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Phase-6 Watershed Model

Development Progress Update

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Outline of Presentation

1. Extension of simulation period to *2013*.

2. Review of incorporation of lag-time & time varying transit time distribution of an effluent.

3. Exploration and feasibility of rSAS.

1. Extension of Simulation Period to ***2013***

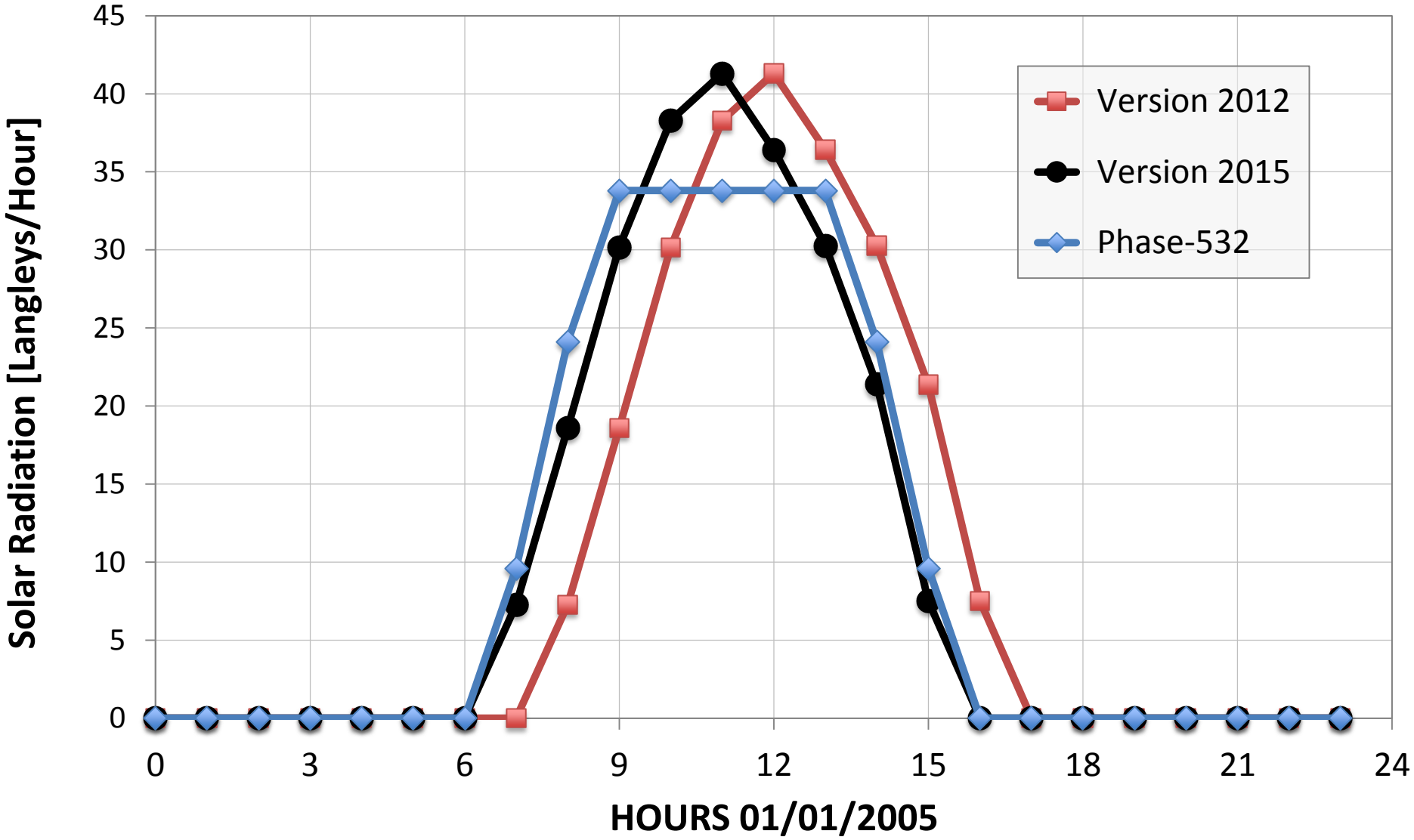
Data Gathering / Data Development Phase

- Precipitation & Meteorological Forcing:
  - Cloud cover, **Dew-point temperature, Potential evapotranspiration, Precipitation, Solar radiation, Temperature, and Wind speed**
  - Transfer to WDMs
  - Atmospheric Deposition
- Flow & Water Quality Observations (USGS-dataRetrieval, CUAHSI-HydroDesktop)
- Point Sources
- Diversions

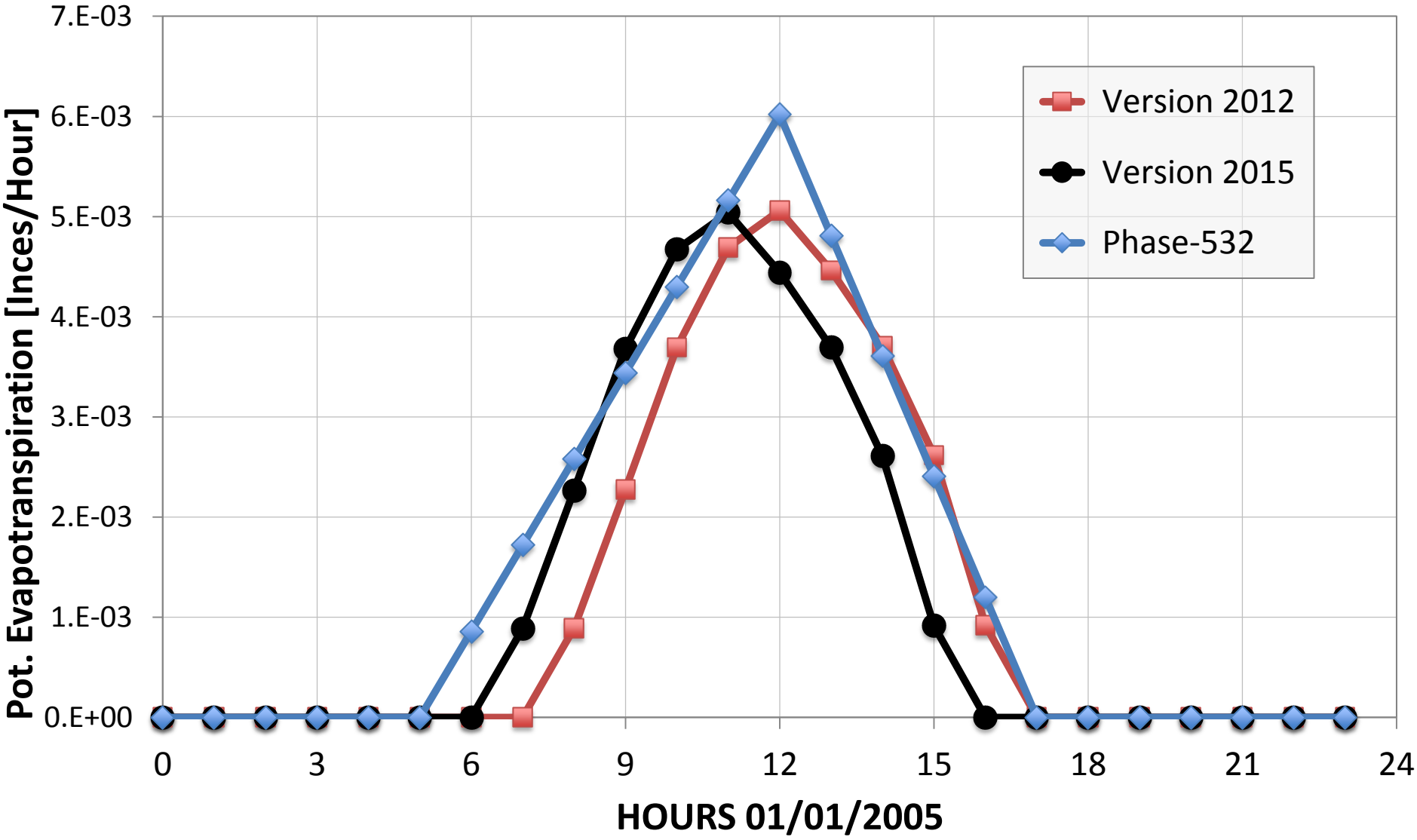
Refinements to data processing methods

- Refresh and extend NLDAS-2 database
- Major revisions to data processing code, scripts, and output file structure
  - Clean up for overall clarity
  - Merges for easy operation
  - Archival by years rather than one big file
- Adjust for hour shift (i.e., *observation* vs. *simulation* mode).

Adjust an hour shift: e.g., Solar radiation



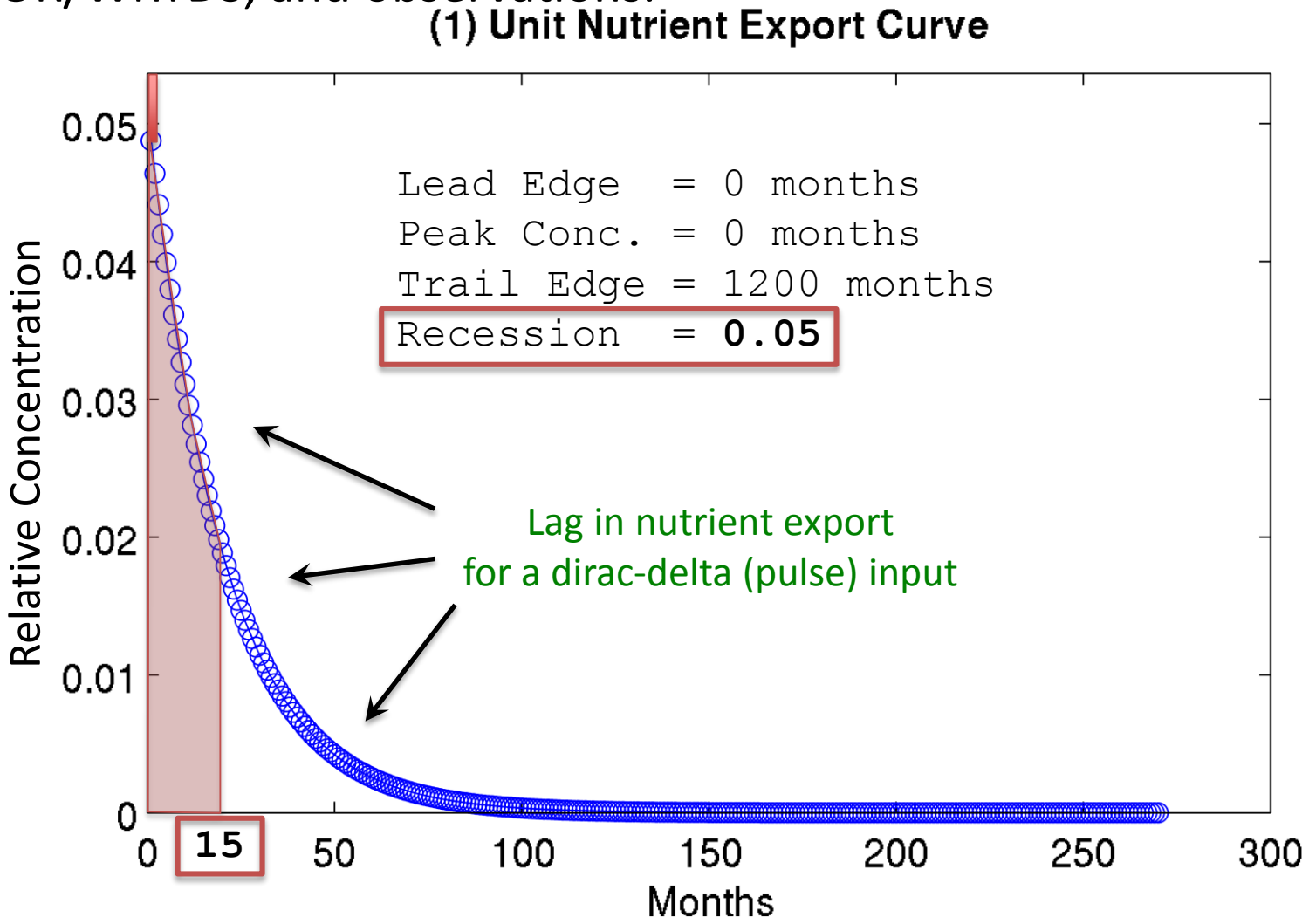
Adjust an hour shift: e.g., **Pot. ET**

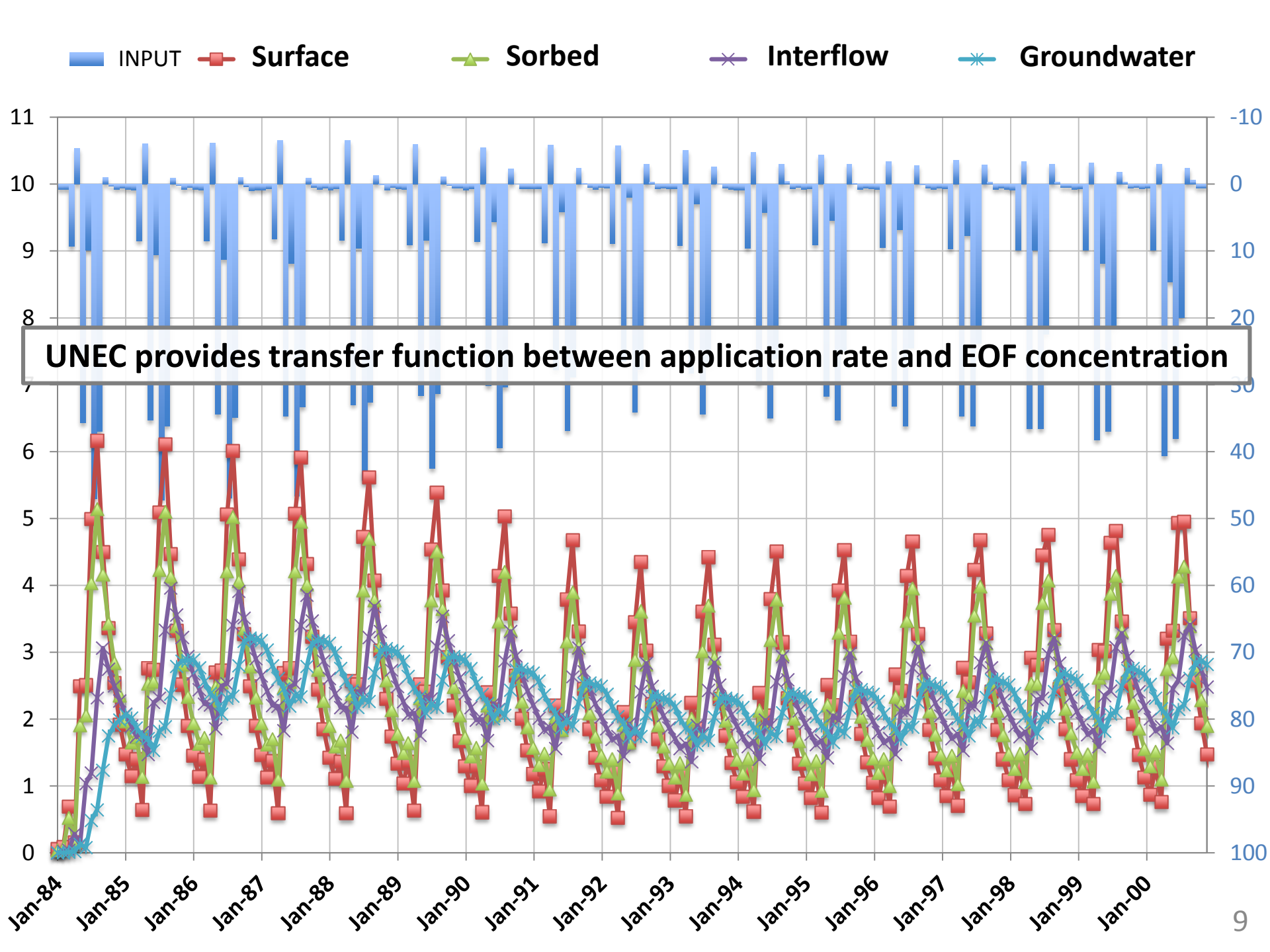


2. Review of incorporation of lag-time & time varying transit time distribution of ***nutrients***

- An implementation of lag-time using a conceptual model was reviewed previously (Oct, 2014 MQRM) as a *provisionally operational* Phase 6 watershed model.
- Method uses *Unit Nutrient Export Curves* (formerly *breakthrough curves*) for transport flow paths (surface, sediment, interflow, and groundwater).
- Edge-of-field (EOF) exports were calibrated to a-priori export targets.

Unit nutrient export curve stochastically describes transport of nutrients as a probability density function. UNEC parameters could be obtained from mean transit times estimated from models (e.g., *MODFLOW*, *APLE*); seasonal concentrations from ESTIMATOR/WRTDS, and observations.




INPUT
Surface
Sorbed
Interflow
Groundwater
UNEC provides transfer function between application rate and EOF concentration
11
10
9
8
6
5
4
3
2
1
0
-10
0
10
20
40
50
60
70
80
90
100
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
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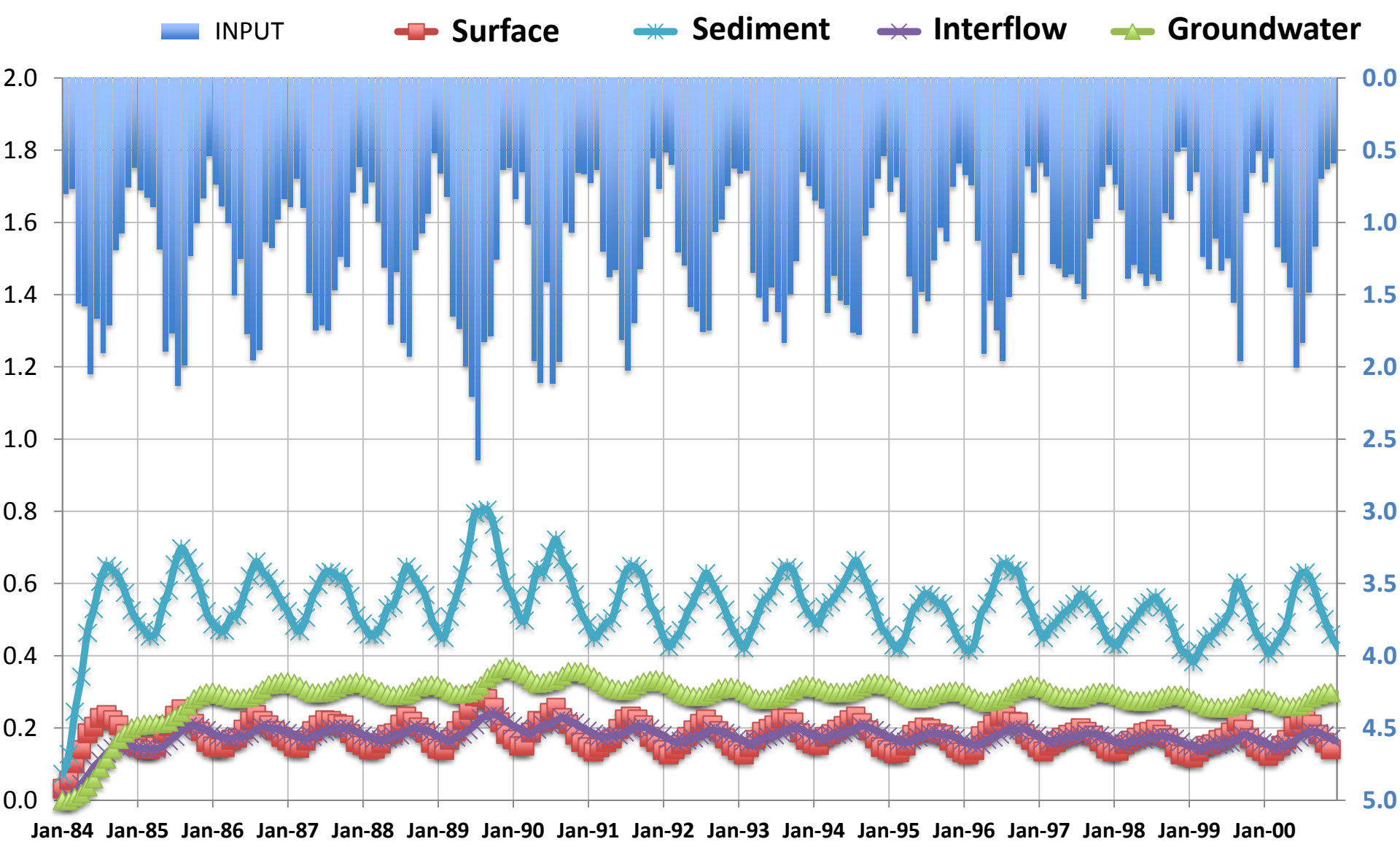
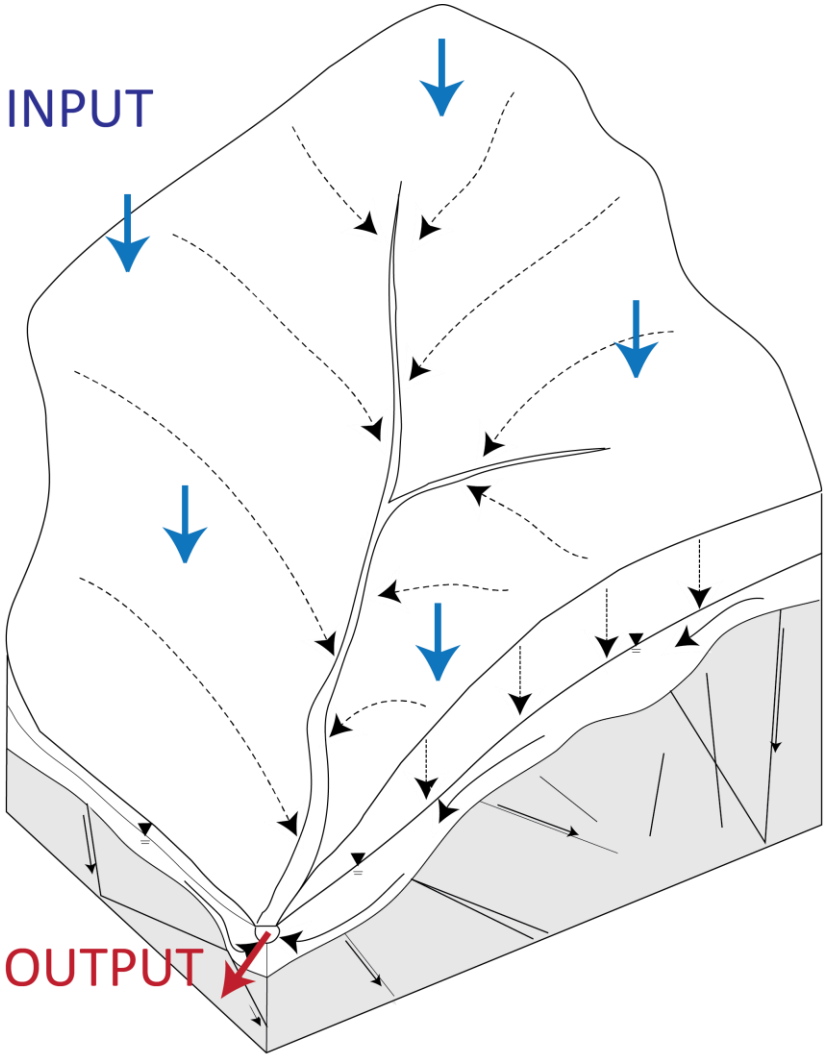
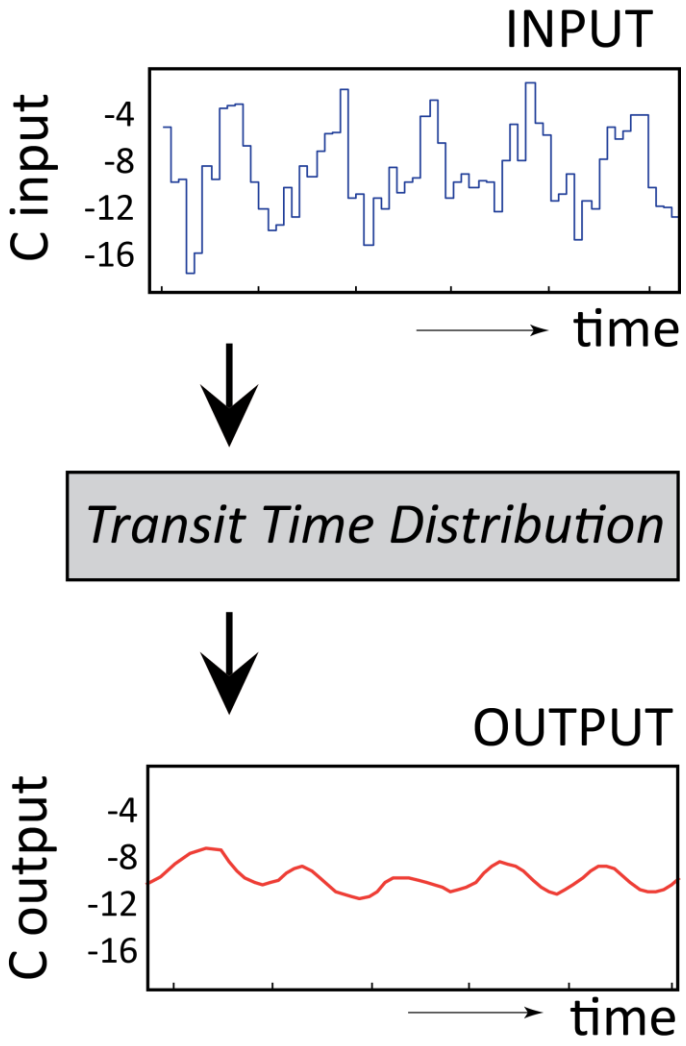
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00

A10001 **forest**: UNEC (PO4X)

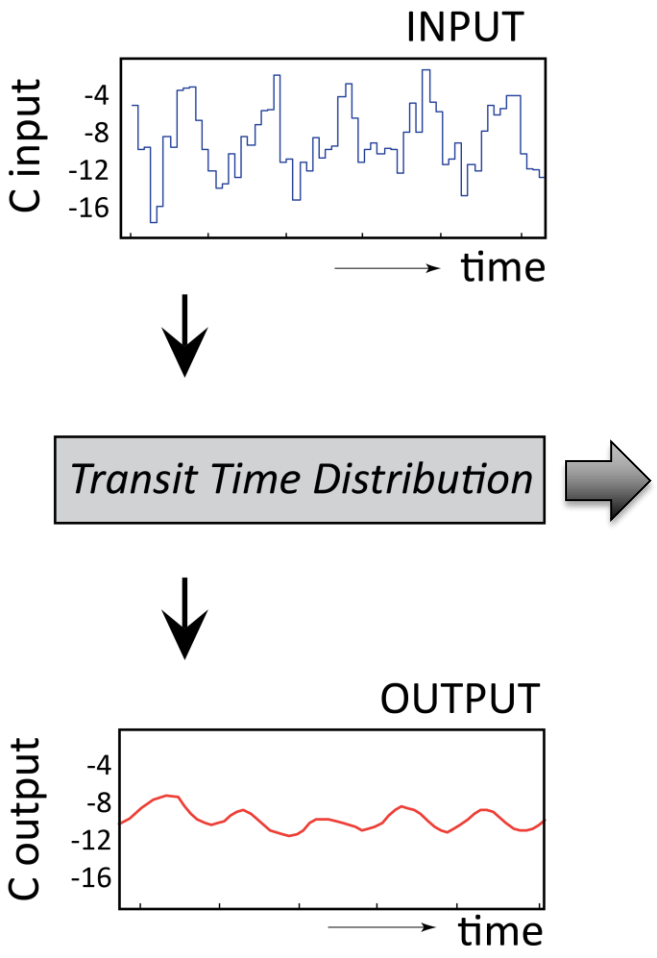


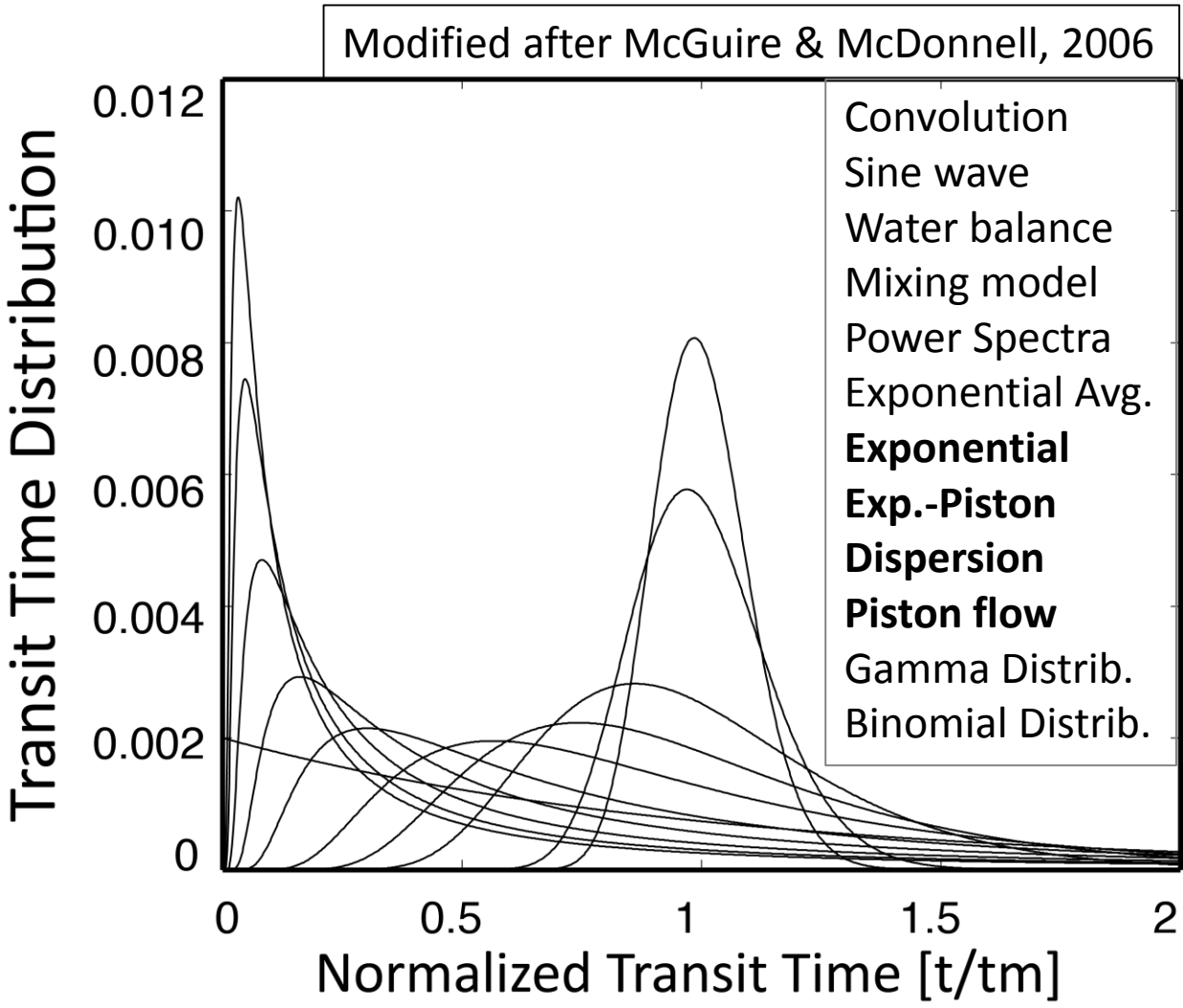
McDonnell et al., 2010: Transit time distribution (TTD) described how a conservative tracer input to a catchment will be 'filtered' as the water passes through the system to the catchment outlet, yielding a damped and lagged signal with less high-frequency variation.



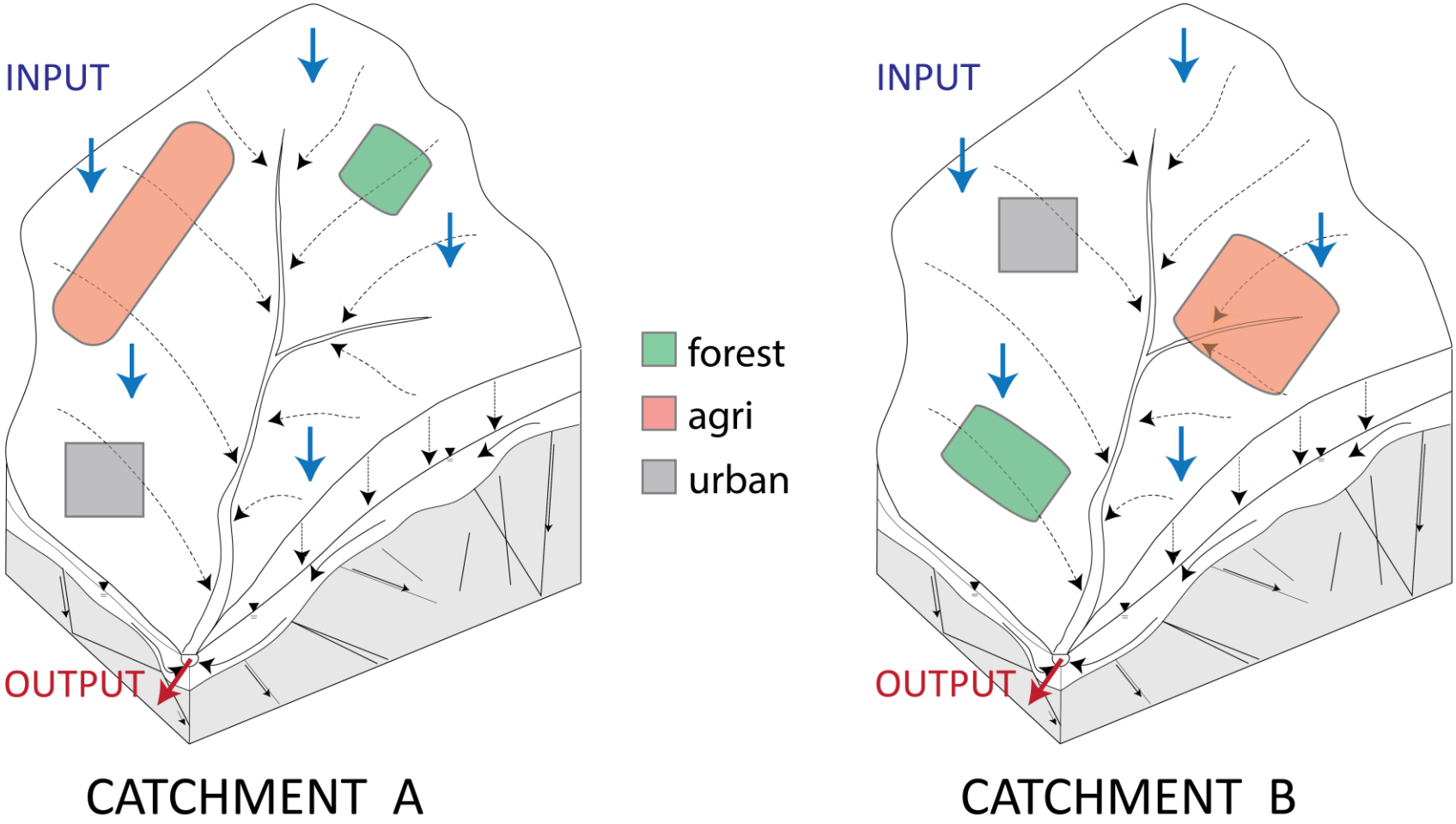


Different Possible Forms of TTDs





TTD describes the integrated effect of all flow pathways expressed at the discharge location of a flow system or in the case of catchments, at the basin outlet.

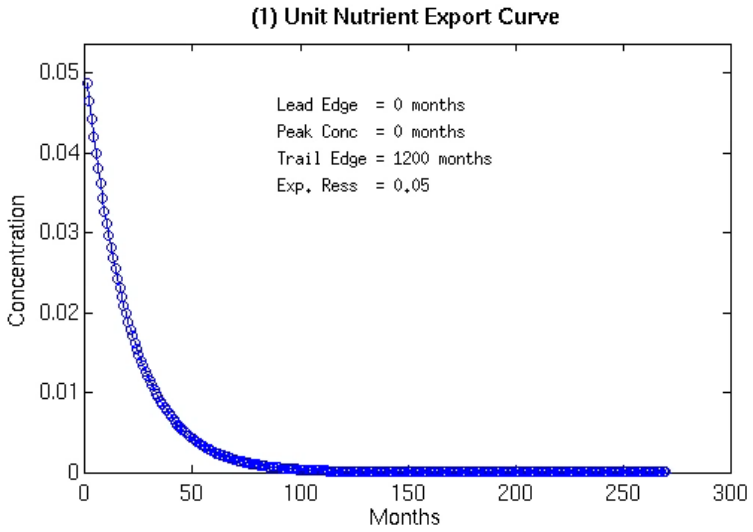


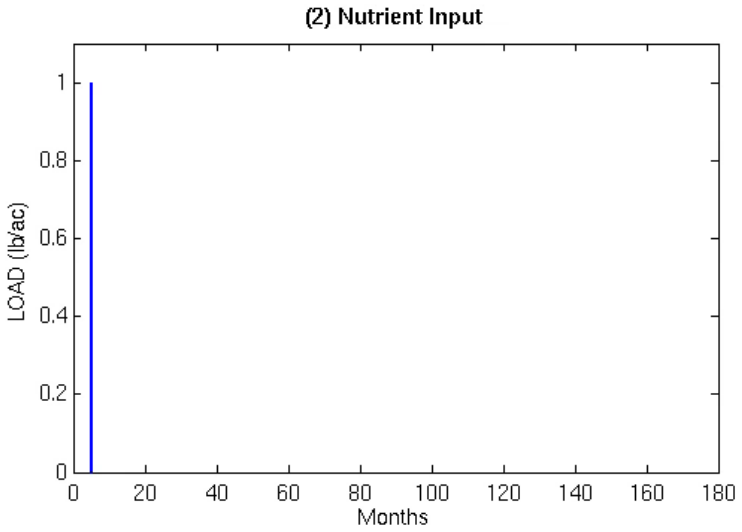
CATCHMENT A

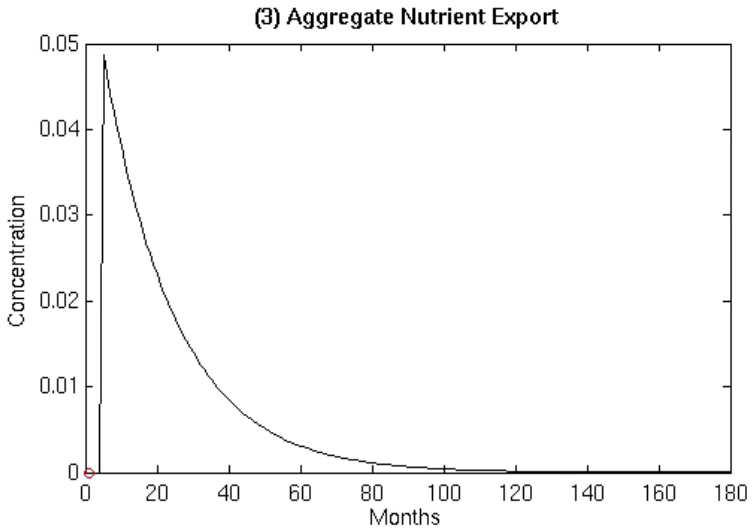
CATCHMENT B

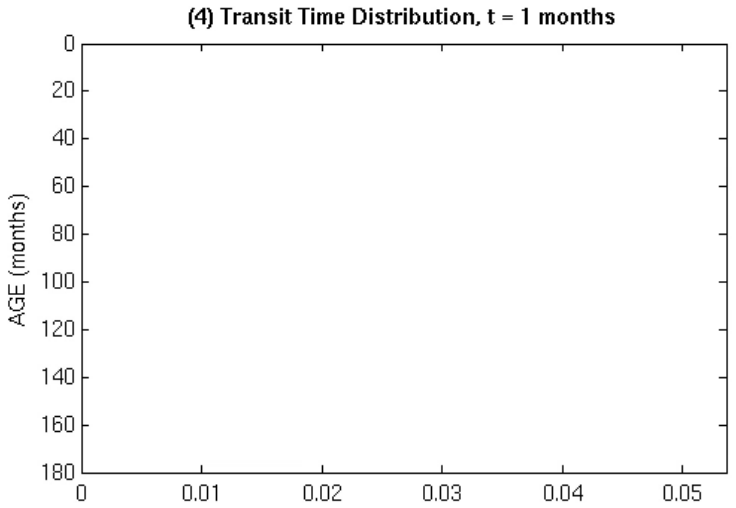
Since BMP *filters* are applied to nutrient loads simulated at ***land-use scale***, we could not use a lumped transit time distribution in favor of simulating a catchment's integrated response.

Dirac-delta / Pulse input



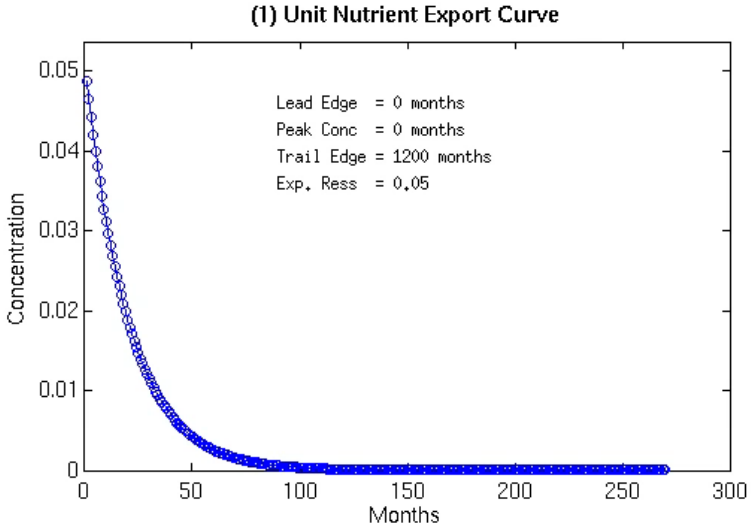


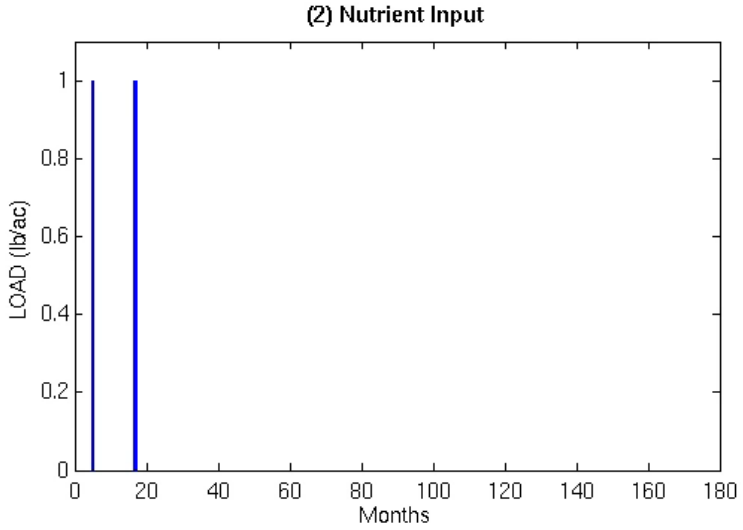


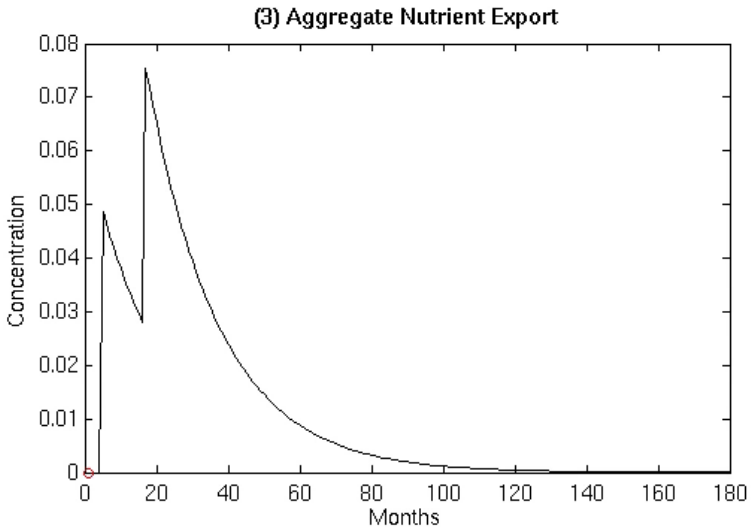


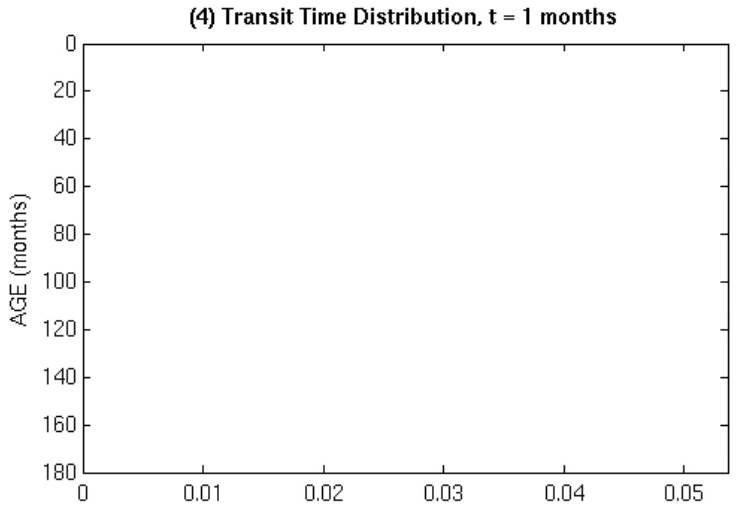
Dirac deltas / Pulse inputs

UNECs are superimposed to obtain the output as the convolutions of inputs.

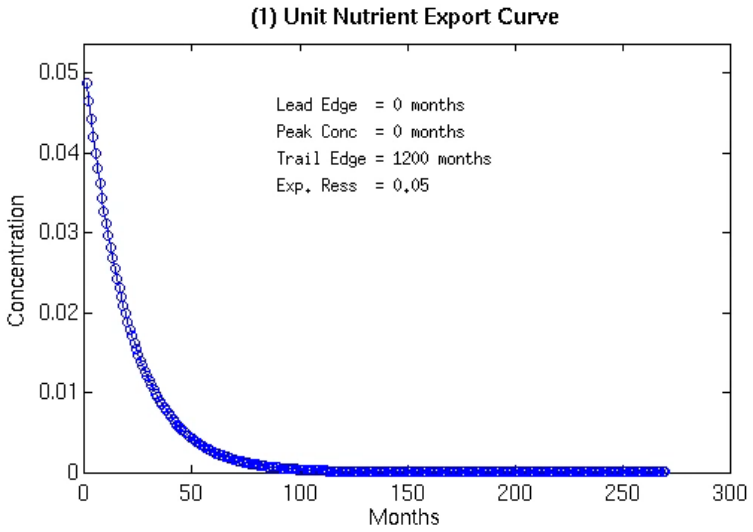


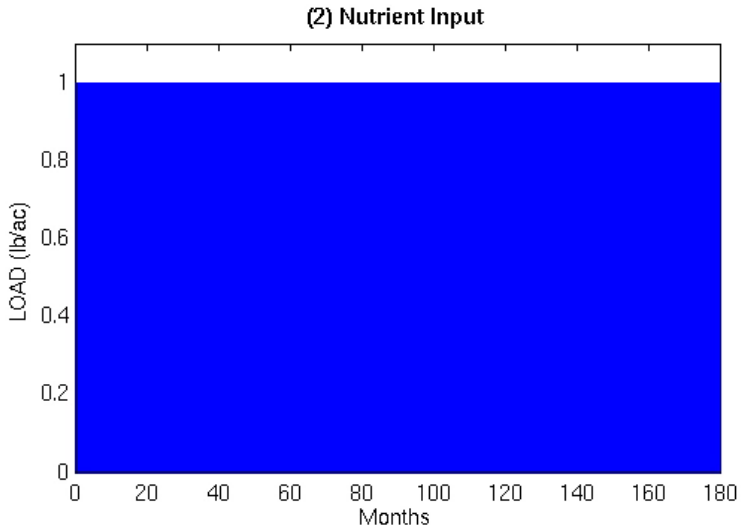


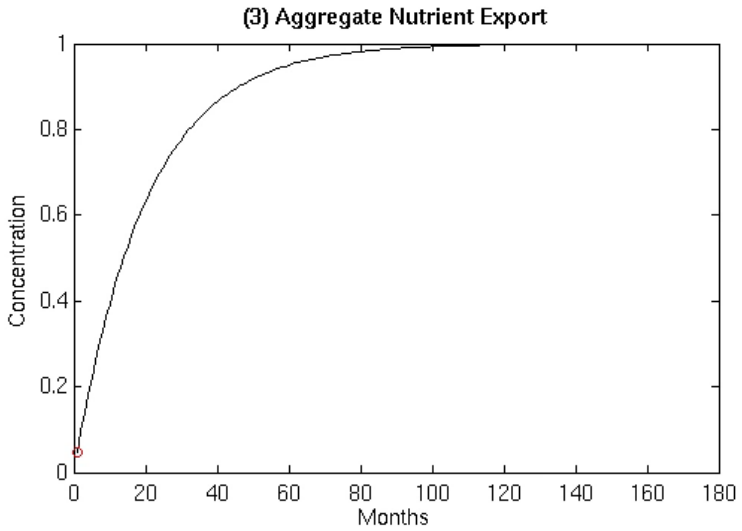


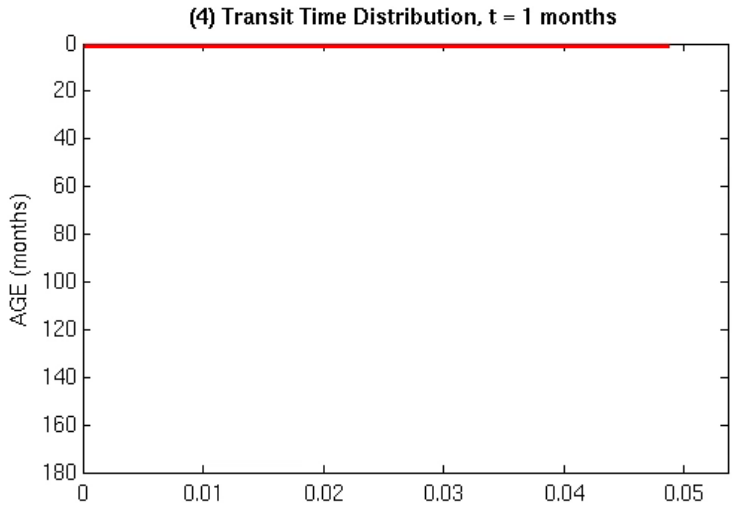


Continuous inputs

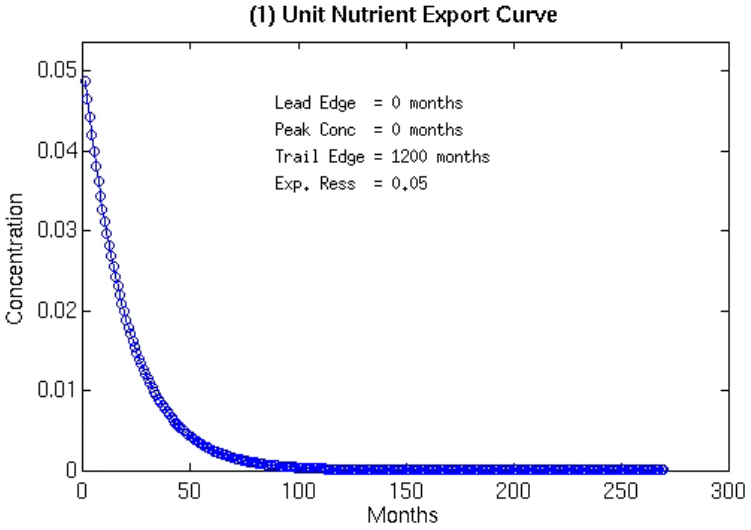


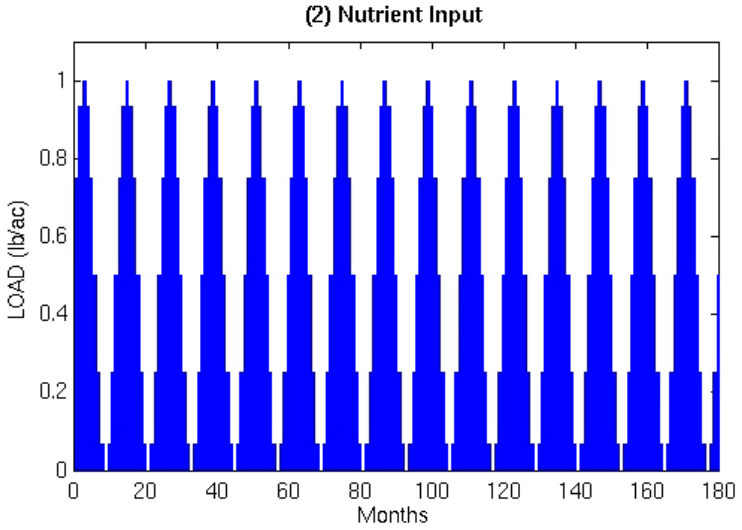


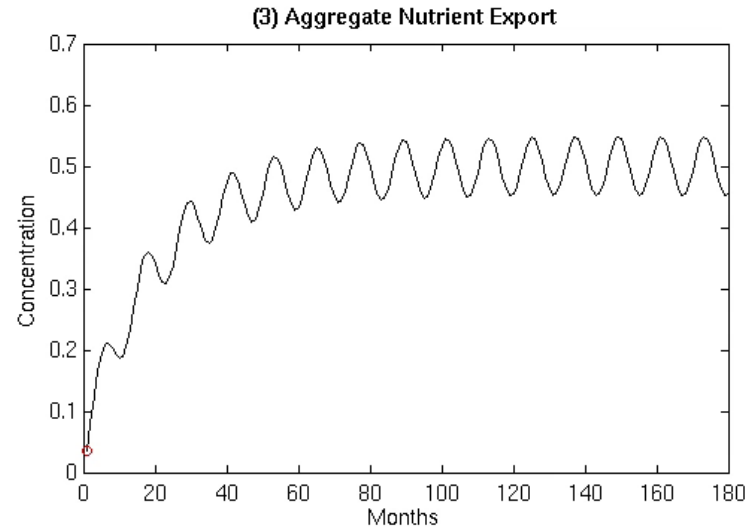


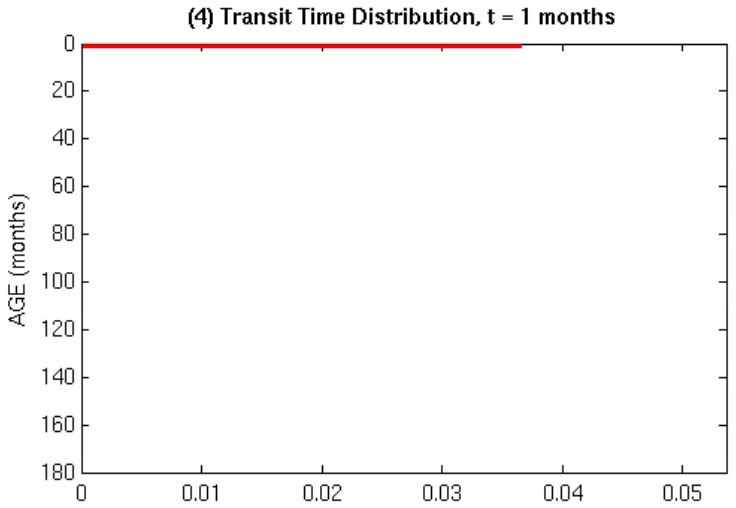


Sinusoidal inputs

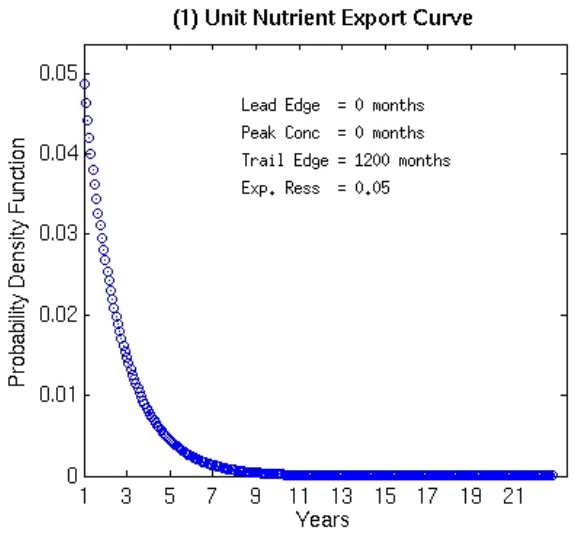


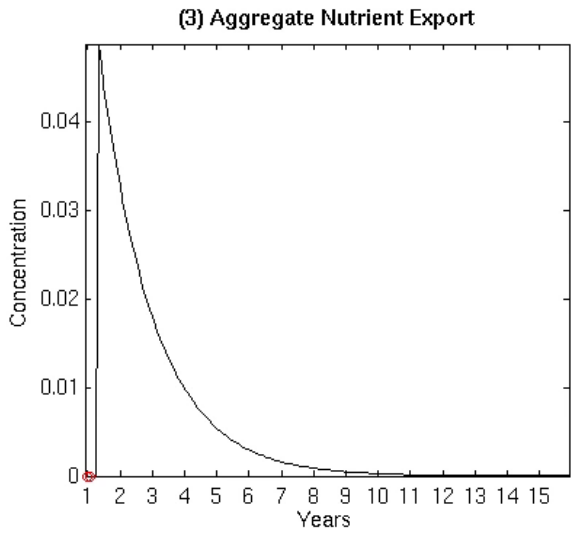


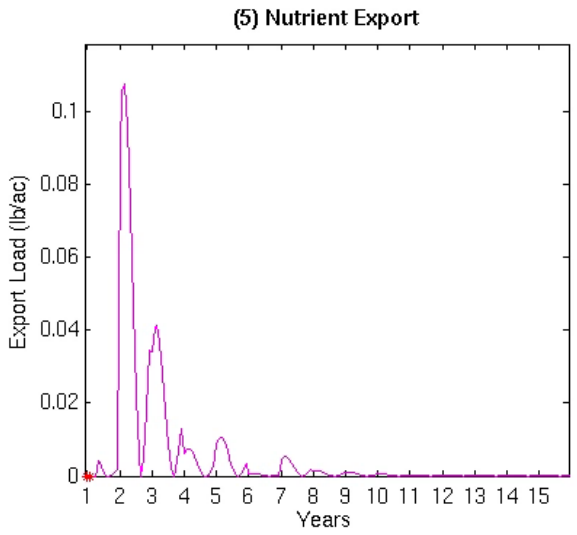


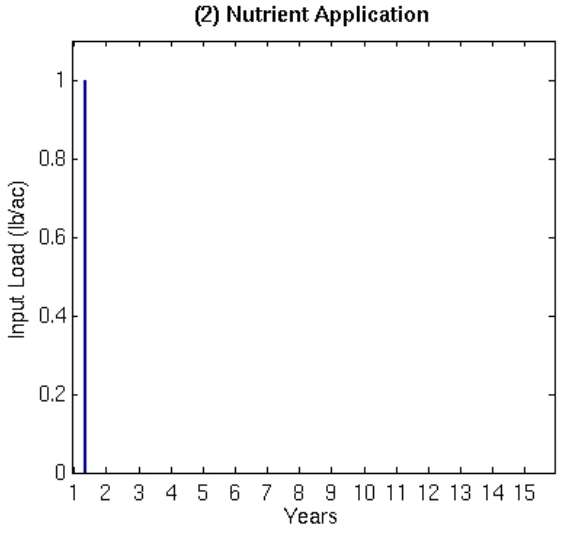


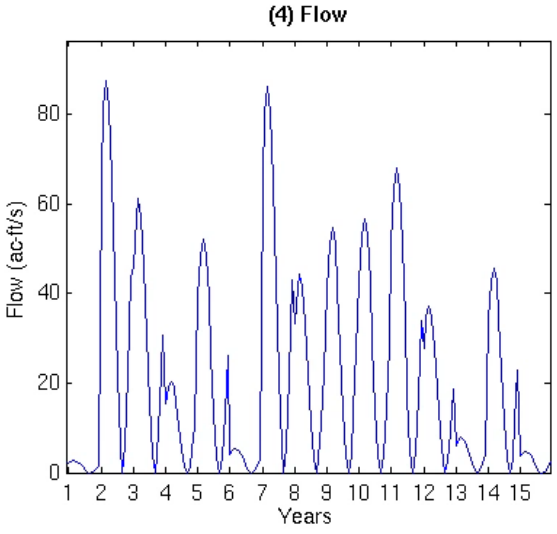
Dirac delta / pulse input – variable flow

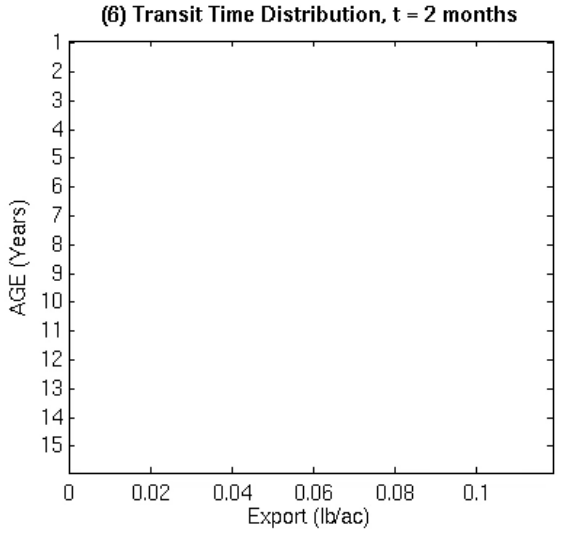




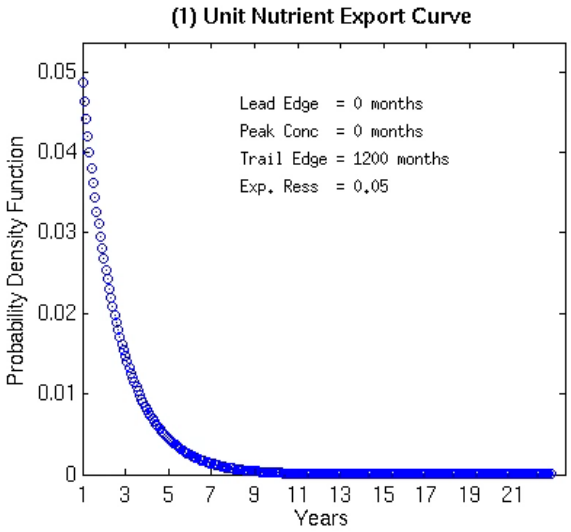


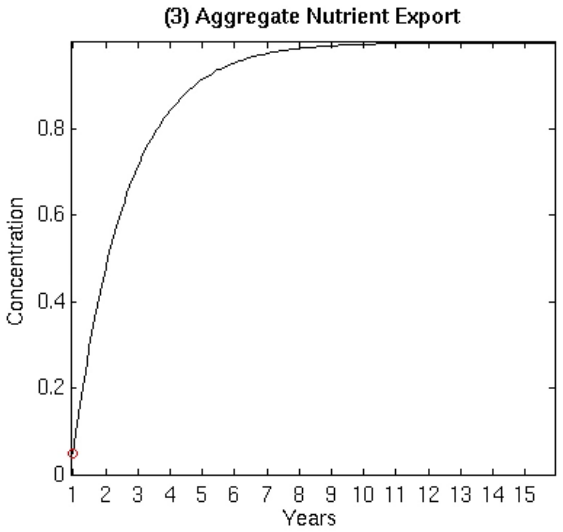


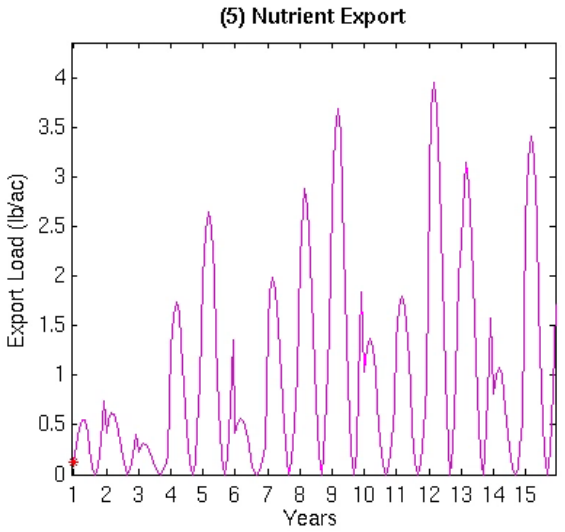


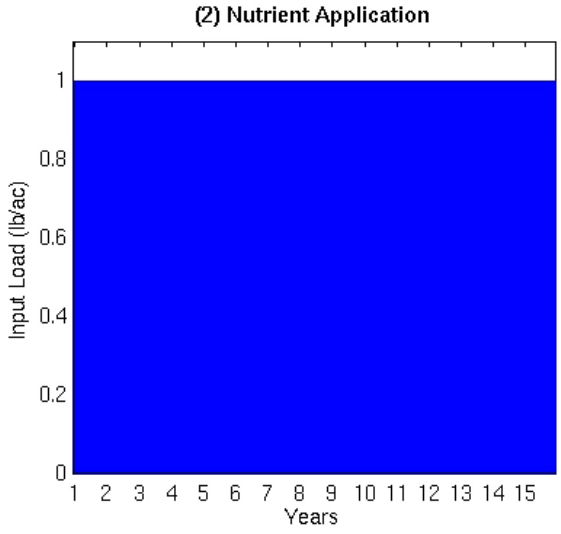


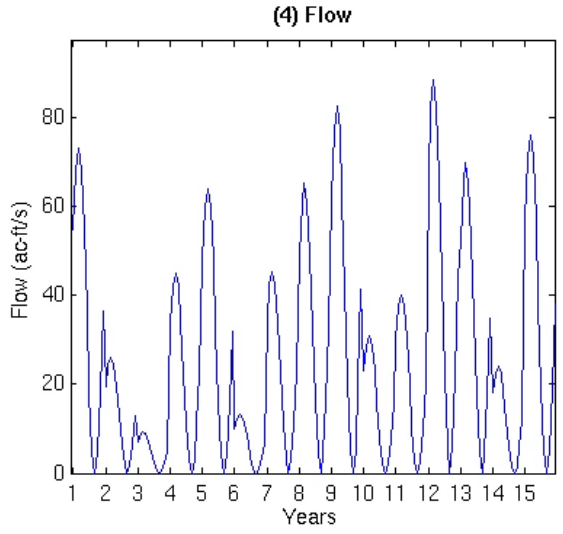
Continuous inputs – variable flow

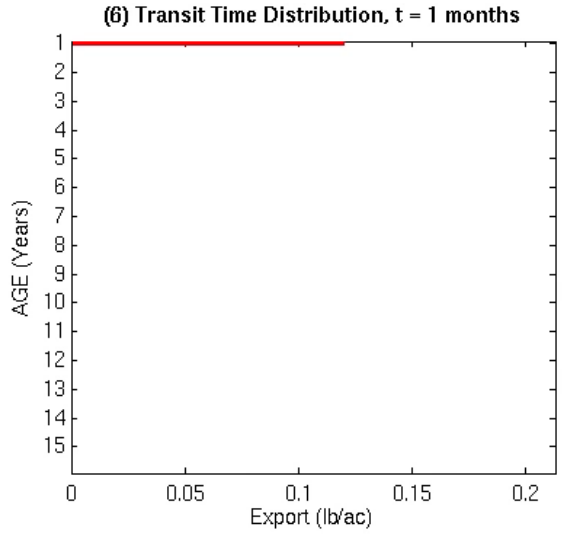




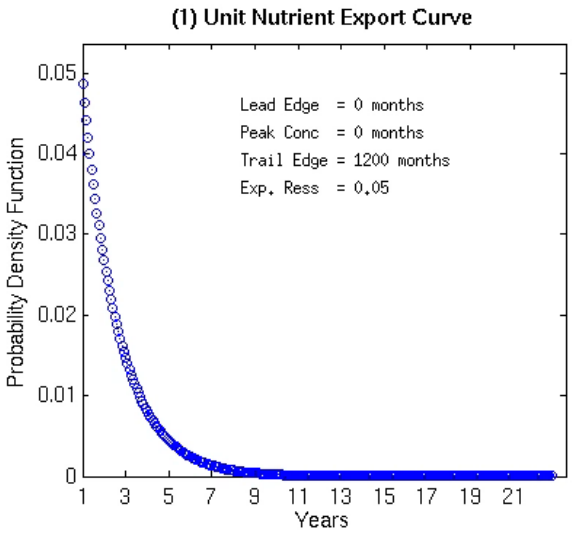


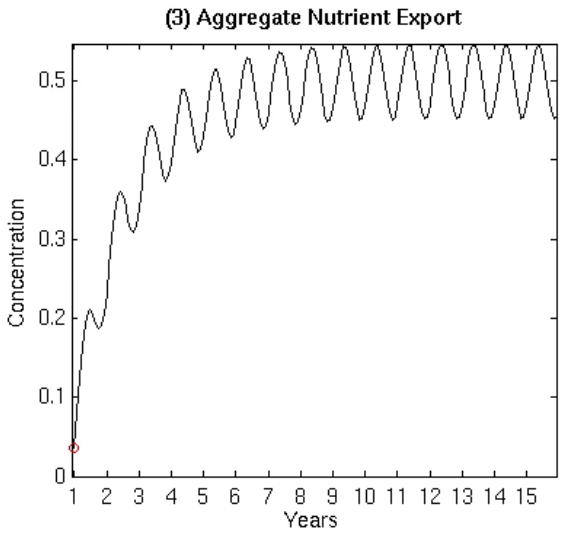


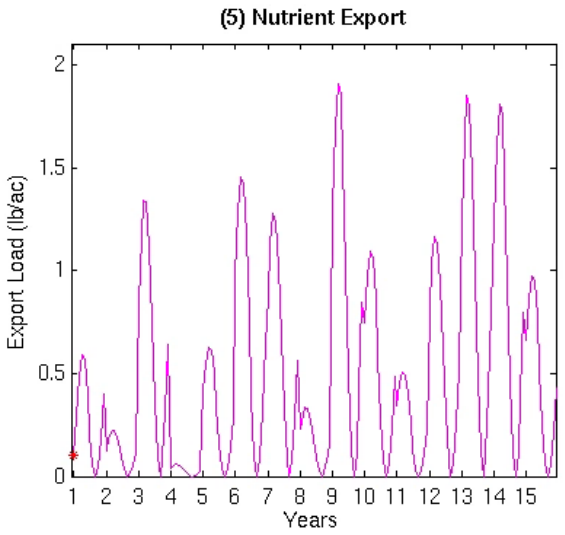


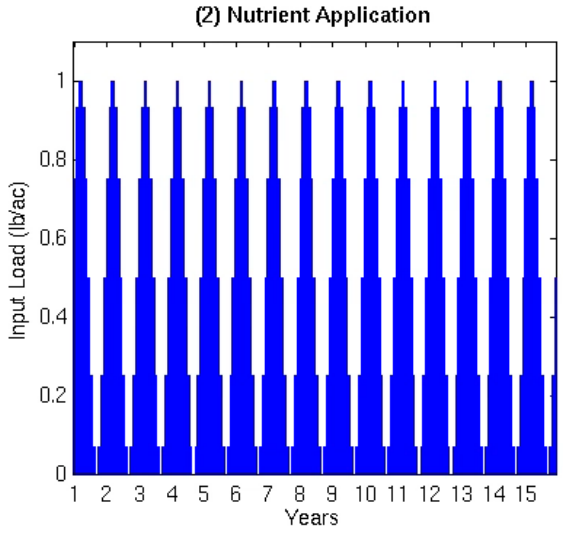


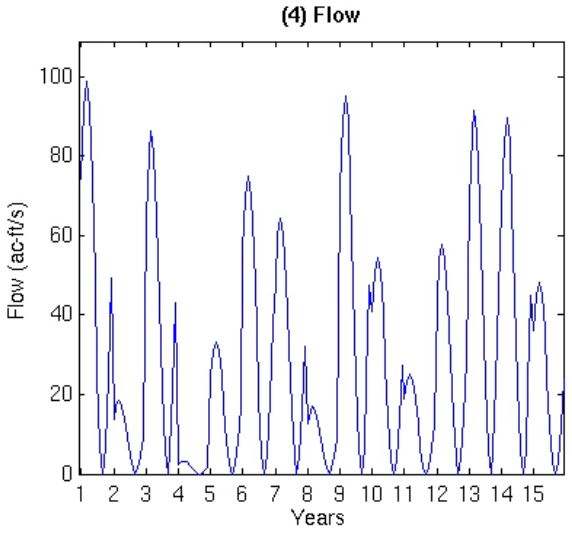
Sinusoidal inputs – variable flow

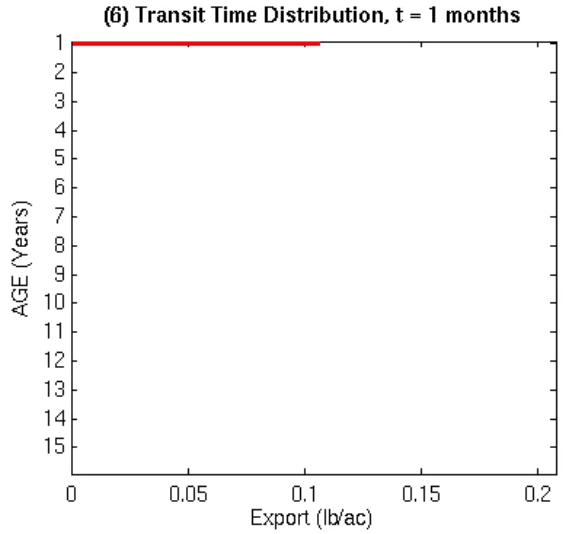




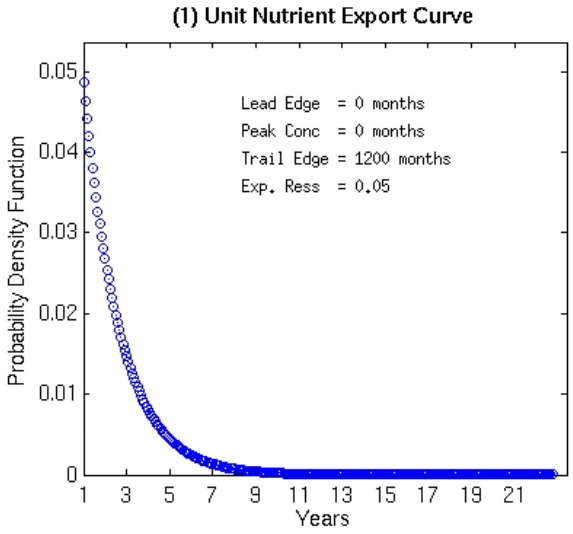


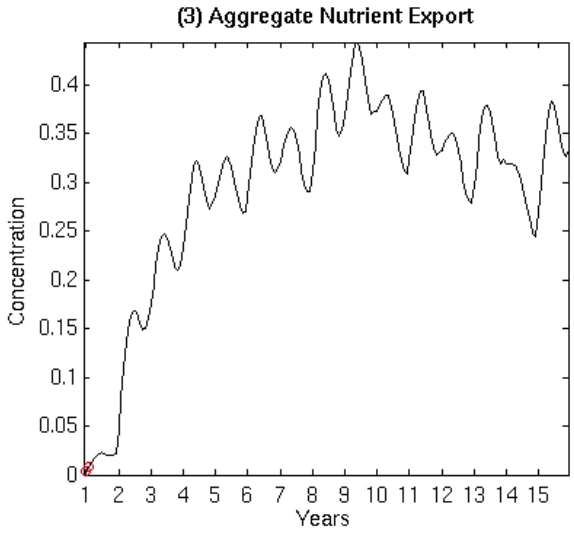


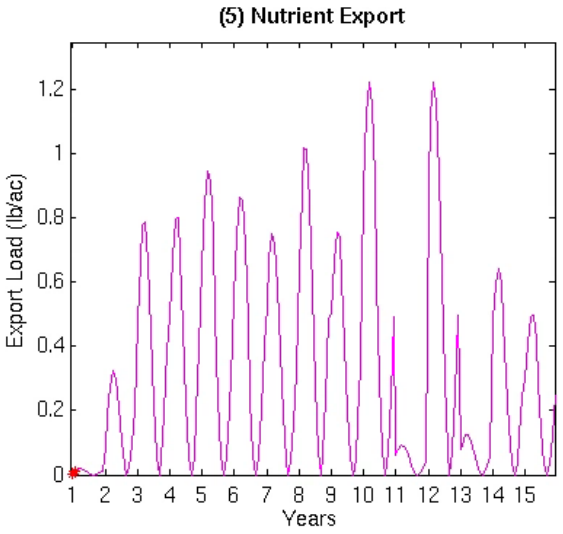


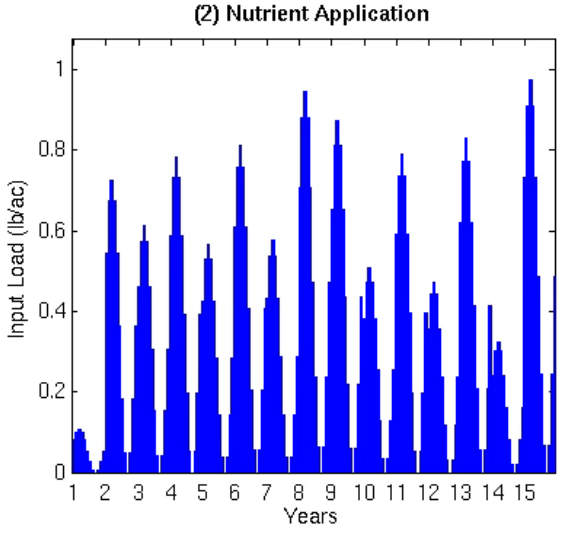


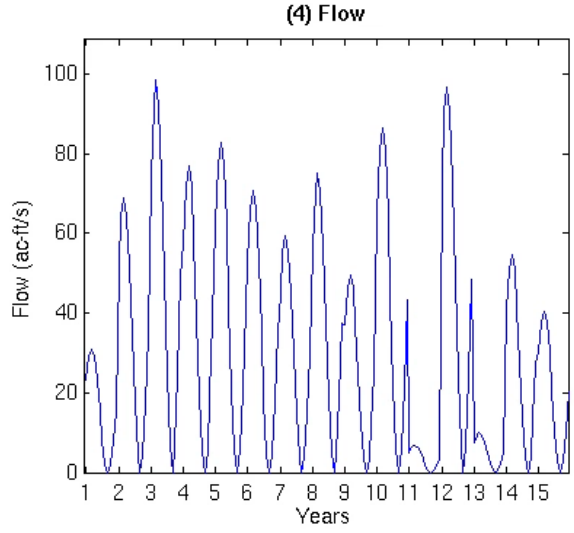
Sinusoidal variable inputs – variable flow

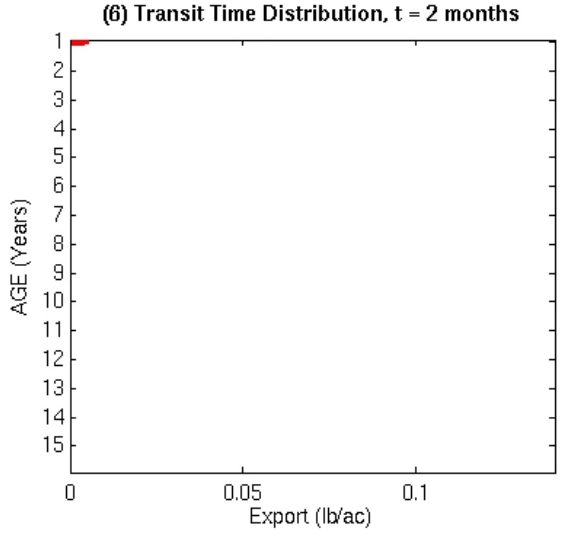












3. Exploration and feasibility of rSAS.

- Jan 17, 2015: Received rSAS tool from *Dr. Ciaran Harmon*

- Jan 23, 2015: A simple test case of run on desktop with assistance from *Dano Wilusz*.

- Need to work on to get it to run on Bluefish.

Appendix

Transit time distributions are usually inferred using lumped parameter models that describe integrated transport of tracer through a catchment. These models do not require detailed hydrological characterization of the physical system and, consequently, are often used for characterizing catchments where data are limited.

The mean transit time of a tracer is simply the first normalized moment of concentration at the catchment outlet.

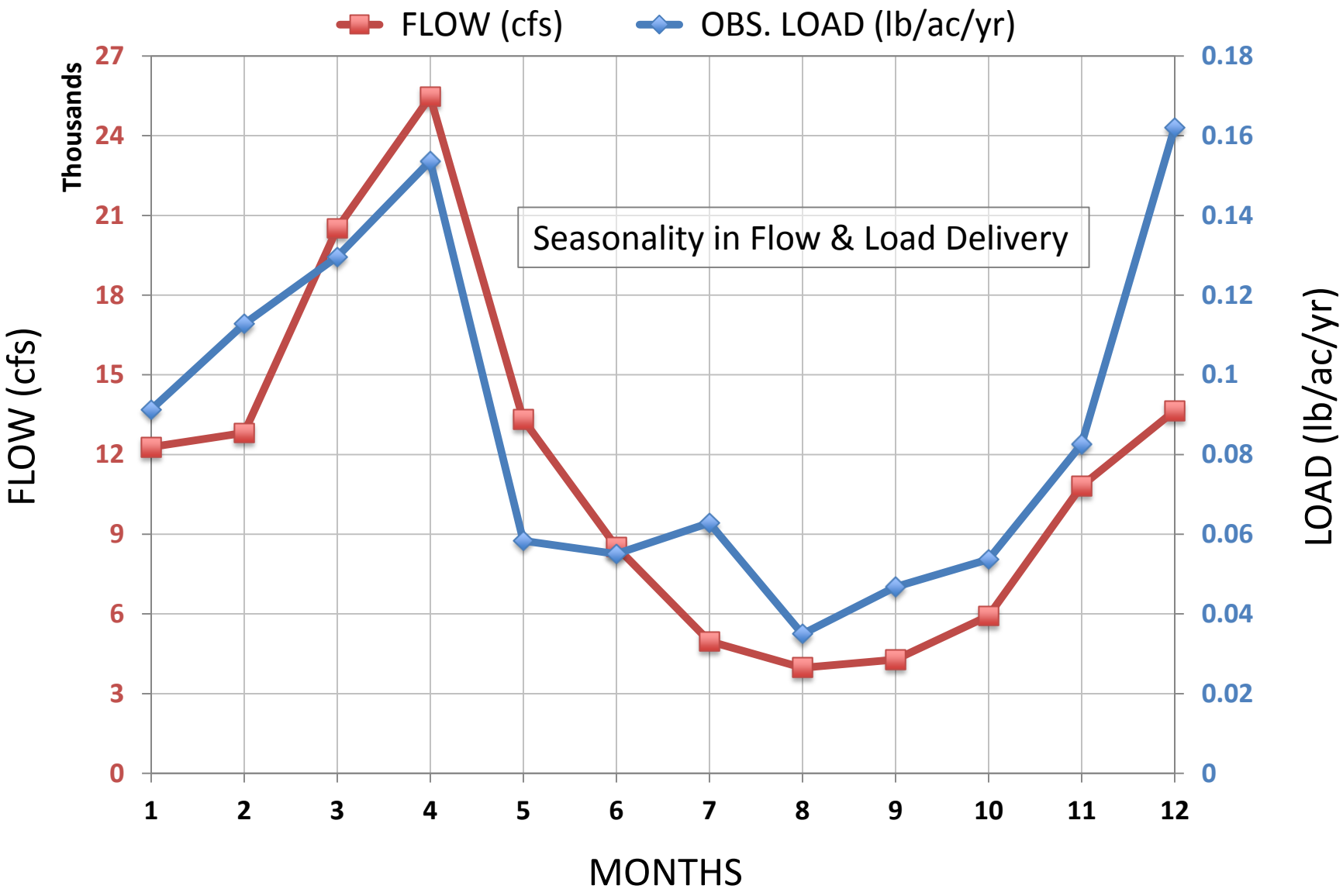
$$d_{OUT}(t) = \int_0^{\infty} g(t) d_{IN}(t - t)\, dt = g(t)\, d_{IN}(t)$$

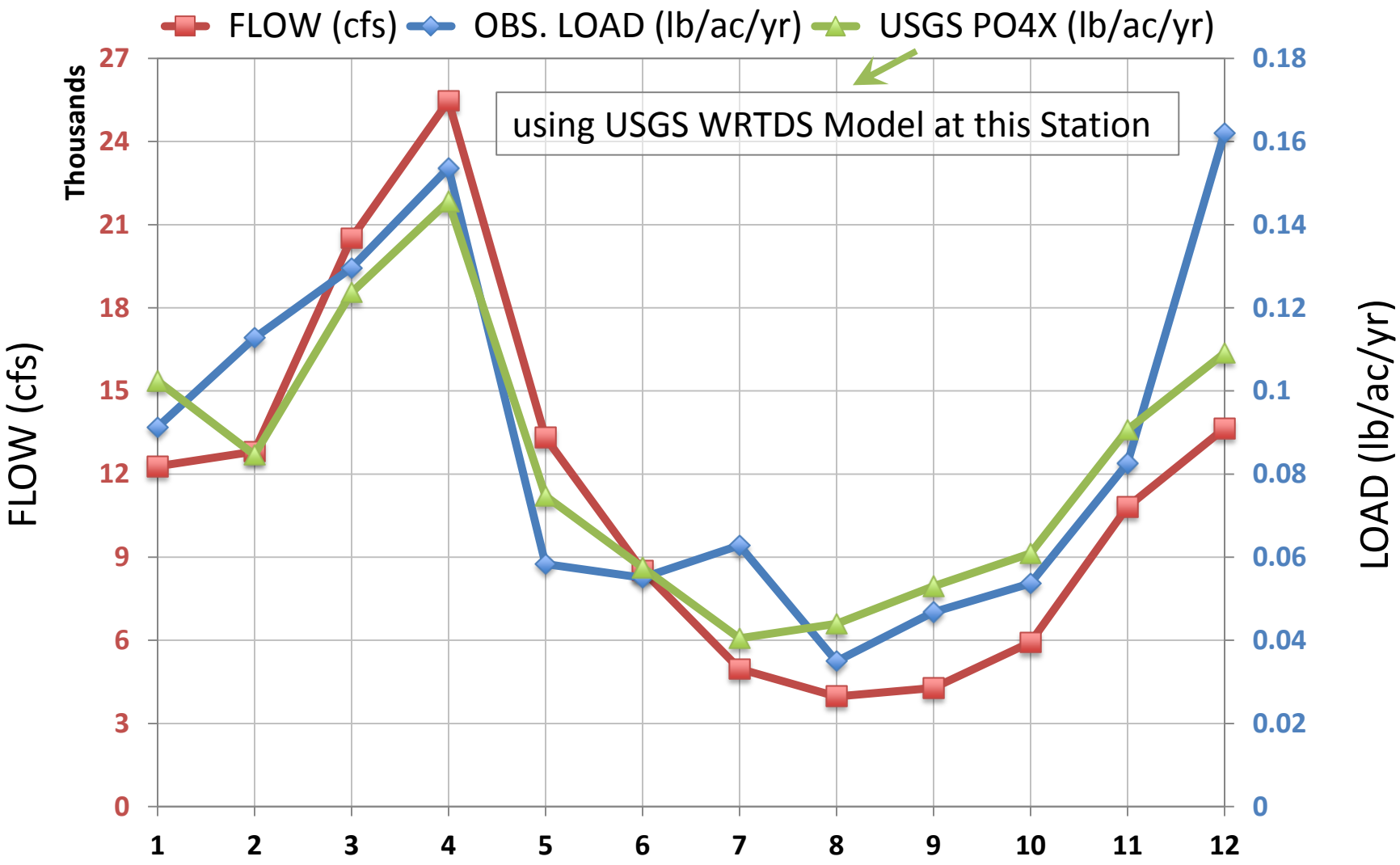
the convolution integral, which states that the stream outflow composition at any time, $d_{OUT}(t)$ consists of tracer, $d_{IN}(t - t)$, that fell uniformly on the catchment in the past $(t - t)$, which becomes lagged according to its transit time distribution, $g(t)$

Transit time distribution of water and tracer are different.

Mean transit time of water and *conservative* tracer would be equal if there were no stagnant zones in a catchment.

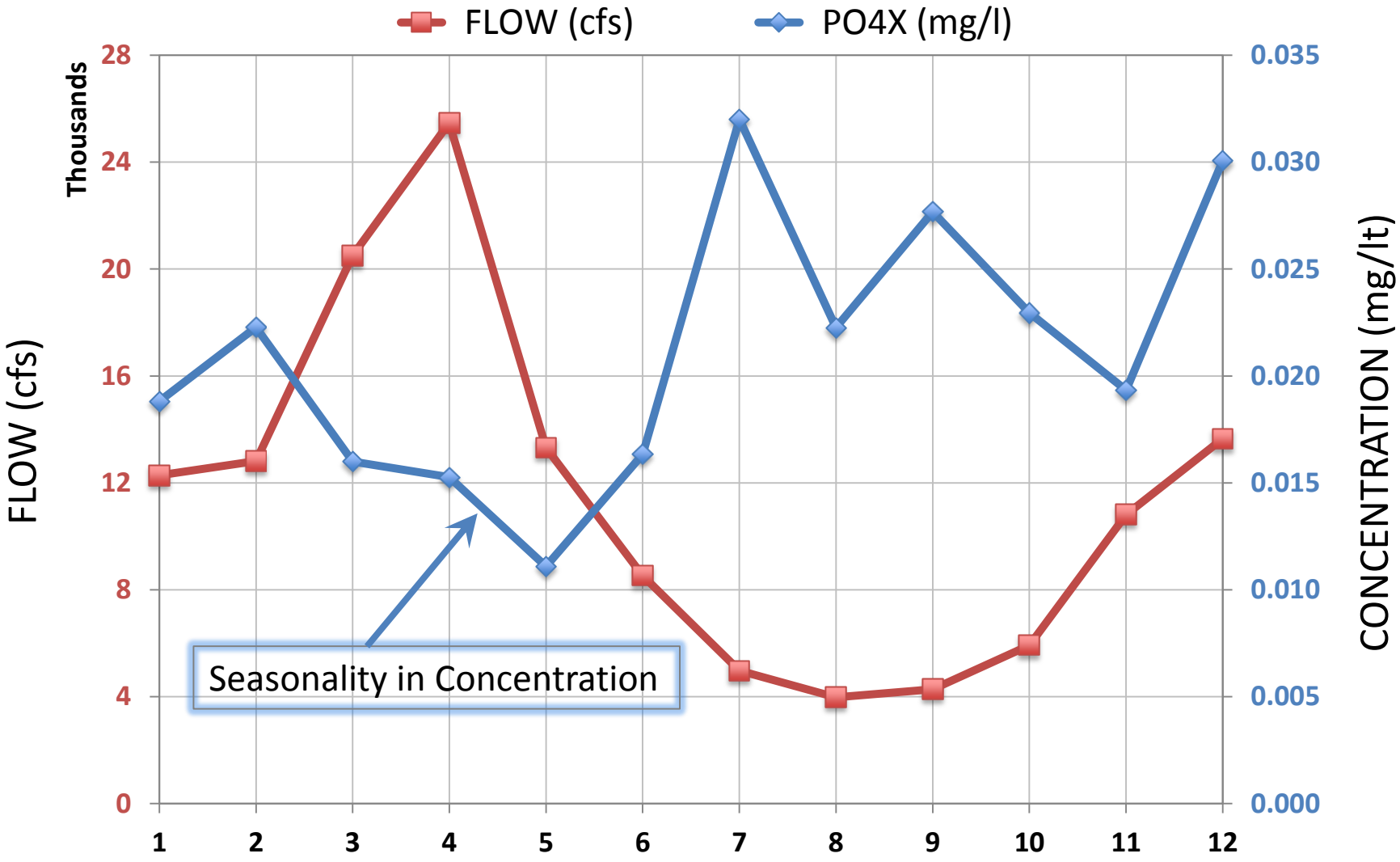
SU7_0850_0730: 70% forest

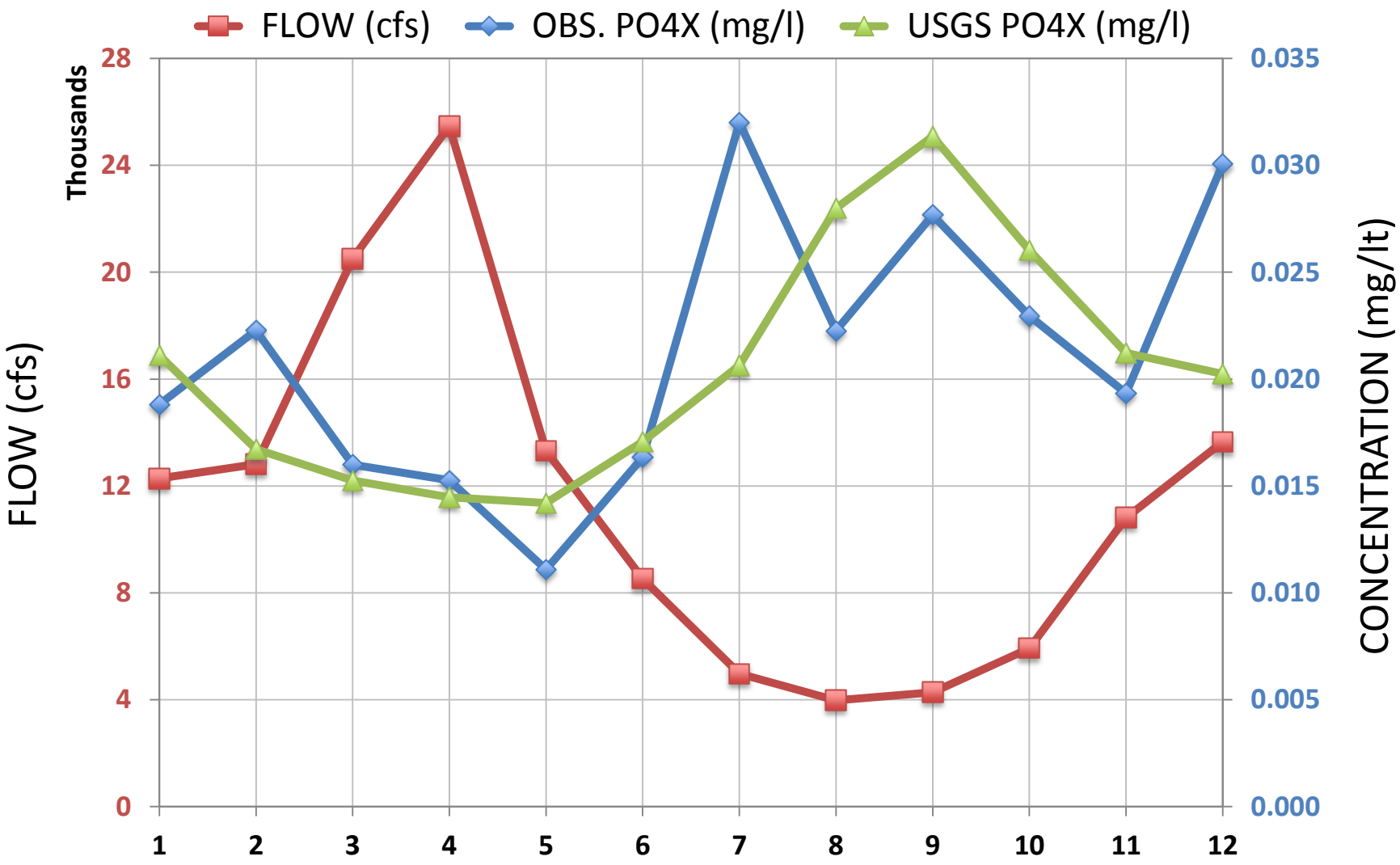




USGS Analysis using WRTDS or ESTIMATOR: http://cbrim.er.usgs.gov/monthly_loads_query.html

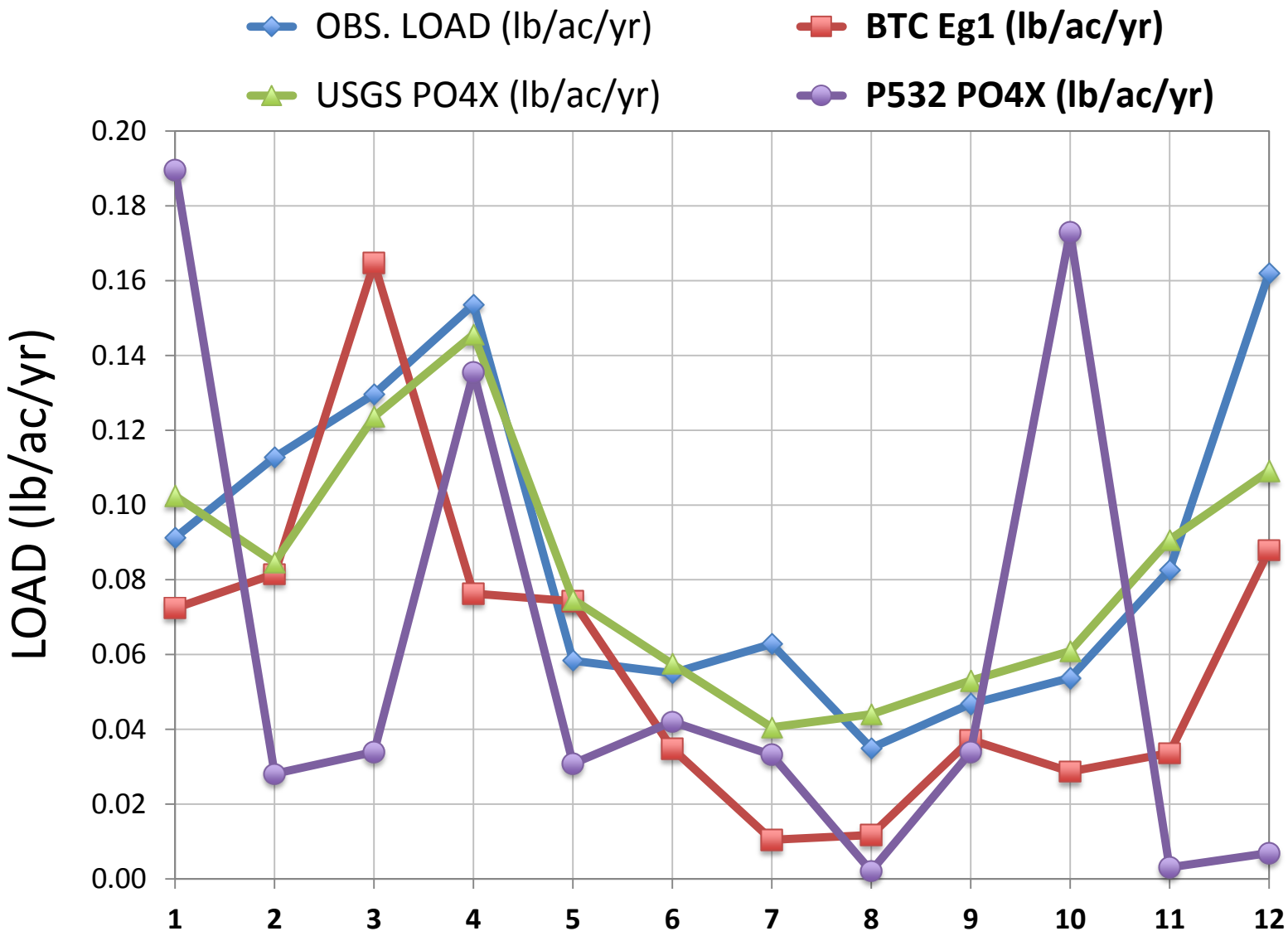
SU7_0850_0730: 70% forest



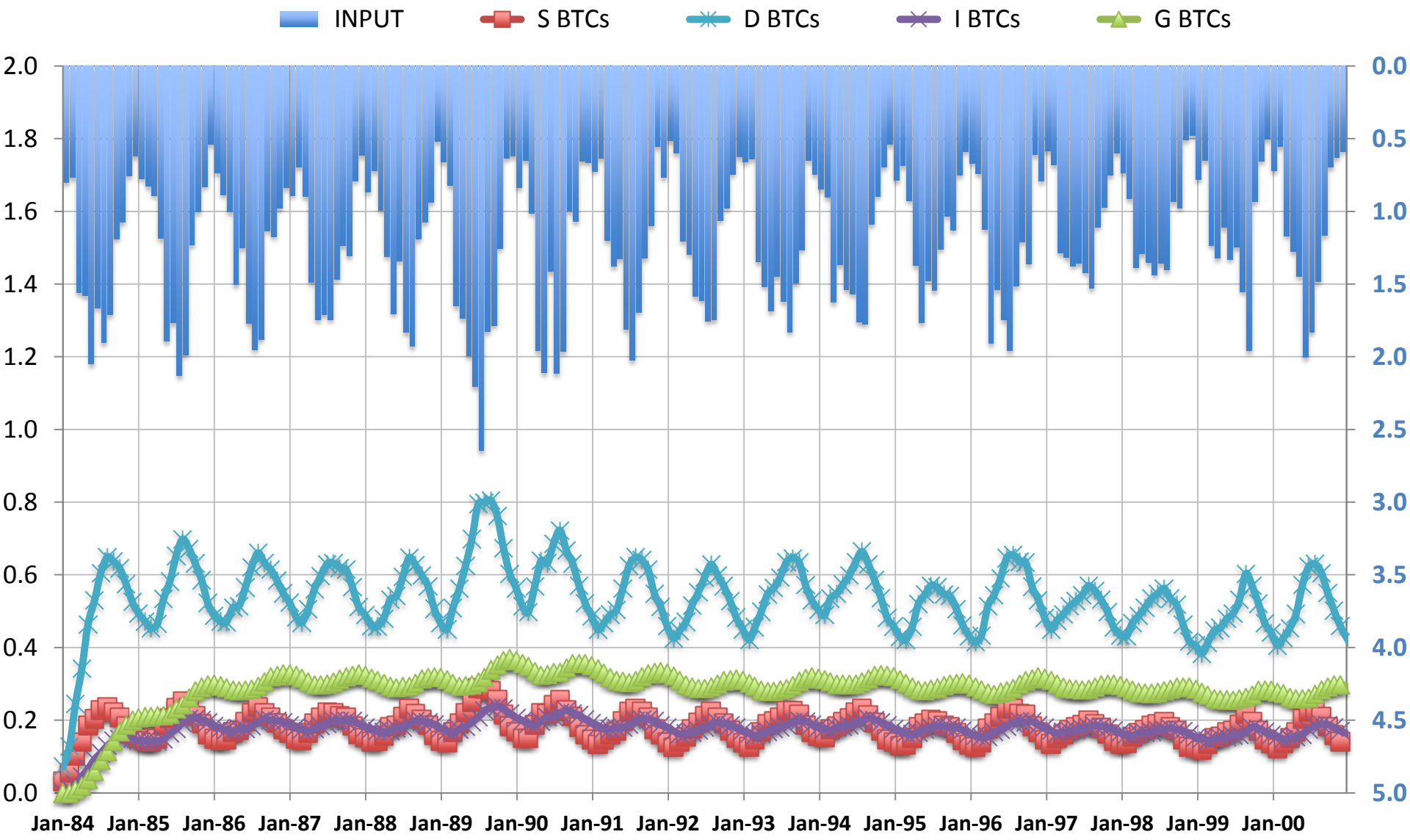

FLOW (cfs)
OBS. PO4X (mg/l)
USGS PO4X (mg/l)
FLOW (cfs)
Thousands
28
24
20
16
12
8
4
0
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
CONCENTRATION (mg/lt)
1
2
3
4
5
6
7
8
9
10
11
12

SU7_0850_0730: 70% forest vs. A10001 forest

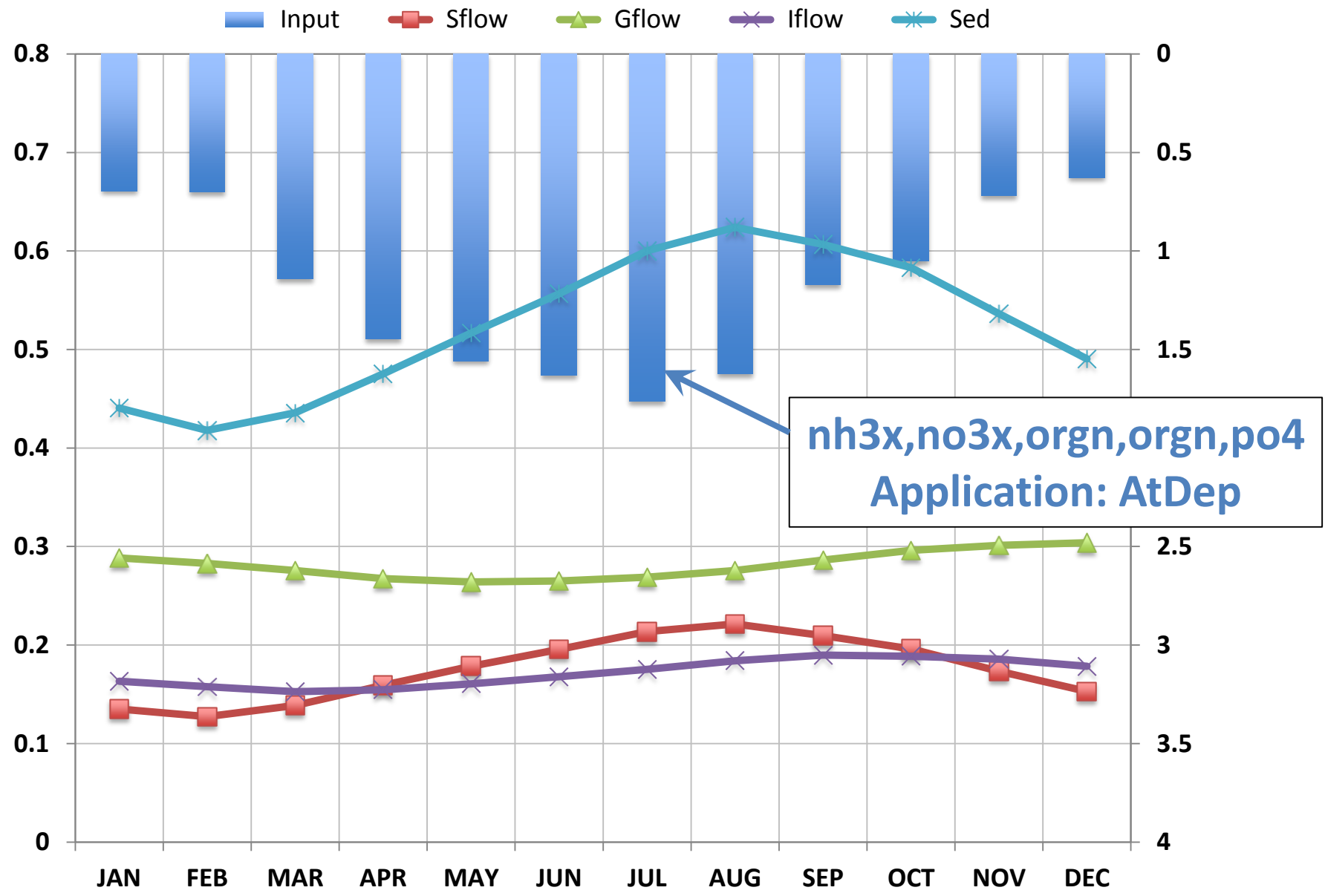
Seasonality in forest response from Observation vs. Model



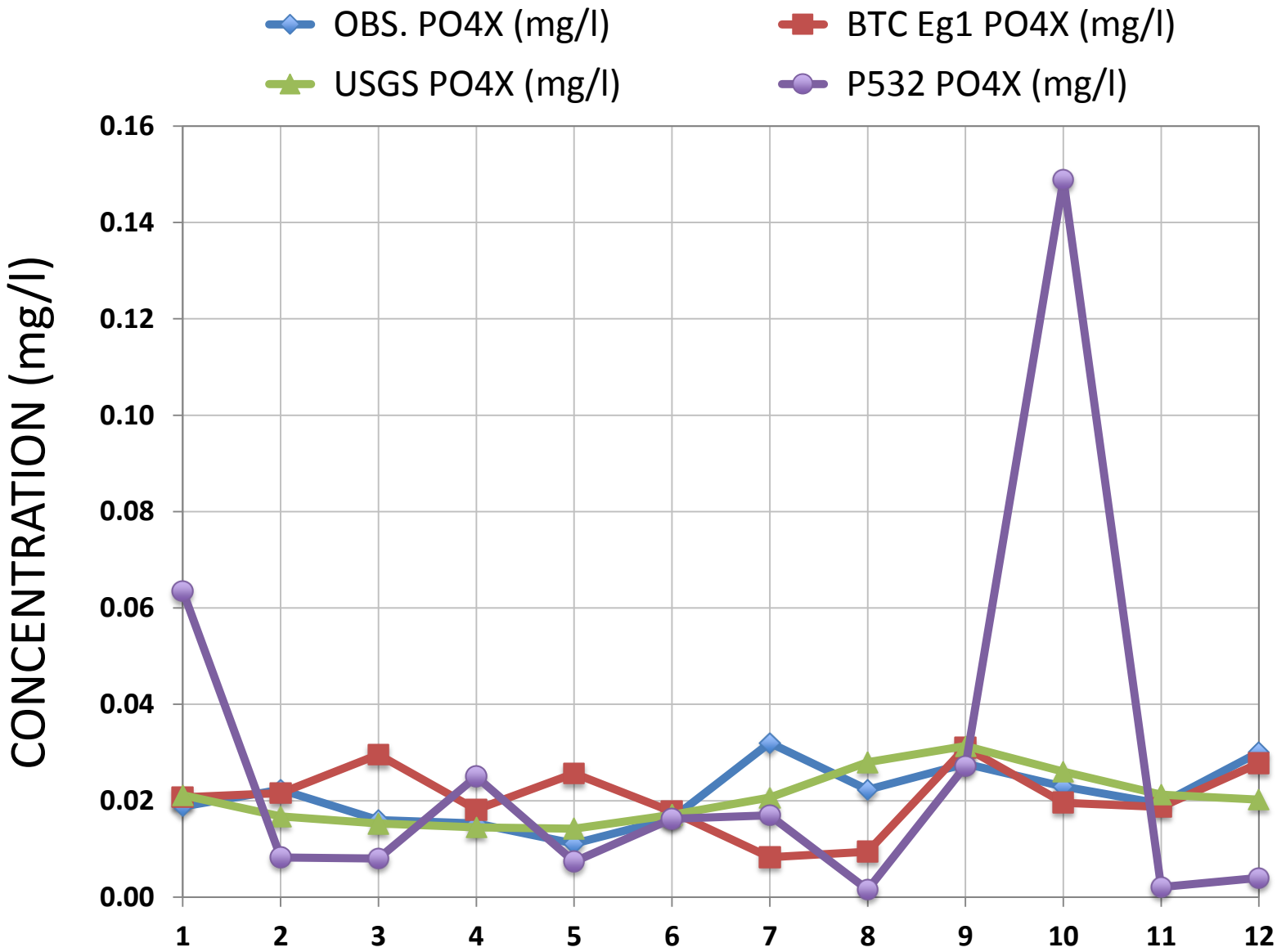
A10001 Forest: Breakthrough Curves (PO4X)



SU7_0850_0730: 70% forest vs. A10001 forest



Seasonality in forest response from Observation vs. Model



Next Steps …

- Parameterize Breakthrough Curve parameters to capture seasonality:
  - possibly for three major land-use categories (i.e. forest, agriculture, urban)
  - do so for total nitrogen and total phosphorous load. Break them out further if evidence points that way.
- Revise model draft sensitivities to incorporate other sources.
  - E.g., APLE
- Incorporate (labile and refractory) organic P in the framework.