A Comparison of RiverWare and StateMod as Water Allocation Model Platforms

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RiverWare User Group Meeting

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Background

- **RiverWare**:
  - Water rights model of the Colorado Rio Grande. CO Rio Grande Compact delivery logic with on-the-fly calculation of Curtailment (NRCS runoff forecast), Compact storage in reservoirs, irrigation district storage, municipal and ag pumping depletions, etc.
  - Planning model for ECCV, ACWWA, and United on South Platte. Presented last year about pumping depletions, groundwater recharge, and river exchanges.
- **StateMod**:
  - Worked as subcontractor on South Platte DSS. Focused on operating rules, plans, and reservoir operations for St. Vrain Creek, which includes Left Hand Creek, City of Longmont, and many irrigators and rural water districts.

History and Use of StateMod

- Originally developed in 1986 (2 *years older than me*) – still maintained in Fortran
- State of Colorado: CWCB and DWR
- Support now from Open Water Foundation
- Users in Wyoming have adapted it

- The goal of the **Colorado Decision Support System (CDSS)** is to have a state-wide planning model that is integrated with a database of hydrologic data (**HydroBase**).

Water Right Allocation in RiverWare

- First mention of water rights allocation using doctrine of Prior Appropriation is in v.5 (latest release is 6.9.4)
- Taught in "Water Accounting in RiverWare"
  - CADSWES Training and support

- Perhaps not **RiverWare**'s primary focus – "Allocatable Flow" treated as an account, accounting methods allocate water within Computational Subbasin.

Use as Water Allocation Platforms

- Prior Appropriation system
- Reservoir operations
- Accounting

1. **Agriculture**: Water Rights, IWR, CU, Return Flows
2. **Municipal/Industrial (M&I)**: Water Rights, Changed Water Rights/Decree Requirements, Reservoir operations, Trans-Basin Imports, Reusable Effluent
3. **State/Federal**: ISF, Interstate Compact, Flood Control, Power Generation, Regional Supply

Agriculture

RiverWare

- Demands are generated outside model platform
- Various methods determine efficiencies, return flow routing
- Multiple water rights require individual accounts

StateMod

- StateCU generates demands
- StateMod input files specify efficiencies, return flow timing and location
- One water user may have several priorities

Municipal / Industrial (M&I)

RiverWare

- Water users have a demand for raw water
- Changed rights, return flow obligations, pumping depletions, recharge accretions, re-use, etc. require some **creativity** with objects, methods, and RPL

StateMod

- In 2015-2016, large effort to incorporate municipal operations into operating rule suite
- Little flexibility to deviate from built-in operating rules

State / Federal

RiverWare

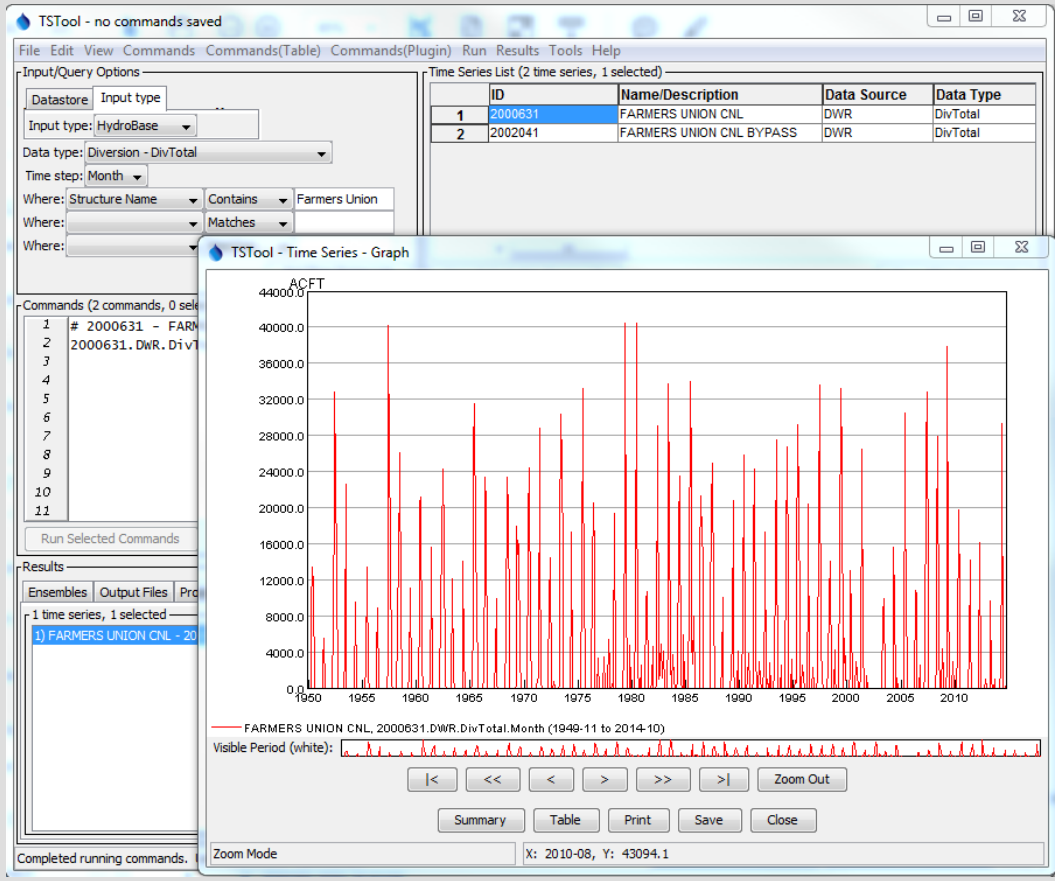
- ISF reaches (Control points)
- Many built-in methods for flood control, hydroelectric, thermal, etc.
- RPL flexibility for Interstate Compact requirements

StateMod

- ISF rights simulated
- Reservoir targets and specific Colorado Compacts (South Platte, Rio Grande, La Plata…)
- Little support for Federal-level operations

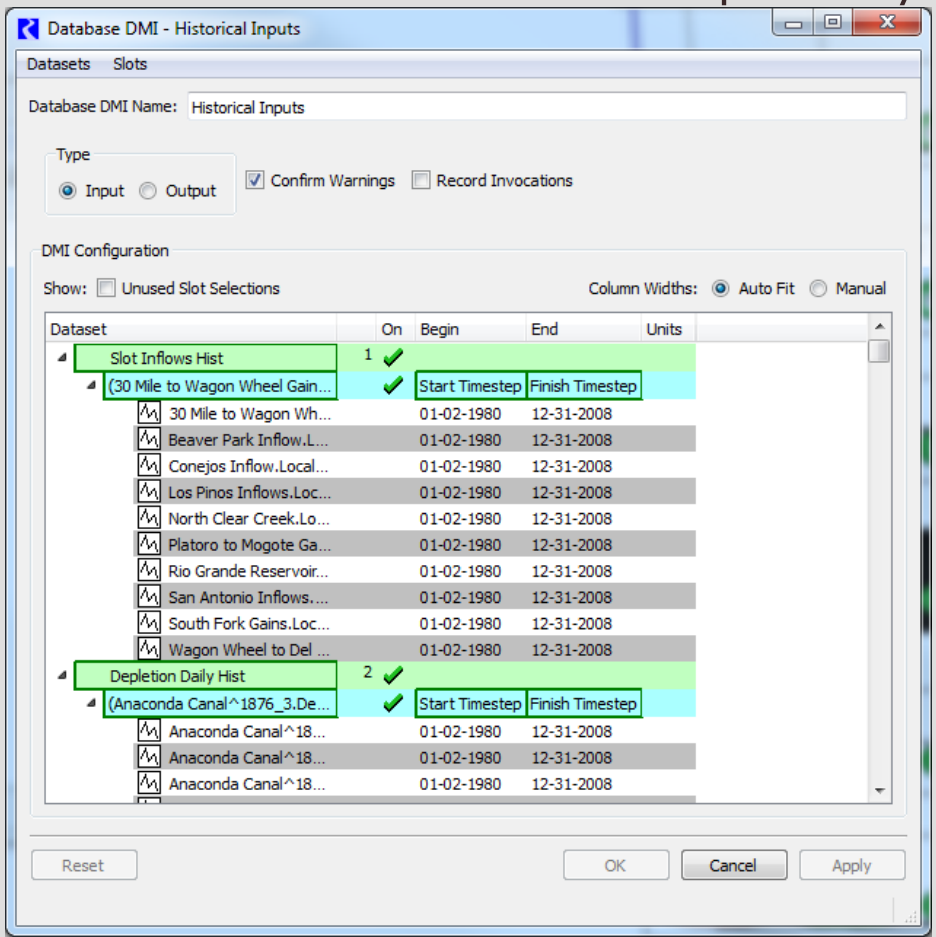
Data Management - StateMod

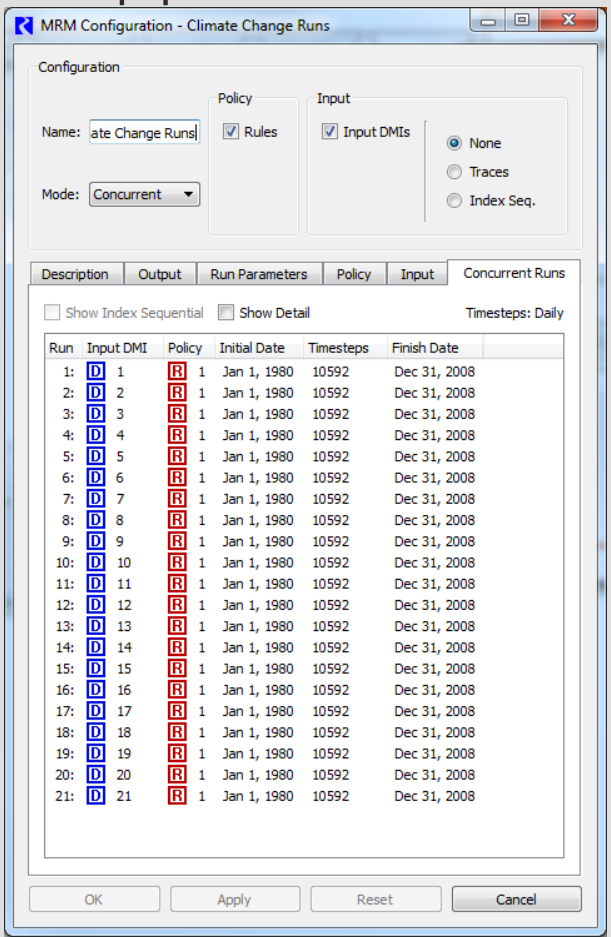
- One of **StateMod**'s greatest strengths is its integration with a database of hydrologic data, **HydroBase**
  - Database updated by Colorado DWR several times annually
  - Water rights, diversion records, reservoir volumes, climatic data, irrigation practice / coverage, streamflow, etc.
  - Built-in methods for manipulation of data (fill, regression, etc.)



Data Management - RiverWare

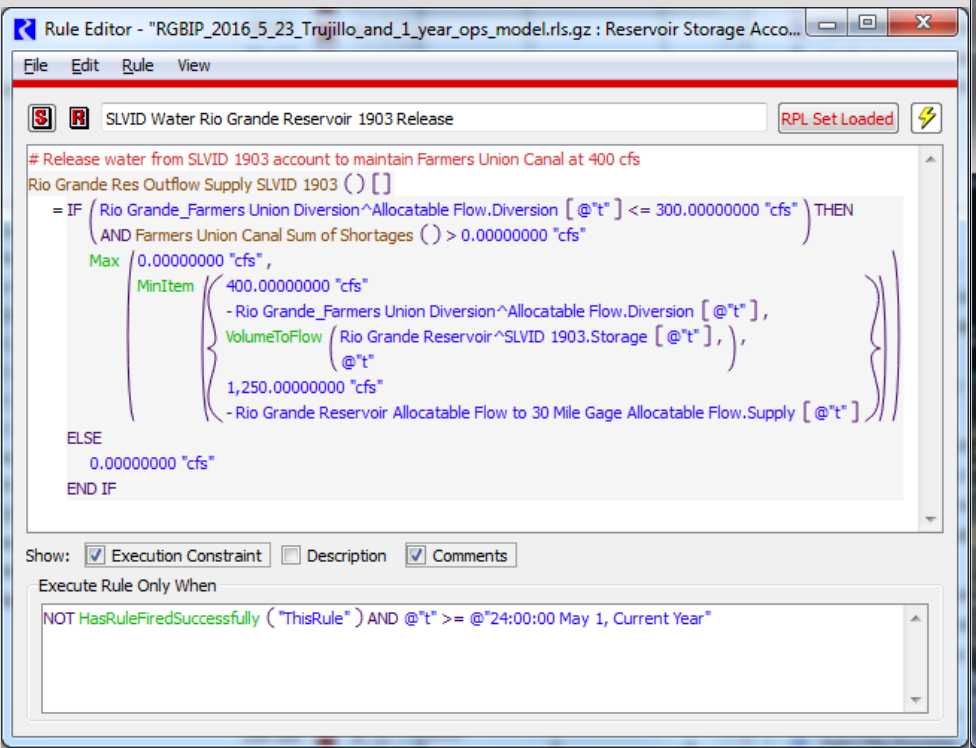
- DMI Manager, Snapshots, MRM
- For our purposes, water rights, hydrologic data, user demand, etc. is completely user supplied

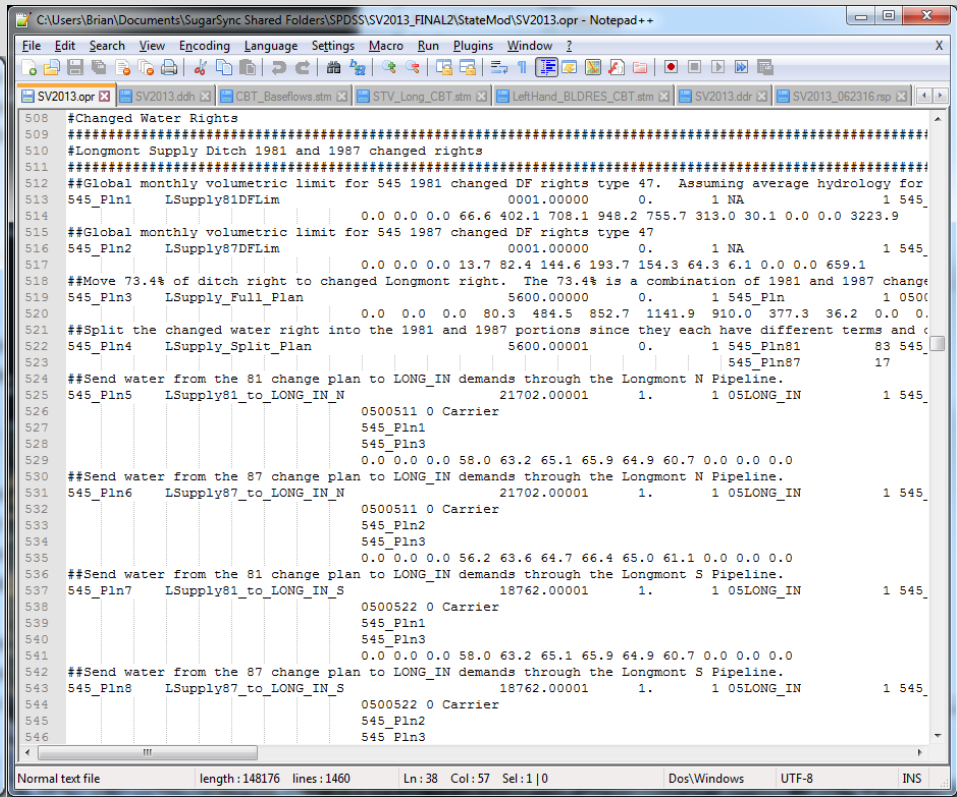




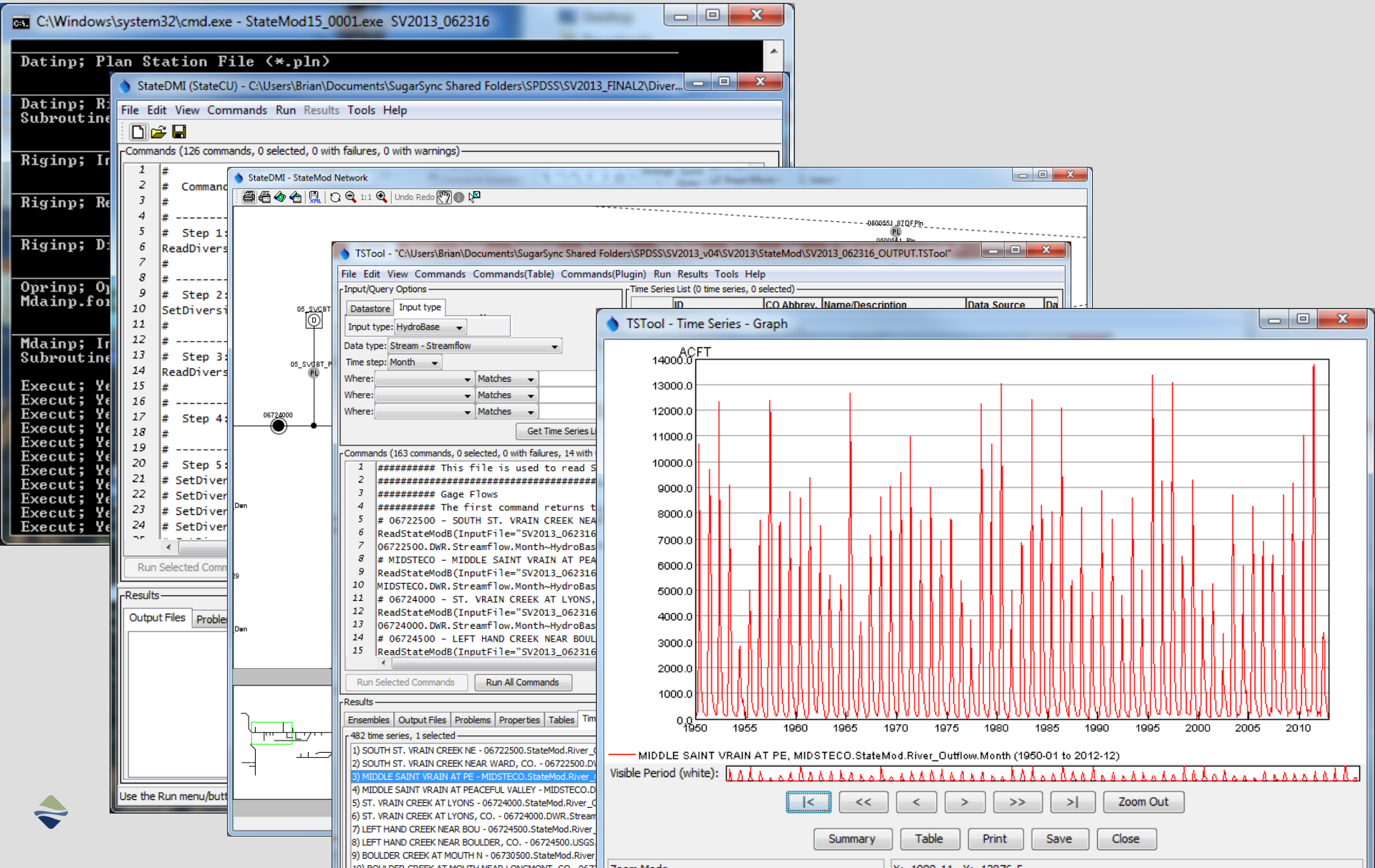
Operational Flexibility

- **RiverWare** uses RPL – extremely flexible!
- **StateMod** uses modified priority system that intertwines water right administration number (Colorado) and operating rule order
  - Operating Rules and Plans are strictly controlled

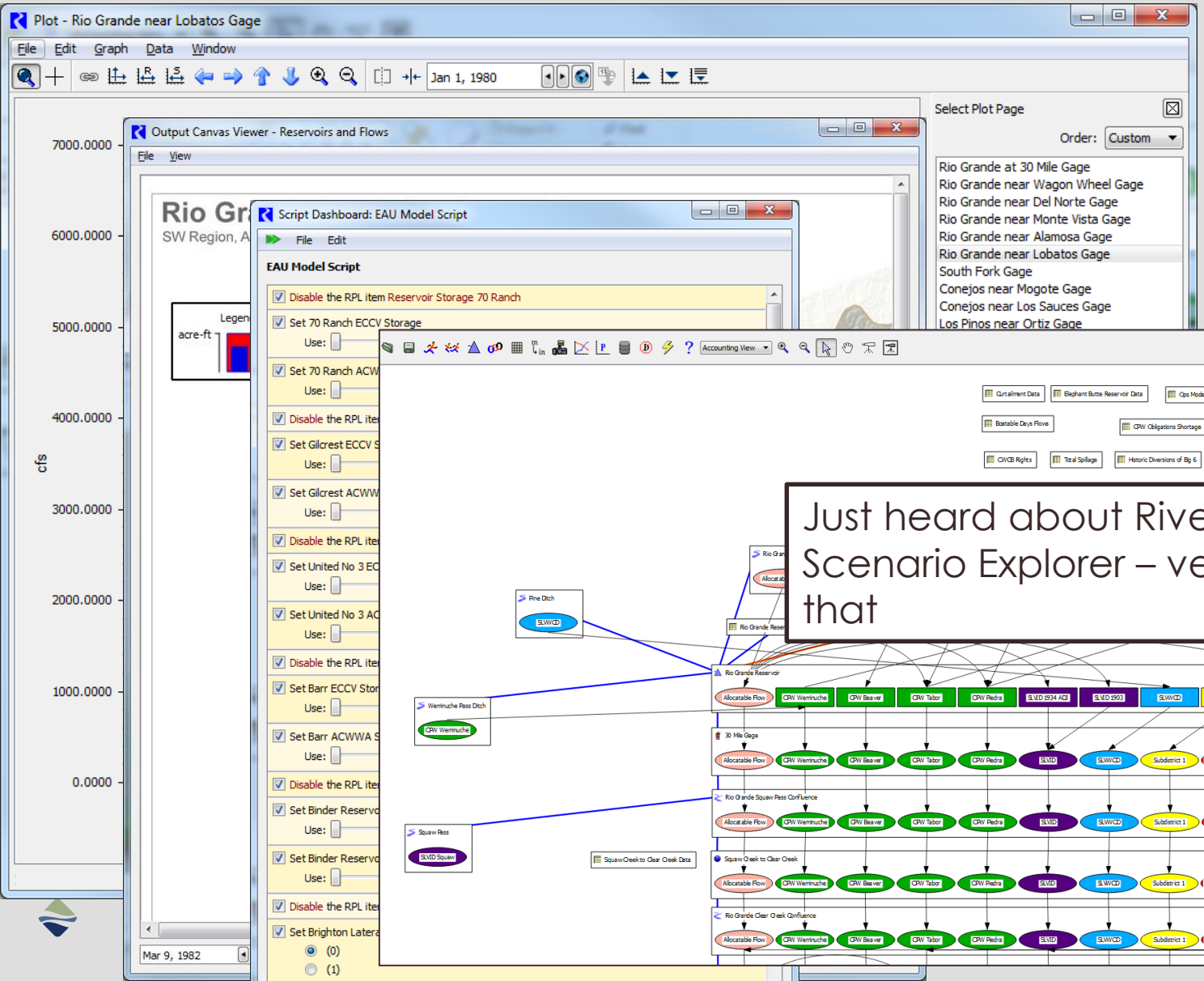




GUI/Output and Visualization - StateMod



GUI/Output and Visualization - RiverWare



Just heard about RiverWare Scenario Explorer – very excited for that

Debugging – StateMod

"The Call" on the river (the most junior water right diverting) is a main feature of the output

C:\Users\Brian\Documents\SUGARSYNC SHARED FOLDERS\SPDSS\SV2013_FINAL2\StateMod\SV2013_062316....

File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

LeftHand_BLDRES_CBT.stm | SV2013.ddr | SV2013_062316...

```
2372321   GetFile; Opening River_Network
2372322     SV2013.rin
2372323
2372324   GetVer; File name     = SV2013.rin
2372325           File version = 0
2372326
2372327   Datinp; Number of Network Station
2372328    Datinp; ioutN @ line 1053  0
2372329
2372330
2372331   Datinp; Reservoir Station File (*
2372332
2372333   GetFile; Opening Reservoir_Static
2372334     SV2013.res
2372335
2372336   GetVer; File name     = SV2013.res
2372337           File version = 0
2372338
2372339   GetRes; Reservoir Station File (*
2372340     SV2013.res
2372341
2372342   GetRes; Warning See *.chk for det
2372343
2372344   GetRes; Number of Reservoirs =
2372345
2372346
2372347   Datinp; Diversion Station File (*
2372348
2372349   GetFile; Opening Diversion_Static
2372350     SV2013.ddsf
2372351
2372352
2372353   GetFile; Problem reading file #
2372354           File name: SV2013.ddsf
2372355   Stopped in GetFile, see log file
2372356
```

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SV2013_062316.xca

```
1   #
2   # _____________________________________________________________________
3   # *.xca       Call Data File
4   #
5   #     1950      : iystr   Starting year of simulation
6   #     2012      : iyend   Ending year of simulation
7   #
8   # Statemod Version: 15.00.01 Date = 2015/10/28)
9   # Run date:           8/15/16 13: 2: 1
10  # Time Step:         Monthly
11  #
12  # _____________________________________________________________________
13
14  Call Summary
15  Note: The calling right is estiamted to be the most senior
16        water right at the calling location that is shorted.
17        If none is reported (NA) it typically occurrs when a
18        structure is diverting at a carrier location, not its
19        physical location
20
21  OutCallR    Year Mon   Day Imcd Call Location  Call Right Call Location Name
22  _________ ____ ___ _____ ____ _____ _____ _____ _____ _____ _____ _____ _____
23  OutCallR    1950 JAN     1  107 0500547          171.2000 OLIGARCHY DITCH
24  OutCallR    1950 JAN     1   90 0500511           28.5000 LONGMONT NORTH PIPELINE
25  OutCallR    1950 JAN     1  120 05LONG_PUMP       -1.0000
26  OutCallR    1950 FEB     1  120 05LONG_PUMP       -1.0000
27  OutCallR    1950 FEB     1   75 0502115_Dwn       -1.0000
28  OutCallR    1950 FEB     1   96 0500526           15.0000 HIGHLAND DITCH
29  OutCallR    1950 FEB     1  136 05_LHVRIN         -1.0000 Left Hand Valley Reservo
30  OutCallR    1950 MAR     1  120 05LONG_PUMP       -1.0000
31  OutCallR    1950 MAR     1  100 0500529           10.0000 SWEDE DITCH
32  OutCallR    1950 MAR     1   90 0500511           28.5000 LONGMONT NORTH PIPELINE
33  OutCallR    1950 MAR     1  145 05LONG_RFOs       -1.0000
34  OutCallR    1950 APR     1  120 05LONG_PUMP       -1.0000
35  OutCallR    1950 APR     1  143 0500575          999.0000 WILLIAMSON DITCH
36  OutCallR    1950 MAY     1   35 0500551            2.0200 PELLA DITCH
37  OutCallR    1950 MAY     1  120 05LONG_PUMP       -1.0000
38  OutCallR    1950 JUN     1   35 0500551            2.0200 PELLA DITCH
39  OutCallR    1950 JUN     1  120 05LONG_PUMP       -1.0000
40  OutCallR    1950 JUL     1  120 05LONG_PUMP       -1.0000
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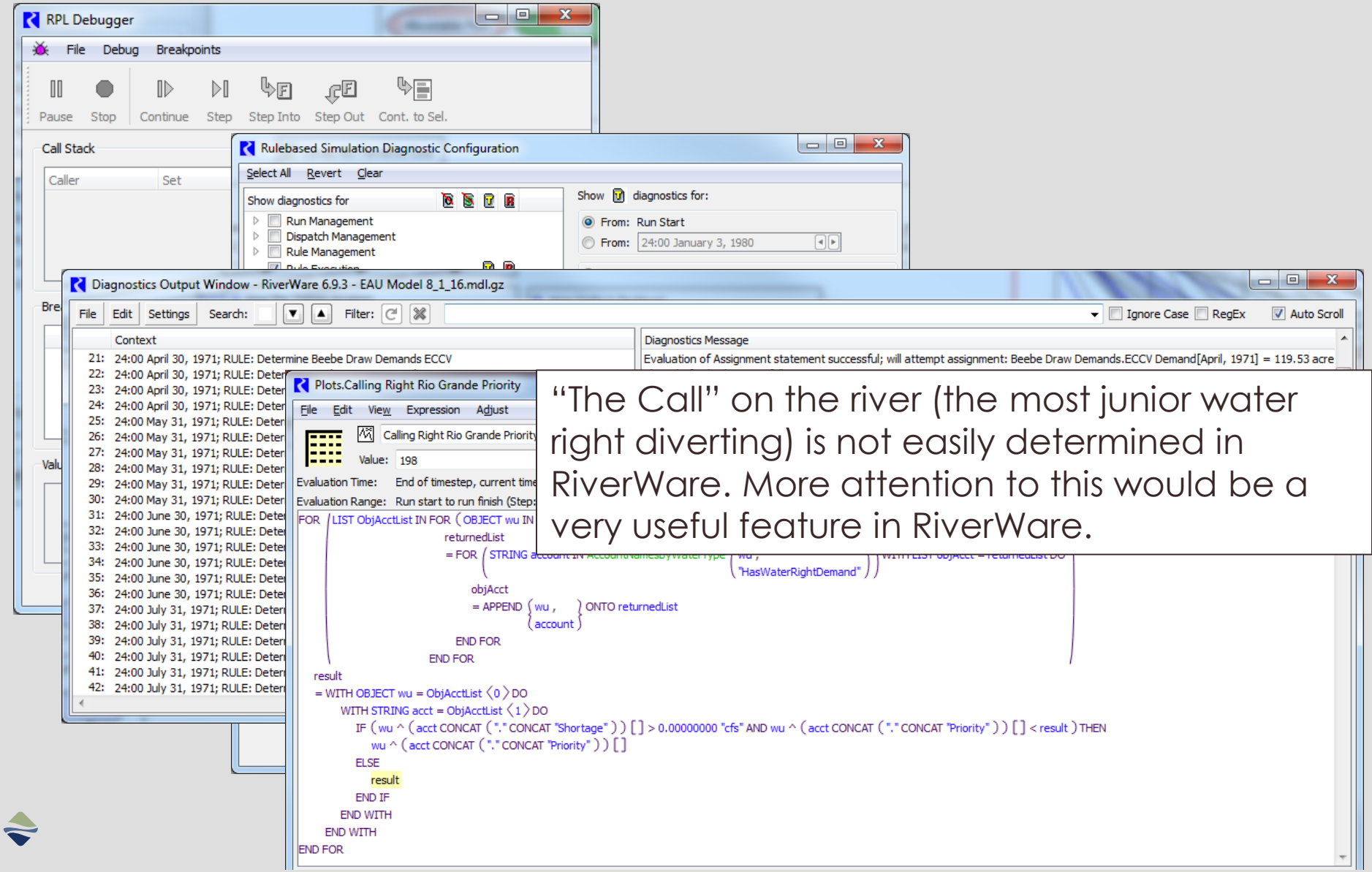
Debugging – RiverWare



"The Call" on the river (the most junior water right diverting) is not easily determined in RiverWare. More attention to this would be a very useful feature in RiverWare.

RiverWare is Appropriate When…

- Operational **flexibility** (RPL) for complex accounting and administration
- **State** and **Federal**-level operations (large-scale)
- Small-scale M&I operations (decree terms, swaps, agreements), irrigation operations (SW/GW, reservoir supply, aug plans), or policy logic (Colorado Rio Grande Compact Curtailment)
- Multiple scenario
- **Visual**ization

StateMod is Appropriate When…

- Drawing heavily on **HydroBase** database of hydrologic data
- Focus on **agricultural** and **M&I** operations
- Generation of base flows
- Data manipulation (fill, regression, scaling, etc.)
- **Cooperative** modeling effort (CDSS)
  - Standardized techniques for ag/M&I operations
- Less wiggle room for scaling larger or smaller
  - State/Federal level not easy to incorporate, too large-scale
  - Municipal operations, decree terms, irrigation operations (SW, GW, aug plans, res supply) too small-scale