Status of Central Valley Groundwater-Surface Water Simulation Model (C2VSim) Calibration

IWFM User's Group
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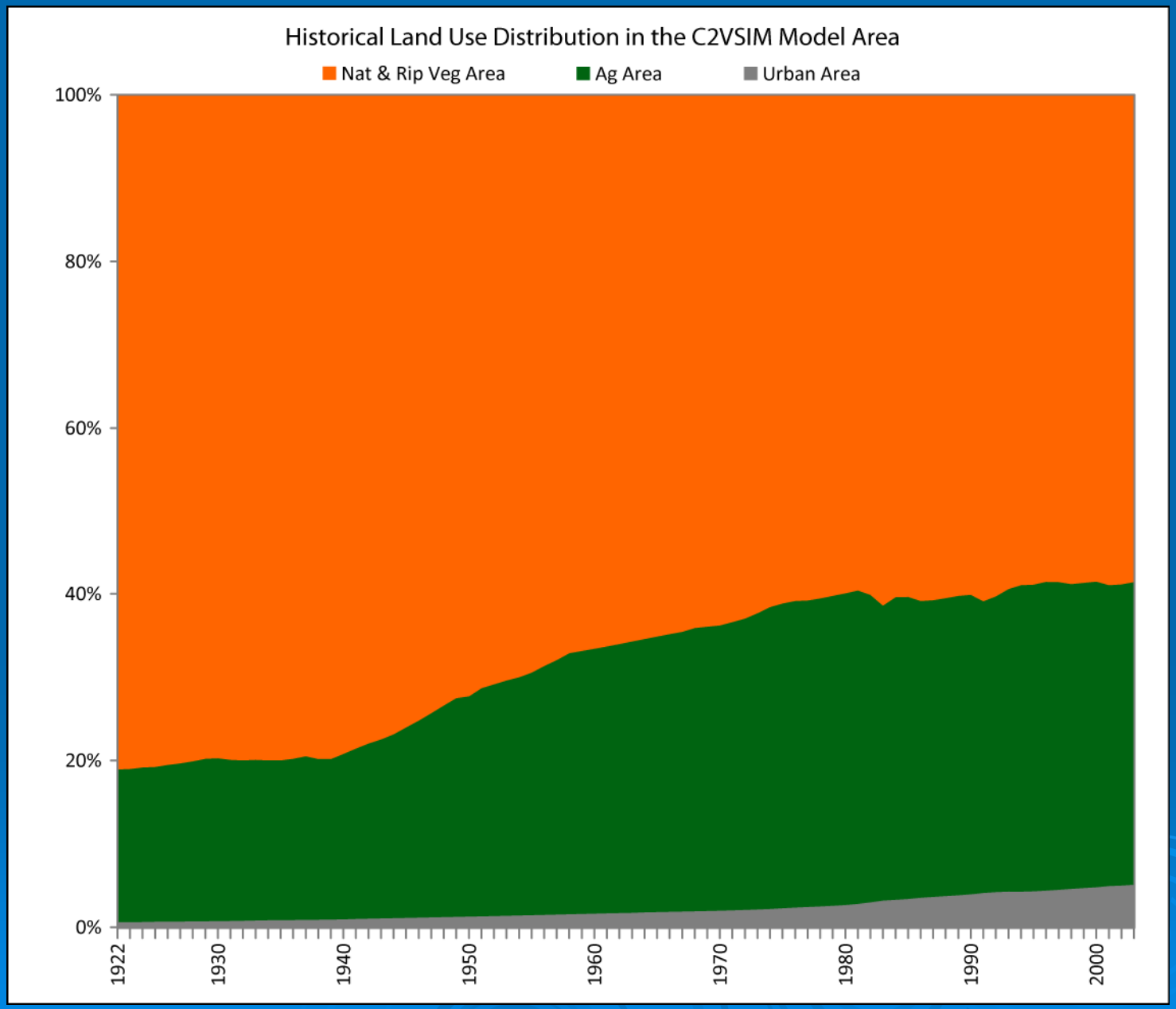
Outline

- Model Framework
- Calibration Tools
- Status
- Future Work

California's Central Valley

- 55,000 sq. km. (20,000 sq. mi.)
- 25 MAF/yr surface water discharge
- Agricultural Production
  - 6.8 million acres (27,500 sq. km)
  - 10% of US crops value in 2002
- Population growth
  - 1970: 2.9 million
  - 2005: 6.4 million
- Pumping
  - ~9 MAF in 2002, or 13% if US pumping
  - Not measured or regulated


Historical Land Use Distribution in the C2VSIM Model Area
Nat & Rip Veg Area
Ag Area
Urban Area
100%
80%
60%
40%
20%
0%
1922
1930
1940
1950
1960
1970
1980
1990
2000

C2VSIM Model Grid

Finite Element Grid

- 3 layers or 9 layers
- 1393 nodes
- 1392 elements

Surface Water System

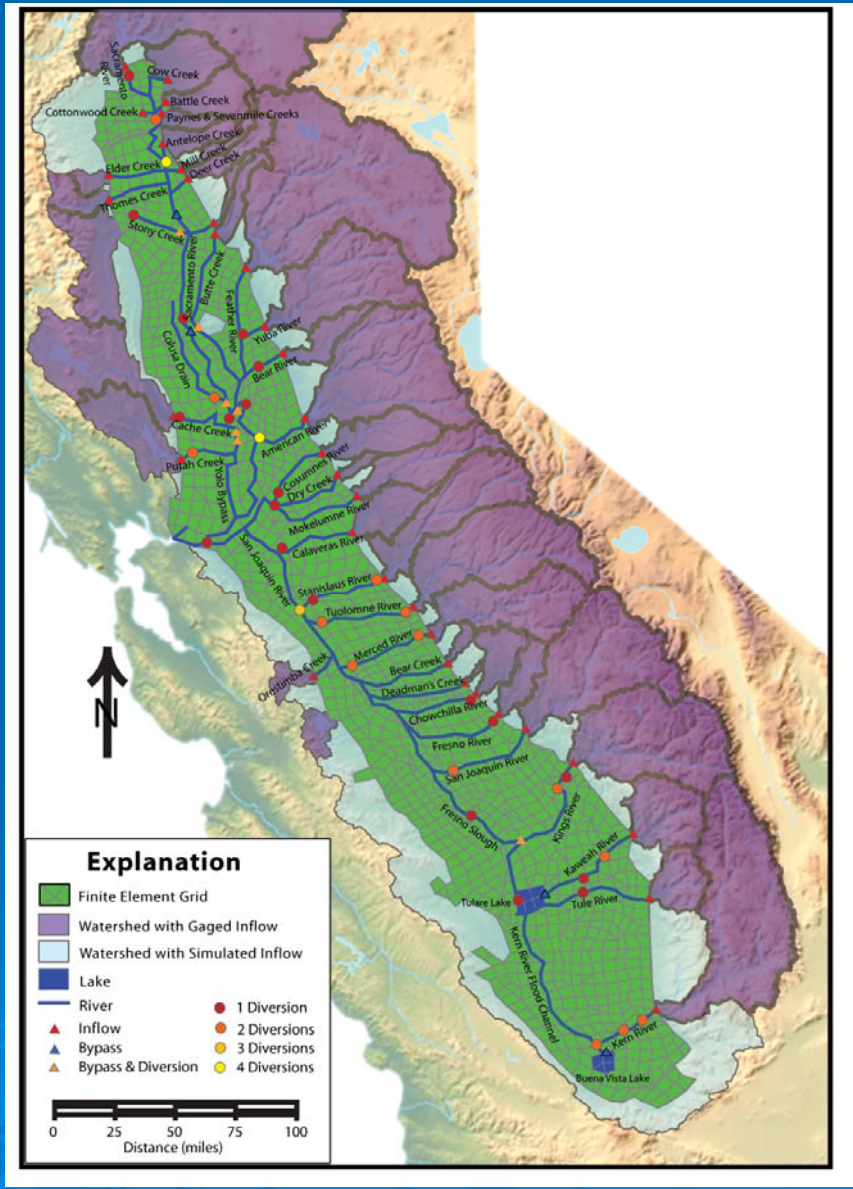
- 75 river reaches
- 2 lakes
- 164 surface water diversions
- 6 bypasses

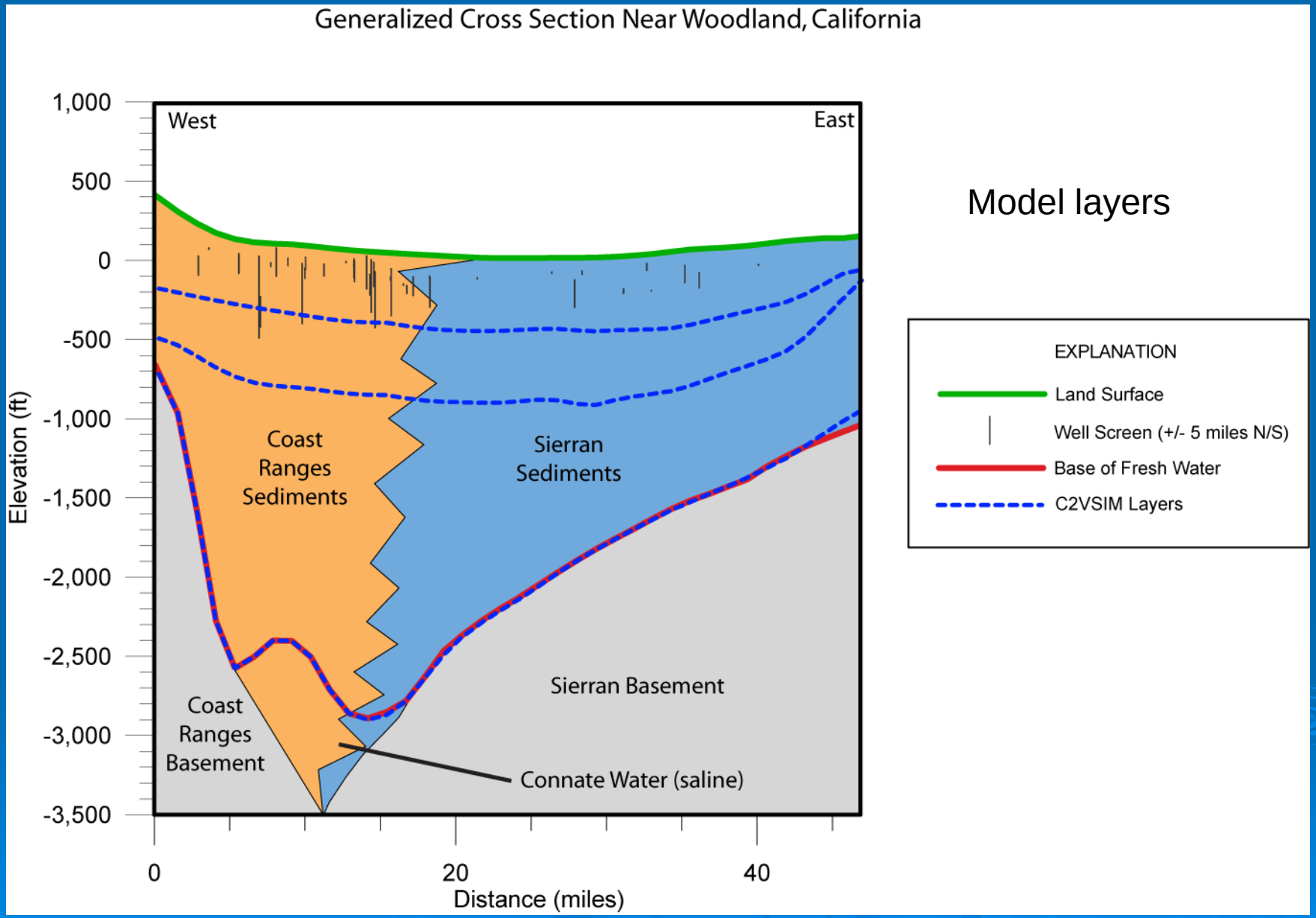
Land Use Process

- 21 subregions
- 4 Land Use Types
  - Agriculture
  - Urban
  - Native
  - Riparian

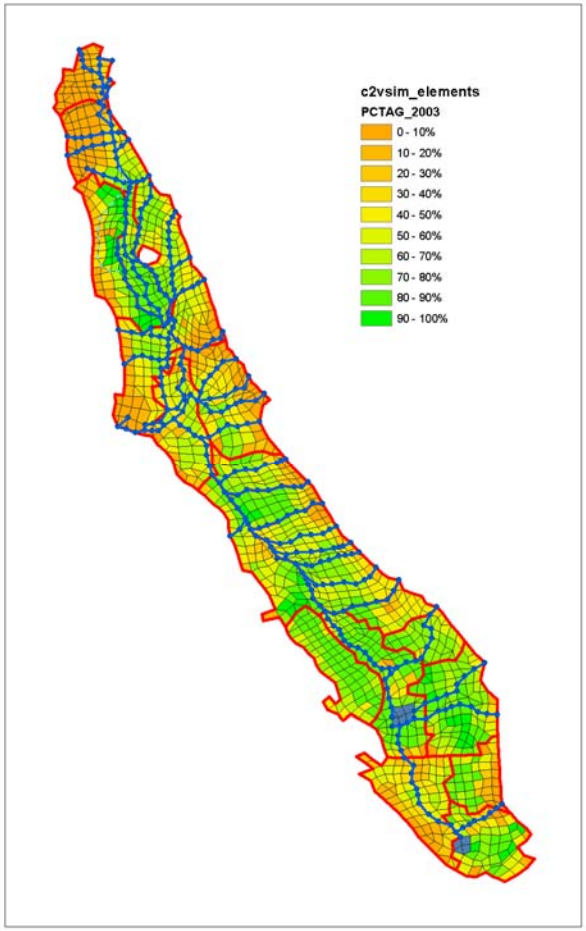
Simulation periods

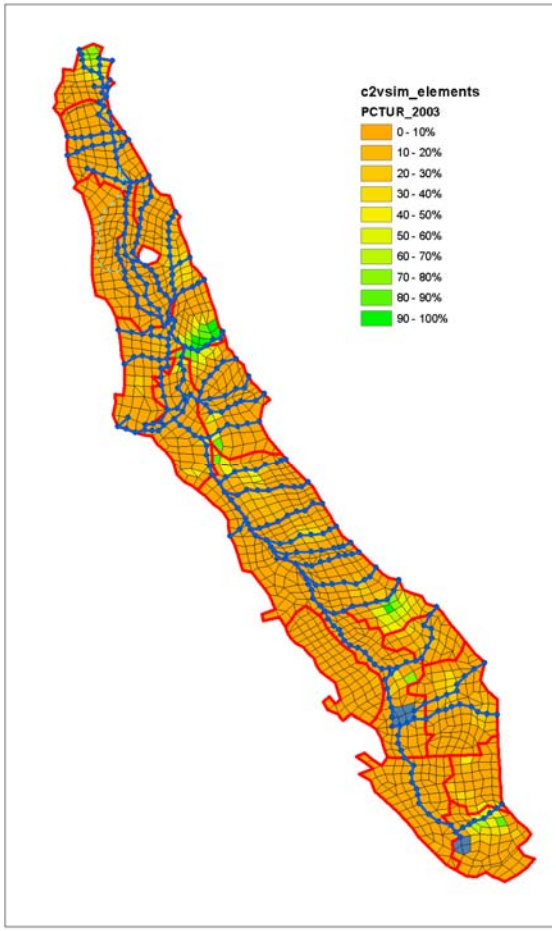
- 10/1921-9/2003 (5 min)
- 10/1972-9/2003 (2 min)

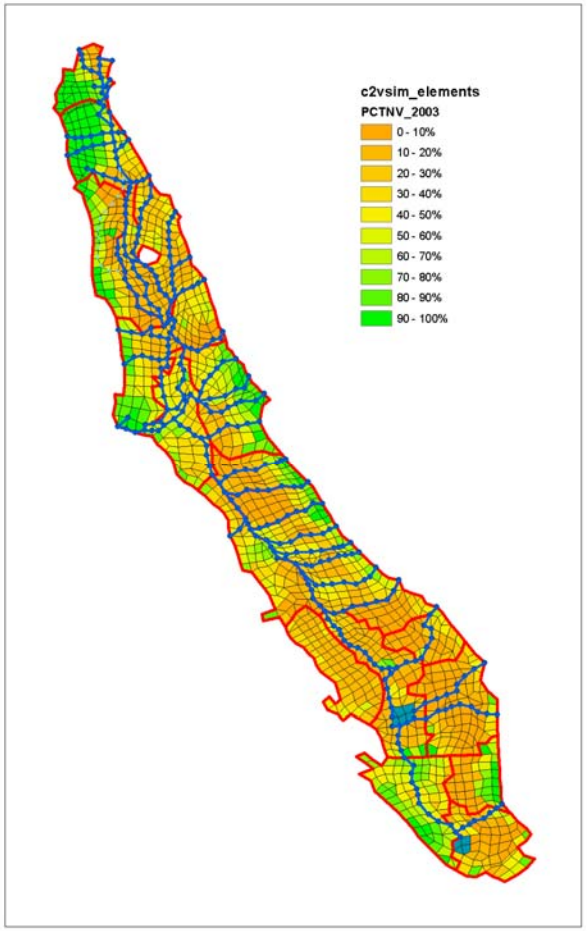



Generalized Cross Section Near Woodland, California
West
East
1,000
500
0
-500
-1,000
-1,500
-2,000
-2,500
-3,000
-3,500
Elevation (ft)
Coast Ranges Sediments
Sierran Sediments
Sierran Basement
Coast Ranges Basement
Connate Water (saline)
0
20
40
Distance (miles)
Model layers
EXPLANATION
Land Surface
Well Screen (+/- 5 miles N/S)
Base of Fresh Water
C2VSIM Layers

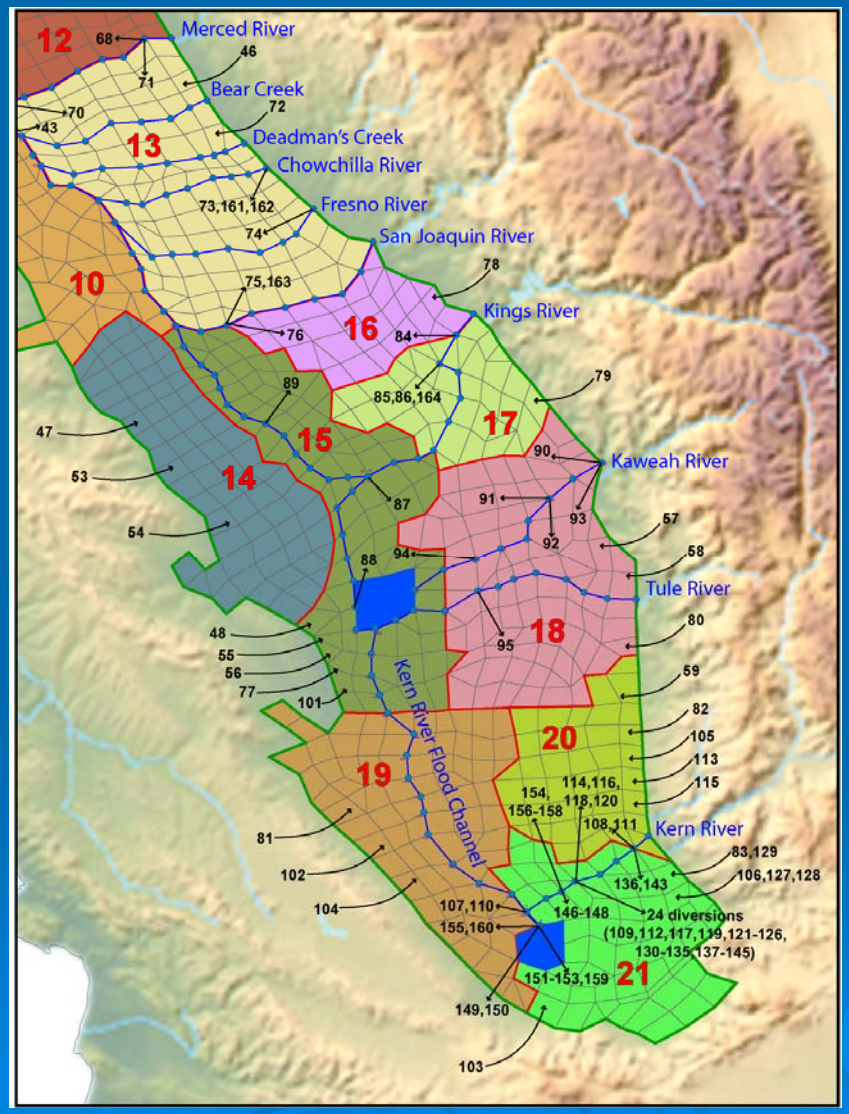
C2VSIM Land Use 2003



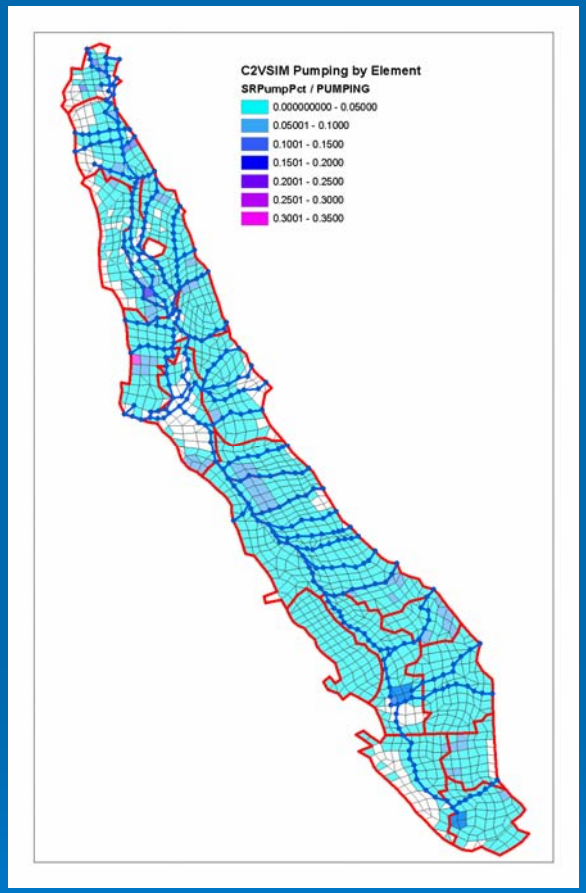


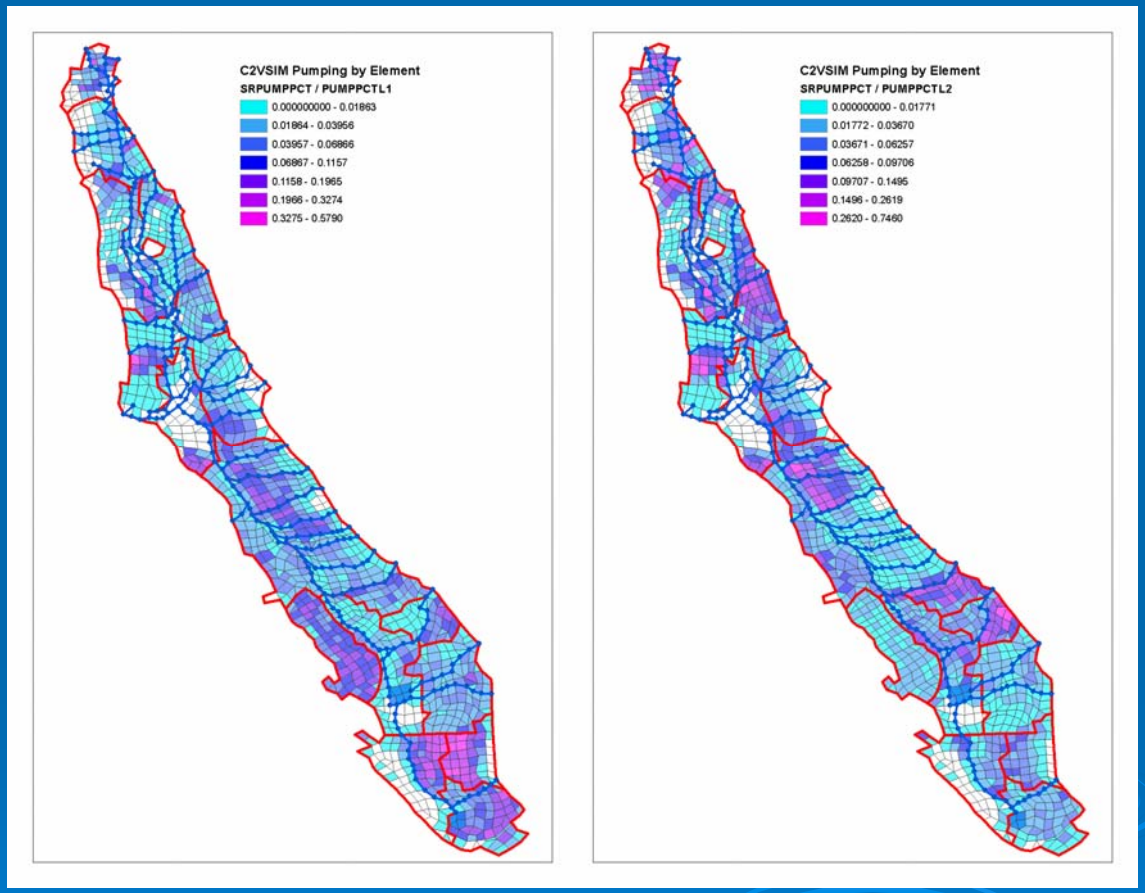


C2VSIM Diversions



C2VSIM Groundwater Pumping





C2VSIM Initial Calibration

Pilot Points

139 in layers 1 and 2 (K_h, K_v, S_y, S_s), 39 in layer 3 (K_h, K_v, S_s)

19 for Corcoran Clay (K_v)

Other parameters

Stream-reach conductance

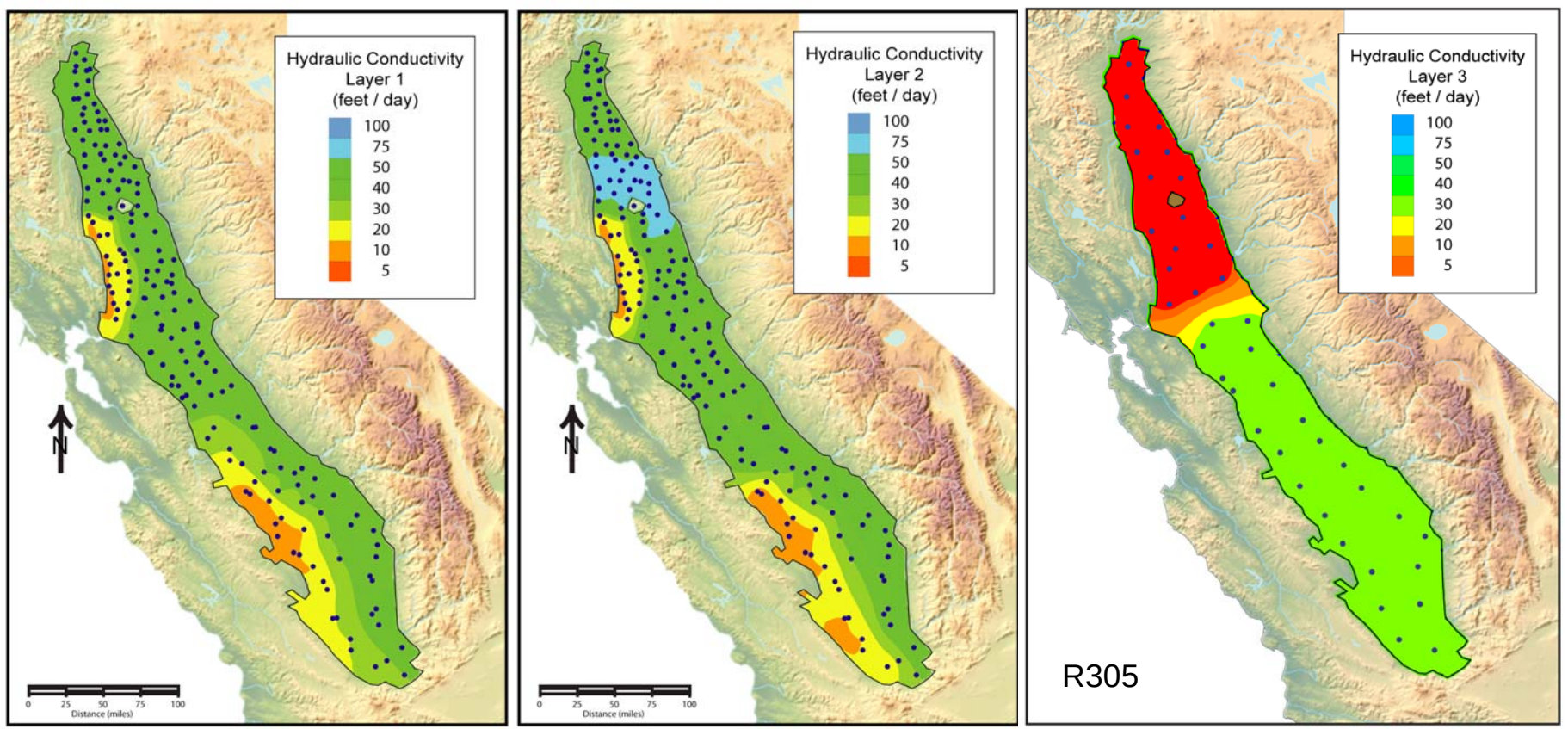
15,789 Calibration Observations

Sites	per site	total
221 groundwater head	52	10,503
9 vertical head gradient	52	1,976
9 river flow	52*	3,276
34 stream-groundwater flow reaches	1**	34

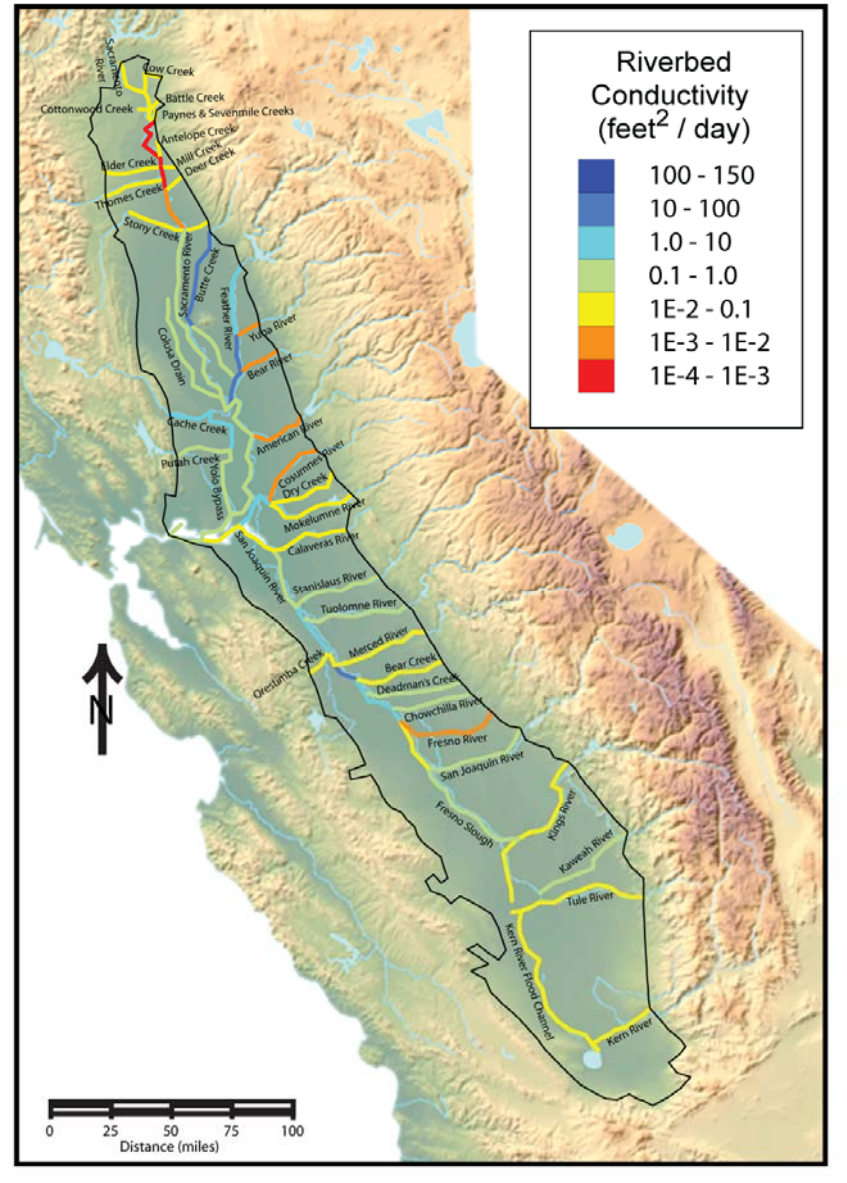
Calibration Period Water Years 1975-99 (IC 10/1972)

* For 8 of 9, ** monthly average rate

Hydraulic Conductivity



Streambed Conductance



C2VSIM Improvements

Modifications to the C2VSim Framework

- Historical precipitation time series from PRISM 2km x 2km grid
- Refined rivers: Sacramento-San Joaquin Delta, Kern River Flood Channel
- Refined lakes: Tulare Lake and Buena Vista Lake
- Delineated small-stream watersheds
- Canal seepage rates and locations
- Delta export diversions

Review

- Stream inflows, surface water diversions
- Land use distribution, crop acreages
- Crop Evapotranspiration rates
- Groundwater pumping distribution

Other

- Updated to IWFM v3.02
- Climate change simulations with IWFM-CVPM linkage

Second C2VSim Calibration

Pilot Points

398 in each layer (K_h, K_v, K_{corc}, S_y, S_s, S_{sce}, S_{sci})

Other parameters

Stream-node conductance Pumping fractions

Small watershed parameters

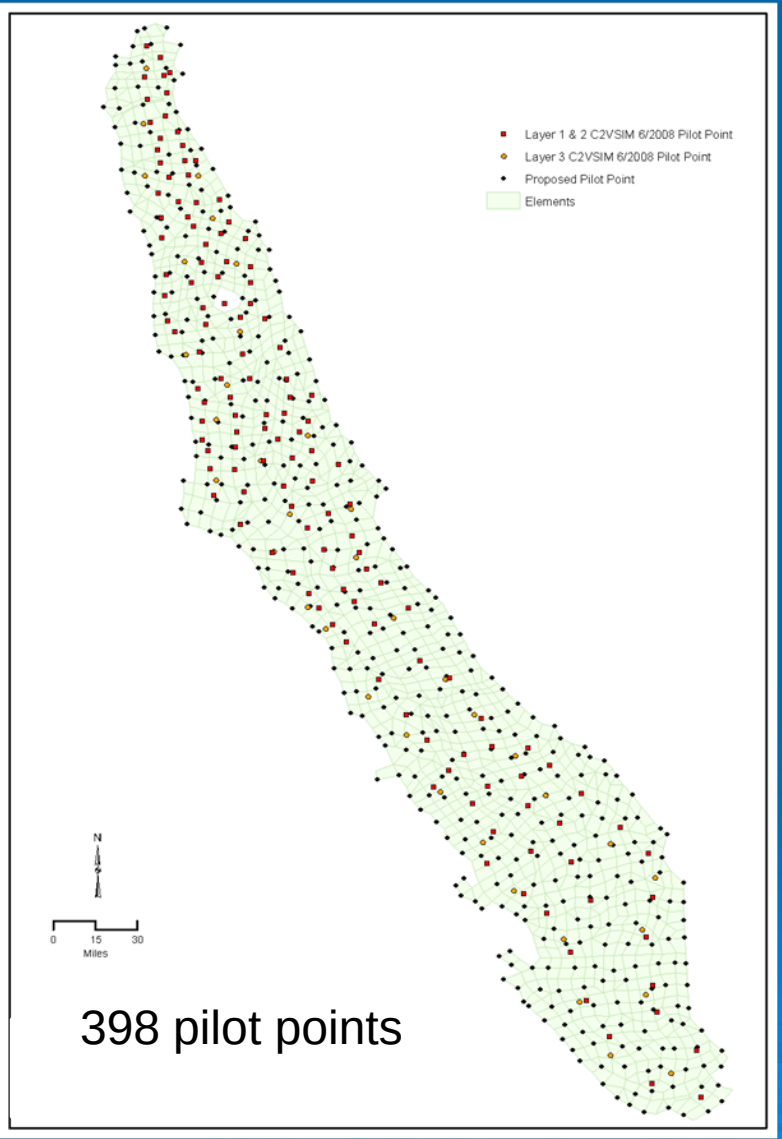
64,593 Calibration Observations

Sites	observations
2,378 groundwater wells	56,947
112 vertical head gradient well pairs	1,976
22 river flow gages	5,636
34 stream-groundwater flow reaches	34*

Calibration Period Water Years 1975-99 (IC 10/1972)

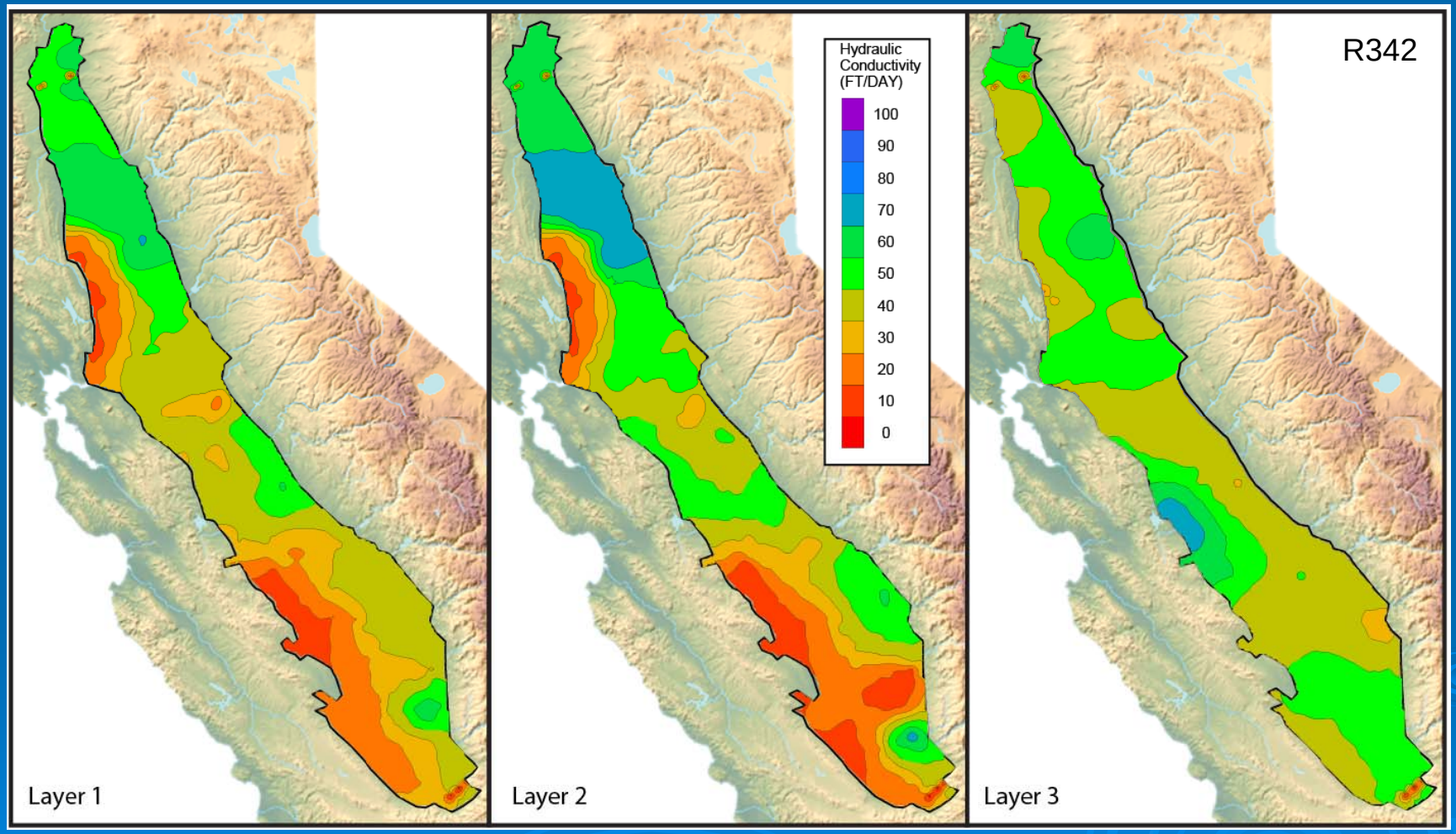
* monthly average rate

C2VSim Pilot Points

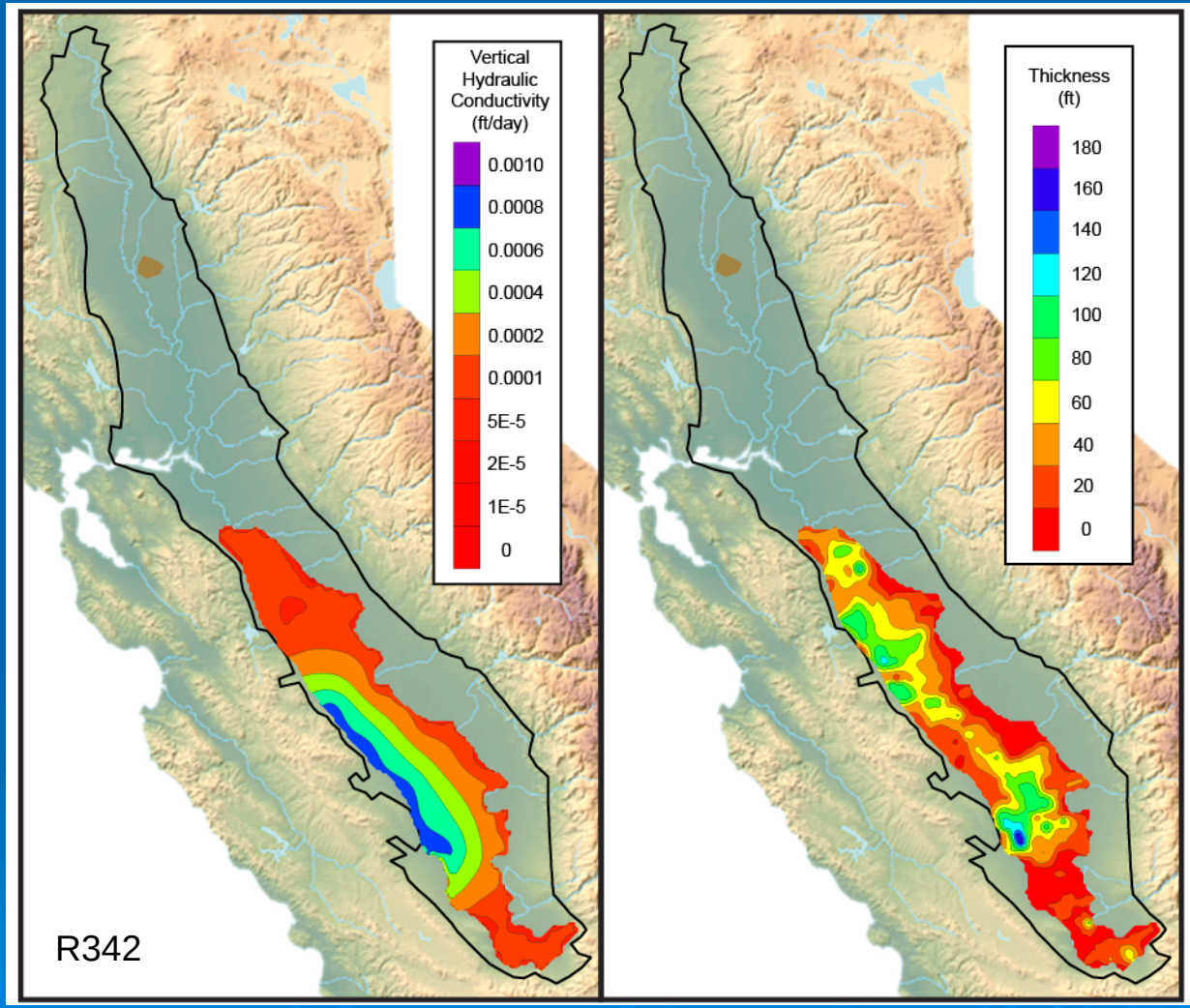


398 pilot points

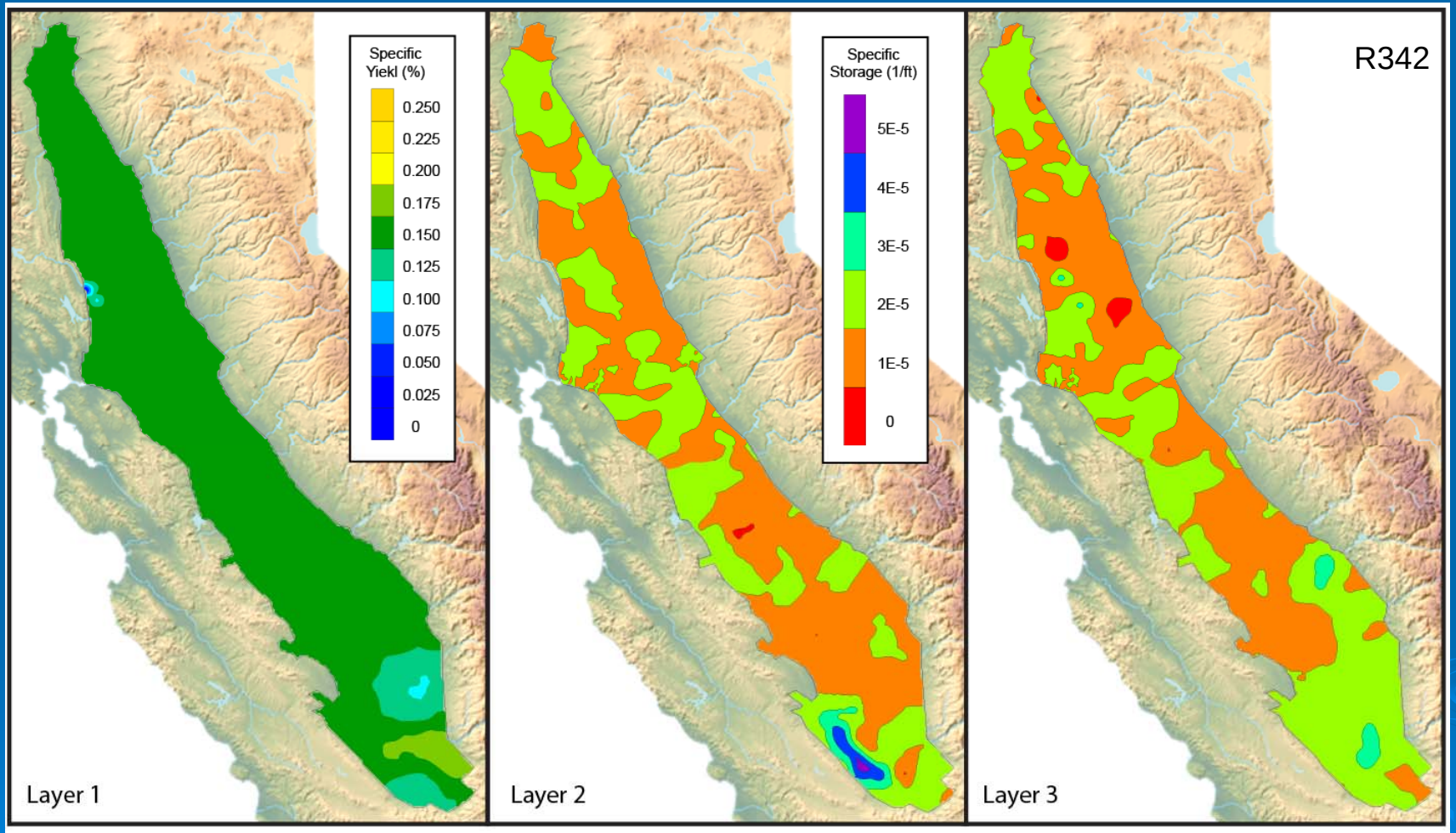
Hydraulic Conductivity



Corcoran Clay Confining Unit



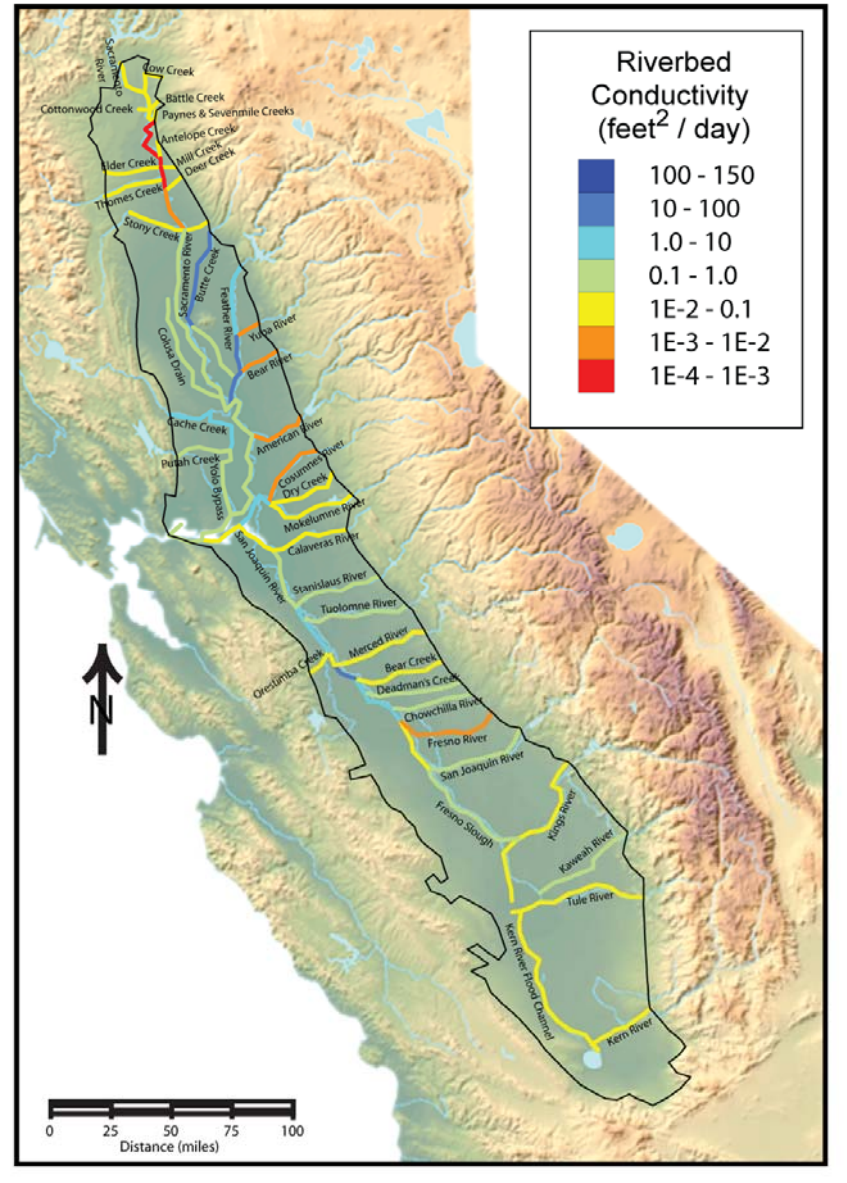
Storage Parameters



Specific Yield (%)

Specific Storage (per FT)

Streambed Conductance



Current C2VSIM Calibration

Nodal Parameter Values

1393 in each layer (K_h, K_v, K_{corc}, S_y, S_s, S_{sce}, S_{sci})

Other parameters

Stream-node conductance Pumping fractions

Small watershed parametersLand-surface parameters

64,593 Calibration Observations

Sites	observations
2,378 groundwater wells	56,947
112 vertical head gradient well pairs	1,976
22 river flow gages	5,636
34 stream-groundwater flow reaches	34*

Calibration Period Water Years 1975-99 (IC 10/1972)

* monthly average rate

USDOE NERSC Computer

'Carver'

- IBM iDataPlex
- 3200 cores (400 x 8/node)
- 34 Tflop/sec

C2VSIM Status

Review of model framework and input data sets

- Land use, crop acreages
- Stream inflow, surface water diversions
- Areal and vertical pumping distribution, irrigation efficiency
- Evapotranspiration rates

Calibration status

- Completed two rounds of increasing refinement
- Use NERSC ‘Carver’: IBM iDataPlex, 3200 cores, 34 Tflop/sec
- Parallel PEST with 128 cores: 1500 parameters x 5 iterations in 9 hr 13 min
- 23 pieces for all parameters, then entire model for each parameter type

Publication

- Complete review & calibration
- Developing documentation
- Expected release to public in Spring 2011

Model Improvements

Complete model calibration

- Increased parameter density (pilot points)
- Increased calibration observations data set
- Publish completed model

Review selected water budget components:

- Land use, crops and diversions
- ASR programs and groundwater exports
- High wet-season diversions (refuges?)
- Check crop ET values
- Verify simulated runoff

Future Work

Extend simulation time period (WY 2004-2009)

- Precipitation
- Land use and crop acreages
- Surface water diversions

Refine model grid

- 1) Subdivide current elements, retain subregions
- 2) New grid with smaller subregions

Update C2VSIM with IWFM improvements

- Element-level water budget calculations

Questions?