



Hindcasting Water Levels for EDEN Gaging Stations, 2000-2006

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Advanced Data Mining

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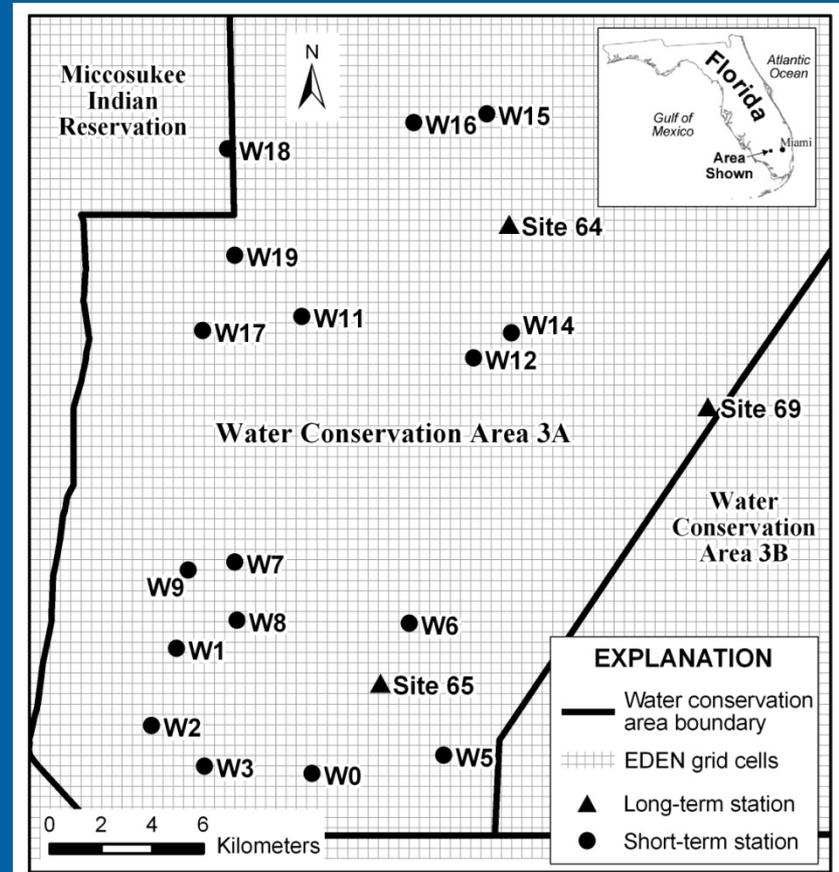
July 30, 2008

What's on tap?

- **Methods development in WCA3a**
- **Application to EDEN**
- **Quiet desperation**
- **The fix**
- **Results and discussion**

Problem : How to Estimate Water Depths at Ungaged Sites

- Dataset – WCA 3a
 - Water-level from 3 sites
 - Water-depth data from 17 sites
- EDEN grid and vegetation attributes
 - % prairie
 - % sawgrass
 - % slough
 - % upland
- UTM North
- UTM South

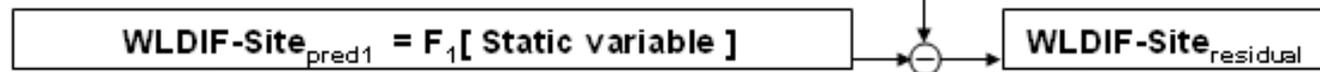


Approach

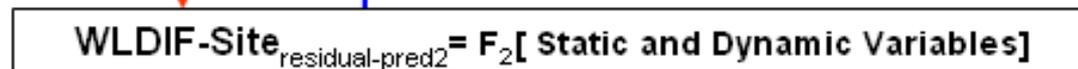
- **Two step ANN model**
 - **First step: estimate mean water-depths using static model – “spatially interpolating” ANN scheme**
 - **Second step: estimate water-depths variability using dynamic variables**

Two-step Model

Static Model



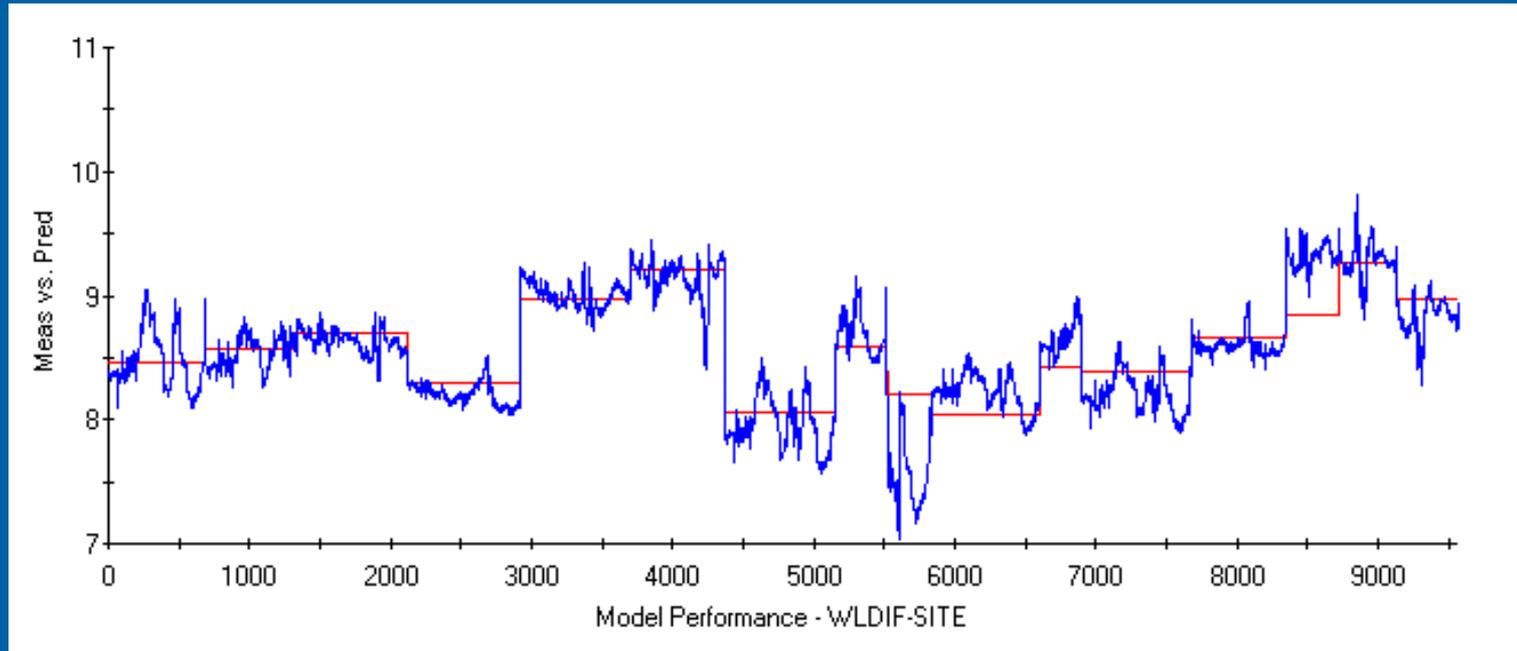
Dynamic Model



Final Prediction

$$WLDIF-Site_{pred} = WLDIF-Site_{pred1} + WLDIF-Site_{residual-pred2}$$

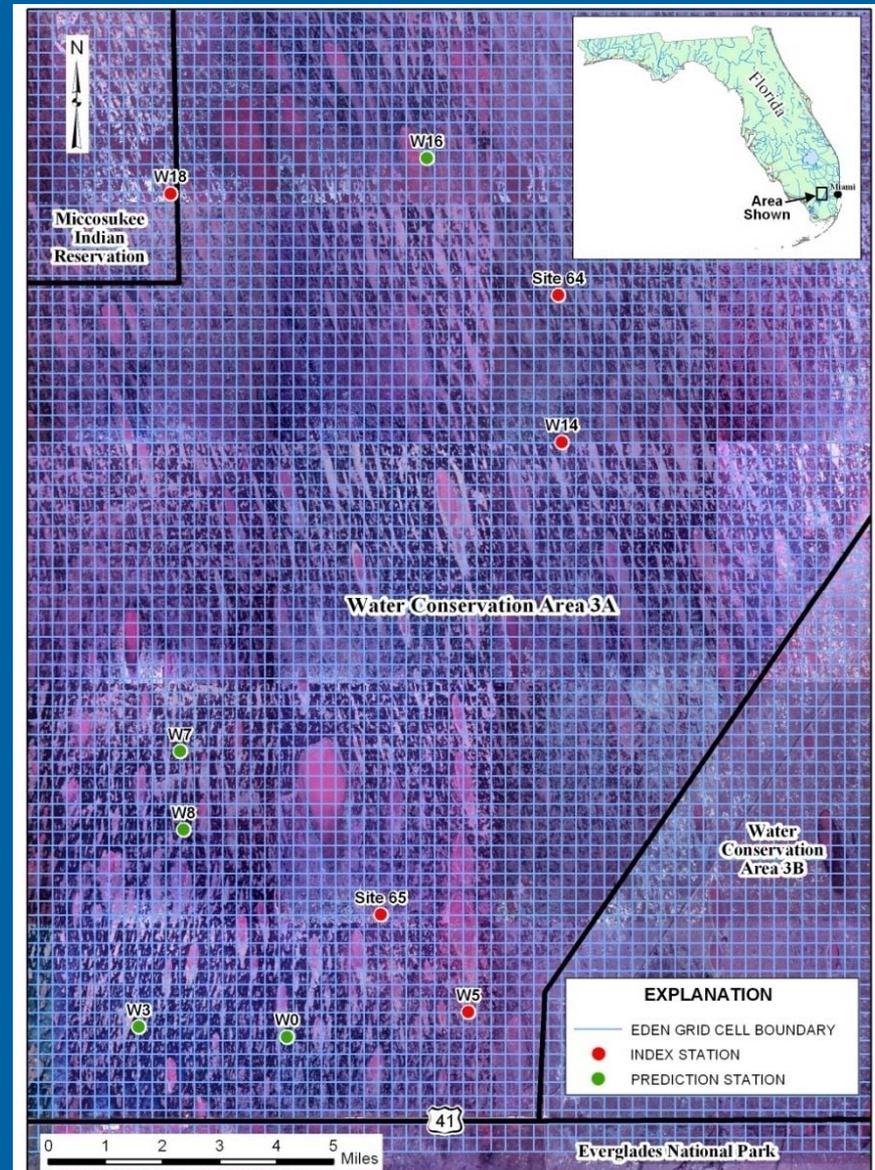
Static Model Results



- Each “step” represents a different site
- Model able to generalize water level difference but not the variability

Dynamic Model

- 5 “index” stations (red dots)
- Combination of static and dynamic data
- 5 validation stations (green dots)



Final Model Results

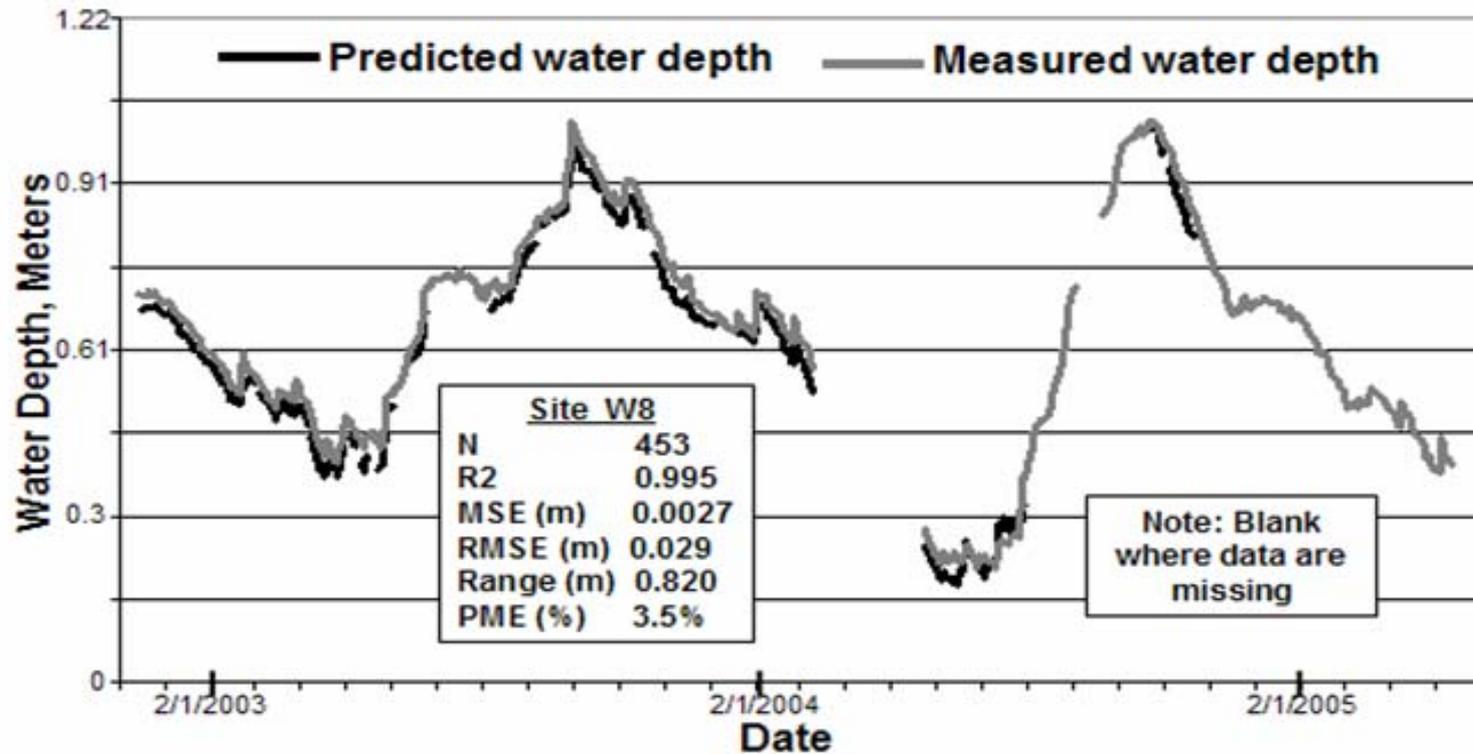


Figure 5. Plot showing measured (light trace) and predicted (dark trace) water depths for Site W8. Predictions are not continuous due to missing data for one or more of the index stations.

Hindcasting 25 EDEN Sites

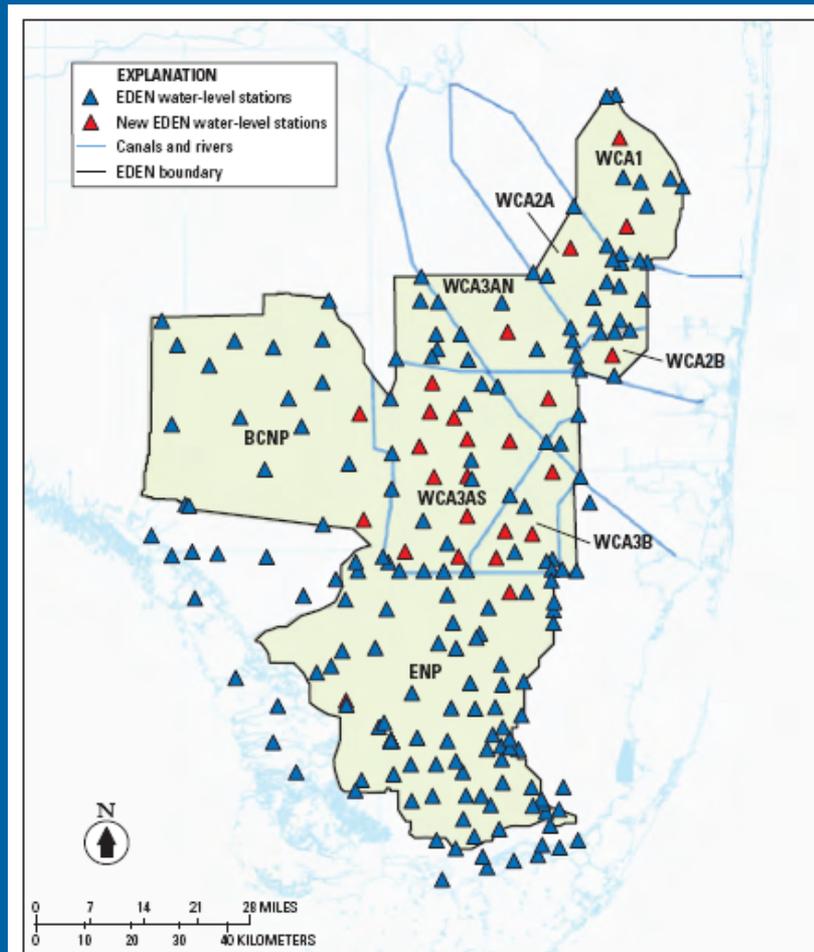
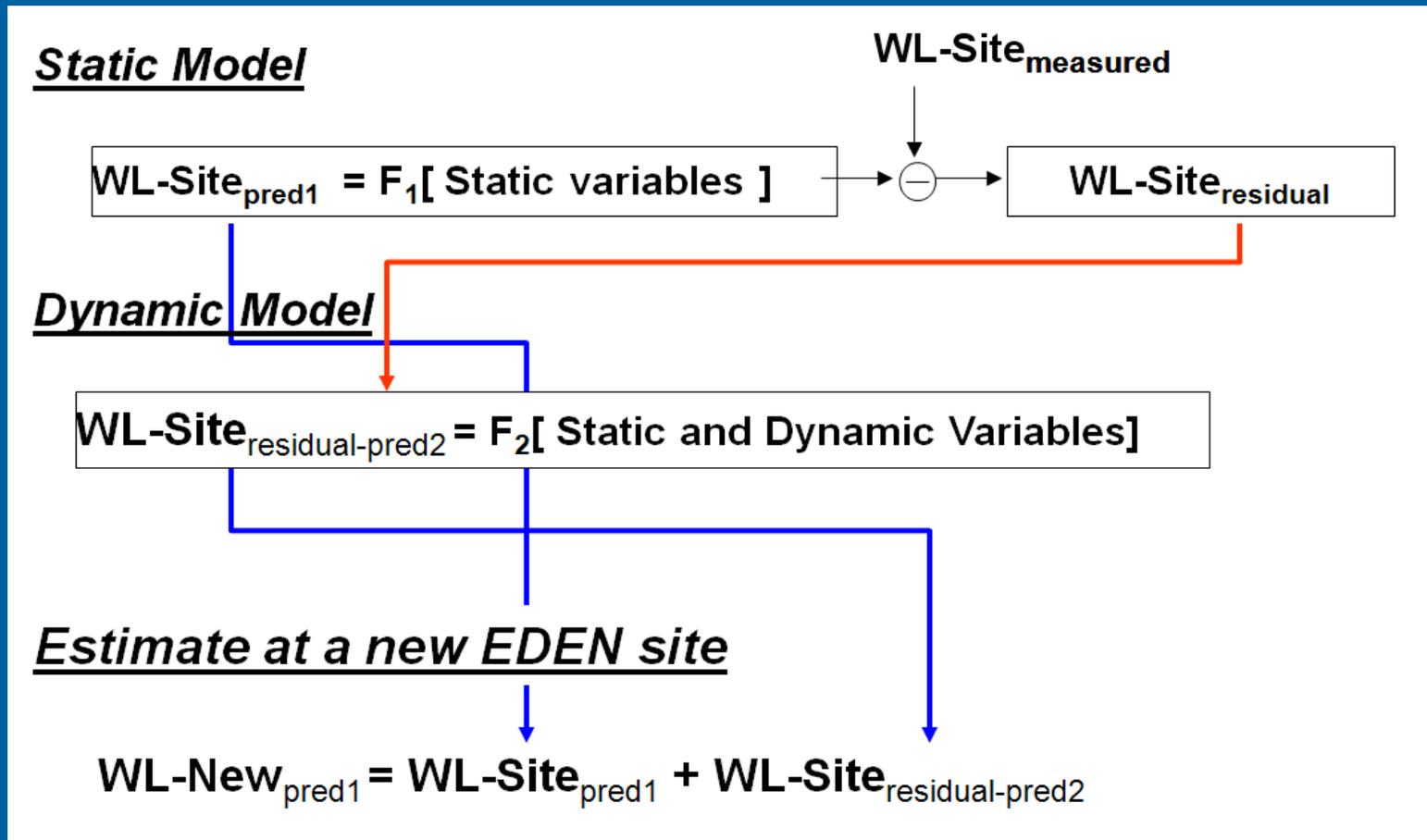


Figure 1. Locations of Everglades Depth Estimation Network (EDEN) gaging stations in southern Florida (modified from Pearlstine and others, 2007).

Existing EDEN sites : 7 years (61,400 data points)

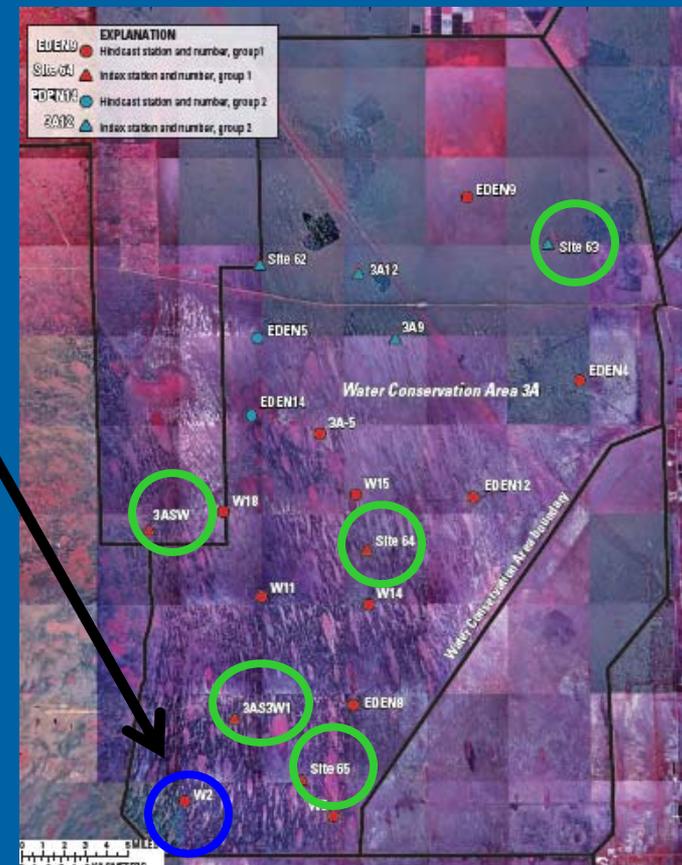
New EDEN sites : 4 -12 months of data (925- 8,760 data points)

Approach: Similar 2-Step Model

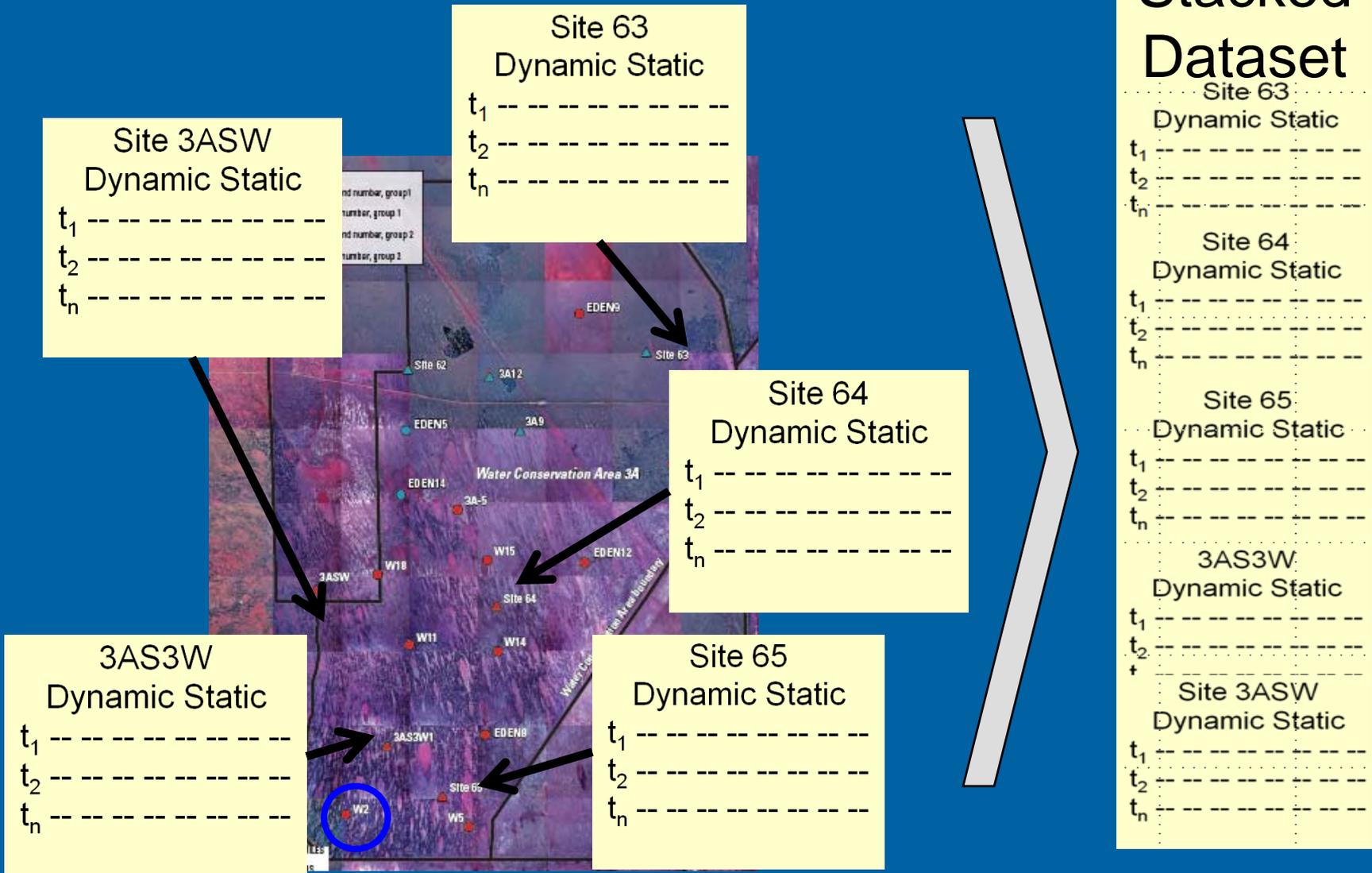


Approach: Similar 2-Step Model

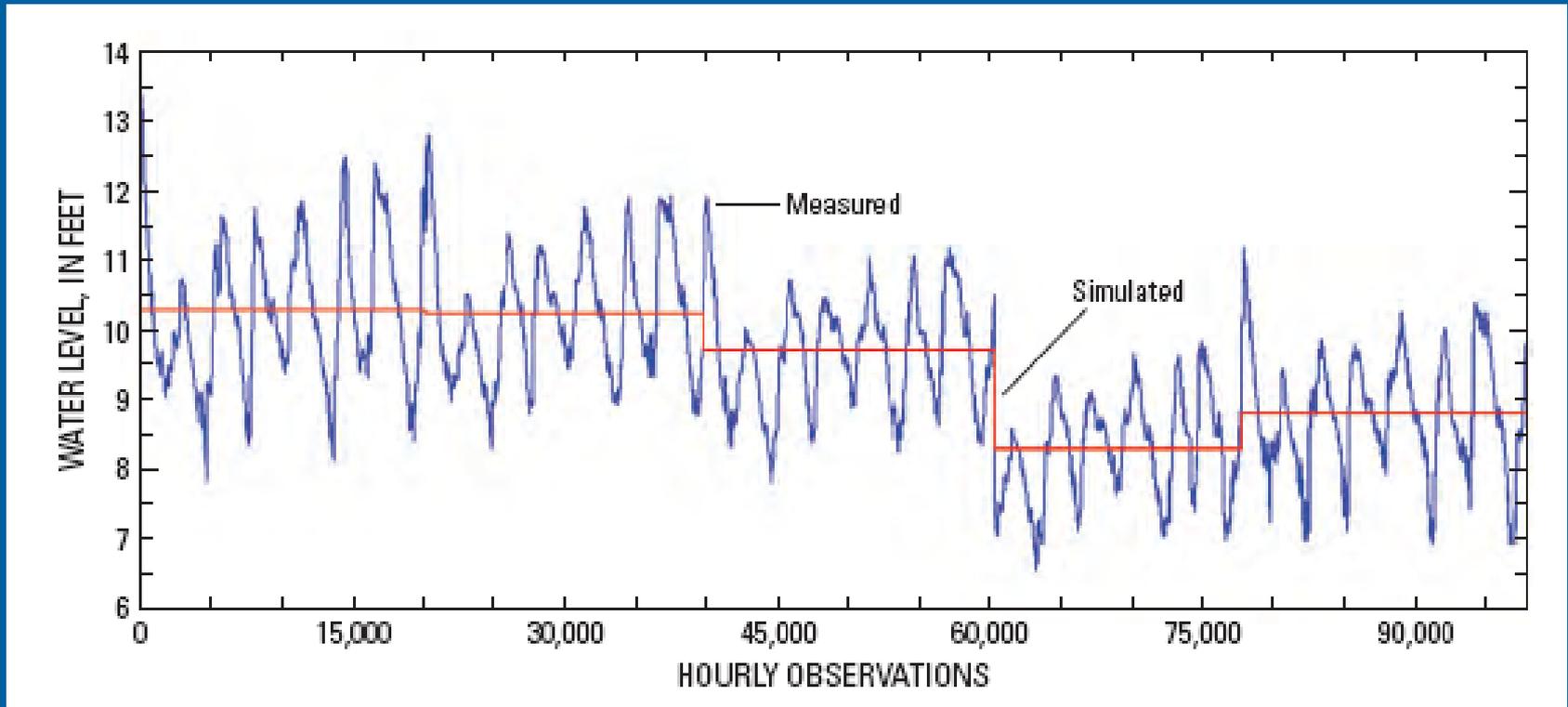
- Separate models for each area
- Number of potential inputs sites reduced using dynamic clustering
- Hindcast example – W2
- Input Sites
 - Sites 63, 64, 65, 3ASW3, and 3AWS



Spatially Interpolating ANN Model Stacked Dataset



Static Model Results



Site 63

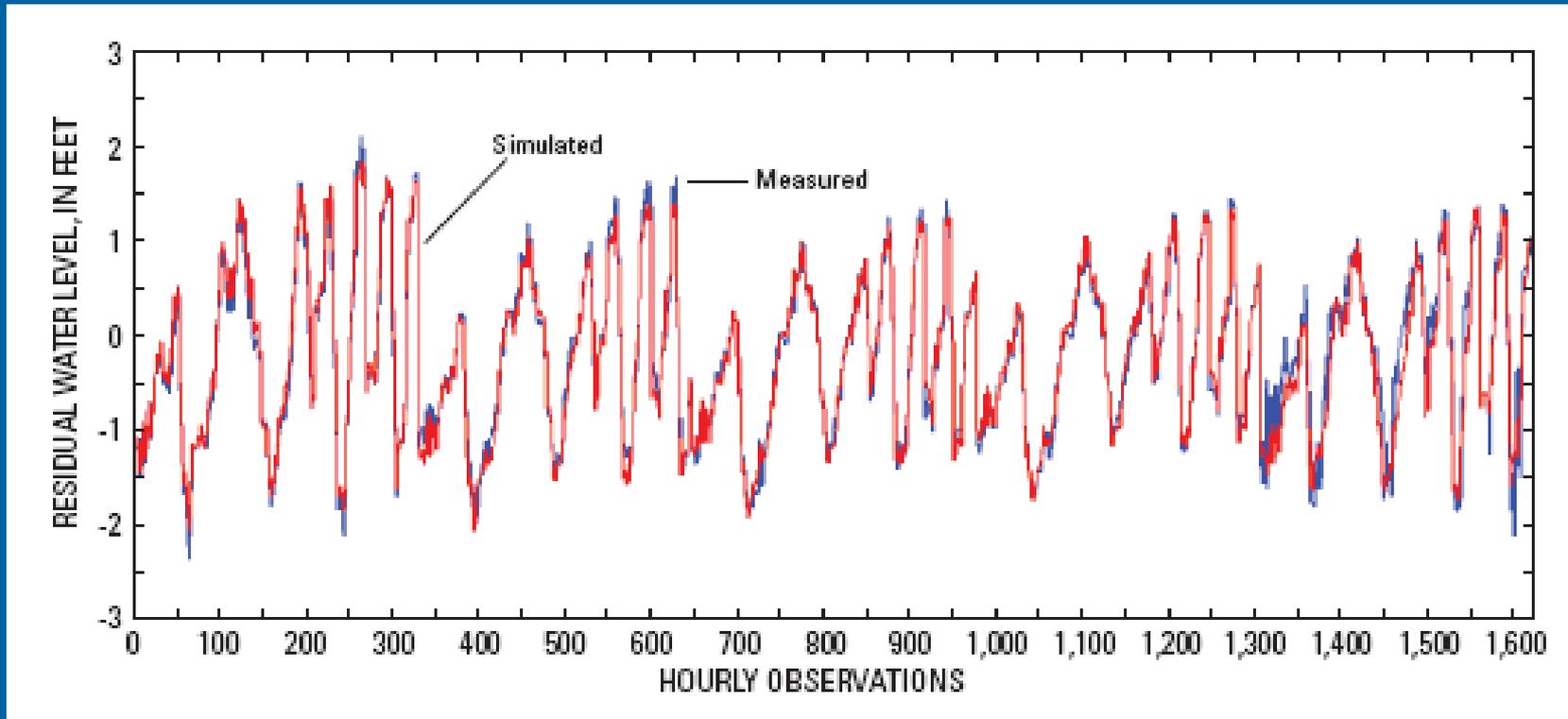
Site 64

Site 65

3AS3W

3ASW

Dynamic Model Results



Site 63

Site 64

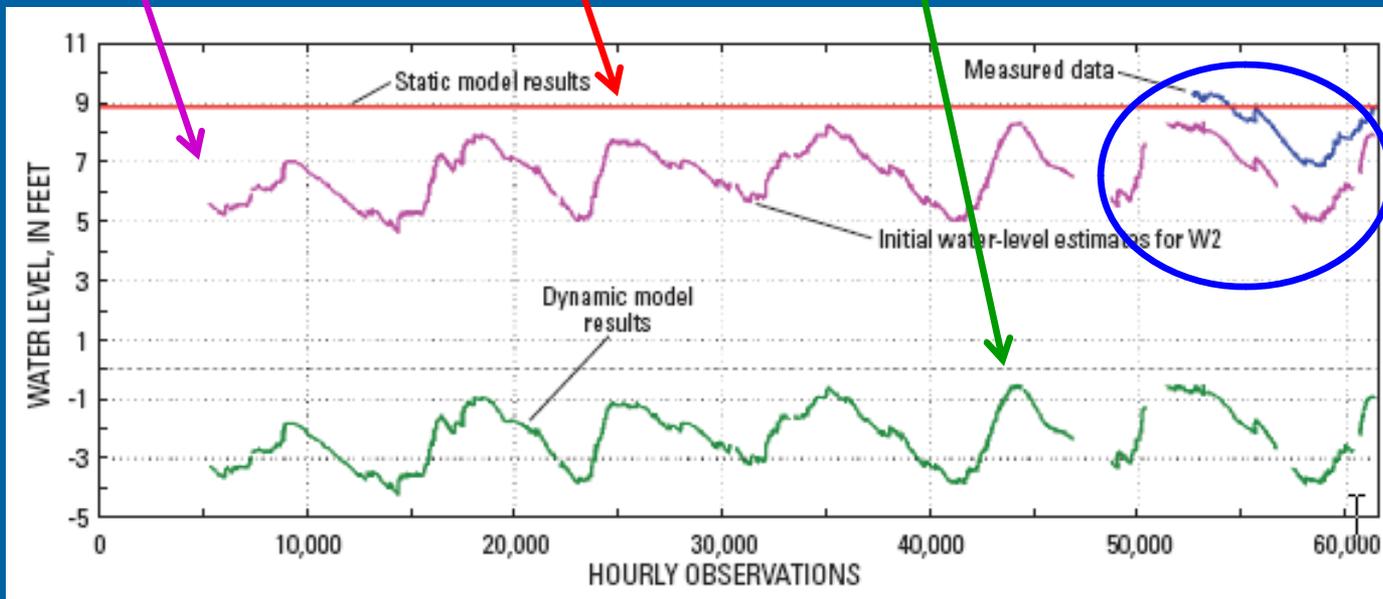
Site 65

3AS3W

3ASW

Initial Water Level Estimate – W2 “Quiet Desperation”

$$WL\text{-New}_{\text{pred}1} = WL\text{-Site}_{\text{pred}1} + WL\text{-Site}_{\text{residual-pred}2}$$



What is going on?

Data for W2 not used to train models

Possible Causes

- Datum confusion
- Gage offset
- W2 located lower edge of area covered by input sites
- Limited information content of static variables
- Did not use difference from a standard signal (decorrelated dynamic variables)

Third-step Model: Error correction

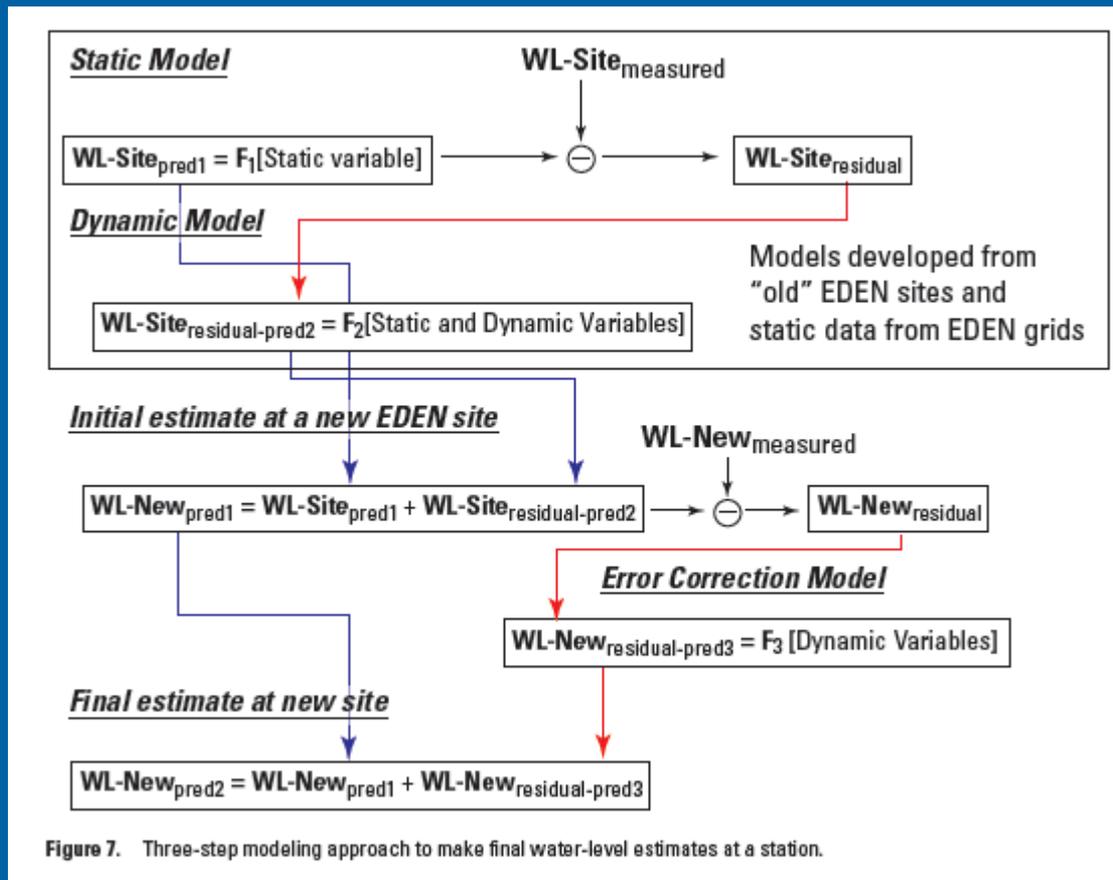
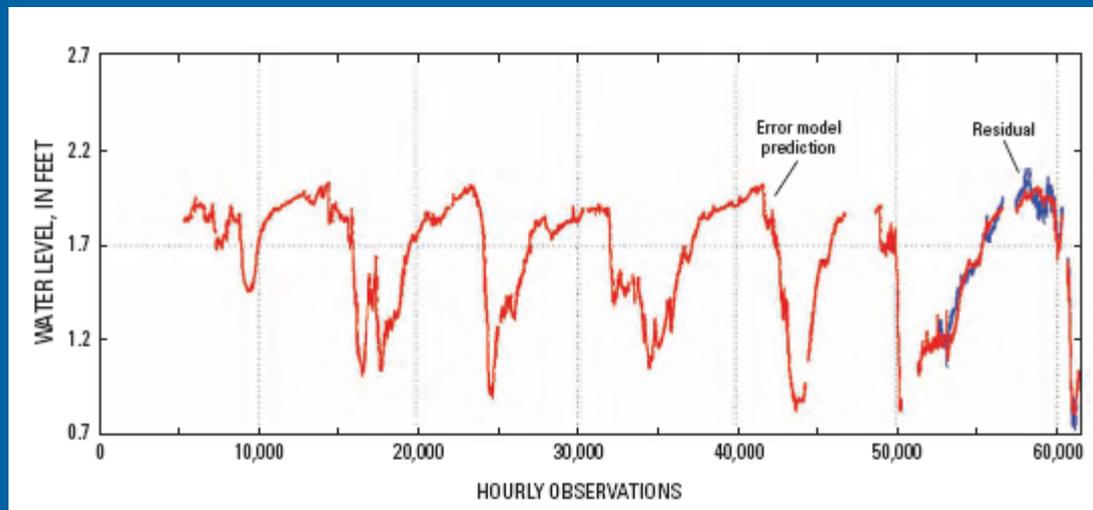
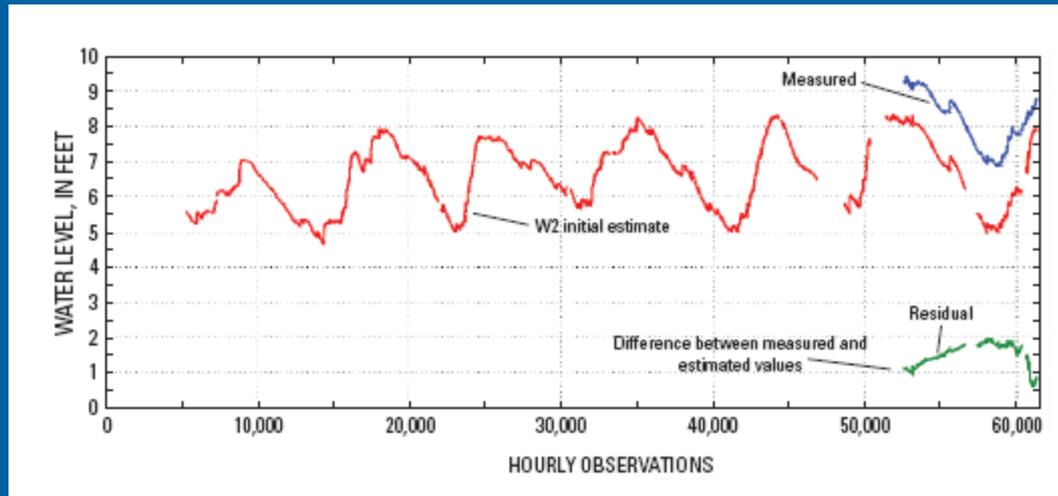
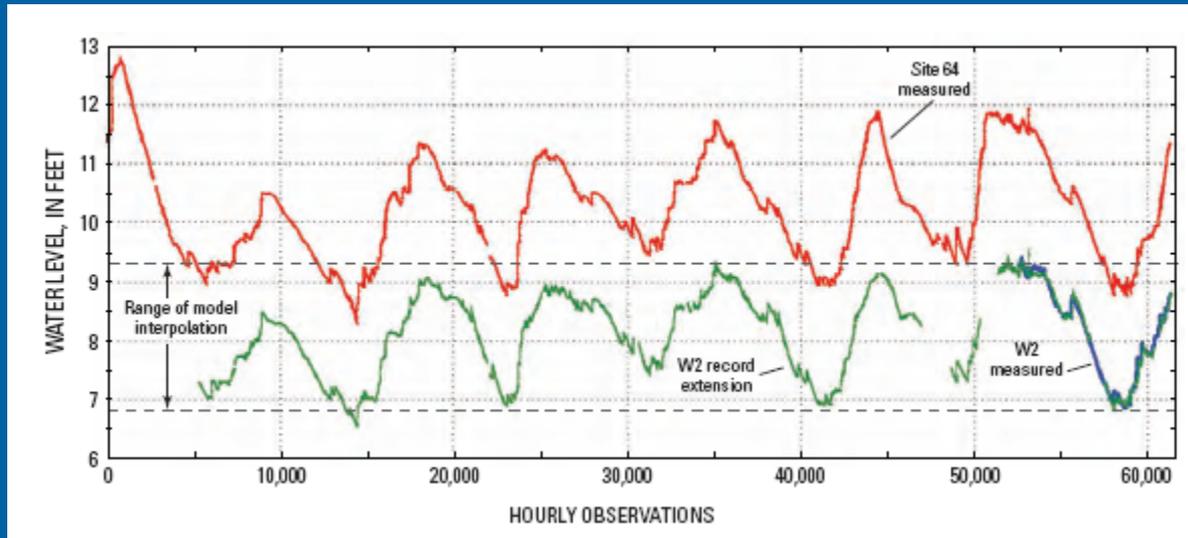


Figure 7. Three-step modeling approach to make final water-level estimates at a station.

Error Correction Model Results



Final Hindcast



Summary Statistics for Hindcasting Models

Table 4. Summary statistics for water-level estimates for new Everglades Depth Estimation Network (EDEN) stations.

[n, number of data values; R, Pearson coefficient; R², coefficient of determination; Min, minimum; ft, feet; Max, maximum; ME, mean error; RMSE, root mean square error; PME, percent model error]

Site	n	R	R ²	Data range		ME	RMSE	PME
				Min, in ft	Max, in ft			
Water Conservation Area 1 (fig. 15)								
North_CA1	41,721	0.943	0.889	13.82	16.38	-0.046	0.134	5.2
South_CA1	43,409	0.991	0.983	12.85	15.90	0.008	0.088	2.9
Water Conservation Area 2 (fig. 17)								
EDEN11	2,637	0.950	0.902	10.97	13.19	-0.054	0.044	2.0
EDEN13	1,968	0.955	0.912	7.07	7.69	-0.018	0.006	1.0
Water Conservation Area 3A (fig. 20)								
3A-5	5,684	0.998	0.995	8.15	10.10	0.002	0.001	0.1
EDEN4	2,399	0.999	0.998	6.96	10.30	0.001	0.002	0.1
EDEN5	1,653	0.999	0.999	8.01	10.20	0.004	0.001	0.1
EDEN8	2,442	0.999	0.999	6.79	9.19	0.001	0.001	0.0
EDEN9	925	0.999	0.998	7.69	10.55	-0.006	0.004	0.1
EDEN12	7,648	0.999	0.998	6.84	9.59	-0.002	0.001	0.0
EDEN14	969	0.906	0.821	8.66	9.59	0.011	0.010	1.1
W2	7,648	0.998	0.995	6.86	9.42	0.008	0.003	0.1
W5	7,648	0.999	0.998	6.84	9.59	-0.001	0.001	0.0
W11	7,628	0.999	0.998	7.08	10.08	-0.012	0.002	0.1
W14	7,628	0.998	0.997	7.00	10.00	-0.013	0.003	0.1
W15	3,859	0.999	0.998	7.47	9.67	-0.001	0.001	0.0
W18	7,628	0.998	0.996	7.92	10.21	-0.000	0.002	0.1
Water Conservation Area 3B (fig. 26)								
TI-8	5,684	0.996	0.993	4.59	6.16	0.002	0.001	0.1
TI-9	5,684	0.996	0.992	5.29	6.42	0.009	0.001	0.1
EDEN7	2,419	0.998	0.996	5.24	6.96	0.008	0.001	0.1
EDEN10	2,419	0.995	0.990	5.06	6.32	0.007	0.002	0.1
Big Cypress National Preserve (fig. 29)								
EDEN1	3,864	0.960	0.921	7.13	7.82	0.018	0.003	0.4
EDEN6	1,591	0.984	0.968	8.76	10.73	0.030	0.007	0.4
Everglades National Park (fig. 31)								
EDEN3	5,294	0.989	0.978	0.07	1.75	-0.042	0.006	0.4
Met1	1,238	0.994	0.989	5.23	5.76	0.000	0.000	0.0

Summary

- **Estimation of water depth at ungaged sites**
 - ANNs able to accurately predict water depths at ungaged sites
 - Use of static and dynamic variable produce a multi-variate “kreiging” of water depths
 - Methodology will be used to hindcast “new” network stations

Questions

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Open-File Report 2007–1350

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