



**U.S. Fish & Wildlife Service**

**Arthur R. Marshall**

**Loxahatchee National Wildlife Refuge**

# Model Equations and Structure

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# Findings from the CMF Model

## (Workshop 1)

- Chloride
  - modeled well as a conservative
- Sulfate
  - modeled using apparent settling rate,  $k_s$
  - $K_s$  varied spatially, approximated zero order removal
- Total Phosphorus
  - Used k-c\* model
  - Followed transients in canal & peripheral marsh
  - Not reliable in interior, did not model transients well

# MIKE-FLOOD/ECO Lab Equations

Rate of mass accumulation =

- + Mass inflow - mass outflow
- + Dispersion in – out
- + Production - disappearance

$$A_{cell} \frac{dhc}{dt} = Q_i c_i - Q_o c_o + disp + source - k_s c$$

# Inflow – aerial deposition

Wet deposition = rain rate \* rain concentration

Dry deposition = loading rate

# Outflow – ET (evapotranspiration)

Evaporation = does not transport mass

Transpiration =  $ET * \% \text{ Trans} * C$

## Source-Sink: Chloride

- Chloride is assumed to be conservative and has no other source or sink terms

# Source-Sink: Sulfate

- No internal source
- First order apparent settling at low concentration
- Constant disappearance flux rate (zero order) independent of  $c$  at high concentration
- Transition is modeled using Monod relationship with half-saturation constant

$$\frac{dhc}{dt} = (\dots) - k_0 \frac{c}{k_{1/2} + c}; \quad k_s = \frac{k_o}{k_{1/2}}$$

# Source-Sink: Total Phosphorus (TP)

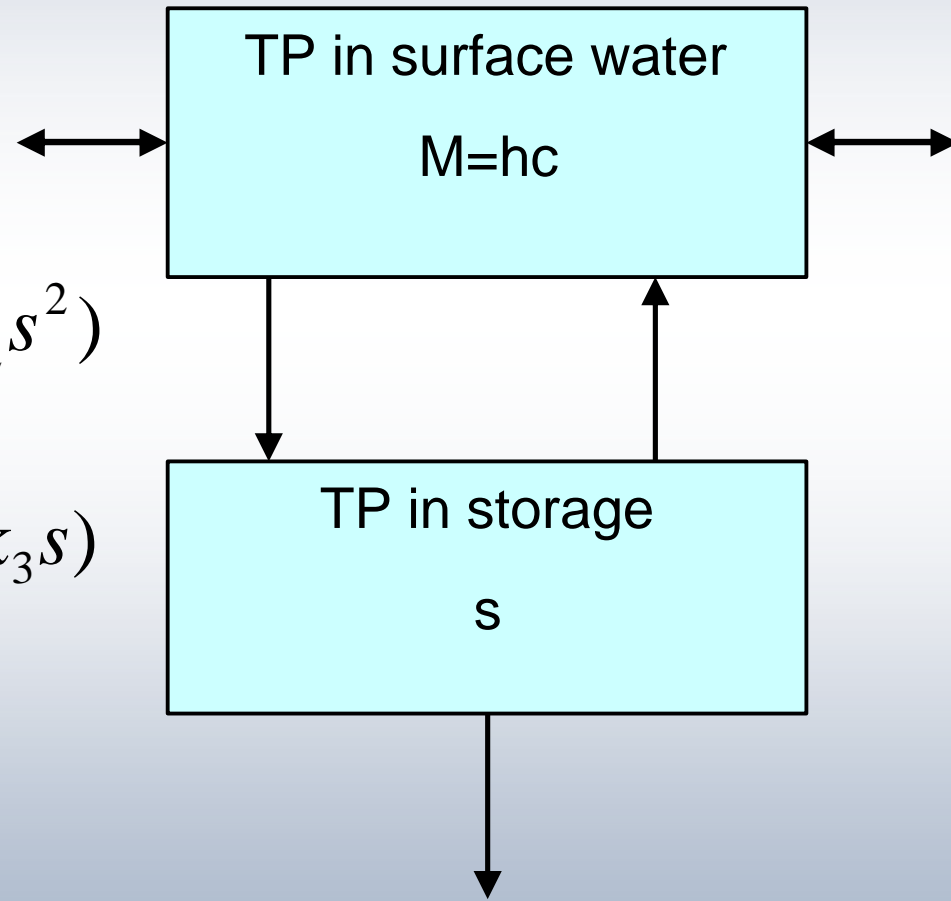
- TP is modeled using equations structured as in DMSTA (<http://www.walker.net/dmsta/index.htm>)
- TP is assumed to have 2 state-variables
  - surface water component (transports)
  - storage component (stationary)
- TP moves into and out of storage
- TP in storage can be permanently lost to burial



# TP Model Structure

$$\frac{dhc}{dt} = (\dots) - (f_c f_z k_1 s c) + (k_2 s^2)$$

$$\frac{ds}{dt} = (f_c f_z k_1 s c) - (k_2 s^2) - (k_3 s)$$



# TP Model Structure:

At steady-state this model can be re-parameterized to the k-c\* model

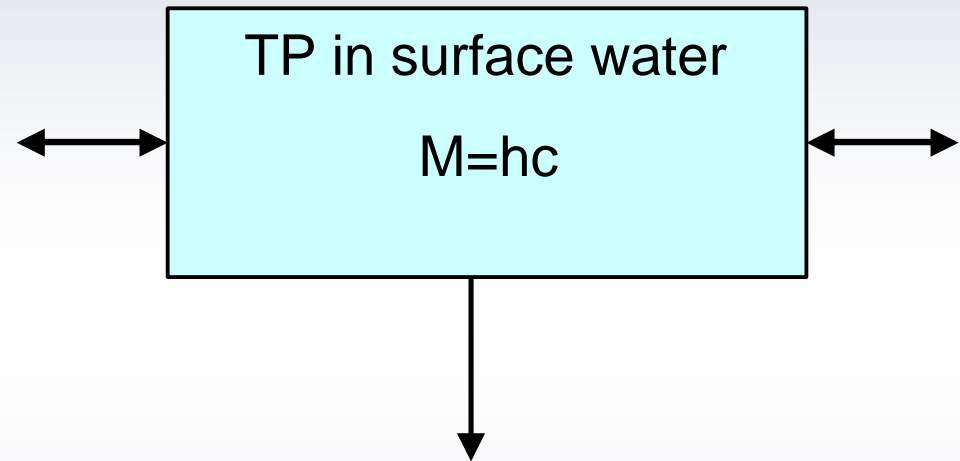
$$\frac{dhc}{dt} = (\dots) - k_s (c - c^*)$$

$$k_s = k_1 k_3 / k_2$$

$$c^* = k_3 / k_1$$

$$c_1 = (1000k_2 + k_3) / k_1$$

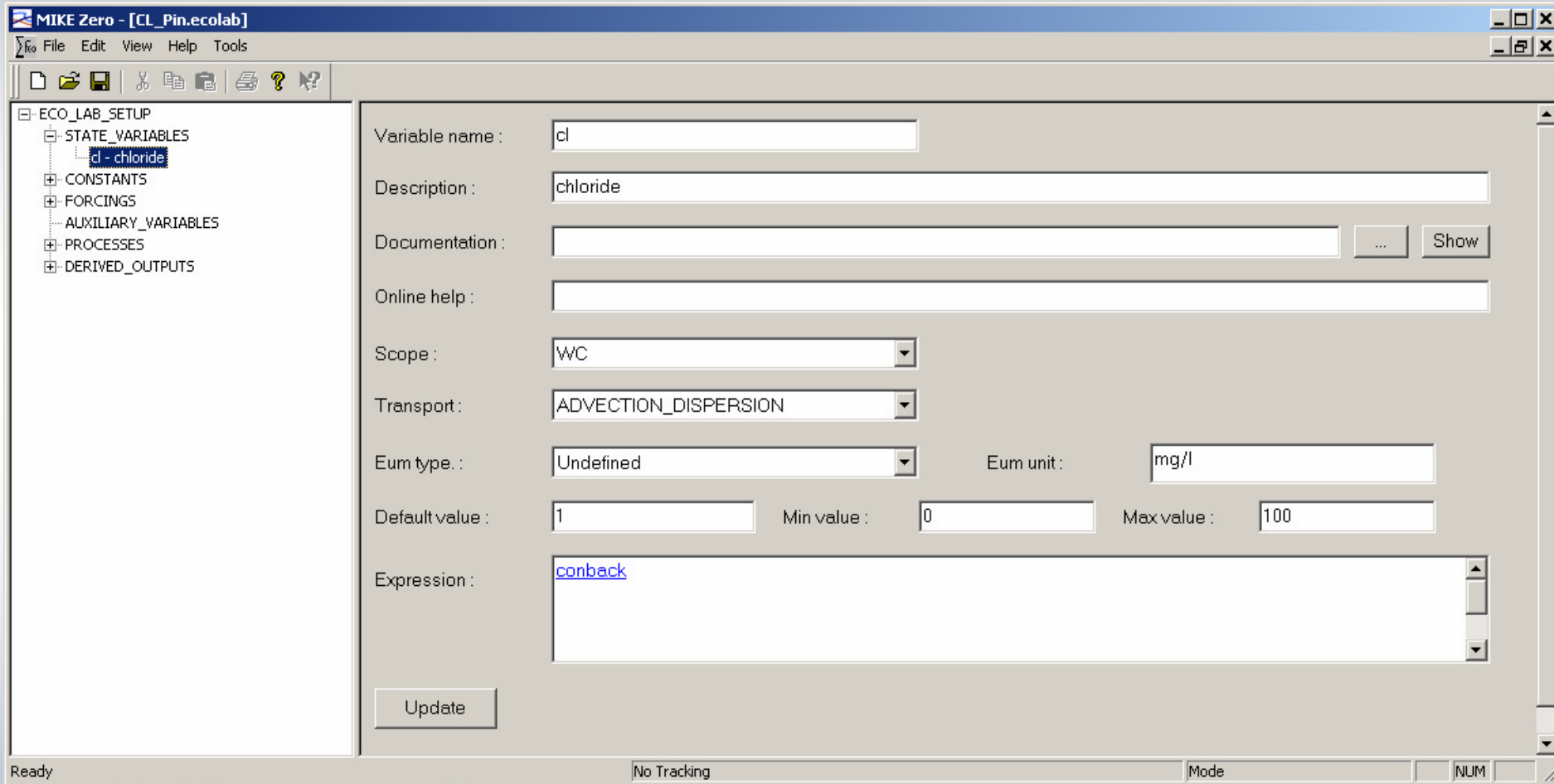
$$c_1 = \text{steady-state } c \text{ when } s = 1000 \text{ g} / \text{m}^2$$



# Eco LAB Setup

- State variables
- Constants
- Forcings
- Auxiliary variables
- Processes
- Derived outputs

# EcoLab User Interface



Questions?

