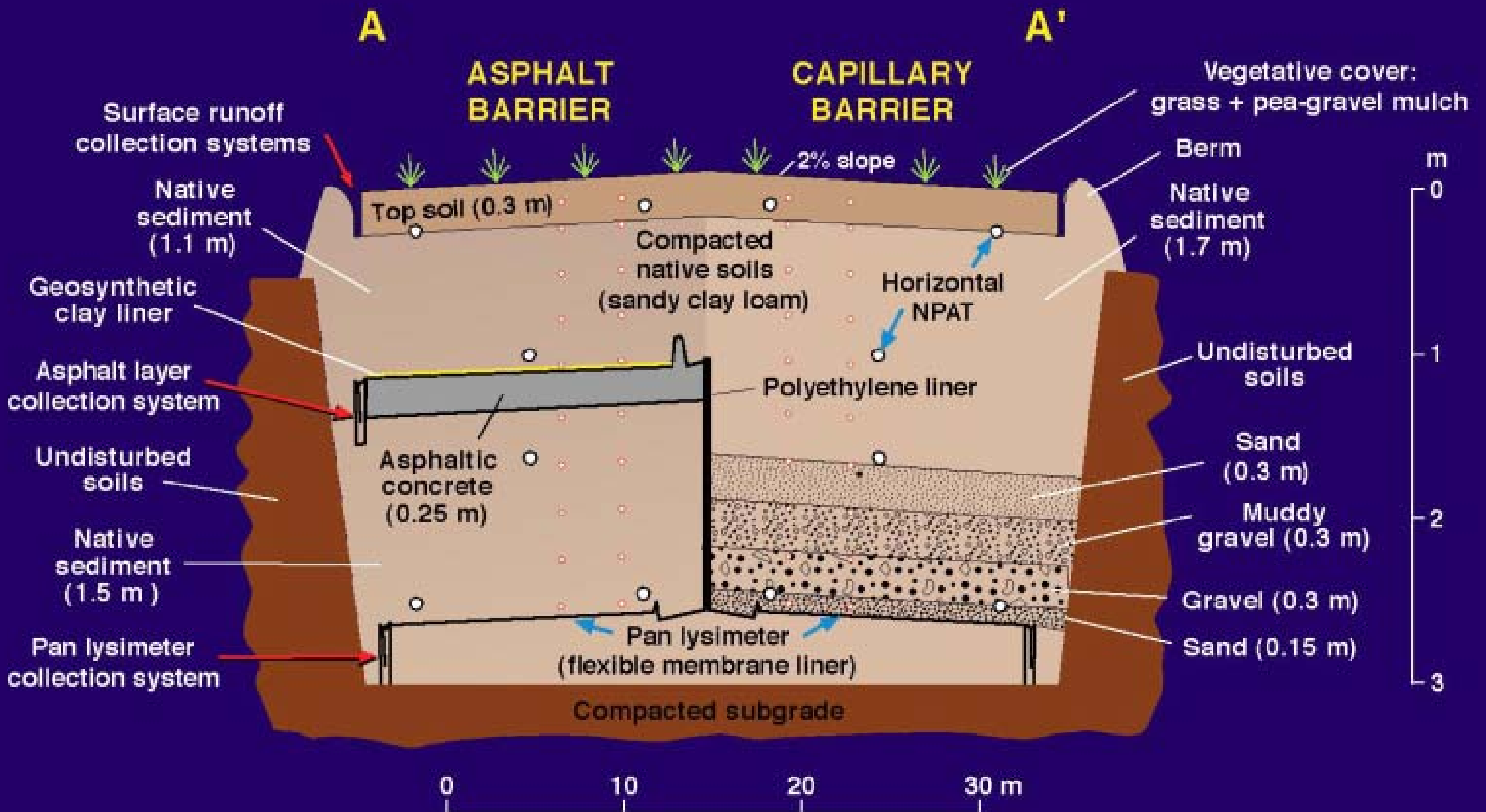
Cross Section of Barriers at Texas Site



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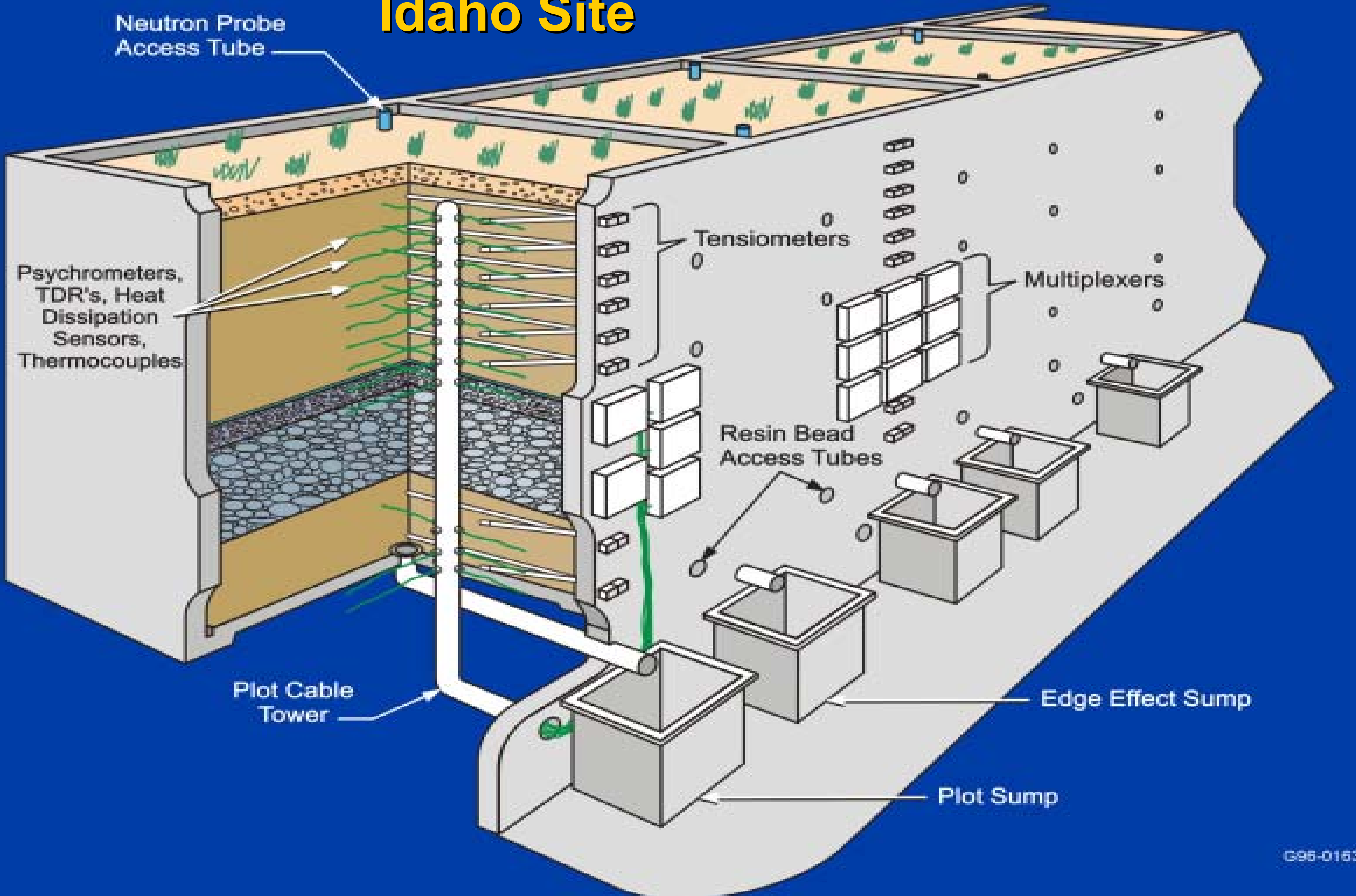
Idaho Site

Internal View of Engineered Barriers with Plot Cutaway

Idaho Site



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MODEL RESULTS: Texas Site Runoff

- Measured runoff: 6 cm
- HELP and SoilCover: 1 cm
- All other codes: 0 cm
- Precipitation intensity: daily vs. hourly, similar results
  - 15-min input, HYDRUS-1D and VS2DTI, ~1 cm runoff
- Hydraulic conductivity:
  - decrease K one order magnitude: ~6 cm runoff

Water Balance Results for Texas Site

		E	RMSE	ΔS	RMSE	D
Measured		32.6		4.1		0.0
HELP	d	21.5	5.2	14.2	4.5	0.9
HYDRUS-1D	d	35.0	1.6	1.6	1.7	0.0
	hr	33.4	1.2	3.3	1.1	0.0
SHAW	d	31.5	0.8	4.8	0.7	0.3
	hr	33.1	0.7	3.5	1.0	0.2
SoilCover	d	34.6	1.4	2.1	1.4	0.0
	hr	25.7	3.5	6.6	1.0	0.0
SWIM	d	34.1	1.4	2.6	1.5	0.0
	hr	33.6	1.4	3.0	1.5	0.0
UNSAT-H	d	29.7	2.0	6.7	1.7	0.3
	hr	29.9	2.0	6.6	1.7	0.3
VS2DTI	d	17.9	7.1	18.8	7.1	0.0
	hr	29.9	2.0	6.8	1.9	0.0

Precip 36.7; PET 164.0

All units in cm

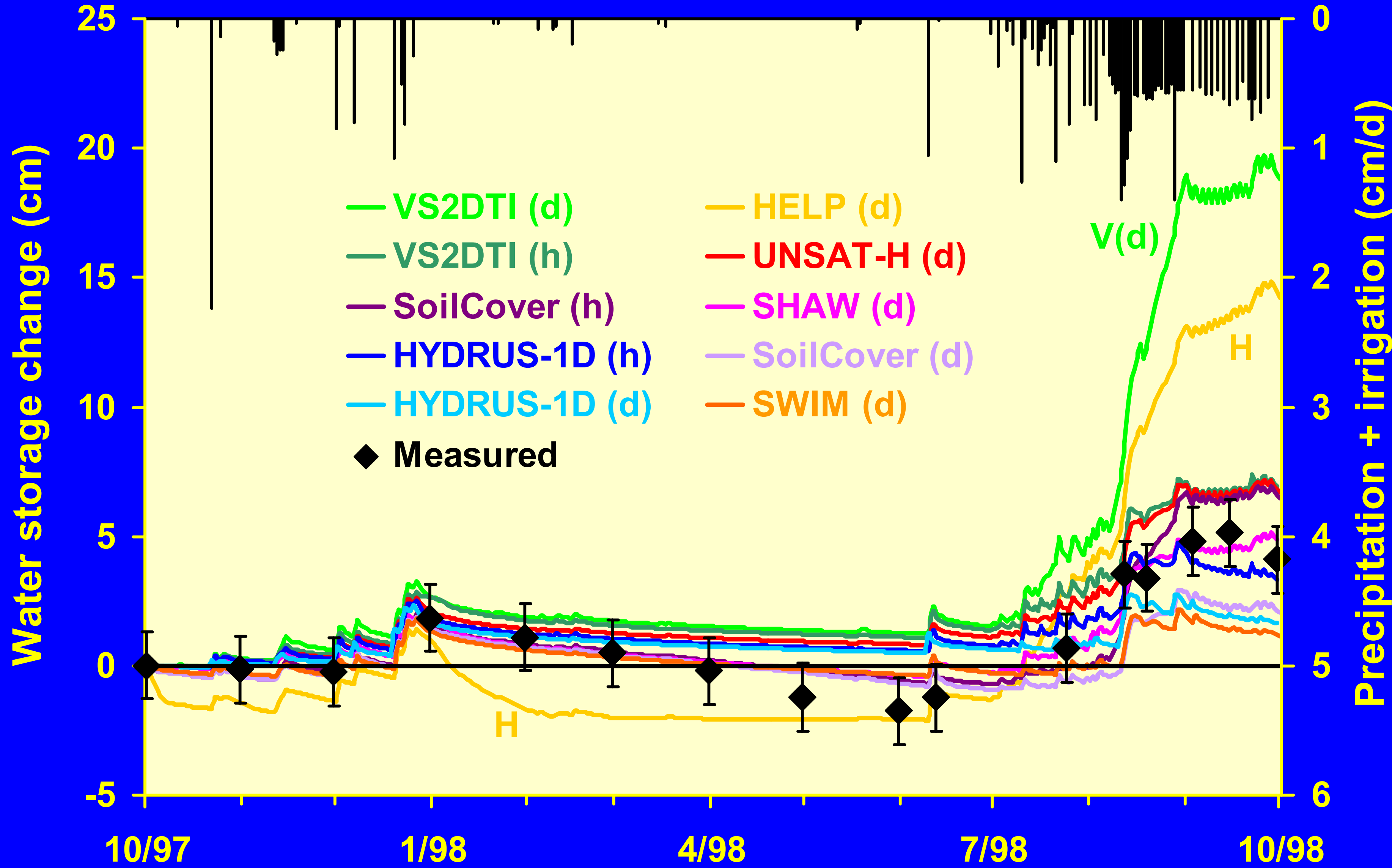
EXPLANATION FOR CODE DIFFERENCES (TEXAS)

		E	ΔS
UNSAT-H	d	29.7	6.7
HYDRUS-1D	d	35.0	1.6
UNSAT-H* (HYD)	d	34.4	2.0
VS2DTI	d	17.9	18.8
UNSAT-H* (VS2DTI)	d	18.0	18.4

Precip 36.7; PET 164.0

All units in cm

MEASURED AND SIMULATED WATER STORAGE, TEXAS



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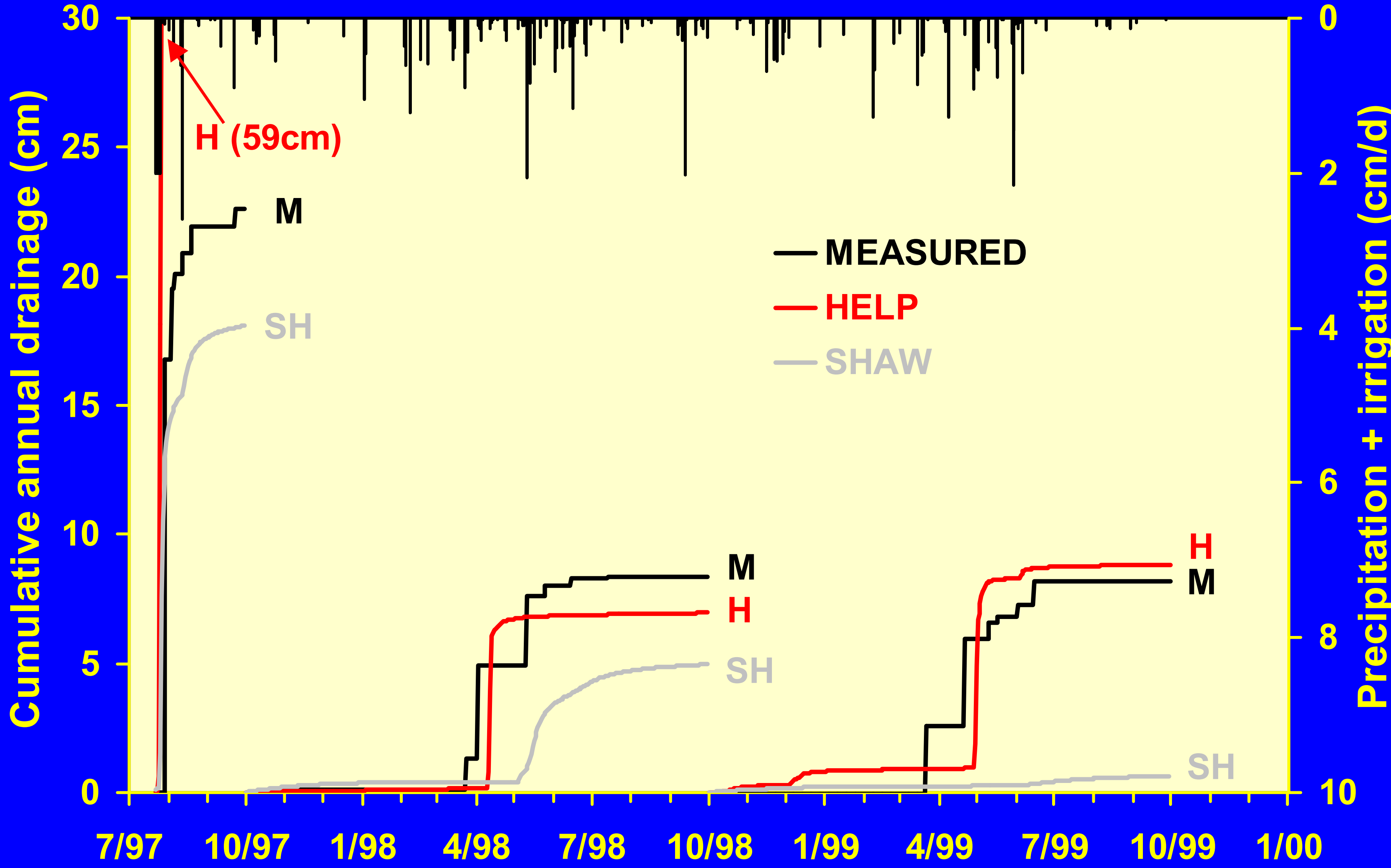
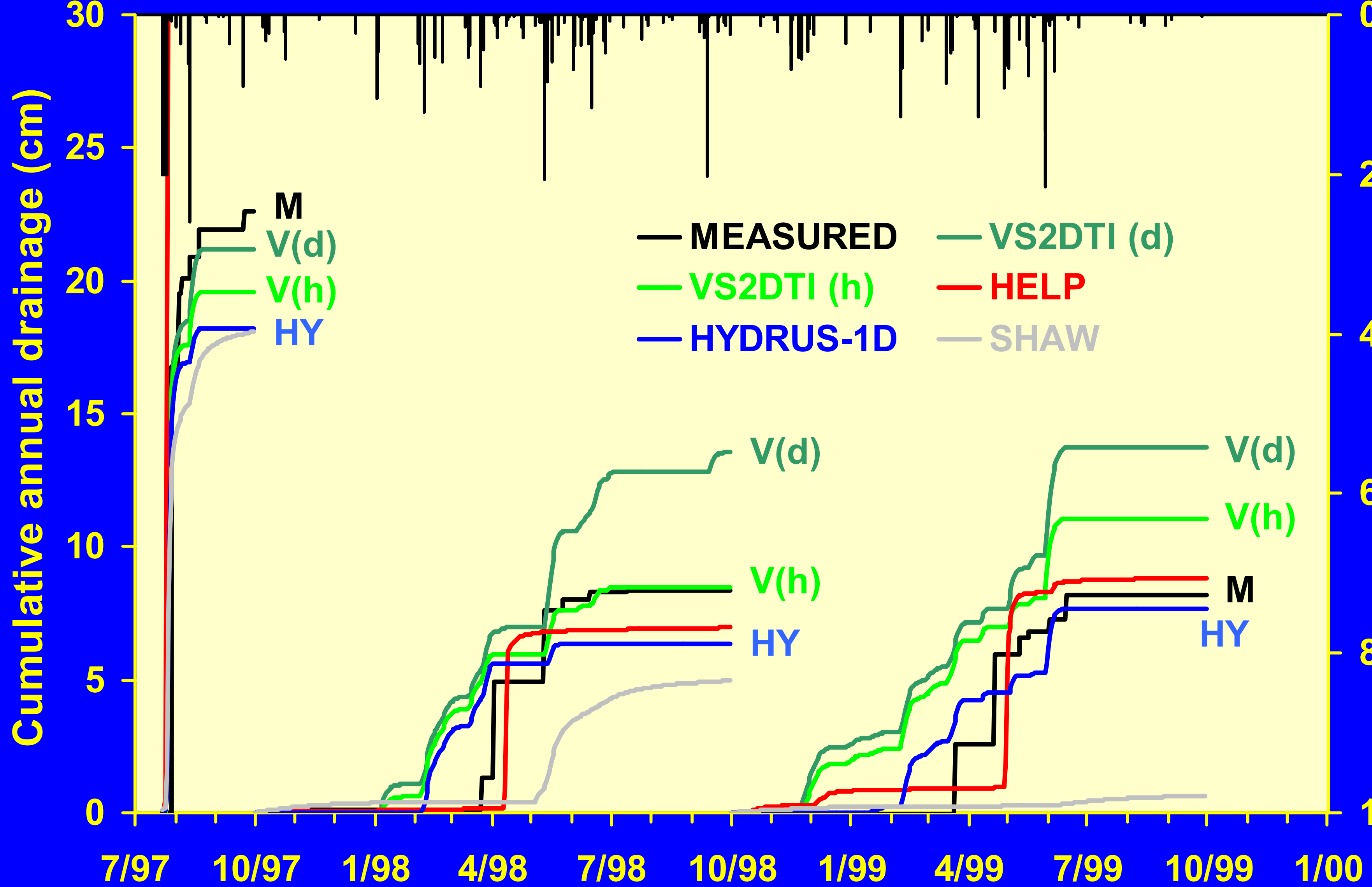
MEASURED AND SIMULATED DRAINAGE IDAHO SITE



MEASURED AND SIMULATED DRAINAGE
IDAHO SITE



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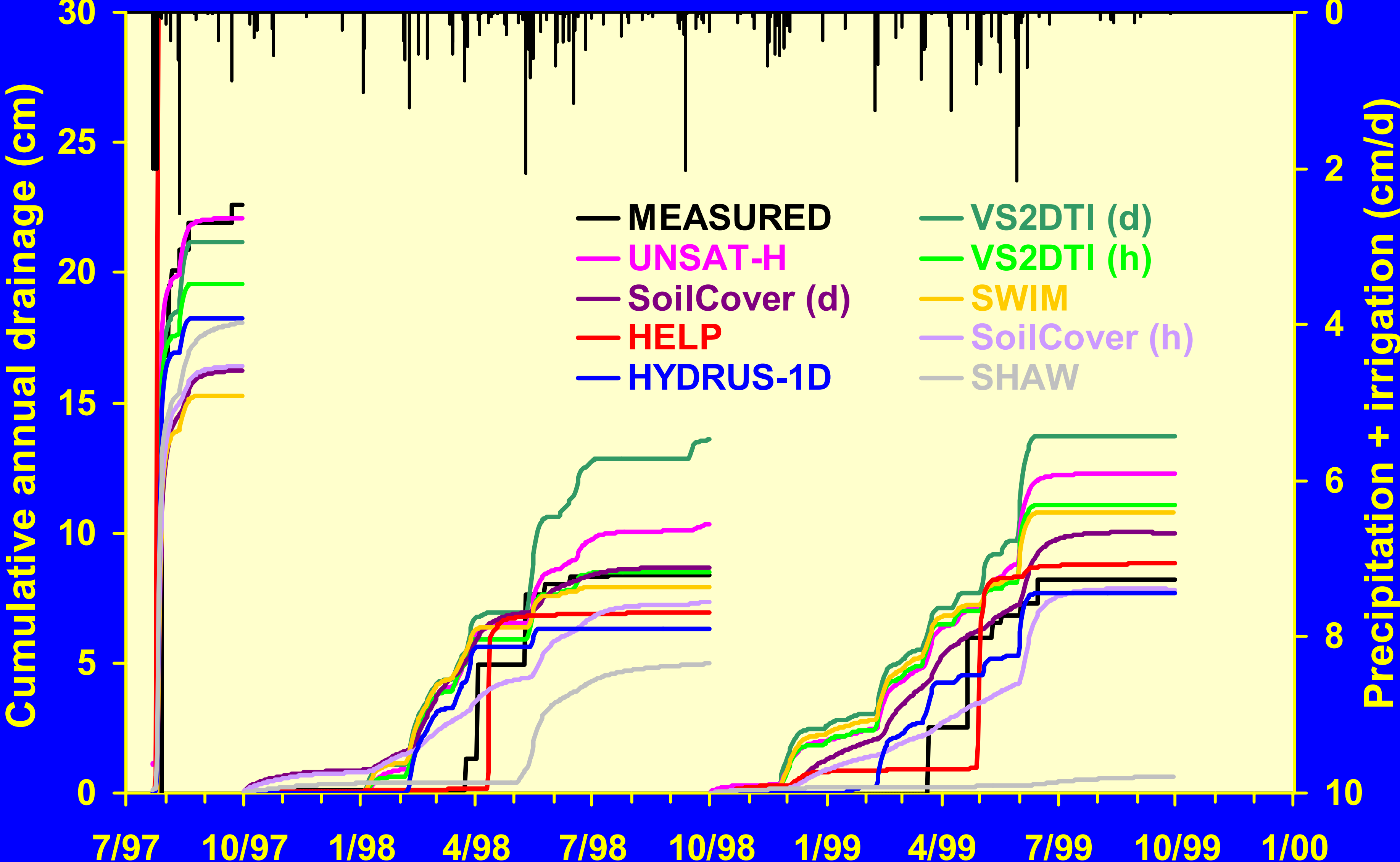

MODEL RESULTS FOR IDAHO SITE

		pre WY98 P 75.9 PET 45.8			WY98 P 24.2 PET 118.0			WY99 P 19.8 PET 129.3	
		E	ΔS	D	E	ΔS	D	E	ΔS	D
Measured		5.2	48.0	22.7	15.4	0.5	8.3	11.7	-0.8	8.9
UNSAT-H	d	5.2	48.7	22.1	13.1	0.8	10.3	10.1	-2.6	12.3
SoilCover	d	9.9	49.7	16.2	16.8	-1.2	8.7	11.2	-1.3	10.0
	hr	7.7	51.4	16.4	12.5	3.6	7.4	9.3	2.2	7.8
SWIM	d	9.5	51.1	15.3	16.1	0.2	7.9	10.4	-1.3	10.8
	hr	9.0	50.9	16.0	16.7	0.3	7.3	11.0	-1.7	10.5
VS2DTI	d	3.5	51.3	21.2	10.0	0.7	13.6	9.0	-2.8	13.7
	hr	5.2	51.2	19.6	15.4	0.4	8.5	11.3	-2.5	11.1
HYDRUS-1D	d	10.2	48.0	17.7	18.7	-0.8	6.3	13.5	-1.3	7.7
	hr	9.5	48.2	18.2	17.7	-0.2	7.4	13.5	-1.3	7.7
HELP	d	10.0	7.3	58.7	15.4	1.9	7.0	13.6	-2.6	8.8
SHAW	d	9.3	48.5	18.1	19.9	-0.7	5.0	22.8	-3.6	0.6
	hr	9.1	48.5	18.3	21.2	-0.7	3.6	23.0	-3.7	0.6

All units in cm

EXPLANATION FOR CODE DIFFERENCES (IDAHO SITE)

		pre WY98 P 75.9 PET 45.8			WY98 P 24.2 PET 118.0			WY99 P 19.8 PET 129.3		
		E	ΔS	D	E	ΔS	D	E	ΔS	D
UNSAT-H	d	5.2	48.7	22.1	13.1	0.8	10.3	10.1	-2.6	12.3
VS2DTI	d	3.5	51.3	21.2	10.0	0.7	13.6	9.0	-2.8	13.7
UNSAT-H * (VS2DTI)	d	3.4	48.9	23.6	8.3	0.9	15.0	7.9	-2.8	14.7
HYDRUS-1D	d	10.2	48.0	17.7	18.7	-0.8	6.3	13.5	-1.3	7.7
UNSAT-H * (HYD)	d	9.8	48.5	17.7	16.9	-0.5	7.8	11.7	-2.3	10.5
SHAW	d	9.3	48.5	18.1	19.9	-0.7	5.0	22.8	-3.6	0.6
UNSAT-H * (SHAW)	d	6.8	48.5	20.6	19.8	-1.4	5.9	16.4	-5.1	8.5

All units in cm

SUMMARY

- Intercode comparison …. reliability of various codes …
- Explanation of outliers
  - storage routing (HELP) versus Richards' equation (all other codes)
  - upper boundary condition during rain, time discretization of input (e.g. VS2DTI)
  - lower boundary condition (unit gradient versus seepage face)
  - water retention functions (Brooks & Corey versus van Genuchten
- Code performance varies with site and with meteorologic forcing at a particular site

Current Research

- Simulation of vegetated systems
- Simulation of physical flow system based on lysimeter data under nonvegetated conditions
- Preliminary results of simulating vegetation effects suggests that cannot prescribe vegetation parameters a priori because vegetation responds dynamically to water availability

- Presentation and pdf of paper
  – www.beg.utexas.edu