Numerical Model for Short-Term Forecasting of Everglades Hydrology Using a Current Conditions Water-Level Network

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GEER 2017
Greater Everglades Ecosystem Restoration
Advancing Science, Restoring the Everglades

Hydrologic forecasting with a numerical model

- Simulate and calibrate model based on known time period
- Modify model parameters to represent potential future conditions
- Gain insight from modified simulation
- Doesn’t relate directly to daily management operations

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What is EDEN?

- An integrated network of water-level gages,
- Ground elevation and surface-water level models,
- Daily water-depth and water-surface maps, and
- Online applications to evaluate critical habitats

RECOVER: Restoration Coordination & Verification
A Federal-State (Florida) partnership

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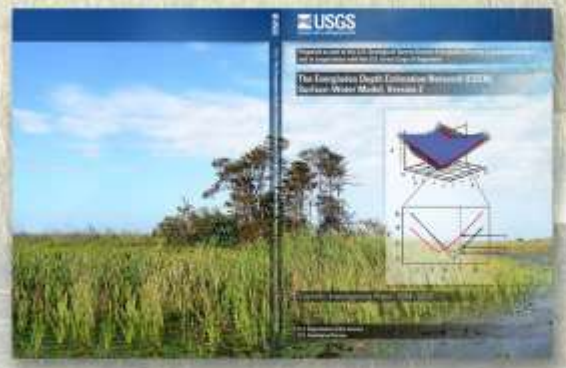

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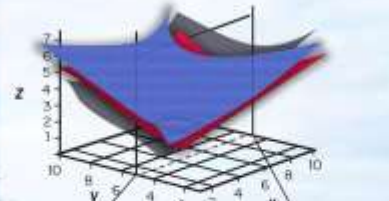
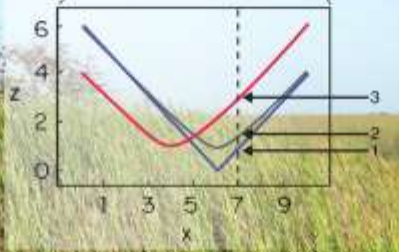
Prepared as part of the U.S. Geological Survey Greater Everglades Priority Ecosystems Science

The Everglades Depth Estimation Network (EDEN) Surface-Water Model, Version 2





Scientific Investigations Report 2014-5209

U.S. Department of the Interior
U.S. Geological Survey

http://pubs.usgs.gov/sir/2014/5209/pdf/sir2014-5209.pdf

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From monitoring data to water-level surfaces

WATER-LEVEL SURFACES

Daily, from 1991 – present

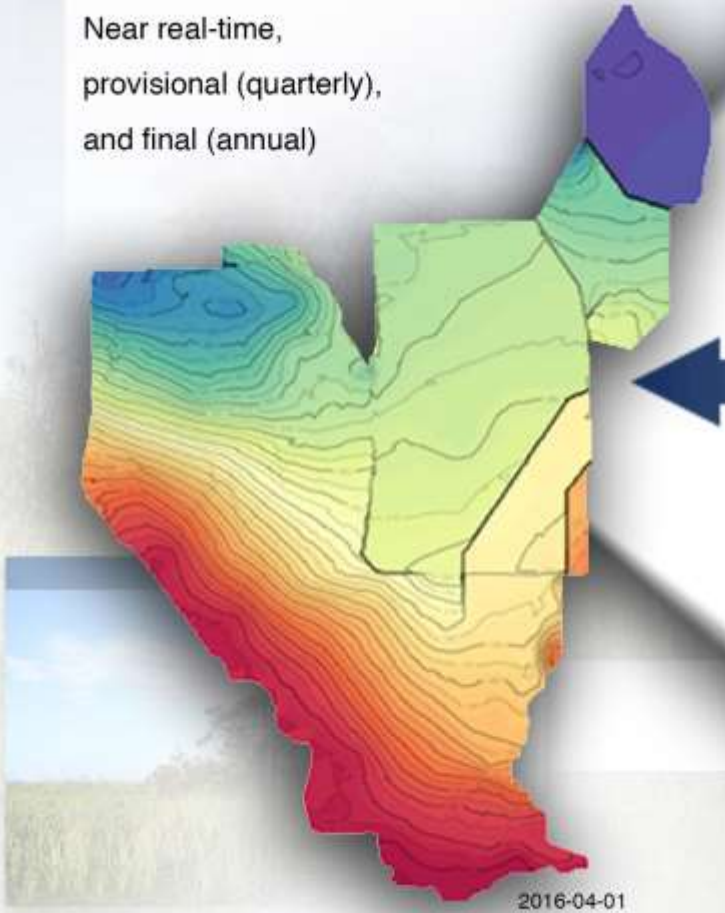
400 x 400 meter grid (over 57,000 cells)

Data Review:

Near real-time,

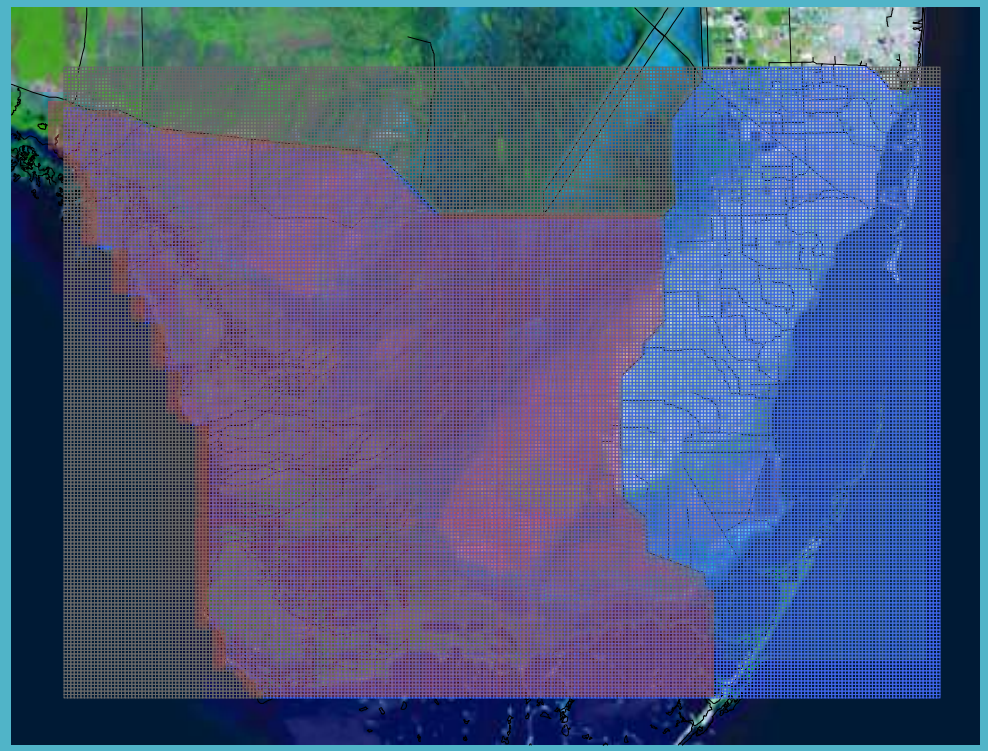
provisional (quarterly),

and final (annual)



FTLOADDS Simulator used to develop BISECT model

- Coupled hydrodynamic surface-water/groundwater simulator
  - Simulates flow and salinity transport in both surface water and groundwater
  - Constructed from the SWIFT2D surface-water and SEAWAT groundwater simulators



- SPATIAL GRID SCALE:
  - Rows: 186 (500 Meters)
  - Columns: 259 (500 Meters)
  - Layers: 15 (1-11 2 Meters, layers 12-15 Vary Based upon bottom of geological units)
- TEMPORAL SCALE:
  - Surface water: 5 minute
  - Groundwater: Daily
  - Simulation Period:
    - 1996-2004

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FTLOADDS (Flow and Transport in a Linked Overland/Aquifer Density Dependent System) Combines:

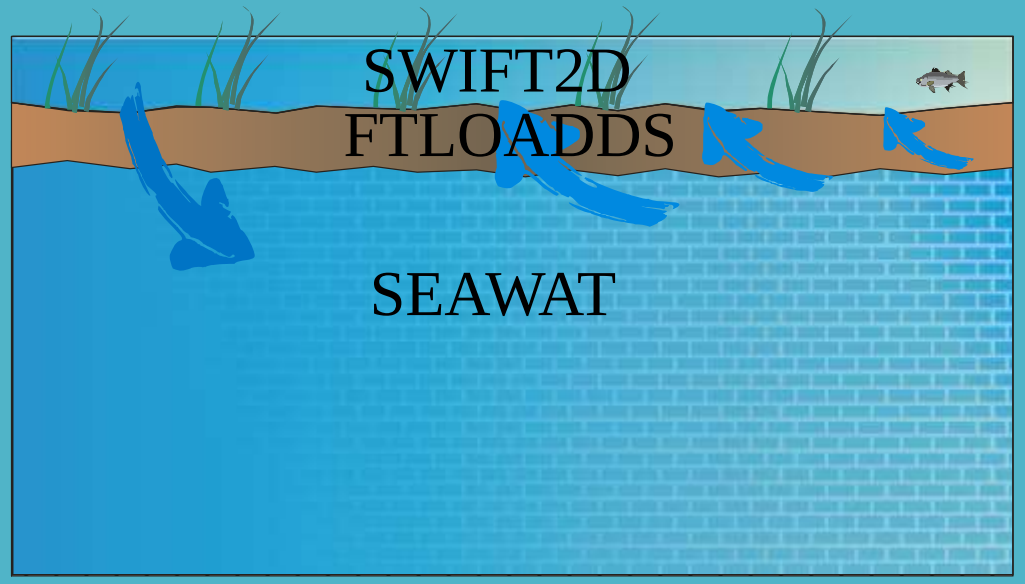
- ***SWIFT2D*** *hydrodynamic surface water code*
- ***SEAWAT*** *variable density ground-water flow and transport code*

Satisfies requirements for modeling South Florida

- *Hydrodynamic representation of surface water in two-dimensions*
- *Three dimensional representation of groundwater*
- *Salinity transport is represented in each model and passed with leakage*

Modifications

- *Heat Transport*
- *Interfaces with other models*



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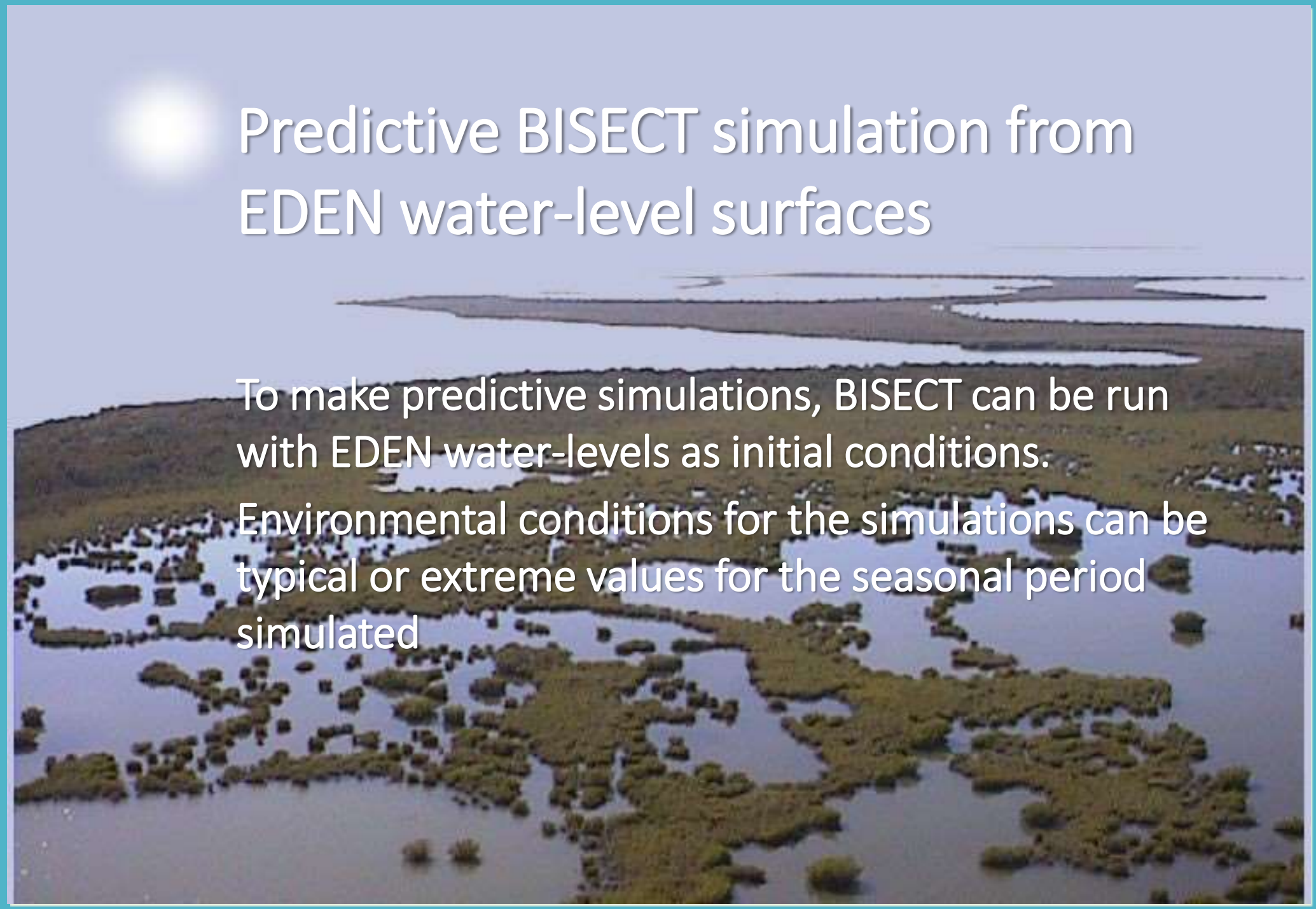
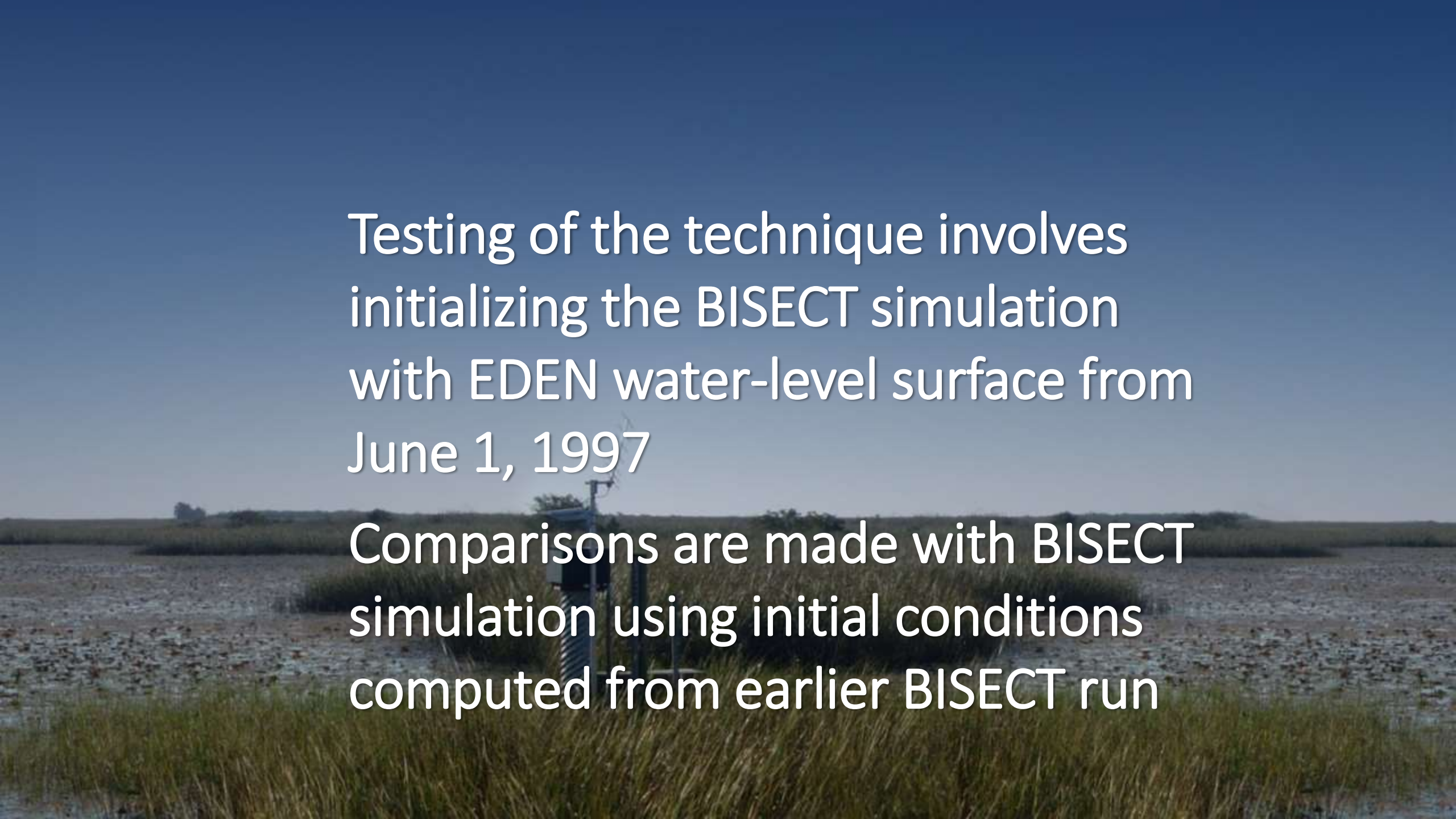
Predictive BISECT simulation from EDEN water-level surfaces



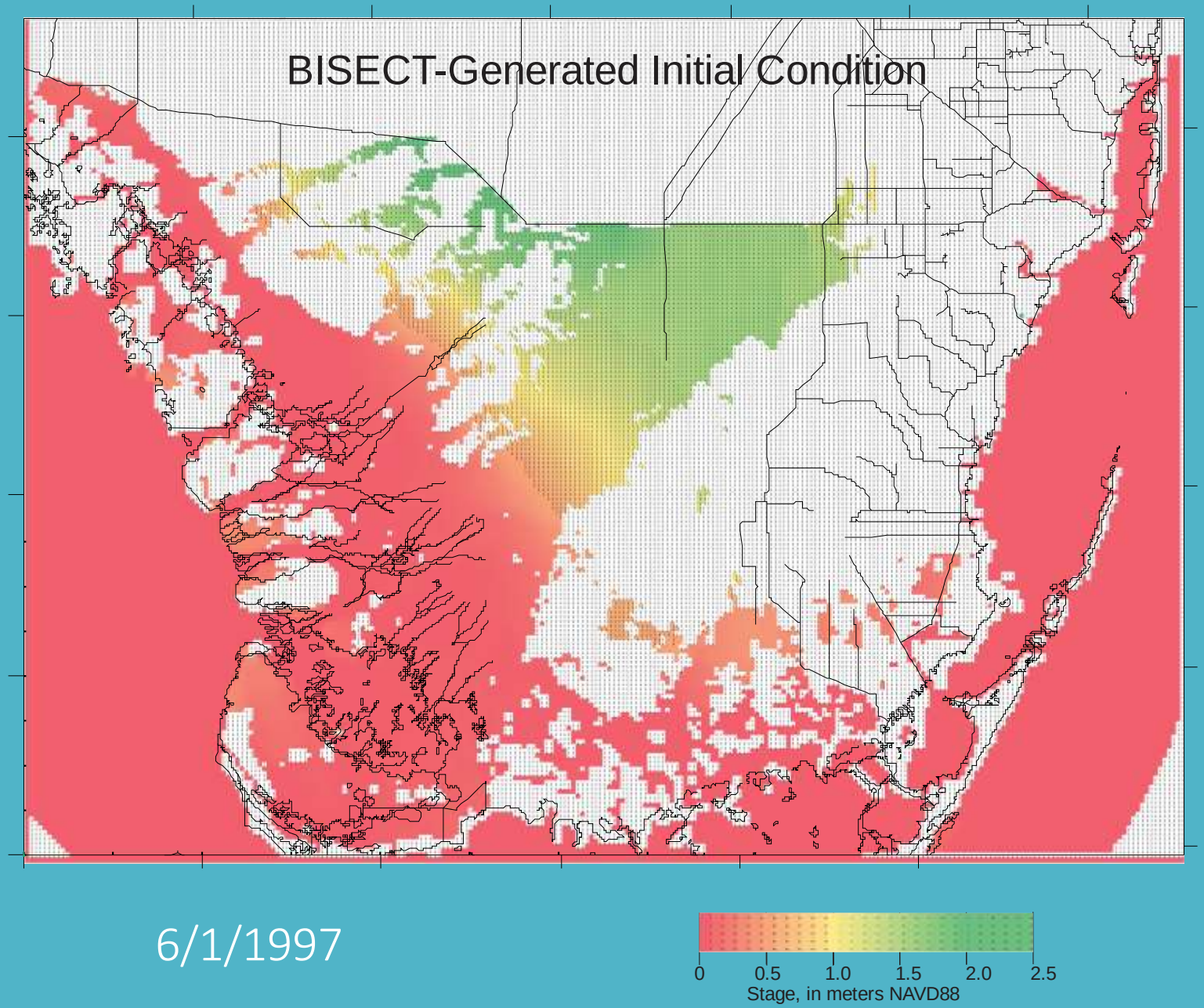
To make predictive simulations, BISECT can be run with EDEN water-levels as initial conditions.

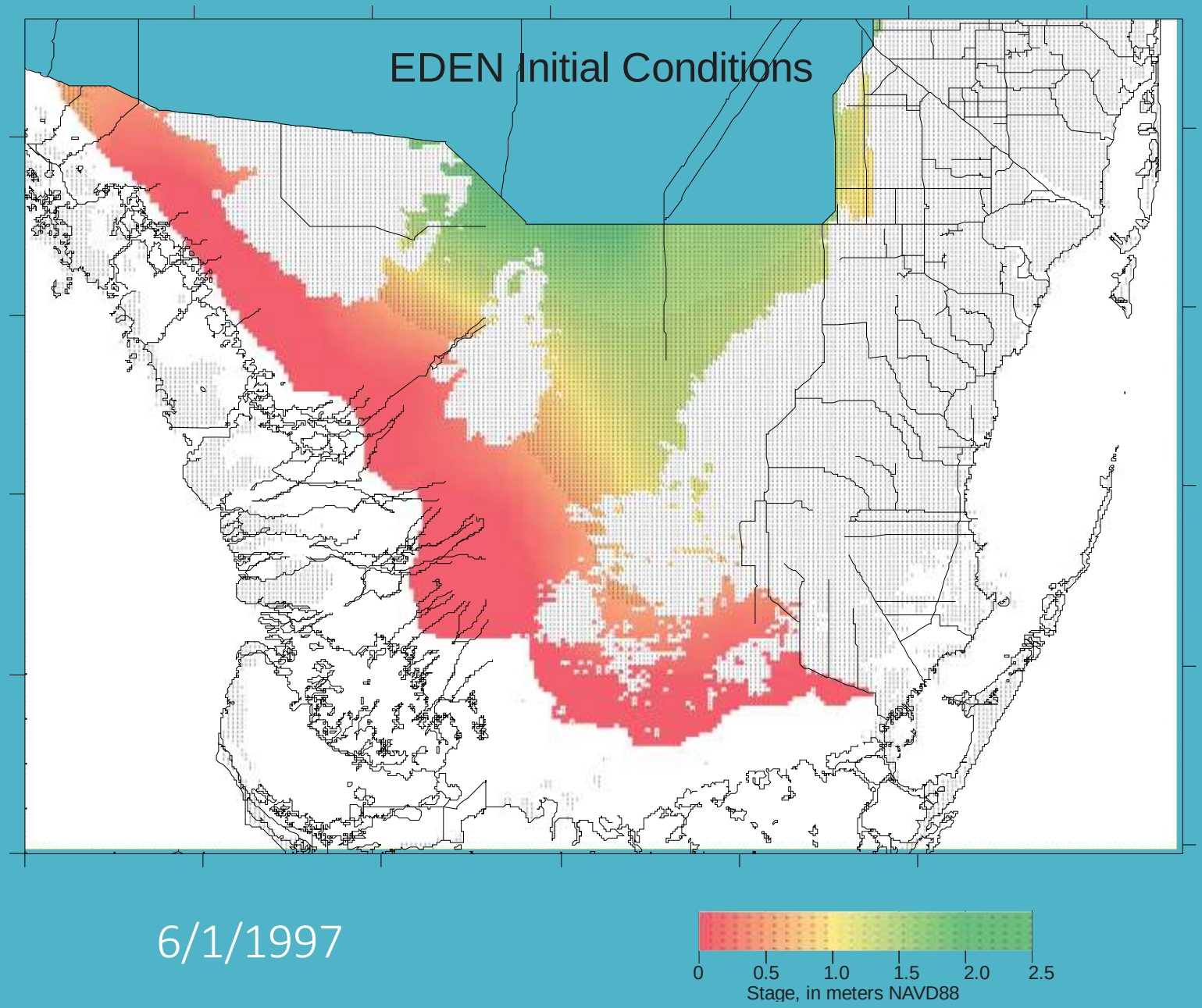
Environmental conditions for the simulations can be typical or extreme values for the seasonal period simulated

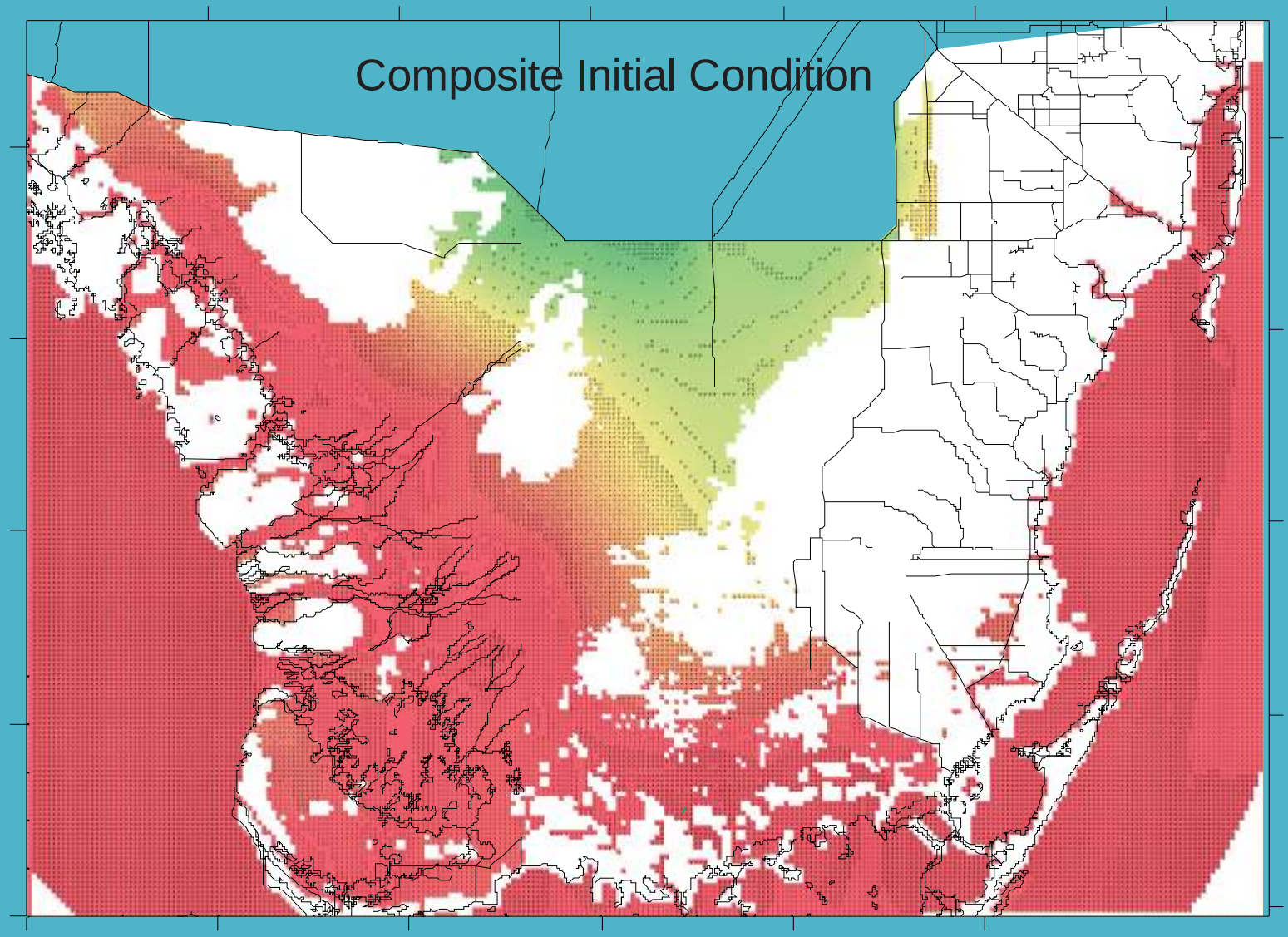


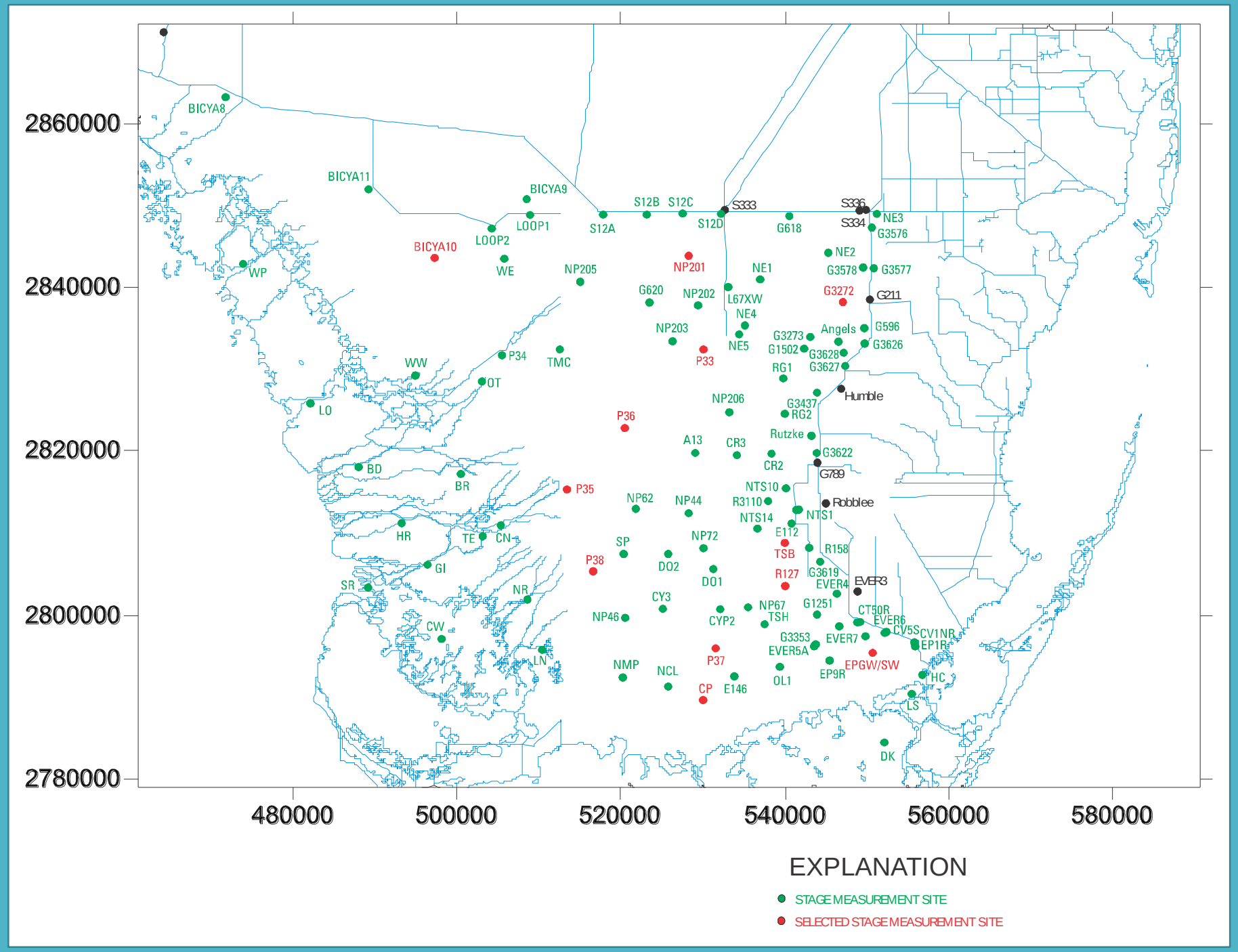
Testing of the technique involves initializing the BISECT simulation with EDEN water-level surface from June 1, 1997

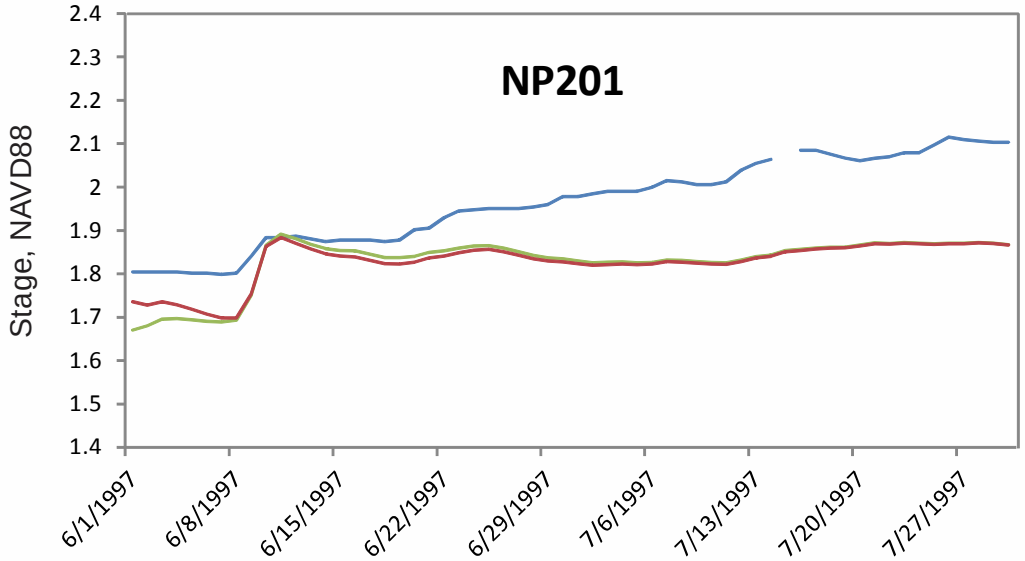
Comparisons are made with BISECT simulation using initial conditions computed from earlier BISECT run

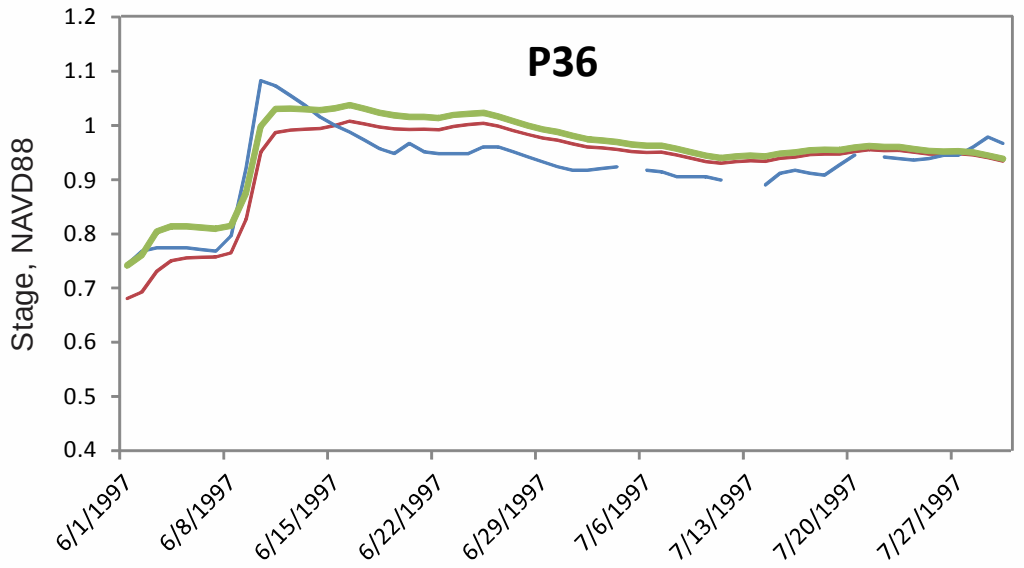

BISECT-Generated Initial Condition
6/1/1997
0
0.5
1.0
1.5
2.0
2.5
Stage, in meters NAVD88

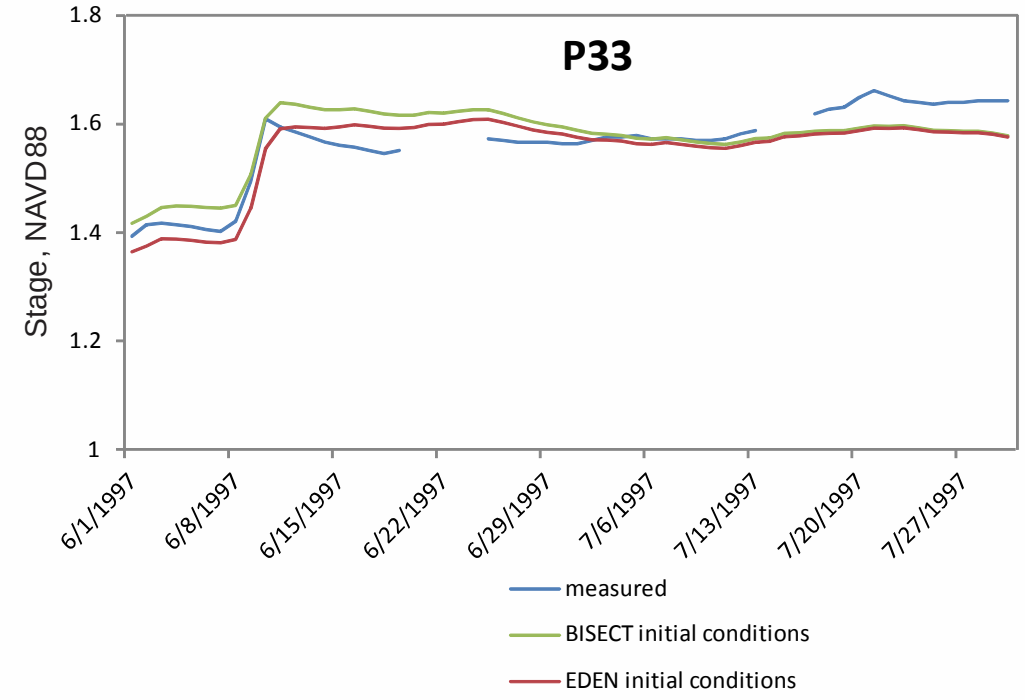

EDEN Initial Conditions
6/1/1997
0
0.5
1.0
1.5
2.0
2.5
Stage, in meters NAVD88

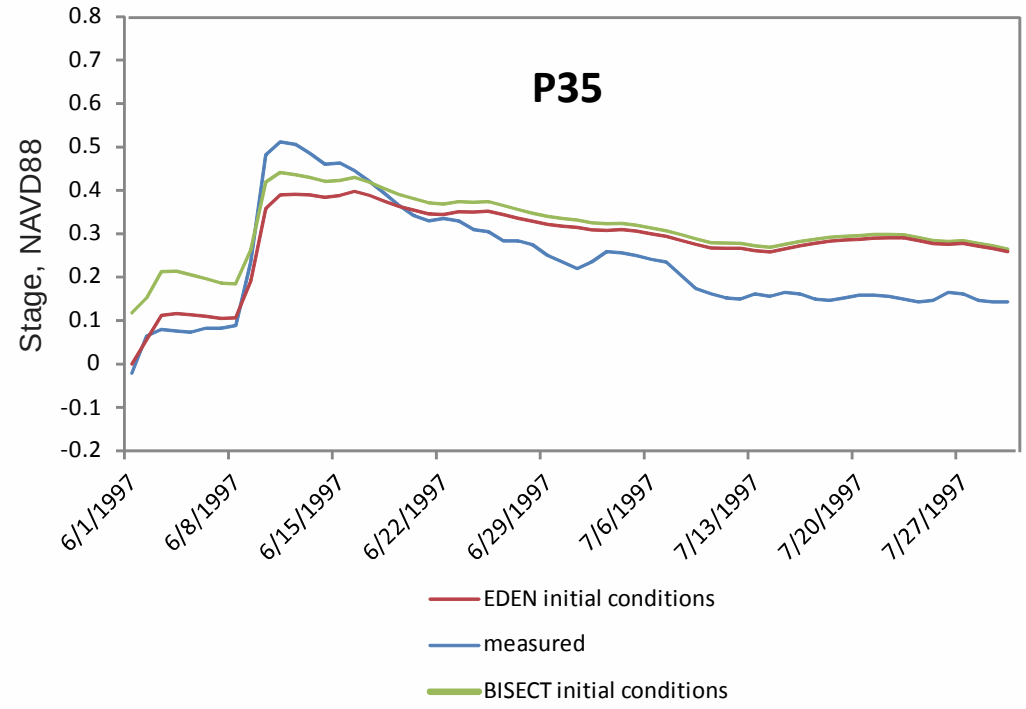

Composite Initial Condition
6/1/1997
0
0.5
1.0
1.5
2.0
2.5
Stage, in meters NAVD88

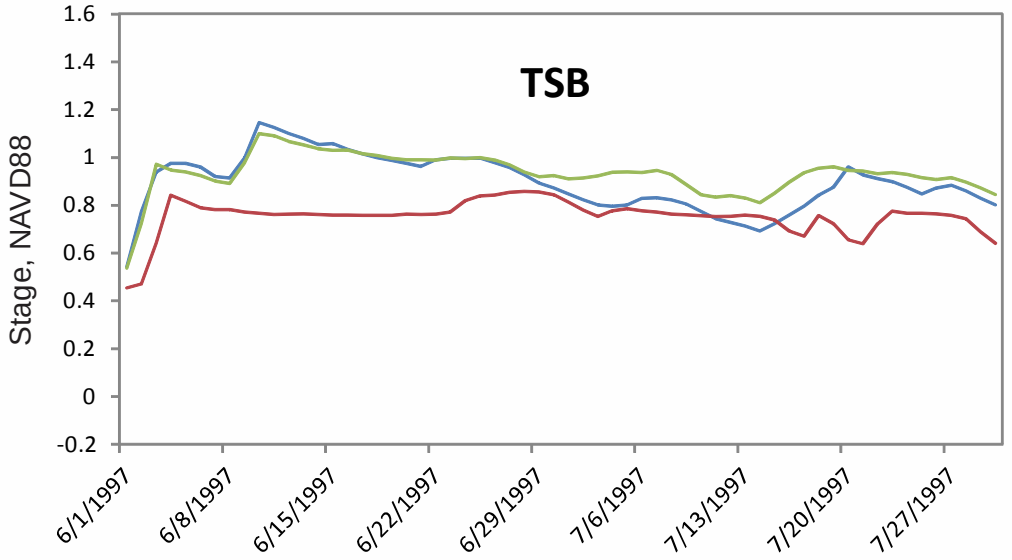

2860000
2840000
2820000
2800000
2780000
480000
500000
520000
540000
560000
580000
BICYA8
BICYA11
BICYA9
BICYA10
LOOP1
LOOP2
S12A
S12B
S12C
S12D
S333
S336
S334
NE3
G3576
G618
NE2
G3578
G3577
NP201
NE1
NP205
WP
WE
G620
NP202
L67XW
G3272
G211
NE4
NP203
Angels
G596
G3273
G1502
G3628
G3626
NE5
P33
P34
TMC
RG1
G3627
WW
OT
Humble
LO
NP206
G3437
RG2
P36
Rutzke
A13
CR3
G3622
CR2
G789
BD
BR
P35
NTS10
NP62
NP44
R3110
Robblee
NTS14
NTS1
HR
TE
CN
E112
NP72
SP
TSB
R158
P38
DO2
R127
G3619
GI
DO1
EVER4
EVER3
SR
NR
CY3
NP67
G1251
CT50R
NP46
CYP2
TSH
EVER6
CV5S
CV1NR
CW
G3353
EVER7
EP1R
EVER5A
P37
EPGW/SW
LN
NMP
NCL
EP9R
HC
OL1
CP
E146
LS
DK
EXPLANATION
STAGE MEASUREMENT SITE
SELECTED STAGE MEASUREMENT SITE

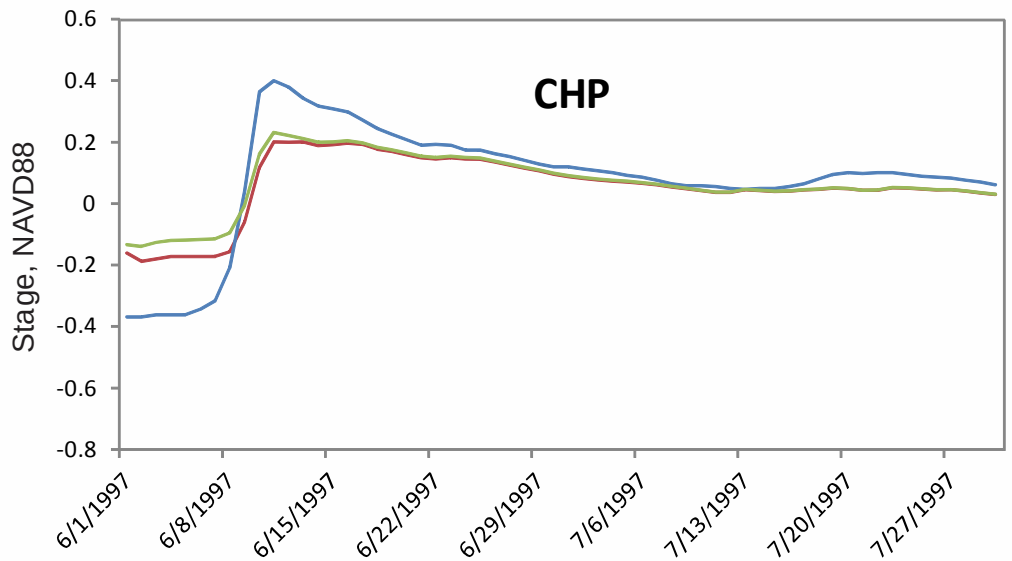

NP201
Stage, NAVD88
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997

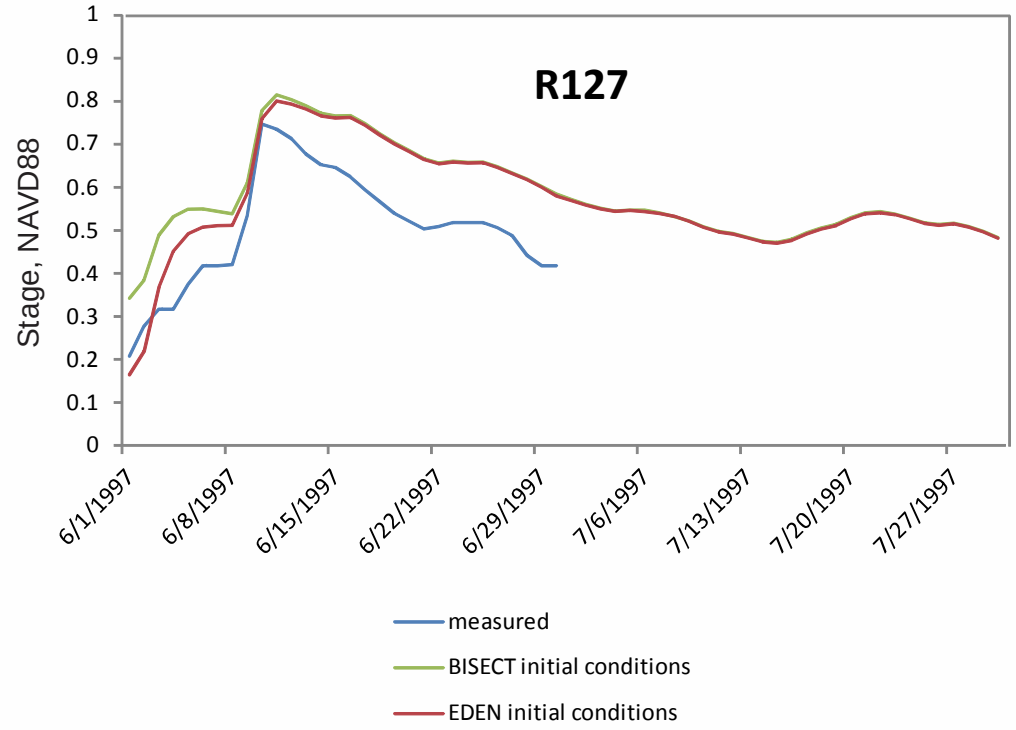

P36
Stage, NAVD88
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997

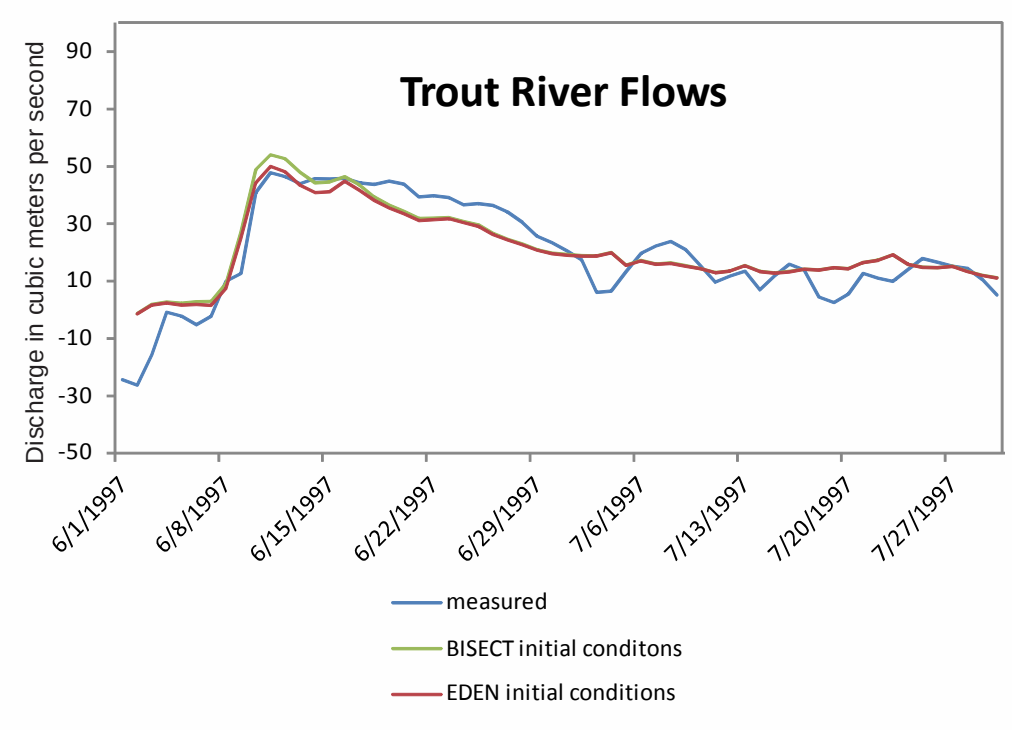

P33
Stage, NAVD88
1.8
1.6
1.4
1.2
1
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997
measured
BISECT initial conditions
EDEN initial conditions


P35
Stage, NAVD88
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997
EDEN initial conditions
measured
BISECT initial conditions


TSB
Stage, NAVD88
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997


CHP
Stage, NAVD88
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997


R127
Stage, NAVD88
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997
measured
BISECT initial conditions
EDEN initial conditions


Trout River Flows
Discharge in cubic meters per second
90
70
50
30
10
-10
-30
-50
6/1/1997
6/8/1997
6/15/1997
6/22/1997
6/29/1997
7/6/1997
7/13/1997
7/20/1997
7/27/1997
measured
BISECT initial conditons
EDEN initial conditions

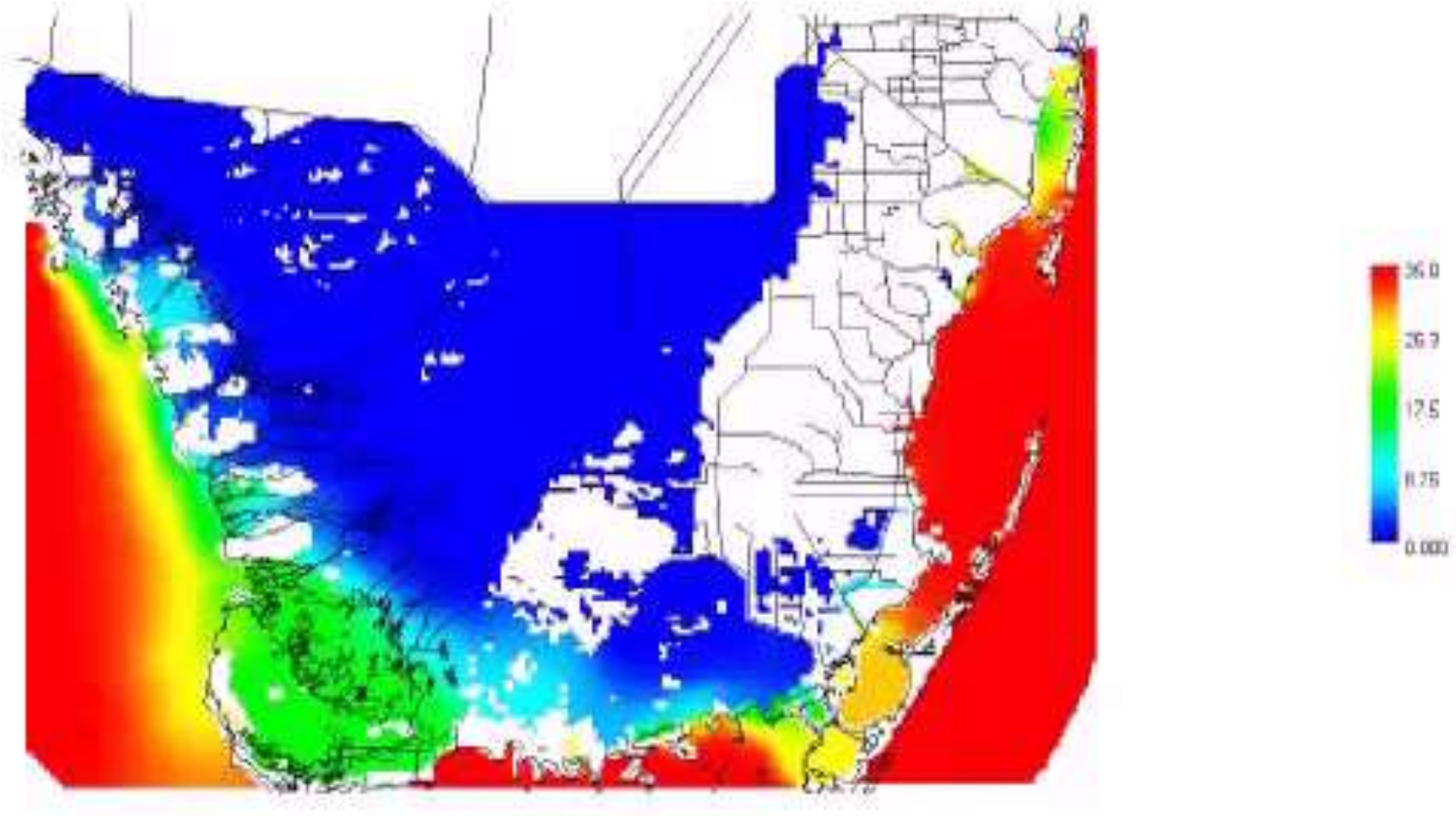
Implementing EDEN/BISECT short-term forecast

1) The environmental conditions for the predictive simulation are numerous and varied; parameters such as wind, evapotranspiration, and sea-level can be set to typical values for the dates simulated.
2) Controlling variables such as rainfall and control-structure operations can be defined by the user; a selection of high, average, or low rainfall series and defined structure inflows and outflows.
3) A real-time predictive tool for the Everglades will provide water managers such as ACOE and SFWMD planning information, especially when the effects of storm events can be simulated.

A hydrodynamic simulation is ideal for a short-term prediction of hydrologic response to a Hurricane strike

- During **major storm events**, dynamic inundation brings water and salinity ashore
- A user could choose a particular hurricane configuration and strike date and simulate a near future event
- Can be used for water management planning and forecasting

Hurricane Wilma



Time = 259 (9-16-1996)

Consideration for user interaction

- Numerical simulation may take significant time (minutes) which is not amenable to online results
- When allowing various options for control inflows, rainfall, and especially storm configurations, the number of potential simulations becomes quite large.
- The numerical model has prodigious output including surface water, groundwater, and salinity parameters, so output display is complex and difficult.

Question?

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