Application of Riverware to Deschutes Basin Opportunity Assessment

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Deschutes Case Study Outline

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Project Goal: *Identify opportunities to increase hydropower generation and environmental benefits while avoiding detrimental impacts to other water uses*

- Current Deschutes Basin Models and Data
- Deschutes Modeling Strategy
- Riverware Modeling Steps & Model Status
- Model Validation
- Model Inputs
- Infrastructure and Configuration
- Operations
- Model Outputs
- Model Uncertainties
- Future Projects Activities

Deschutes MODSIM Development - STATUS

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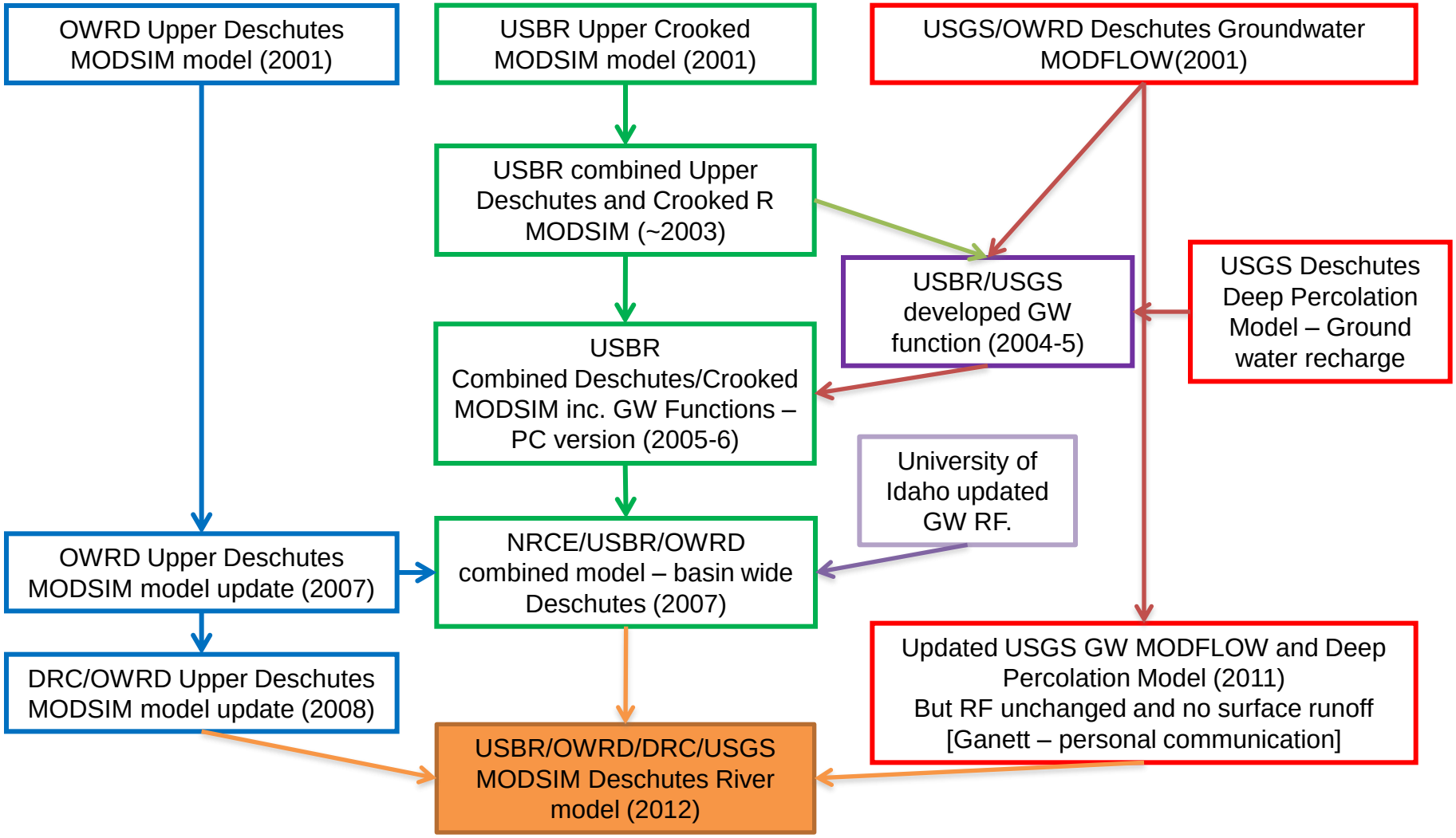
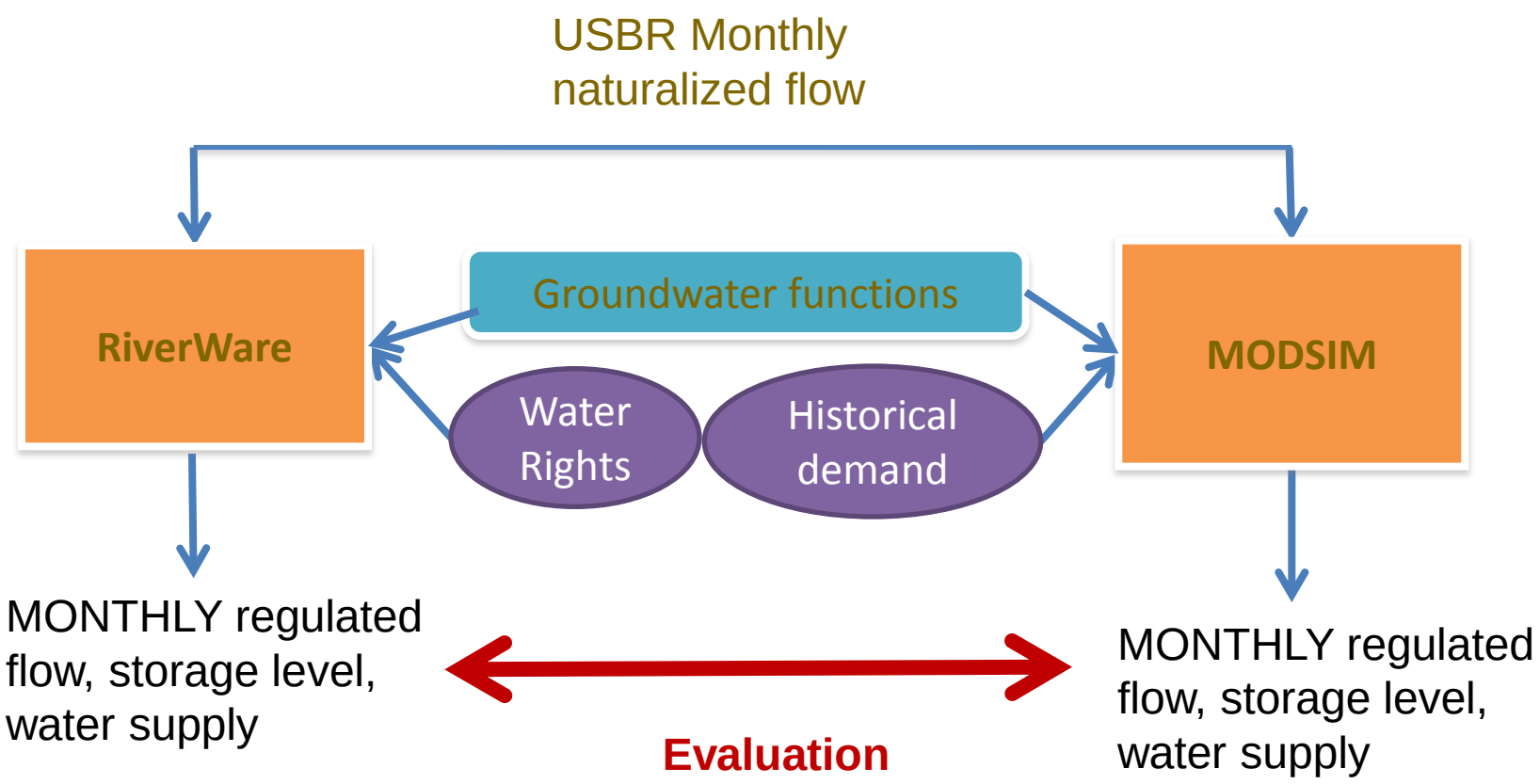


Baseline for BSOA and Monthly RiverWare

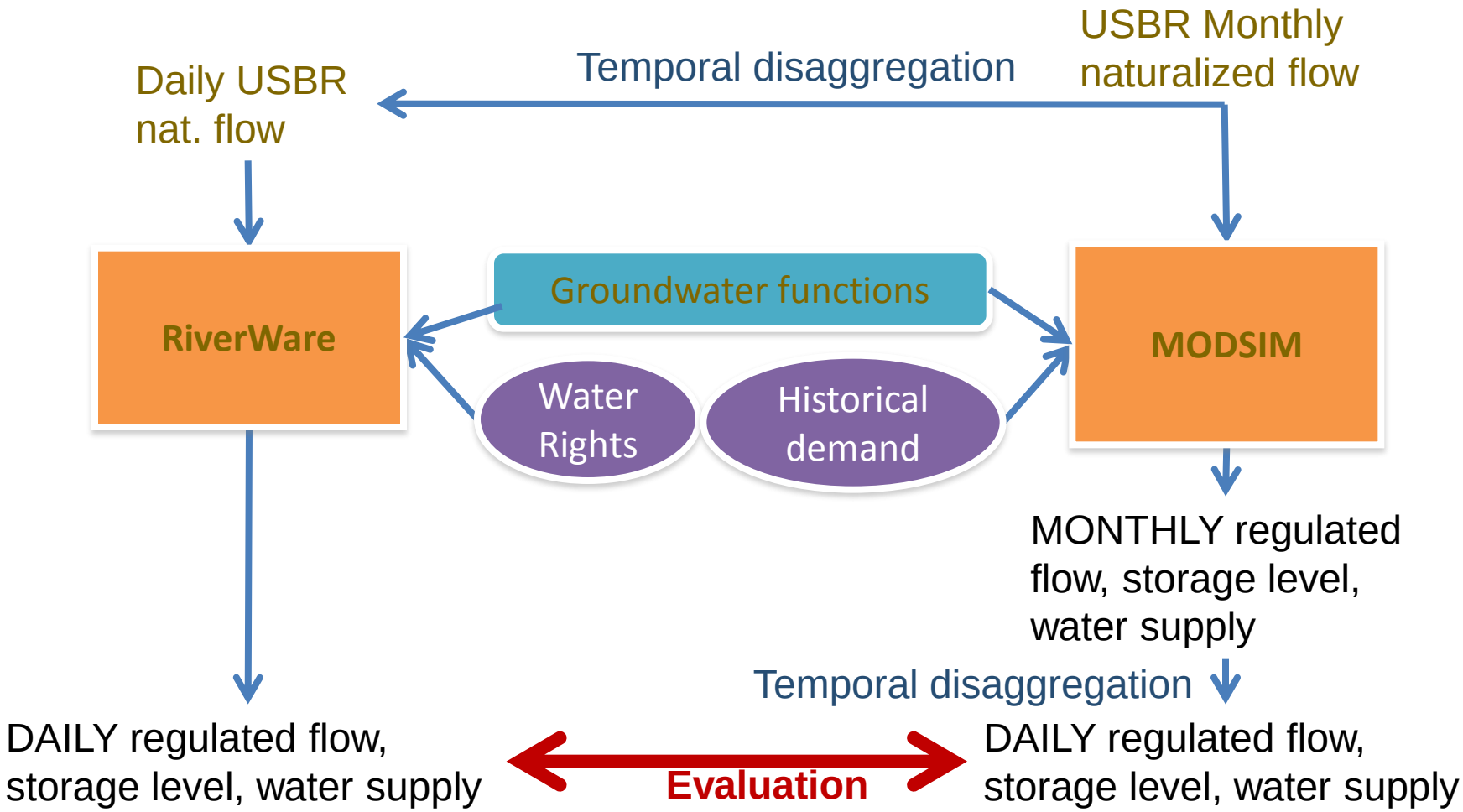
WHY RIVERWARE?

- <u>If we have MODSIM why are we building another model?</u>
- What are the capabilities Riverware offers?
  - Finer temporal scale - daily
    - Environmental Assessment
    - Hydropower
  - Water rights accounting
  - Groundwater interaction
  - Flexible coding for operational rules
  - Data-centered design for model update ease
  - Wide use and recognition

Deschutes Modeling Strategy



Evaluate the Change in Time Scale



Evaluate the Performance of the Daily Model

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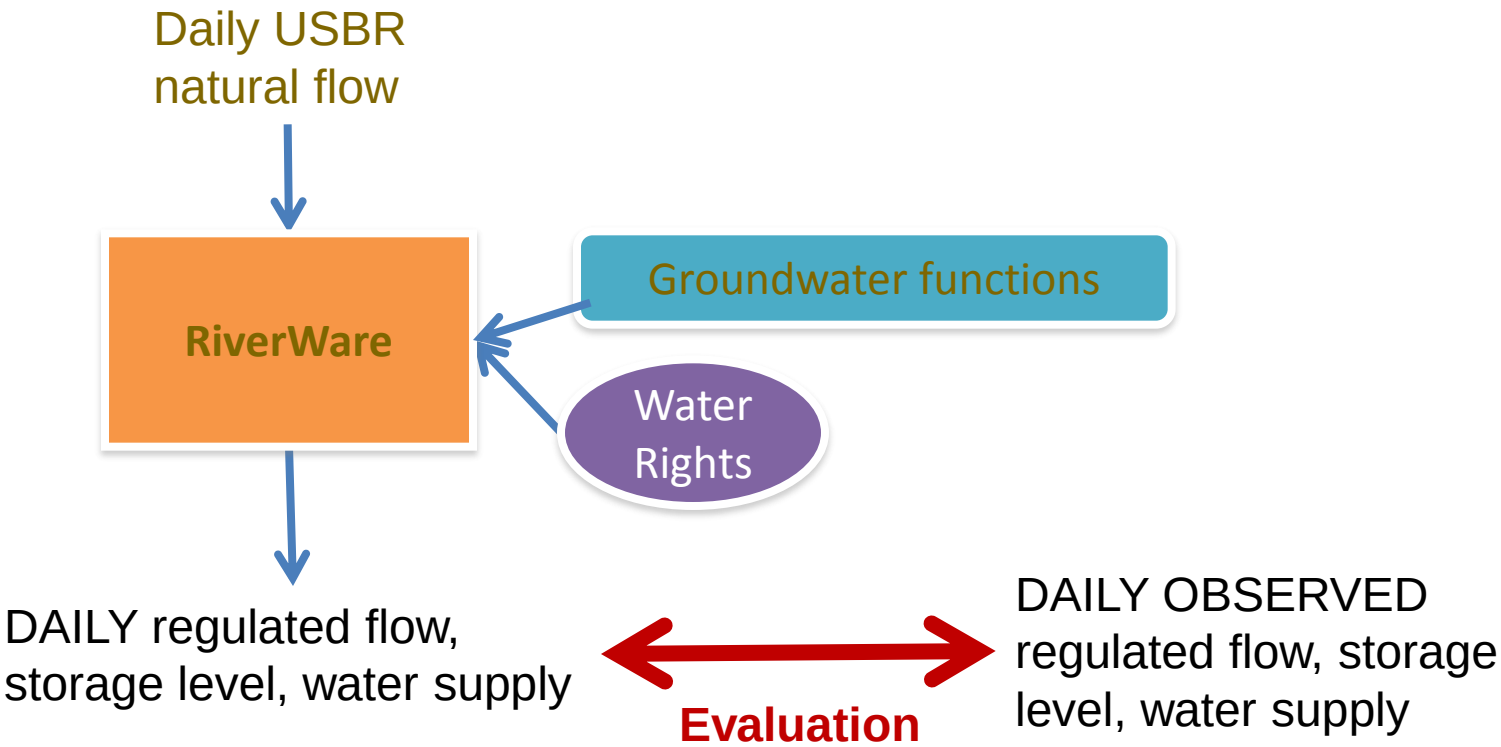
Daily time scale with respect to observations



Model Validation Strategy

- Evaluate the modeling:
  - Monthly time scale using MODSIM as reference
  - Compare with observed data
- Evaluate the change in time scale on the modeling:
  - Daily time step: evaluate RiverWare using temporally disaggregated MODSIM output
- Evaluate performance of the model:
  - Daily time scale using observational data
- Metrics for validation and evaluation are:
  - Discharge
  - Storage
  - Water supply
  - Monthly/daily mean errors; monthly and daily variability; frequency of daily/monthly events

Riverware Modeling Steps

Pure Simulation → Allows for simulating an existing basin condition

Calibration → Insures objects are setup and functioning properly

Rule Base Simulation → To prioritize the "if-then" operating policy and simulations

Calibration → CURRENT PHASE OF THE MODEL

and function properly

Validation → Model can simulate a wide range of flow or simulation cases

Riverware Modeling Steps

Water Accounting Simulation → Logic written to drive operations based on water right. Accounts are managed → Tracks legal ownership of water and bases operation on ownership.

Calibration → Accurately show Shortages in demand based on changes in the Basin

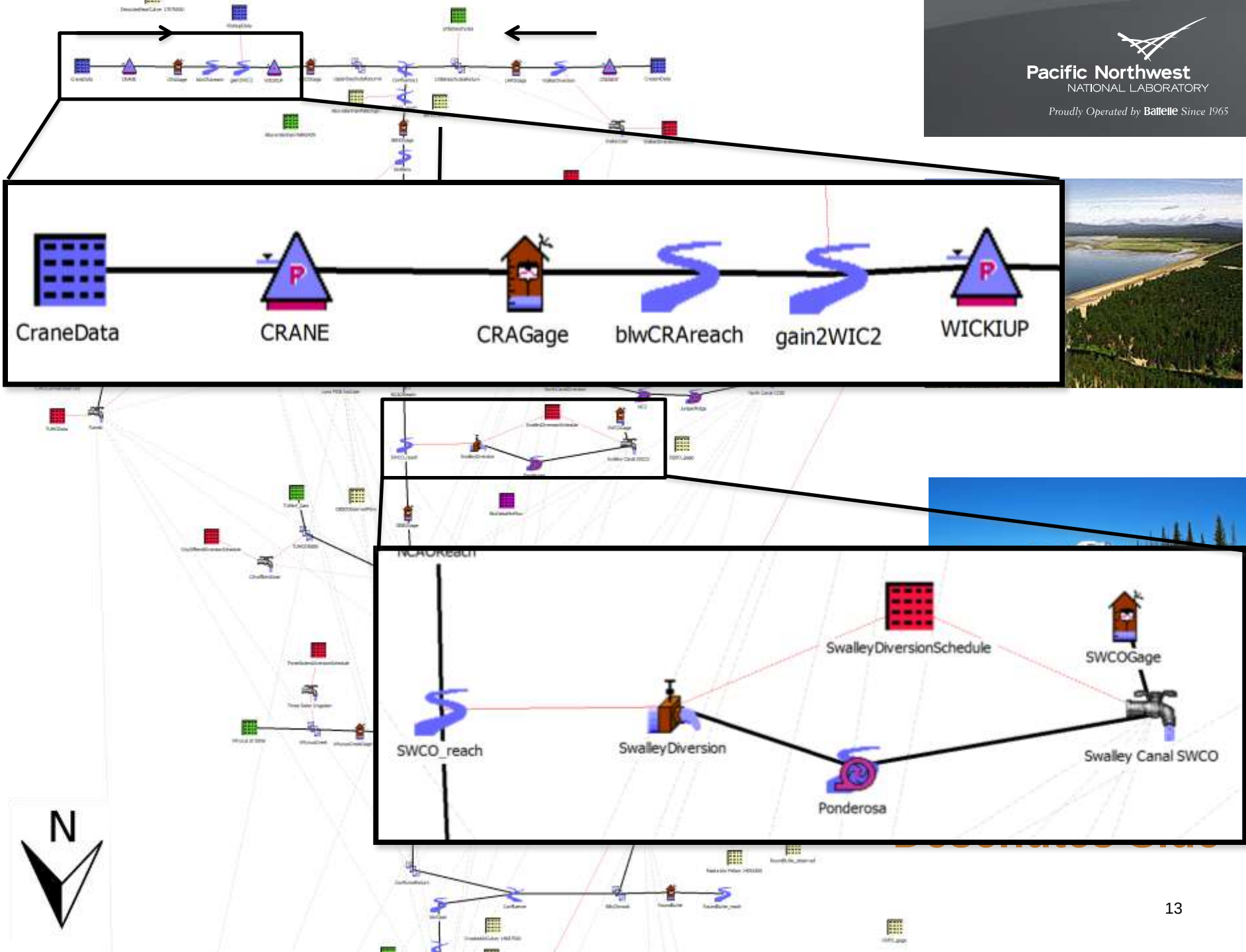
Validation → Compare simulated data with observed data at several time periods → Ensure legal ownership Is properly being simulated for any flow condition

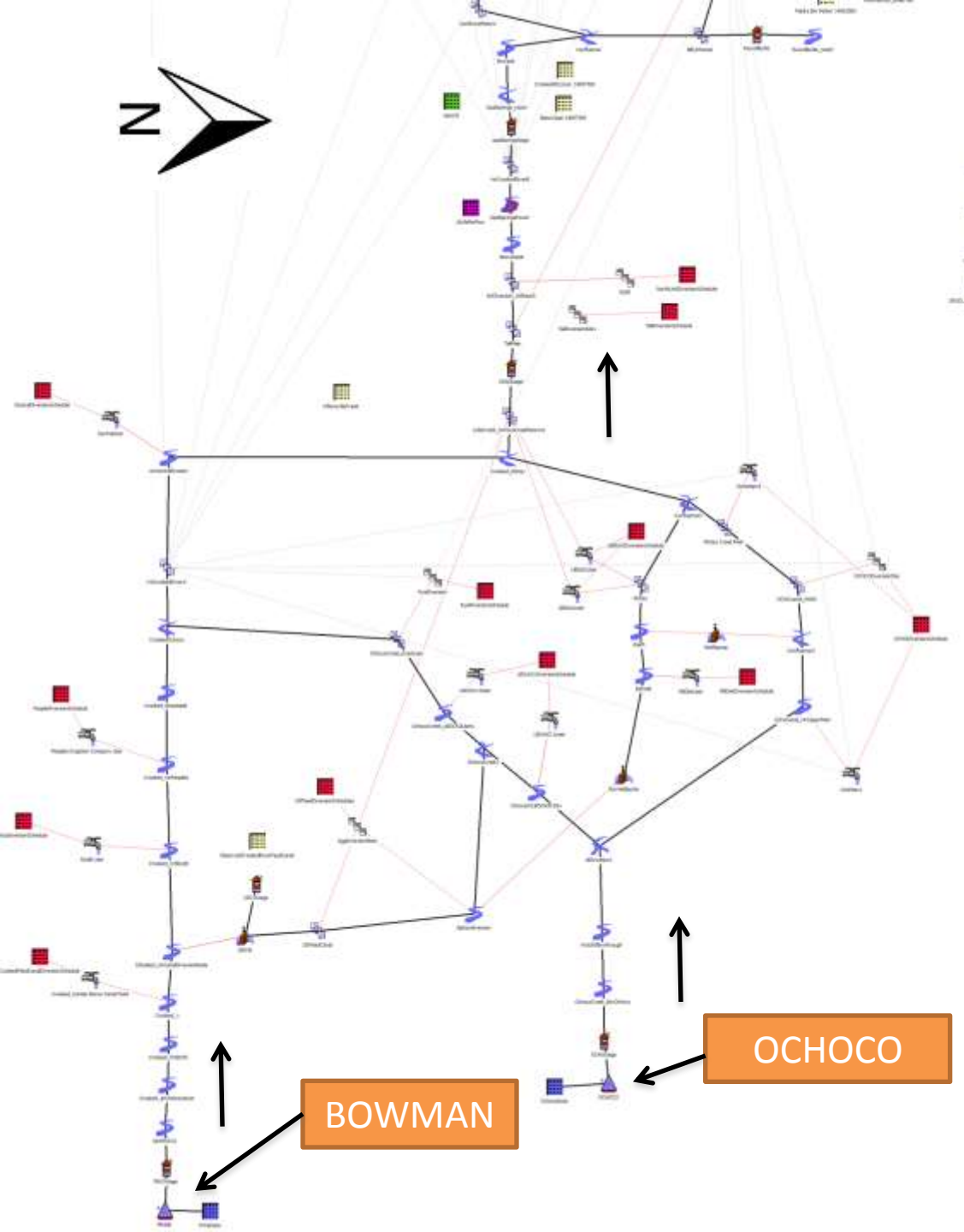
Model Inputs

- Hydrology
  - Naturalized monthly inflows developed for MODSIM were input into a daily sequence from 1928 to 2008
  - A disaggregation technique from USBR & UI is currently being evaluated to develop daily inflow
  - Inflow locations include:
    - Inflow to Crane Prairie, Wickiup, Crescent Lake, Bowman, and Ochoco Dams
    - Significant Tributaries: Little Deschutes, Tumalo Creek, Whychus Creek, and Metolius River
    - Sideflow locations: above Benham Falls on Deschutes, and below Opal Springs

Model Infrastructure

- Groundwater:
  - 50-year lag for return flow and was developed by USBR/USGS with MODFLOW
  - Each irrigation canal has between 3 to 15 return flow locations
  - Groundwater storage was not considered in modeling scope
- Dams:
  - Crane Prairie, Wickiup, Crescent Lake, Bowman, Ochoco
    - All include hydropower capacity
- Diversion/Water Users:
  - 28 diversions from Arnold, Central Oregon, North Unit, Ochoco, Three Sister, Swalley, Lone Pine and Tumalo irrigation districts
- Hydropower:
  - 8 locations: Opal Springs, Siphon, Juniper Ridge, Ponderosa, Monroe Drop, Mile 45, Mile 51, and NC-2
- Pumping Stations:
  - Ochoco Relift and Barnes Butte


CraneData
CRANE
CRAGage
blwCRAreach
gain2WIC2
WICKIUP
SwalleyDiversionSchedule
SWCOGage
SWCO_reach
SwalleyDiversion
Swalley Canal SWCO
Ponderosa
N

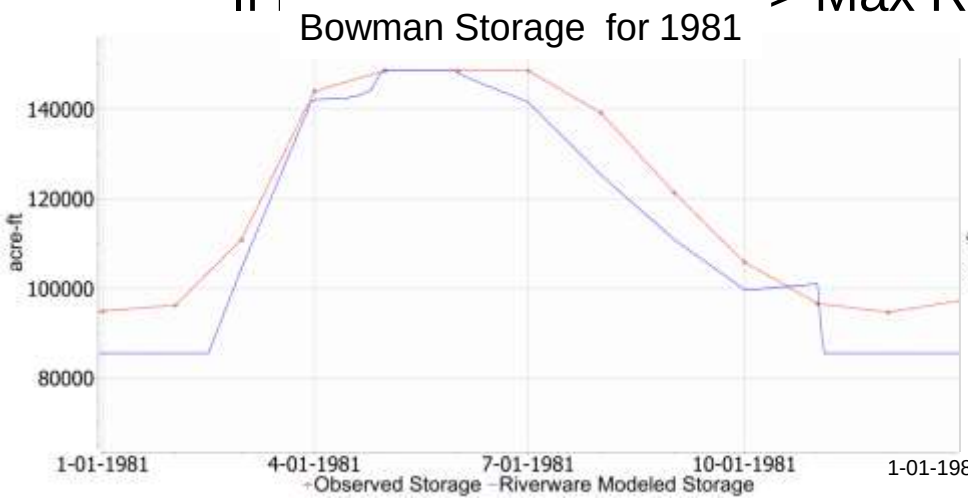


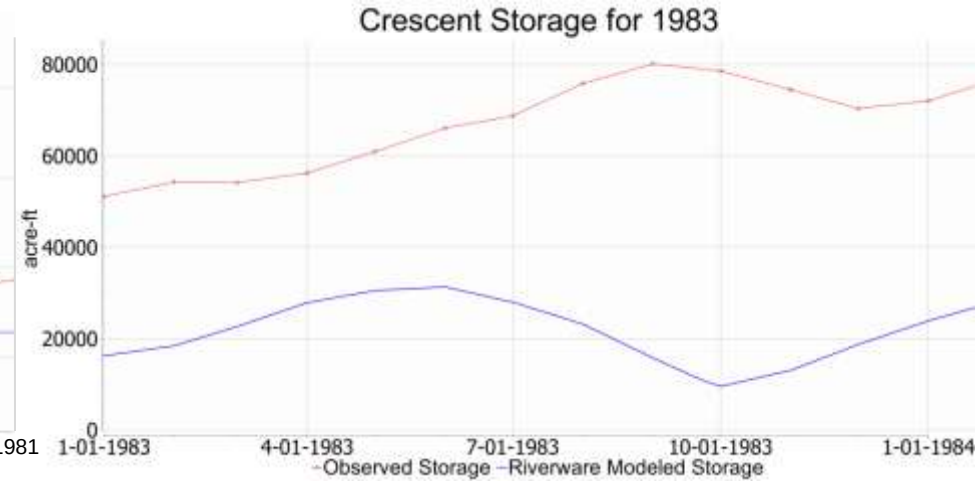
Model View: Crooked River

Reservoir Operations

- Operations are driven by rules in most Riverware models

If Reservoir Storage(t) > Max Reservoir Storage:





- Model accuracy depends on how well you define these operations

Accurate Rules

Insufficient Rules

Current Model Reservoir Operations

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Bowman and Ochoco Dams

- Flood control releases were set by storage criteria from USBR and USACE
- Irrigation release are made during Irrigation season
- Minimum environmental release

Crescent Lake Dam

- Supplemental irrigation releases are made for Tumalo irrigation district
- Minimum environmental flow releases
- Non-irrigation season releases are only made if the reservoir is full and must pass inflow

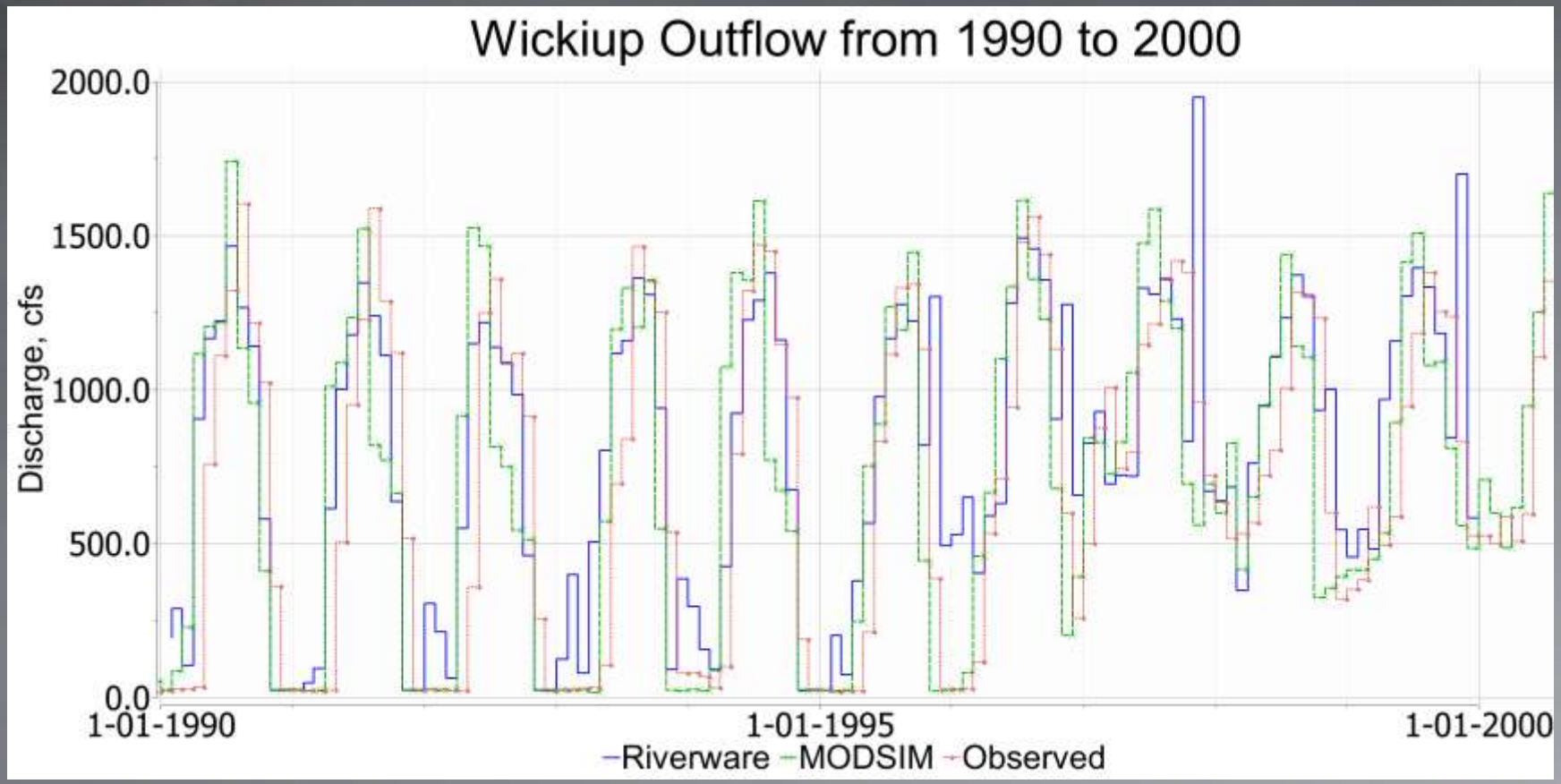
Current Model Reservoir Operations

- **Wickiup and Crane Prairie Dams**
  - Operations are in tandem based on the IDA of 1938
  - Crane will only release non-irrigation flows if the reservoir is full and must pass inflow
  - In wet years during non-irrigation season:
    - Crane fills to maximum while releasing minimum required flows due to significant seepage.
    - Wickiup then fills until storage maximum while releasing minimum flows.
  - In dry years during non-irrigation season:
    - Wickiup fills first and then Crane Prairie.
  - Wickiup is also responsible for meeting minimum flows below Bend

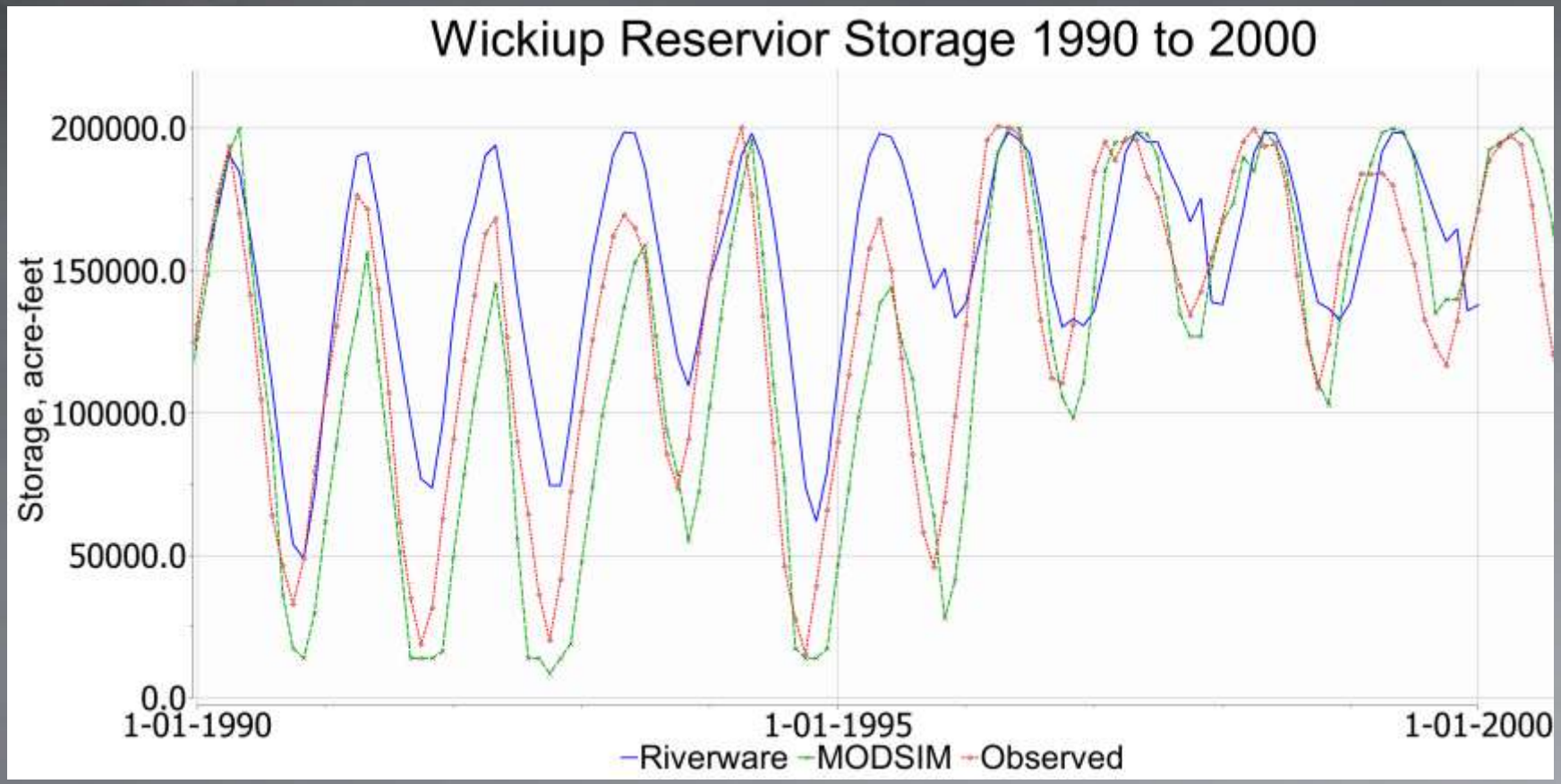
Source of Model Uncertainties

- Flow:
  - Monthly inflow into reservoirs
  - Daily gains
  - Groundwater
    - Valid at the daily time scale
    - Spatial variability uncertainty:
      -> the number of reaches in RiverWare was increased
- Operations:
  - Unofficial agreements
  - Other operations
- Demands:
  - All linked together
  - Monthly data

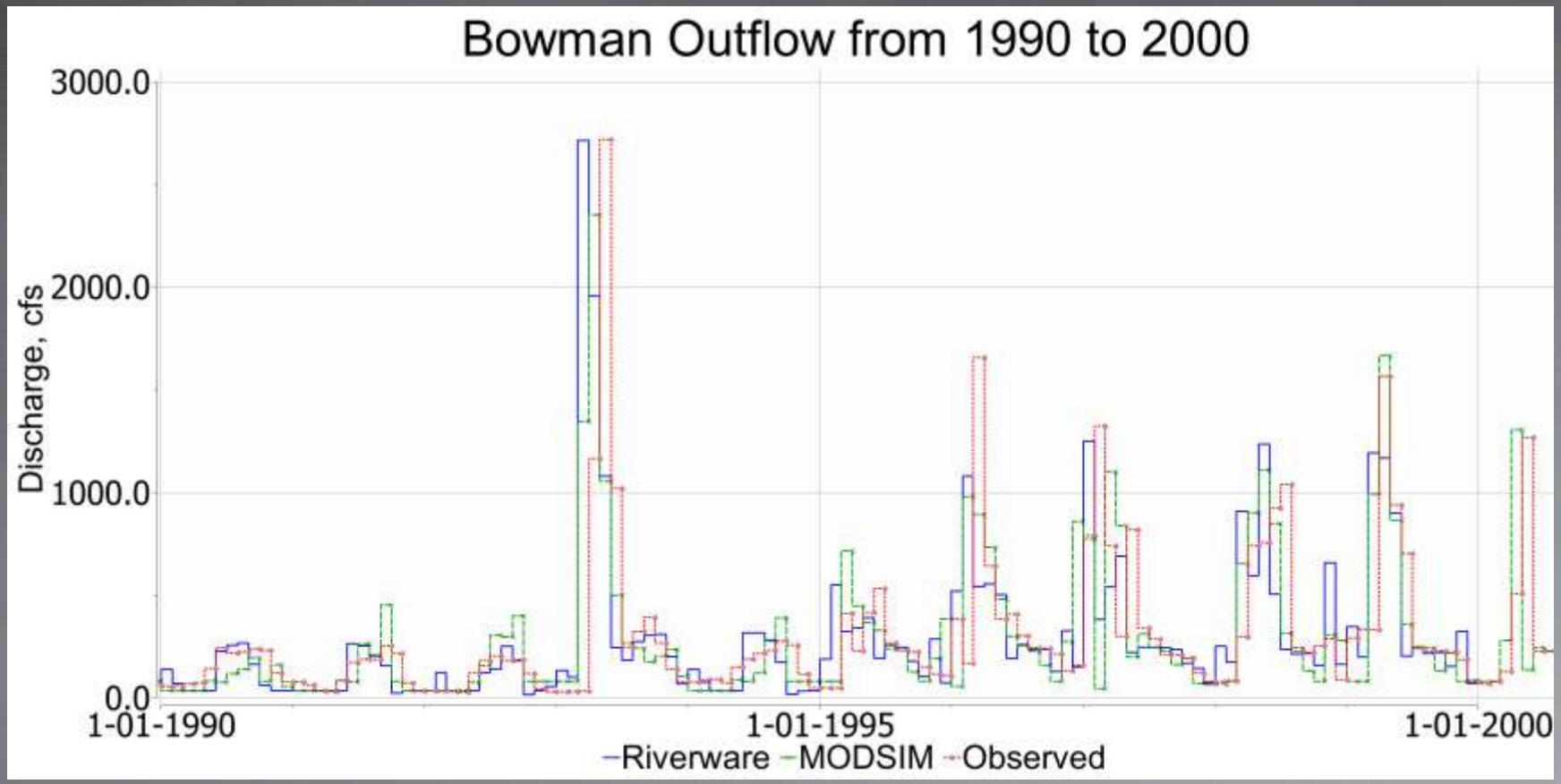
Model Outputs – Wickiup Outflow



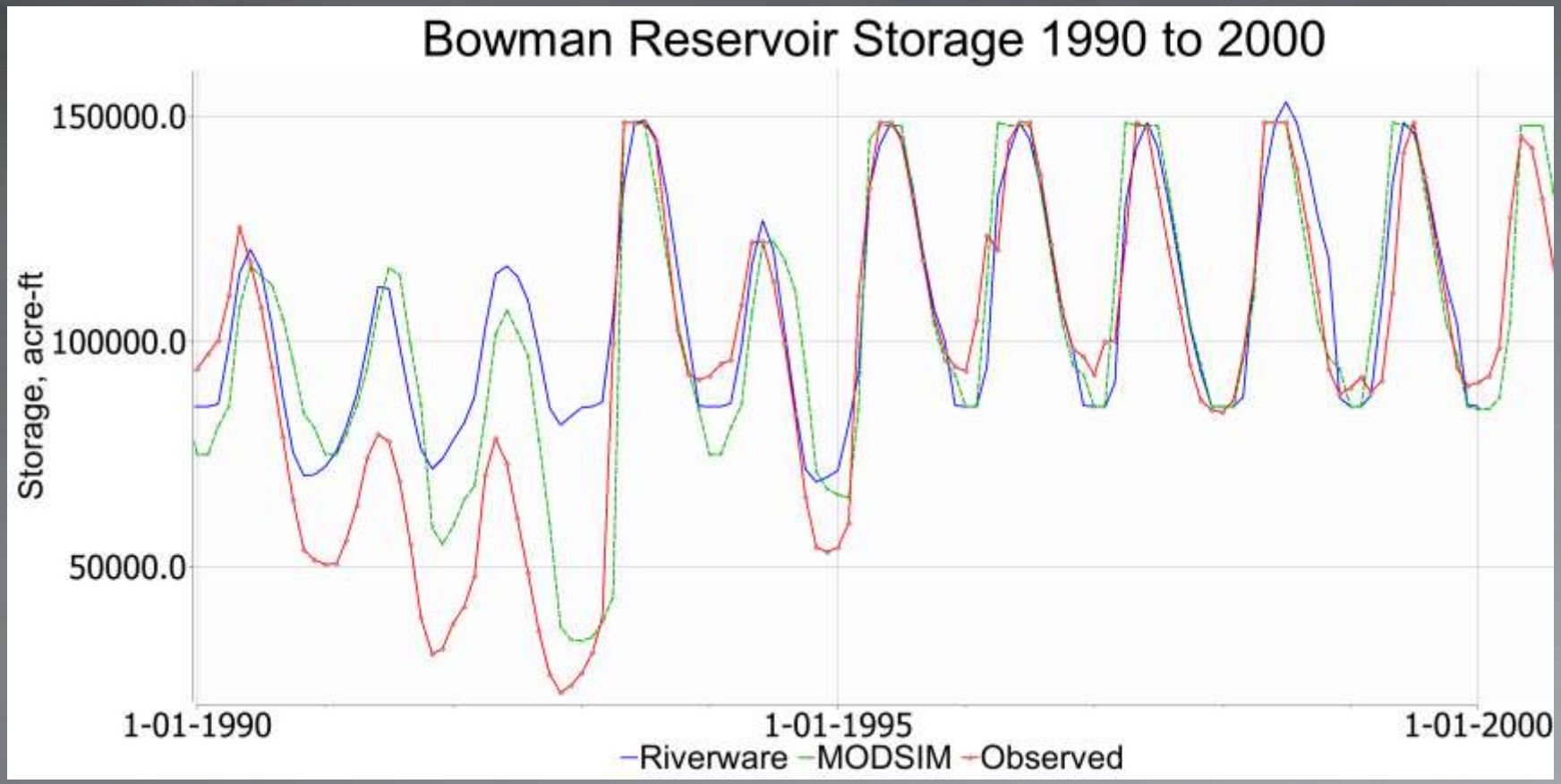
Model Outputs – Wickiup Storage



Model Outputs – Bowman Outflow

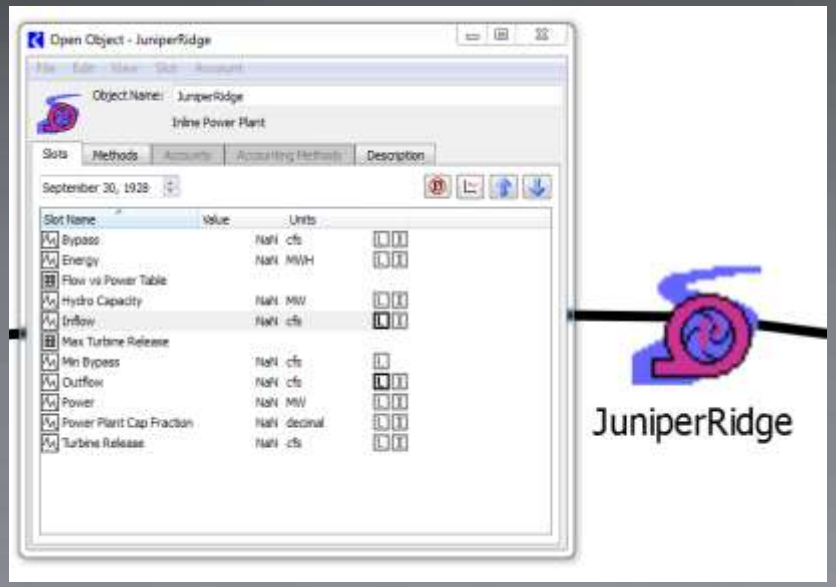


Model Outputs – Bowman Storage



Model Outputs

- Energy for all power objects (MWH)
- Diversion request and storages (cfs)
- Water accounting for all object
- Groundwater losses (cfs)
- Output file capabilities:
  - Plots
  - Excel format (.xlxs or .csv)
  - Riverware format file (.rdf)



Results

- Monthly trends are relatively being captured
- Wet years are simulated better then dry years
- Improvements that need to be made:
  - Flood control releases need more detailed information for Crane and Wickiup
  - Wickiup needs more flexible rules during the irrigation season for simulations of increased baseline flow conditions
  - Refine rules to better capture dry years

Future Activities for 2013

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- Continue to work with OWRD & USBR to fine-tune reservoir operations
- Validate model at monthly and daily scale
- Increase detail for power generation equations
- Implement and validate water rights accounting model
- Model accessibility for other organizations