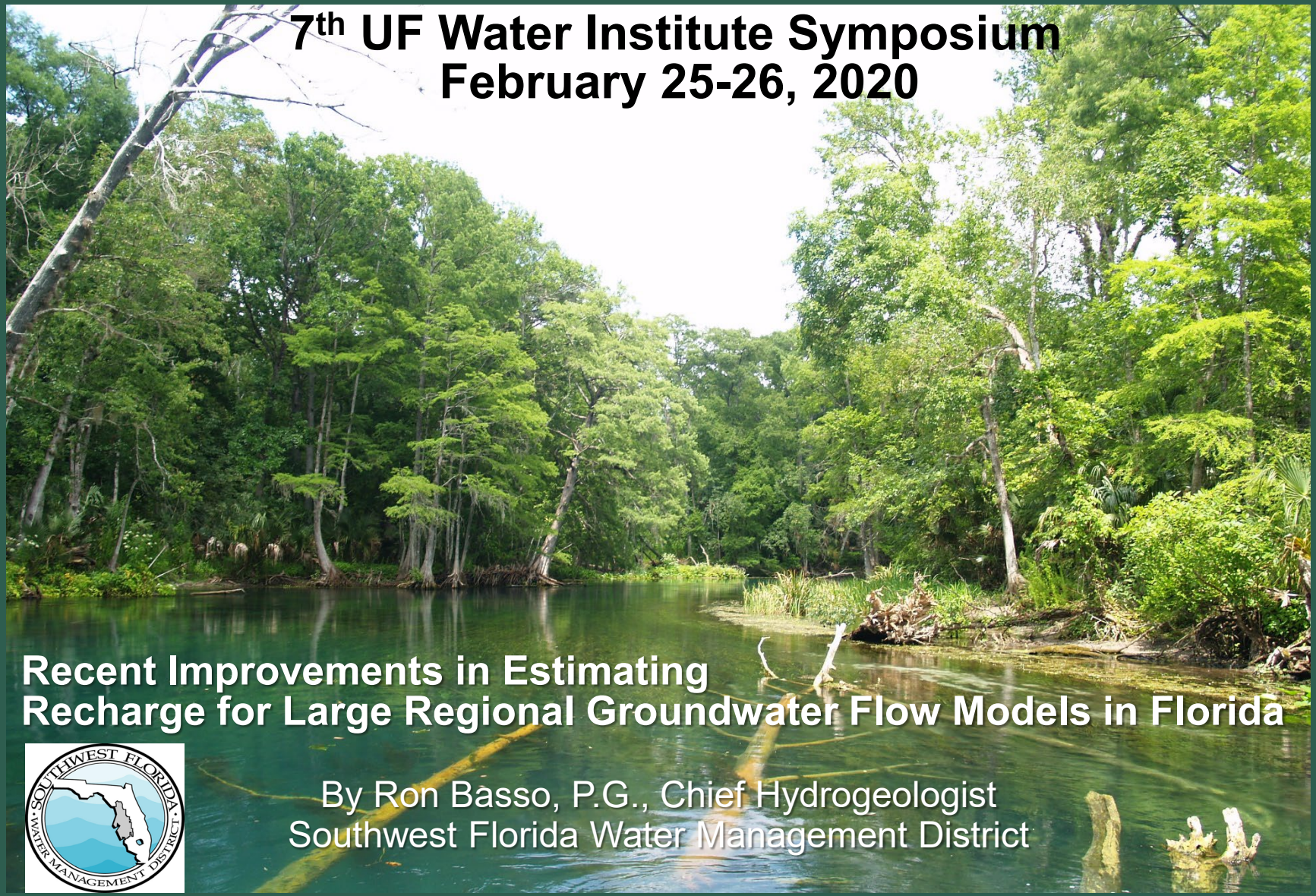

7th UF Water Institute Symposium
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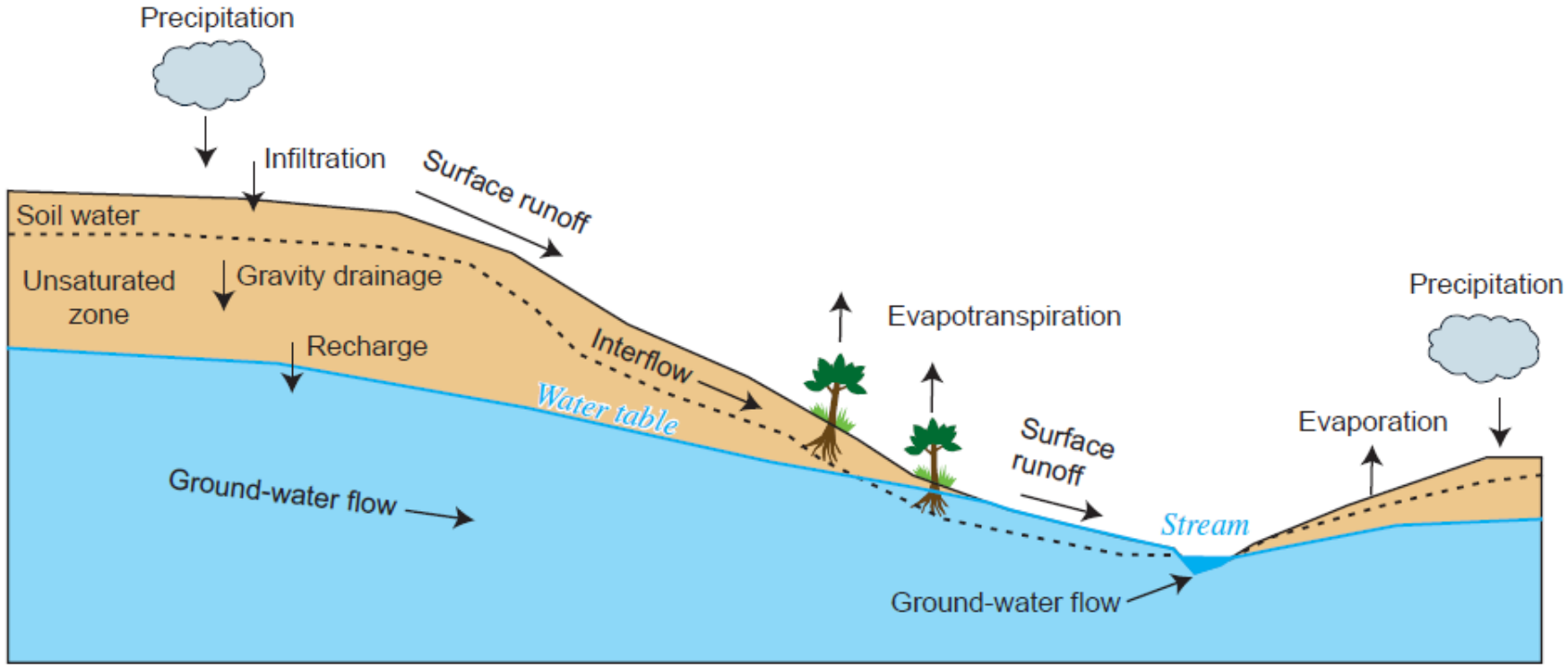
Recent Improvements in Estimating Recharge for Large Regional Groundwater Flow Models in Florida

By Ron Basso, P.G., Chief Hydrogeologist
Southwest Florida Water Management District

Background

- Groundwater models are widely used in water resource planning and management
  - Evaluate current and future withdrawal impacts to natural systems such as lakes, springs, wetlands, and legal users
- Regional-scale groundwater models are moving toward simulating the complete hydrologic cycle
- Evapotranspiration (ET) and Recharge (RCH) are the two largest components of the hydrologic cycle
- Reliable estimation of ET and RCH is important in regional-scale groundwater modeling
- The Districts are better accounting for spatial and temporal variation of ET and RCH due to distributed land use, soil type, depth to water table, physiography, return water, and meteorological conditions to better predict groundwater flow

Hydrologic Cycle



Methods for determining Recharge

- Water Budget
  - Empirical approach
  - Requires data on rainfall, runoff, estimates of ET, water table depth, and geology
  - Greater range of uncertainty, difficult for shorter-term transient calibration
- Surface Water Hydrology models: HSPF, PRMS
  - Surface water catchment areas – honors boundary conditions
  - Requires sub-daily time steps (HSPF) for accuracy
  - Less spatial accuracy
- Fully Integrated models: MIKESHE, MODHMS, IHM
  - Distributed parameter, data intensive, most grid based
  - More accurate
  - Increased runtime

- Model run time is a major consideration in regional-scale models
  - Extends over several thousands of square miles
  - Requires models to be calibrated to represent wide range of climatic conditions with longer calibration periods
  - Groundwater model run time is about 15-20 hrs for long-term transient simulations

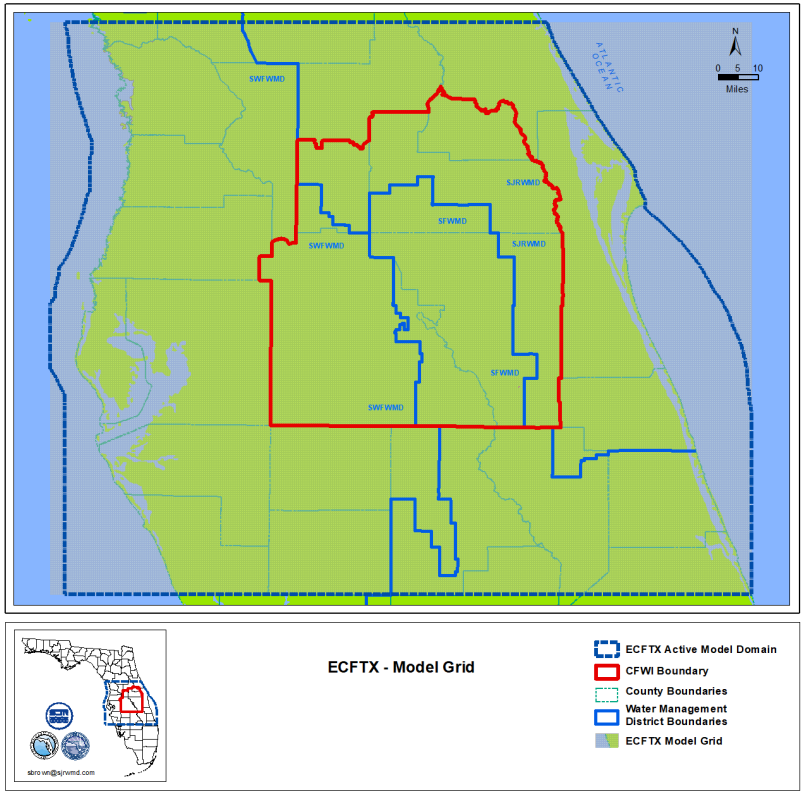
- Simple but robust method that can simulate ET and RCH rates reasonably accurately for regional-scale model is needed

Groundwater Models

Collaboration between SWFWMD, SJRWMD, and SFWMD

East-Central Florida Expansion

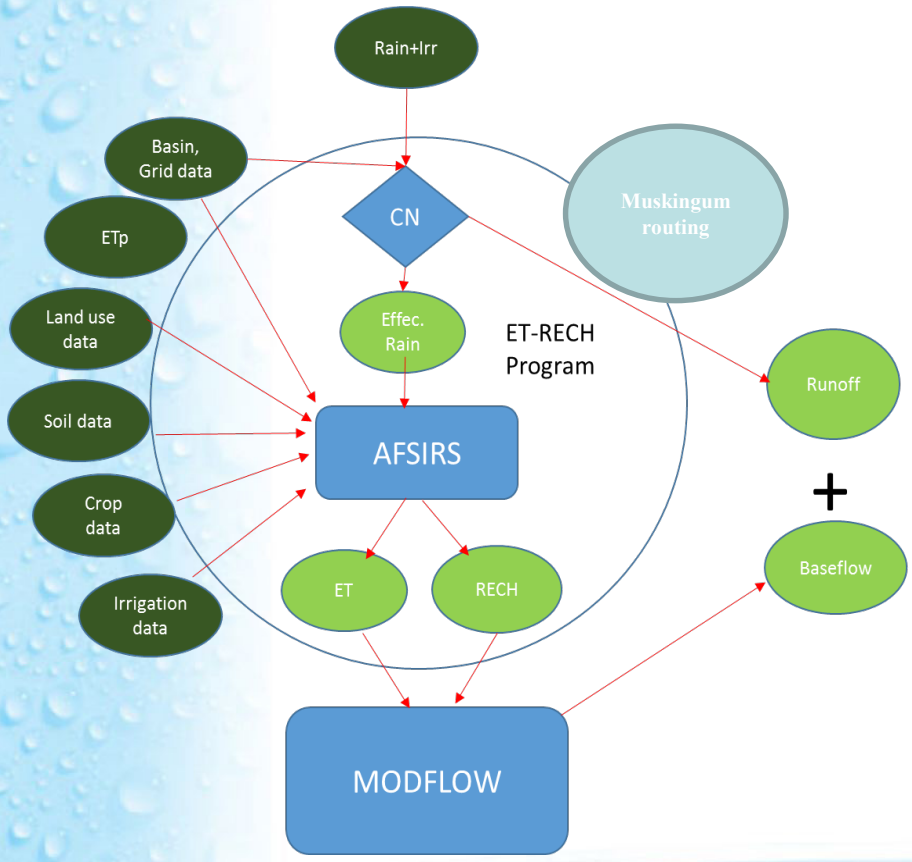
1. 1,250 ft Cells/Fully 3D – 11 layers
2. Modified AFSIRs program for recharge and ET
3. Transient model calibrated from 2003-2014 – MODFLOW NWT
4. Cooperative with SWFWMD, SFWMD and SJRWMD
5. Completed late 2019



Model Design

- Unsaturated zone water balance model
  - Daily root zone water balance model Agricultural Field Scale Irrigation Requirement Simulation Model (**AFSIRS**) developed by University of Florida to simulate unsaturated zone ET and RCH
- Groundwater Model
  - United States Geological Survey's (USGS) groundwater model **MODFLOW-NWT** used to simulate groundwater ET and RCH
- Surface runoff routing
  - Muskingum method
- Rectangular grids based on the groundwater model
  - Further sub divided into to different land use polygons depending GIS coverages
- GIS based inputs

Runoff-ET-Recharge (RUNER) Model

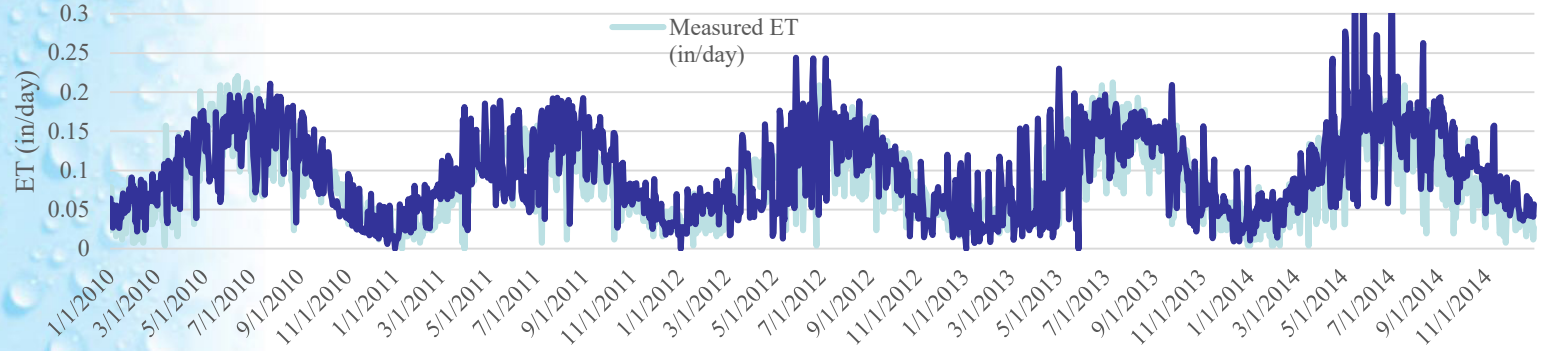


- Apply to each land use polygon in each model cell
- Accumulate runoff and baseflow by basin
- First pass: Run MODFLOW with first ET and Recharge estimates
- Compare the observed stream flow hydrograph with the simulated
- Second pass: Adjust CN to change runoff and river and drain bed conductance to change baseflows
- Compare the observed stream flow hydrograph with the simulated
- Repeat the process until a good match and better statistics are obtained

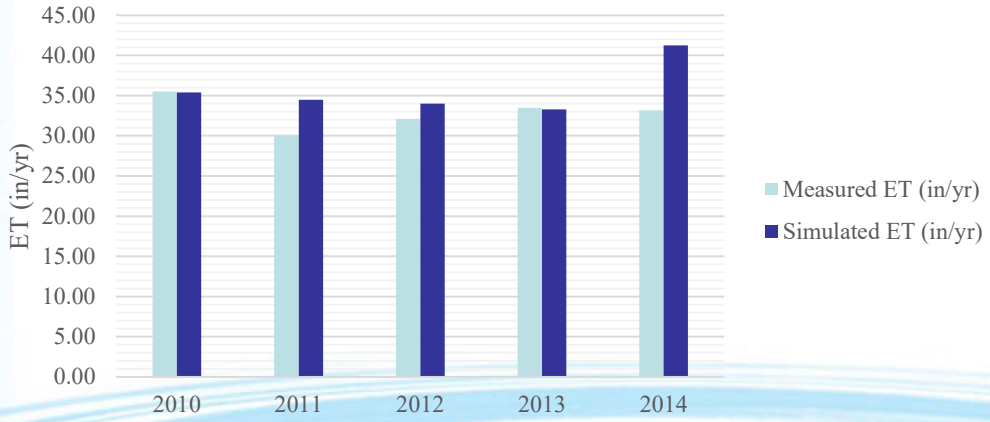
Verification

- ✓ Lake Wales Ridge, Orange County
- ✓ Blue Cypress Marsh Site, Indian River County
- ✓ Starkey Pasture Site, Pasco County
- ✓ UCF, Orange County

Daily ET Comparison Starkey Site-Pasco County: 2010-2014

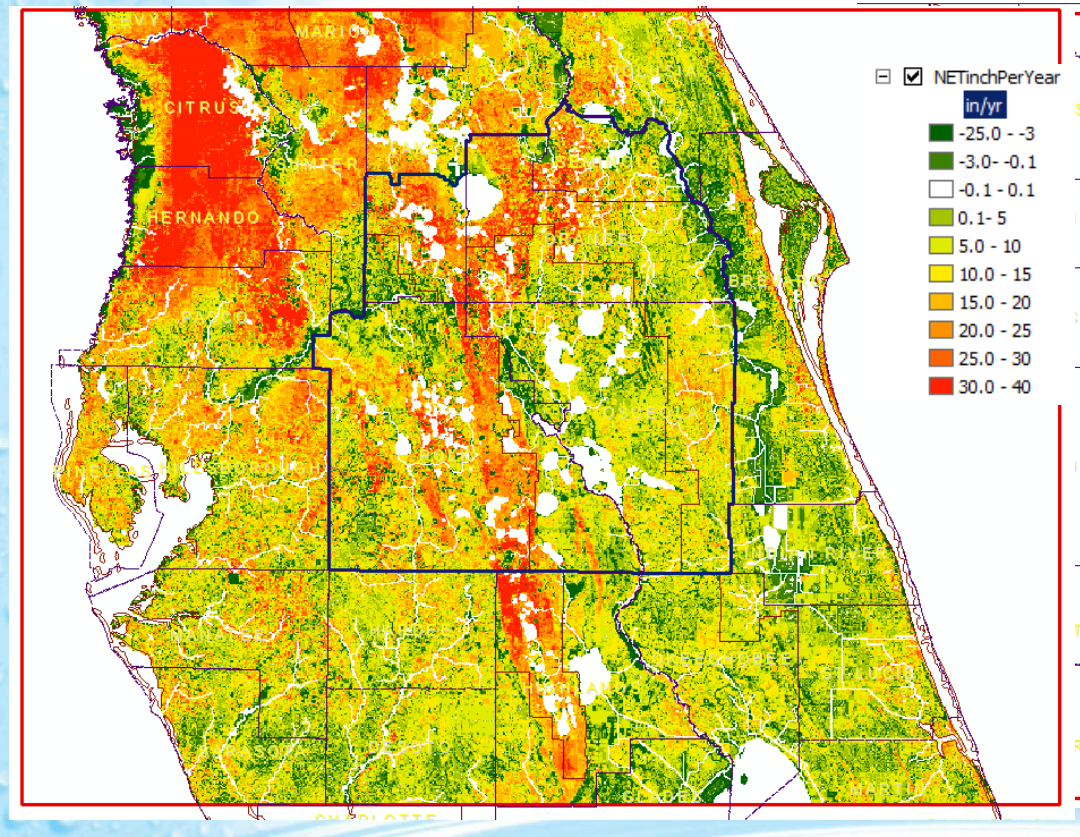


Annual ET Rates Comparison: 2010-2014

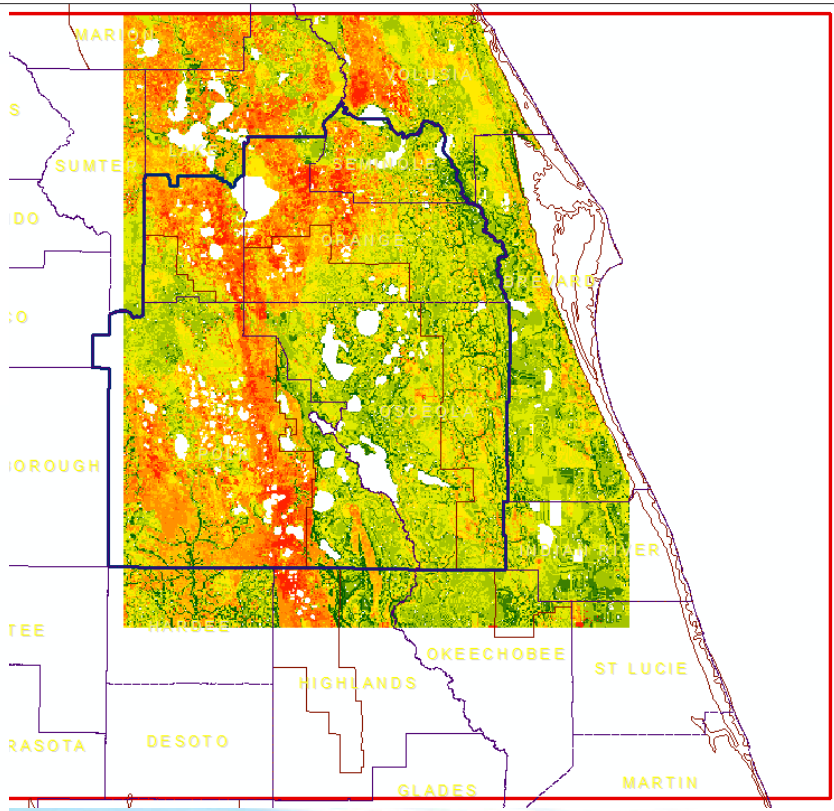


Net Recharge Comparison ECFT Model

ECFTX model

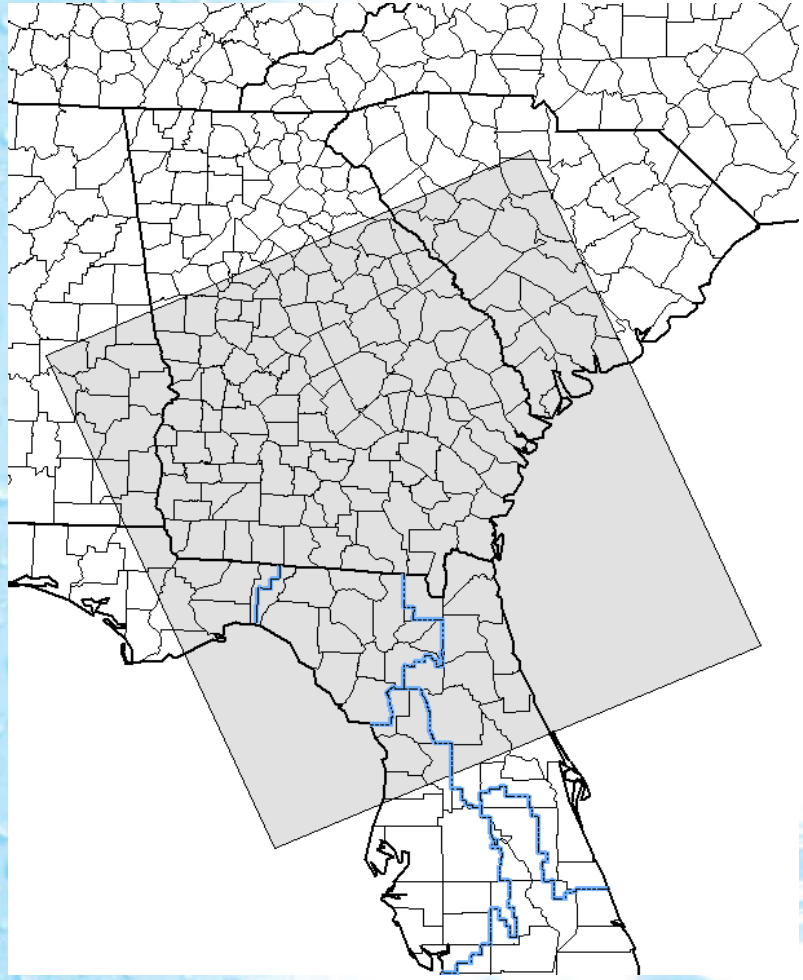


ECFT model



Groundwater Flow Models

Collaboration with other WMDs



North Florida/SE Georgia Model

1. 2,500 ft Cells/Fully 3D – 7 layers
2. HSPF Fluxes for recharge and ET
3. Cooperative with SJRWMD and SRWMD
4. Completed 2018

Model Overview

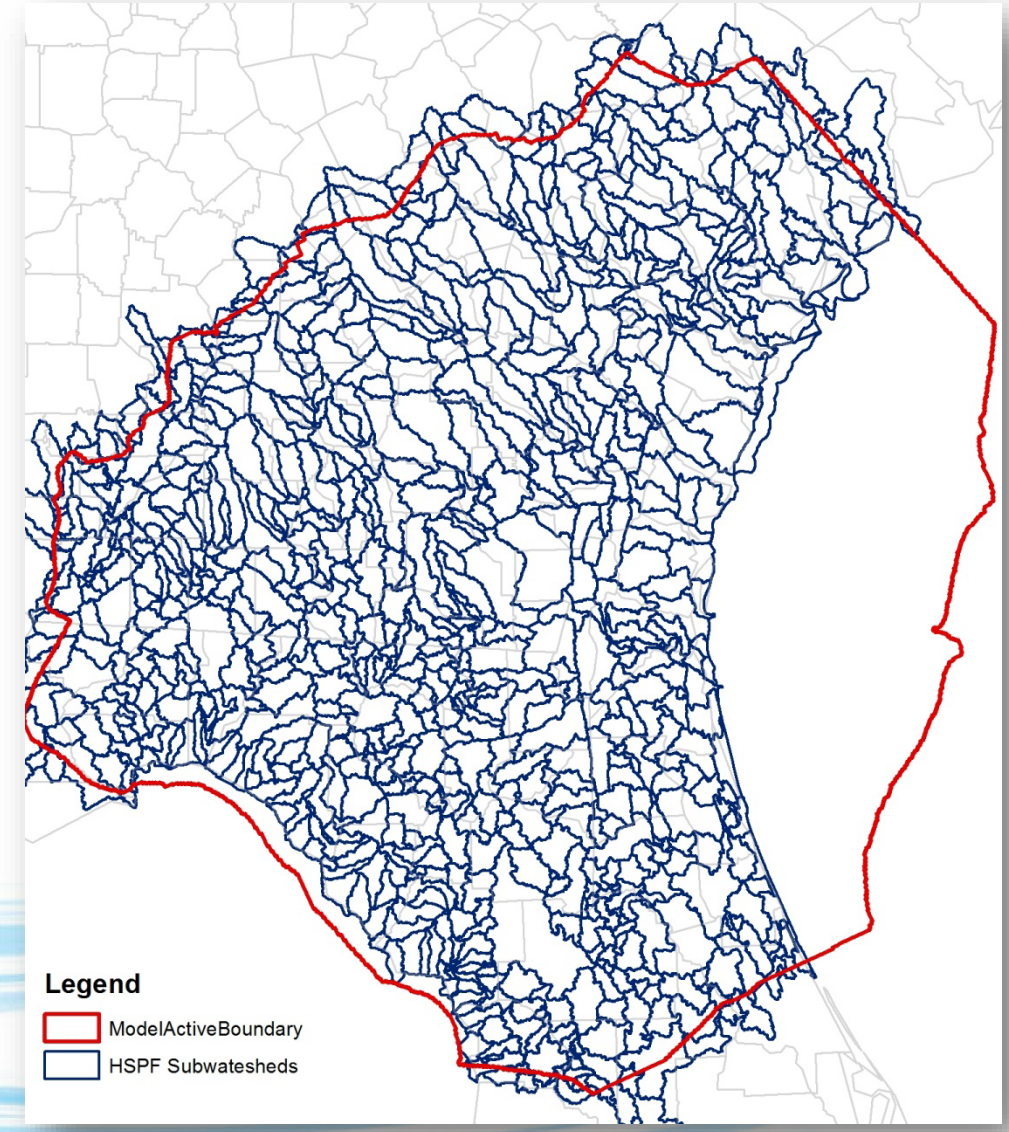
- 60,000 square miles
- MODFLOW-NWT
- 2500 x 2500 ft grid
- 7 layers
- Calibrated to 2001 and 2009 steady-state periods

Recharge Methodology

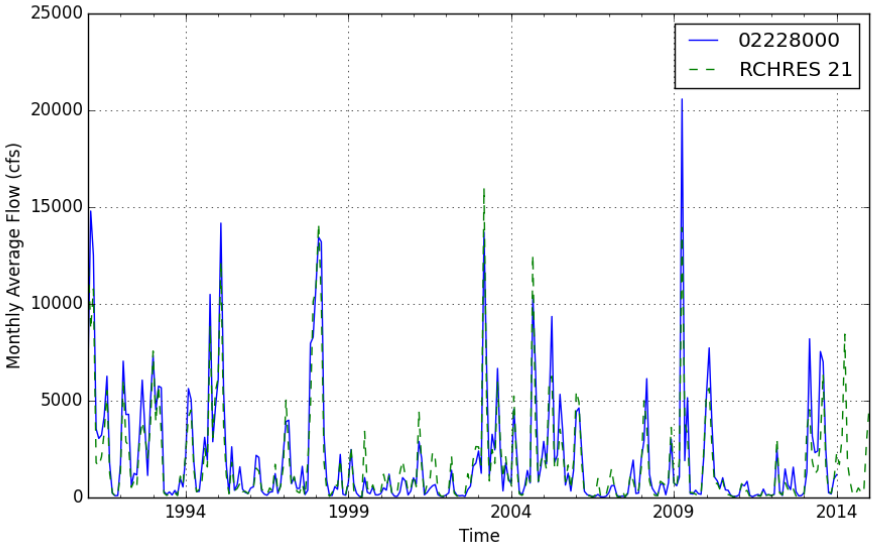
- HSPF
  - Gross Recharge
  - Maximum available saturated ET
  - Sinks and Drainage Well flows
- MODFLOW
  - Recharge Package – for gross recharge input
  - ET Package – for groundwater ET simulations
    - Maximum available saturated ET
    - ET Extinction Depth
- PEST Model Calibration
  - Recharge multipliers per subwatershed
  - MSET multipliers per subwatershed

Overview of HSPF Models

- Surface Water (HSPF) Models
- More than 900 subwatersheds
- Rainfall: NLDAS (North American Land Data Assimilation System)
- PET: Modified NLDAS based on USGS datasets
- Agricultural Irrigation
- Residential/Commercial Irrigation
- Golf Course Irrigation
- Septic Fields Seepage

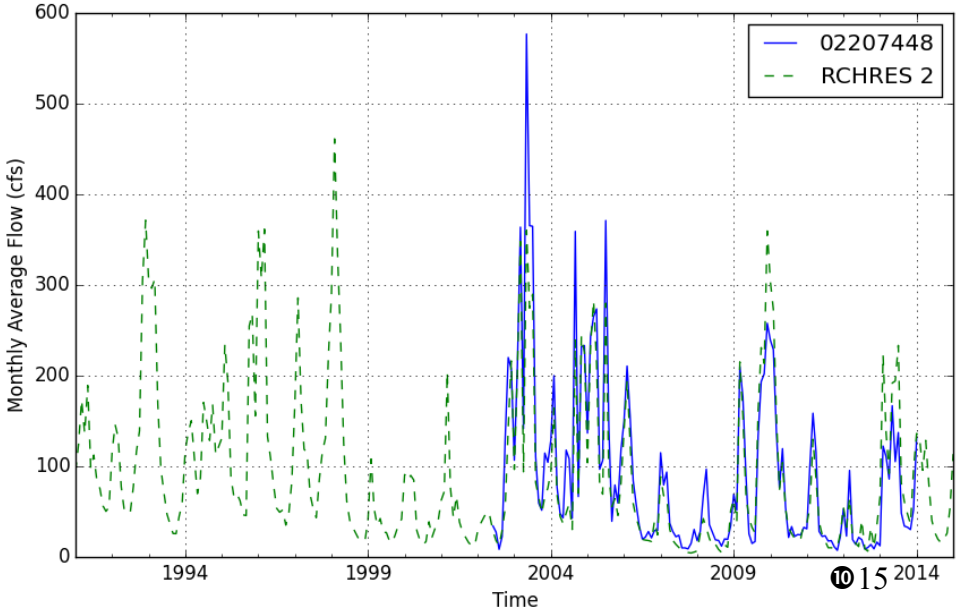


Calibration of HSPF Models

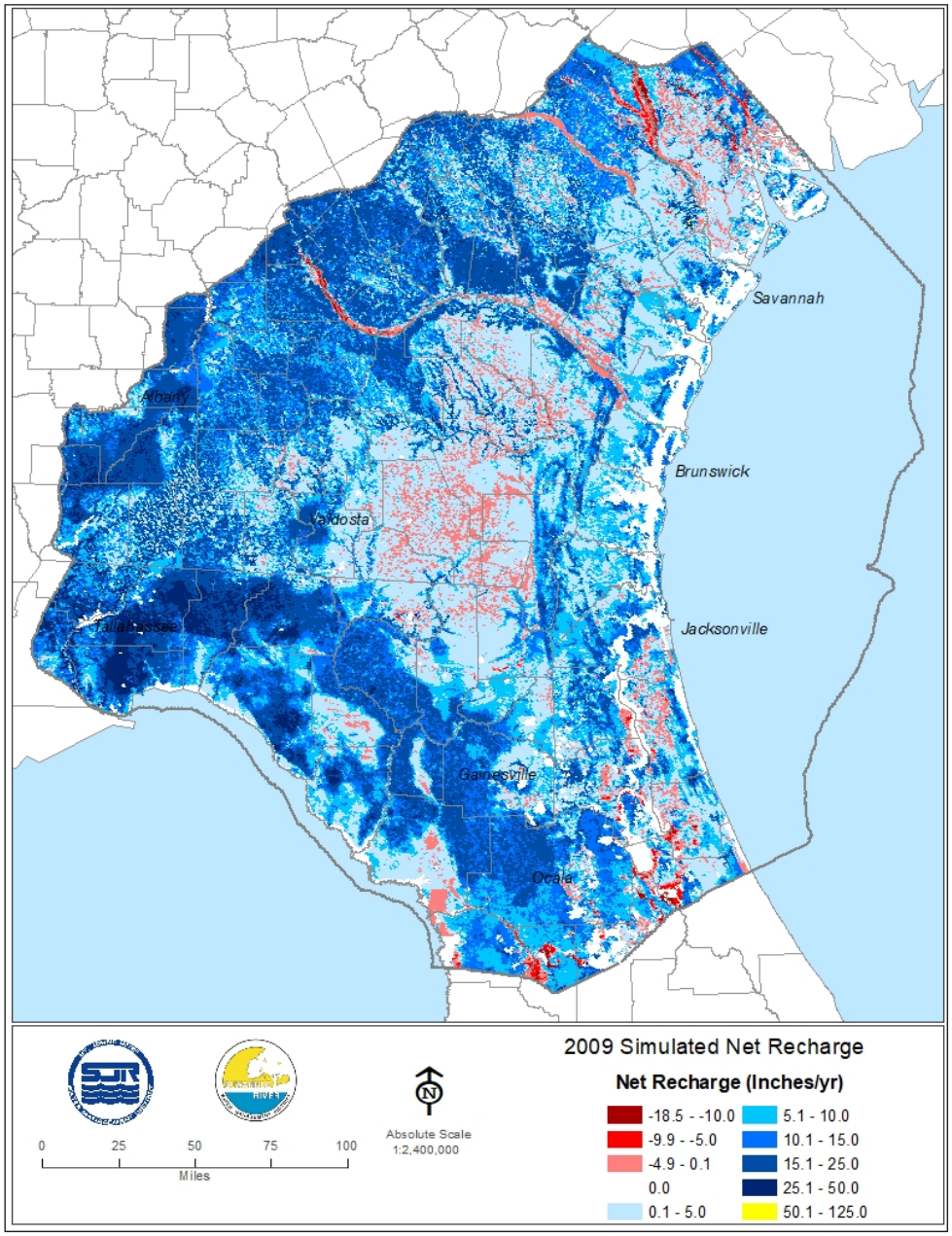


- Over 900 subwatersheds
- Transient calibration
- 1992 through 2014
- Hourly simulations

- Precipitation
- Evapotranspiration
- Agricultural Irrigation
- Non-Agricultural Irrigation
- Septic Fields Seepage



Net Recharge for 2009



Summary

- Groundwater models are widely used in water supply planning, minimum flows and levels, and resource management
- Regional-scale groundwater models are moving toward simulating the complete hydrologic cycle
- Surface water models are increasing being applied to develop Recharge and ET estimates outside of the groundwater model code
- Results in reduced uncertainty for recharge and groundwater ET
- Better recharge inputs further constrain the range of hydraulic conductivity values within groundwater flow models – leading to better prediction results