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Advancements in Representing Everglades Hydrology With Data Integration and Physics-Based Models

Greater Everglades Ecosystem Restoration (GEER)
April 22-25, 2019

Eric Swain
Leonard Pearlstine
Saira Haider
James Beerens
Tiffany Troxler
Melinda Lohmann

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NATIONAL PARK SERVICE

EVERGLADES DEPTH ESTIMATION NETWORK
EDEN

http://sofia.usgs.gov/eden/

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

RECOVER
assessment
science
integration
evaluation

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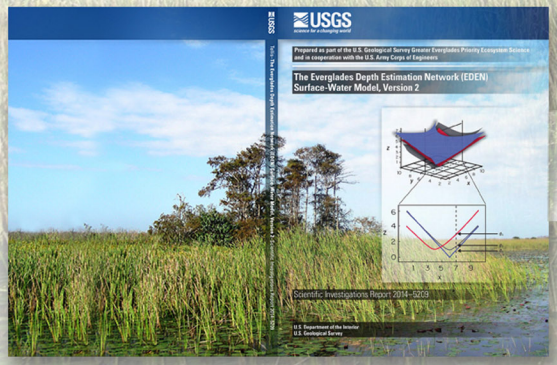

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Tellis—The Everglades Depth Estimation Network (EDEN) Surface-Water Model, Version 2—Scientific Investigations Report 2014–5209

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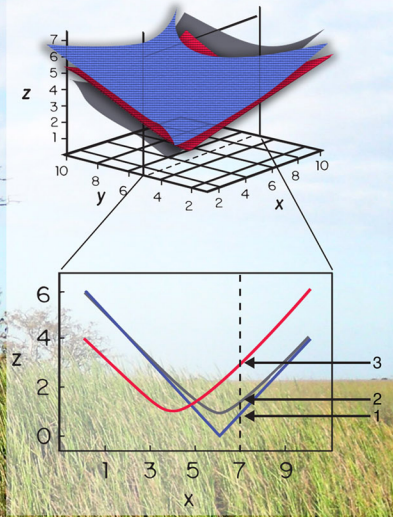
Prepared as part of the U.S. Geological Survey Greater Everglades Priority Ecosystems Science

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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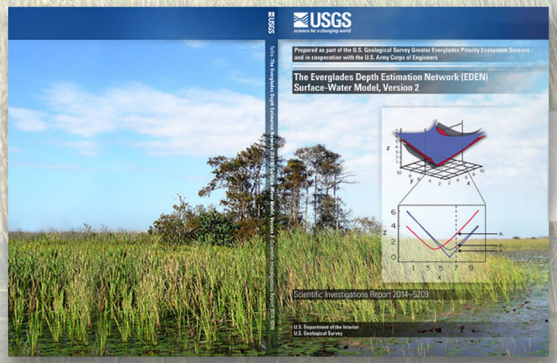
The Monitoring Network

314 water-level stations are served by EDEN

and operated by:

- USGS
- Everglades National Park
- Big Cypress National Preserve
- South Florida Water Management District

275 are real-time



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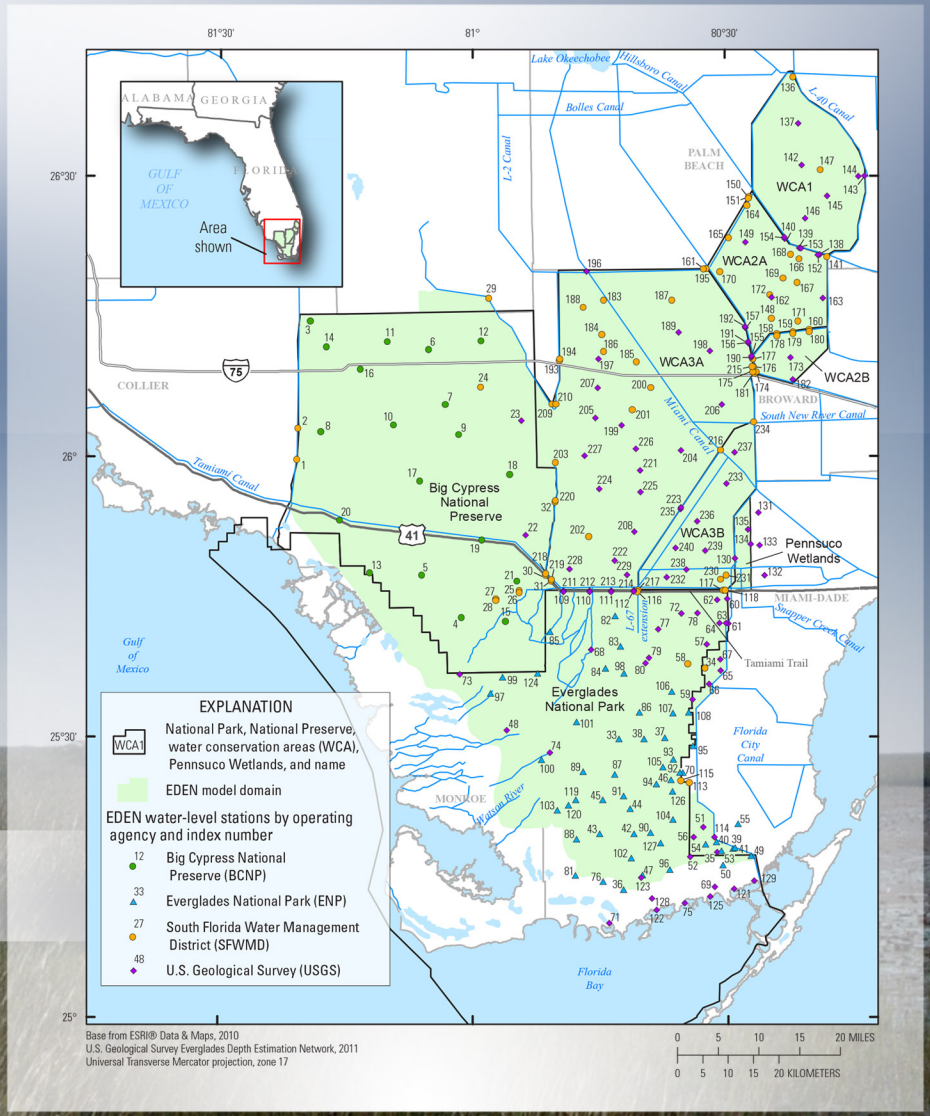


From monitoring data to water-level surfaces

WATER-LEVEL SURFACES

Daily, from 1991 – present

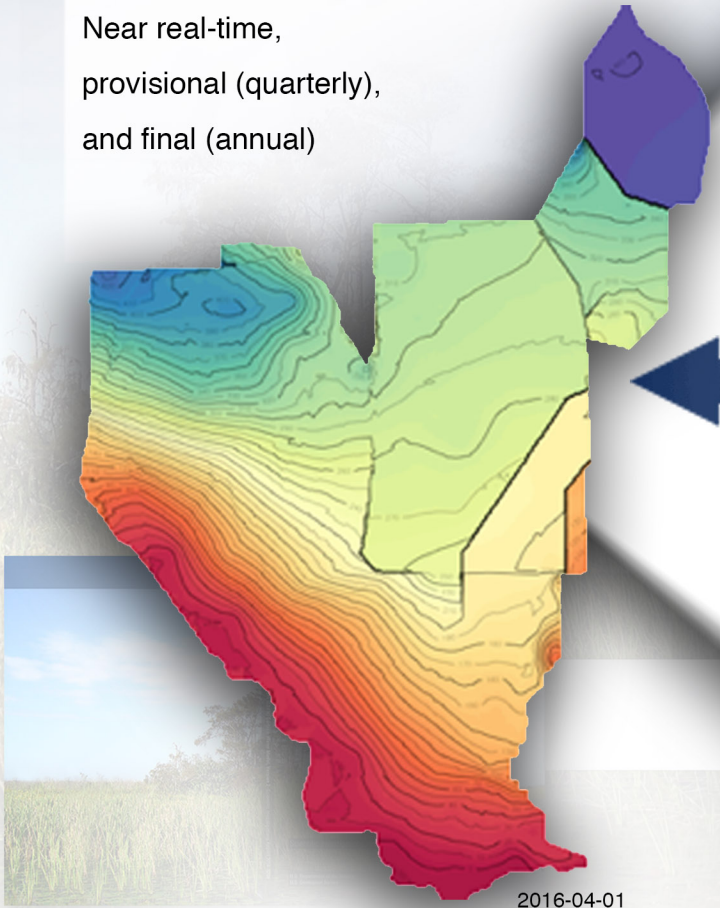
400 x 400 meter grid (over 57,000 cells)

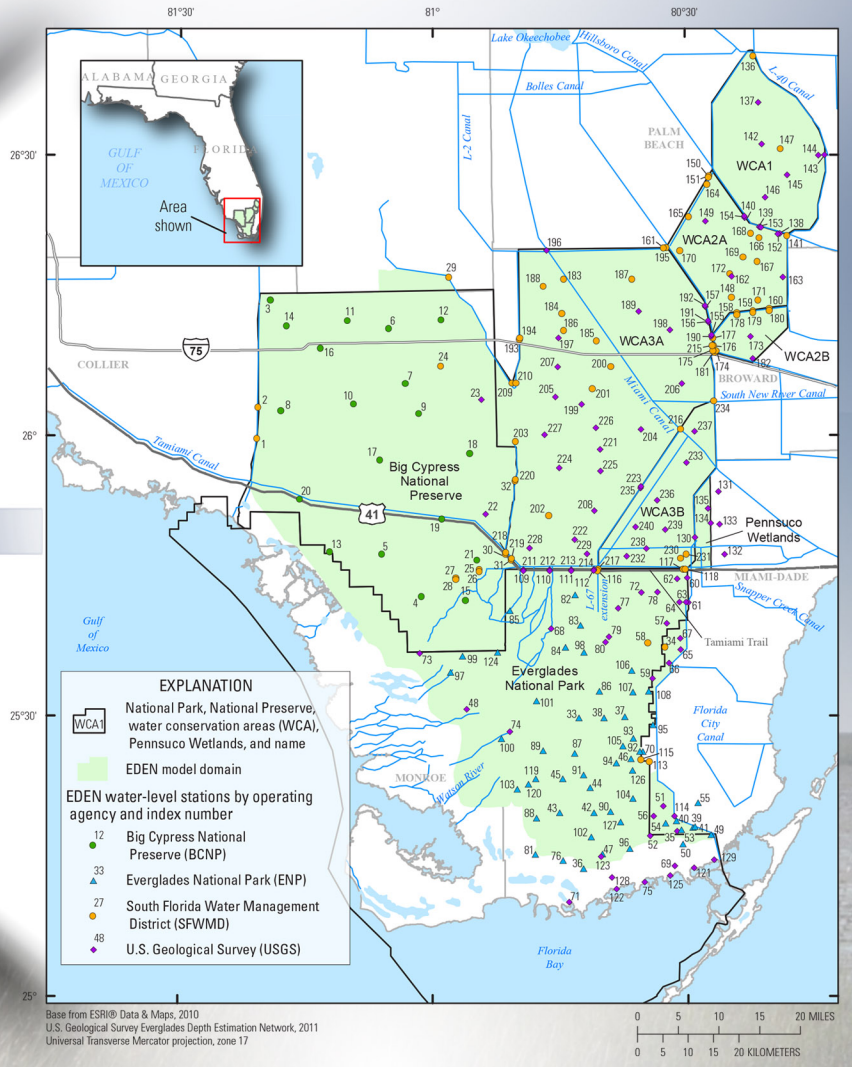
Data Review:

Near real-time,

provisional (quarterly),

and final (annual)





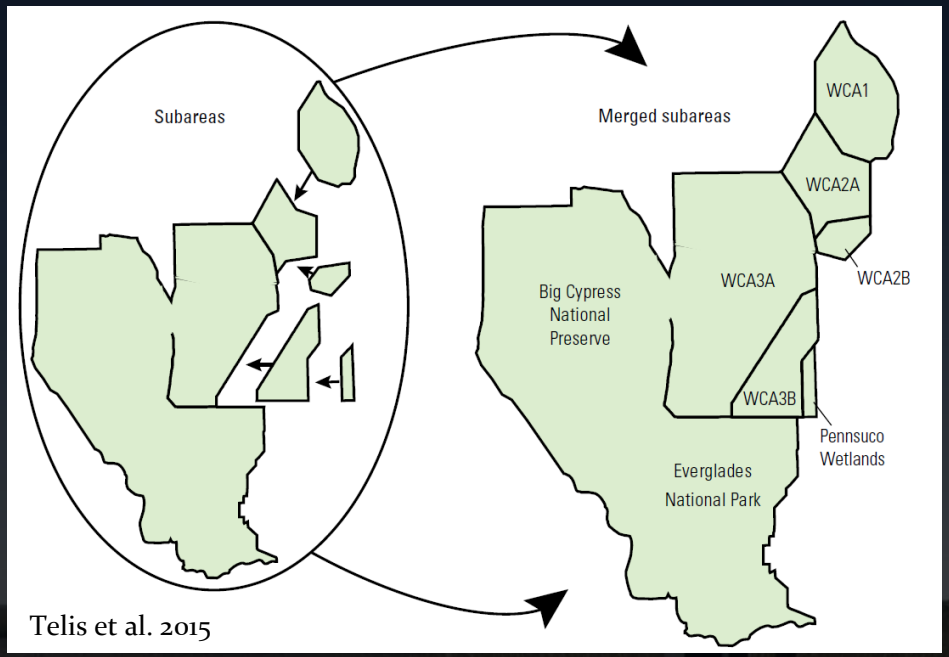
Migration to R in v3

Transparency

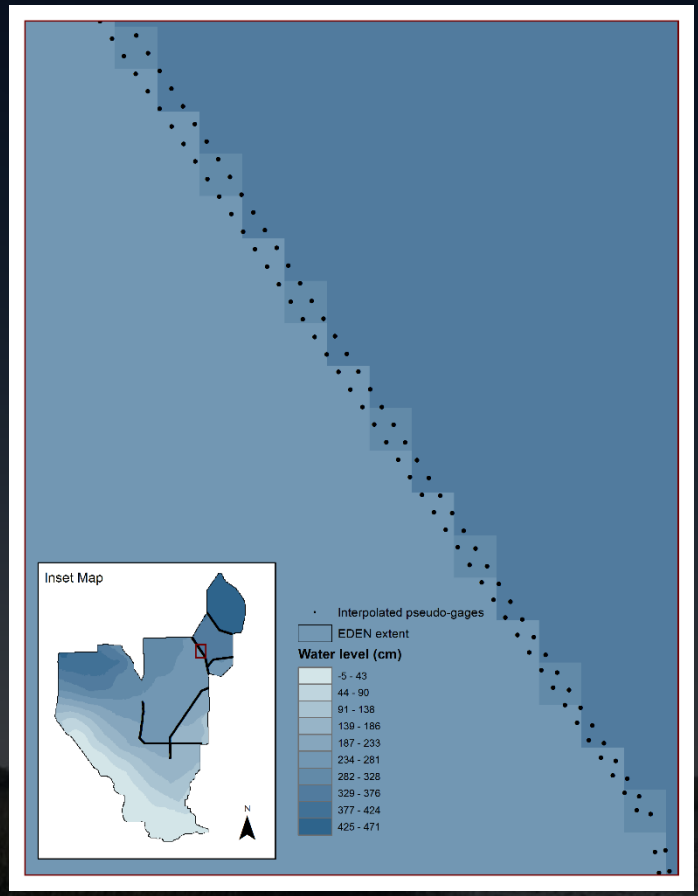
Efficiency

Computational speed

Subareas in v2:



Telis et al. 2015



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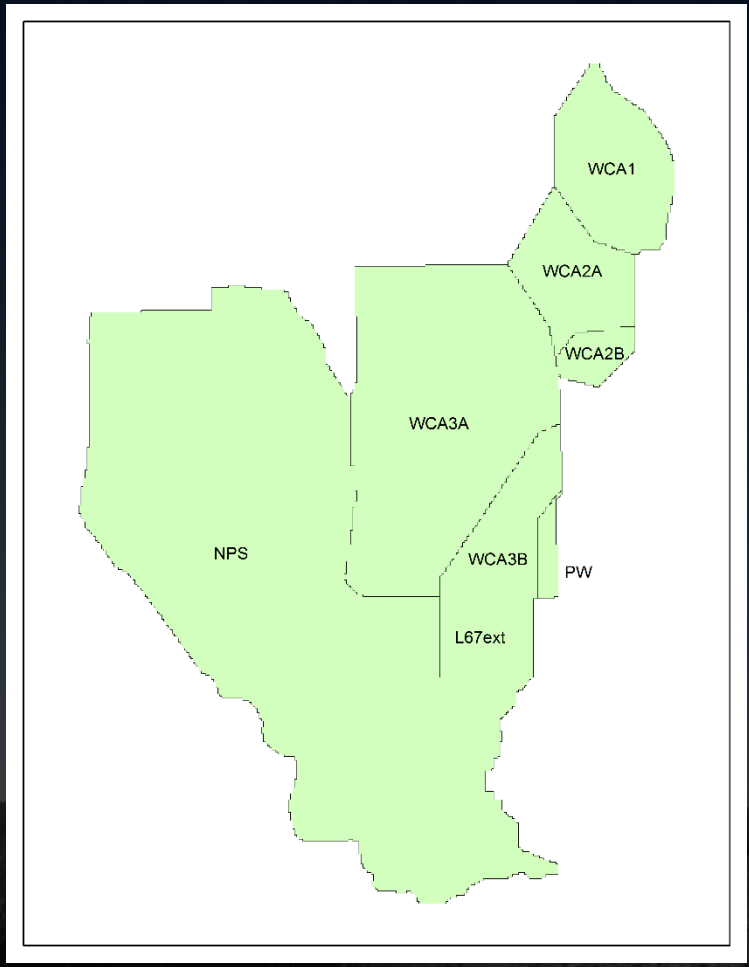
Subareas in v3:

- 8 subareas (5 in v2)



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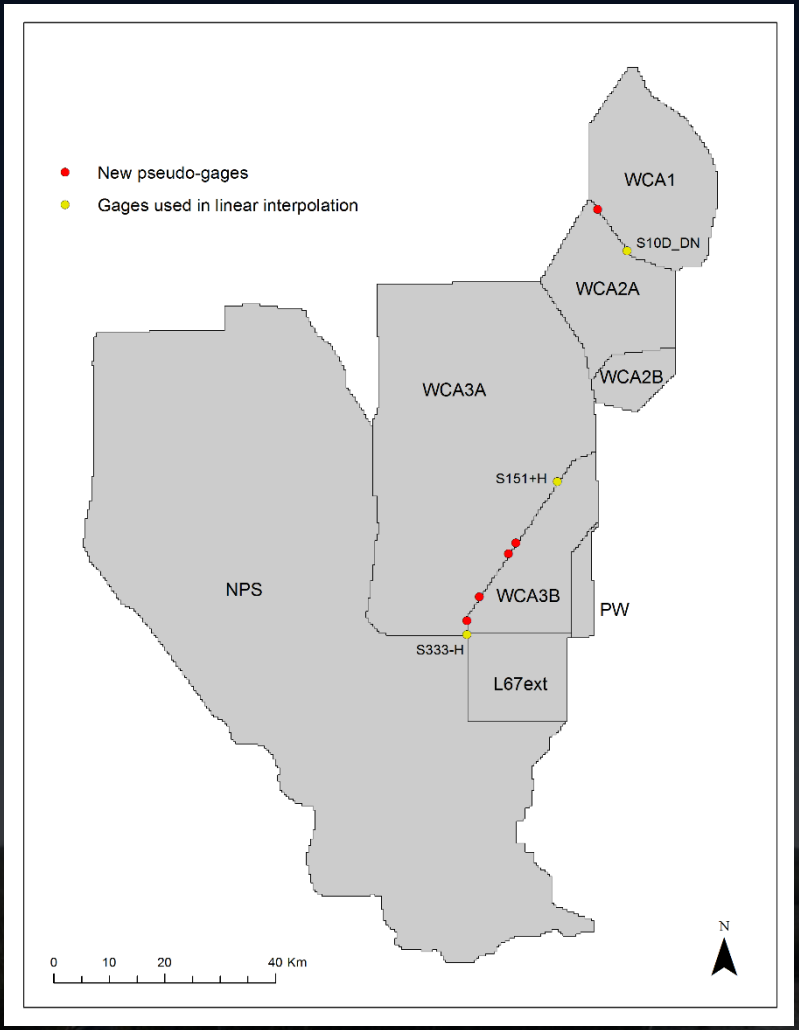
New pseudo-gages



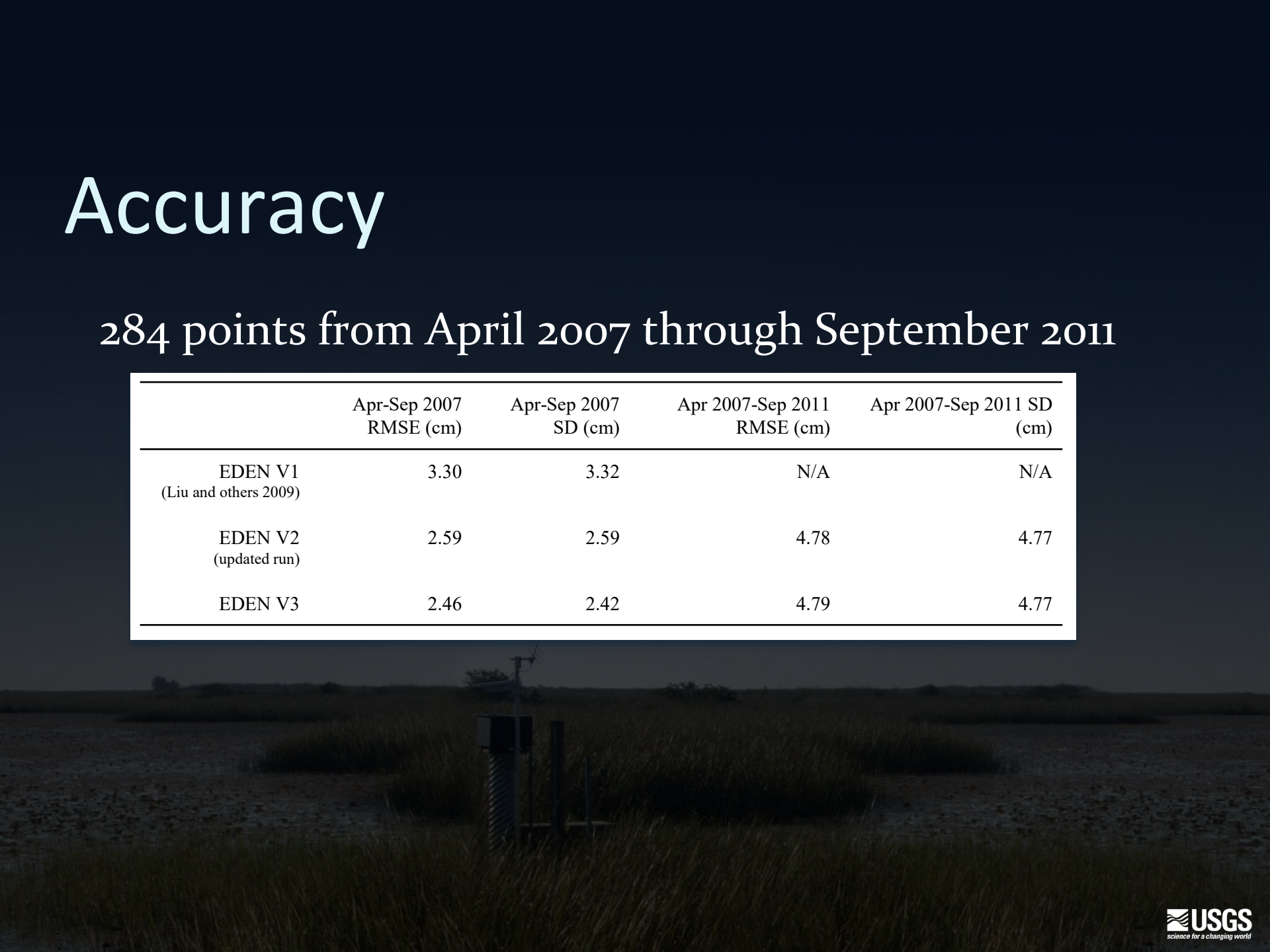
RBF parameters

RBF Parameters	EDEN V2	EDEN V3
Kernel function	Multiquadric	Multiquadric
Kernel parameter	16.77	0
Maximum neighbors	1	8
Minimum neighbors	1*	8*
Sector type	8 sector	NA
Angle	350°	350°
Major semiaxis	31000	31 [uses ratio only]
Minor semiaxis	30000	30 [uses ratio only]

Accuracy

284 points from April 2007 through September 2011

	Apr-Sep 2007 RMSE (cm)	Apr-Sep 2007 SD (cm)	Apr 2007-Sep 2011 RMSE (cm)	Apr 2007-Sep 2011 SD (cm)
EDEN V1 (Liu and others 2009)	3.30	3.32	N/A	N/A
EDEN V2 (updated run)	2.59	2.59	4.78	4.77
EDEN V3	2.46	2.42	4.79	4.77



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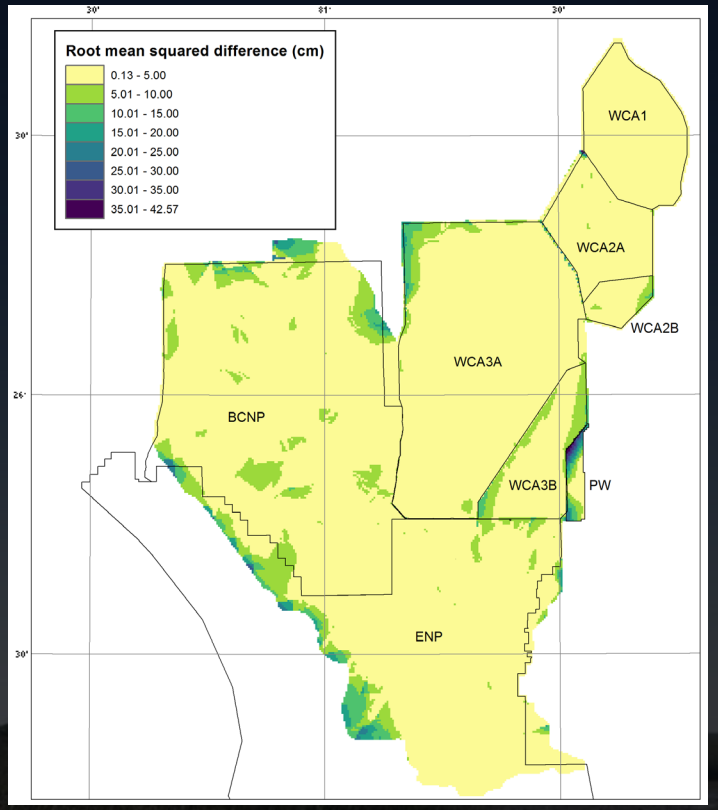
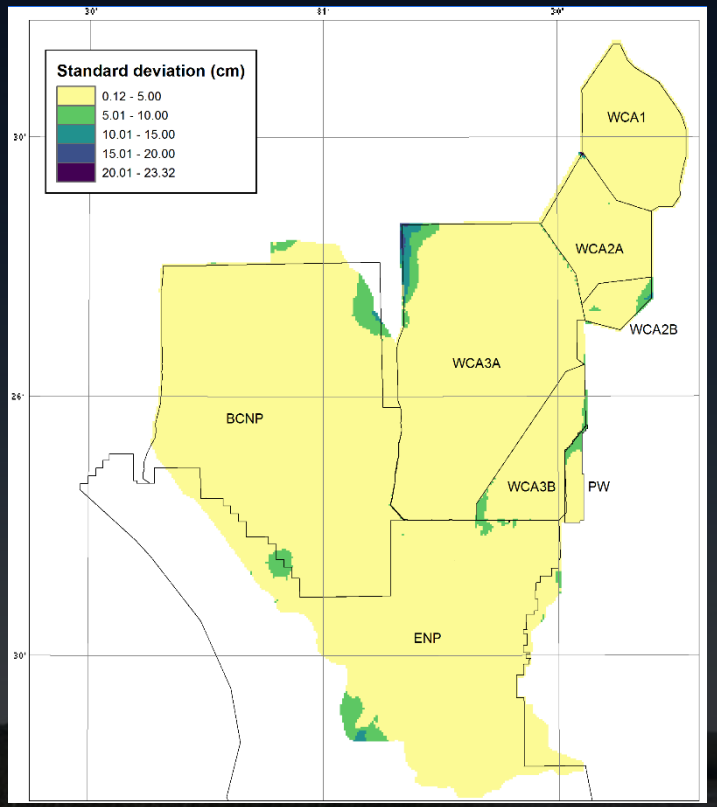
Comparison to v2

- April 1 2014 – March 30 2018
- Mean root mean squared difference: 3.71 cm



Comparison to v2

- April 1 2014 – March 30 2018
- Standard deviation



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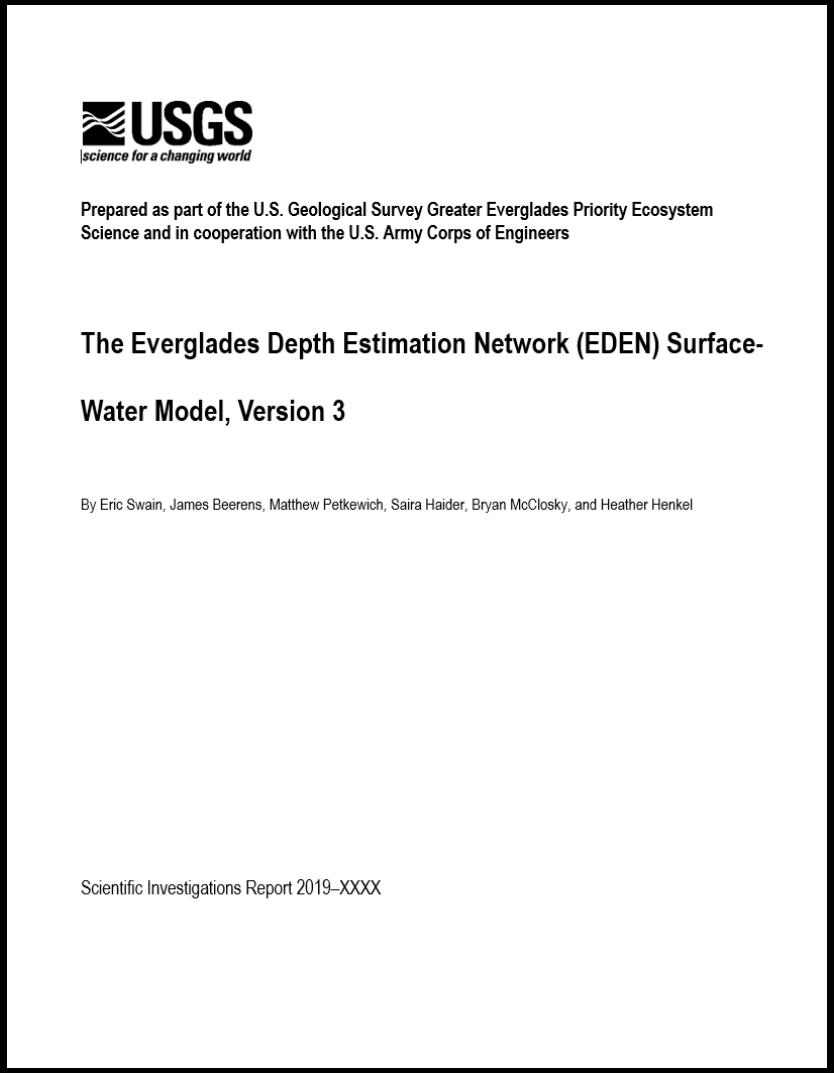
USGS documentation of EDEN version 3 in review



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Prepared as part of the U.S. Geological Survey Greater Everglades Priority Ecosystem Science and in cooperation with the U.S. Army Corps of Engineers

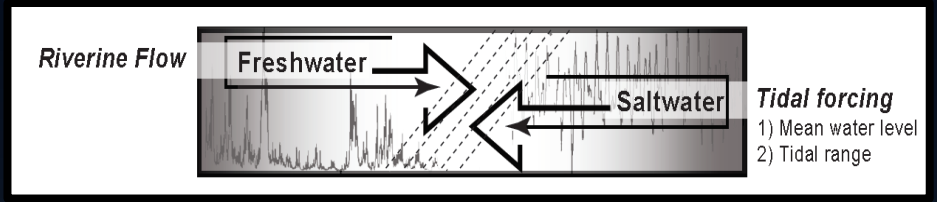
The Everglades Depth Estimation Network (EDEN) Surface-Water Model, Version 3

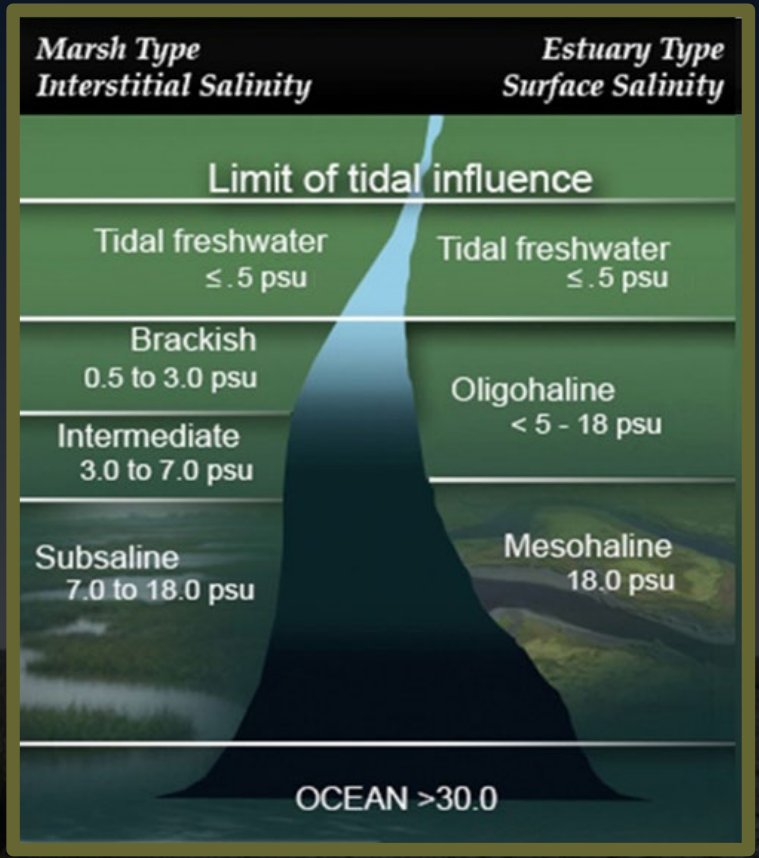
By Eric Swain, James Beerens, Matthew Petkewich, Saira Haider, Bryan McClosky, and Heather Henkel

Scientific Investigations Report 2019–XXXX

Coastal Salinity Index (CSI)

- Similar approach to the Standardized Precipitation Index (SPI)
  - Conrads and Darby (2017) https://doi.org/10.1175/BAMS-D-15-00171.1
- Indicator of salinity changes and location of the freshwater-saltwater interface
- Indicates drought and wetter conditions over multiple time periods
  - 1- to 24-months





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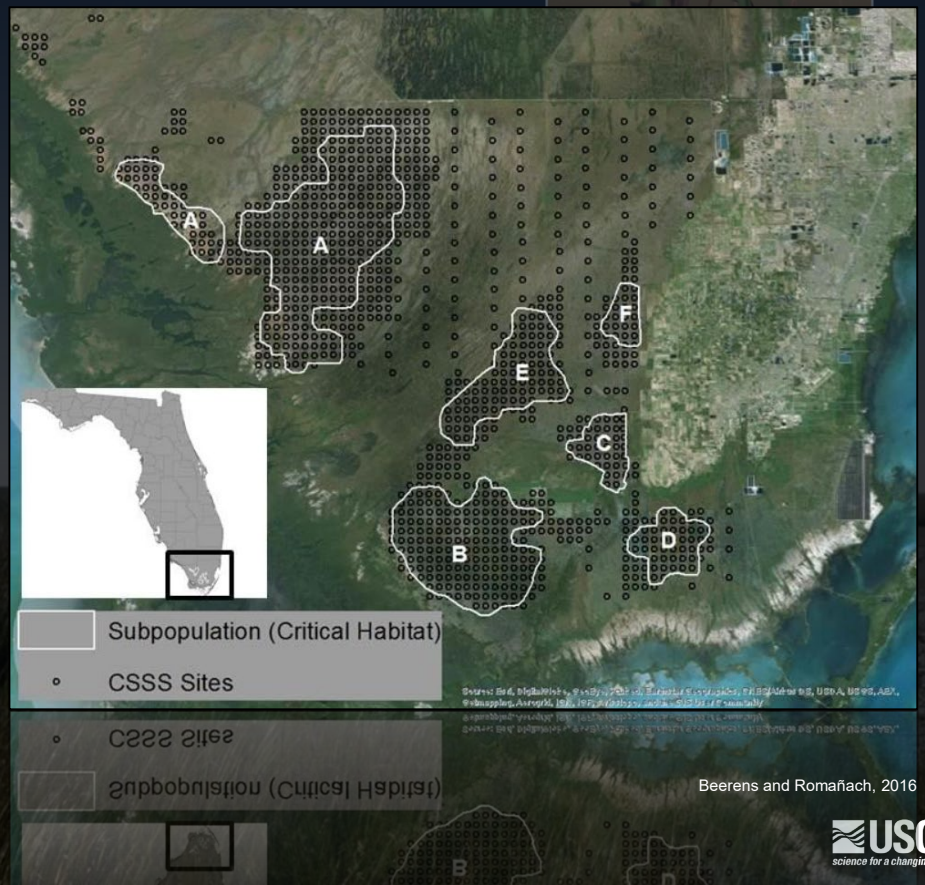
EDEN Web Applications

Cape Sable Seaside Sparrow (CSSS) Viewer

- Sparrows build their nests on the ground and up to seven inches above the ground, and need dry conditions for breeding
- The CSSS Viewer application was developed to evaluate CSSS habitat on a near real-time basis
- Provides statistical information on breeding habitat suitability



Beerens and Romañach, 2016

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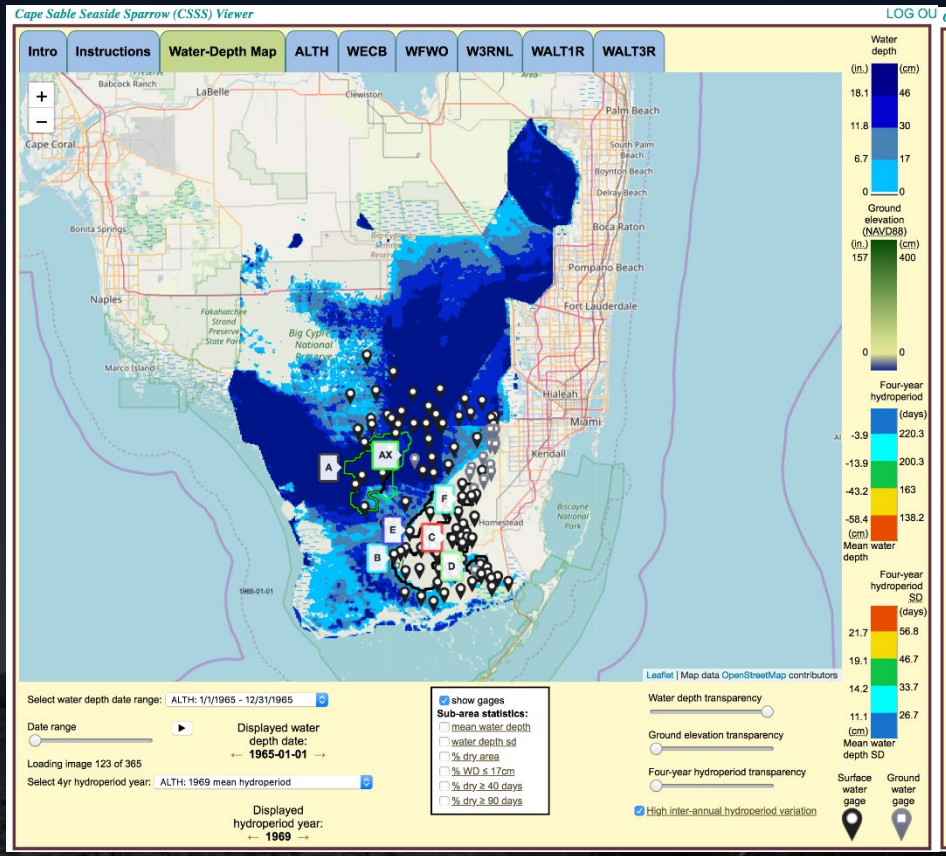
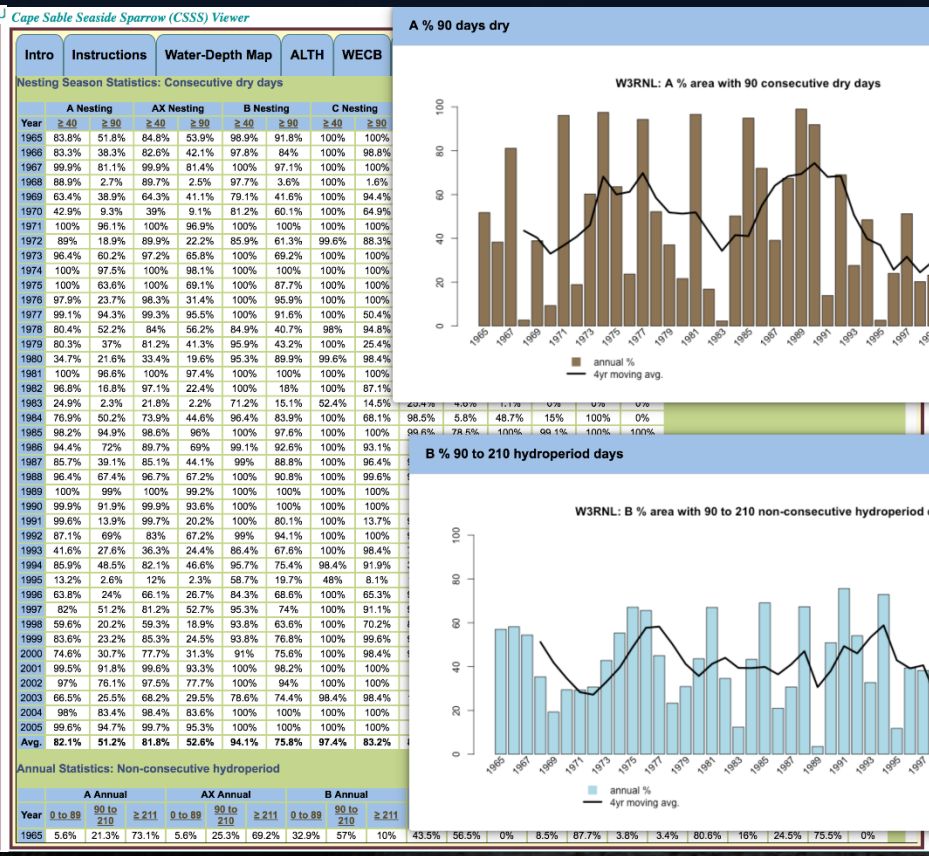
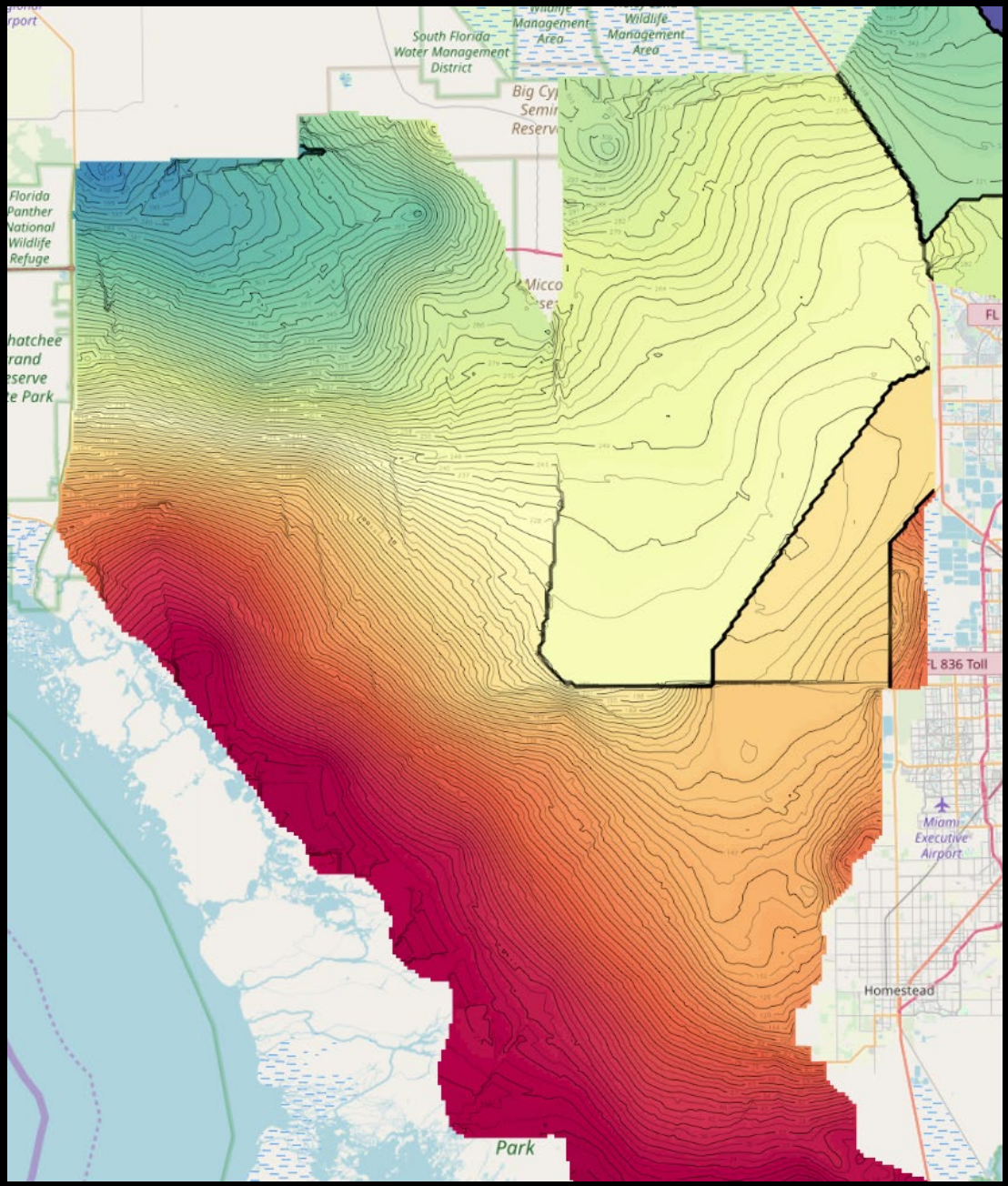
CSSS Scenario viewer

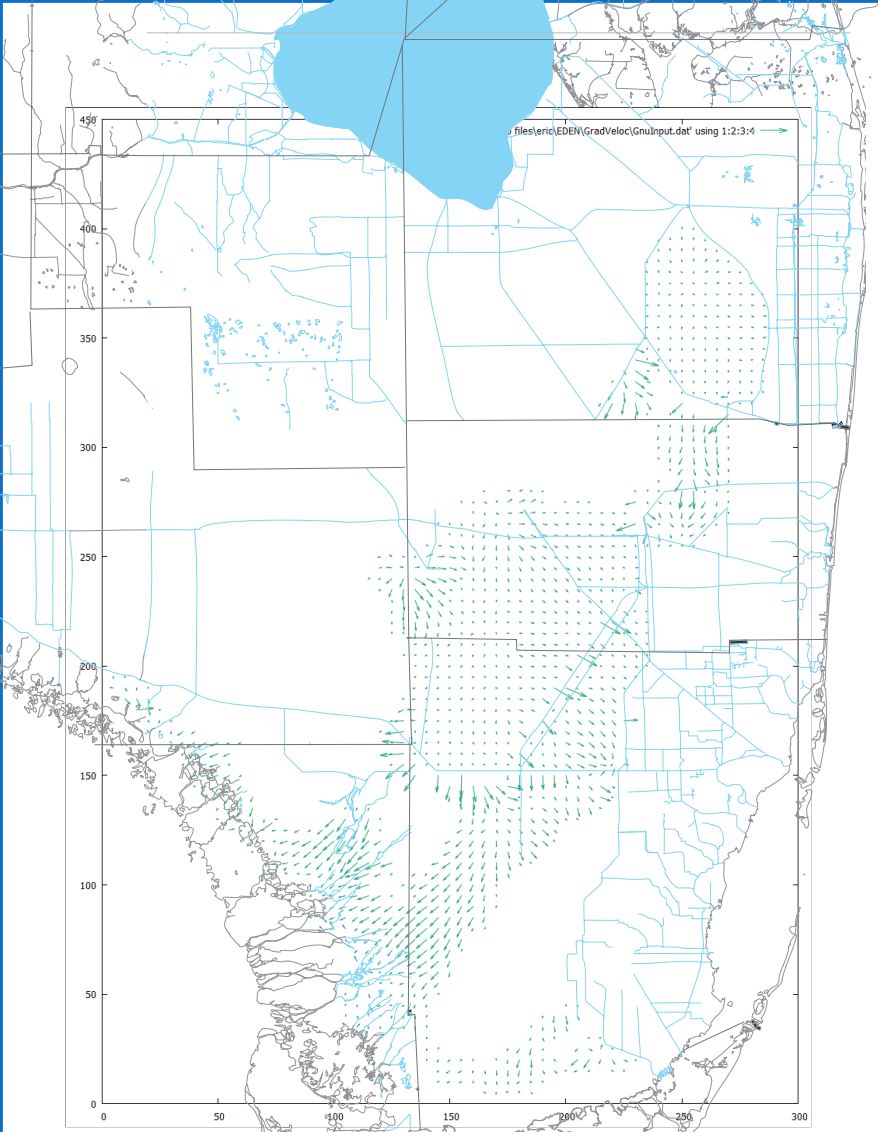




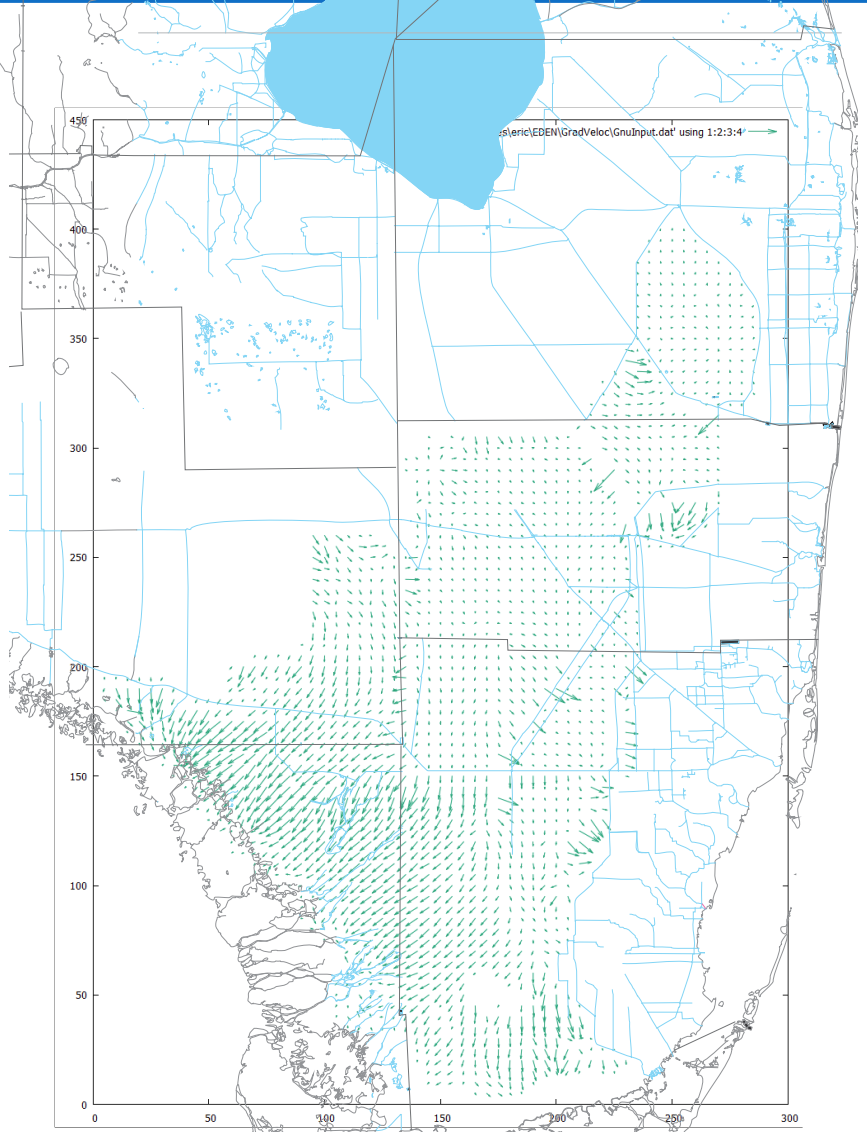
Estimating Gradients and Flux

The water-level and depth surfaces generated daily by EDEN are used to determine gradients which can be used with water depths to estimate flux values.



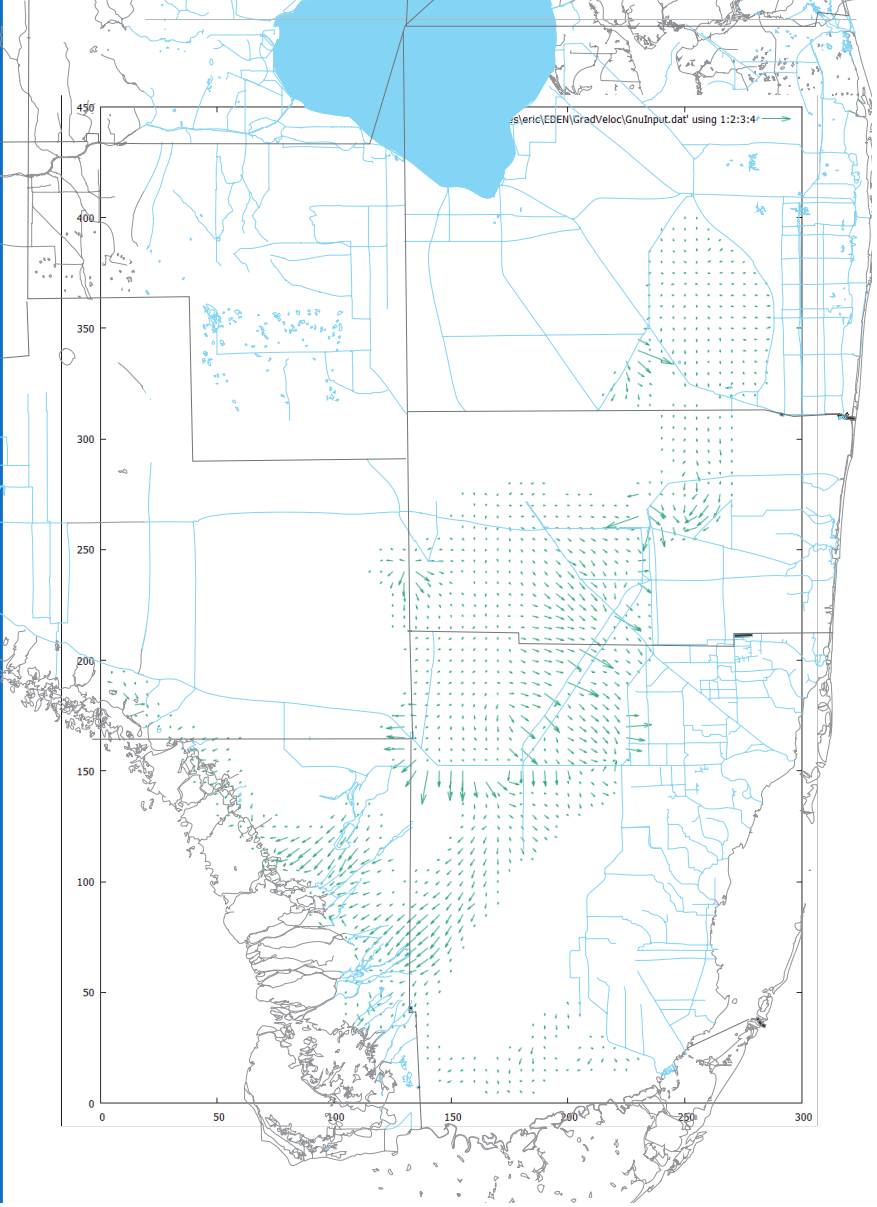


3/31/2018 Gradients

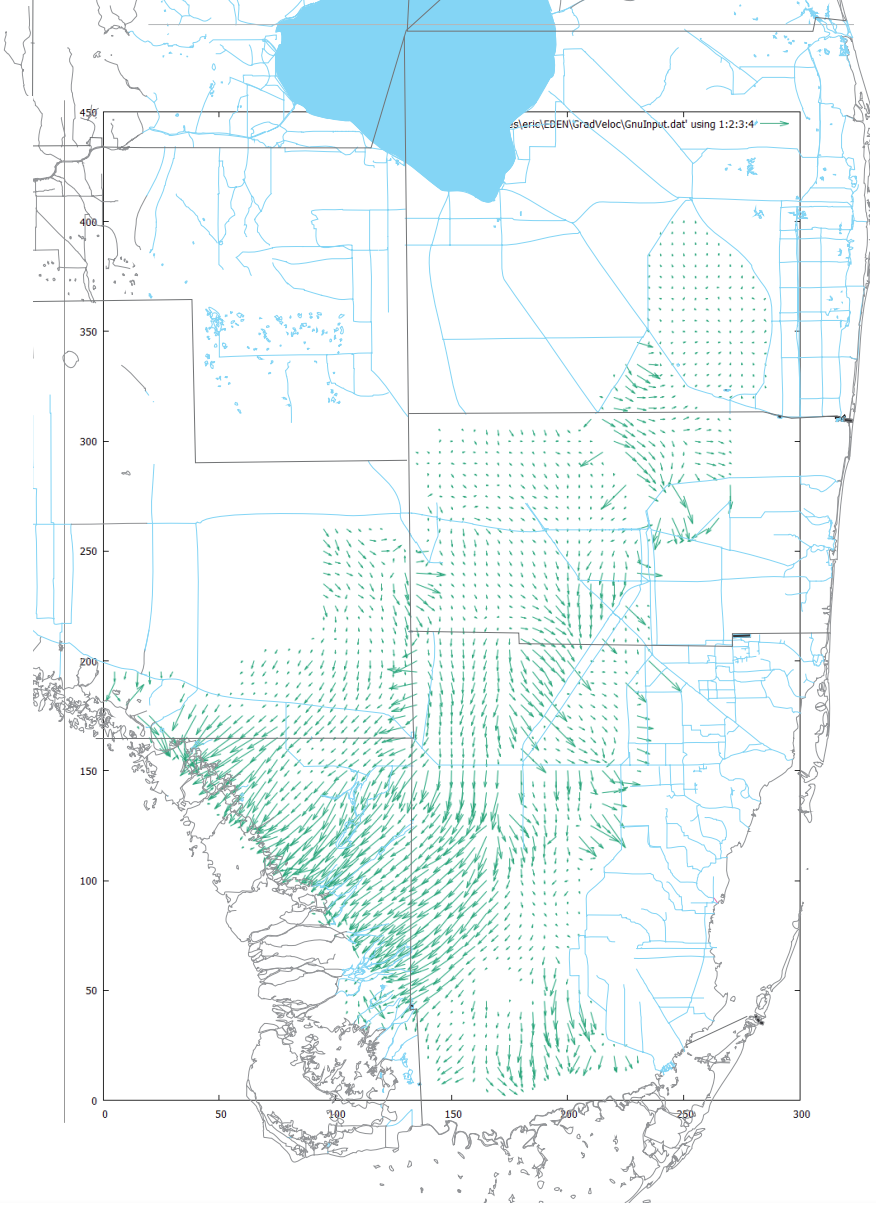


9/30/2018 Gradients

Gradients determined directly from water-level surfaces



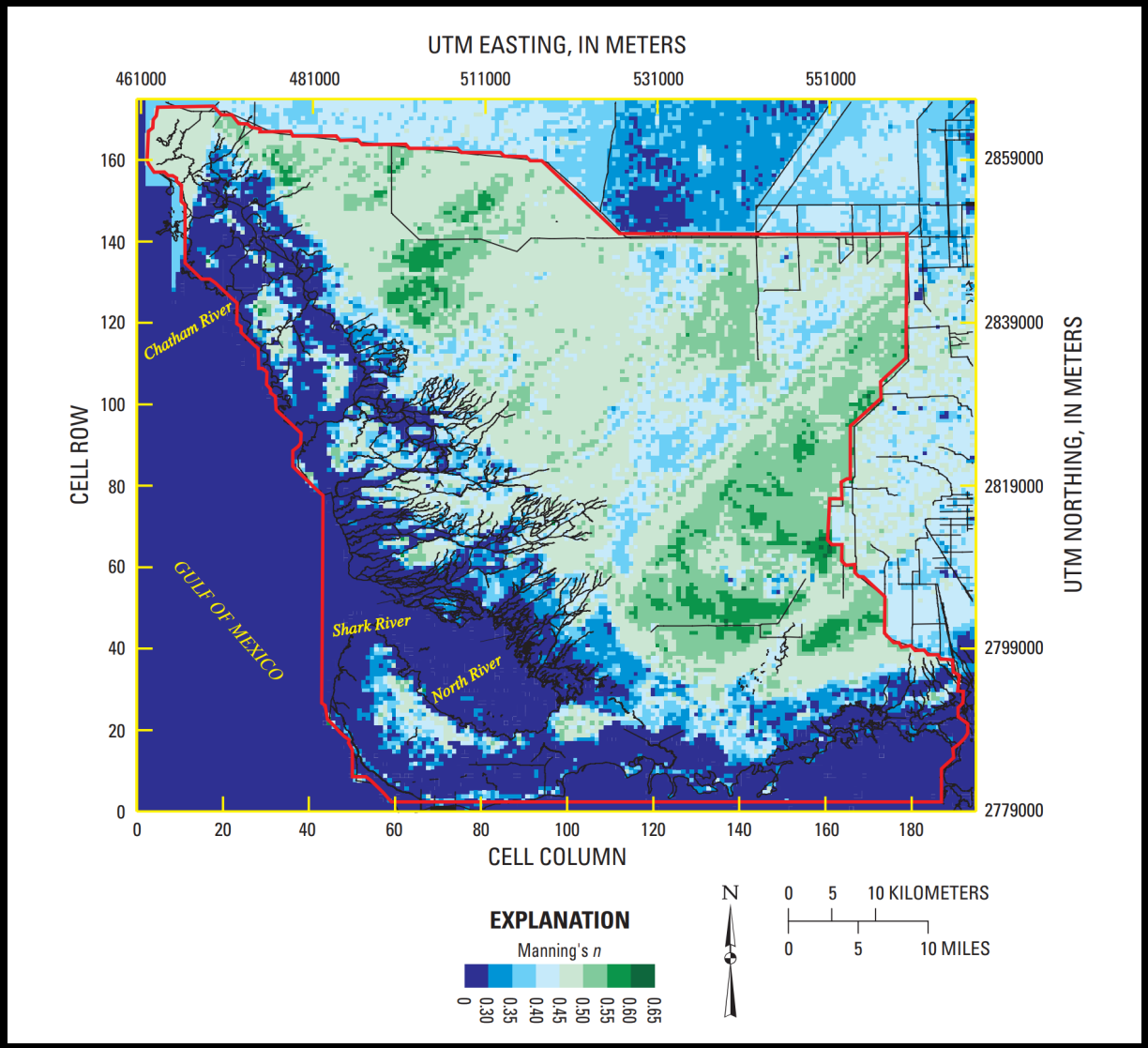
3/31/2018 flux times friction



9/30/2018 flux times friction

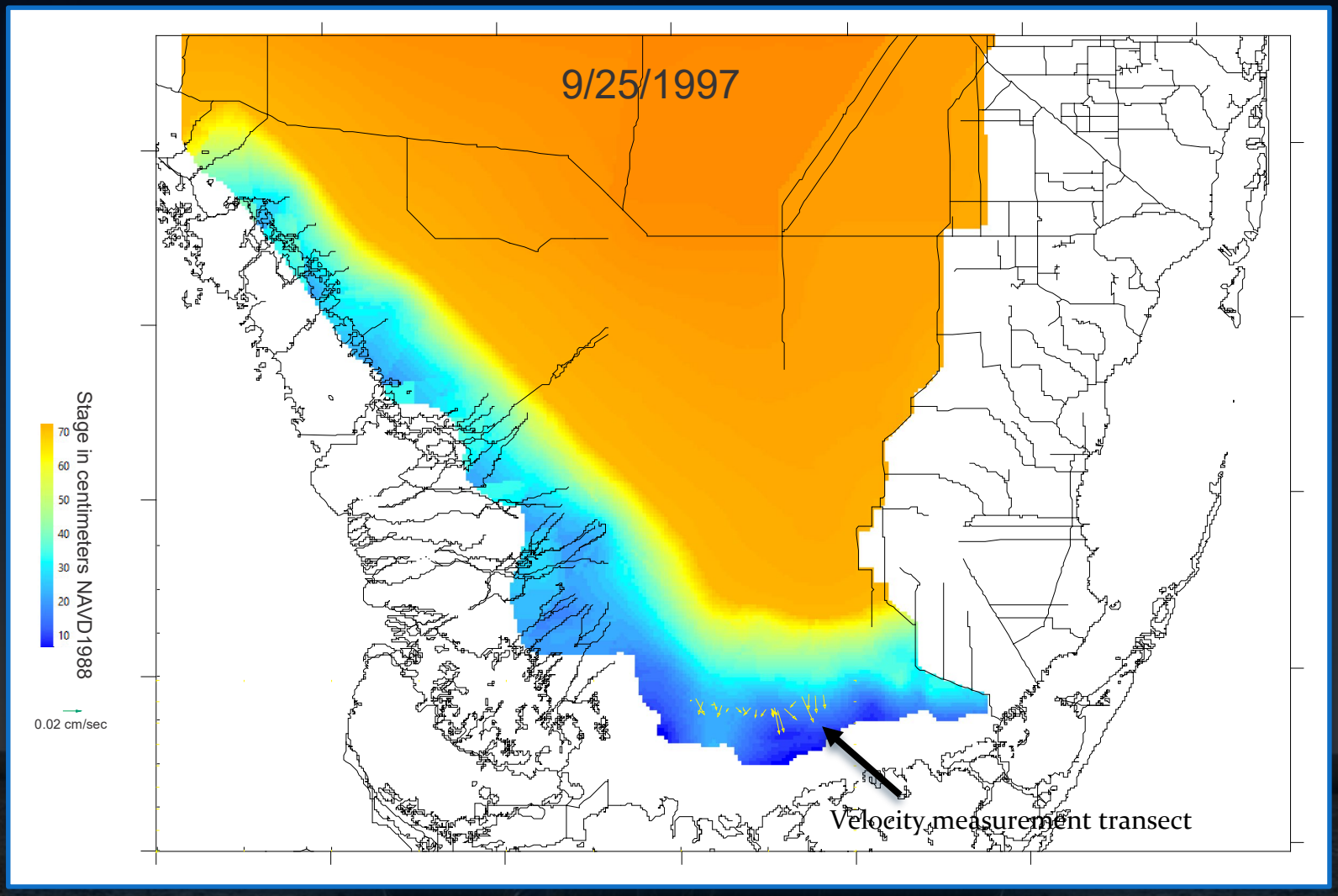
A Mannings relationship gives $qn = d^{5/3}s^{1/2}$

Converting flux times friction to flux



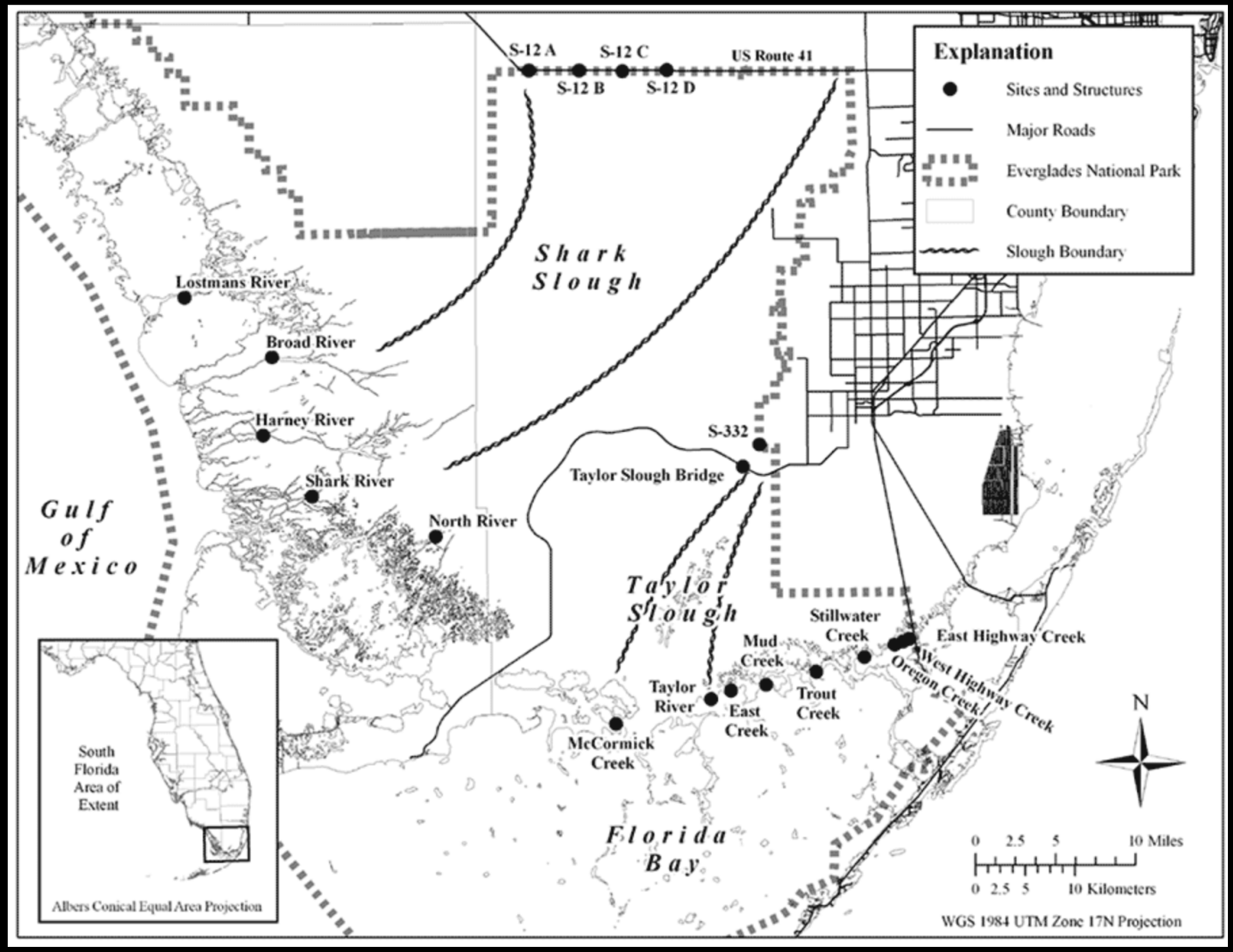
1) Manning's n can be estimated based on vegetation type

Converting flux times friction to flux



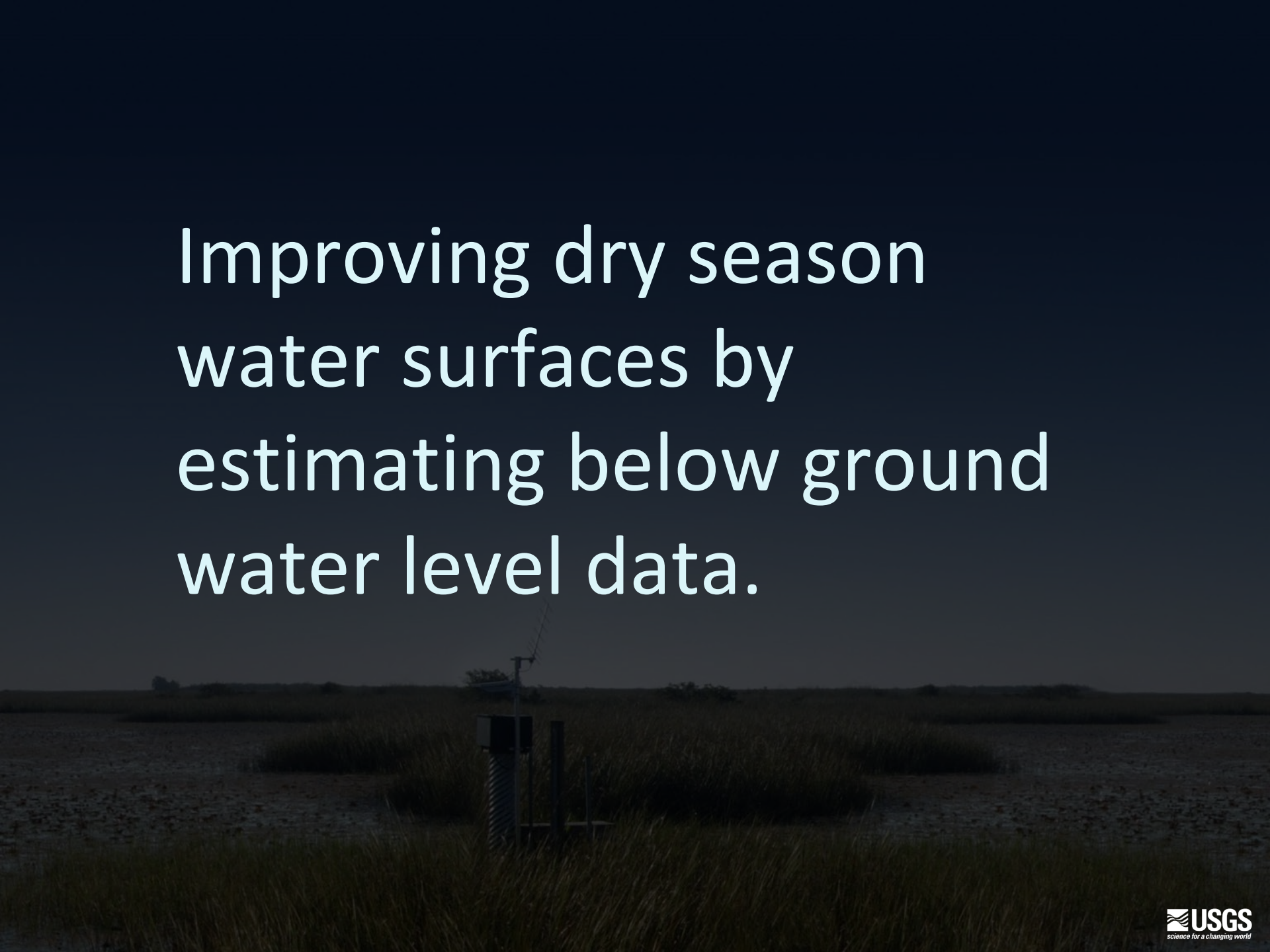
2) Measured velocities in wetlands can be used for calibration

Converting flux times friction to flux



3) Coastal discharge stations can constrain boundary fluxes

Improving dry season water surfaces by estimating below ground water level data.



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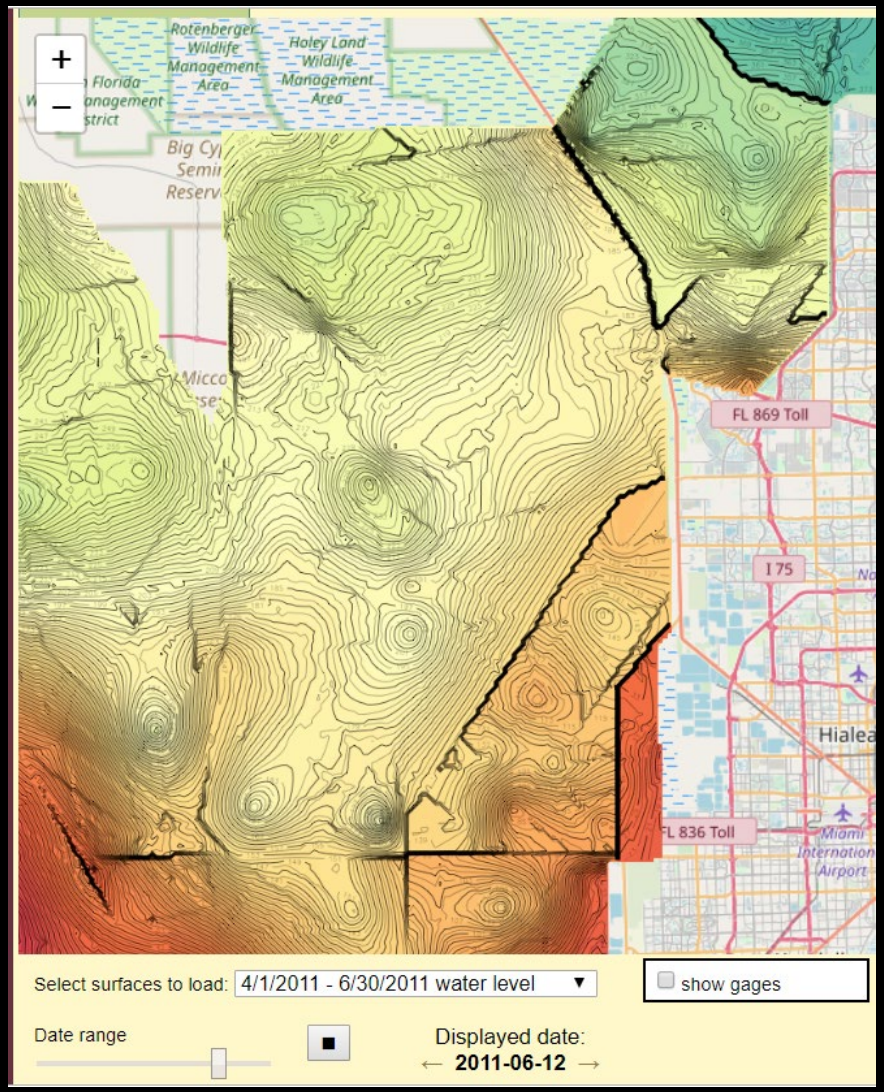
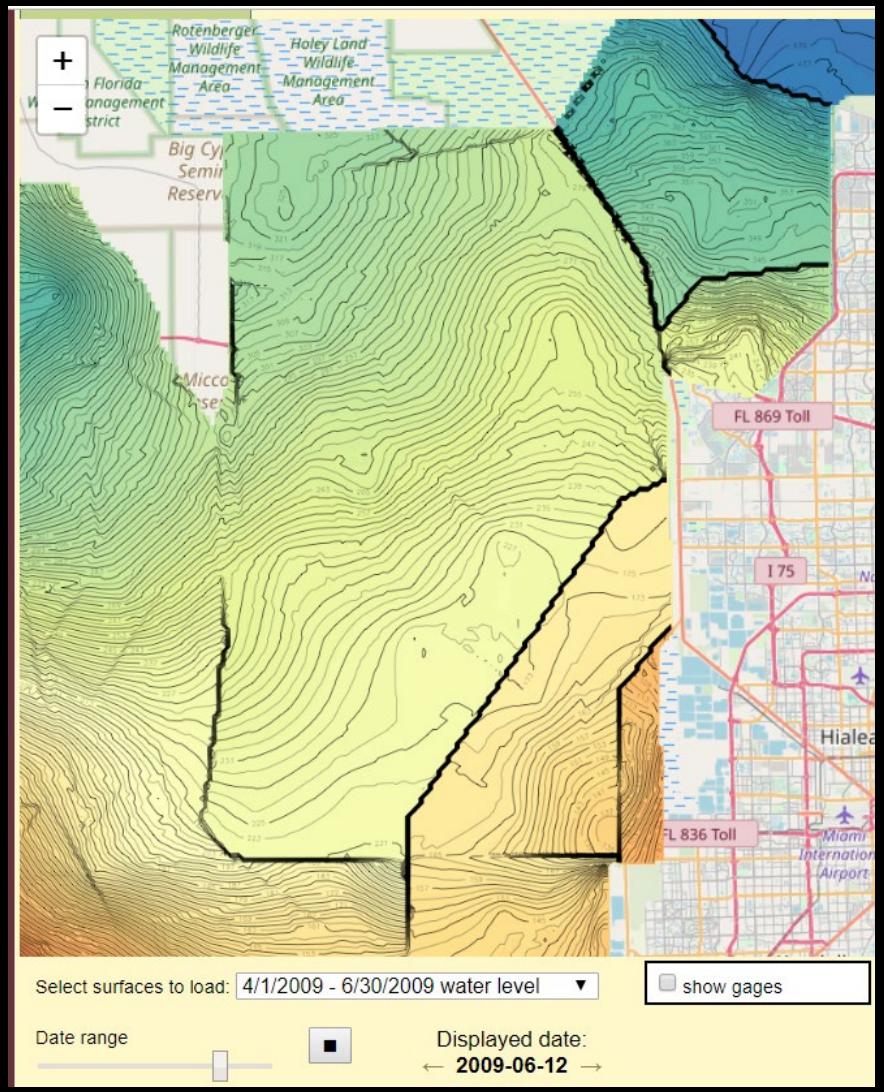
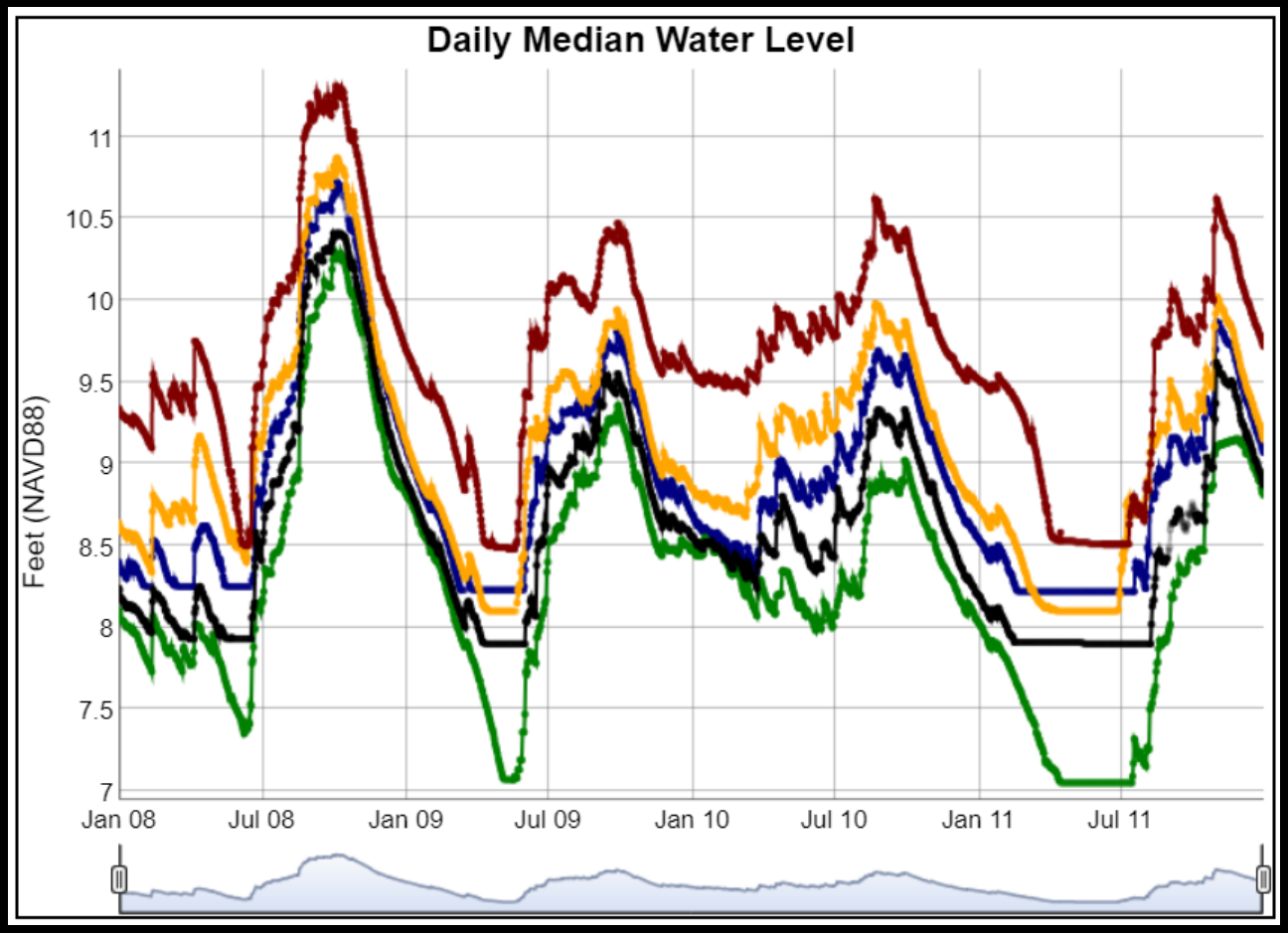
Lowest points at land surface

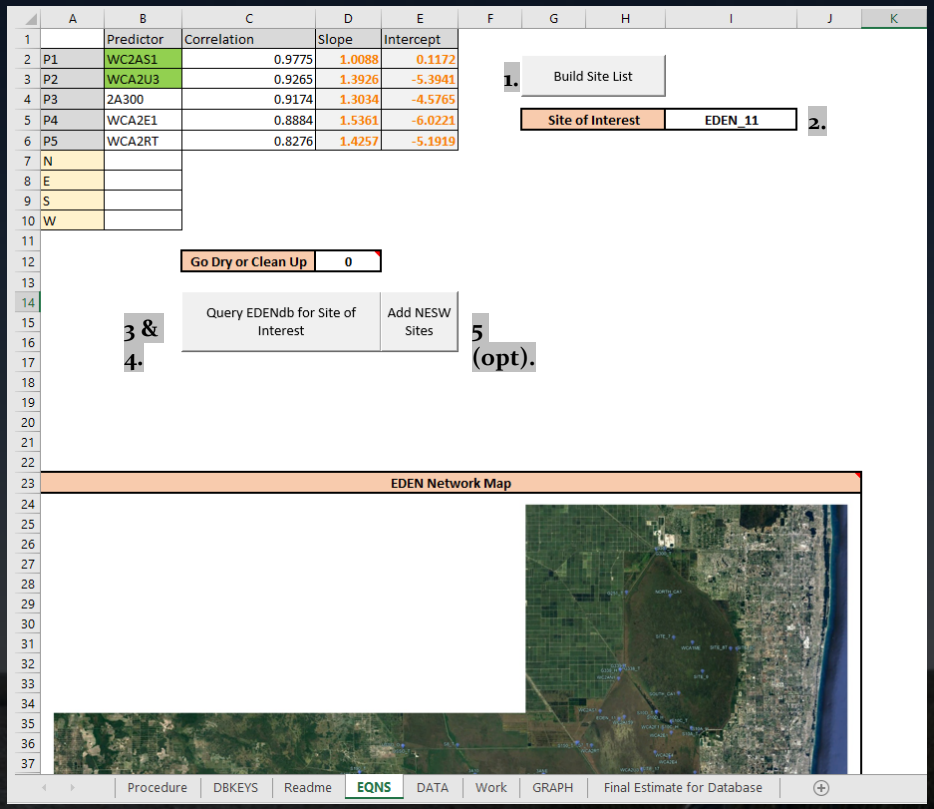


With below ground water level




Daily Median Water Level
Feet (NAVD88)
11
10.5
10
9.5
9
8.5
8
7.5
7
Jan 08
Jul 08
Jan 09
Jul 09
Jan 10
Jul 10
Jan 11
Jul 11
Legend
EDEN_14
EDEN_5
L28S2
W11
W18
Observed data
Estimated data
Hindcasted data
Dry conditions
Recent water levels subject to revision. Non-final data are either real-time or provisional.

Initial Workflow



1. Build list of sites that are currently in the EDEN database
2. User selects a site of interest (SOI)
3. Run a correlation on the SOI with sites in the same area (ENP, BCNP, WCA1, WCA2, etc.)
4. Pull data for site of interest and best 5 correlated sites (P1, P2, P3, etc.) into the workbook for use in corrections
5. If desired, sites can be manually selected for use in corrections, such as sites North, East, South or West of SOI. Users can scroll down to the network map for reference. (**OPTIONAL**)

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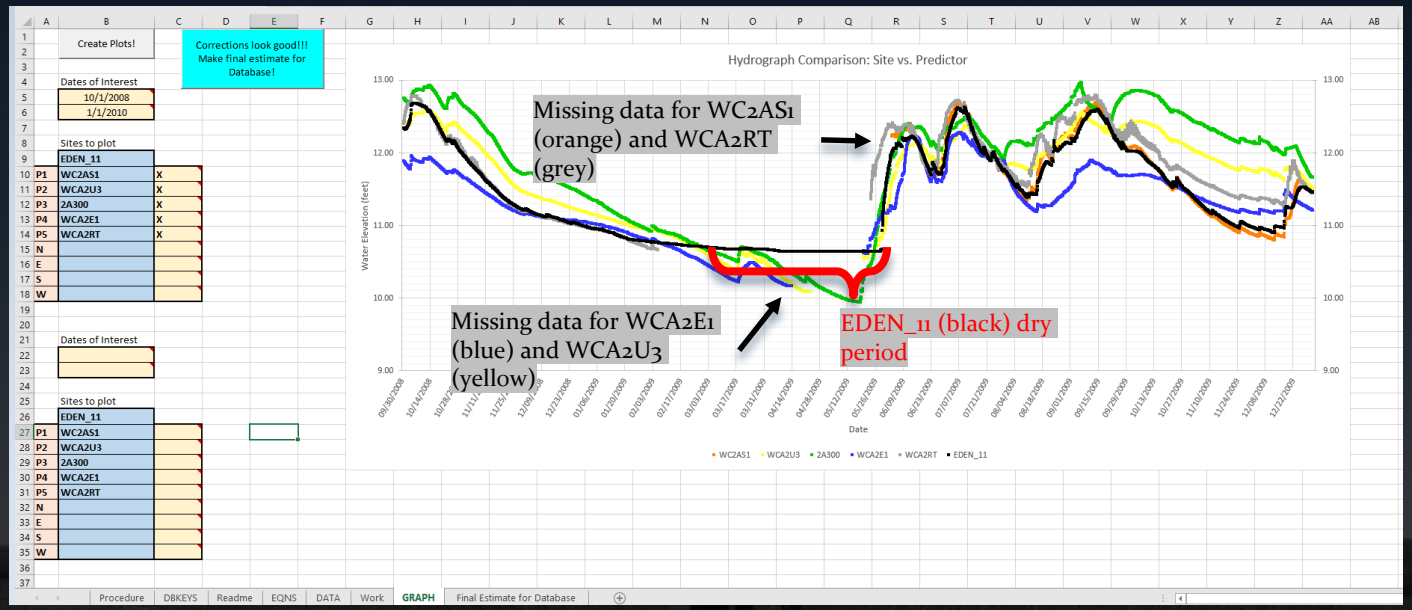
Corrections: Graph Tab



- An example is shown for estimating EDEN_11's dry period
- 2A300 (green) is the only available data with no missing values that we can use to predict the dry period for EDEN_11

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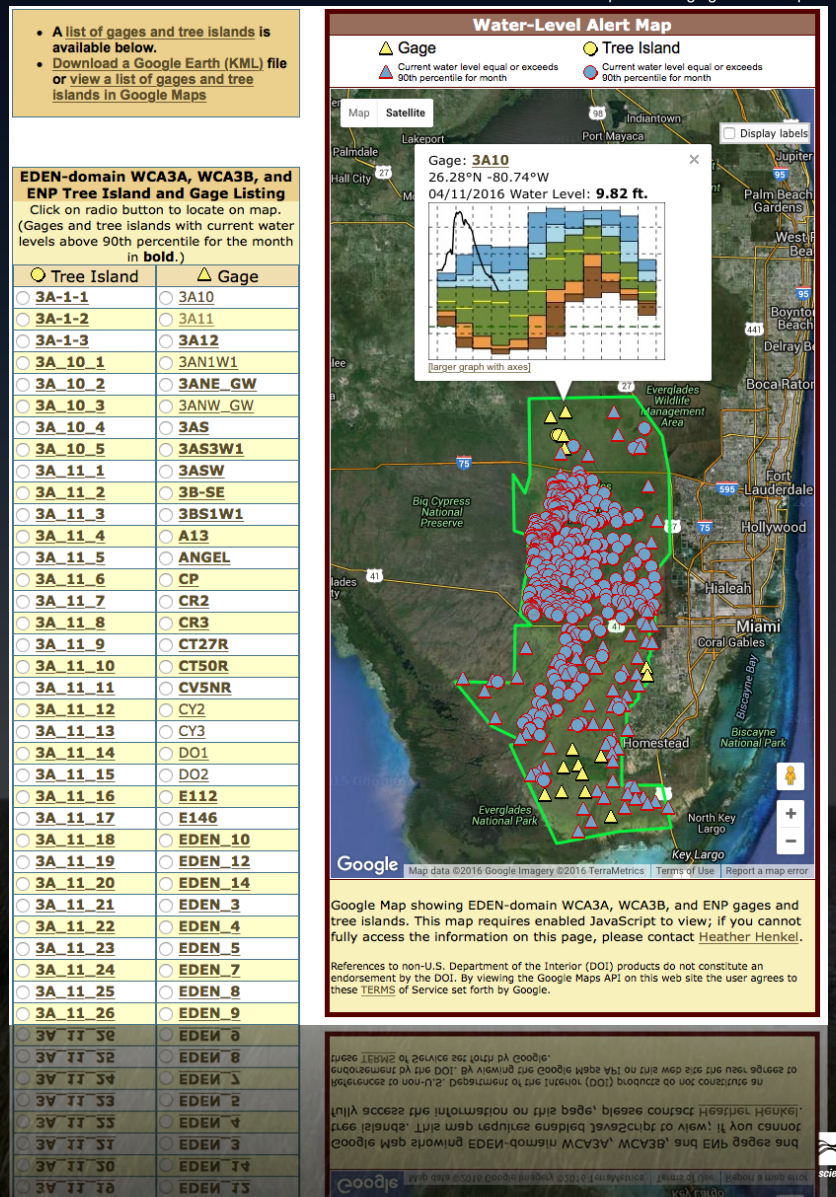
Other uses of EDEN data

Everglades Restoration Transition Plan (ERTP) monitoring

- ERTP monitoring application was developed to compare near real-time water levels to water-level statistics from the previous water management plan, the Interim Operational Plan (IOP)
- Includes 394 tree islands (TI) and 106 monitoring stations within the area of interest (WCA3A, WCA3B, and ENP)
- Daily value of blue gages and TIs exceed the 90th percentile for the month

http://sofia.usgs.gov/eden/ertp/



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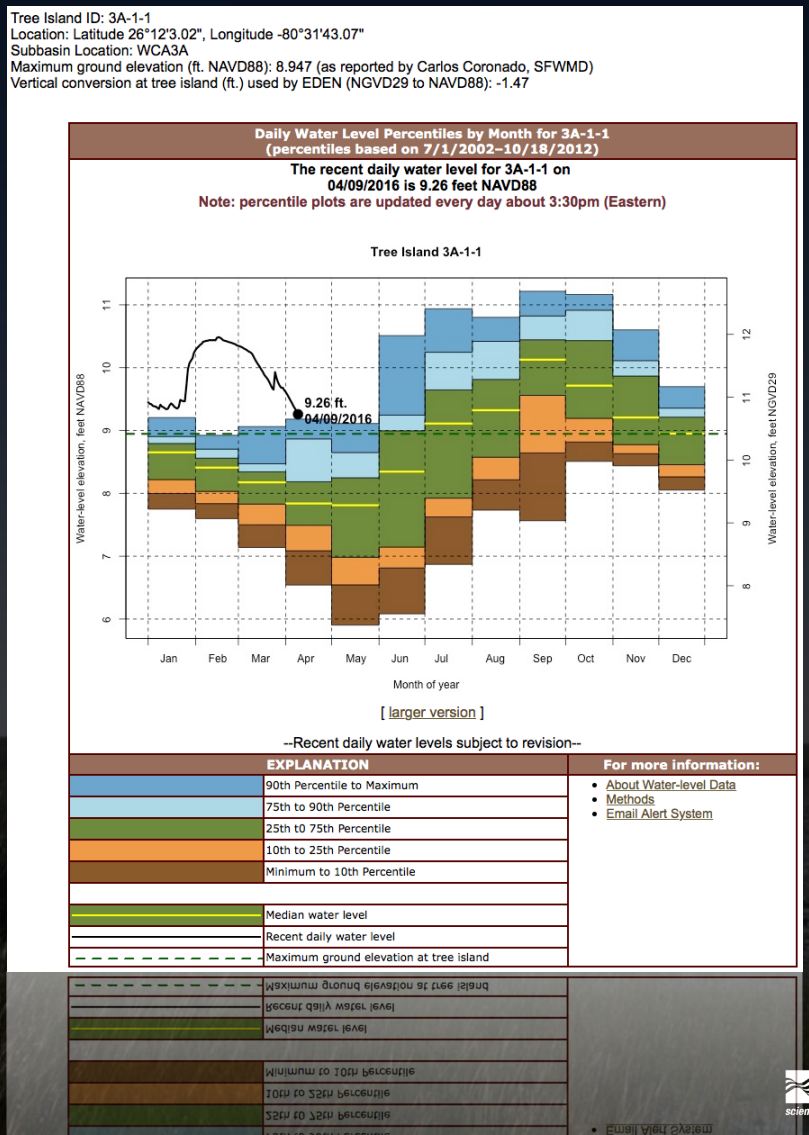
Other uses of EDEN data

Everglades Restoration Transition Plan (ERTP) monitoring

- IOP-period monthly water levels are calculated for all gages and TIs, and current conditions are compared to those percentiles
- Users with cultural, recreational, and environmental concerns can track inundation of tree islands relative to historic levels
- Automated daily email sent to users notifying which gages and tree islands exceed 90th percentile monthly historic water level

http://sofia.usgs.gov/eden/ertp/



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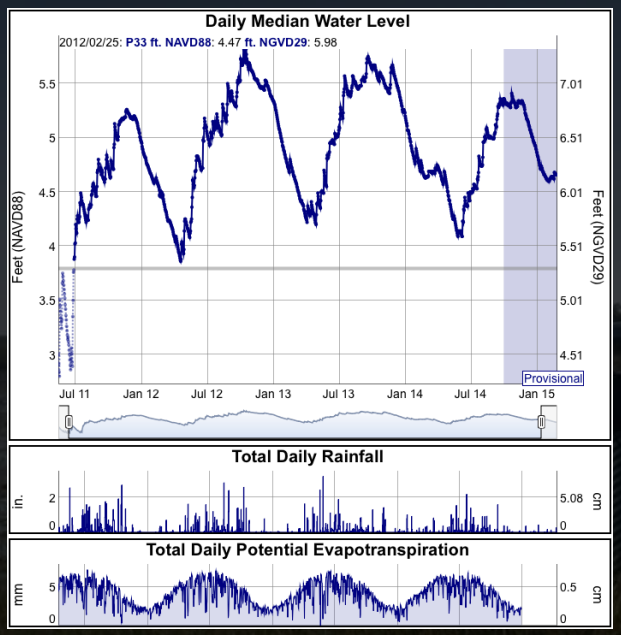
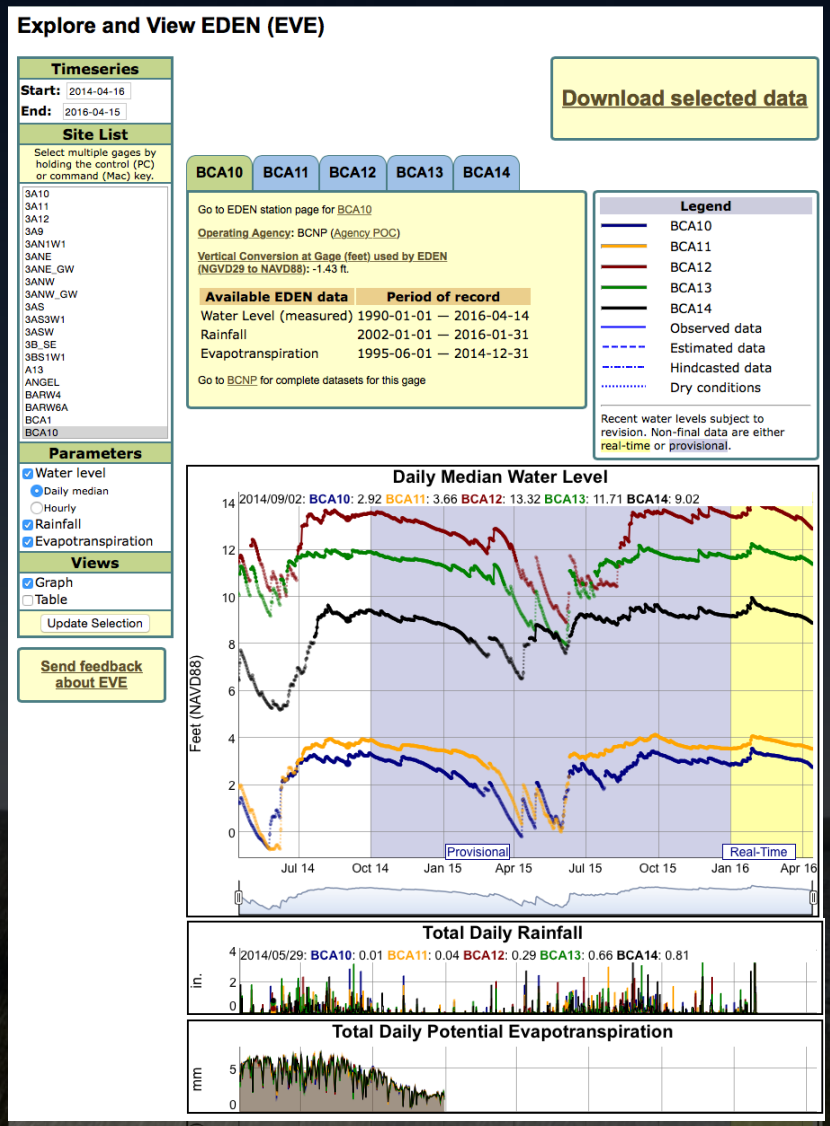
EDEN Web Applications

Explore and View EDEN (EVE)

- EDEN data visualization tool
- Users can view and download water-level, rainfall, and evapotranspiration data for all EDEN monitoring locations





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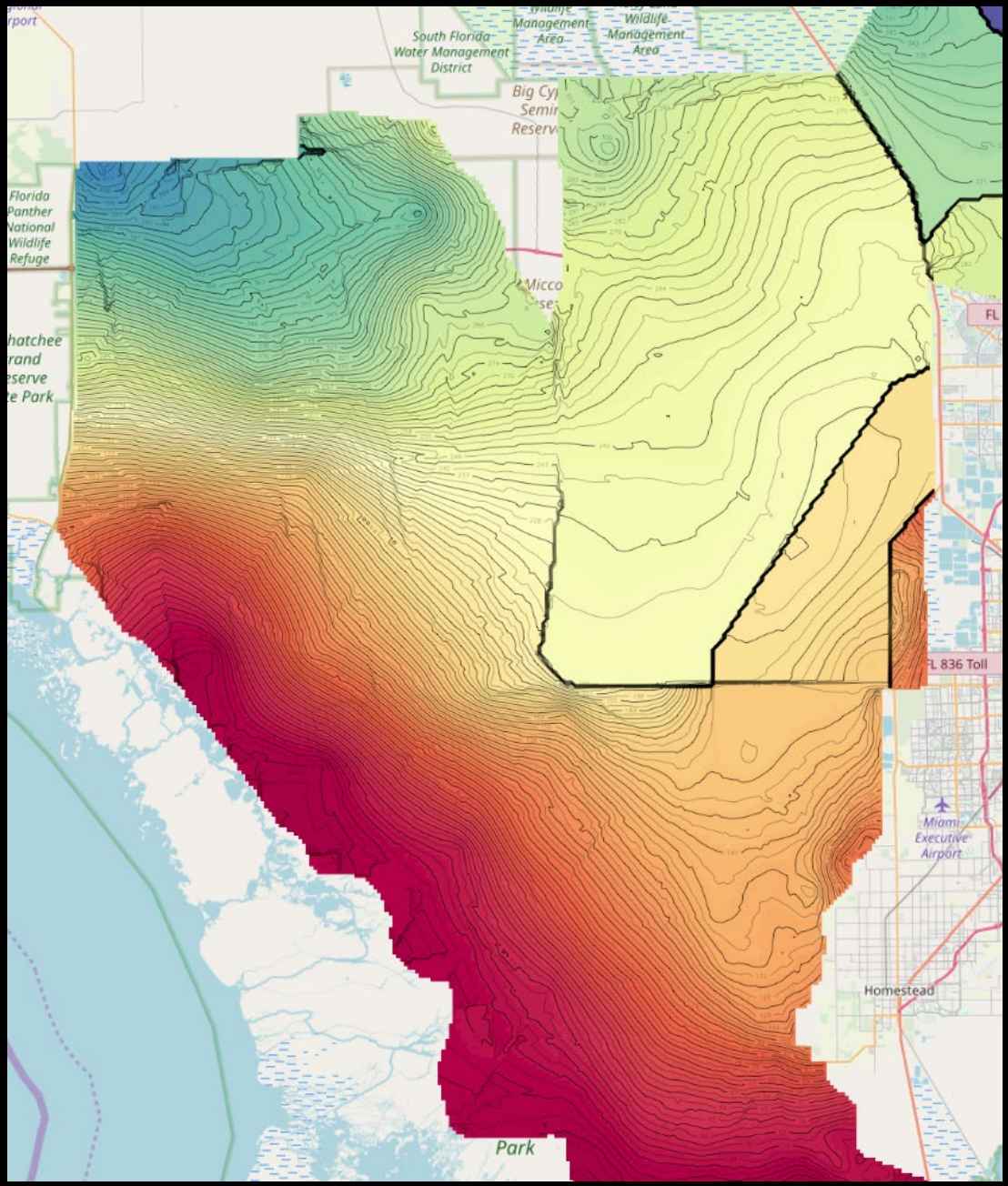
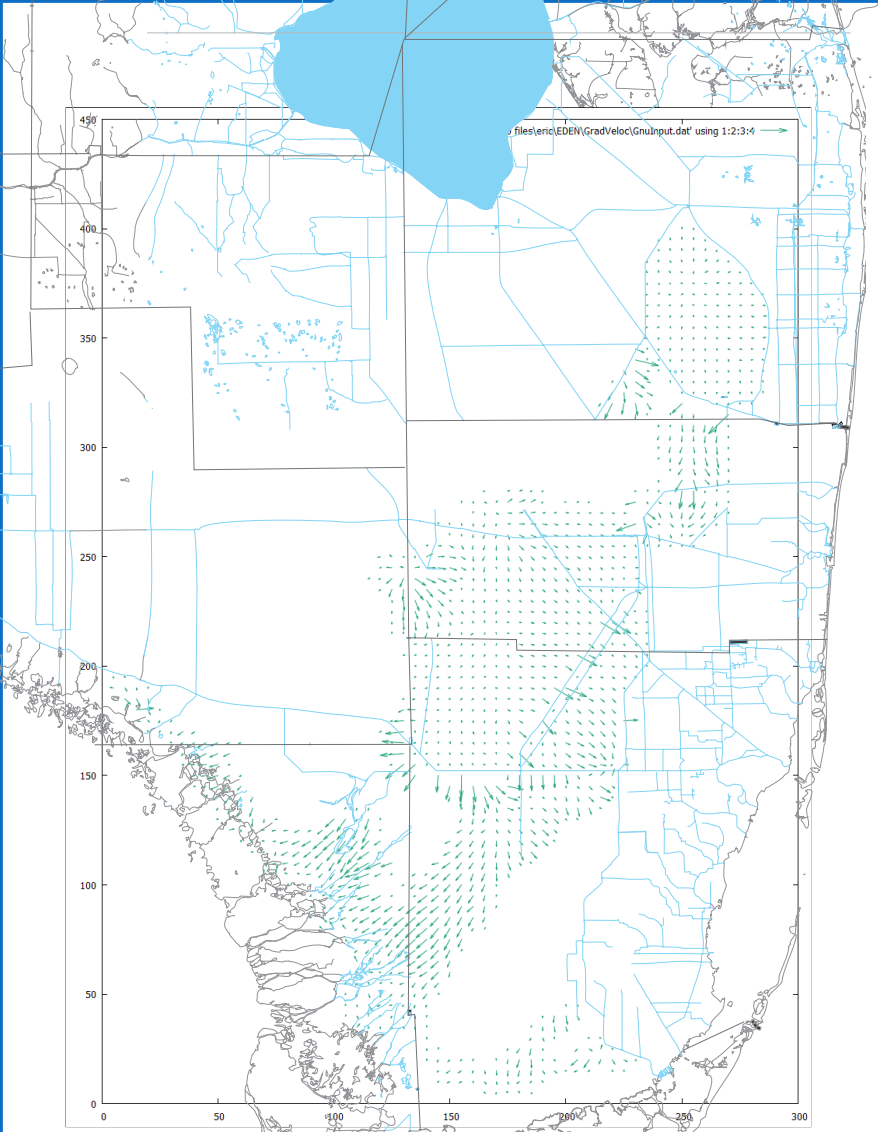
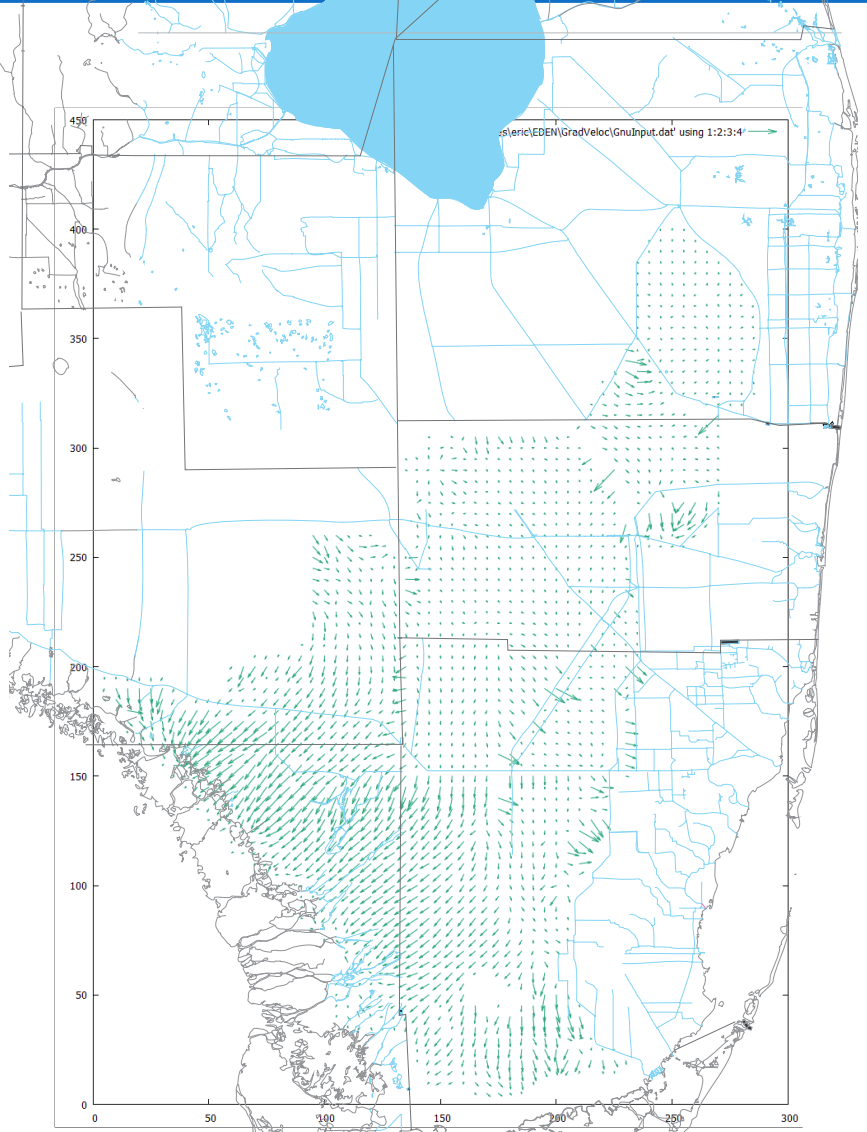


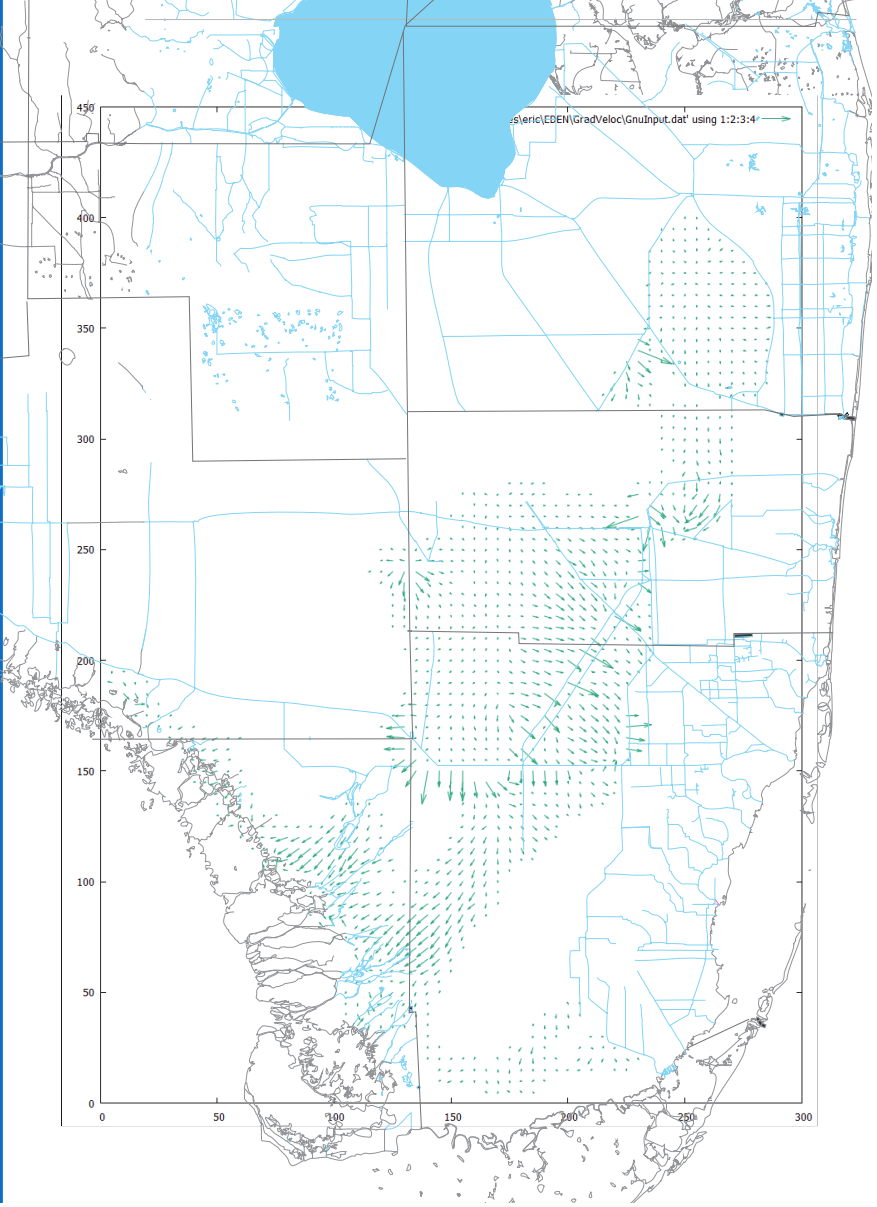


3/31/2018 Gradients

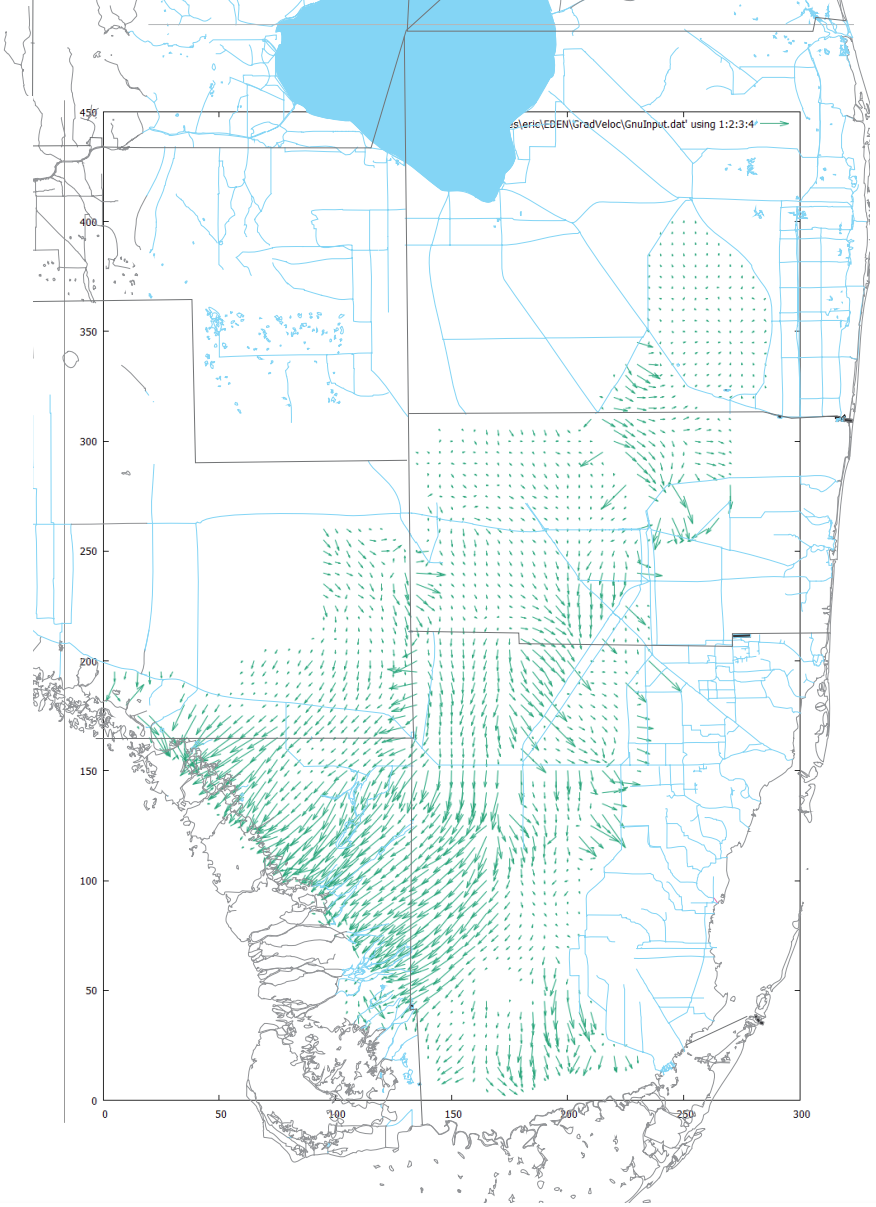


9/30/2018 Gradients

Gradients determined directly from water-level surfaces



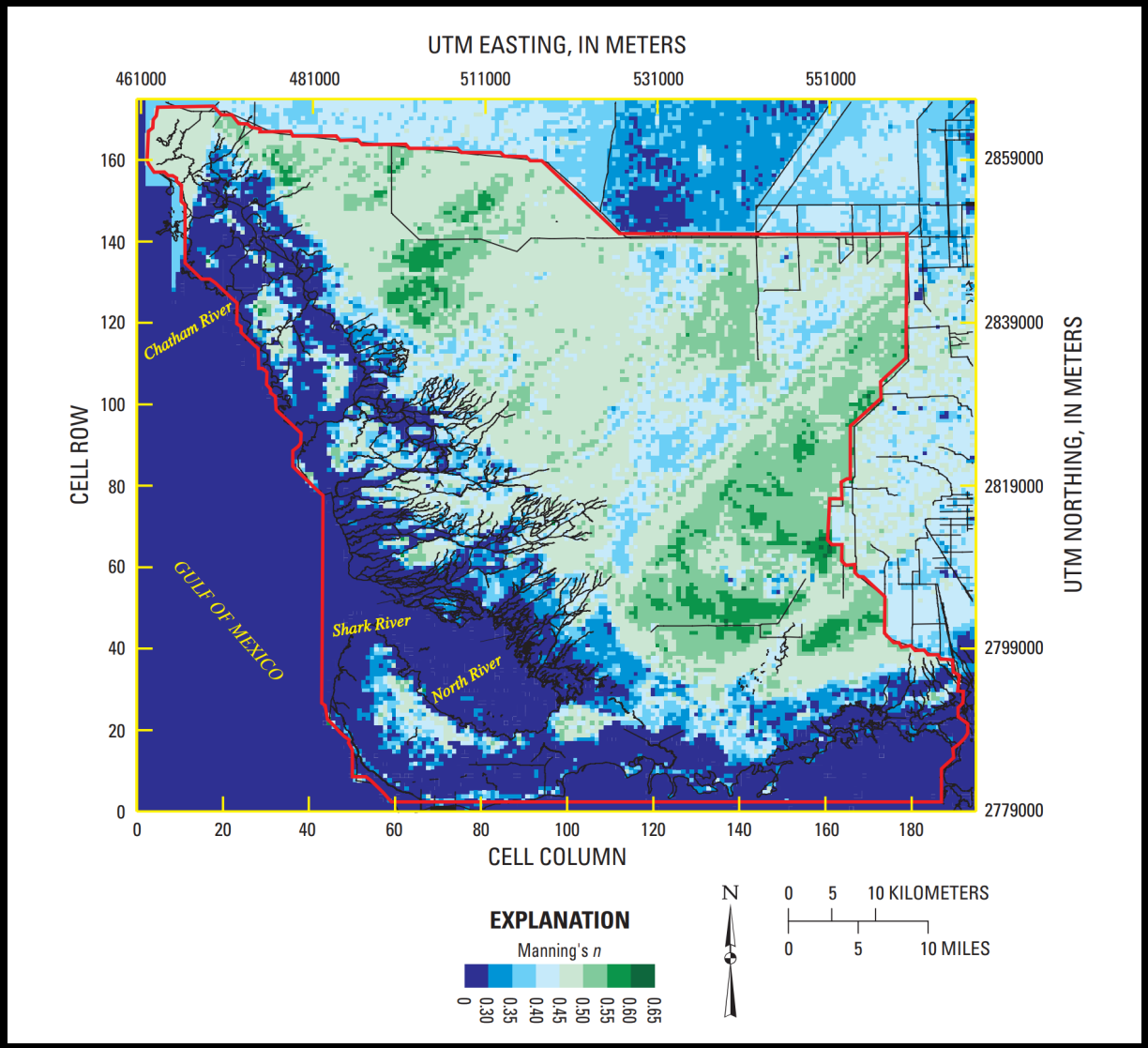
3/31/2018 flux times friction



9/30/2018 flux times friction

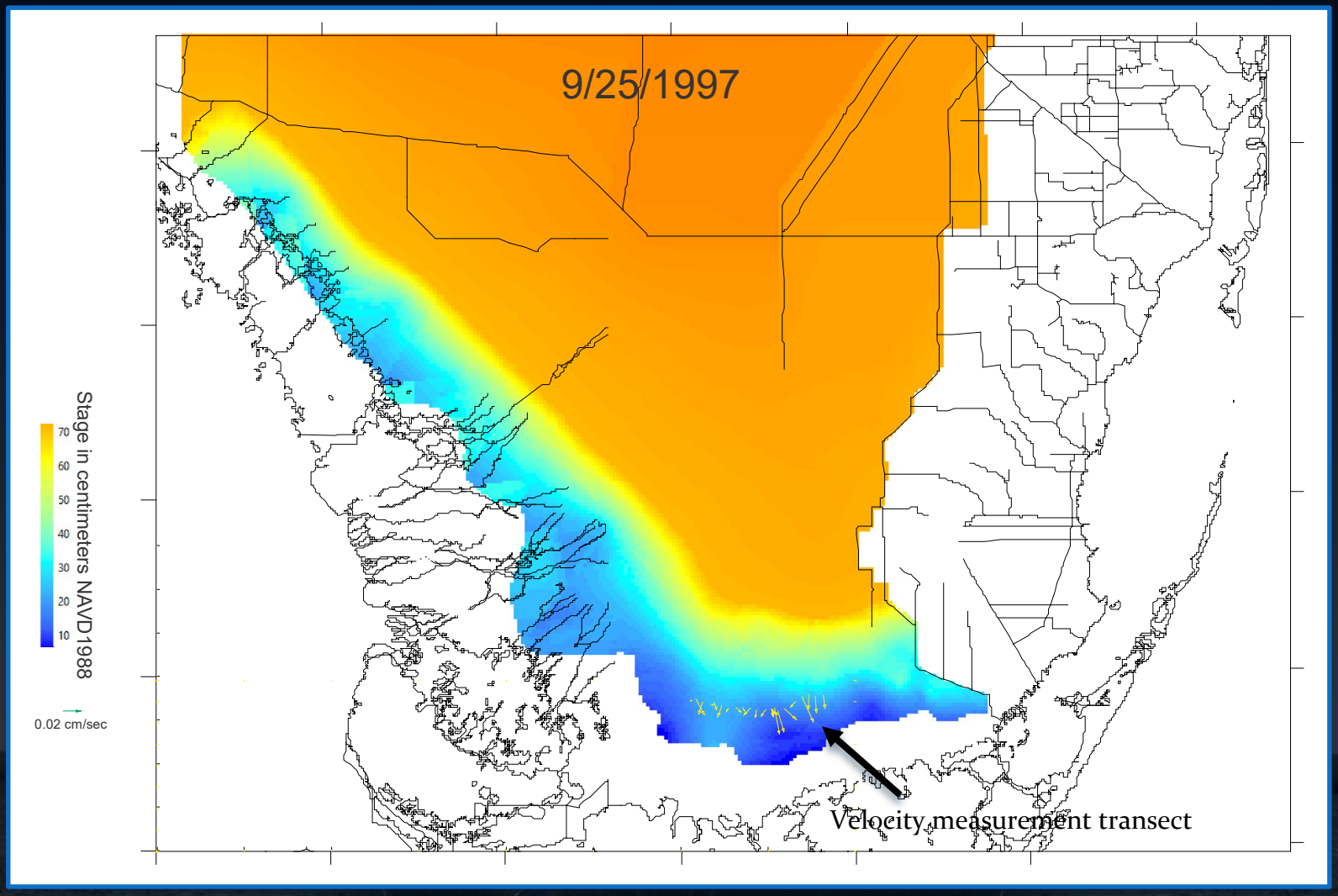
A Mannings relationship gives $qn = d^{5/3}s^{1/2}$

Converting flux times friction to flux



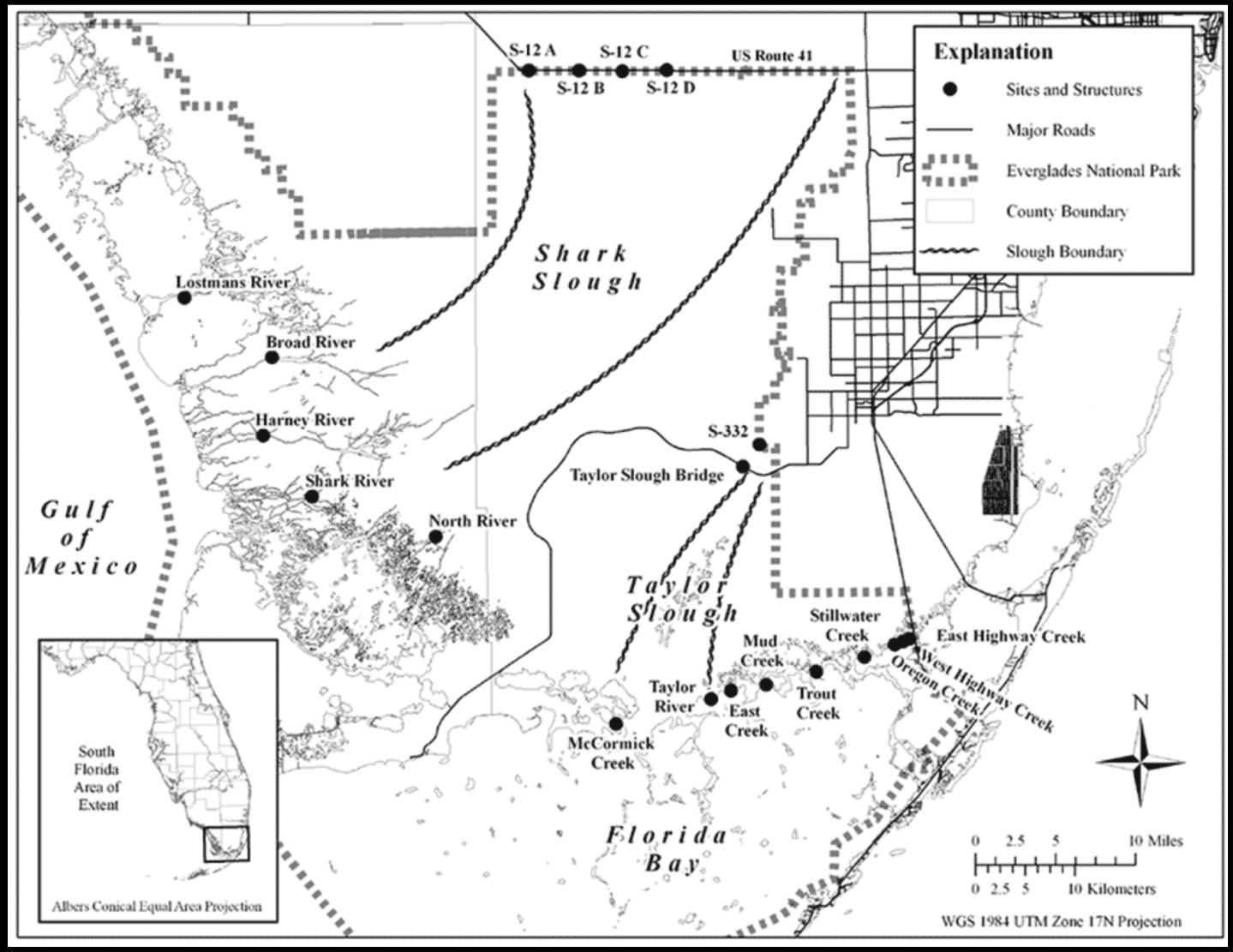
1) Manning's n can be estimated based on vegetation type

Converting flux times friction to flux



2) Measured velocities in wetlands can be used for calibration

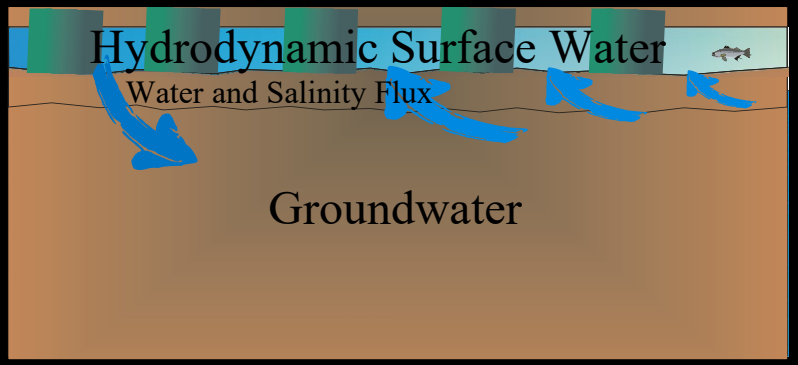
Converting flux times friction to flux

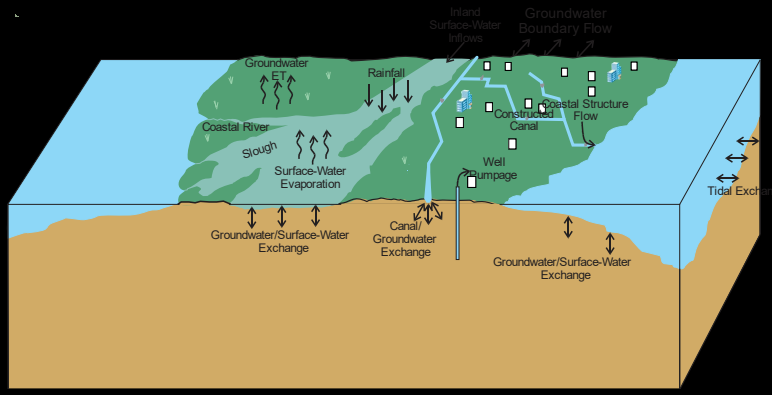


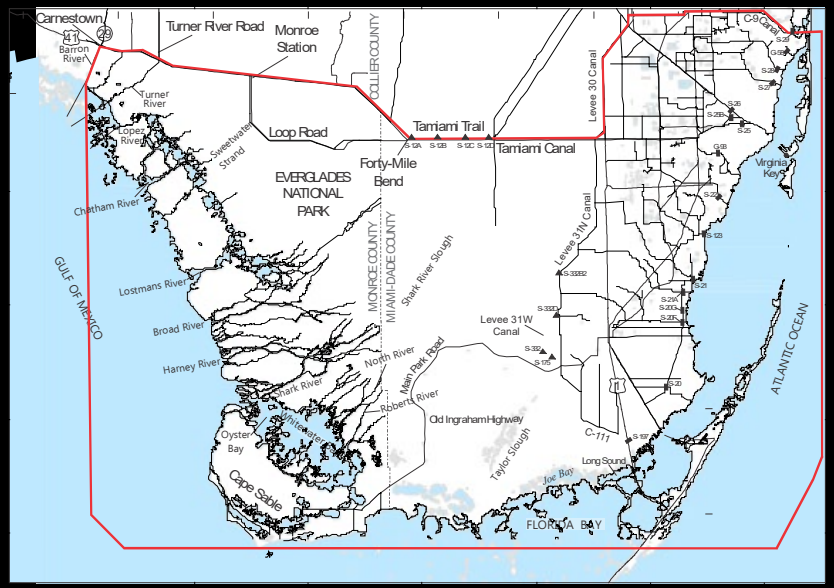
3) Coastal discharge stations can constrain boundary fluxes

Converting flux times friction to flux

- BISECT simulates Everglades surface-water and groundwater
- Hydrodynamic representation of surface water in two-dimensions
- Salinity transport



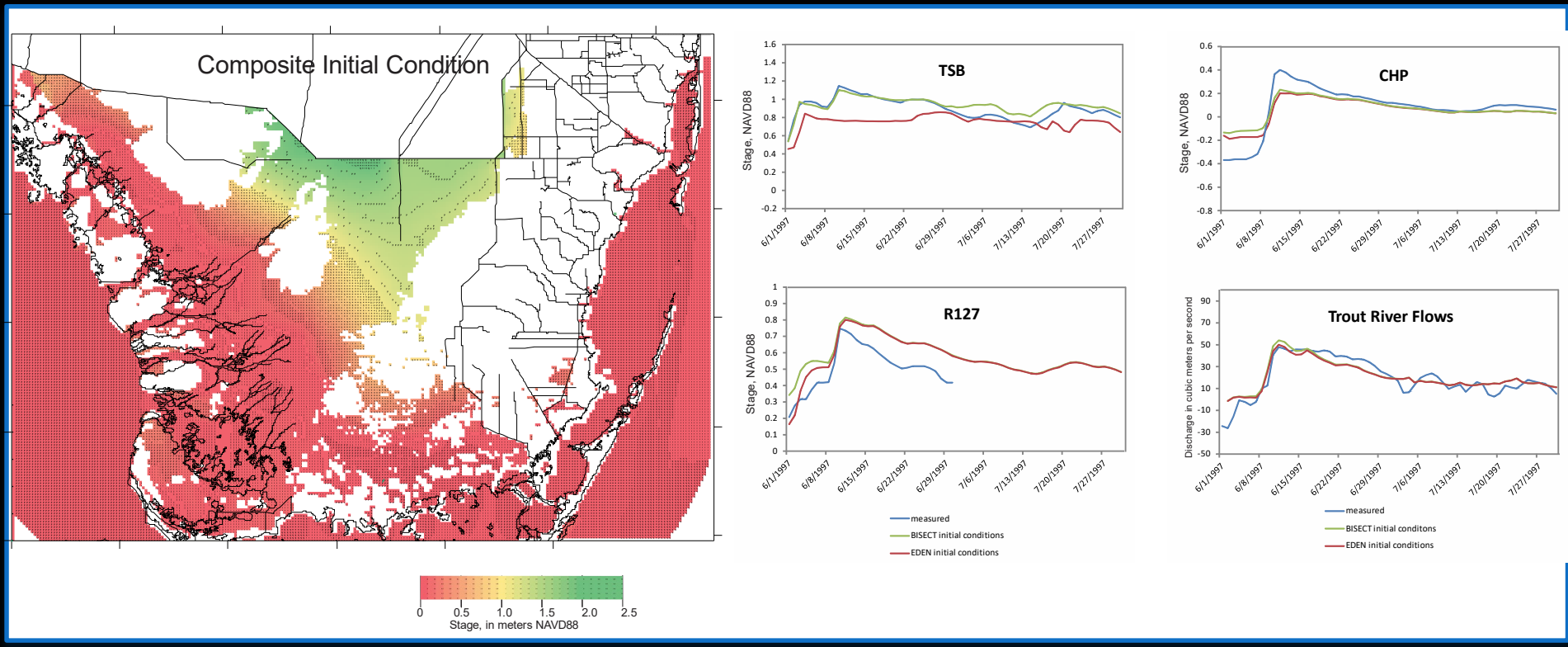




4) Comparison to Biscayne and Southern Everglades Coastal Transport model (BISECT)

Predictive BISECT simulation from EDEN water-level surfaces

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



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Questions?