Continuous Improvement for the Integrated Hydrologic Model & Integrated Northern Tampa Bay Model

University of Florida Water Institute Symposium

February 20, 2024

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Supplying Water To The Region

Southwest Florida Water Management District

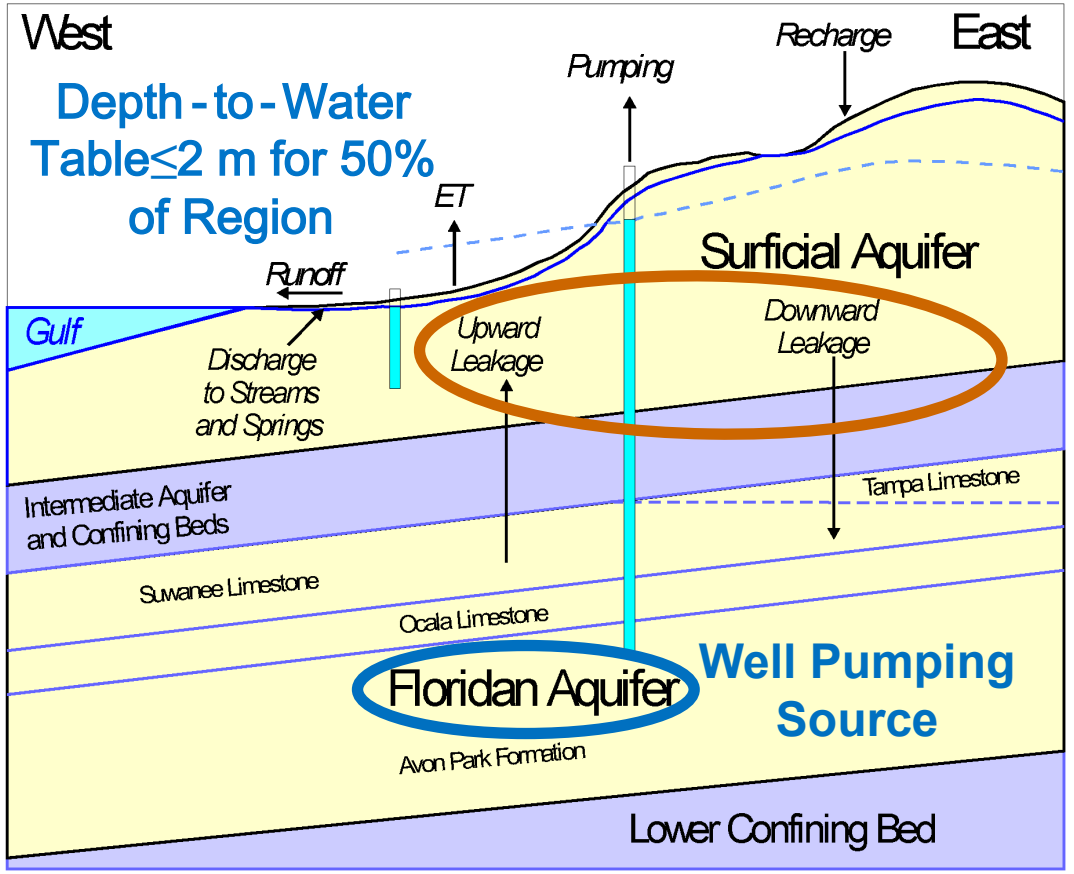
Outline

- Tampa Bay Water – Wholesale drinking water provider
- Integrated Hydrologic Model & Integrated Northern Tampa Bay Model
- Model support for decision making
- Phases of continuous improvement
- Evidence domains for integrated surface water – groundwater models
- Sources of uncertainty in model results
- Examples of continuous improvement
- Summary

Tampa Bay Water
Wholesale Drinking Water Provider to Six Members

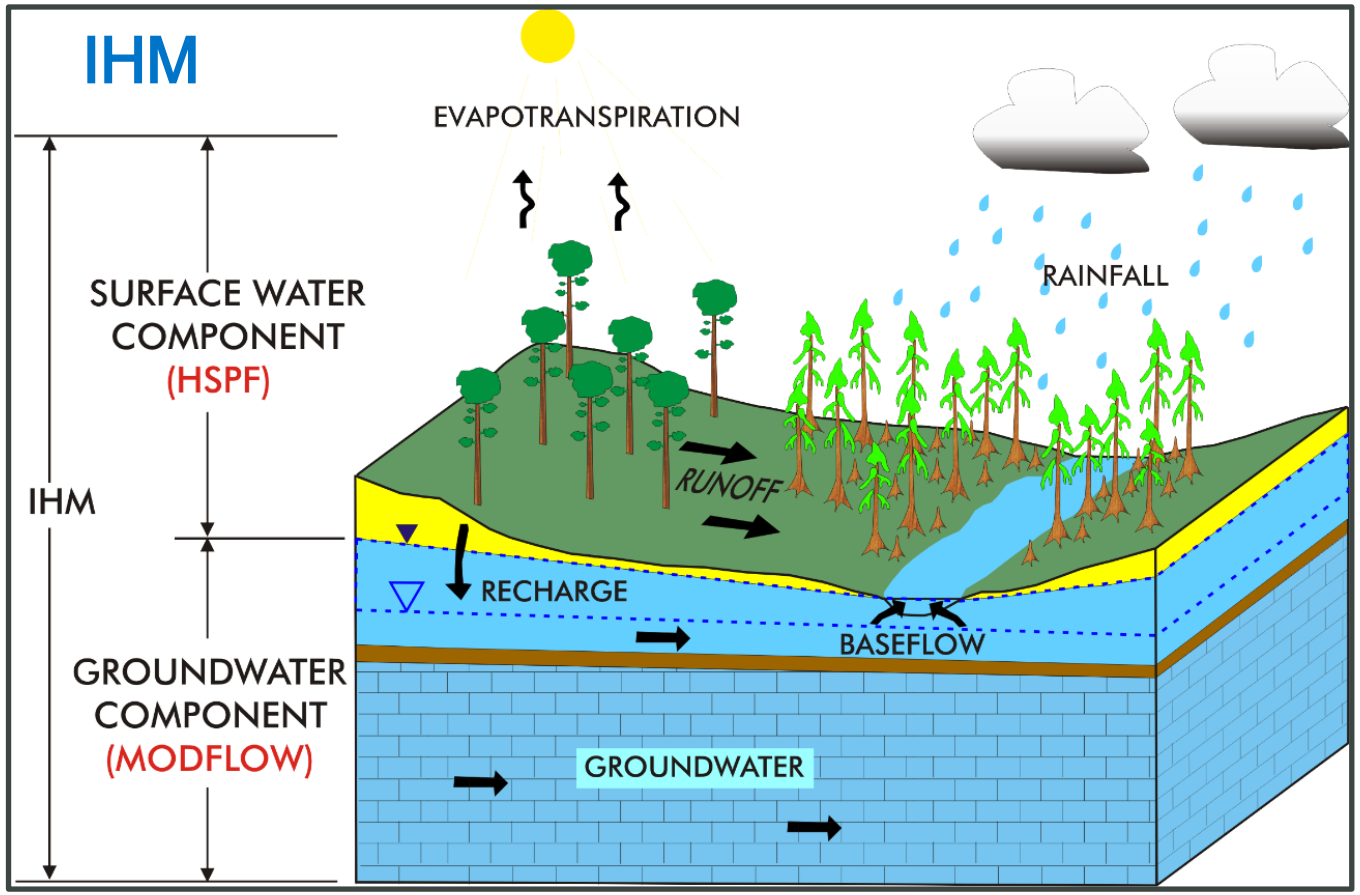
- Integrated, drought-resistant supply system
- Groundwater, Surface Water, Desalinated Water
- 15 Bgal Surface Reservoir
- 2.5 million served

Vertically-Connected Groundwater System

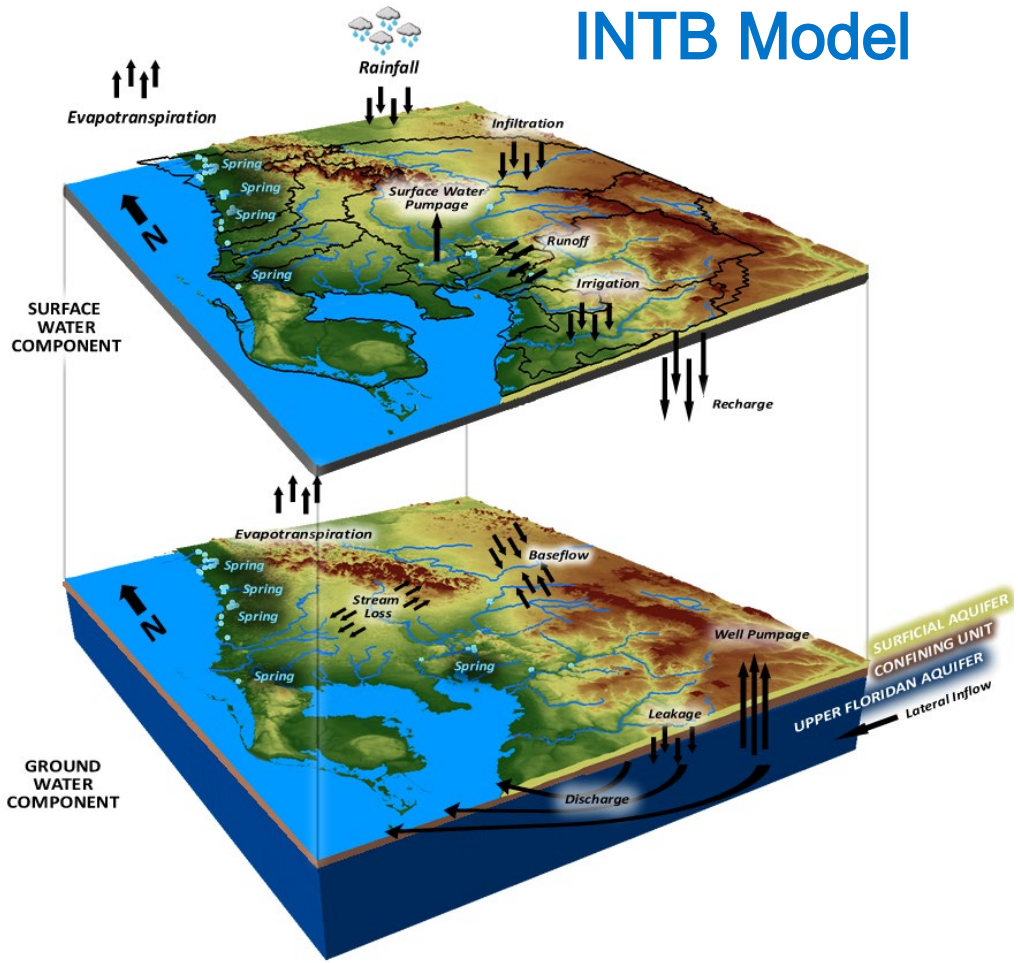


Credit: Geurink and Basso 2013, INTB Model Report

Integrated Hydrologic Model (IHM) & Integrated Northern Tampa Bay (INTB) Model



IntegratedHydrologicModel.org



IHM & INTB Models
Support for Decision Making

- Water supply system
  - Planning (new sources, water shortage mitigation, wellhead protection)
  - Sustainability assessment (climate variability, well pumping, landuse change, climate change, sea level rise)
  - Operations (pumping optimization)
- Ecologic system sustainability (MFL, permitting)
- Partition hydrologic responses (cause & effect)
  - Water use; well & surface water pumping
  - Climate variability & change
  - Landuse change

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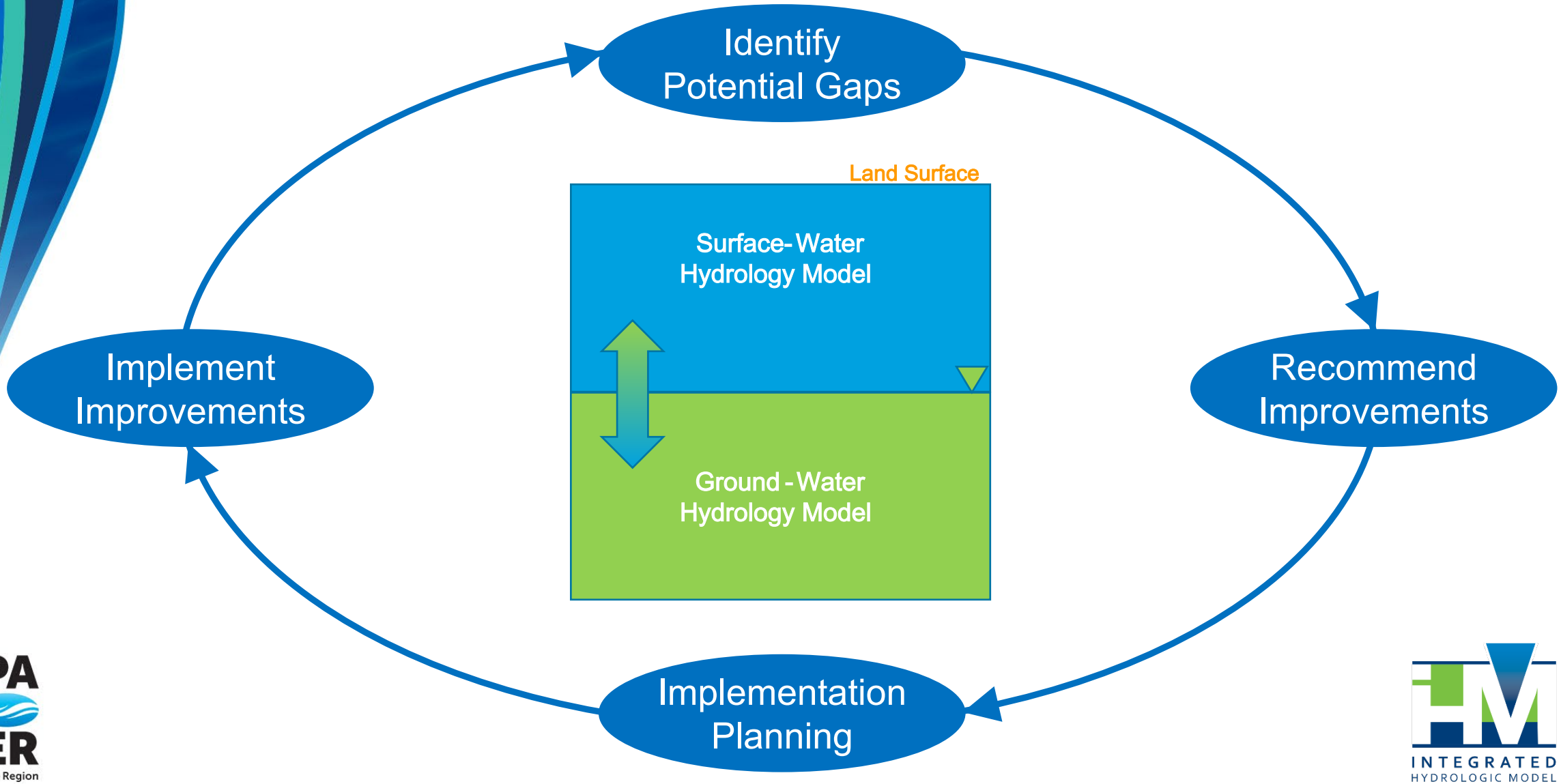
IHM & INTB Models
Phases of Continuous Improvement



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IHM INTEGRATED HYDROLOGIC MODEL

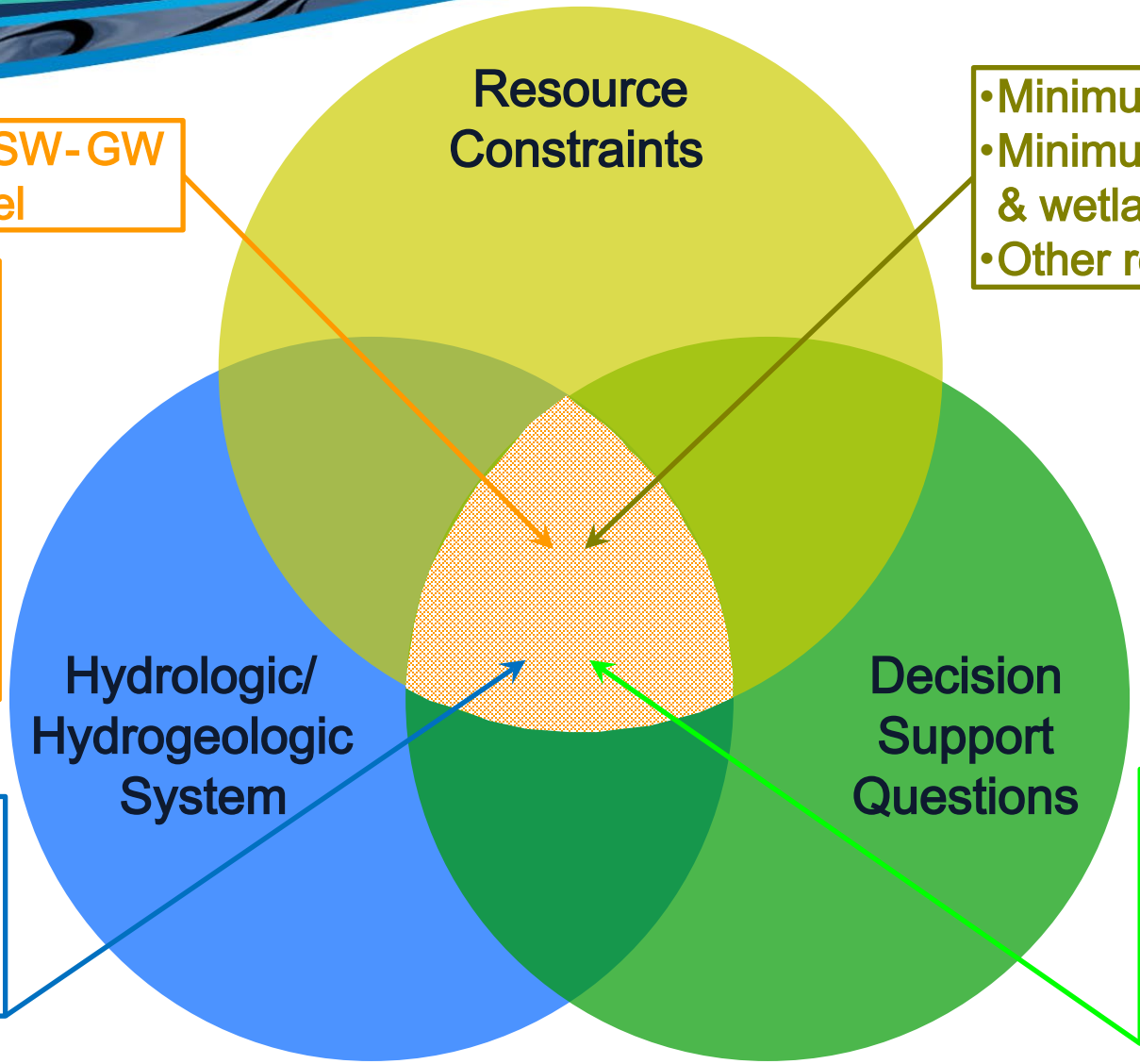
Evidence Domains for Integrated SW-GW Model

Integrated SW-GW Model

Three evidence domains (factors) guide decisions about continuous improvement for Integrated SW -GW Model:

1. Flow Systems
2. Decision Support Questions
3. Resource Constraints

Example shows the intersection for a domain space subset from each Factor representing priorities for continuous improvement

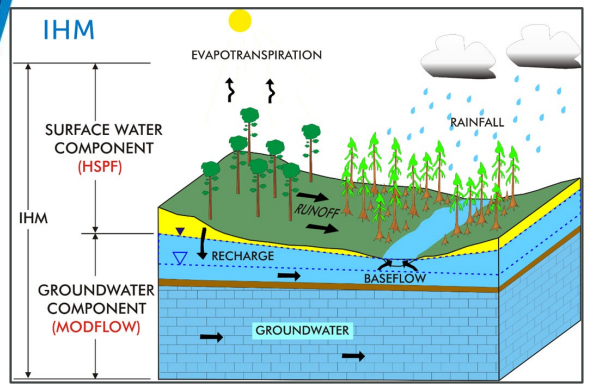


- Minimum streamflow
- Minimum levels for lakes & wetlands
- Other regulatory limits

- Near-surface depth-to-water table
- Vertically-connected groundwater system

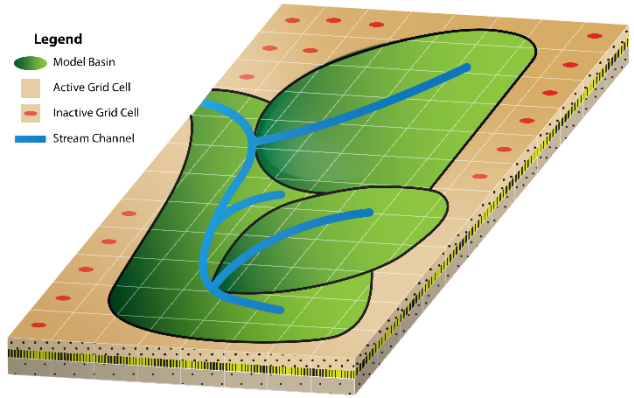
- Sustainability
  - Natural system
  - Potable supply system
- Cause & effect
- Partition responses

IHM & INTB Models
Sources of Uncertainty in Model Results

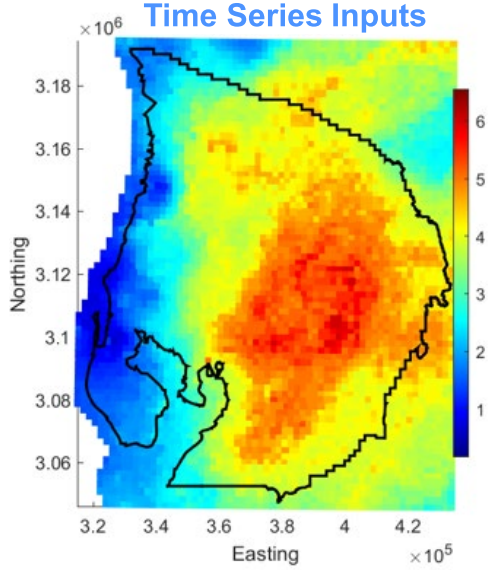


Sources of Uncertainty

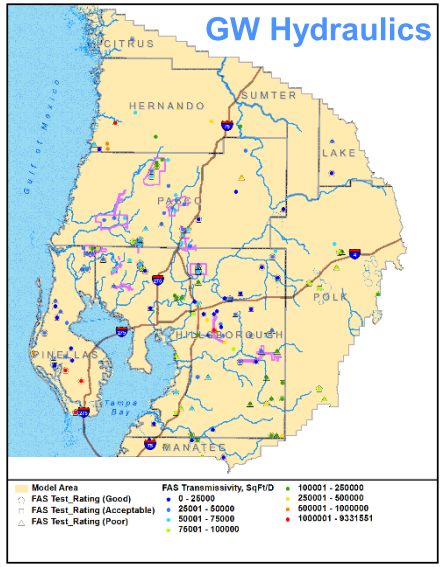
- Simulation Engine
- Conceptualize & Discretize
- Model Input Data
- Target Data & Constraints



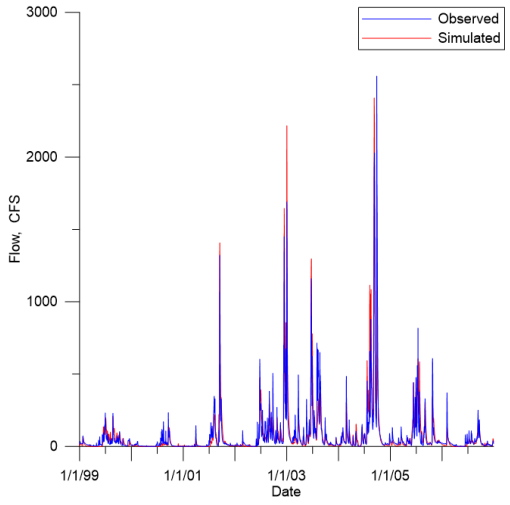
Time Series Inputs



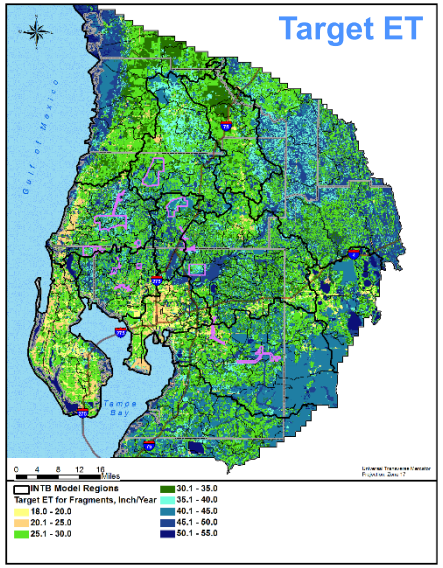
GW Hydraulics



Flows & Levels



Target ET



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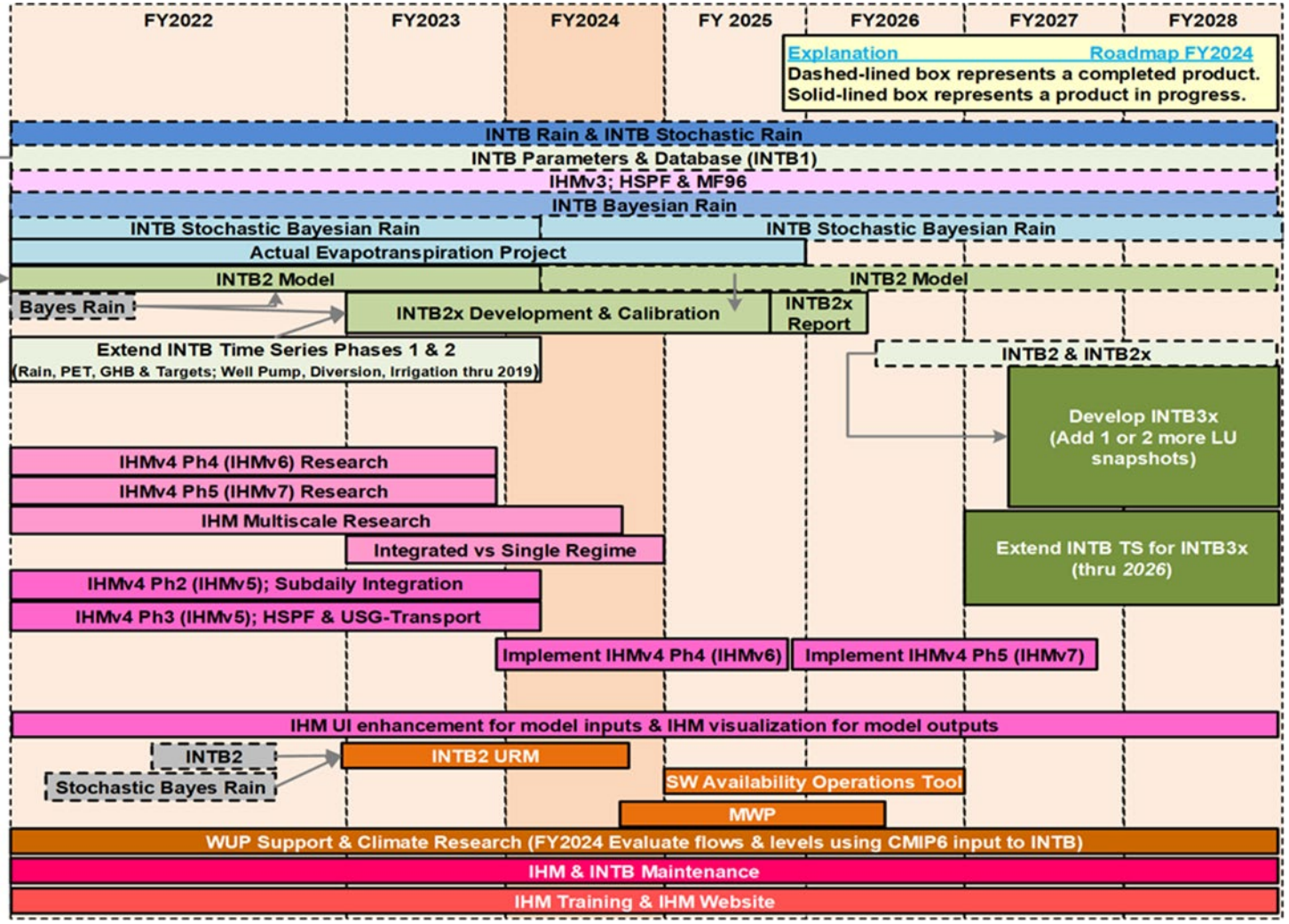
IHM & INTB Models Five-Year Roadmap 2024 Activity Schedule

Sources of Uncertainty

Climate Input Data

Input & Target Data & Model Conceptualization

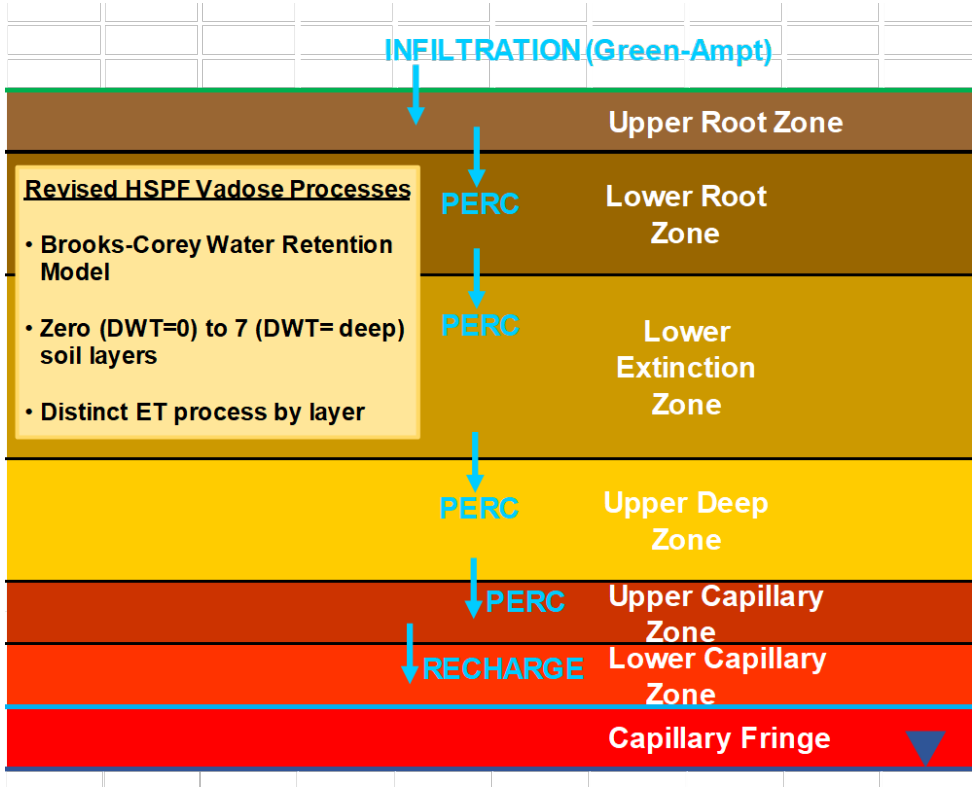
Model Code



IHM & INTB Models; Continuous Improvement Simulation Engine Examples

- Transition from MODFLOW-96 to USG-Transport
- HSPF & IHM integration revisions (details in presentation by Dr. Mark Ross, U. South Florida, this session)

Revised HSPF Vadose Processes & Supporting IHM Revised Integration



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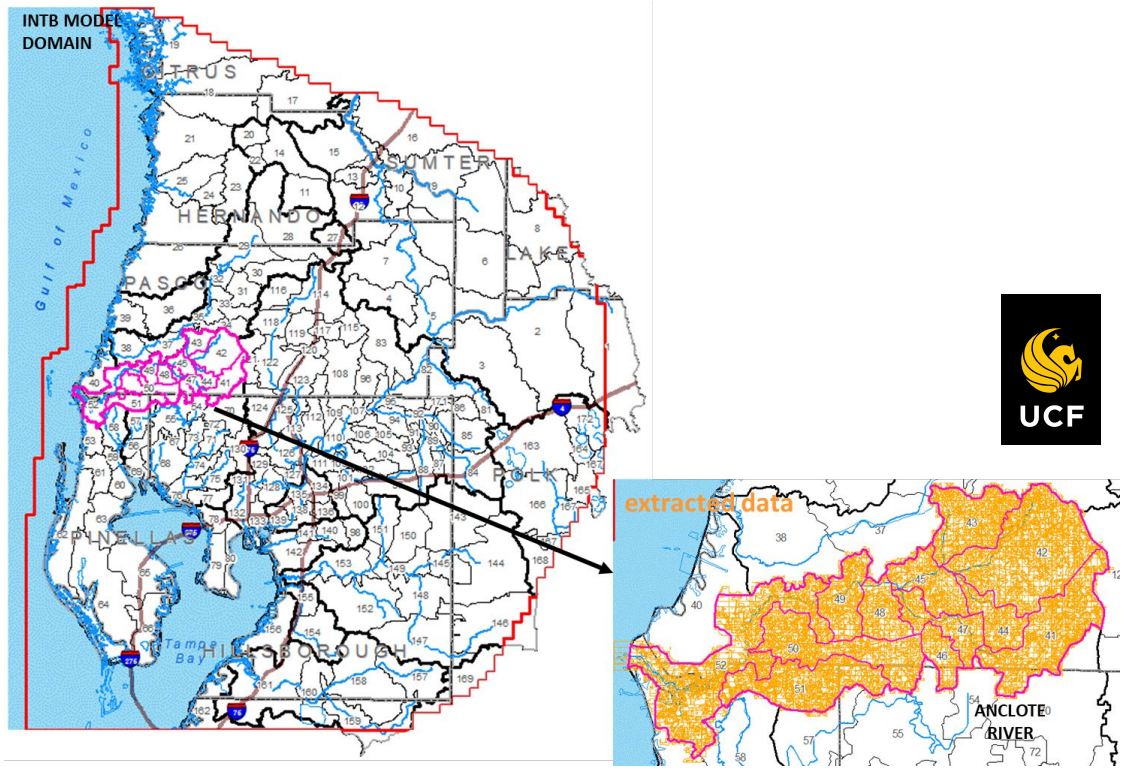
IHM & INTB Models; Continuous Improvement Conceptualization & Discretization Examples

- Transition upland HRUs from landuse only to landuse & soil
- Disaggregate isolated waterbody (i.e., conditionally-connected) reach into wetland only and lake only reaches
- Apply unstructured MODFLOW grid to groundwater
- Landuse change (1995, 2010, others)
- IHM multiscale (details in presentation by Ms. Yu Zhang, U. Central Florida, this session)

IHM Multiscale & Subdomain



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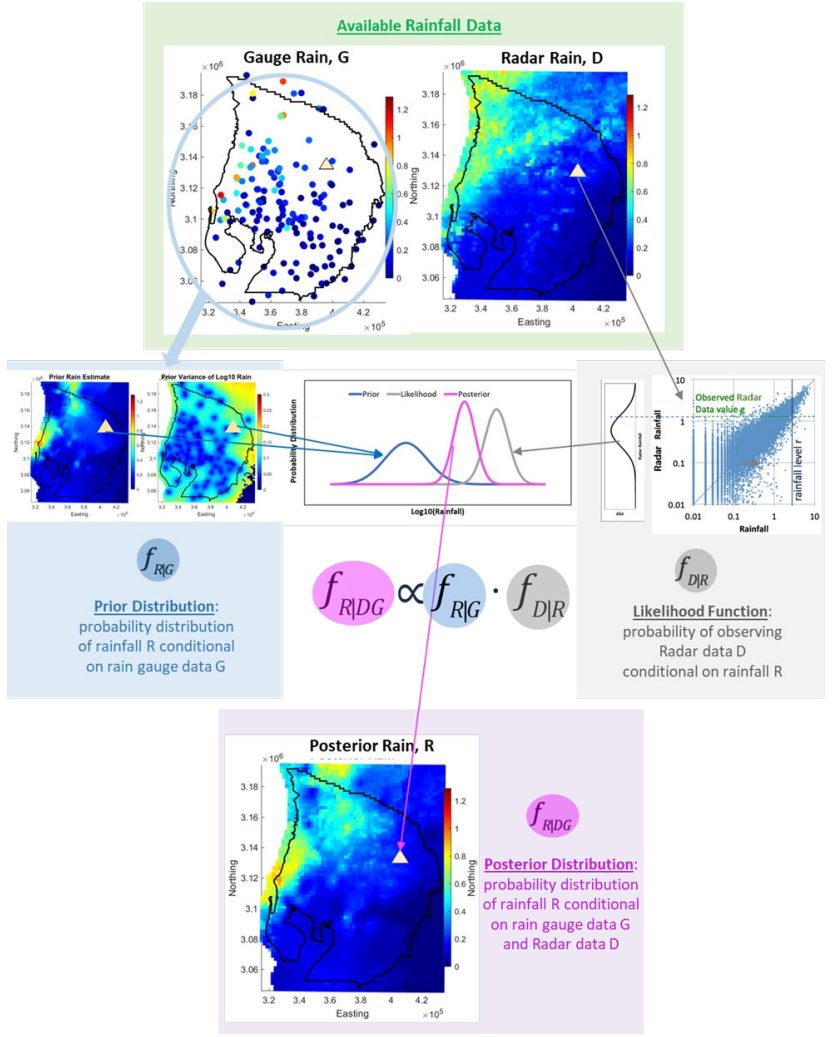
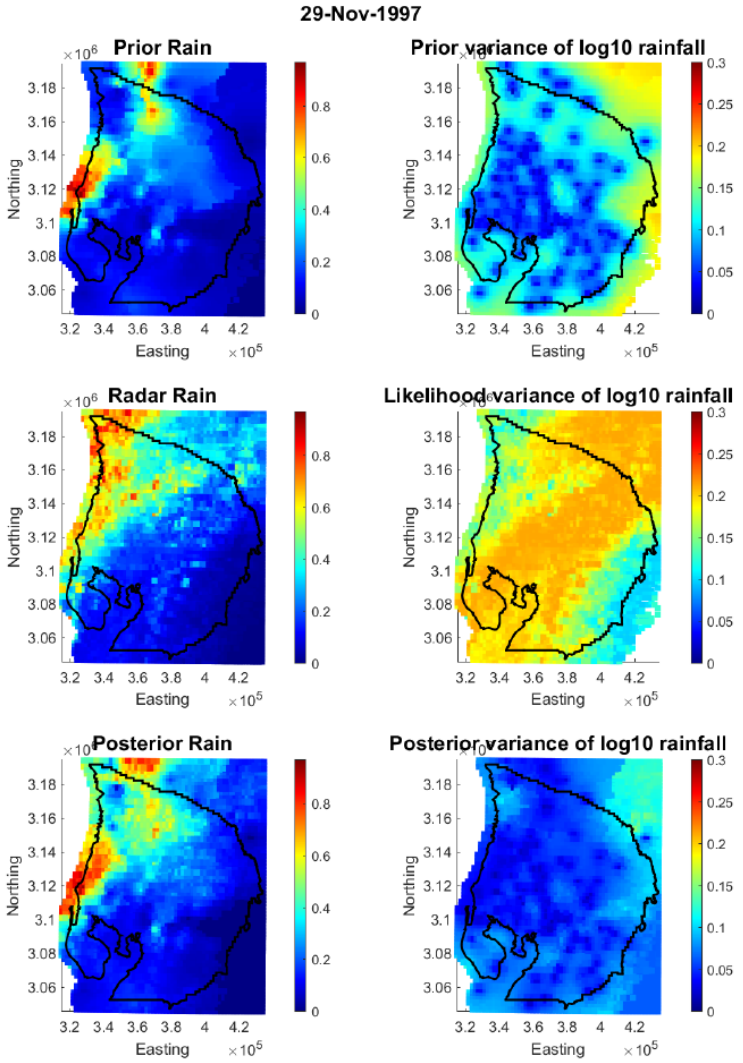
IHM & INTB Models; Continuous Improvement Input Data Examples

- 15-minute Bayesian radar rainfall (combine gauge & radar)
- Daily time series for pumping inputs
- Rigorous QC





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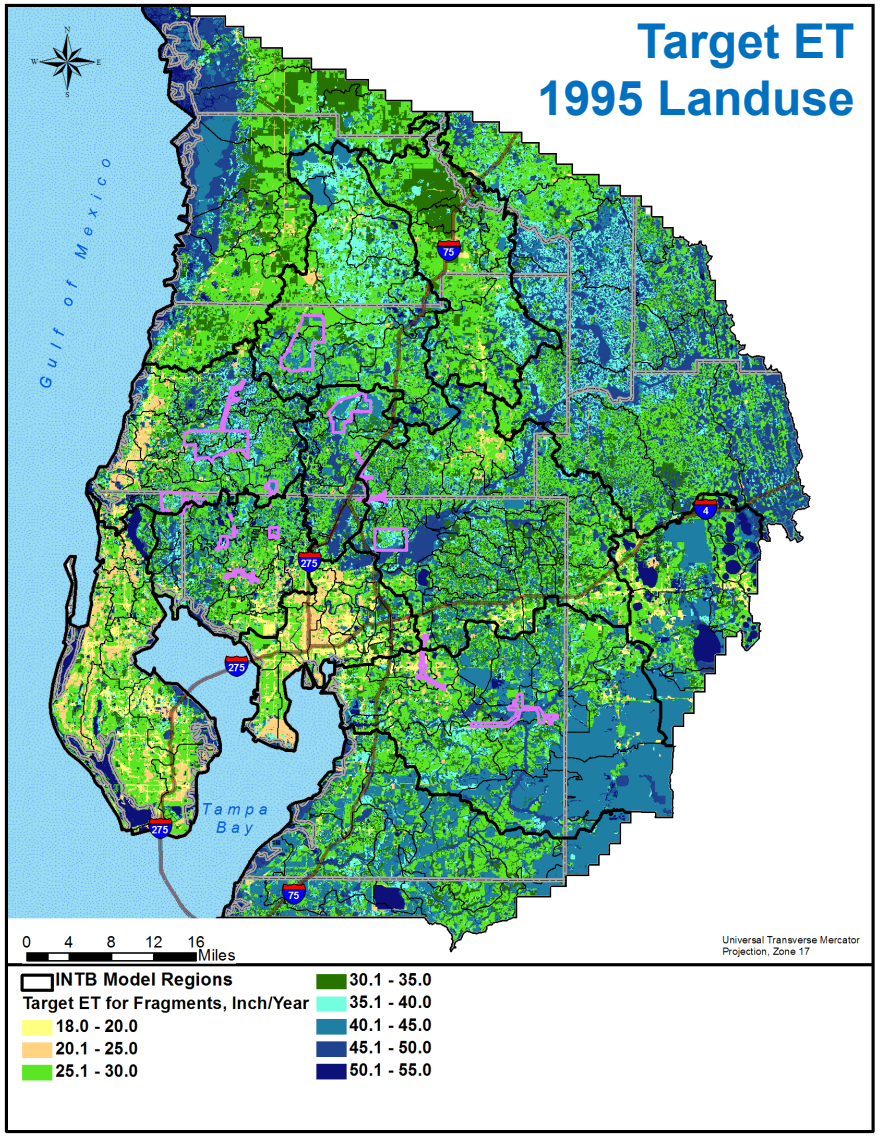
IHM & INTB Models; Continuous Improvement Target Data & Constraints Examples

- Daily time series
- Rigorous QC
- Objective weighting for calibration (type, statistical distribution, spatial distribution, standardized residuals)
- Target ET = function of landuse & DWT



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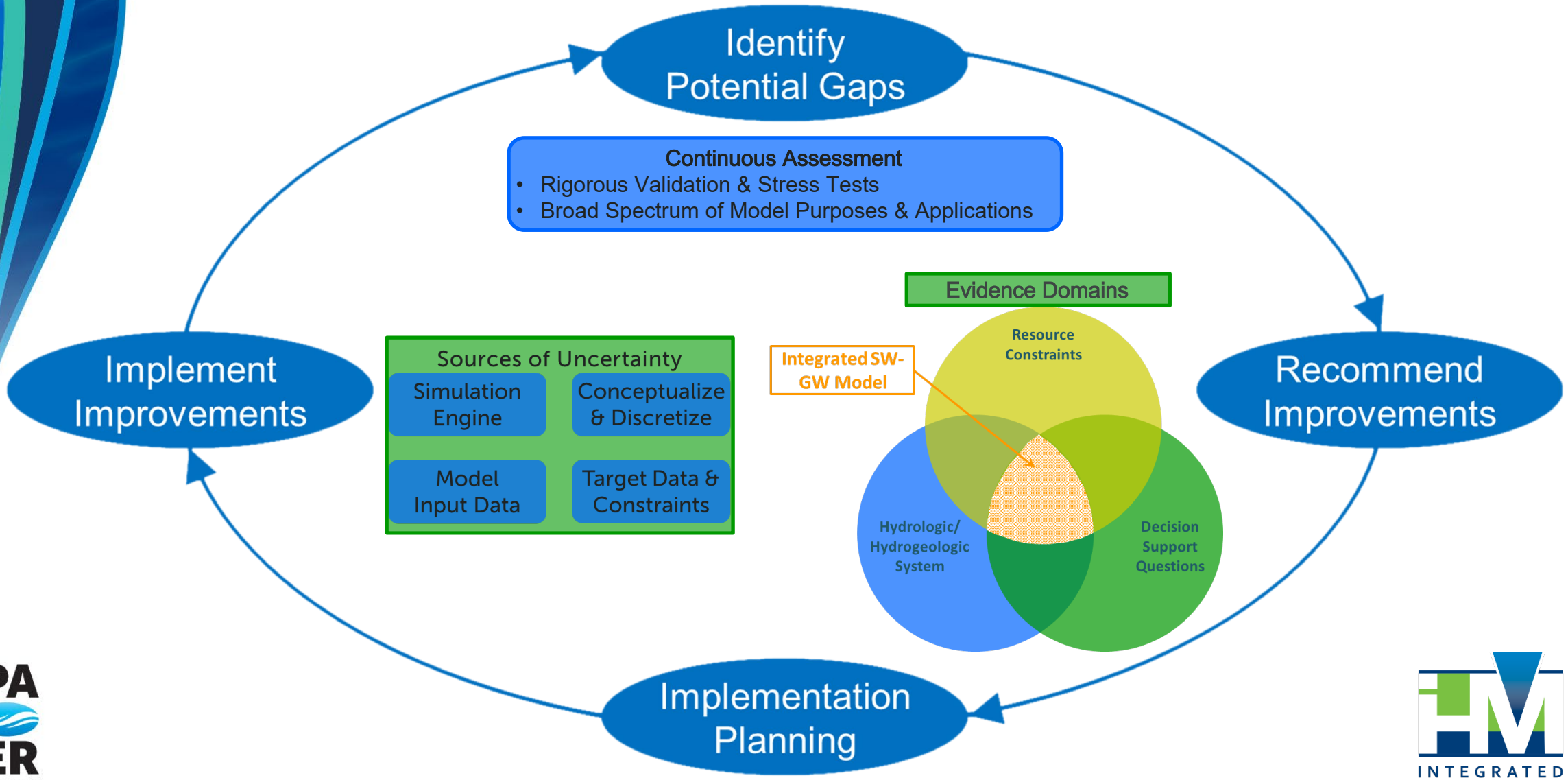
Continuous Improvement for IHM & INTB Models Summary



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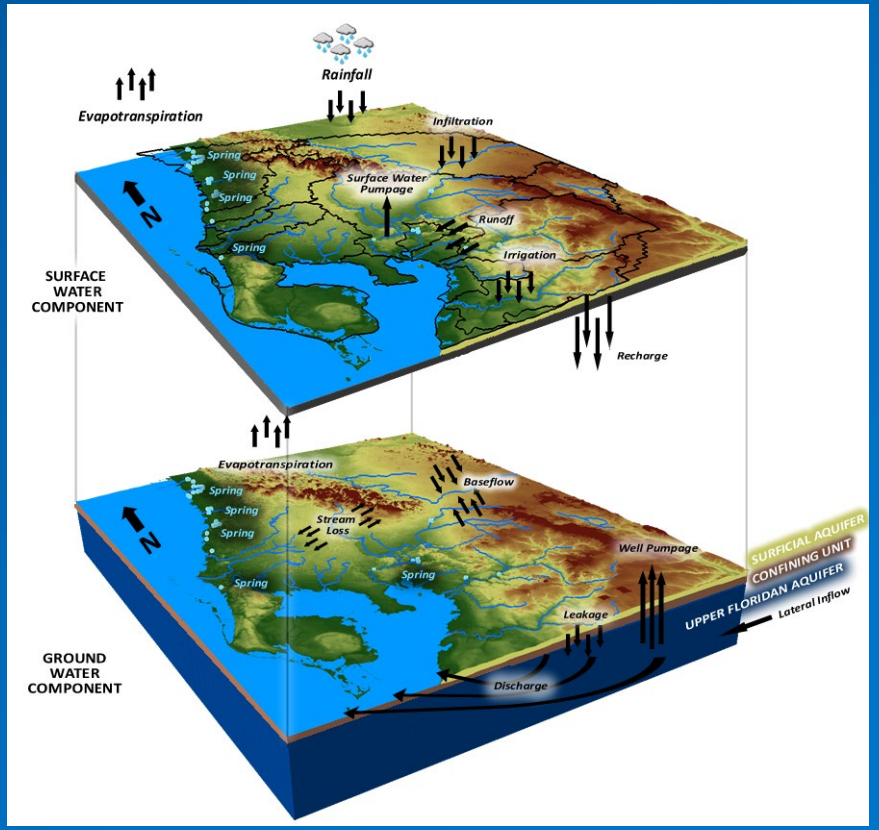
INTEGRATED HYDROLOGIC MODEL



Questions

INTEGRATED HYDROLOGIC MODEL

IHM website: IntegratedHydrologicModel.org

Integrated Hydrologic Model Continuous Improvement History

IHM Version or Developmental Phase	HSPF	MODFLOW	Database Technology	IHM Code Technology	Public Release	Date	Description
IHMv1	v12.0	MF-96	MS Access	VB.Net & VBA	NO	2001-2003	Original
IHMv2	v12.0	MF-96	MS Access	VB.Net & VBA	NO	2004-2009	Efficiencies, Code corrections & bugs
IHMv3	v12.2	MF-96	MS Access & SQL LocalDB	VB.Net & VBA	YES	2010-Current	Efficiencies, Code corrections & bugs, Peer Review 2018
IHMv4 Ph 1	v12.2	MF-96	SQL LocalDB	C#	NO	2018-Current	Technology upgrades
IHMv4 Ph 2	v12.2	MF-96	SQL LocalDB	C#	YES	2024	Subdaily IHM integration; Replace MF-96 with MF-USG & USG-Transport
IHMv4 Ph 3	v12.2	MF-USG & USG-Transport					
IHMv4 Ph 4	NEW	USG, USG-T	SQL LocalDB	C#	YES	~2026	[1] Improve IHM integration
IHMv4 Ph 5	NEW	USG, USG-T	SQL LocalDB	C#	YES	~2028	[2] Improve IHM integration

[1] *Improve IHM integration Ph 4*: Brooks-Corey soil moisture model, Green-Ampt infiltration, Vertical percolation, Transitions between infiltration- & saturation-excess, Improve ET partitioning between vadose and groundwater

[2] *Improve IHM integration Ph 5*: Improve timing and magnitude of recharge to groundwater, Integration uses static top-most active layer, Integration spans multiple MODFLOW layers, Reduce specific yield correction; Specific yield options

Integrated Northern Tampa Bay Model Continuous Improvement History

INTB Version	IHM Version	Landuse Year	Rainfall Sources	Basin Count	Land Segments / Reaches	Groundwater Grid	Date	Description
INTB1	IHMv3	1995	Gauged	172	815 / 409	Structured; Core area cell size 1320 ft	2009-Current	Original; Peer Review 2013
INTB2	IHMv4 Ph1, IHMv4 Ph3	1995	Bayesian: Merge Radar with Gauged	172	815 / 409	Structured; Core area cell size 1320 ft	2023	Reduce variance error; Recalibrate using Bayesian rain
INTB2x	IHMv4 Ph3	2010	Bayesian	172	815 / 409	Structured; Core area cell size 1320 ft	~2025	Landuse change
INTB3/3x	IHMv4 Ph5	TBD	Bayesian	>172	>815 / >409	Unstructured; Core area cell size <1320 ft	~2029	Reduce variance error; Change IHM code; Change conceptual model & reduce discretization scale; Recalibration