Ideas Worth Sharing:
Water Management and Environmental Technologies

Why Water Management and Environmental Technologies?

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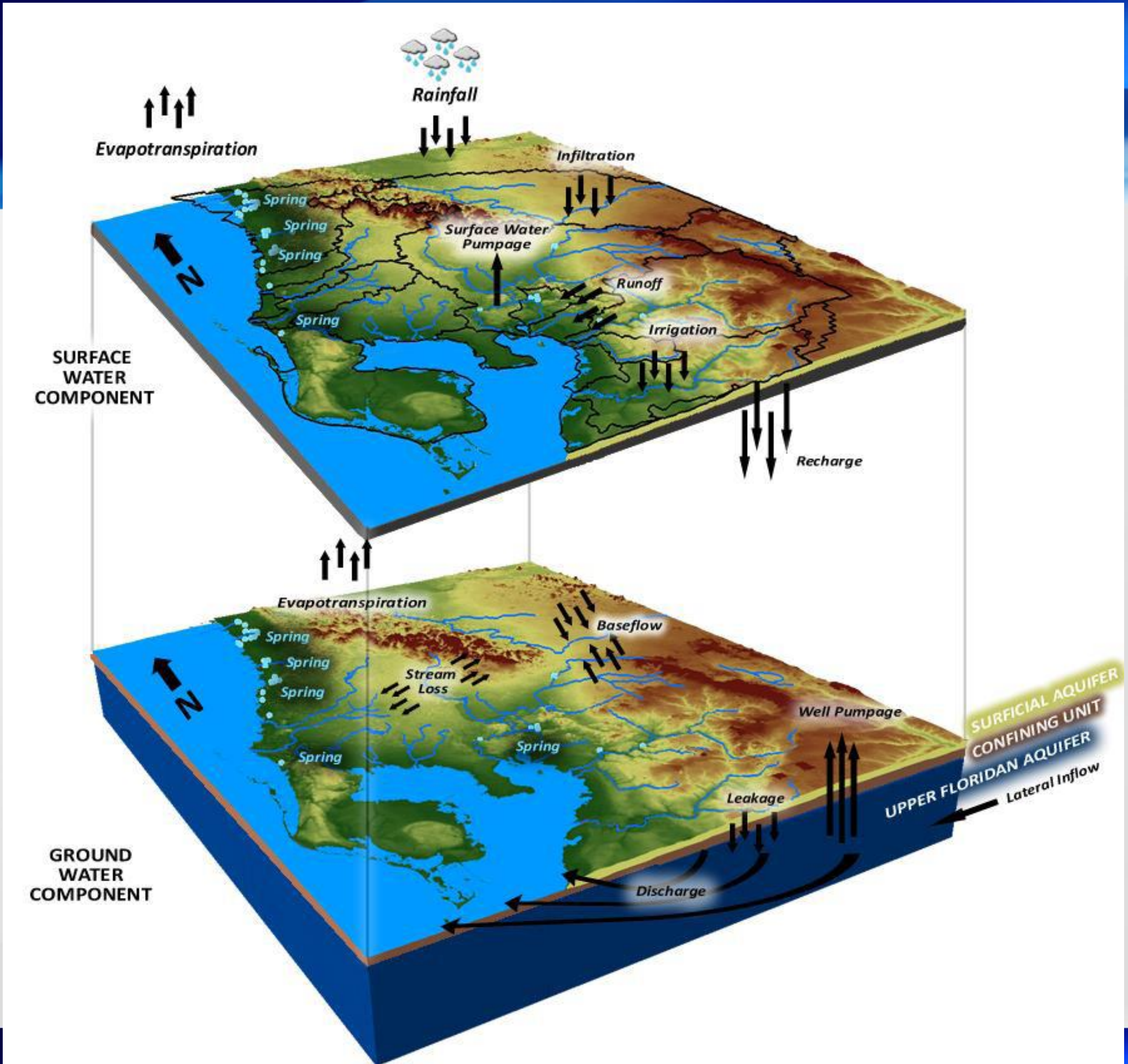
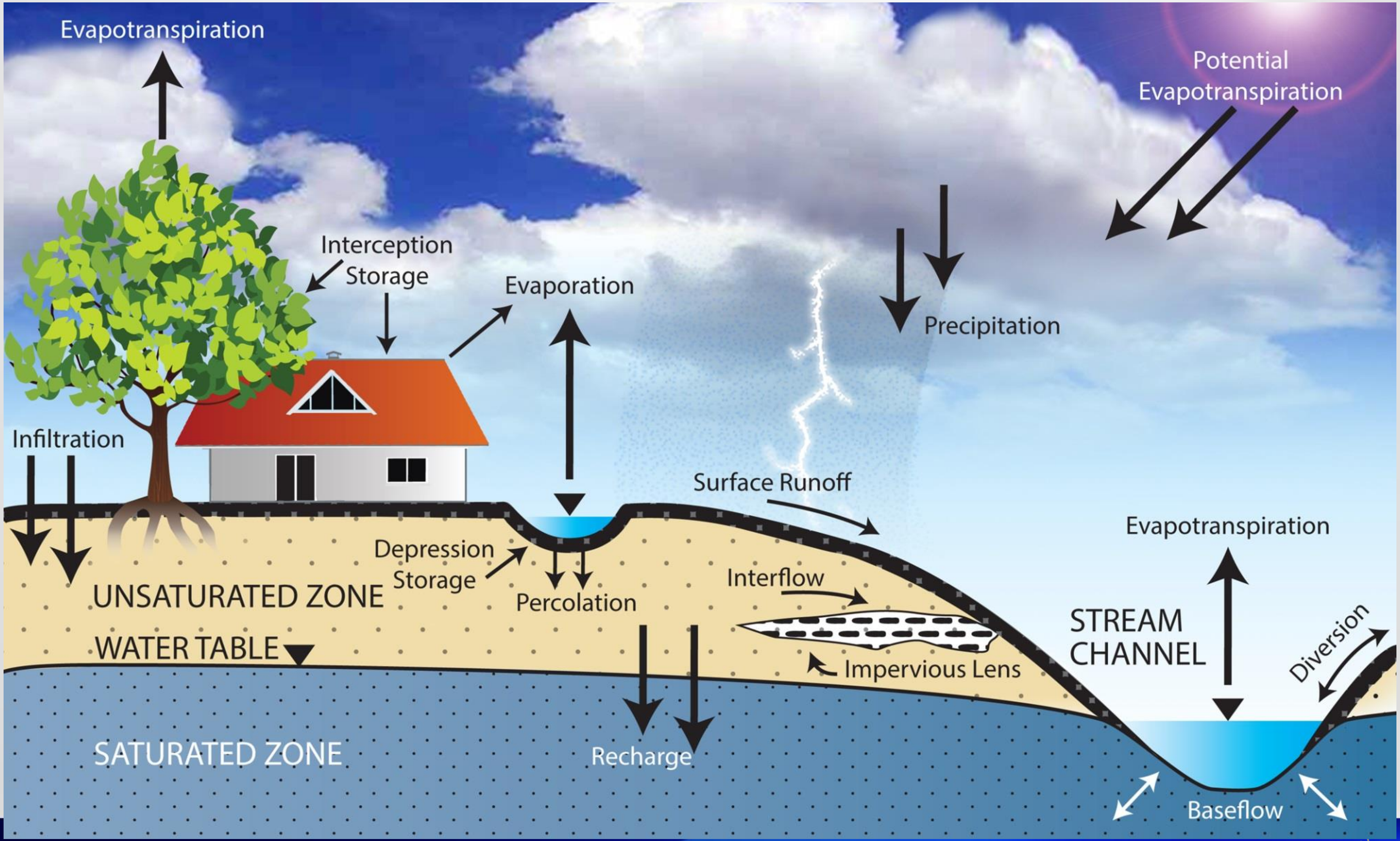
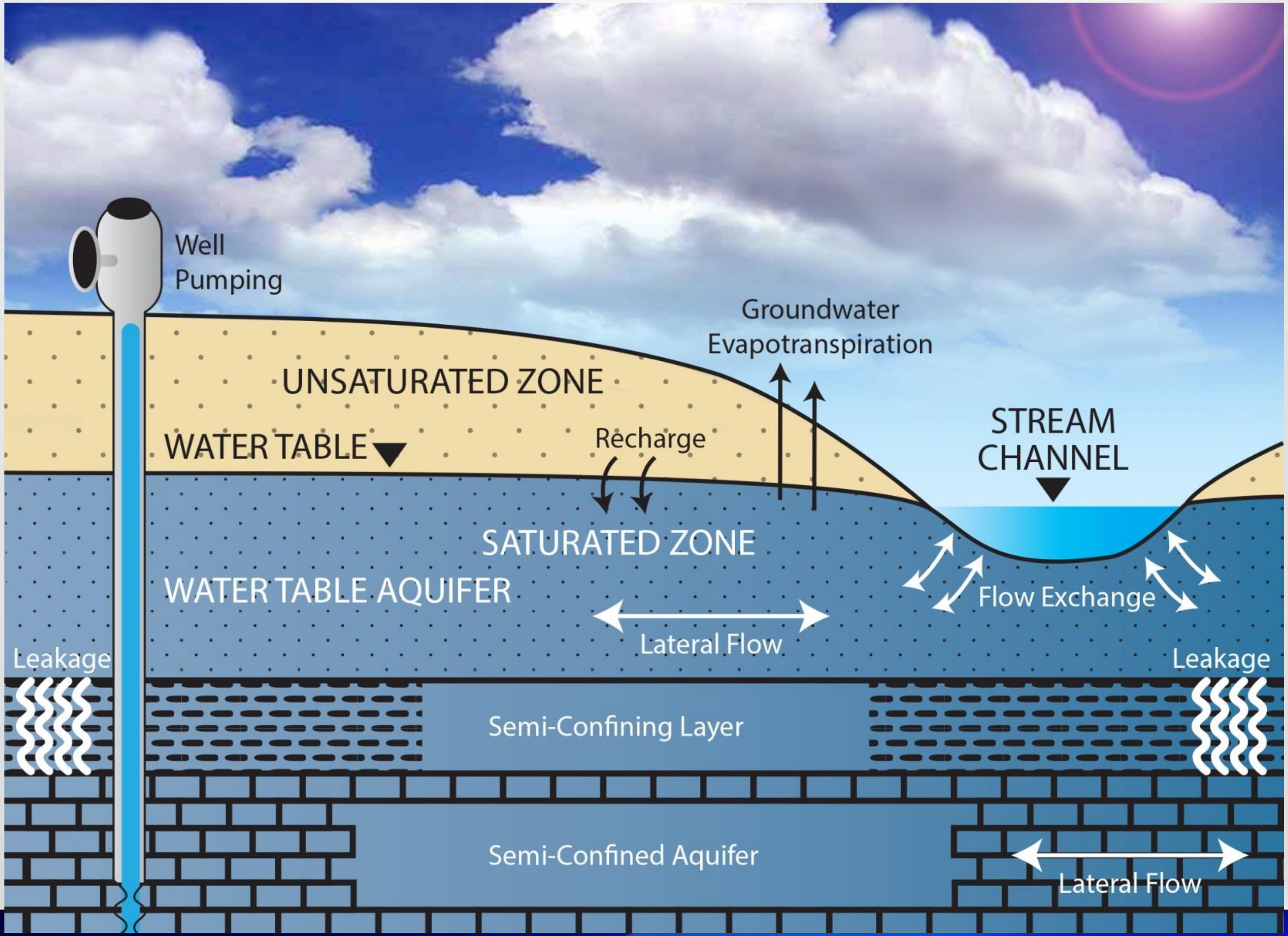

Evapotranspiration
Rainfall
Infiltration
Spring
Spring
Spring
Surface Water Pumpage
Runoff
Spring
Irrigation
SURFACE WATER COMPONENT
Recharge
Evapotranspiration
Baseflow
Spring
Spring
Stream Loss
Spring
Well Pumpage
SURFICIAL AQUIFER
CONFINING UNIT
UPPER FLORIDAN AQUIFER
Lateral Inflow
Spring
Spring
Leakage
GROUND WATER COMPONENT
Discharge

HSPF Primary Processes
Land Segments & Reaches



MODFLOW Primary Processes



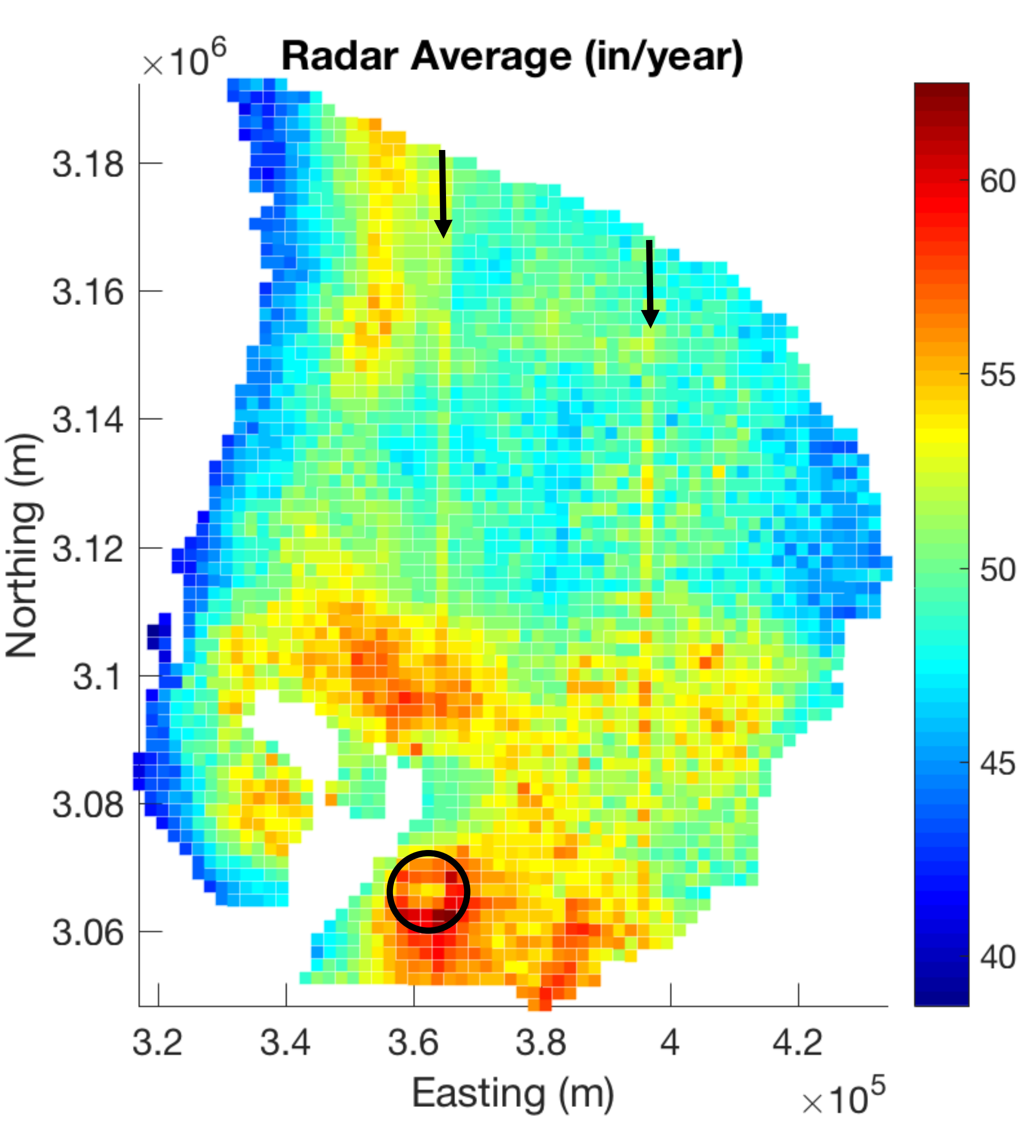
Drivers of the Uncertainty in Water Resources Planning and Management

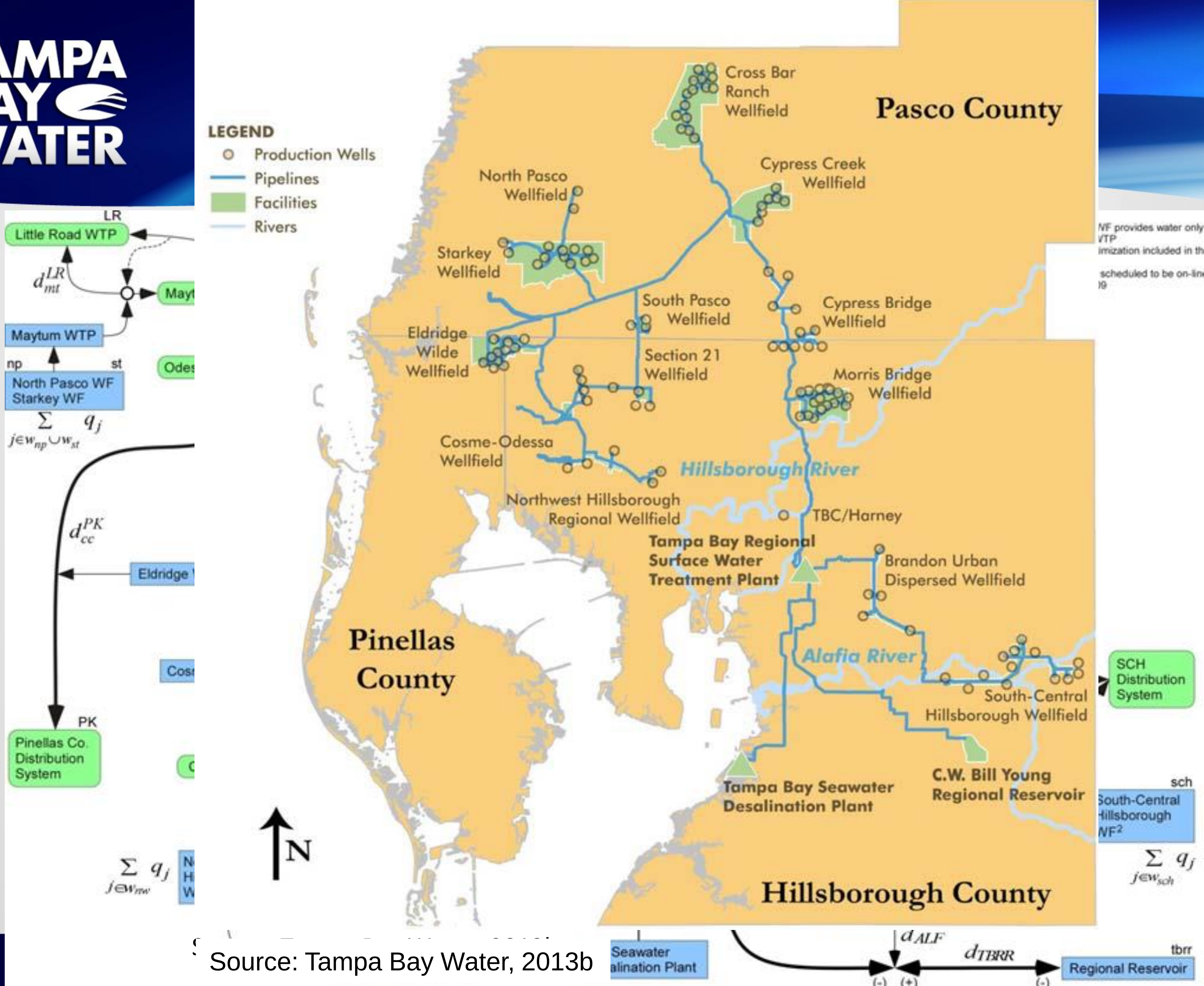
- Climate Change – Temperature
- Major impacts – Rainfall and Evapotranspiration (amount and patterns)
- Hydrologic cycle – new patterns developed, validity of return period (nonstationary, heteroscedasticity)
- Extreme events (Floods and Droughts) – Increase in magnitude and frequency
- Adaptive Management – prepare for the extreme events (Reliability, Resiliency and Vulnerability)
- New infrastructure or new policy on mitigations
- Roles of IoT, Machine Learning, Deep Learning

IoT/Big Data in Water Resources

- Sensors collecting data (SCADA with 1M data points/day)
  - Increase in frequency and number of locations (e.g. from gage rainfall to Doppler Radar rainfall, cellular tower signal)
- Simulation Model
  - Use data to calibrate model
  - Understanding physical system (what if?)
- Linked with optimization (add intelligence) help guiding our decision making
  - Inverse model or parameter estimation
  - Planning and Decision Supports
- Stochastic optimization – Risk/Reliability based design, planning and management

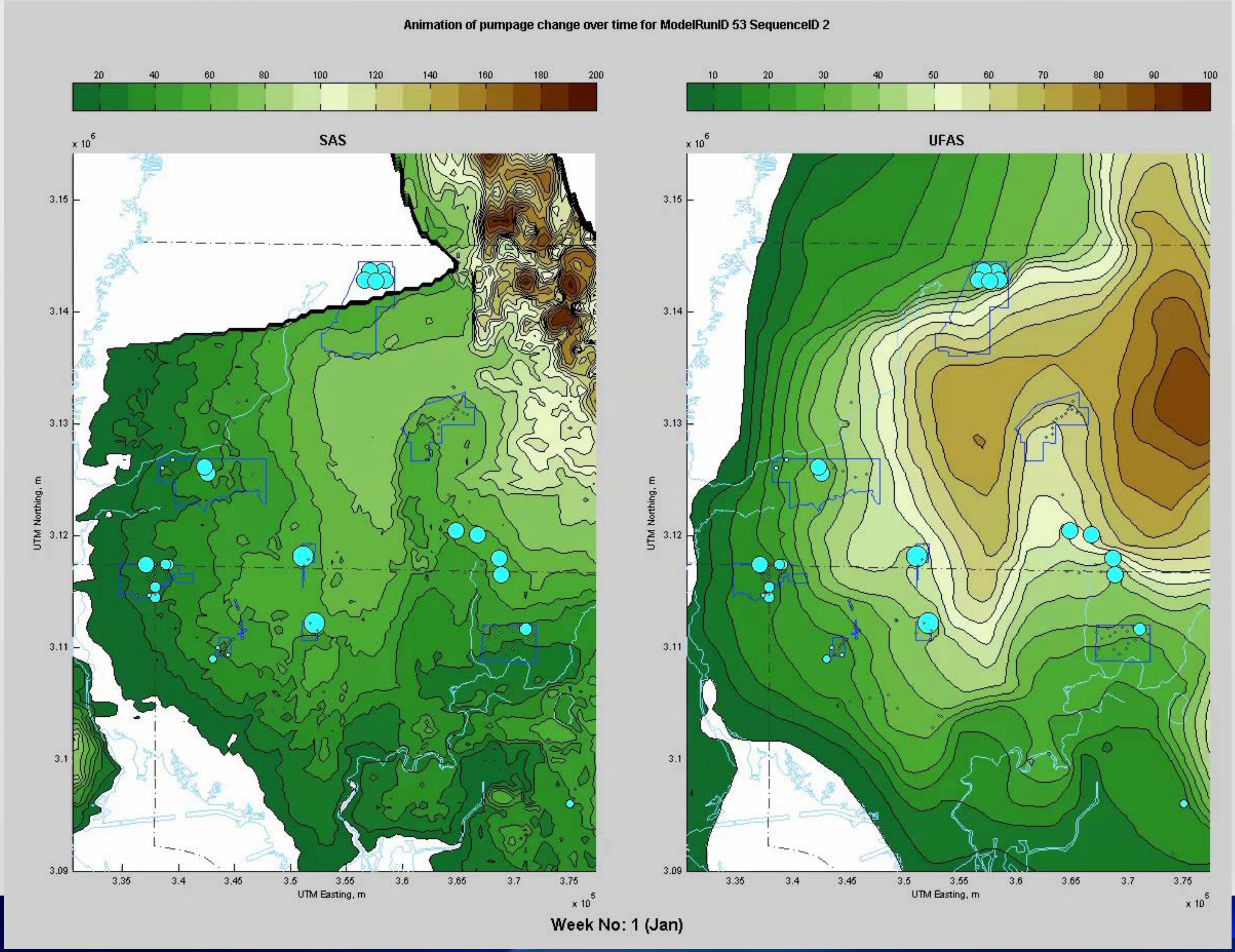
Average NEXRAD rainfall





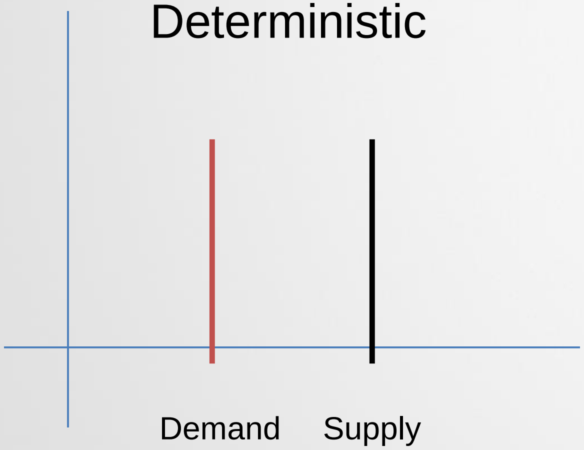
Source: Tampa Bay Water, 2013b

OROP Driven Well and Wellfield Pumping Rotation

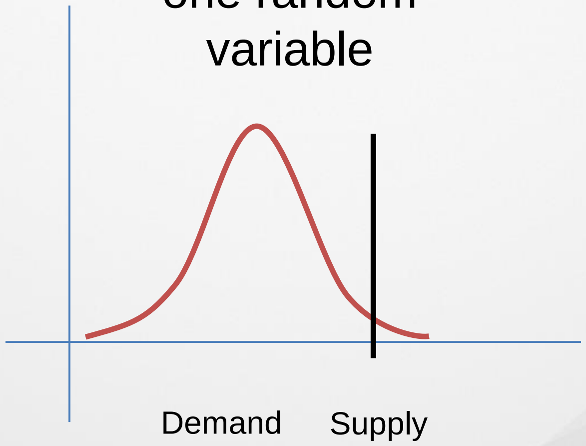


SWRE Model Considering Uncertainties

Deterministic



Stochastic
one random
variable

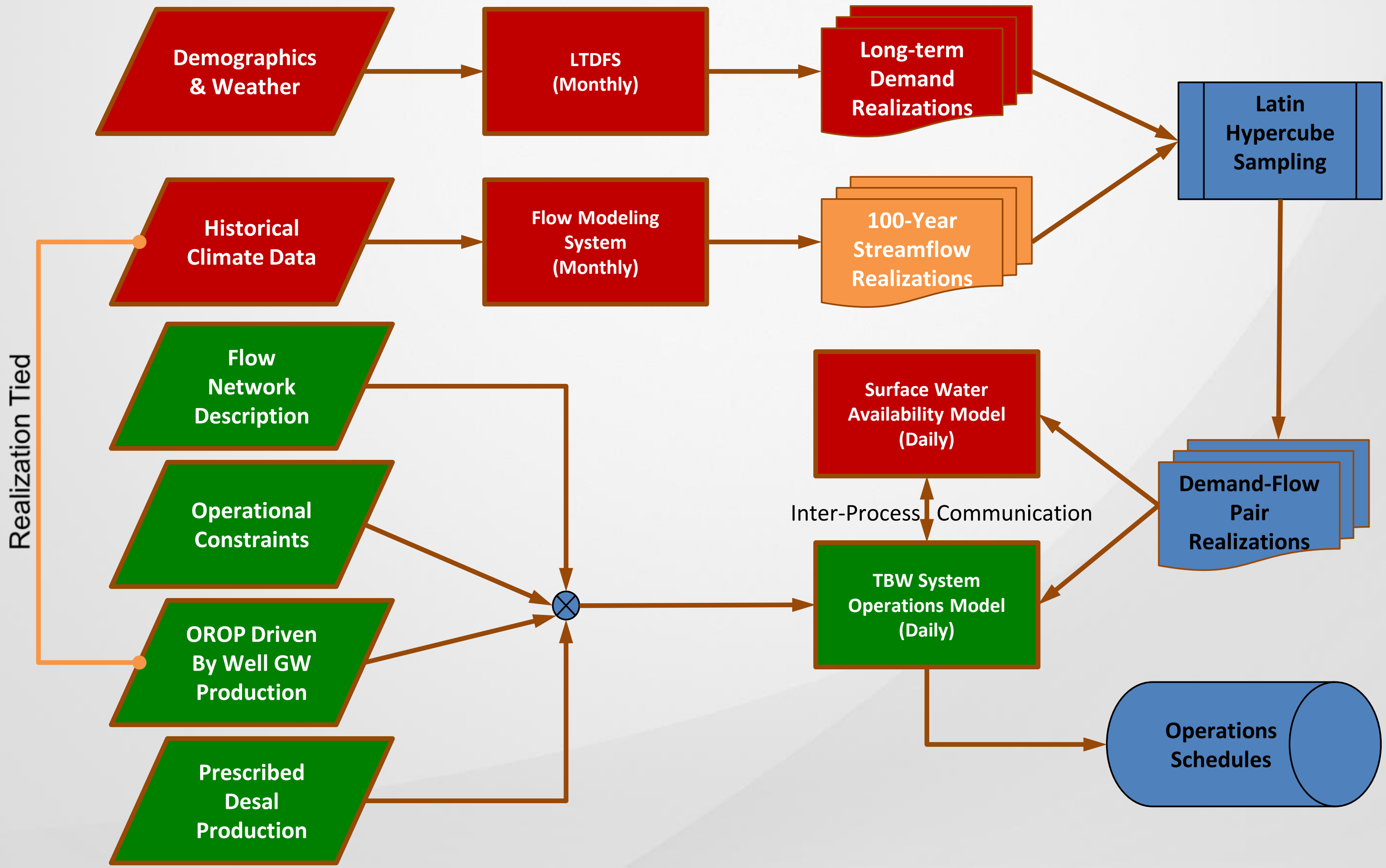


Stochastic
two random
variables

Percent of realizations in satisfactory state

Percent of realizations when (a certain percent of time) CWUP pumpage is under 90 mgd

Schematic of Operational Model



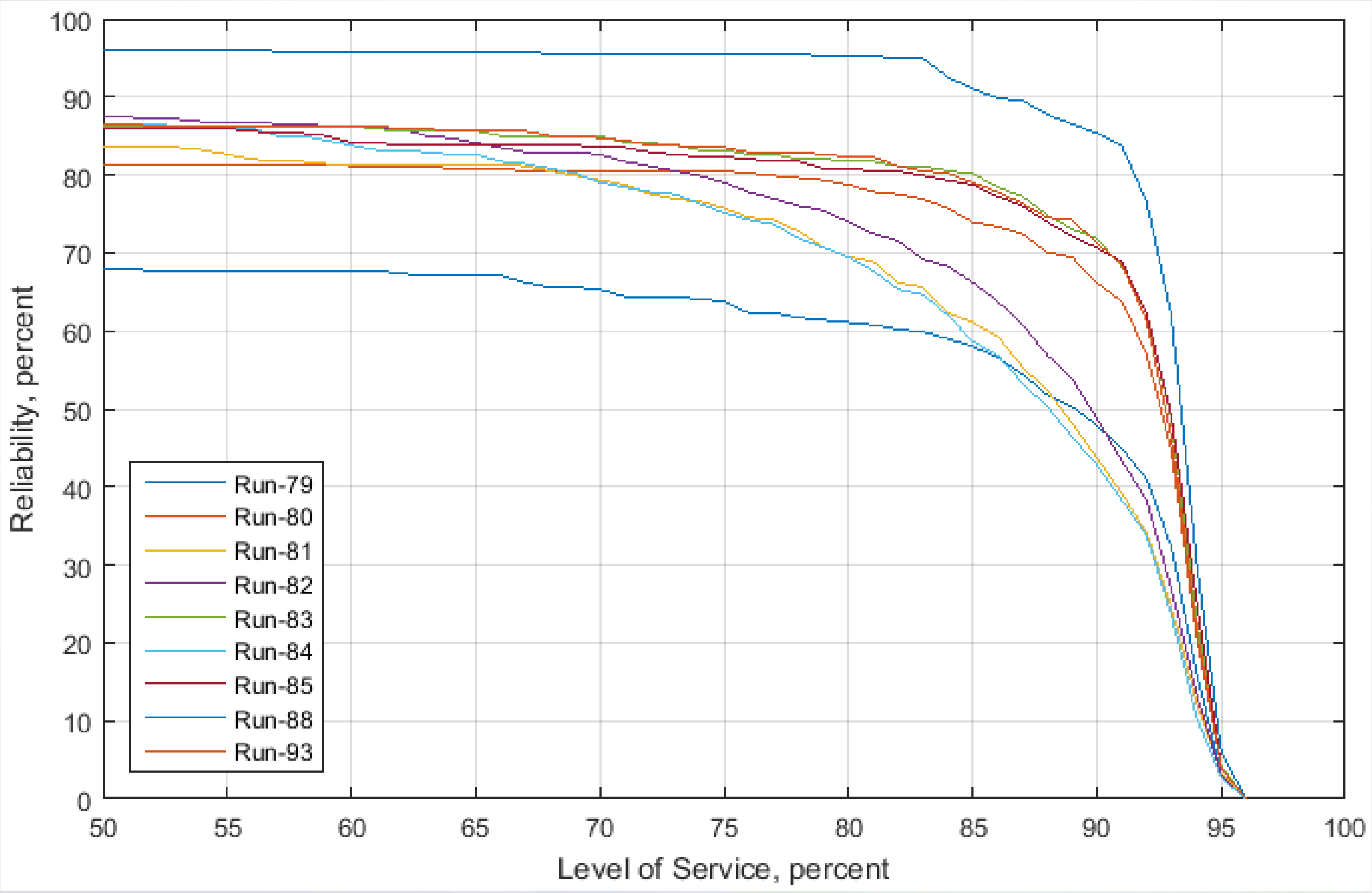
SWRE Model

- Demand and Rainfall are two random variables, each has 1000 of 20-year realizations available for sampling
- Use LHS method to draw 334 samples for each Run
- Well and wellfield allocations followed OROP protocol
- Slack variables were added to help eliminating an infeasible solution
  - 12-Month MAVG for CWUP, SCH, BUD
  - Non-groundwater source (TBC, Alafia, COTSS, Reservoir)
  - Trigger condition use ngw_supply slack variable as a separate supply source

Reliability, Level of Service (LOS) and Resilience

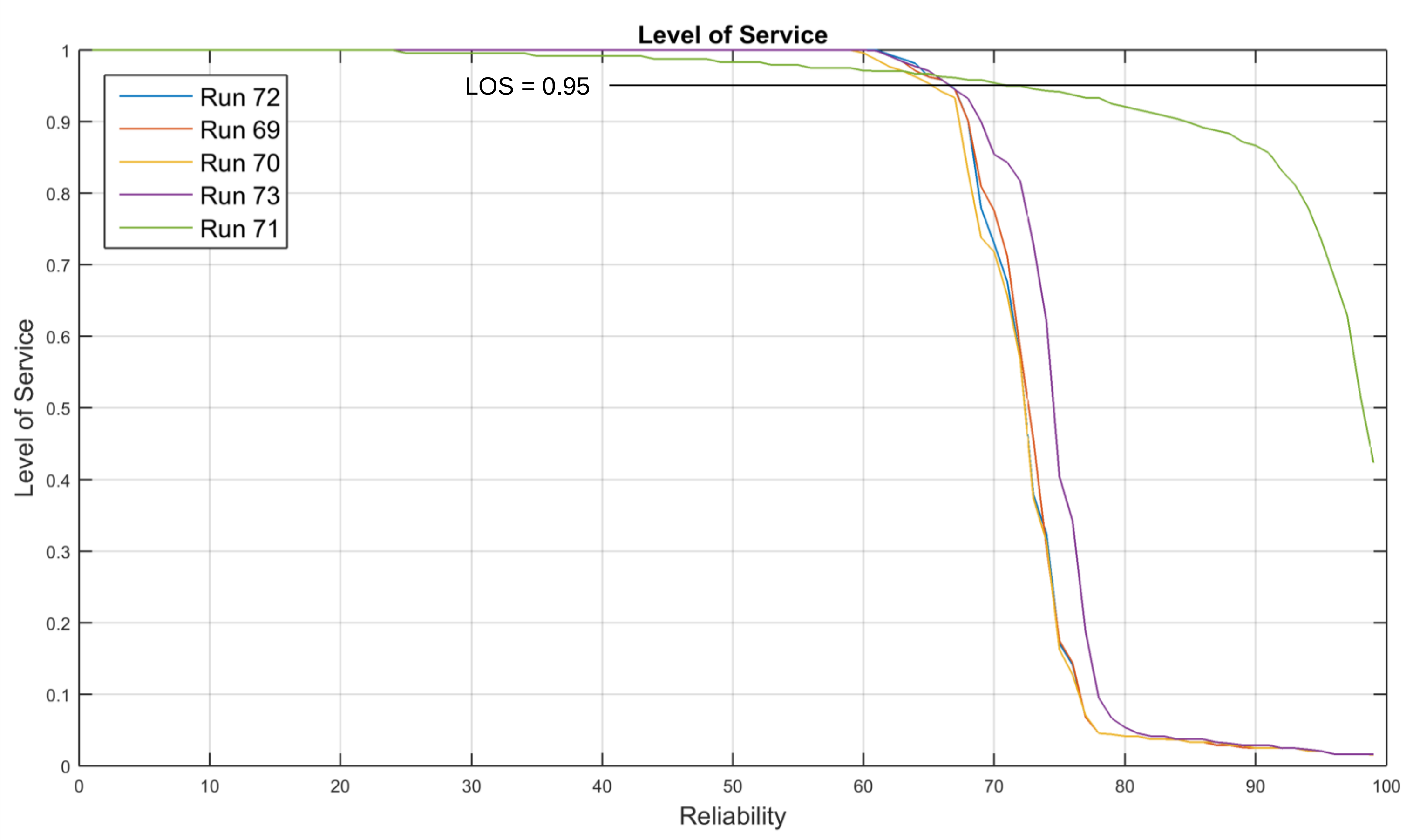
- Reliability – address uncertainty as percent of realizations meeting the satisfactory conditions
- LOS – percent of time without shortage (unmanaged)
  - Interested in LOS at 95% (allow 18 days/year to fail)
- Resilience – expressed in term of duration and severity
  - Can be used to address short-term supply deficits
  - Resilience based on the existing or planned strategies
    - Temporary supply (Morris Bridge Sink, temporary allowable CWUP overage)
    - Example
      - CWUP: 12-month moving average not more than 90 mgd for six months
      - TBC: average/maximum of 5 mgd for six months

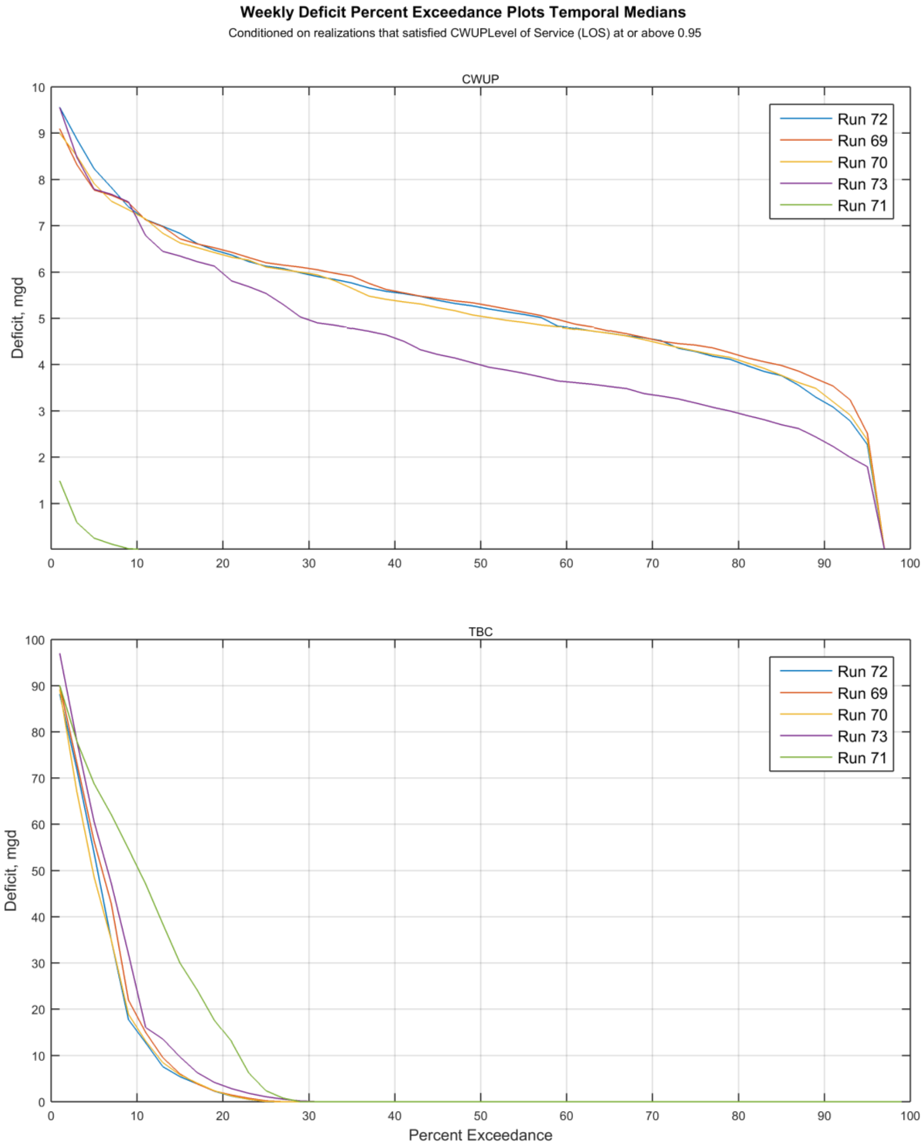
Reliability vs. LOS at Various Options Time Slice 2040

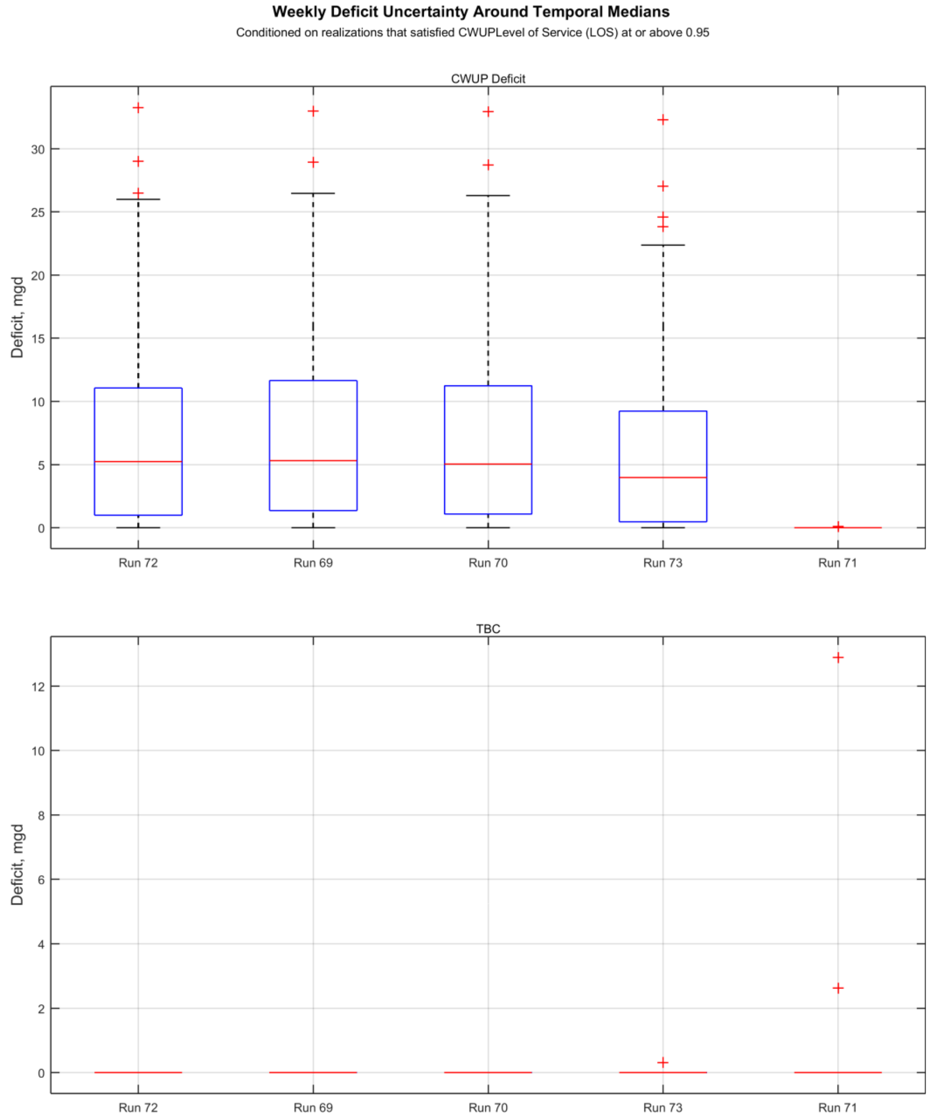


Questions and Comments

Reliability vs. LOS on CWUP Condition




Weekly Deficit Percent Exceedance Plots Temporal Medians
Conditioned on realizations that satisfied CWUPLevel of Service (LOS) at or above 0.95
CWUP
TBC
Run 72
Run 69
Run 70
Run 73
Run 71
Deficit, mgd
Percent Exceedance


Weekly Deficit Uncertainty Around Temporal Medians
Conditioned on realizations that satisfied CWUPLevel of Service (LOS) at or above 0.95
CWUP Deficit
TBC
Deficit, mgd
Run 72
Run 69
Run 70
Run 73
Run 71

Question/Comment