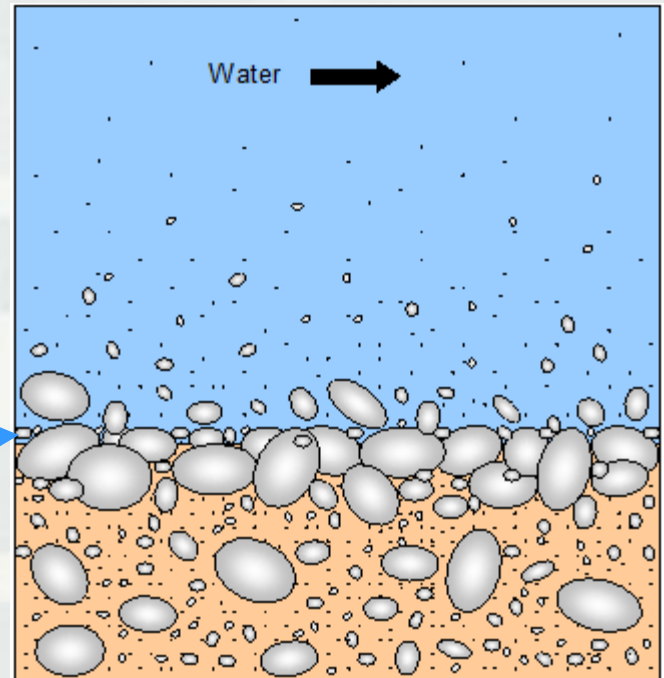


2015 SWAT Conference at Purdue University

Integrating Aquatic Nutrient and Contaminant Simulation Modules into SWAT

Zhonglong Zhang, PhD, PE, Xinzhong Du, PhD, and Billy Johnson, PhD, PE

LimnoTech, Environmental Laboratory, ERDC,
Vicksburg, MS



Outline

- “Plug in” water quality modules
 - Aquatic nutrient simulation module
 - Aquatic contaminant simulation module
 - Integrating NSM and CSM into SWAT
 - Model verification and evaluation
-

Water Quality Modules

- Hydrologic and hydraulic models
 - HEC-RAS
 - HEC-HMS
 - GSSHA
 - “Plug in” water quality modules
 - Temperature
 - Nutrients
 - Contaminants
 - Mercury
 - Dynamic linked library (dll)
-

Water Quality Modules

File Settings

Water Quality

State Variables

Parameters

Derived Variables

Pathways

Number of Kinetic Regions:

1

Select Water Quality Kinetic Type:

	Select	DLL Name	Title	Info
▶	<input checked="" type="checkbox"/>	CSM.dll	Contaminant Simulation Module (CSM)	Info
	<input checked="" type="checkbox"/>	GC.dll	Simple Constituent Simulation Module (GC)	Info
	<input checked="" type="checkbox"/>	HgSM.dll	Mercury Simulation Module (HgSM)	Info
	<input checked="" type="checkbox"/>	NSMI.dll	Nutrient Simulation Module (NSMI)	Info
	<input checked="" type="checkbox"/>	NSMII.dll	Nutrient Simulation Module (NSMII)	Info
	<input checked="" type="checkbox"/>	TEMP1.dll	Simple Temperature Simulation Module (TEMP1)	Info
	<input checked="" type="checkbox"/>	TEMP2.dll	Full Energy Temperature Simulation Module (TEMP2)	Info

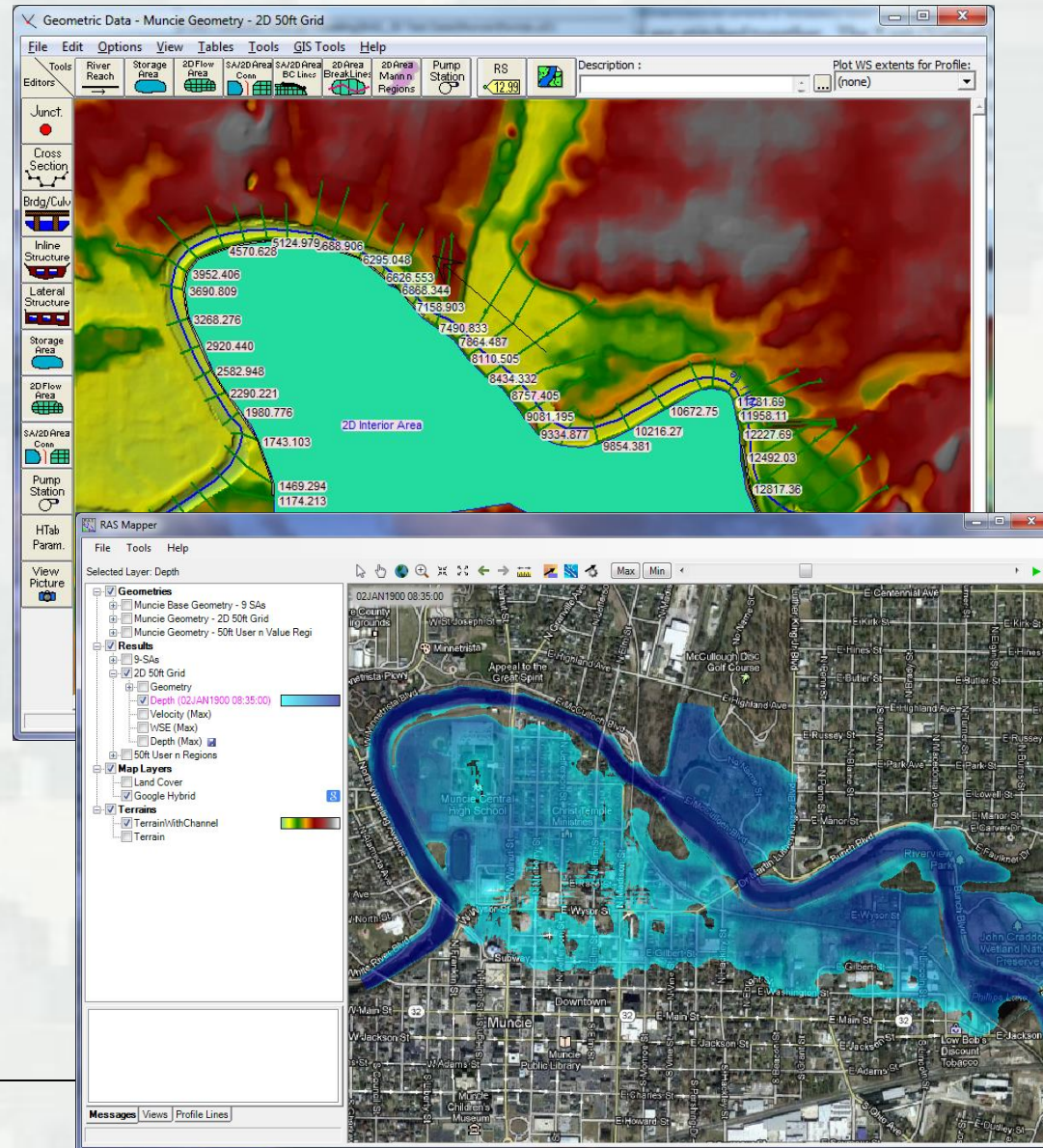
HEC-RAS (River Analysis System)

■ HEC-RAS, Version 4.2:

- Performs 1D hydraulic calculations for a full network of natural and constructed channels
- Sediment transport
- Dimension: longitudinal

■ HEC-RAS Version 5.0

- Adds support for 2D hydraulic modeling
- Dimensions: longitudinal and lateral
- 1D Water quality modeling (temperature, nutrients, contaminants)

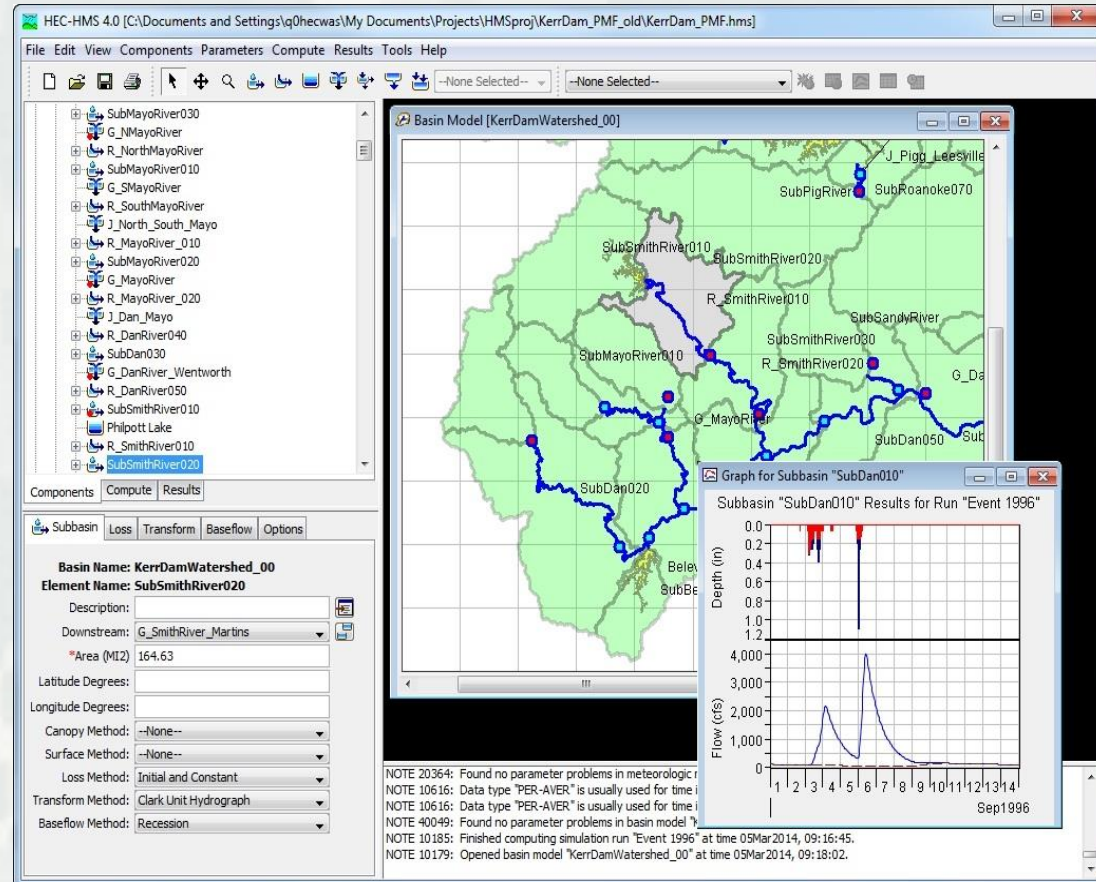


HEC-HMS (Hydrologic Modeling System)

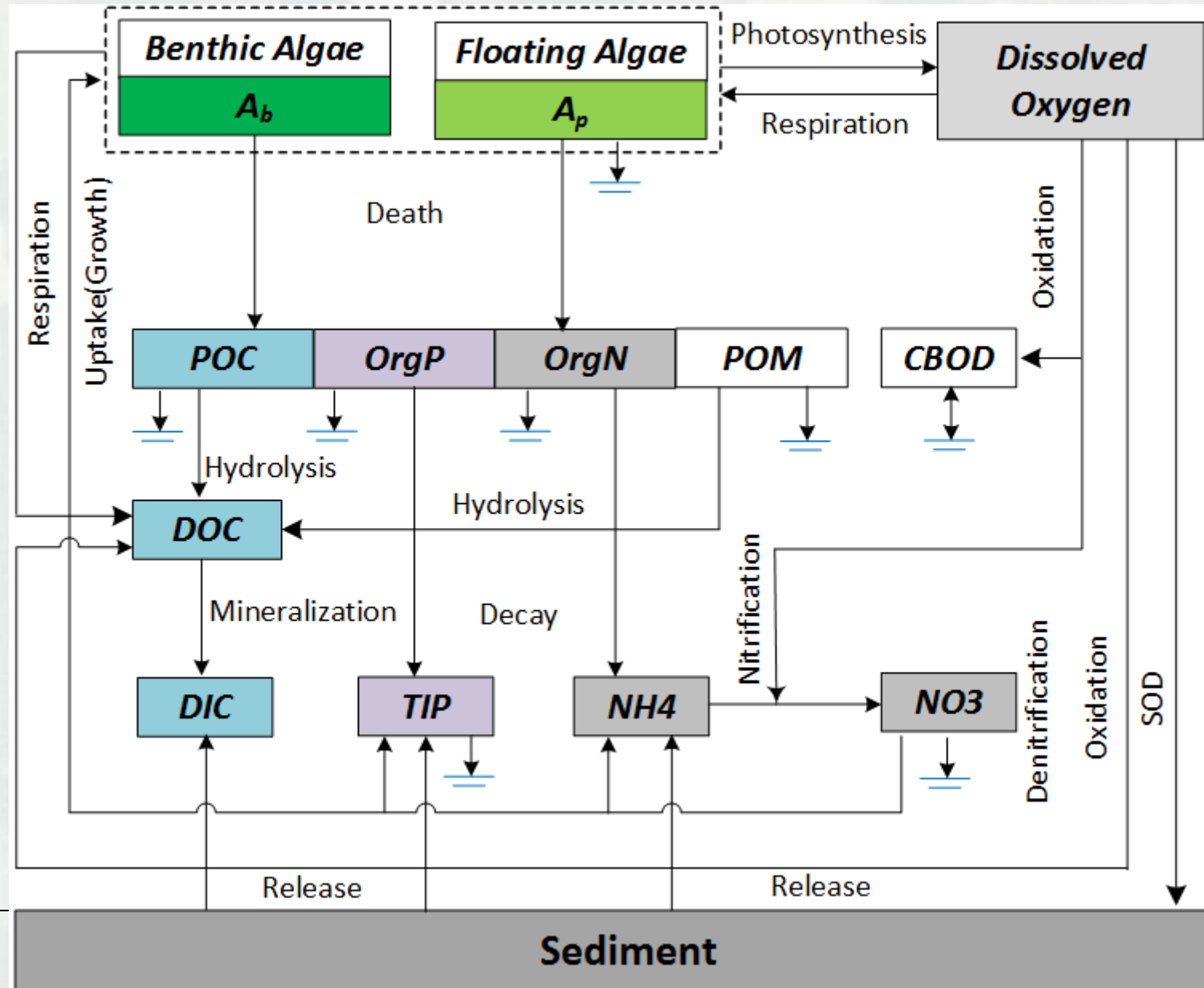
- HEC-HMS simulates the complete hydrologic processes of dendritic watershed systems

- Capabilities:

- Event infiltration
- Unit hydrographs
- Hydrologic routing
- Evapotranspiration
- Snowmelt
- Soil moisture accounting
- Gridded runoff simulation
- Sediment transport
- Reach water quality (NSM)



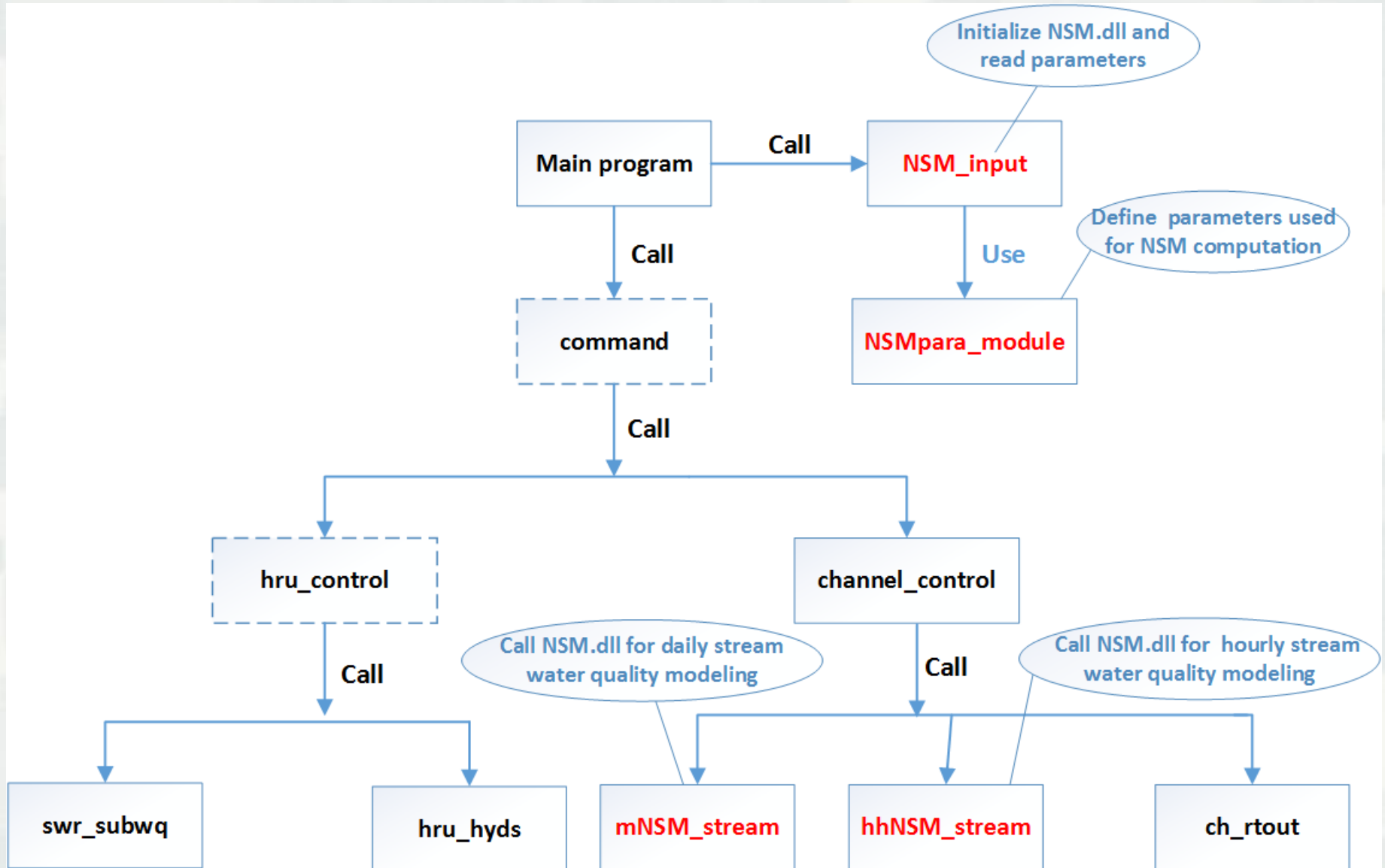
Nutrient Simulation Module I (NSMI)



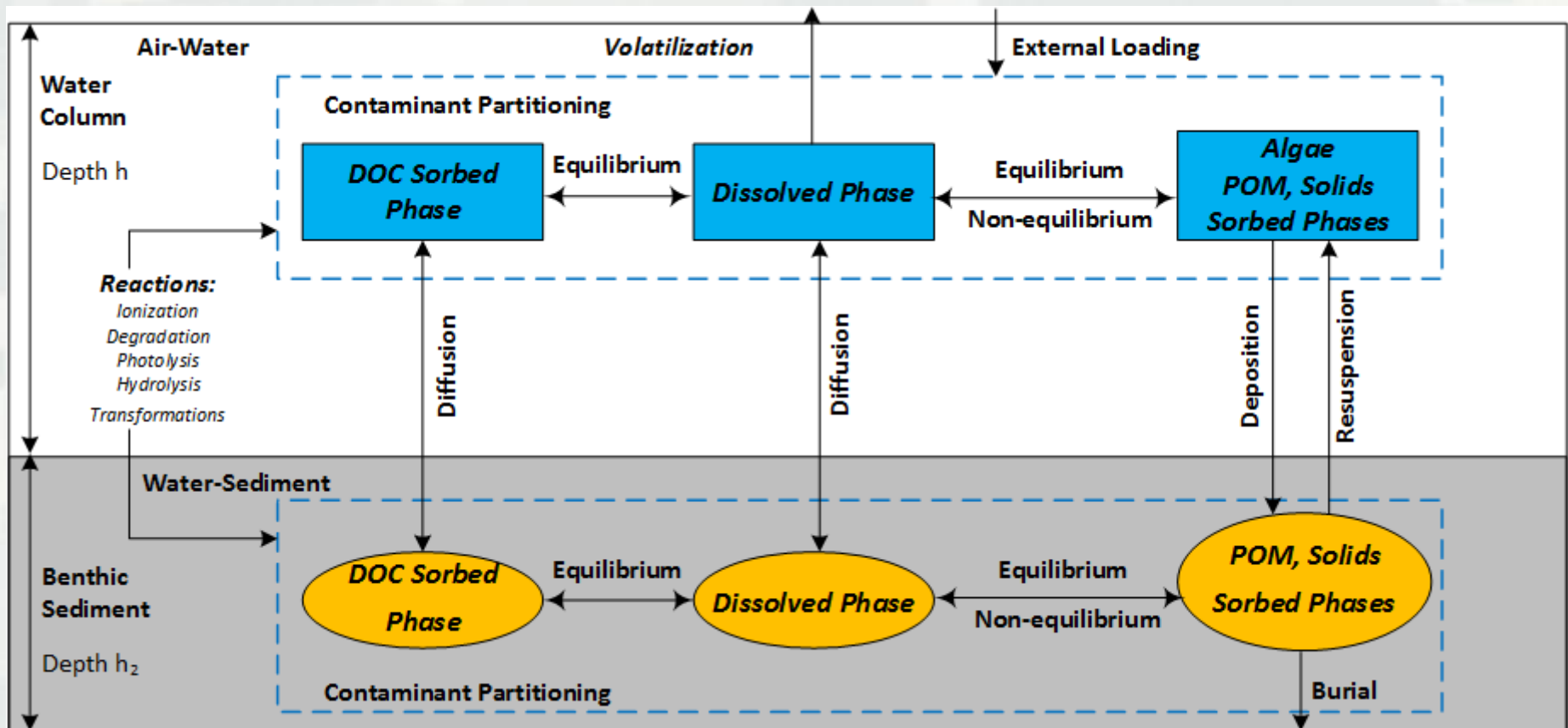
Nutrient Simulation Module I (NSMI)

- State variables (16)
 - Algae (phytoplankton, benthic)
 - Nitrogen (OrgN, NH₄, NO₃)
 - Phosphorous (OrgP, TIP)
 - Carbon (POC, DOC, DIC)
 - Organic matter (POM, POM₂)
 - CBOD
 - DO
 - Alkalinity
 - Pathogen
 - Derived variables
 - Algal biomass
 - TON, TKN, TN, DIP, TOP, TP, TOC, CBOD₅
-
- Light attenuation, oxygen reaeration rate, pH

SWAT- NSMI



Contaminant Simulation Module (CSM)

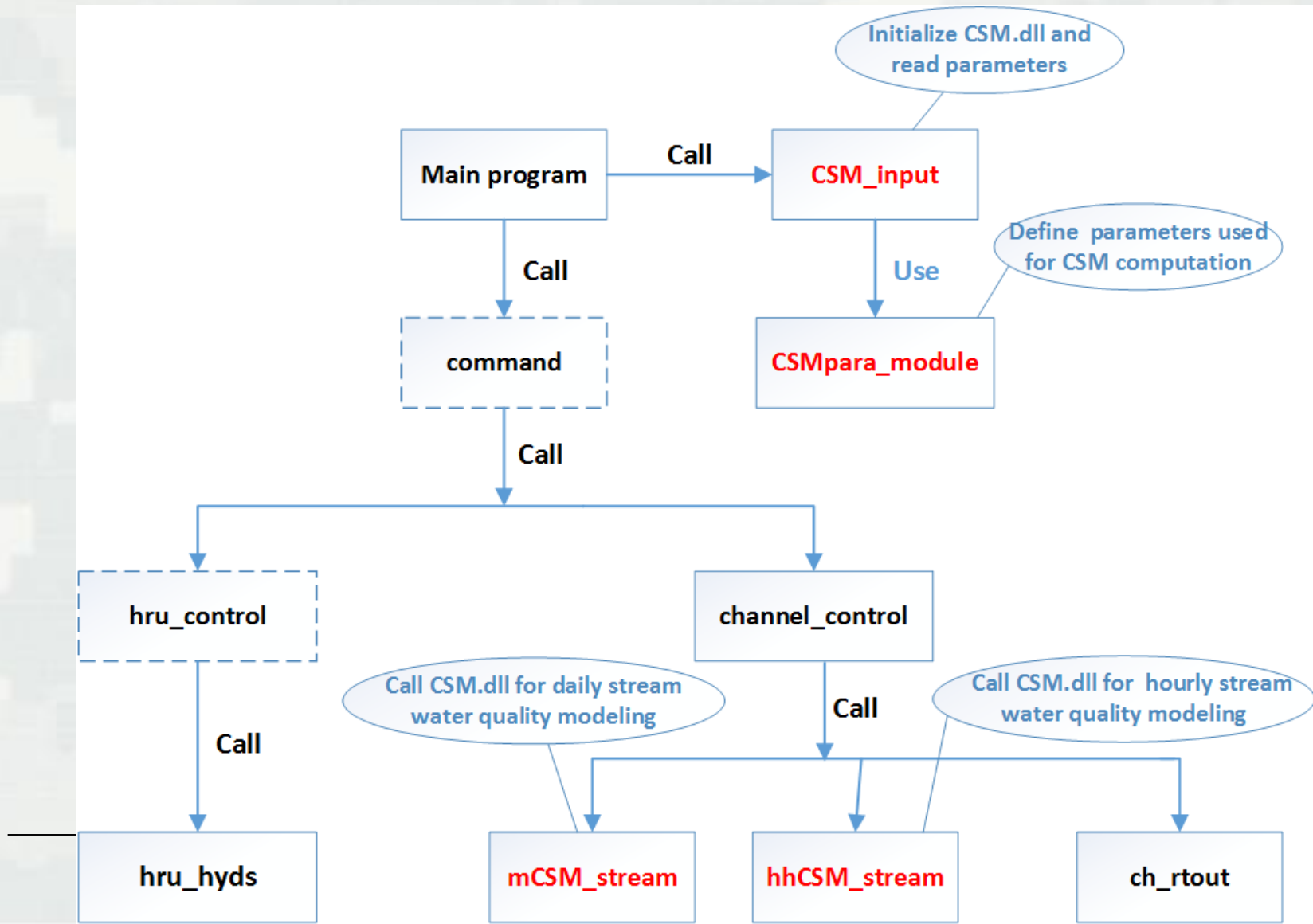


Contaminant Simulation Module (CSM)

- Multi-media kinetics
 - Water column
 - Underlying sediment layer
- Multiple phase partitioning (equilibrium and non-equilibrium)
 - Water
 - DOC (Dissolved Organic Carbon)
 - Algae
 - Organic matter
 - Inorganic solids
- Eight (8) biochemical transformation processes
 - Ionization (5 species)
 - Degradation
 - Hydrolysis
 - Photolysis (Photodegradation)
 - Volatilization

 - User-defined extra reaction (second-order)
 - Transformations and daughter products

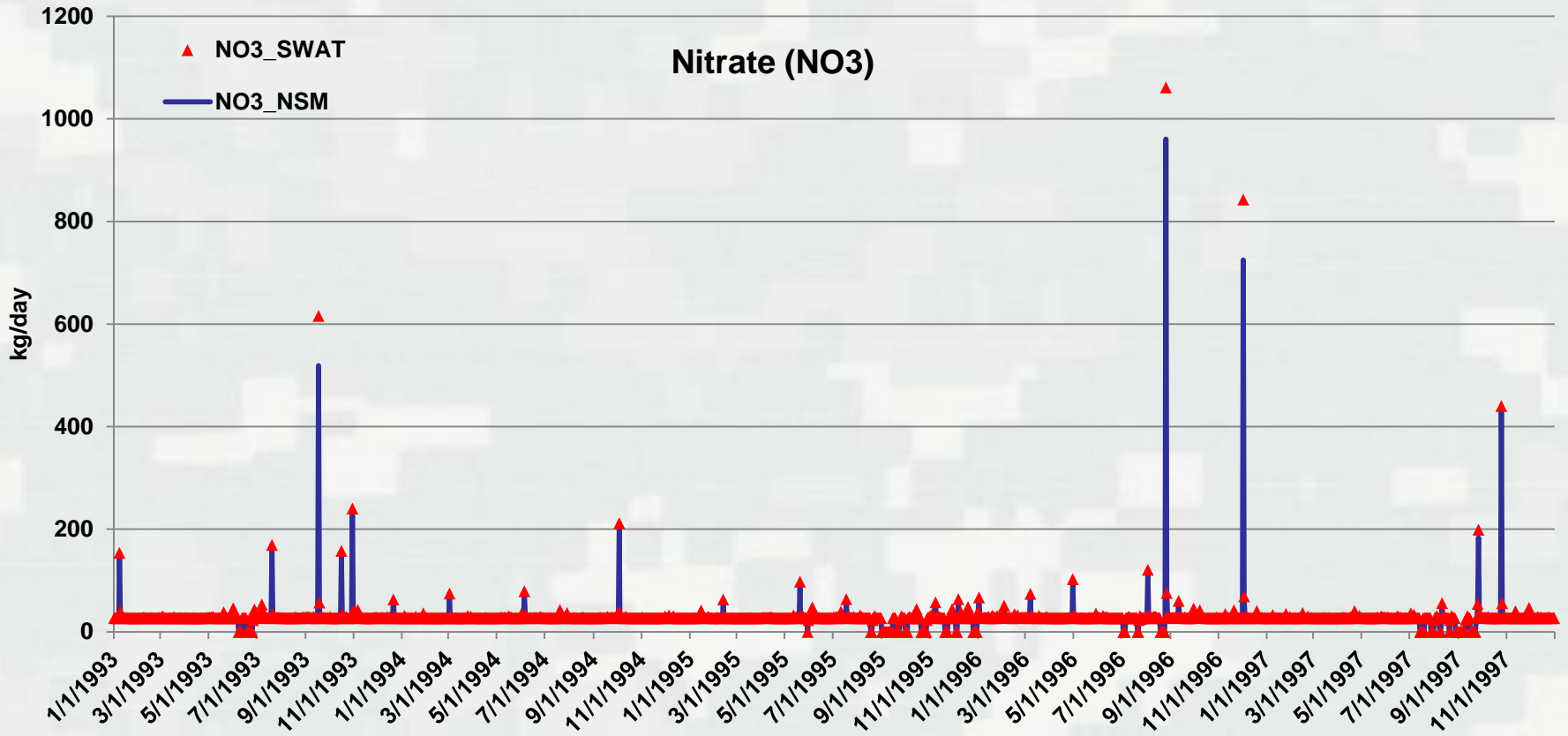
SWAT - CSM



Model Testing and Verification - Proof of Concept

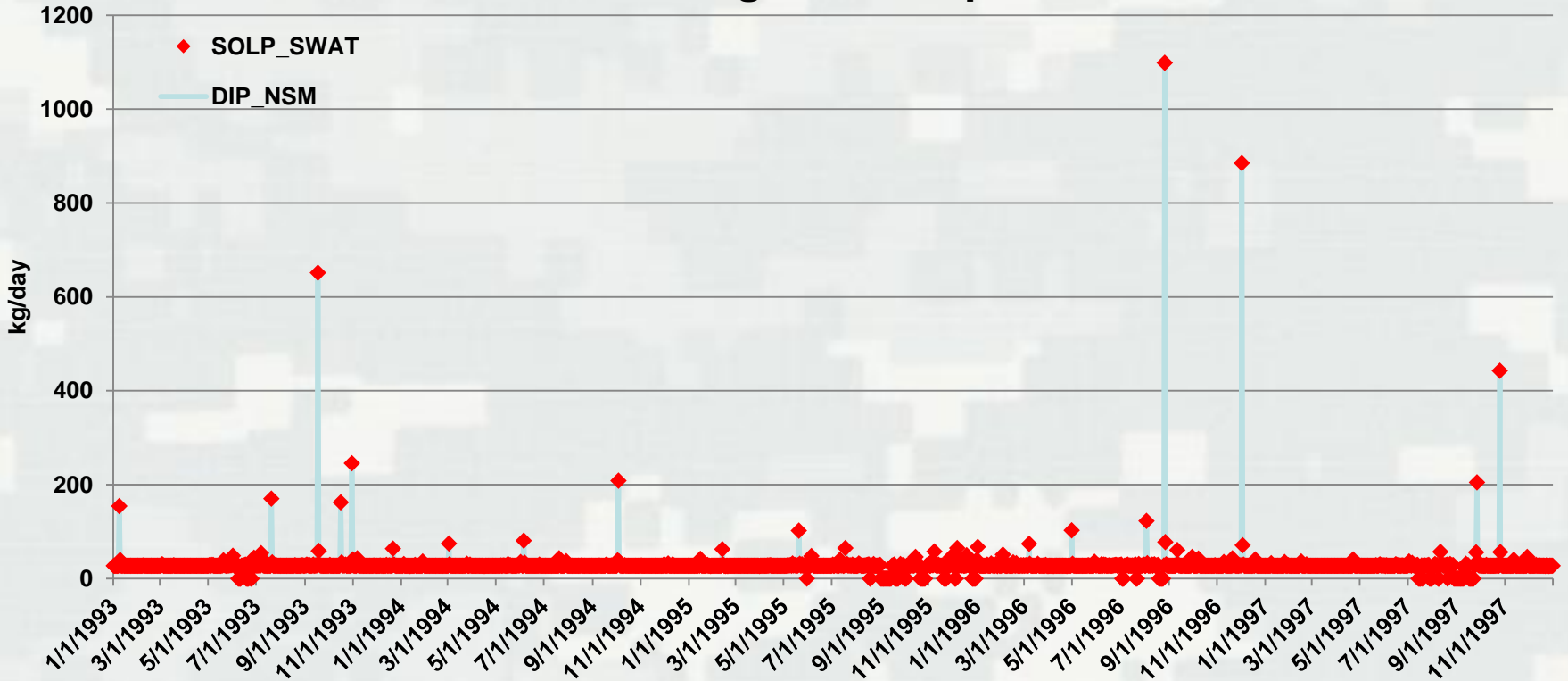


Nutrient Model Testing and Verification - Proof of Concept



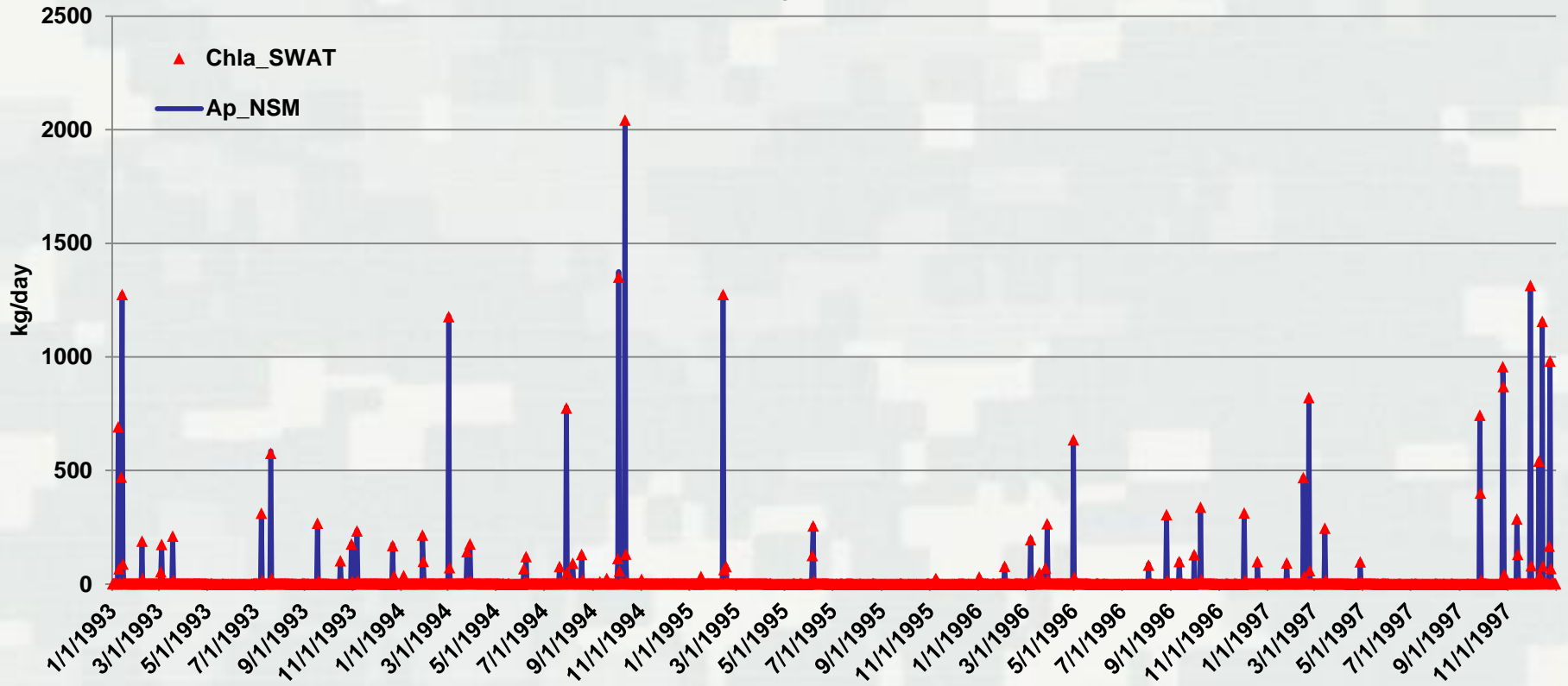
Nutrient Model Testing and Verification - Proof of Concept

Dissolved Inorganic Phosphorous



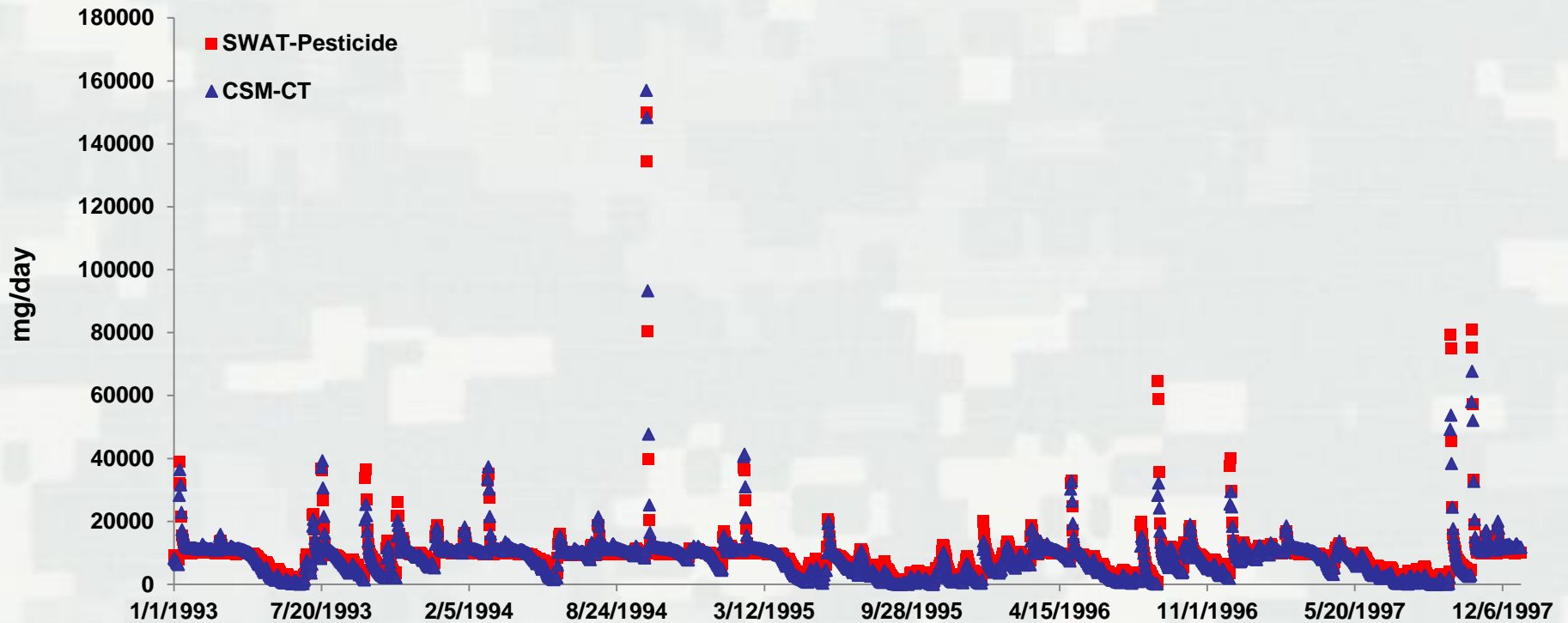
Nutrient Model Testing and Verification - Proof of Concept

Chlorophyll-a (chla)

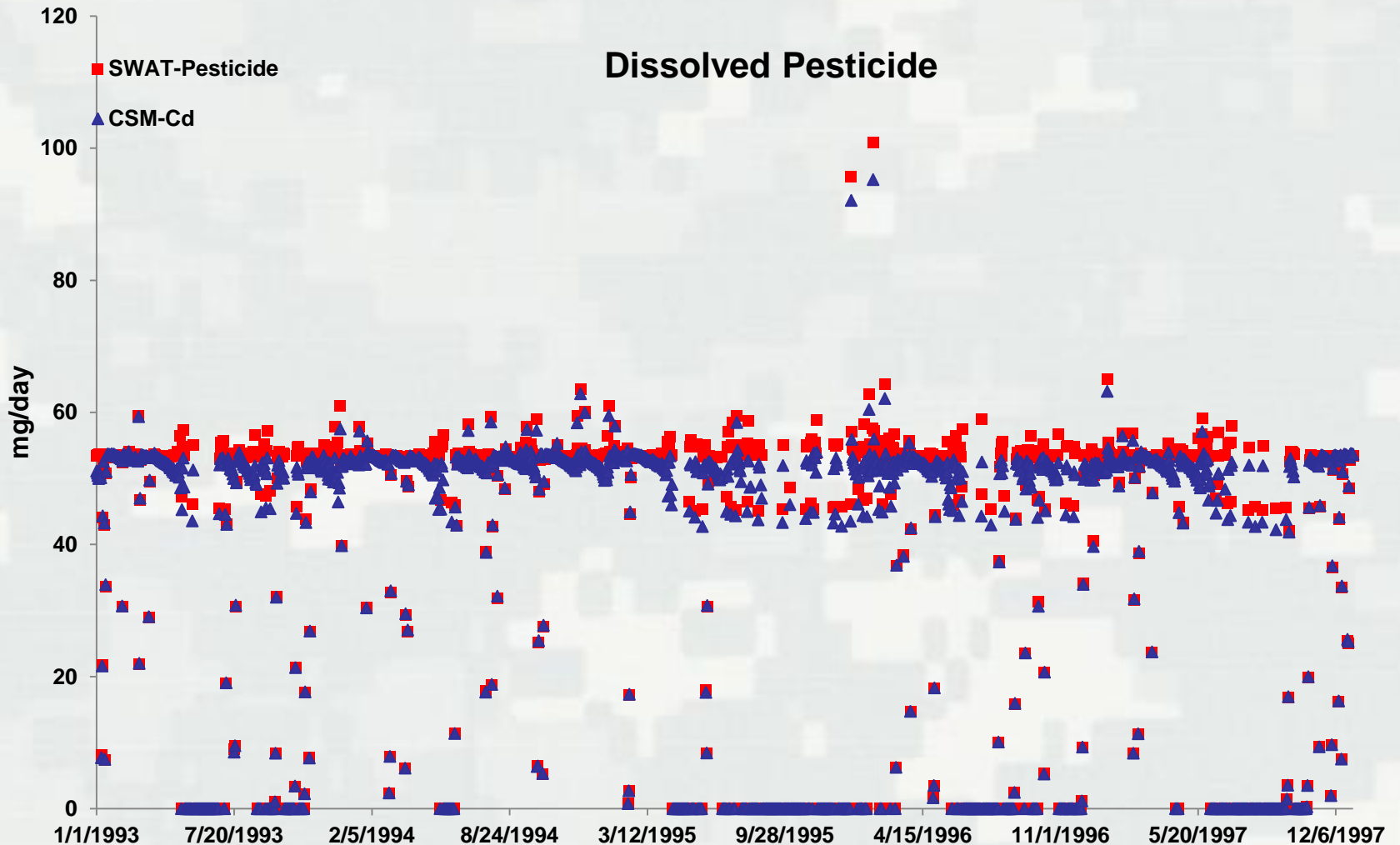


Contaminant Model Testing and Verification - Proof of Concept

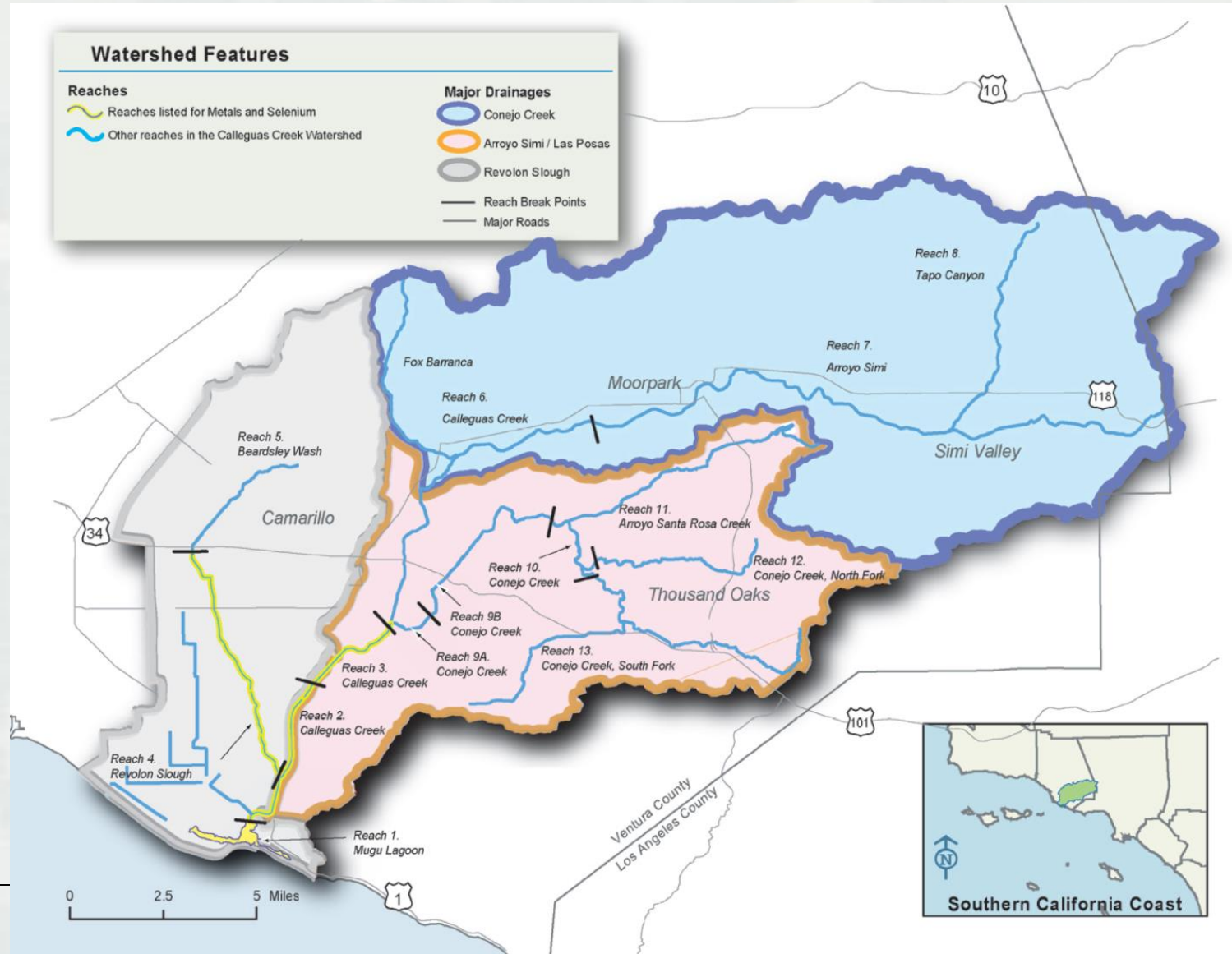
Total Pesticide



Contaminant Model Testing and Verification - Proof of Concept



Model Testing and Verification – Callaguas Creek Watershed



Summary

- NSM and CSM has been integrated into SWAT
 - Further testing and verification
 - Refining model linkage
 - The applicability of the SWAT-NSM/CSM model needs to be further validated/evaluated directly against field data sets.
 - Callugaes Creek watershed
 - Documentation (report, paper).
-

Questions/Comments
