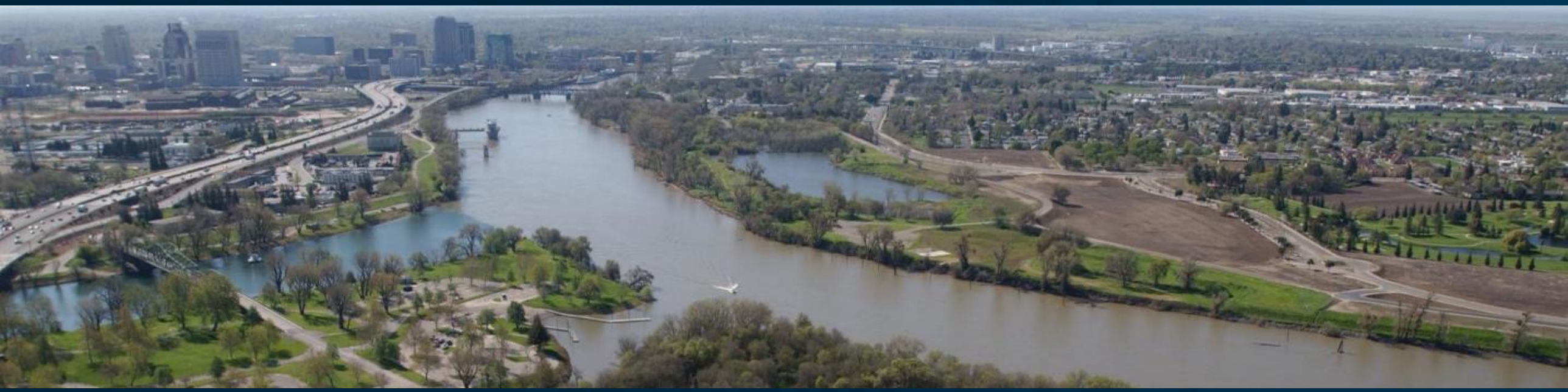
CALIFORNIA DEPARTMENT OF WATER RESOURCES

A Daily Version of the C2VSIM-CG

The Integrated Surface-Groundwater Model of the Central Valley



Norman Johns, Ph.D. and Tariq Kadir, Ph.D., P.E.

Modeling Support Office

California Department of Water Resources

CWEMF Annual Meeting

April 4, 2022

Acknowledgements

Can Dogrul (DWR)

Steven Jepsen (DWR)

Shalamu Abudu (DWR)

Morrie Orang (DWR)

Tyler Hatch (DWR)

Mesut Cayar, Sara Miller (Woodard & Curran)

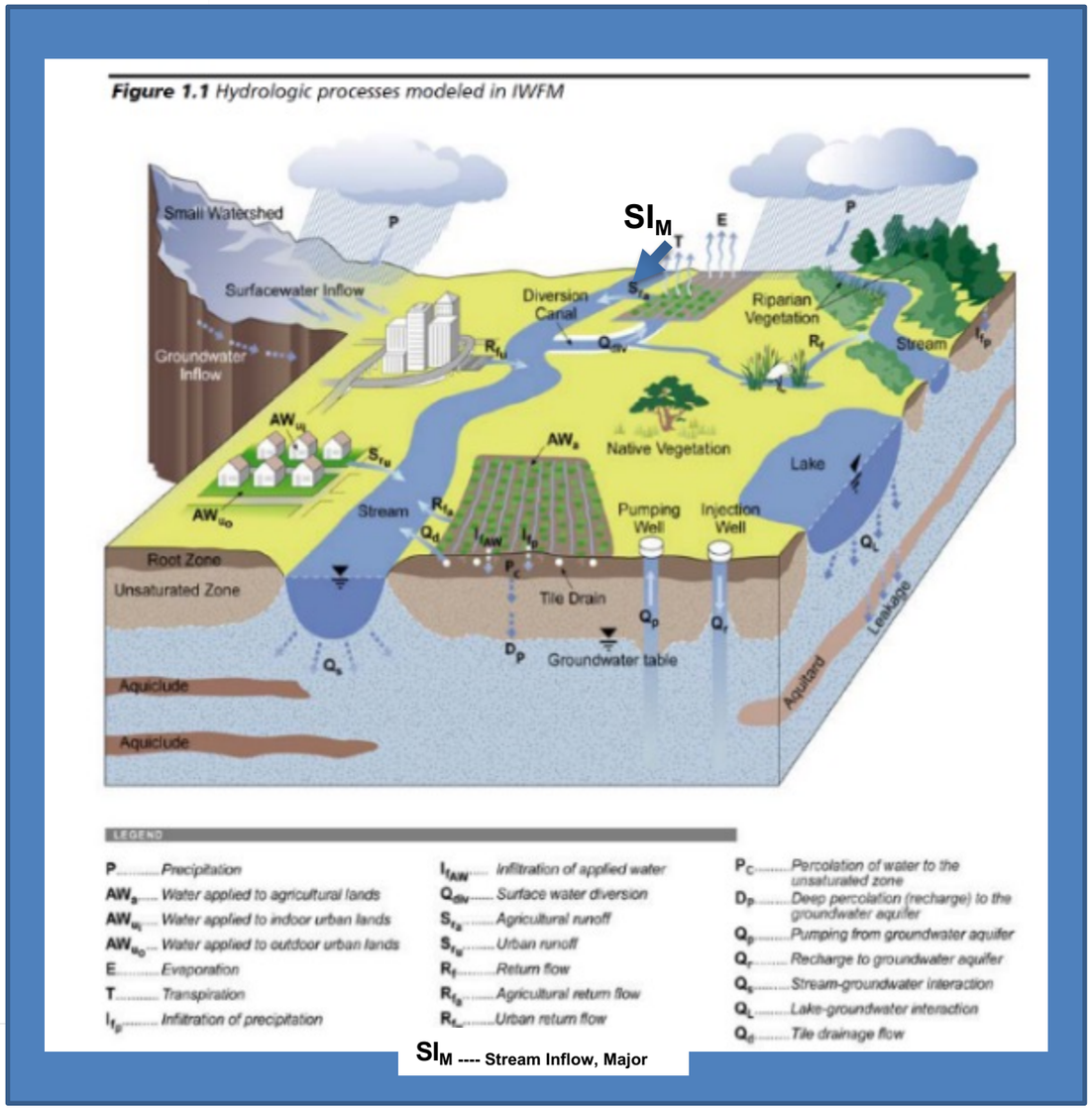
Charles Brush (Hydrolytics)

The C2VSIM Integrated Surface Water-Groundwater Model

Author- Norman Johns, DWR. [04/22]

Coarse-Grid

- simulation period WY 1922-2015



SIM ---- Stream Inflow, Major

CALIFORNIA DEPARTMENT OF WATER RESOURCES

• Why Daily?

Improve C2VSIM-CG model performance & Integrate within CVSOM [integration of IWFM and WRIMS applied to CV]

Computational areas of model that may improve by daily time step

1) estimation of runoff

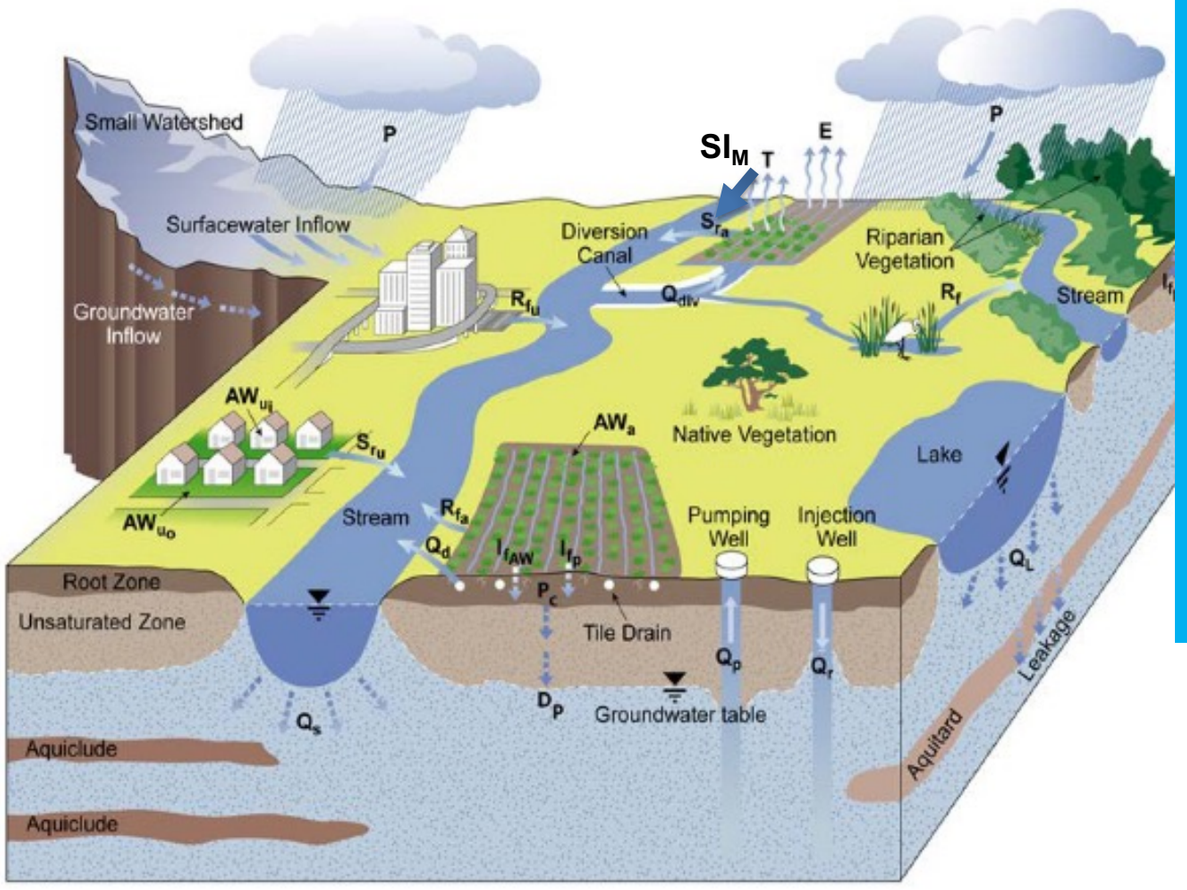
2) routing of stream flows

3) calculation of agricultural demands

4) reduce mis-matches between demands and availability

5) many regulatory & operational constraints are daily

Figure 1.1 *Hydrologic processes modeled in IWFM*



LEGEND

P.....*Precipitation*	I_{fAW}.....*Infiltration of applied water*	P_C.....*Percolation of water to the unsaturated zone*
AW_a.....*Water applied to agricultural lands*	Q_{div}.....*Surface water diversion*	D_P.....*Deep percolation (recharge) to the groundwater aquifer*
AW_{ui}.....*Water applied to indoor urban lands*	S_{ra}.....*Agricultural runoff*	Q_p.....*Pumping from groundwater aquifer*
AW_{uo}.....*Water applied to outdoor urban lands*	S_{ru}.....*Urban runoff*	Q_r.....*Recharge to groundwater aquifer*
E.....*Evaporation*	R_f.....*Return flow*	Q_s.....*Stream-groundwater interaction*
T.....*Transpiration*	R_{fa}.....*Agricultural return flow*	Q_L.....*Lake-groundwater interaction*
I_{fp}.....*Infiltration of precipitation*	R_{fu}.....*Urban return flow*	Q_d.....*Tile drainage flow*

SI_M ---- Stream Inflow, Major

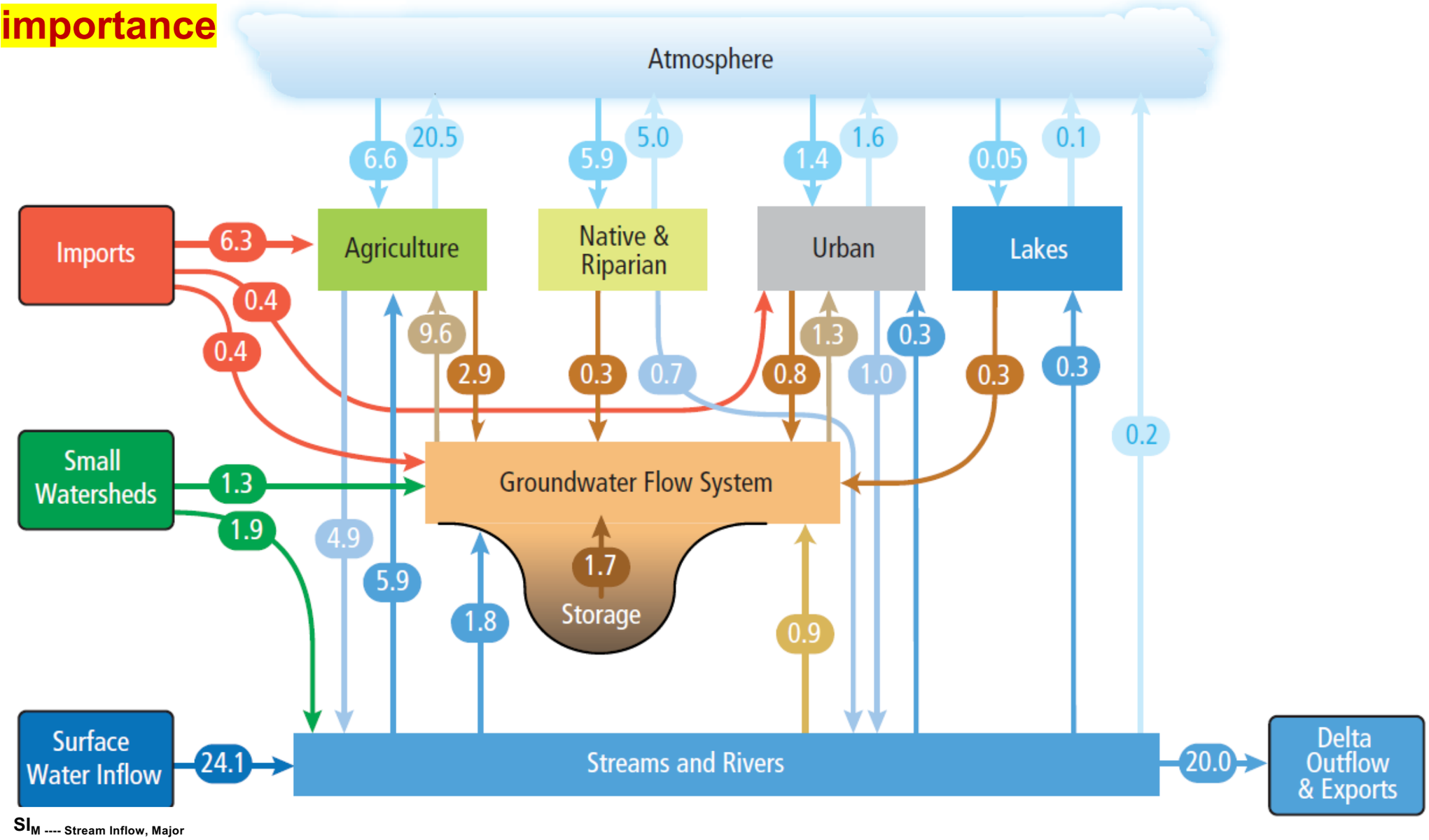
C2VSIM

Prioritizing data streams for conversion to daily:

- Process sensitivity to time increment
- Importance in the model
- Reasonably available daily data (substitution/ patterning)

Figure 41. Simulated average annual water budget for California's Central Valley for water years 2000-2009.

Main model drivers, relative importance



SI_M ---- Stream Inflow, Major

Average Flows for water years 2000-2009

[Million Acre-Feet/Year]

C2VSIM- Data Streams of High Priority for Daily Implementation

Precipitation

Evaporation

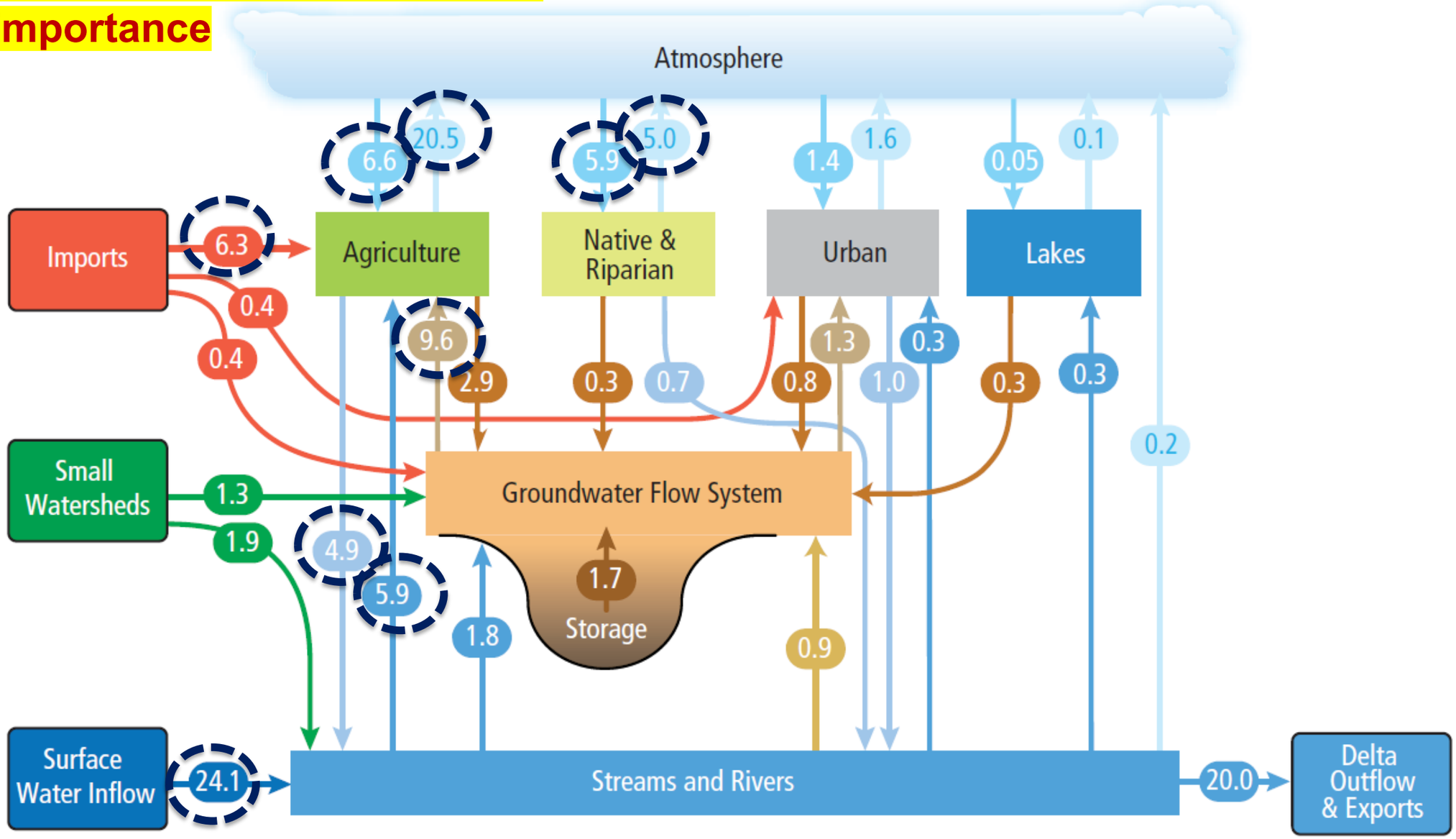
Diversions

Stream Inflows, Major

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Figure 41. Simulated average annual water budget for California's Central Valley for water years 2000-2009.

Main model drivers, relative importance

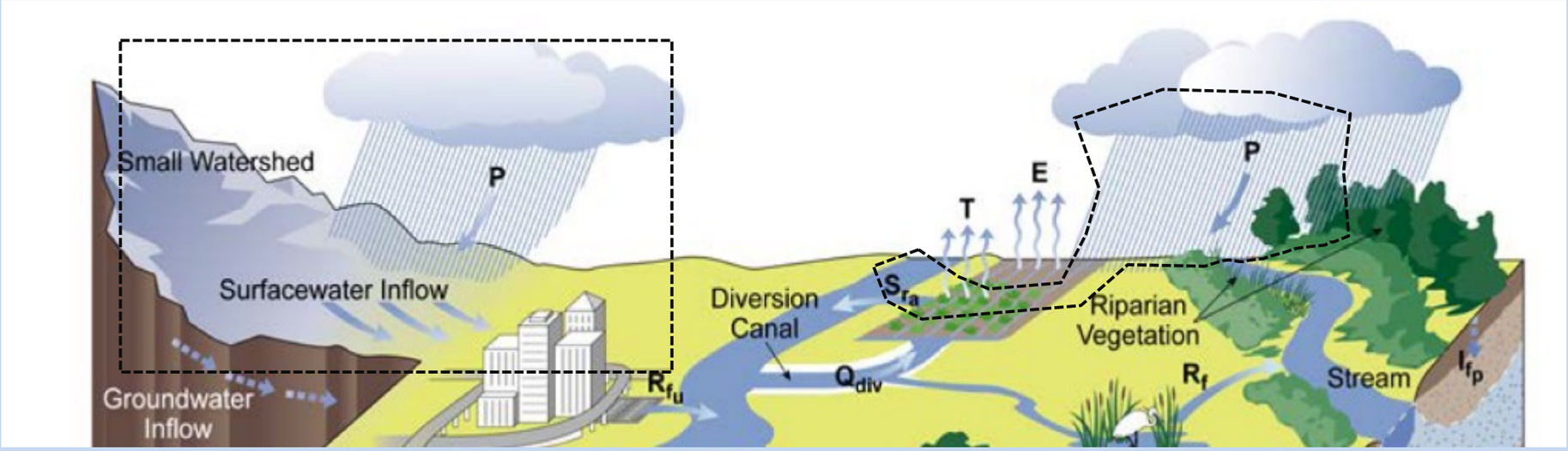


Average Flows for water years 2000-2009

[Million Acre-Feet/Year]

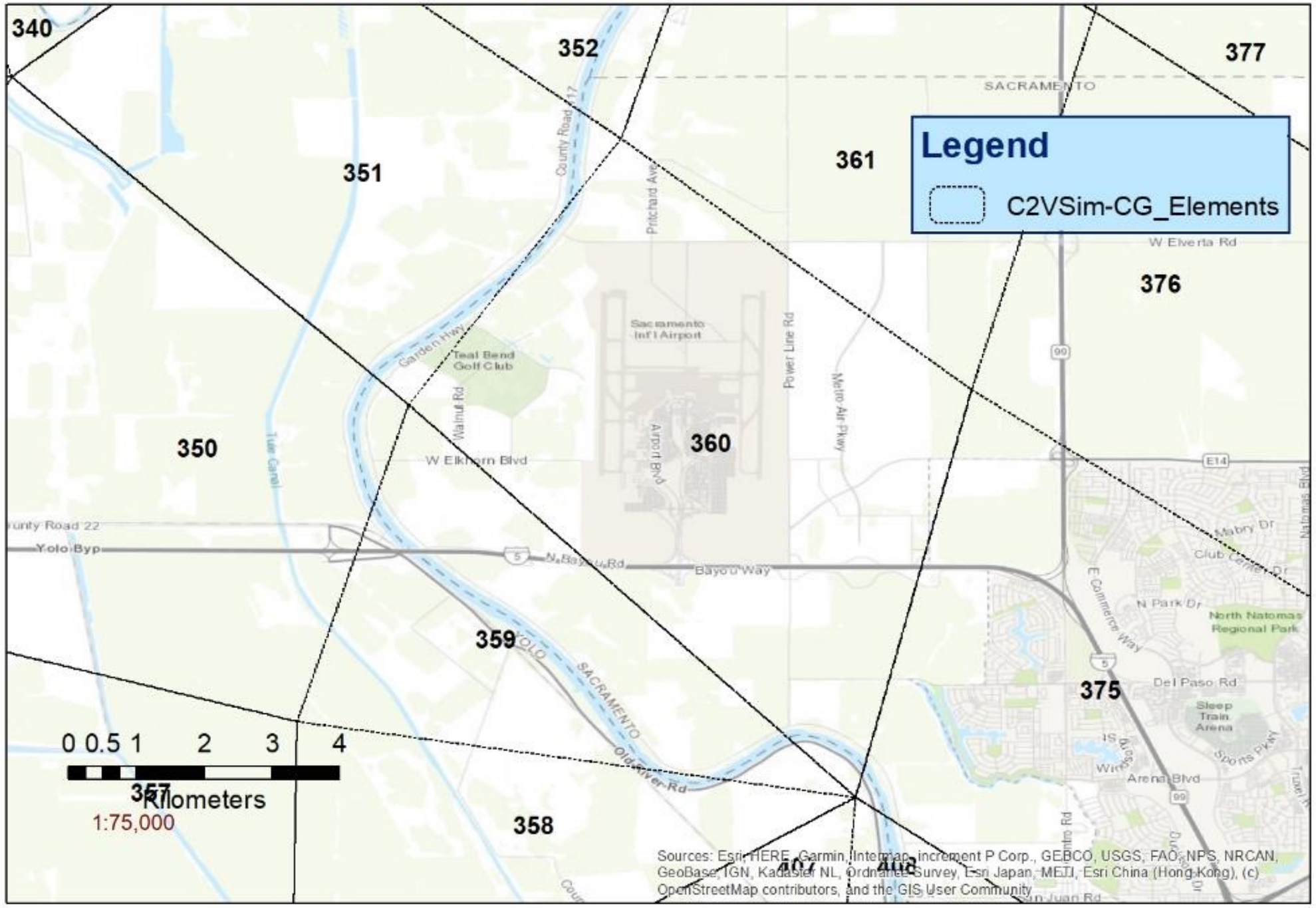
C2VSIM- Data Streams of High Priority for Daily Implementation

Precipitation { & Evapotranspiration}



CALIFORNIA DEPARTMENT OF WATER RESOURCES

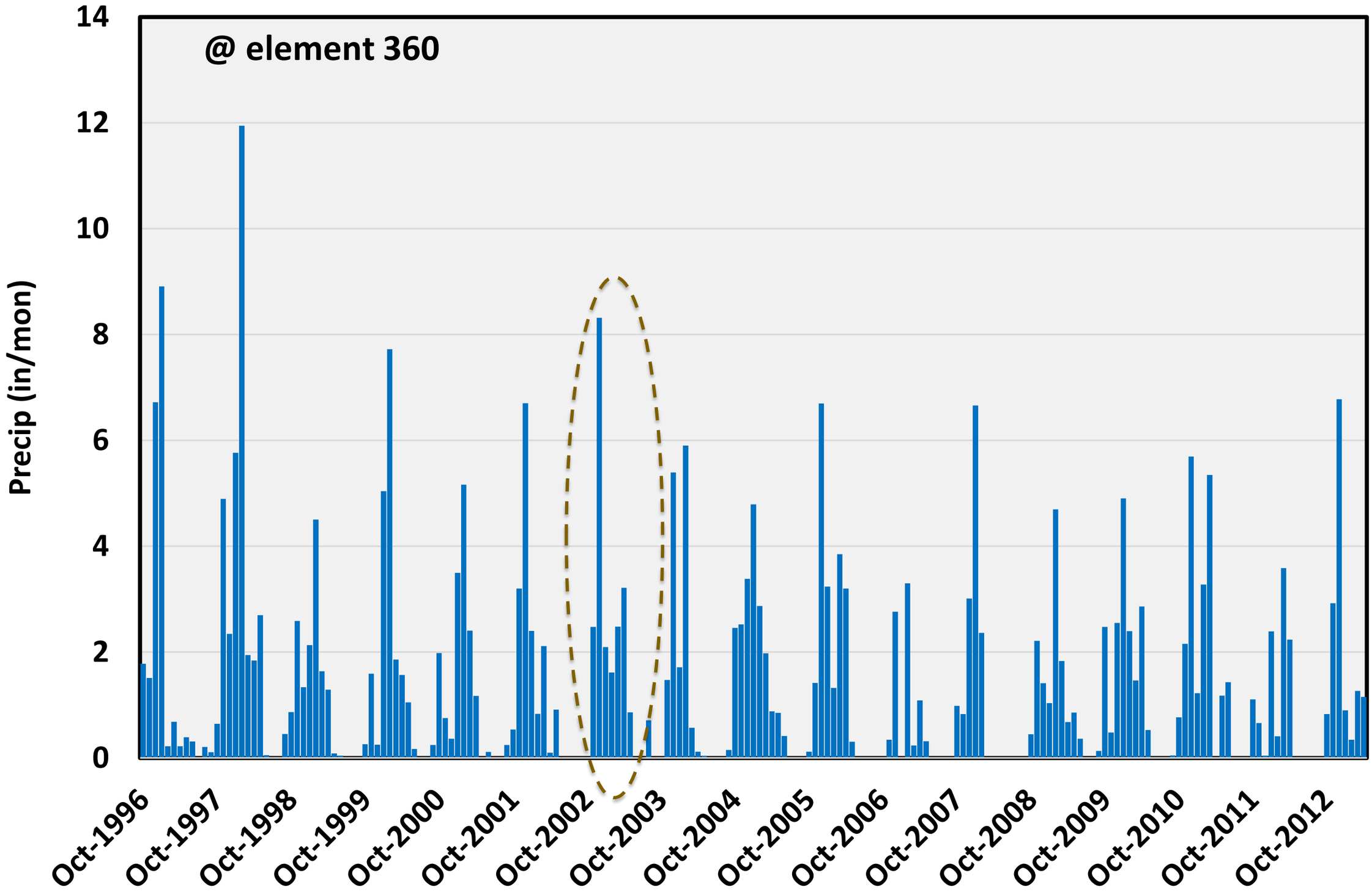
The C2VSim-Coarse Grid Model Domain



Author- Norman Johns, DWR. [04/22]

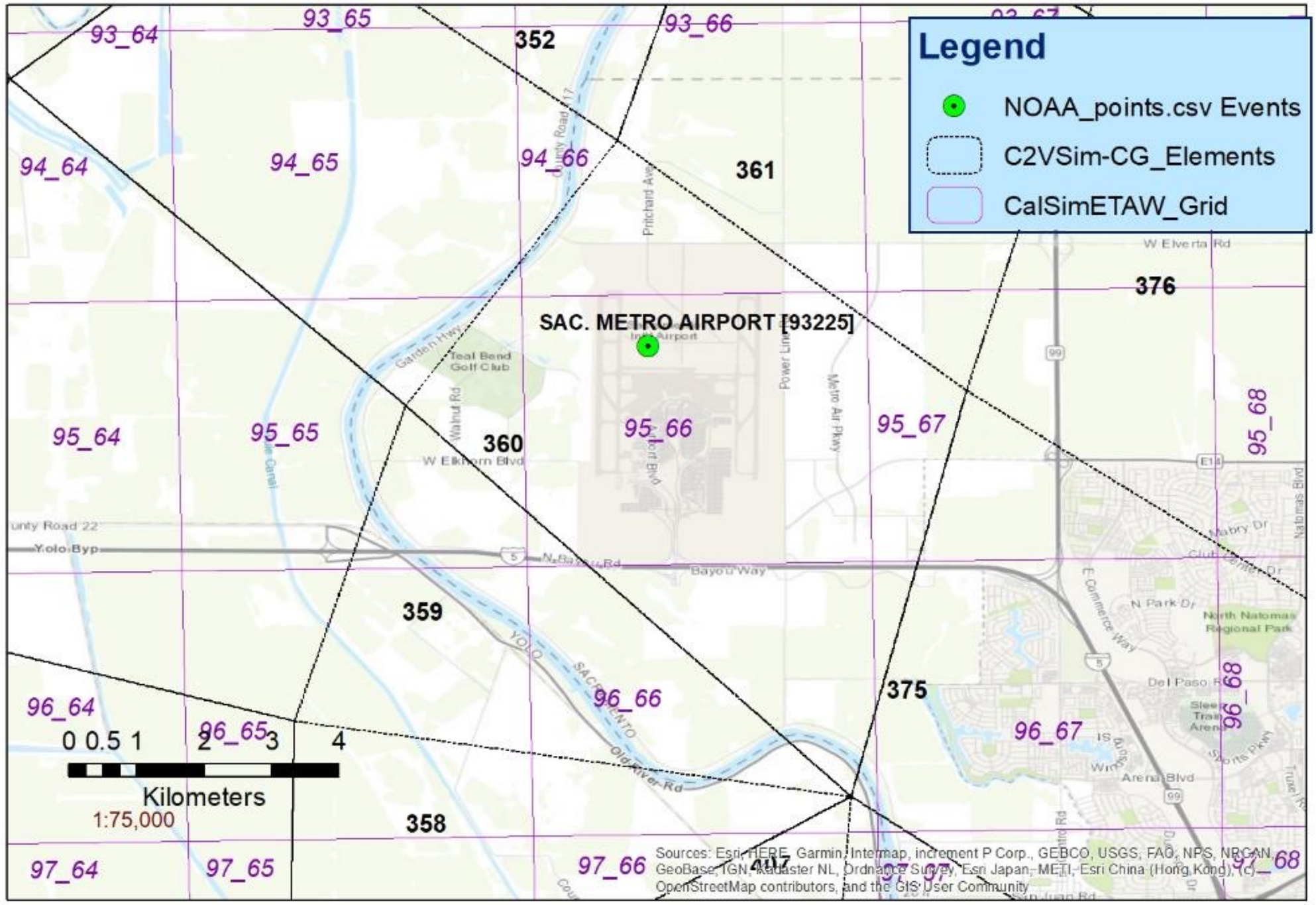
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

C2VSimCG Precipitation, Monthly Time Series Values



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

The C2VSim-Coarse Grid Model Domain



Author- Norman Johns, DWR. [04/22]

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Precipitation [and Evaporation] from DWR's CalSimETAW Program

PRISM inputs

CalSimETAW output

Daily Weather and ETo data output by PRISM grid

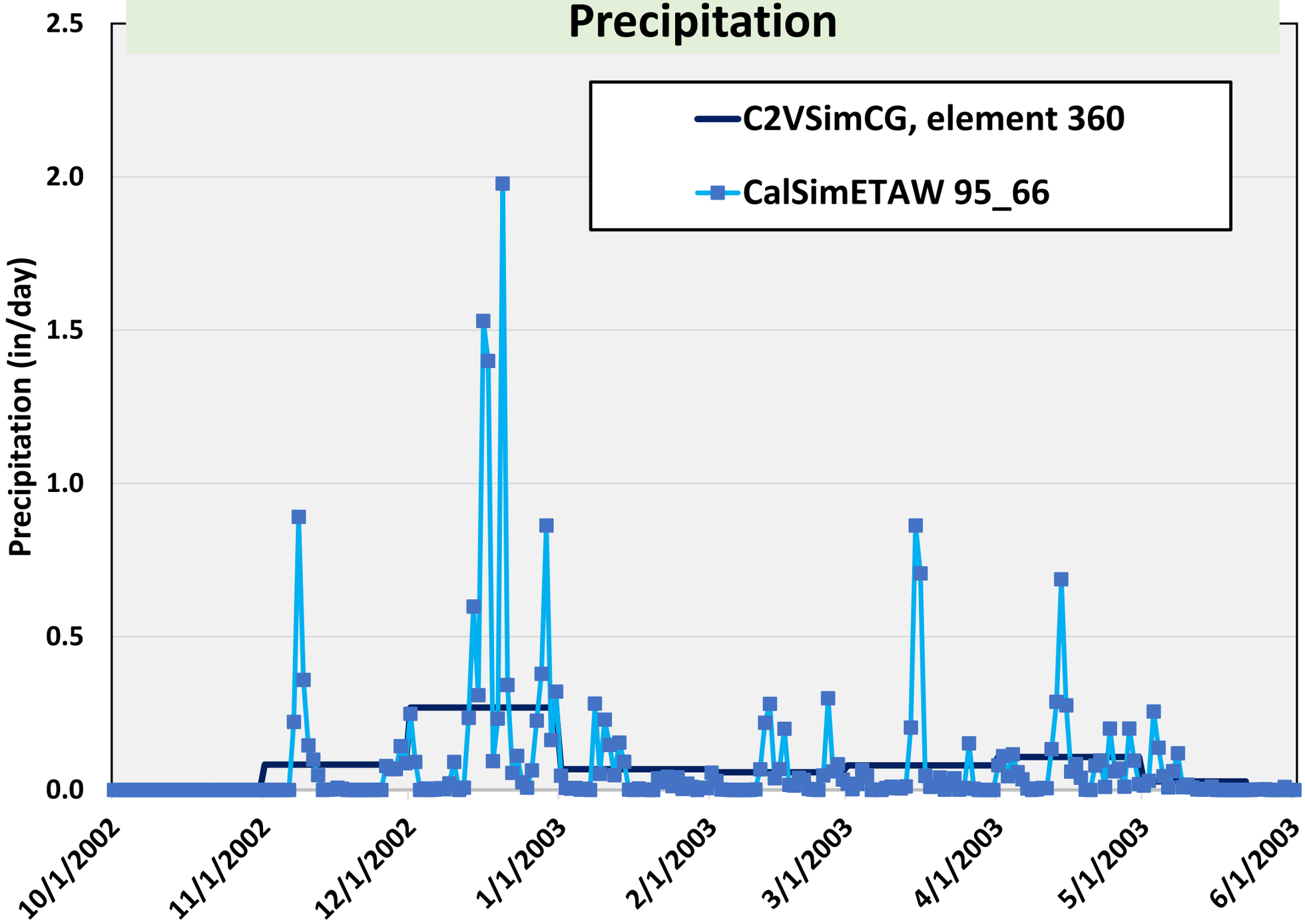
Year	Mon	DOY	Lat	Long	Tmax	Tmin	Pcp	ETo
#	#	#	deg	deg	oC	oC	mm	mm
1921	10	274	40.59	-122.29	29.27	13.08	4.87	3.01
1921	10	275	40.59	-122.29	30.13	12.84	0.49	3.13
1921	10	276	40.59	-122.29	29.09	13.05	0	2.99
1921	10	277	40.59	-122.29	29.94	13.87	0	3.05
1921	10	278	40.59	-122.29	28.84	13.7	1.74	2.92
1921	10	279	40.59	-122.29	29.08	13.37	0	2.97
1921	10	280	40.59	-122.29	30.81	12.43	0.04	3.24
1921	10	281	40.59	-122.29	32.17	13.22	0	3.38
1921	10	282	40.59	-122.29	30.65	13.22	0	3.18
1921	10	283	40.59	-122.29	30.08	13.26	0	3.11

⋮

2019	12	354	40.59	-122.29	8.63	6.4	13.05	0.44
2019	12	355	40.59	-122.29	11.27	5.62	1.64	0.73
2019	12	356	40.59	-122.29	10.66	4.2	1.12	0.75
2019	12	357	40.59	-122.29	9.37	4.13	11.31	0.66
2019	12	358	40.59	-122.29	12.9	-0.45	0	1.02
2019	12	359	40.59	-122.29	8.75	-1.18	4.45	0.79
2019	12	360	40.59	-122.29	6.85	2.97	2.85	0.52
2019	12	361	40.59	-122.29	13.5	4.51	0	0.94
2019	12	362	40.59	-122.29	14.9	4.56	0	1.03
2019	12	363	40.59	-122.29	17.61	5.52	0	1.19
2019	12	364	40.59	-122.29	10.24	3.18	3.25	0.76
2019	12	365	40.59	-122.29	17.89	3.53	0	1.26

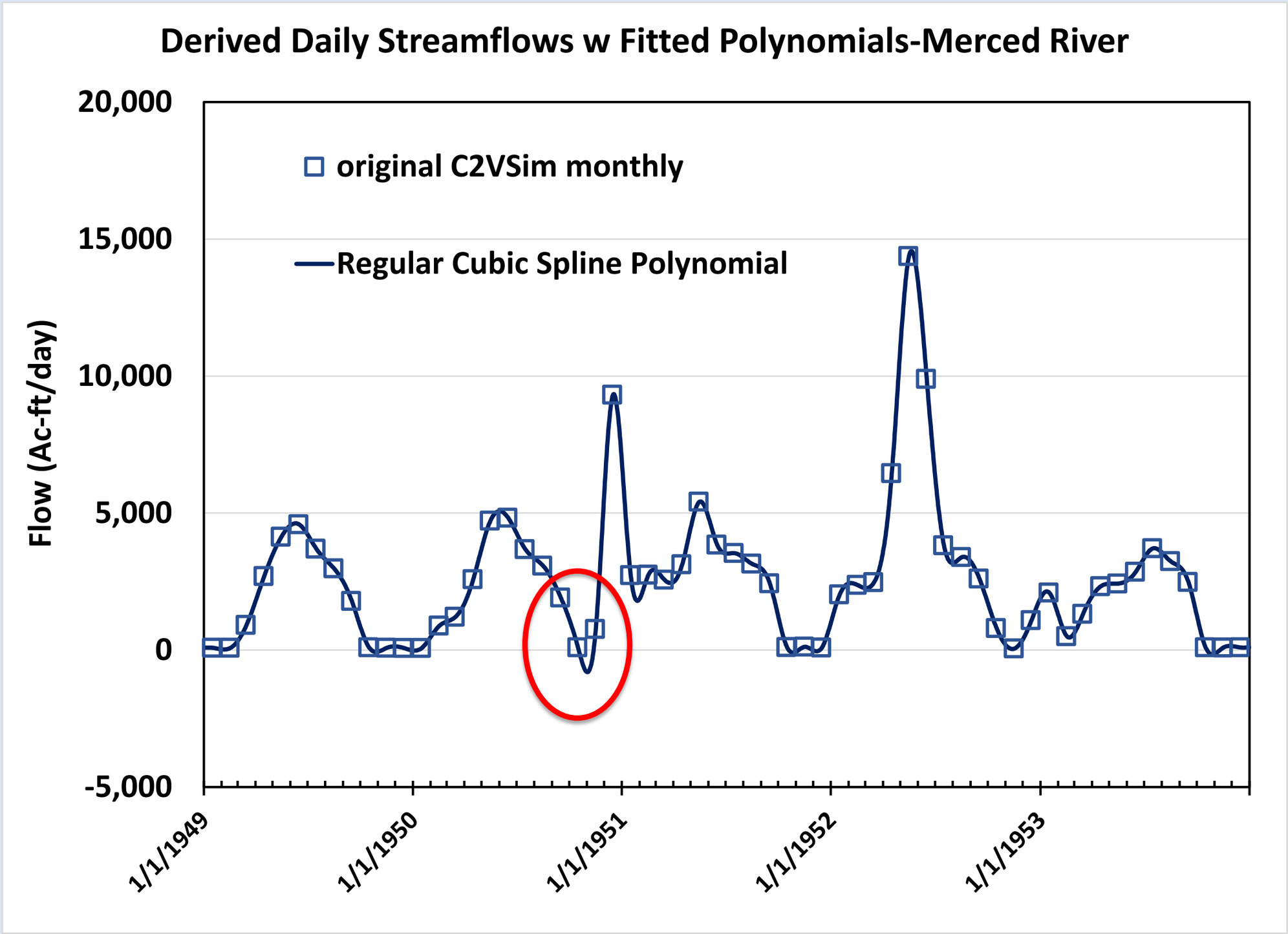
data provided by Morrie Orang, DWR.

Distributing C2VSimCG monthly data to daily pattern - Precipitation

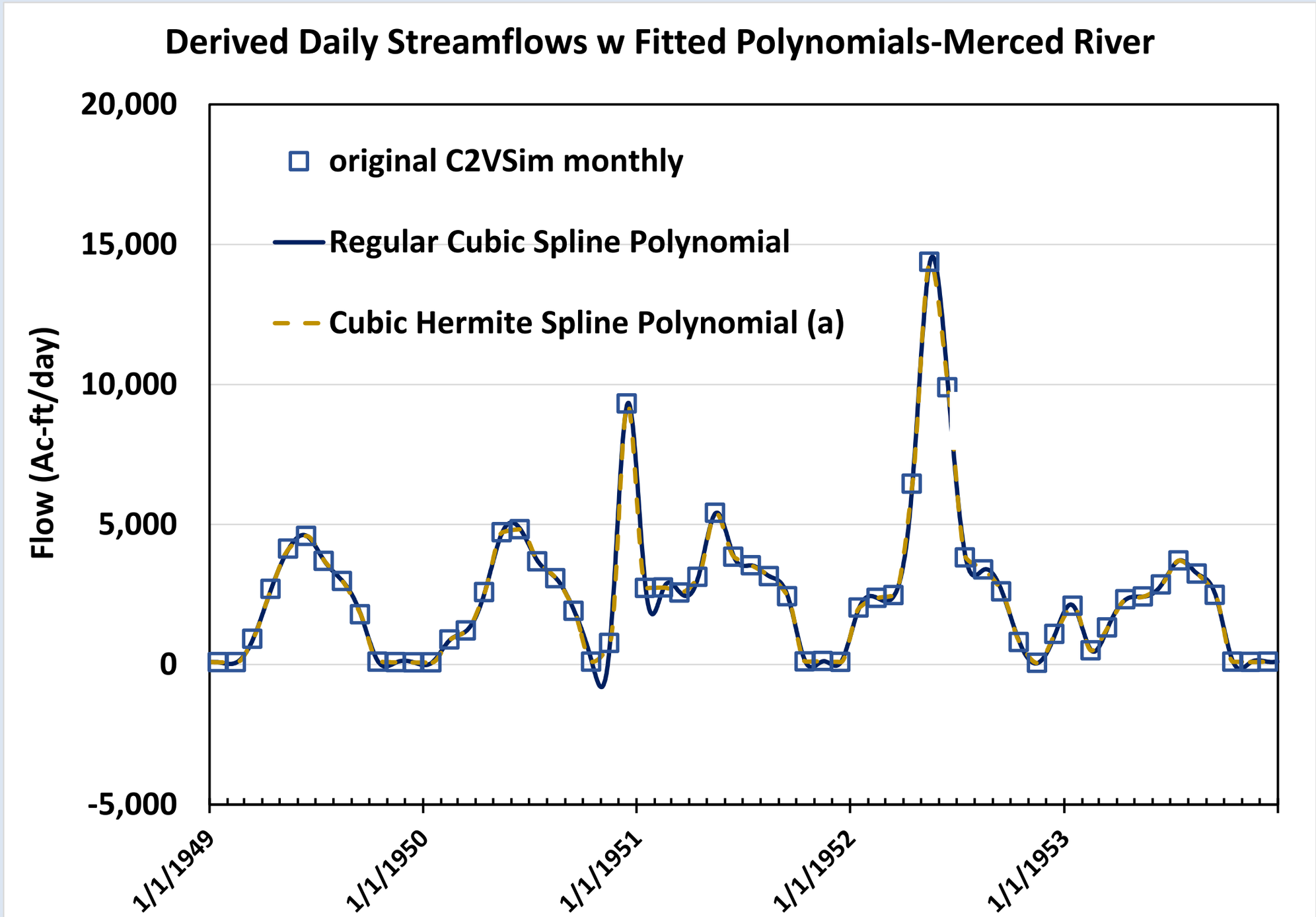


CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Stream Inflows {& Diversions}

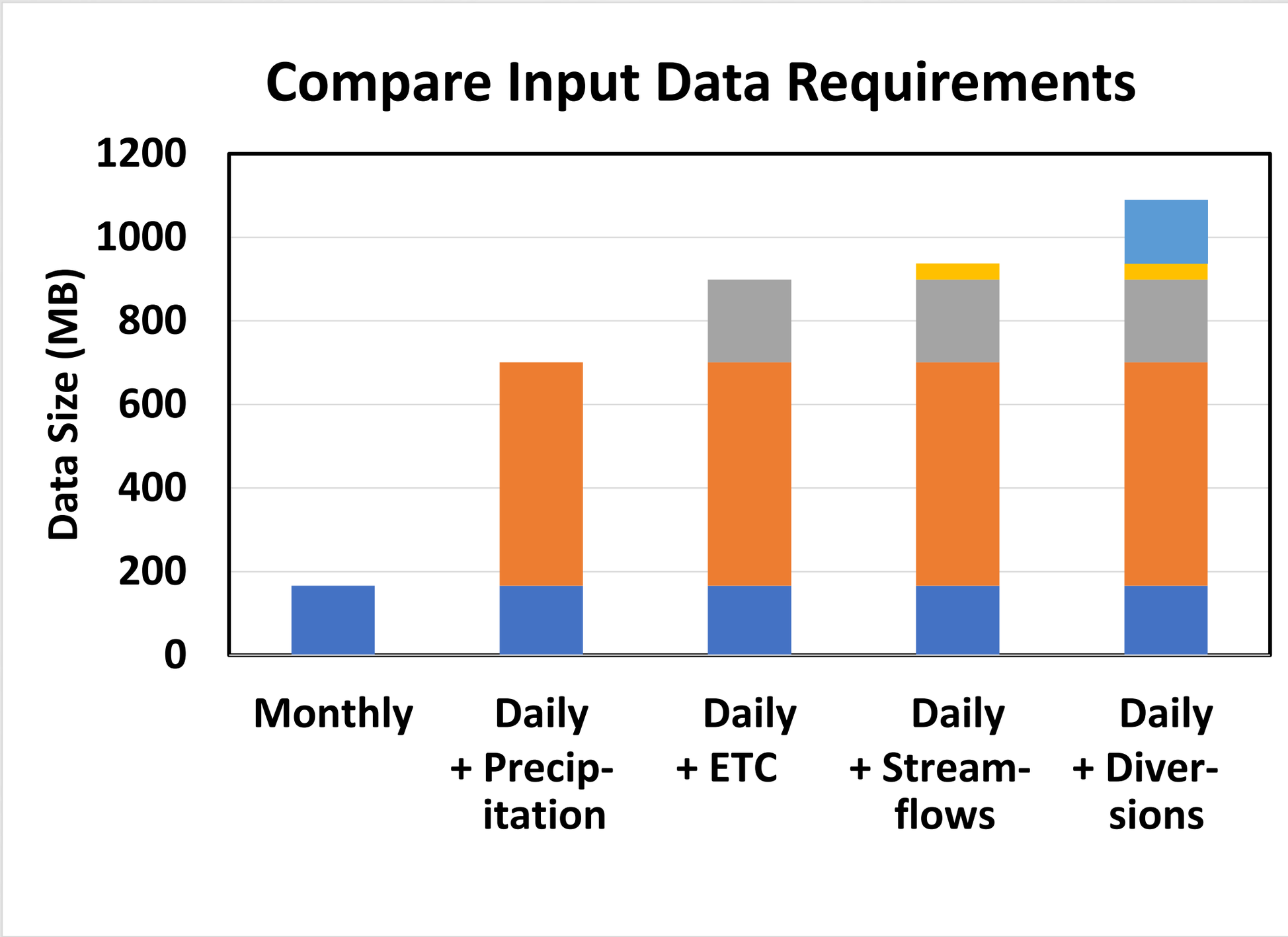


CALIFORNIA DEPARTMENT OF
WATER RESOURCES



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

The scope of the data conversion process



CALIFORNIA DEPARTMENT OF WATER RESOURCES

Preliminary Results

Model Runs Framework

	Run Number				
	001	011	021	031	041
Monthly Base	☑				
Daily component:					
-Precipitation		☑	☑	☑	☑
-Evaporation			☑	☑	☑
-Diversions				☑	☑
-Major Streams					☑

C2VSIM-Daily

A) Status of daily data development

beta

- ✓ **Precipitation**
- ✓ **Evaporation**
- ✓ **Diversions**
- ✓ **Stream Inputs**

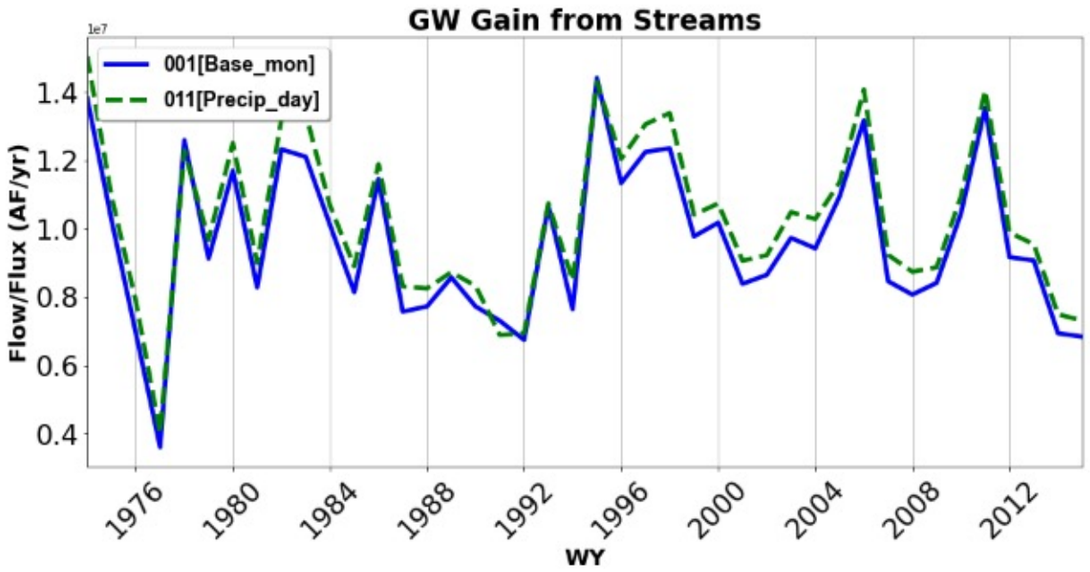
V1.0

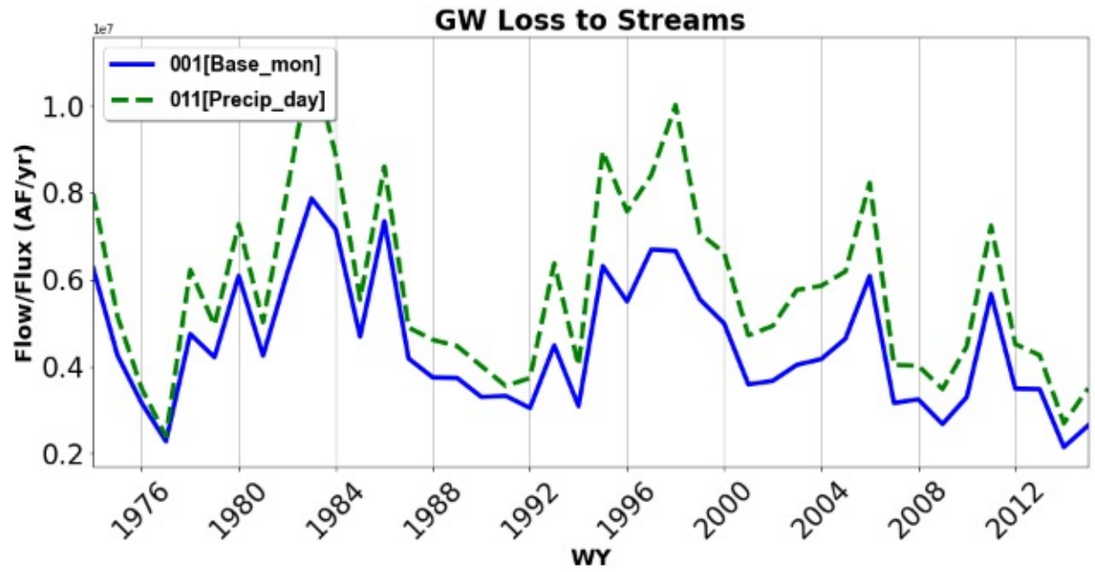
- ✓ **Precipitation**
- **Evaporation**
- **Diversions**
- **Stream Inputs**

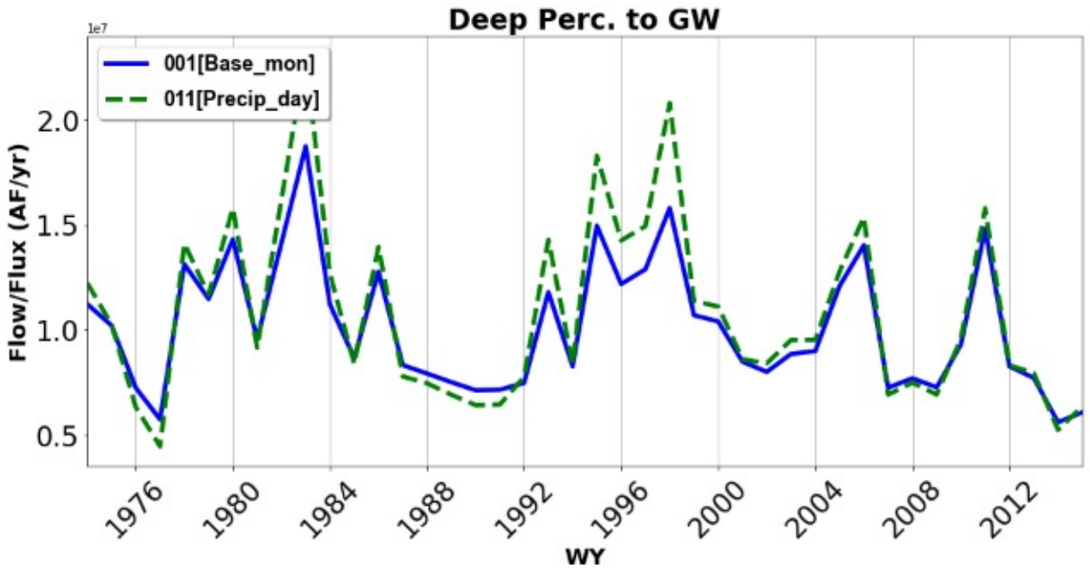
Results: Groundwater Components

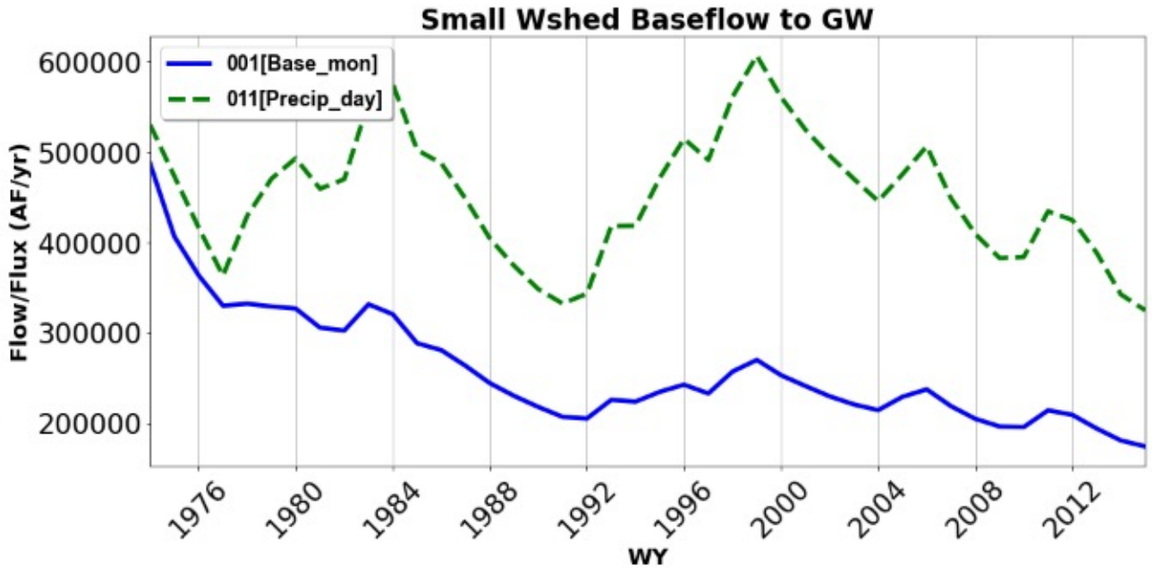
Whole Model Domain

Version: 1.0







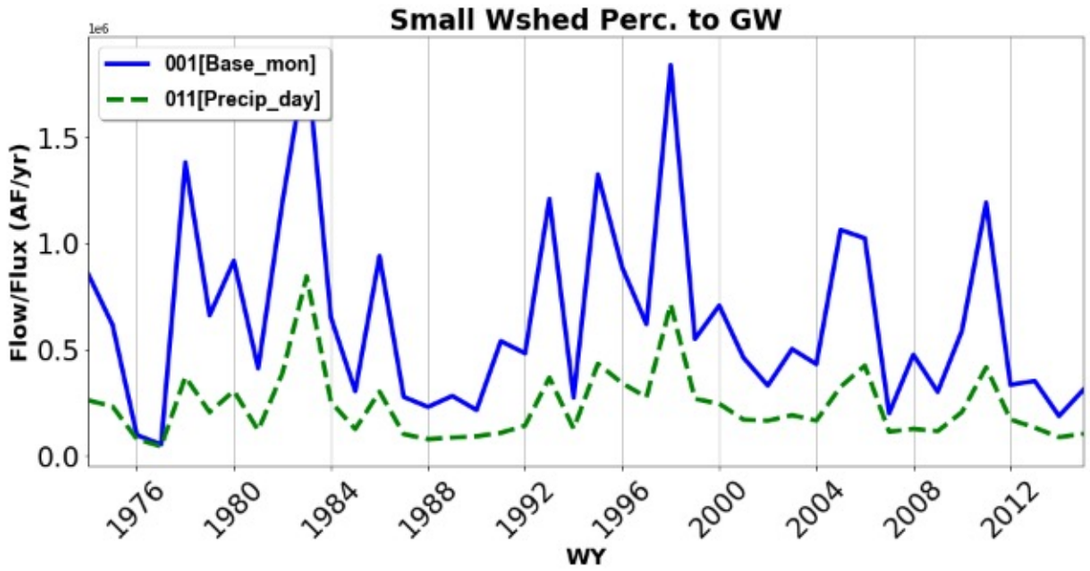


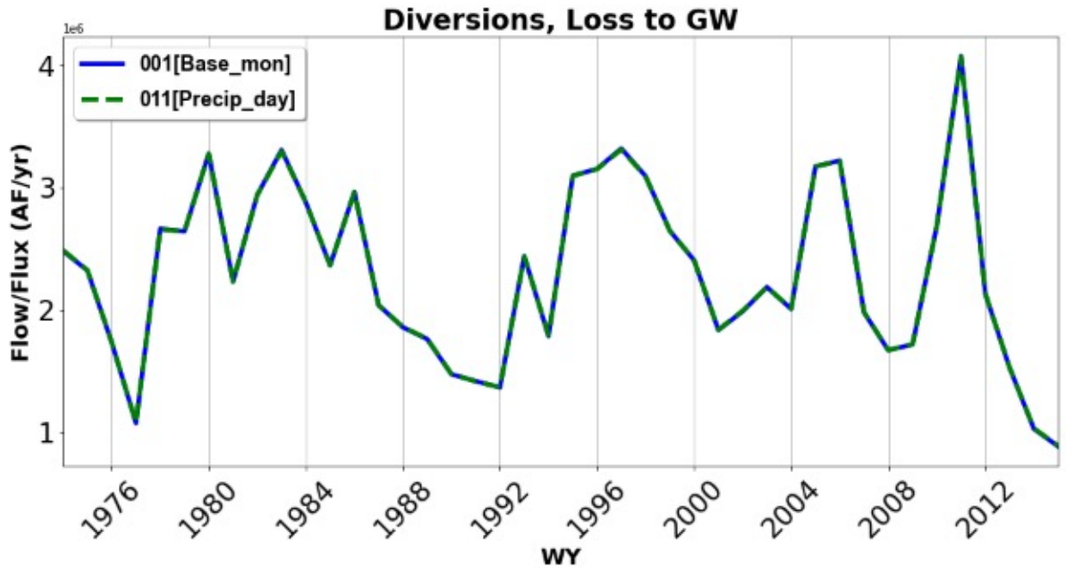
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

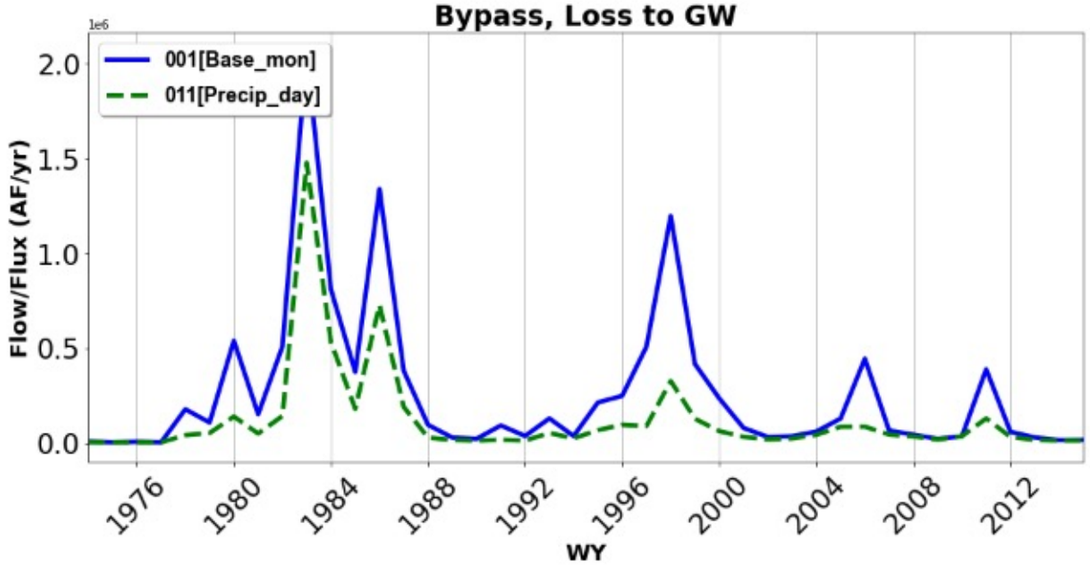
Results: Groundwater Components

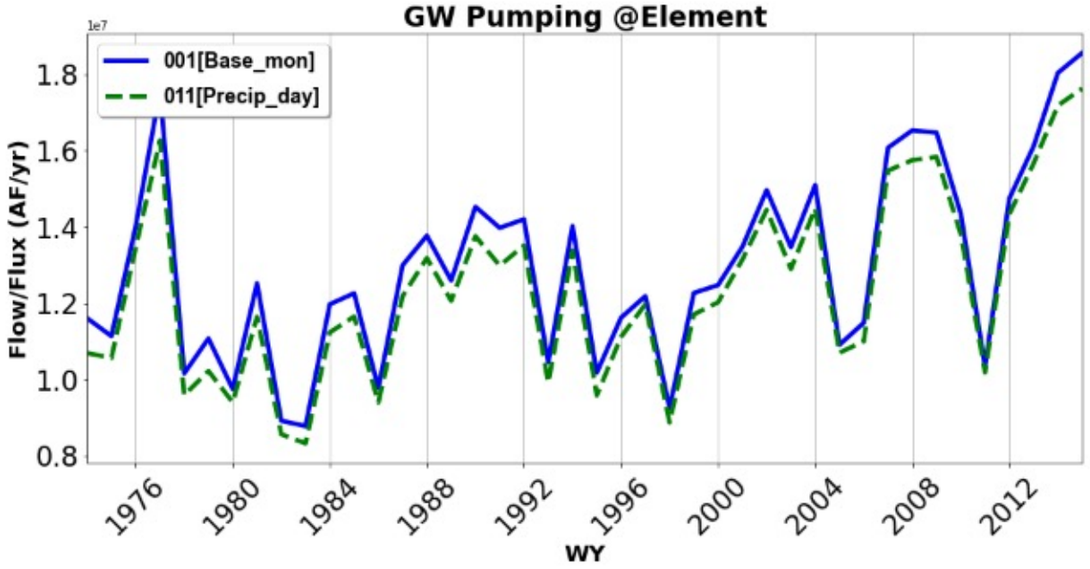
Whole Model Domain

Version: 1.0





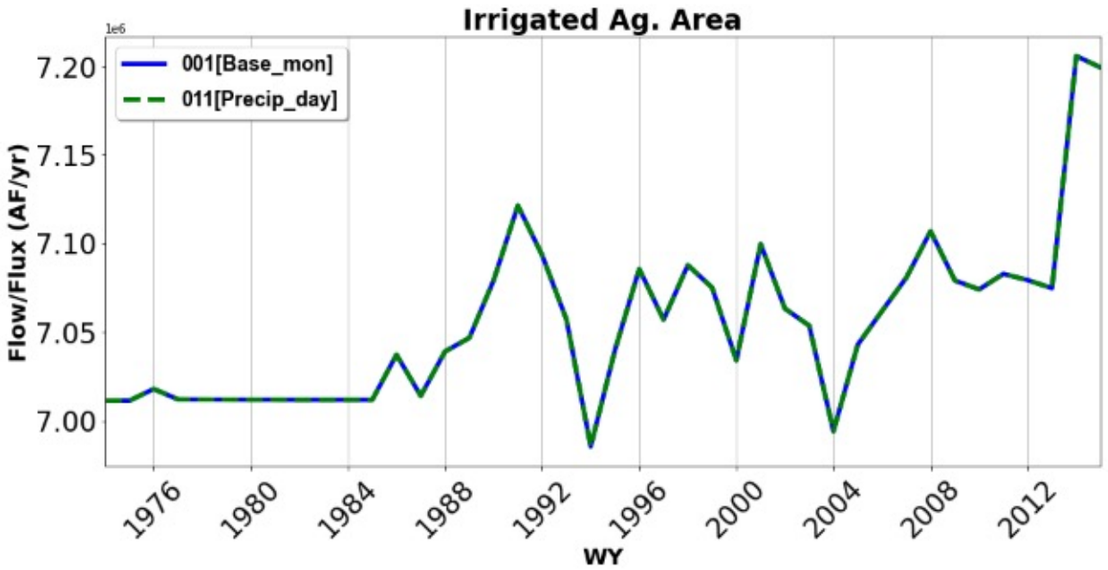


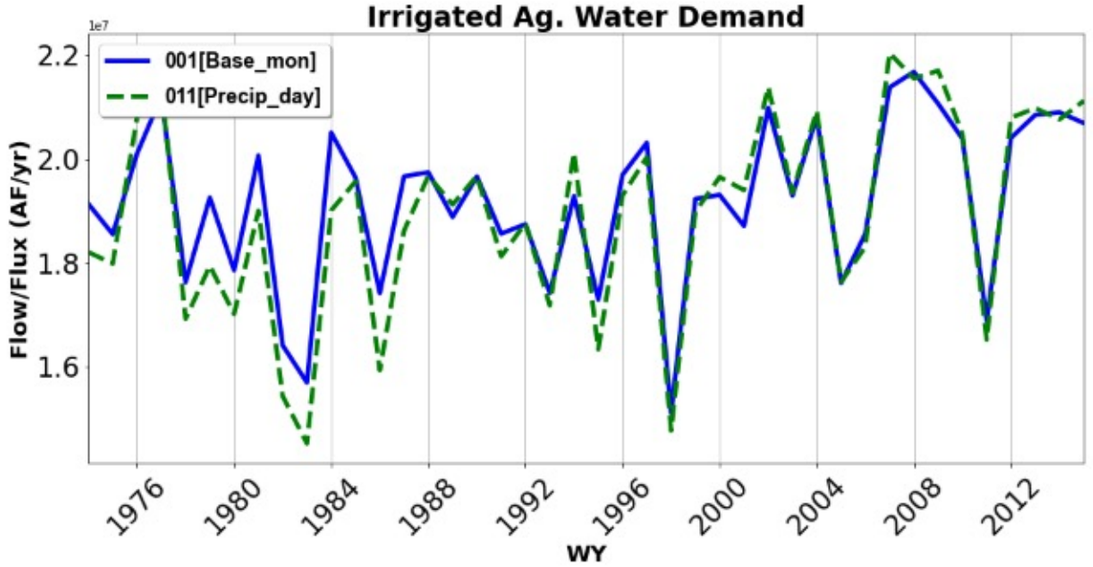


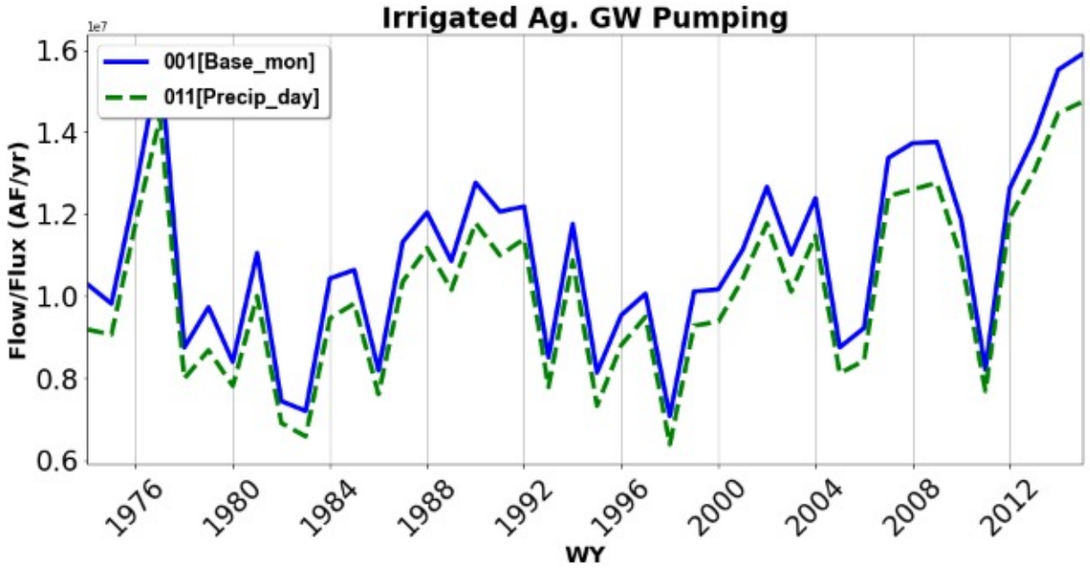
Results: Land & Water Use

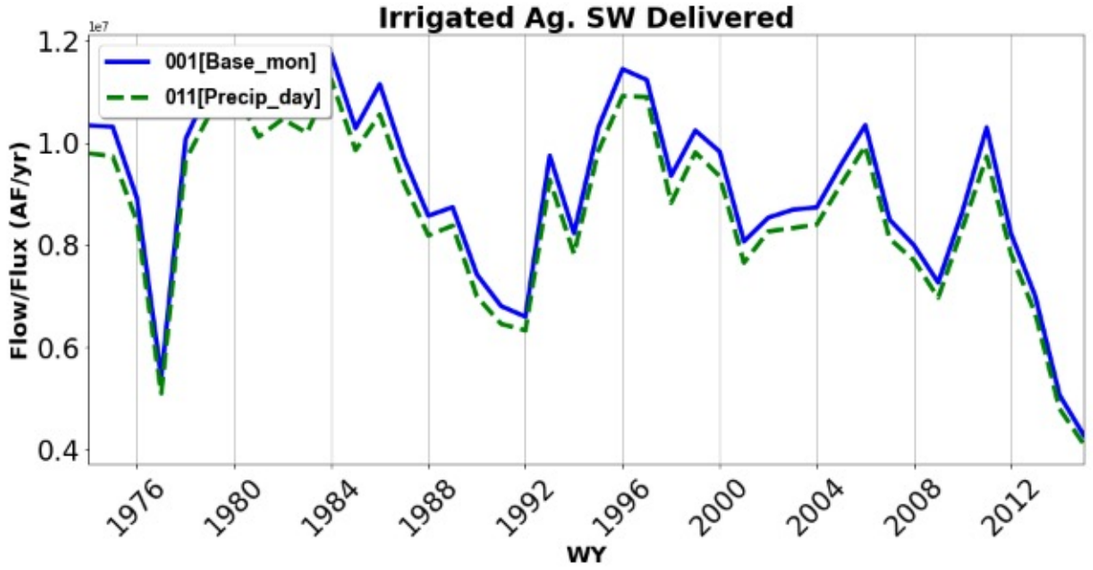
Whole Model Domain

Version: 1.0







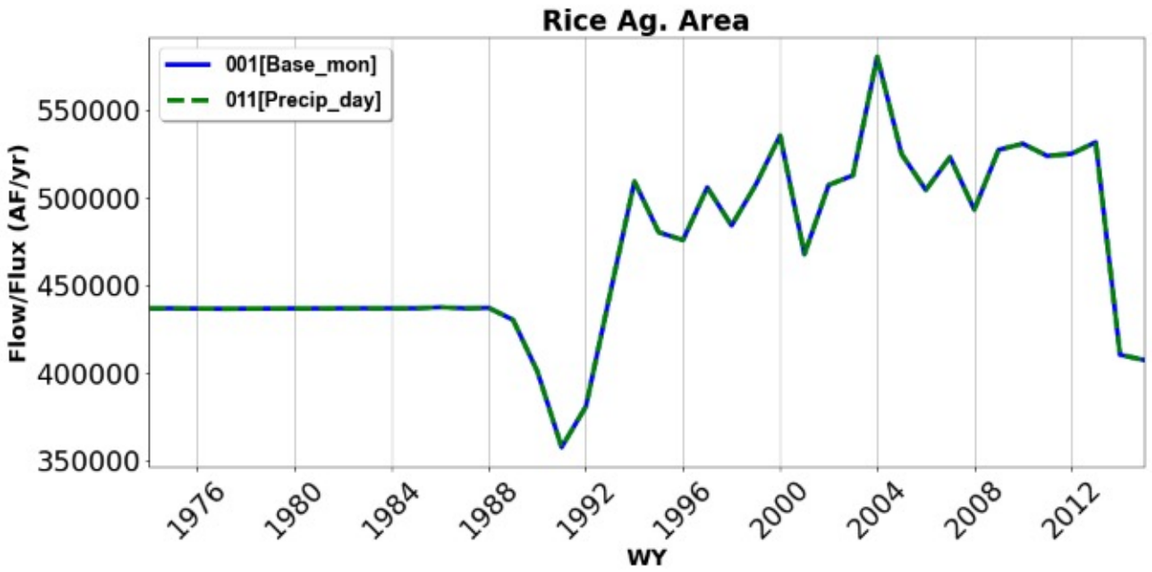


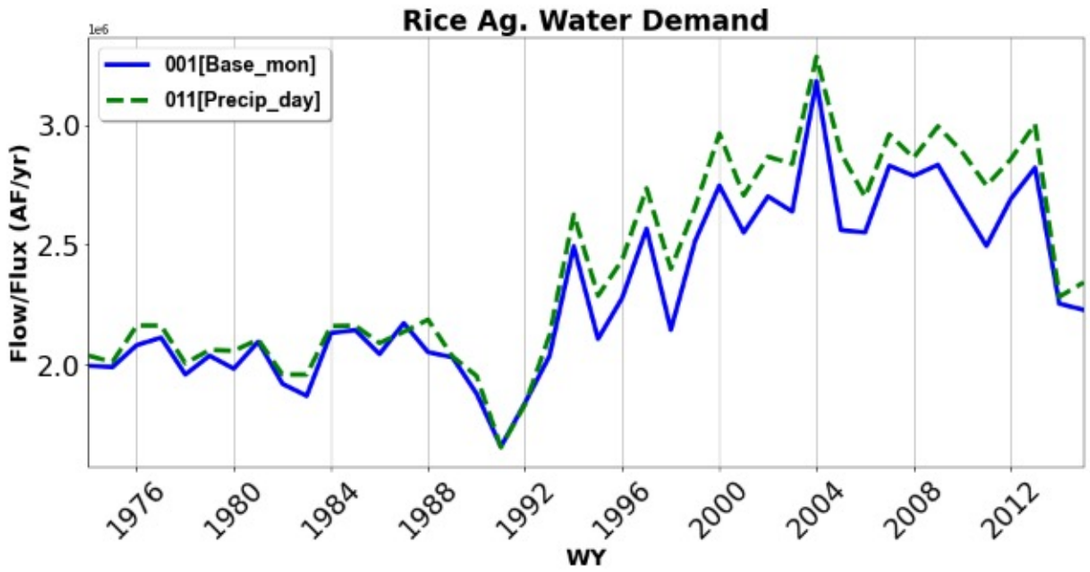
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

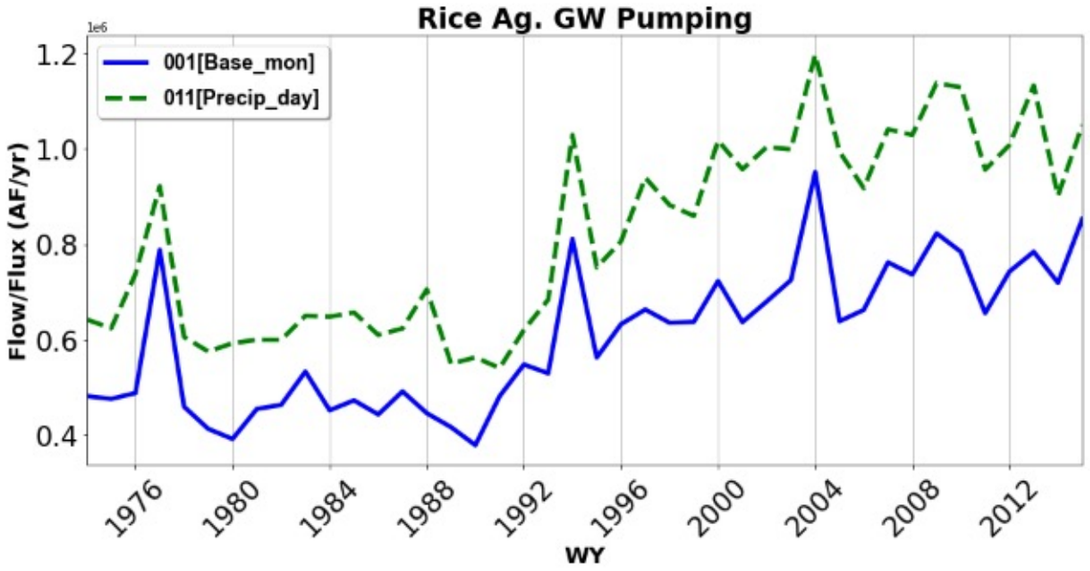
Results: Land & Water Use

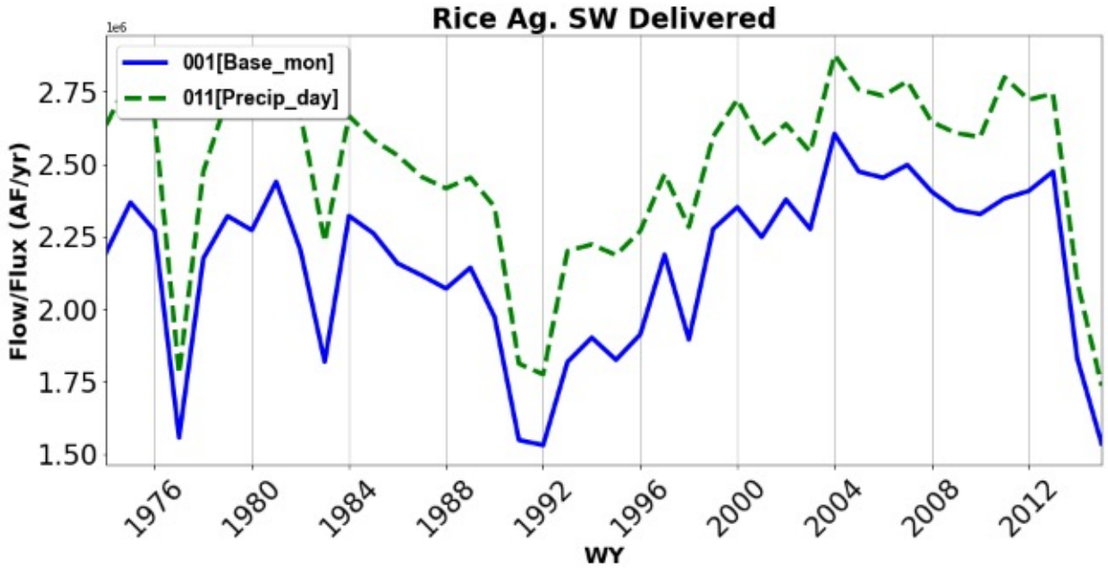
Whole Model Domain

Version: 1.0







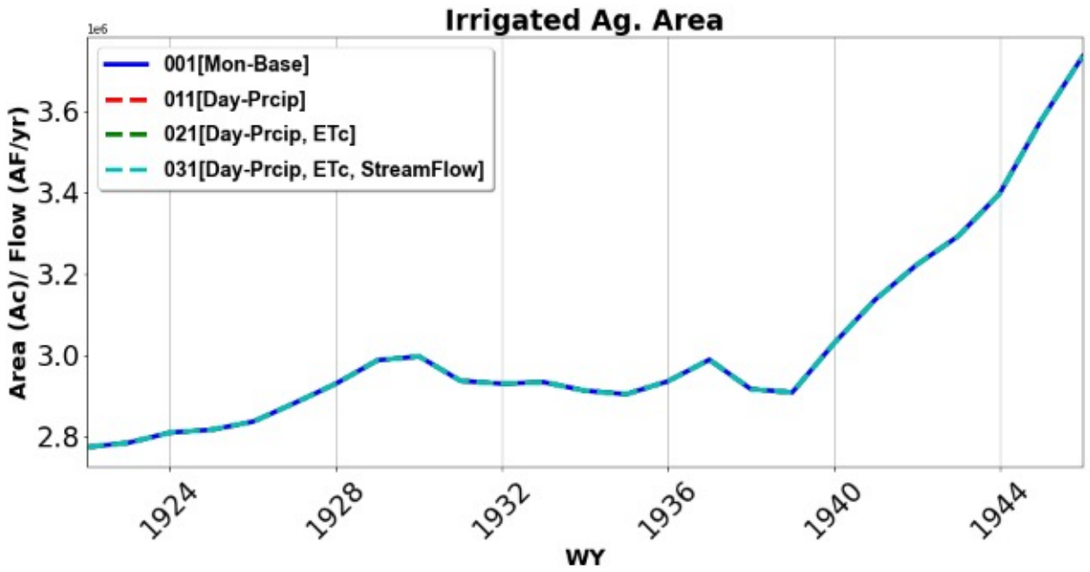


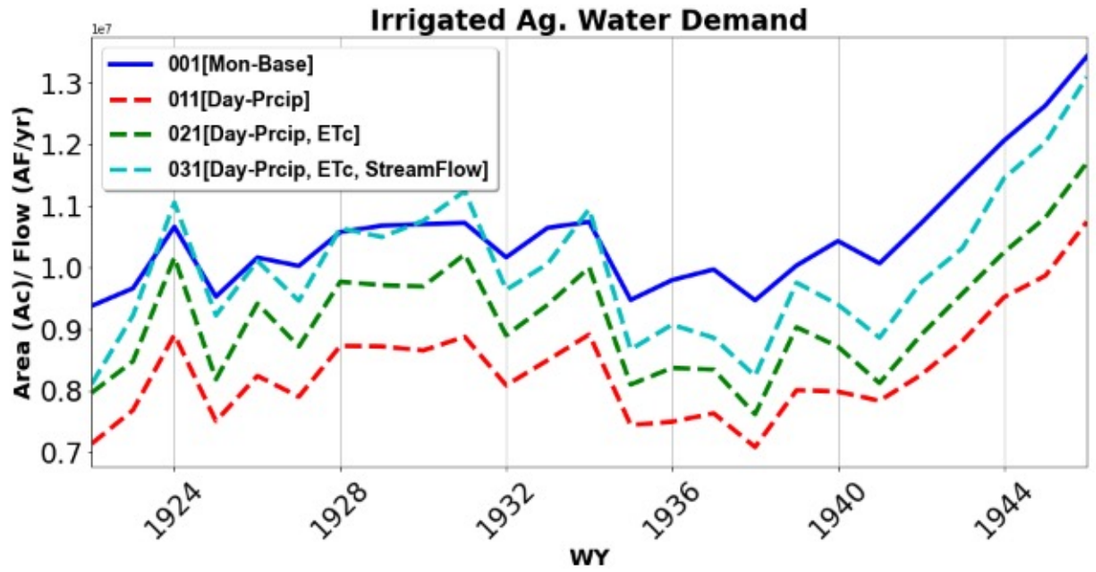
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

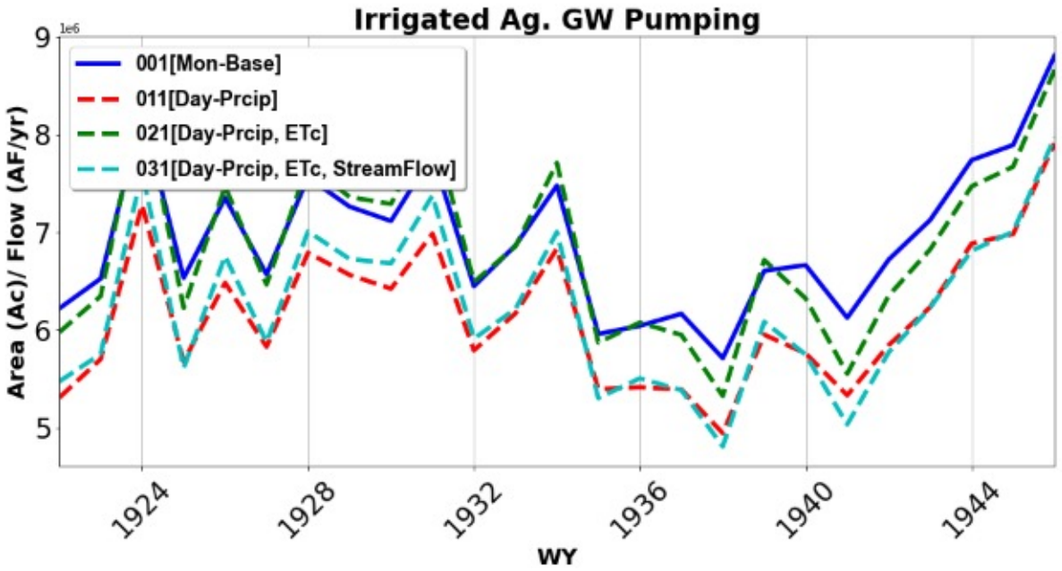
Results: Land & Water Use

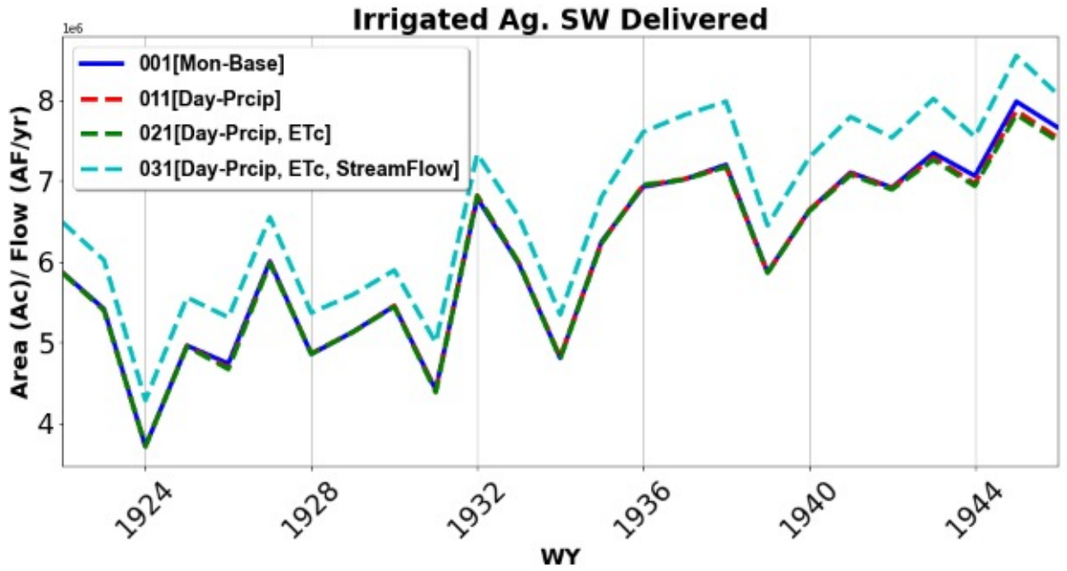
Whole Model Domain

Version: beta



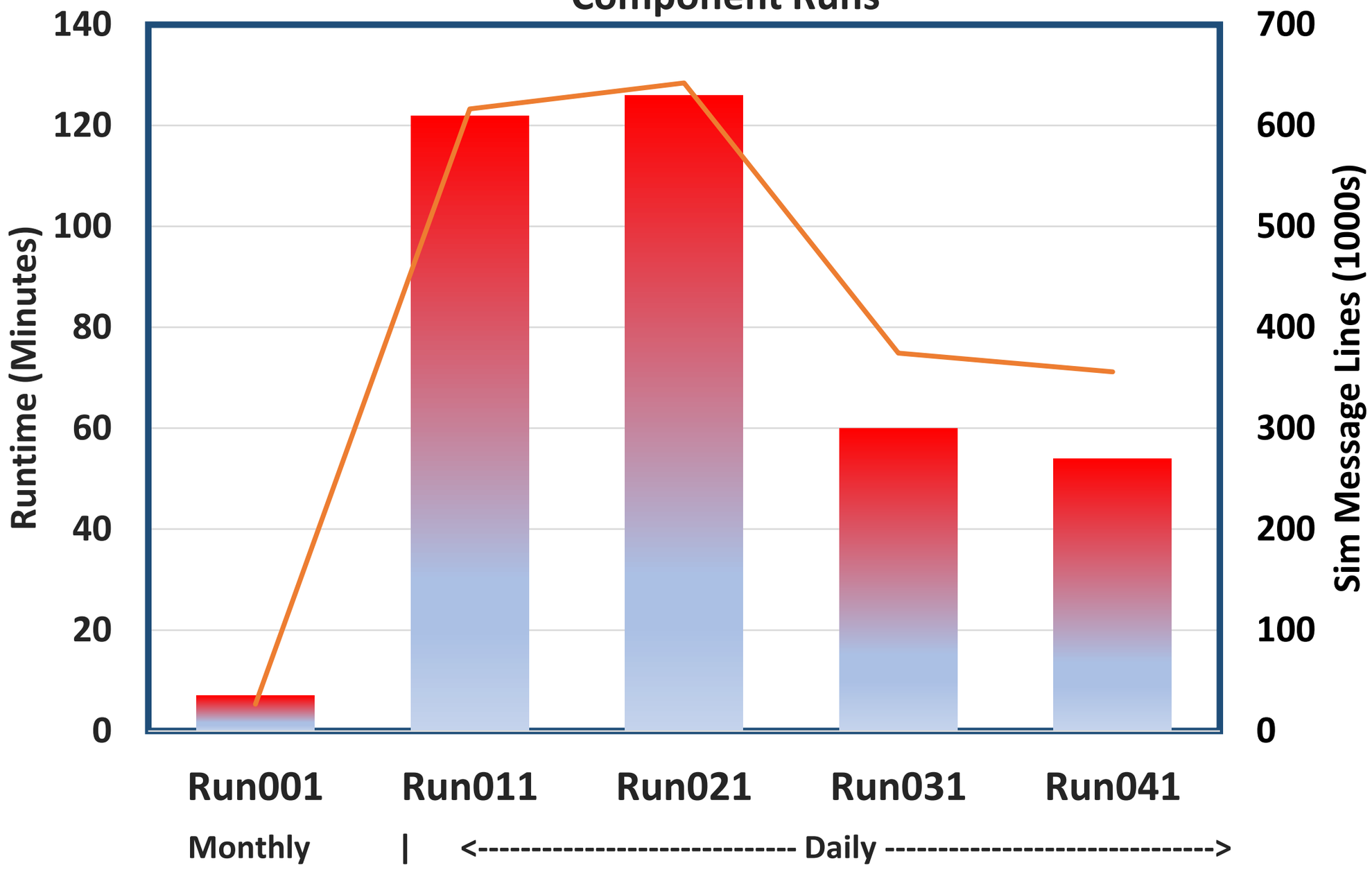




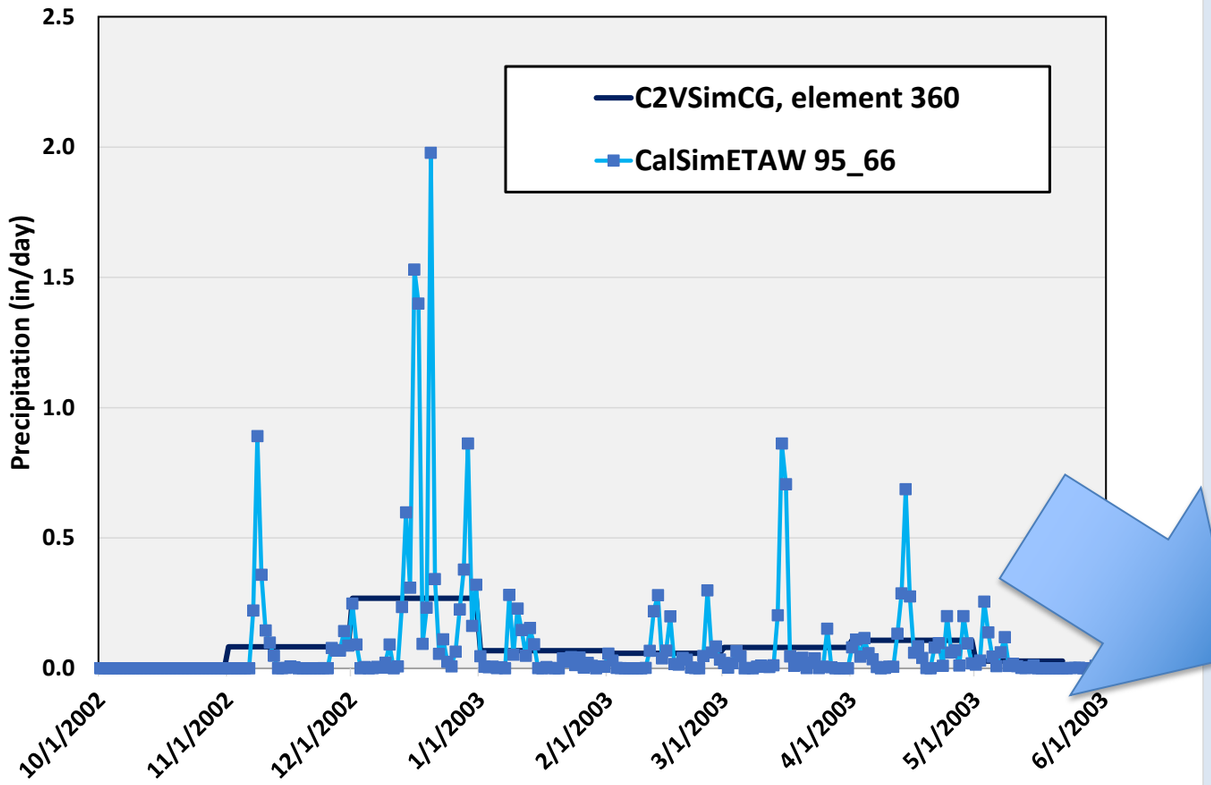


CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Compare Computational Performance, Monthly Base and Daily Component Runs



C2VSim – Surface Runoff Process



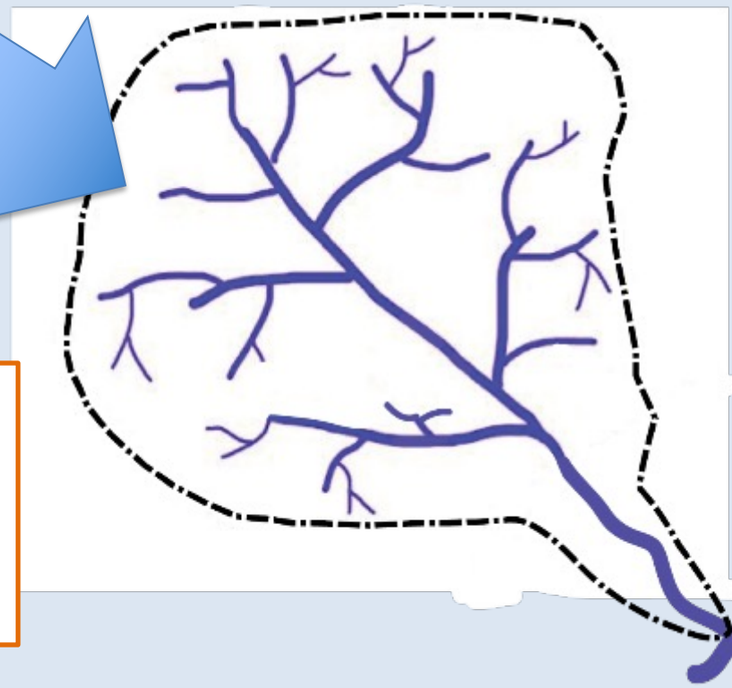
The SCS Method

$$Q = \frac{(P-I_a)^2}{(P - I_a) + S} \qquad (1)$$

$$I_a = 0.2\,S \qquad (2)$$

$$Q = \frac{(P - 0.2\,S)^2}{(P + 0.8\,S)} \qquad (3)$$

$$S = \frac{1000}{CN} - 10 \qquad (4)$$



Pseudo CN* {monthly semi-match}

CALIFORNIA DEPARTMENT OF WATER RESOURCES

C2VSIM-Daily: The Road Ahead

A) Daily data development

B) Daily process improvement

C) IWFM computational improvement

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

C2VSIM-Daily: The Road Ahead

A) Status of daily data development

beta

- ✓ **Precipitation**
- ✓ **Evaporation**
- ✓ **Diversions**
- ✓ **Stream Inputs**

V1.0

- ✓ **Precipitation**
- **Evaporation**
- **Diversions**
- **Stream Inputs**

C2VSIM-Daily: The Road Ahead

B) Daily process improvement

- **Improve Precipitation-Runoff by reverting to daily CNs.**

- **Kinematic wave streamflow routing.**

C2VSIM-Daily: The Road Ahead

C) IWFM computational improvement

- **Modify IWFM output frequency.**

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Thank You

Questions?

norman.johns@water.ca.gov