Direct Linkage Between CalSim-III and C2VSIM through IWFM Groundwater Module

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  - CalSim-III : water resources simulation model for evaluating operational alternatives of large, complex river basins
  - IWFM : Integrated Water Flow Model; an integrated hydrological model that simulates groundwater flow, surface water flow, and surface-groundwater interactions

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  - CalSim-III : water resources simulation model for evaluating operational alternatives of large, complex river basins
  - IWFM : Integrated Water Flow Model; an integrated hydrological model that simulates groundwater flow, surface water flow, and surface-groundwater interactions
  - C2VSIM : California Central Valley SImulation Model; application of IWFM to the California Central Valley

Background (*continued*)

- Excerpts from CA DWR CalSim-III Development web site:

  "In response to the December 2003 recommendations made by the CALFED Science Program review panel on improvements to the existing CalSim-II ..."

  "Among the features of this development project are … *enhancement of current and/or development of new methodologies for simulating ground water flow and the surface water-ground water interaction*."

Background (*continued*)

- Initial decisions:
  - Link C2VSIM to CalSim-III to simulate groundwater flow and stream-groundwater interaction at a finer resolution
  - Direct linkage of C2VSIM to CalSim-III will possibly result in excessive computation times
  - Use discrete kernels (a.k.a. linear response functions) to "emulate" the groundwater module of IWFM in CalSim-III; train them using C2VSIM groundwater module

Background (*continued*)

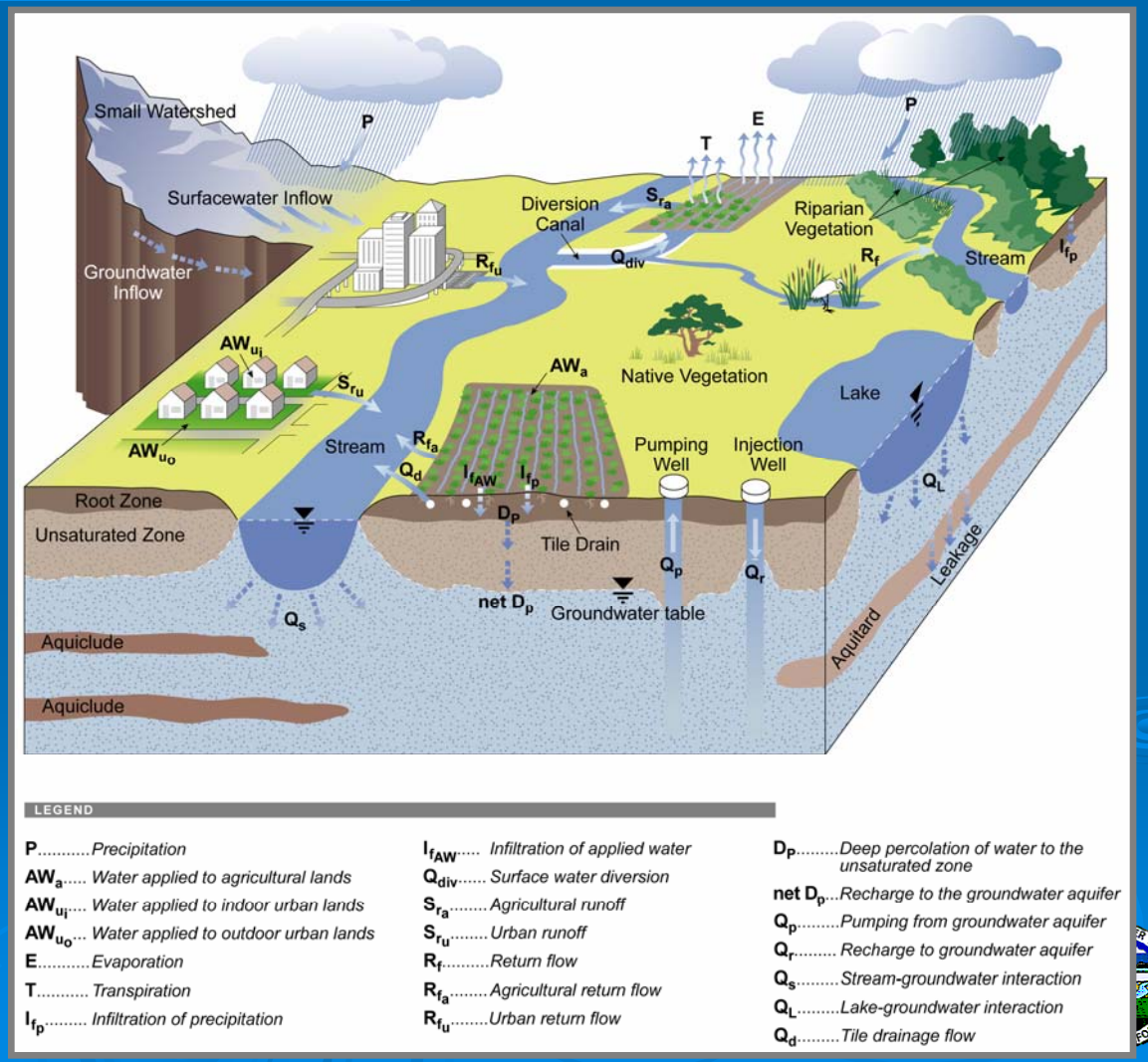
- Some observations during QA/QC process:
  - Under linear conditions, discrete kernels can replicate groundwater elevations and stream-groundwater interaction exactly
  - Training of discrete kernels requires substantial amount of code interception in C2VSIM to print out required information, processing of C2VSIM input data and detailed testing which can all lead to substantial amount of work
  - IWFM and C2VSIM are still in a state of change; when either of them is modified training of discrete kernels need to be re-performed

Background (*continued*)

- Alternative thoughts:
  - Convert groundwater module of IWFM into a stand-alone program that can be called directly from CalSim-III; feed C2VSIM aquifer parameter values into it
  - Test the module's performance in terms of matching C2VSIM results and execution times when linked to CalSim-III

Development of the “Groundwater DLL”

- “Cut” the groundwater component out of IWFM
- Keep the modules for tile drains, small watersheds and pumping in the DLL
- Allow the DLL to “know” the stream network



Development of the "Groundwater DLL" (*continued*)

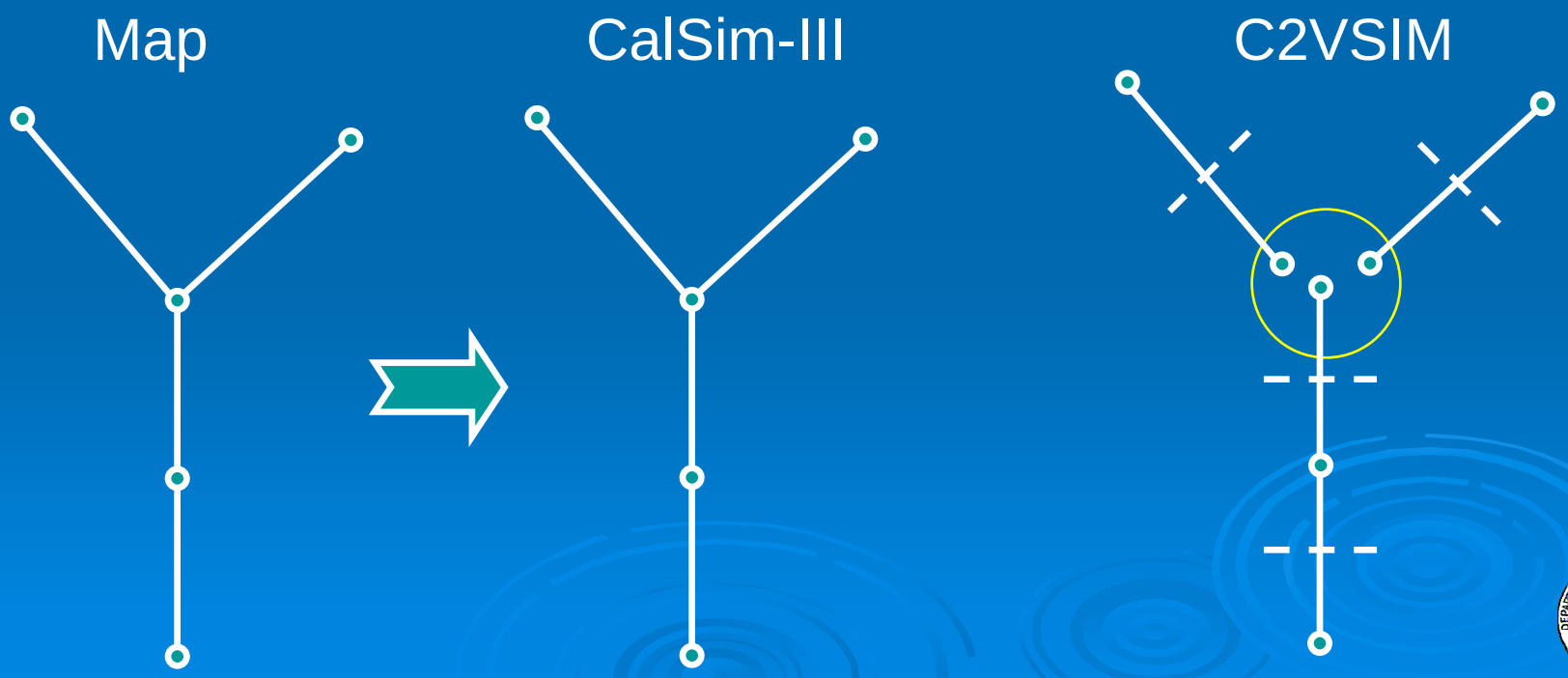
- Mainly an exercise of copying and pasting with minimum amount of additional programming
- Stream-groundwater interaction was implemented as a special form of general head boundary condition:

$$SGI = \begin{cases} C_s\left(h_s - h_g\right) & h_s \geq b_s \;\; ; \;\; h_g \geq b_s \\ C_s\left(h_s - b_s\right) & h_s \geq b_s \;\; ; \;\; h_g < b_s \end{cases}$$

- Development and testing of the DLL as a generic tool took only a week

Implementation of the DLL in CalSim-III

- Resolve conceptual differences in defining stream nodes and stream flows



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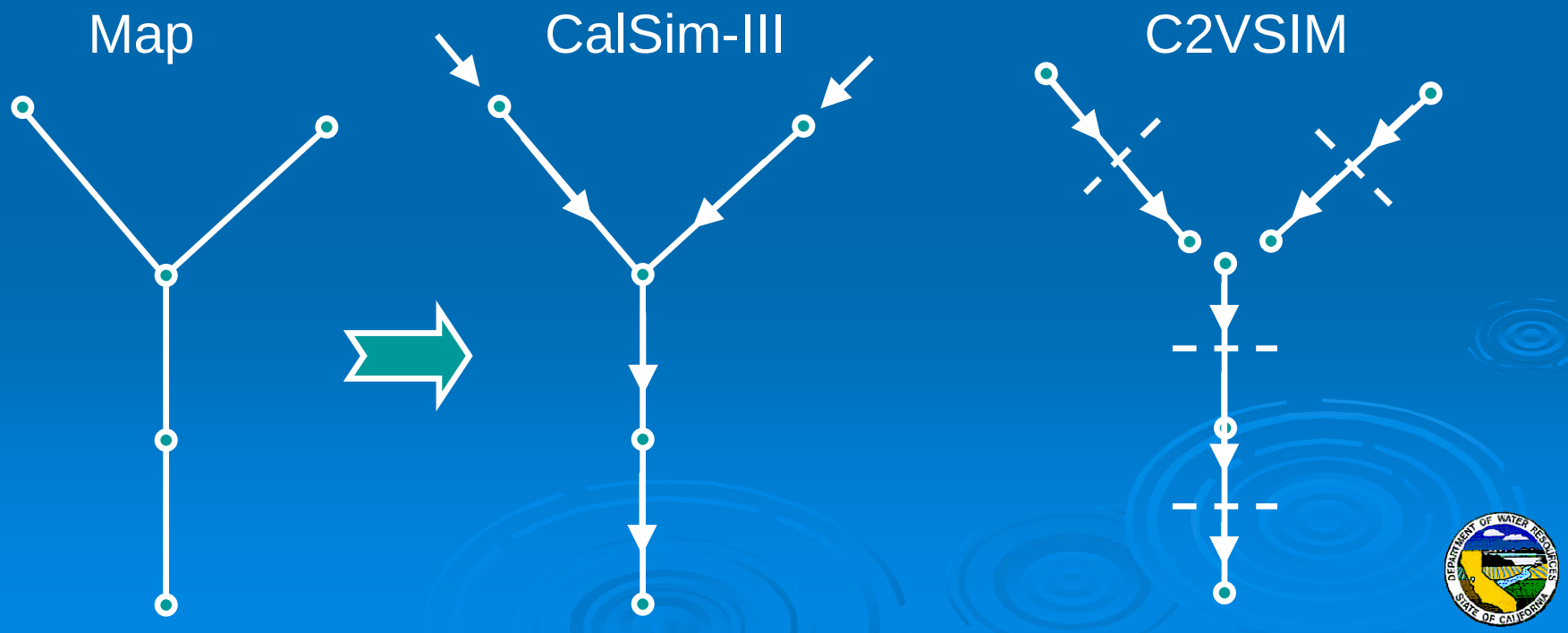

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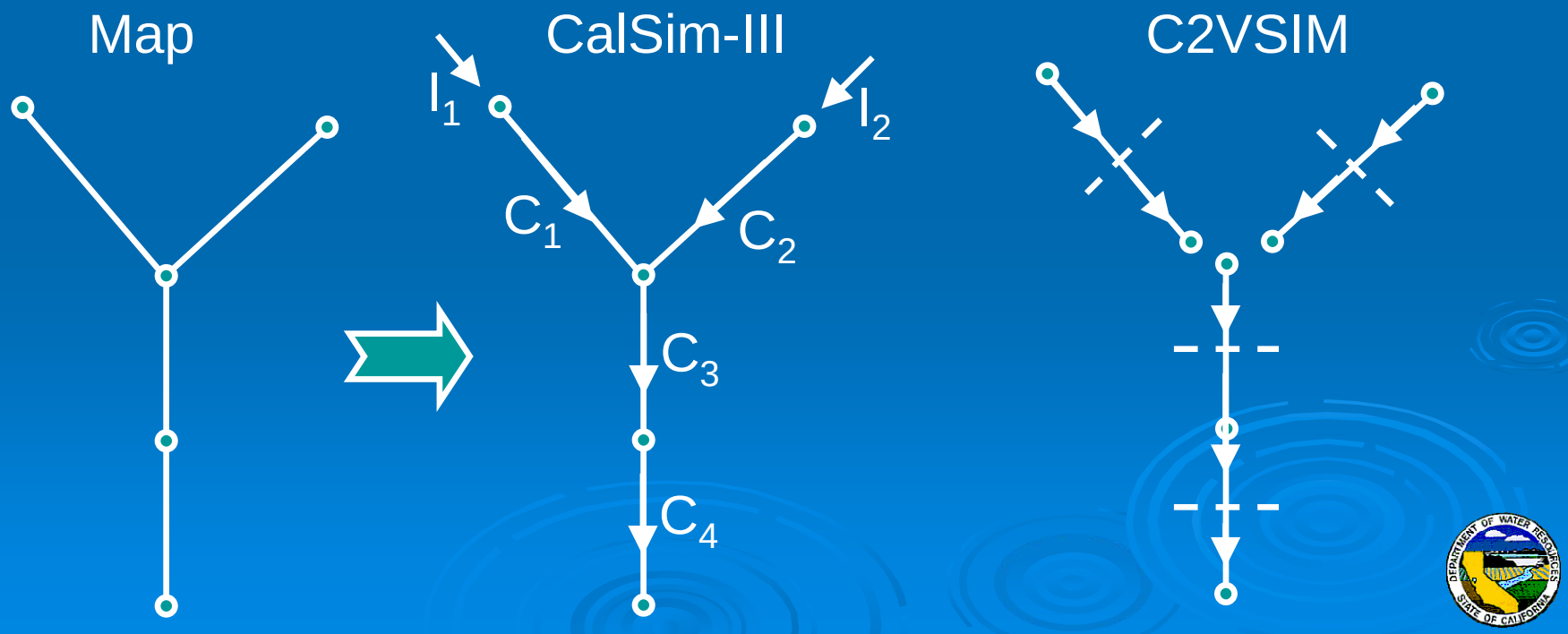

Implementation of the DLL in CalSim-III

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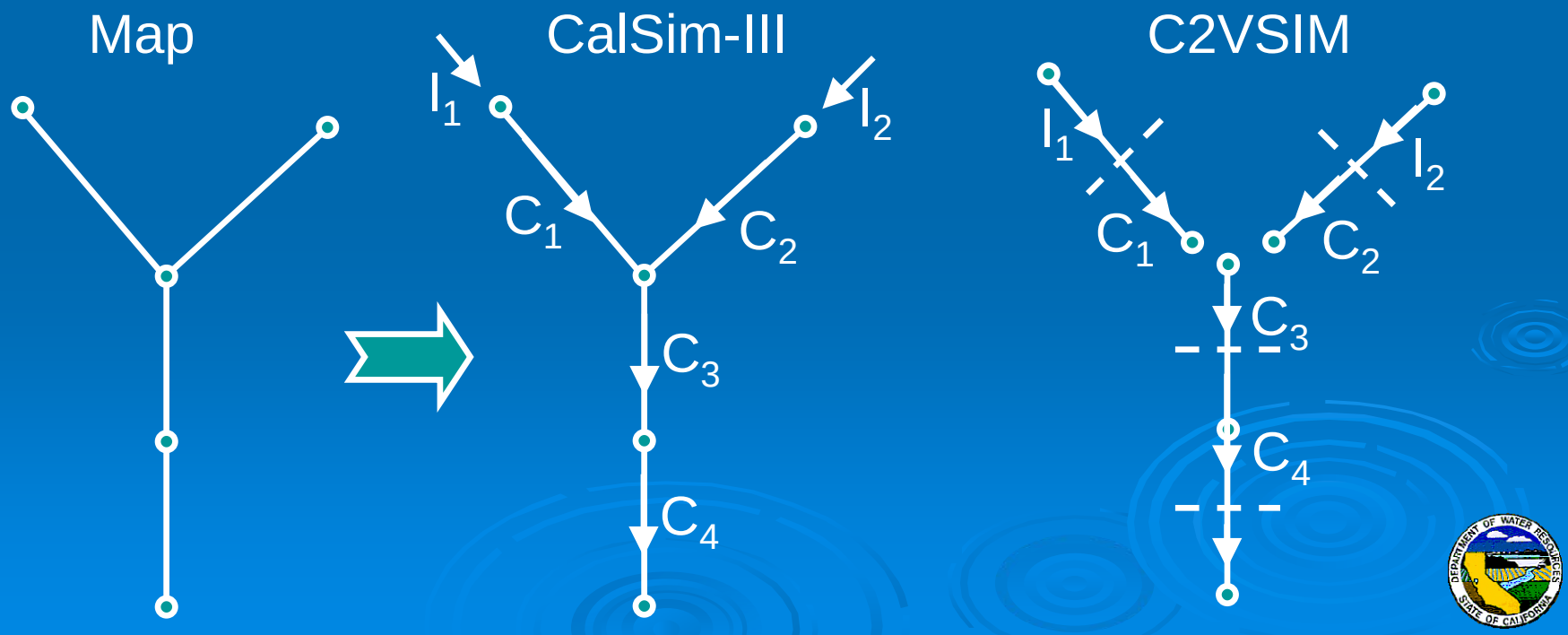

Implementation of the DLL in CalSim-III (*continued*)

- Resolve geographic differences
  - The area covered by CalSim-III and C2VSIM are different
  - Deep percolation and pumping that are past from CalSim-III to the DLL are defined for each WBA which may fall outside C2VSIM boundary
  - Pumping is assumed to occur predominantly in the Central Valley so WBA-level pumping is not modified when passed to the DLL
  - Deep percolation is assumed to be uniform across each WBA, so WBA-level deep percolation was reduced with the percent of WBA area that overlay C2VSIM boundary when passed to the DLL

Implementation of the DLL in CalSim-III (*continued*)

- The DLL uses the same data files that C2VSIM uses to represent the aquifer system
- Stream-groundwater interaction is lagged by one month; i.e. stream-groundwater interaction during the current month is computed using the stream flows from previous month to avoid iterations between CalSim and the DLL
- Pumping and deep percolation are distributed to C2VSIM elements based on user-specified fractions

Advantages of the DLL

- More streamlined information transfer between C2VSIM and CalSim-III
  - Improved consistency between numerical engines used for groundwater simulations (in fact, they are exactly the same)
  - Easy transfer of aquifer parameters from C2VSIM to CalSim as C2VSIM calibration improves (only a matter of copy / paste of C2VSIM data files)
- No need for linearity assumption
- CalSim-III execution times are shorter with the DLL vs with the DKs (1 hour vs 2 hours)

Current Work

- Evaluation of the implementation of the groundwater DLL
- Waiting to get the final deliverable for DKs to compare efficiency with the DLL

Questions?

Comparison of C2VSIM to Groundwater DLL