Cayuga Lake Model

2-D Hydrodynamic Model

Upstate Freshwater Institute

TAC Meeting
Wednesday, January 15, 2014
Cornell University, Ithaca, NY
Two-Dimensional Model

- provide transport framework for a water quality model; TMDL analysis
- CE-QUAL-W2 (W2; US Army Corps of Engineers): dynamic, laterally averaged, two-dimensional (longitudinal-vertical) model
- applied successfully to 100s of waterbodies worldwide
- hydrodynamic submodel predicts water surface elevations, velocities, and temperatures
- model can simulate baroclinic seiches

- long-term simulations (e.g., climate change)
- not suitable for near-field or 3-D simulations
Other Applications of CE-QUAL-W2 by UFI

Finger Lakes (3):
  Owasco
  Skaneateles
  Otisco

NYC Reservoirs (9):
  Ashokan  Cannonsville
  Kensico  Neversink
  Pepacton  Rondout
  Schoharie  West Branch
  New Croton

Others (1):
  Carroll County Lake, TN
Schoharie Reservoir

Distance from dam (m)

Elevation (m)

site 1.5
Manor Kill
water supply intake
site 3
Bear Kill
Schoharie Creek

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Bear Kill
Manor Kill
site 3
water supply intake
dam

1 km

Distance from dam (m)

Elevation (m)

intake

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Ashokan – West Basin

Esopus Creek

27 segments (~330 m avg)
47 layers (1 m)
1 branch

Distance from weir (m)

Elevation (m)

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Rondout Reservoir

Distance from dam (km); Branch 1

Longitude

Latitude

Elevation (m)

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Carroll County Lake, TN

Overall Grid:
27 segments; ~300 m length
32 layers; 0.5 m depth interval

Design of a multi-level release structure
Proposed Hydrodynamic Modeling

- period of development of data for model simulations: 1987-2013 (27 years)
  - calibration: 2013
  - validation: 1998-2006
  - additional simulations: 1987-2013

- model performance features and analyses
  - state variables: water surface elevation, velocity, temperature
  - stratification regime: timing (onset and turnover), and duration of stratification; thicknesses of epilimnion and hypolimnion
  - assessment of barotropic and baroclinic seiches supported by thermistor chain data from 2013 (Cornell University)

- input from 3-D modeling (Cornell University), as necessary
Data Requirements

- bathymetry (Cornell)
  - longitudinal-vertical grid
- meteorological data
  - Game Farm Road, Piling Cluster, Ithaca Airport, Syracuse Airport
- inflows
  - Fall Creek, Cayuga Inlet, Six Mile Creek, Taughannock Creek, Salmon Creek, and LSC, IAWWTP, CHWWTP, Milliken Power Station discharges
  - other minor tributaries as distributed input
- outflows
  - downstream to Seneca River, LSC and Milliken Power Station withdrawals
- water surface elevation
- inflow temperatures
- light extinction coefficients
- in-lake temperatures for model testing
Cayuga Lake: Shelf Boundary
Longitudinal Grid

developed for The project

sites 1998-2006

sites 2013
Example Calibration Data: Site 3

- depth-profiles
Example Calibration Data: Site 2

- timeseries

![Graph showing temperature data from May to October 2013 for site 2, 2 m.]
Next Steps

• complete data files for 2013
• estimate ungaged inflows (hydrologic budget)
• preliminary hydrodynamic model calibration
• evaluate model grid
• model performance evaluation (stratification, hydrodynamics)
Visualization of Turbidity Predictions Following a Runoff Event

Ashokan West – June 25, 2006 through July 11, 2006

Esopus Creek