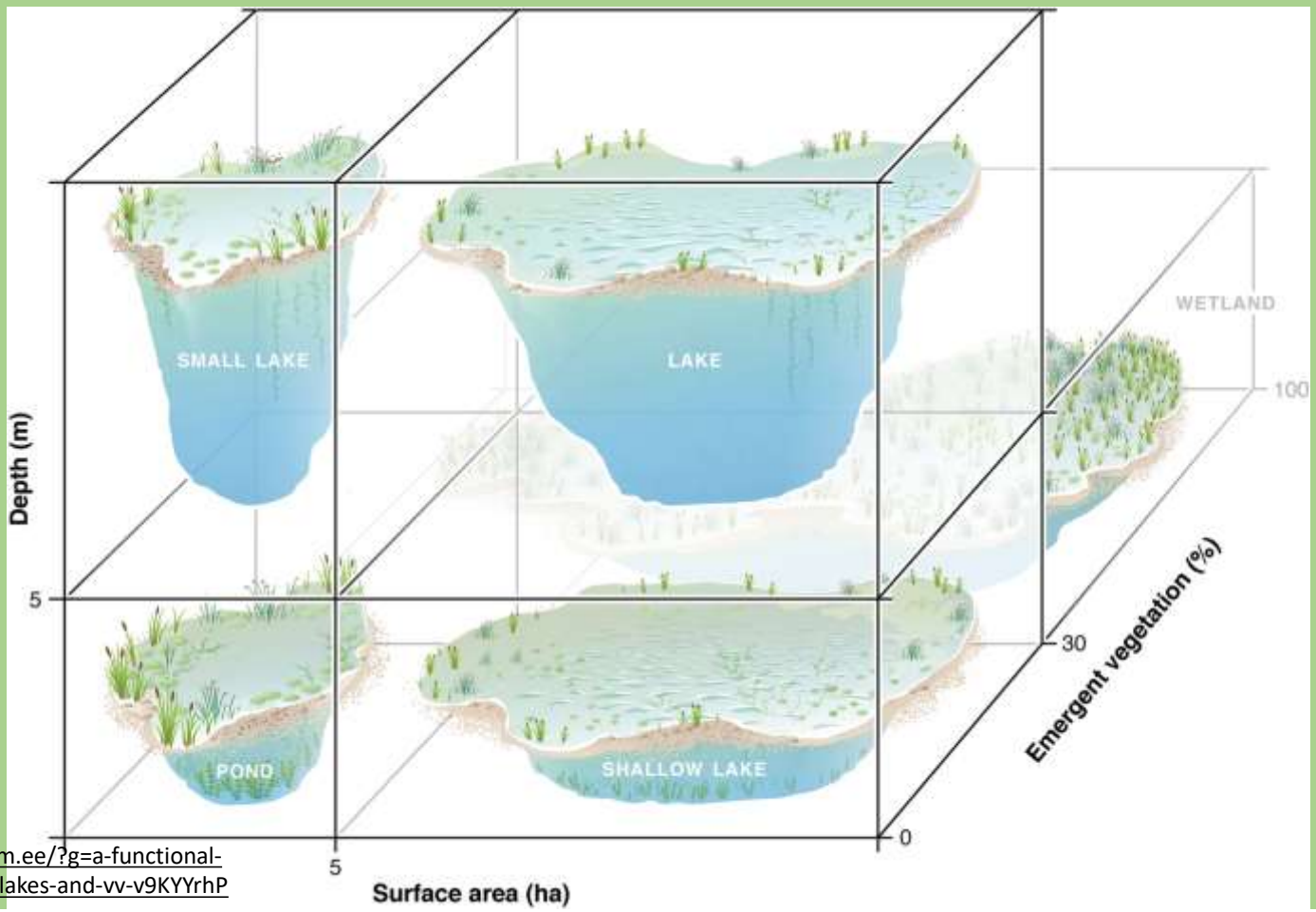
Lake Modeling Capacity and the LAKE2K Model

Ben Cope, EPA Region 10, LSASD

October 2, 2024

There’s a lot of lakes out there to protect…



Source: https://hoidla.spordimuuseum.ee/?g=a-functional-definition-to-distinguish-ponds-from-lakes-and-vv-v9KYYrhP

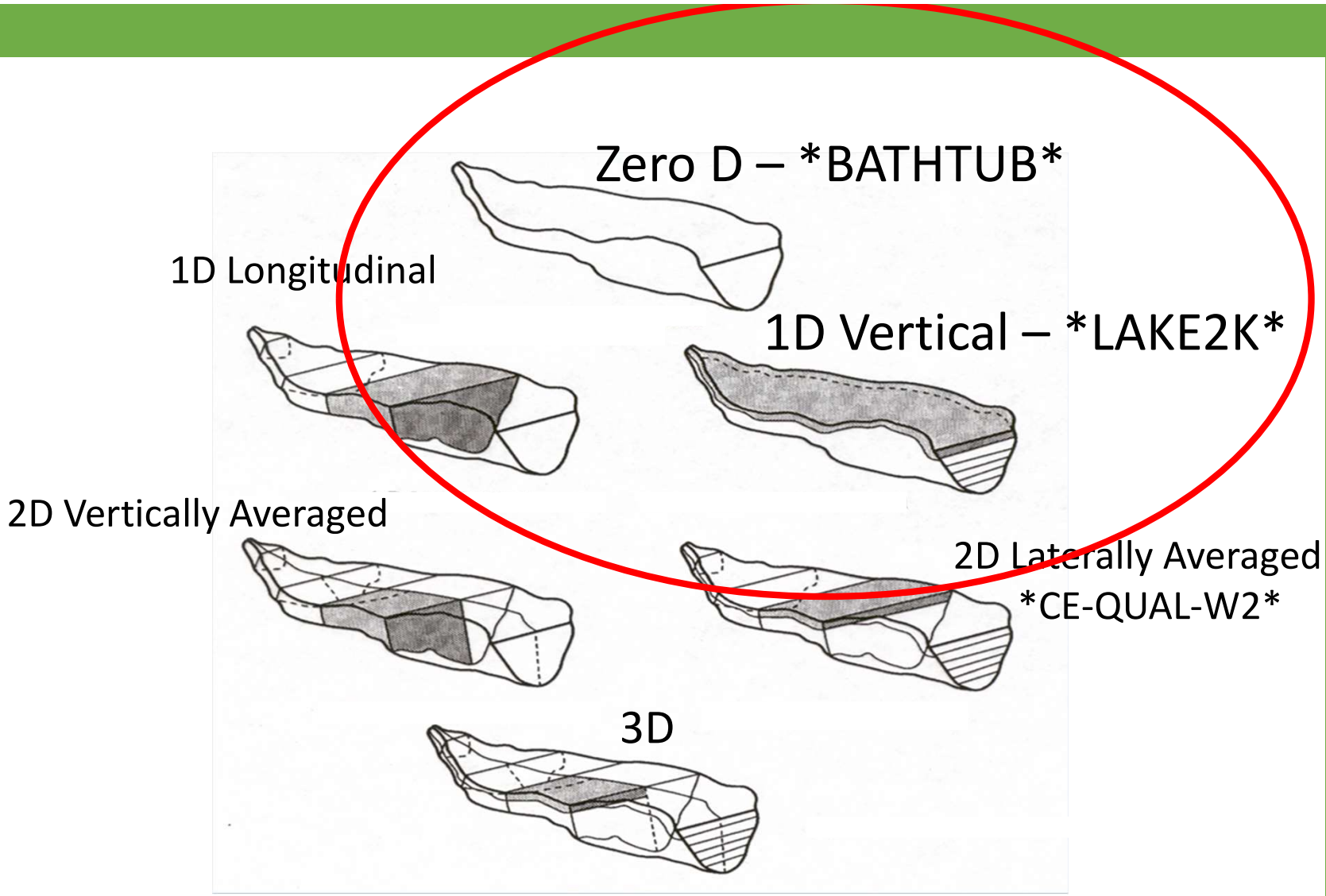
Lake Nutrient Impairments

- TMDL development can be resource-intensive
- Water quality models are essential
  - Limited technical capacity in many state/tribal agencies
  - Current models are limited – very simple or very complex
- Increasing risks
  - HABs
  - Climate Change

EPA's Water Modeling Workgroup (WMW)

- Chartered in 2017
- Goal – Improving water quality modeling capacity
- Annual modeling training workshop
- WMW webinar series – Big Hit!

  https://www.epa.gov/waterdata/surface-water-quality-modeling-training


Zero D – *BATHTUB*
1D Longitudinal
1D Vertical – *LAKE2K*
2D Vertically Averaged
2D Laterally Averaged
CE-QUAL-W2
3D

Water Modeling Workgroup (WMW) Activities

- Updating Old Workhorse Model: BATHTUB
  - Zero dimensional – complete mix
  - Steady state – simulates seasonal average
- Peer Reviewing New Model : LAKE2K
  - One dimensional – 3 vertical layers
  - Dynamic simulation – daily simulation
- Research proposal
  - Applied model comparison and companion guidance on model selection

LAKE2K - 3 Vertical Layers
Epilimnion, Metalimnion, Hypolimnion

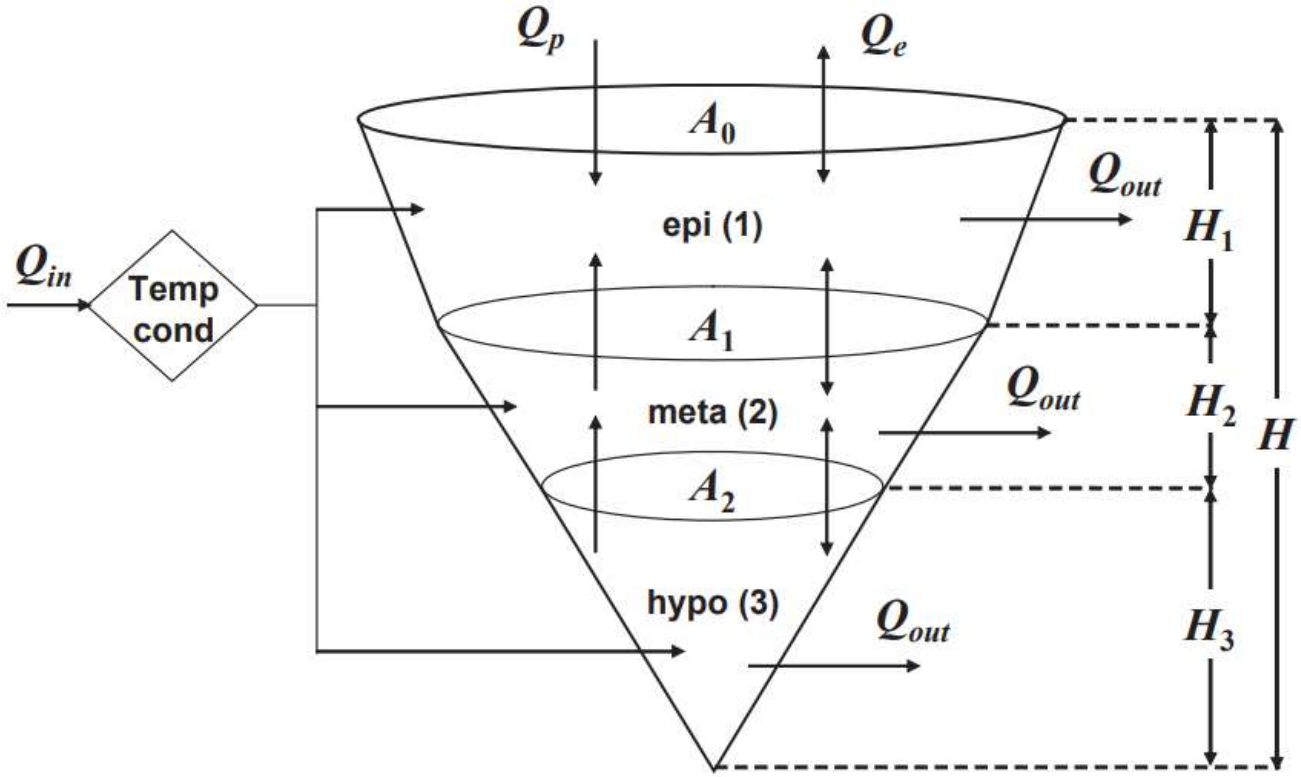


Figure 29 LAKE2K water balance and vertical segmentation scheme.

LAKE2K – Processes Simulated

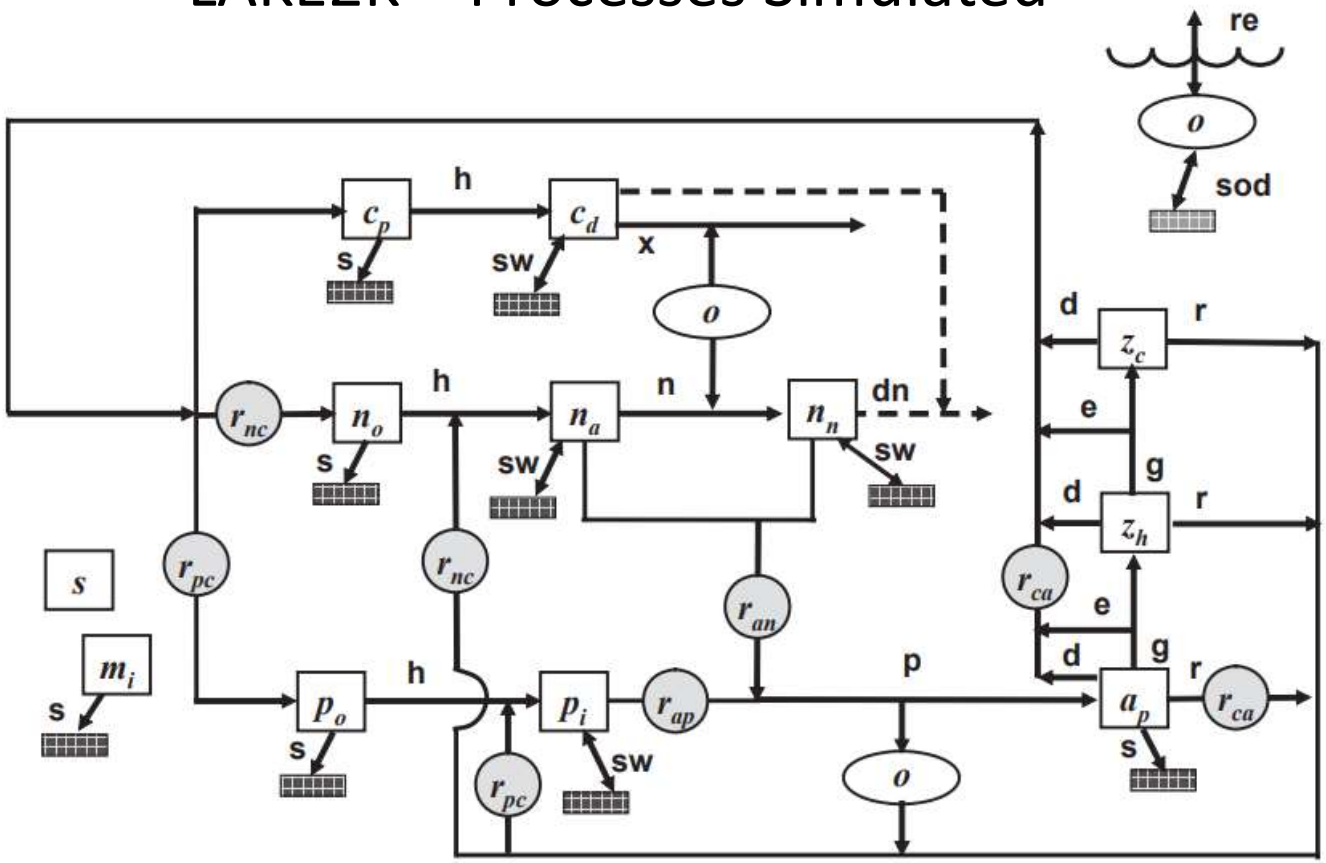
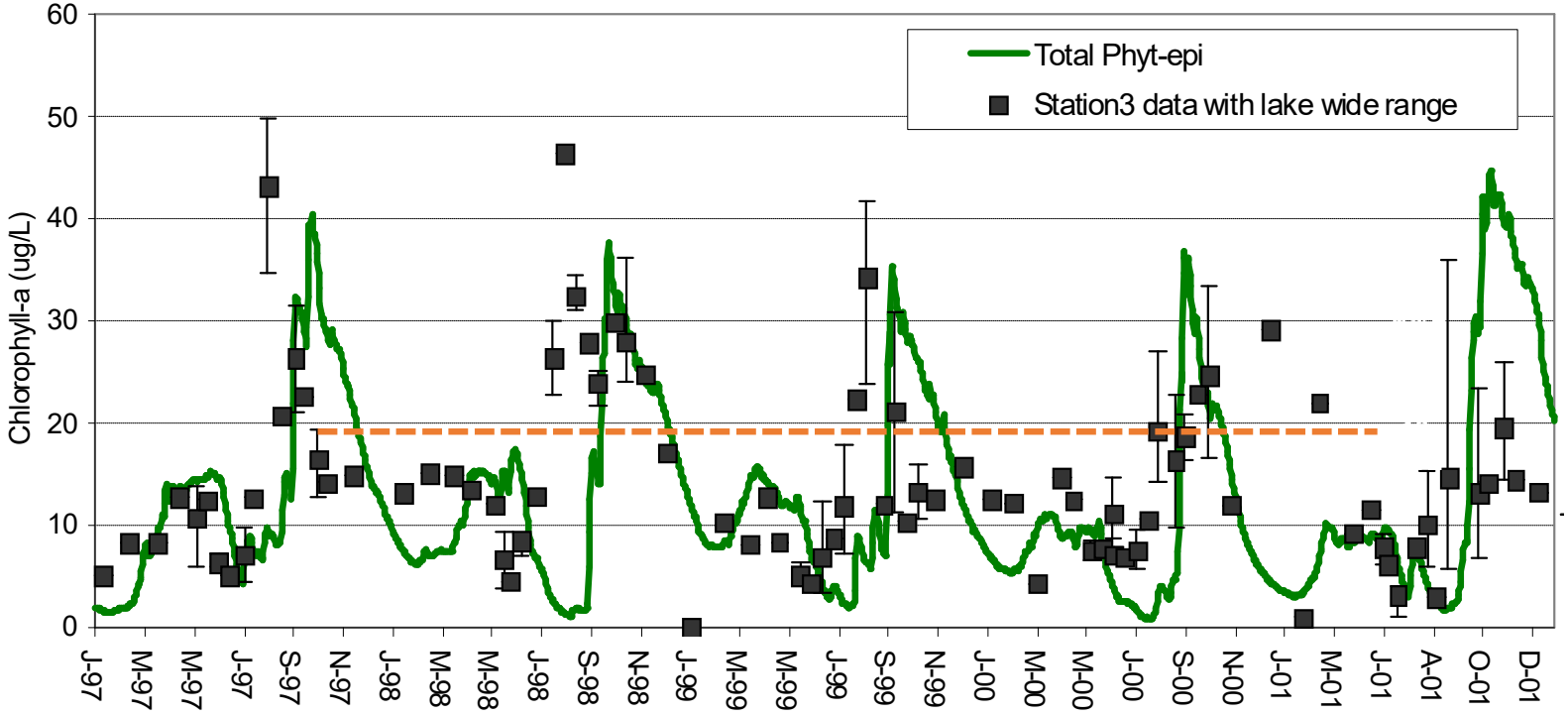
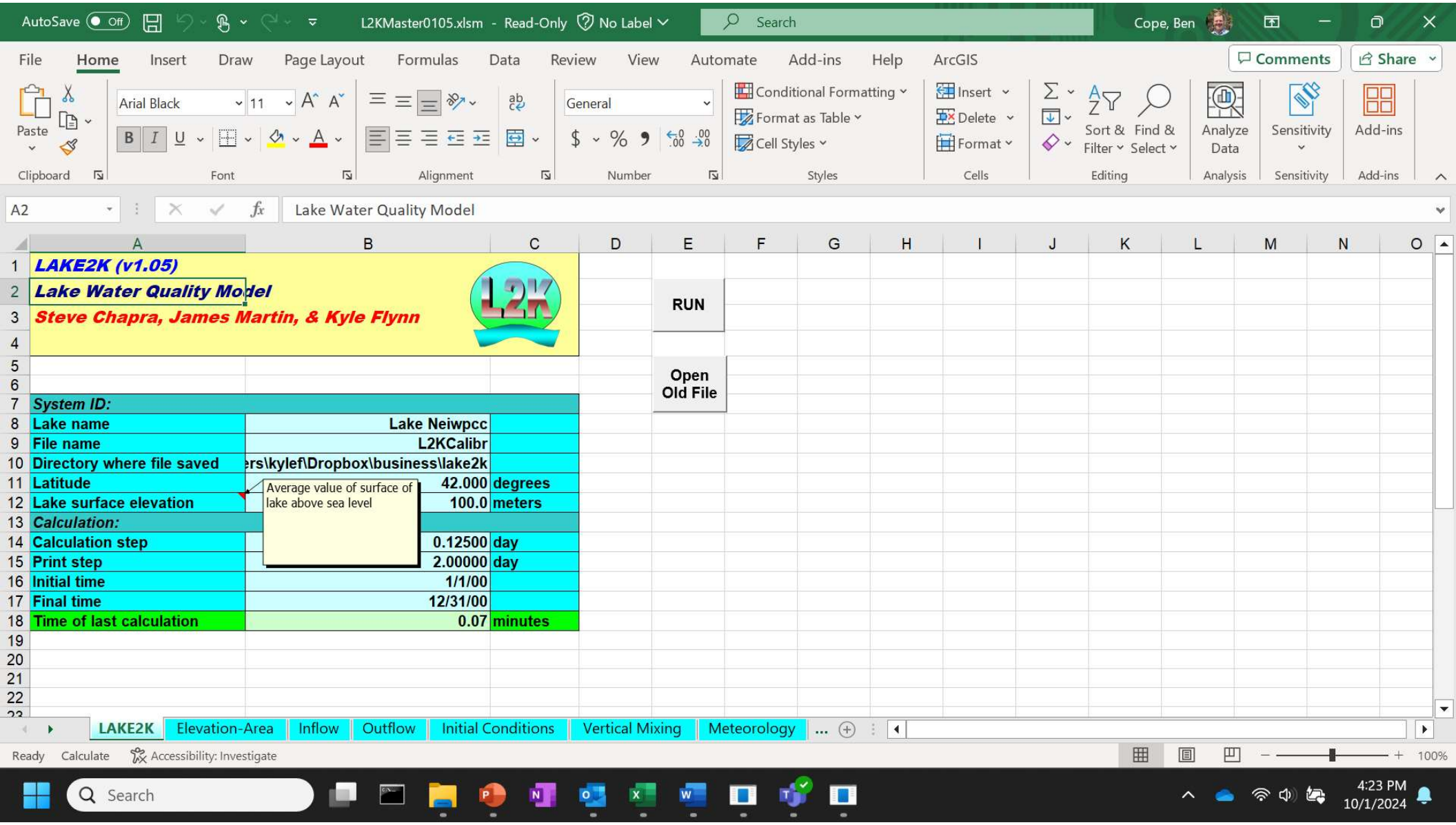


Figure 32 Model kinetics and mass transfer processes. The state variables are defined in Table 3. Kinetic processes are hydrolysis (h), oxidation (x), nitrification (n), denitrification (dn), photosynthesis (p), respiration (r), death (d), grazing (g), and egestion (e). Mass transfer processes are reaeration (re), settling (s), sediment oxygen demand (sod), and sediment-water exchange (sw).

LAKE2K Model Results (epilimnion algae)



Northeastern Pennsylvania
Lake Wallenpaupack nutrient model
Lake2K
Phytoplankton calibration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Find & Select
Analyze Data
Sensitivity
Add-ins
Clipboard
Font
Alignment
Number
Styles
Cells
Editing
Analysis
Sensitivity
Add-ins
A2
Lake Water Quality Model
LAKE2K (v1.05)
Lake Water Quality Model
Steve Chapra, James Martin, & Kyle Flynn
L2K
RUN
Open Old File
System ID:
Lake name Lake Neiwpcc
File name L2KCalibr
Directory where file saved ers\kylef\Dropbox\business\lake2k
Latitude 42.000 degrees
Lake surface elevation 100.0 meters
Average value of surface of lake above sea level
Calculation:
Calculation step 0.12500 day
Print step 2.00000 day
Initial time 1/1/00
Final time 12/31/00
Time of last calculation 0.07 minutes
LAKE2K
Elevation-Area
Inflow
Outflow
Initial Conditions
Vertical Mixing
Meteorology
Ready
Calculate
Accessibility: Investigate
100%
Search
4:23 PM
10/1/2024

Thanks!

- EPA Water Modeling Workgroup – Amy King, John Johnston, Chris Knightes, Jason Gildea
- LAKE2K development team – Steve Chapra, James Martin, and Kyle Flynn
- Tetra Tech