Draft Phase 6 Watershed Model

Modeling Workgroup Conference Call – June 2017

Gopal Bhatt[1] and Gary Shenk[2]

[1] Penn State, [2] USGS

Presentation Outline

- Brief review of the final Draft Phase 6 calibration
- Comparison of simulated and WRTDS loads
- Geographic efficiencies of the simulation
- RIM loads

Draft P6 – River water quality calibration

- On the May 18 conference call, we reviewed an early version of the Draft Phase 6 Model calibrations – http://www.chesapeakebay.net/calendar/event/25078/ **DRAFT G**

- Based on the overall improvement in the model performance and other supporting information[1] a decision was reached for not requiring calibrated regional factors.

- Leading up to the completion of the Draft Phase 6 calibrations following updates were made: **DRAFT P6**
  - Calibration of the Lower Susquehanna reservoirs, including Conowingo Infill
  - Updated parameters for stray[2] river segments
  - Updated simulation with the final draft Phase 6 point-source dataset

[1] http://www.chesapeakebay.net/channel_files/25082/2017_05_18_regional_factors.pdf

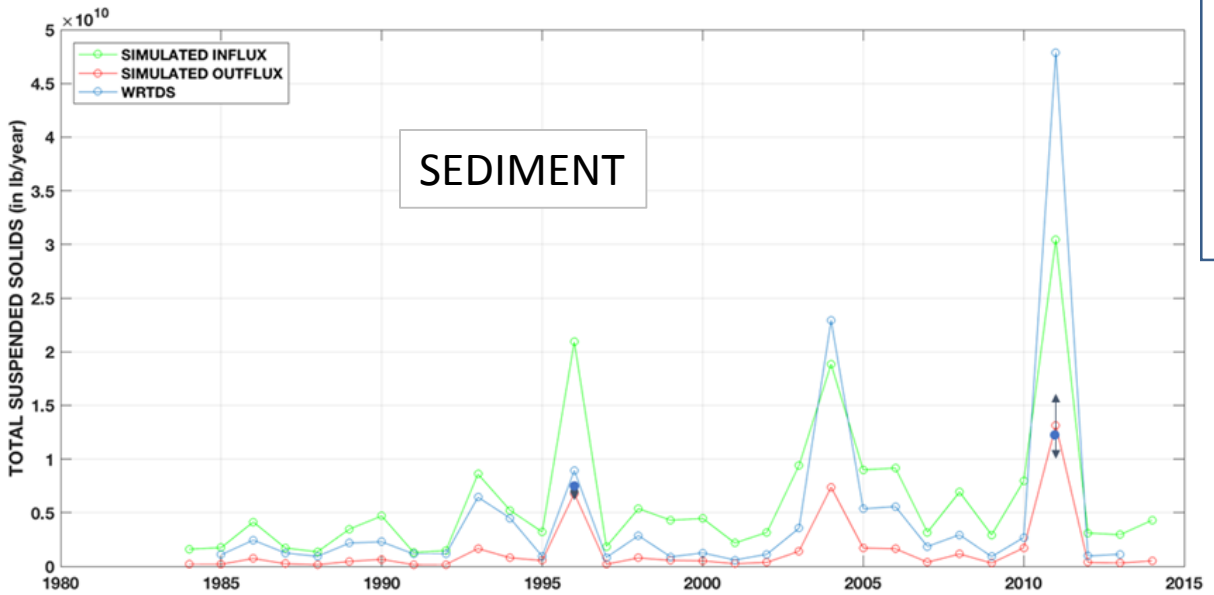
[2] A stray river segment is one which does not have any observations downstream

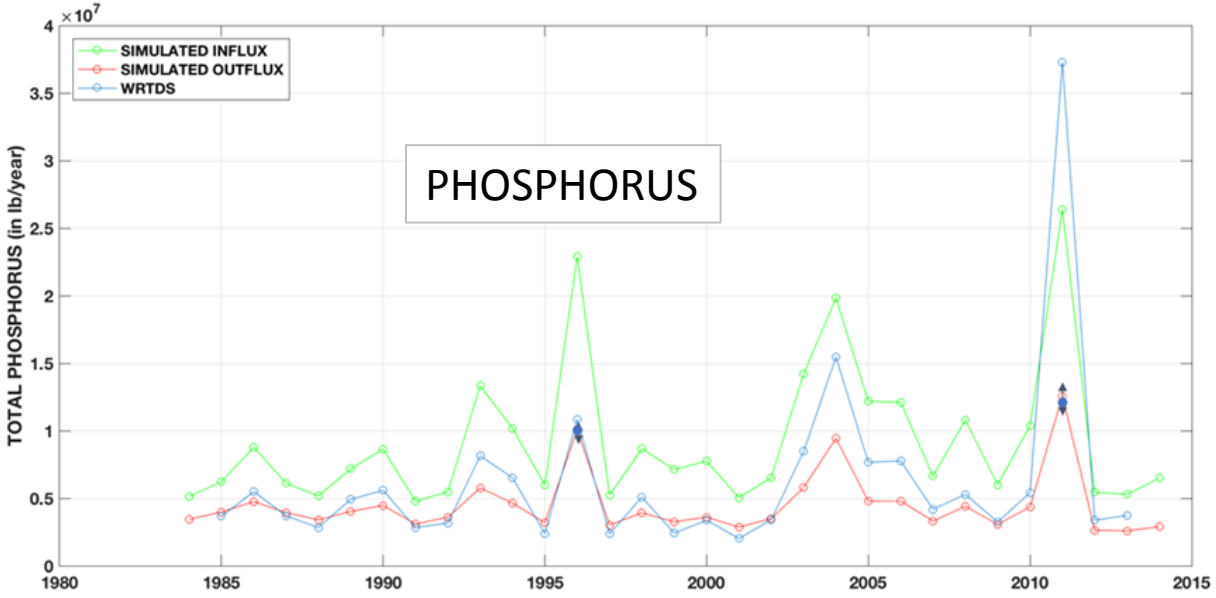
Development of Conowingo Infill simulation

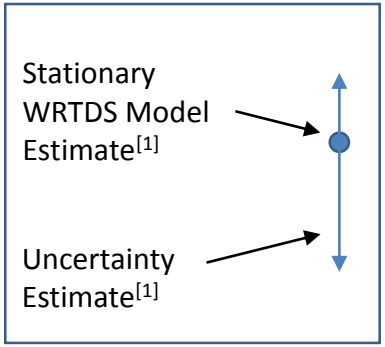
A four step calibration strategy was developed:

1. Estimate no-infill model parameters (the 1990s condition)
2. Estimate changes in deposition parameters (the 2010s condition)
3. Estimate changes in scour parameters (the 2010s condition)
4. Estimate temporal variability in deposition/scour parameters (1984 – 2014)

Step 1: Estimate no-infill model parameters (the 1990s condition)

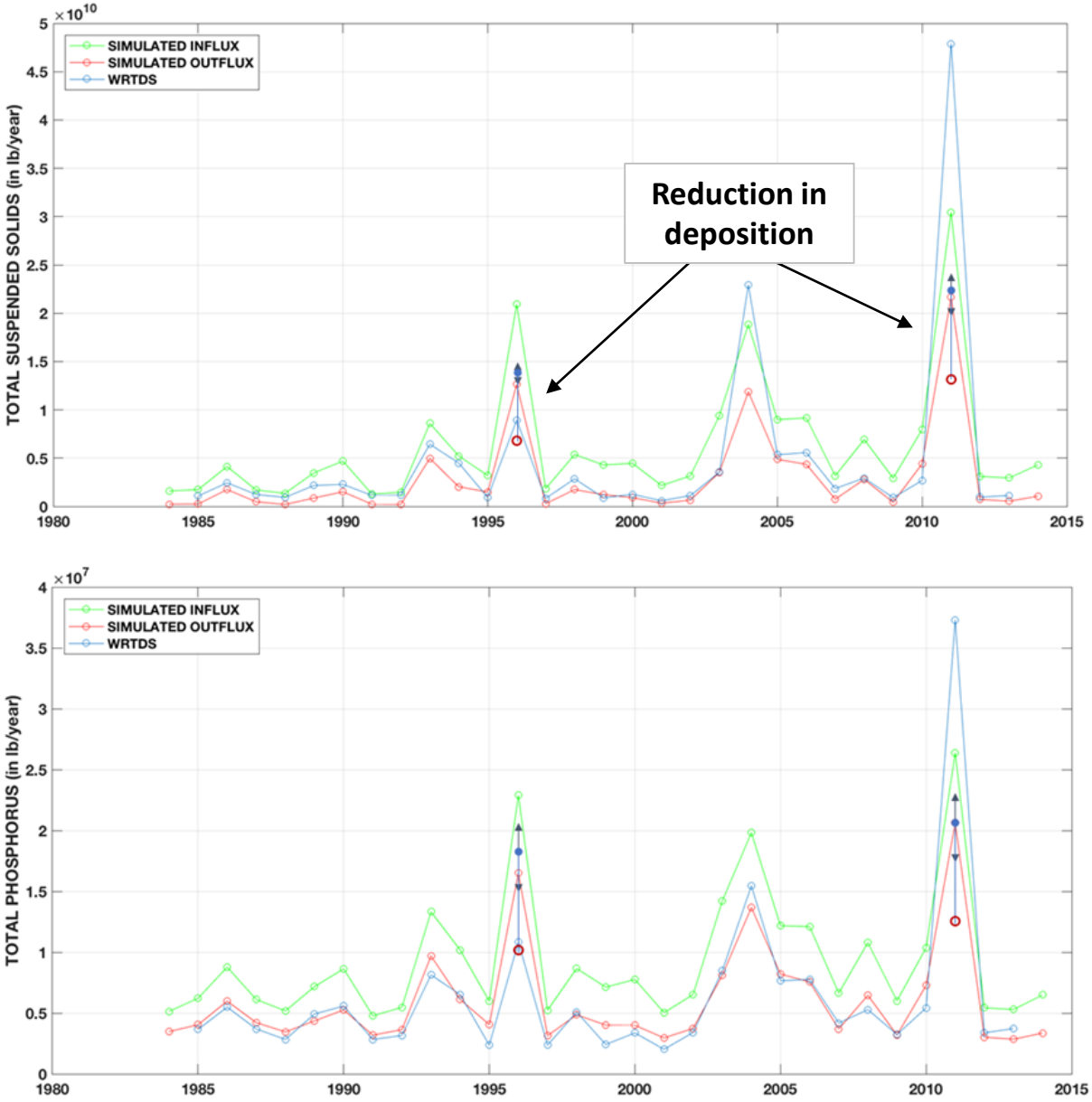




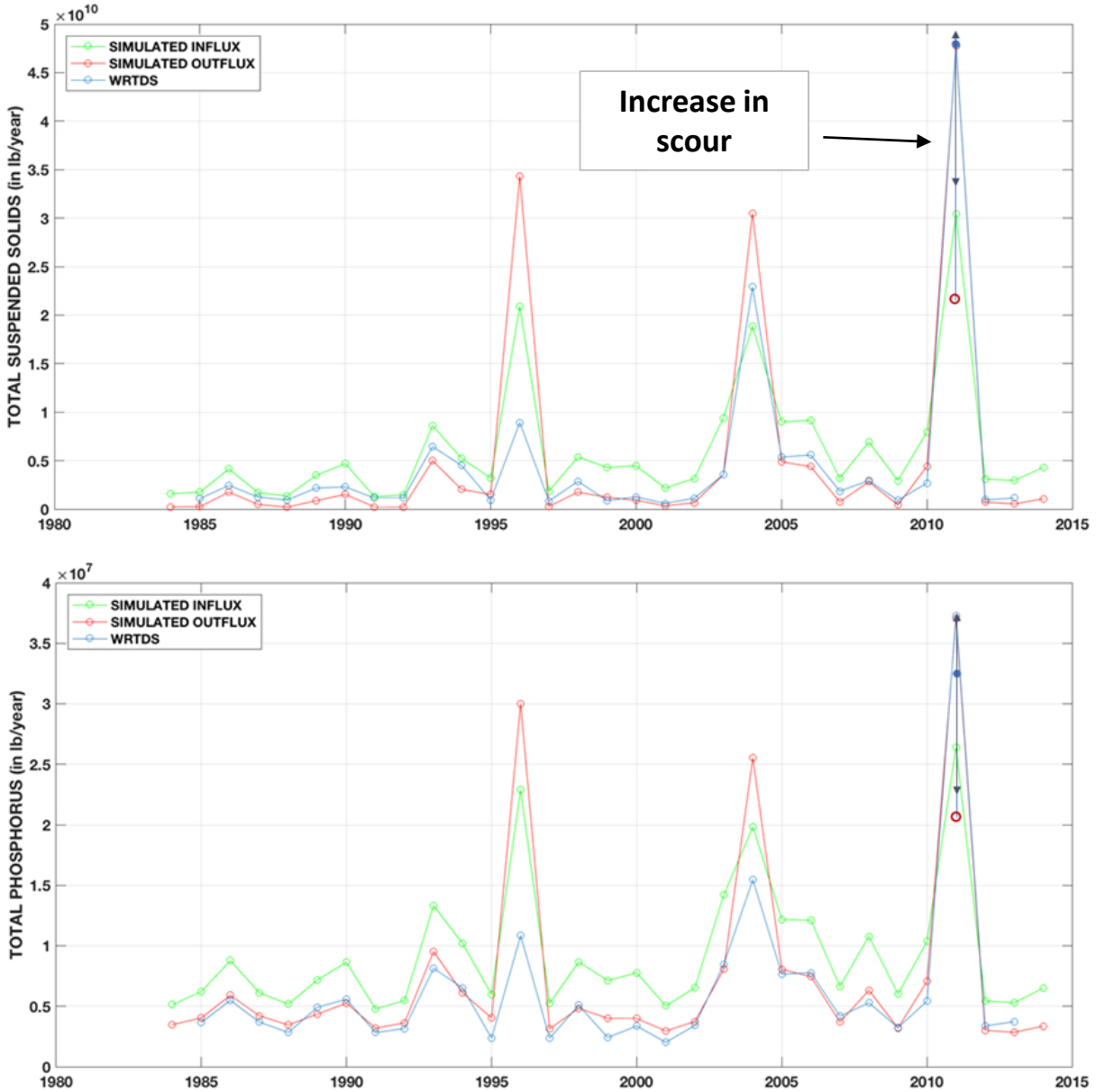


[1] Zhang, Hirsch, and Ball ES&T 2016

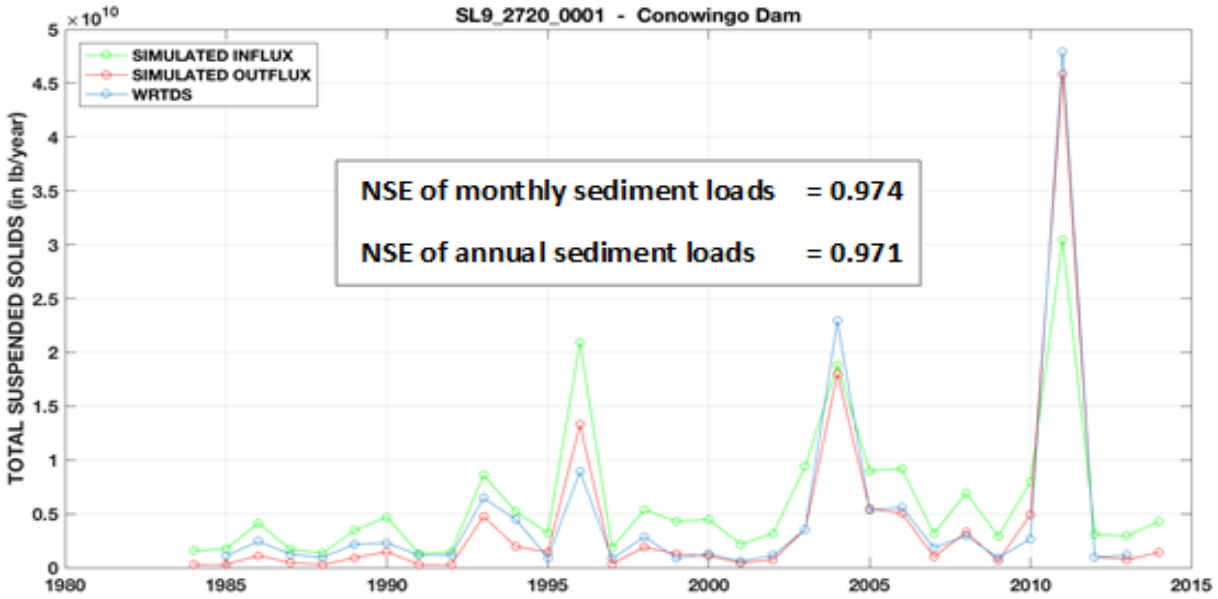
Step 2: Estimate changes in deposition parameters (the 2010s condition)

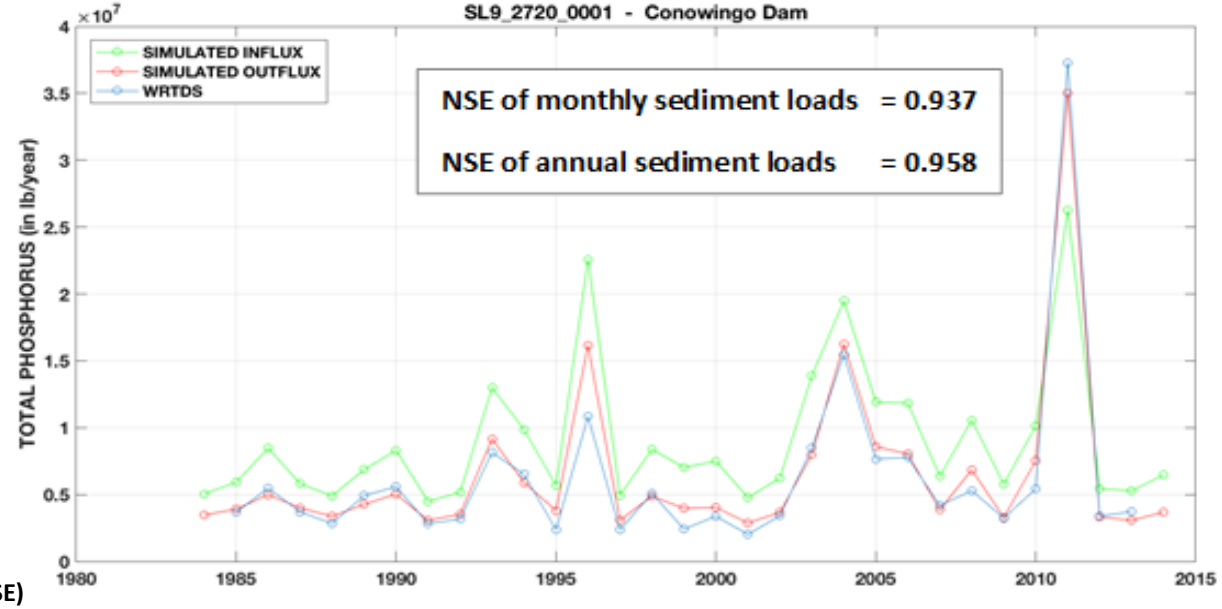


Step 3: Estimate changes in scour parameters (the 2010s condition)



Step 4: Estimate temporal variability in deposition/scour parameters (i.e. 1984 – 2014)



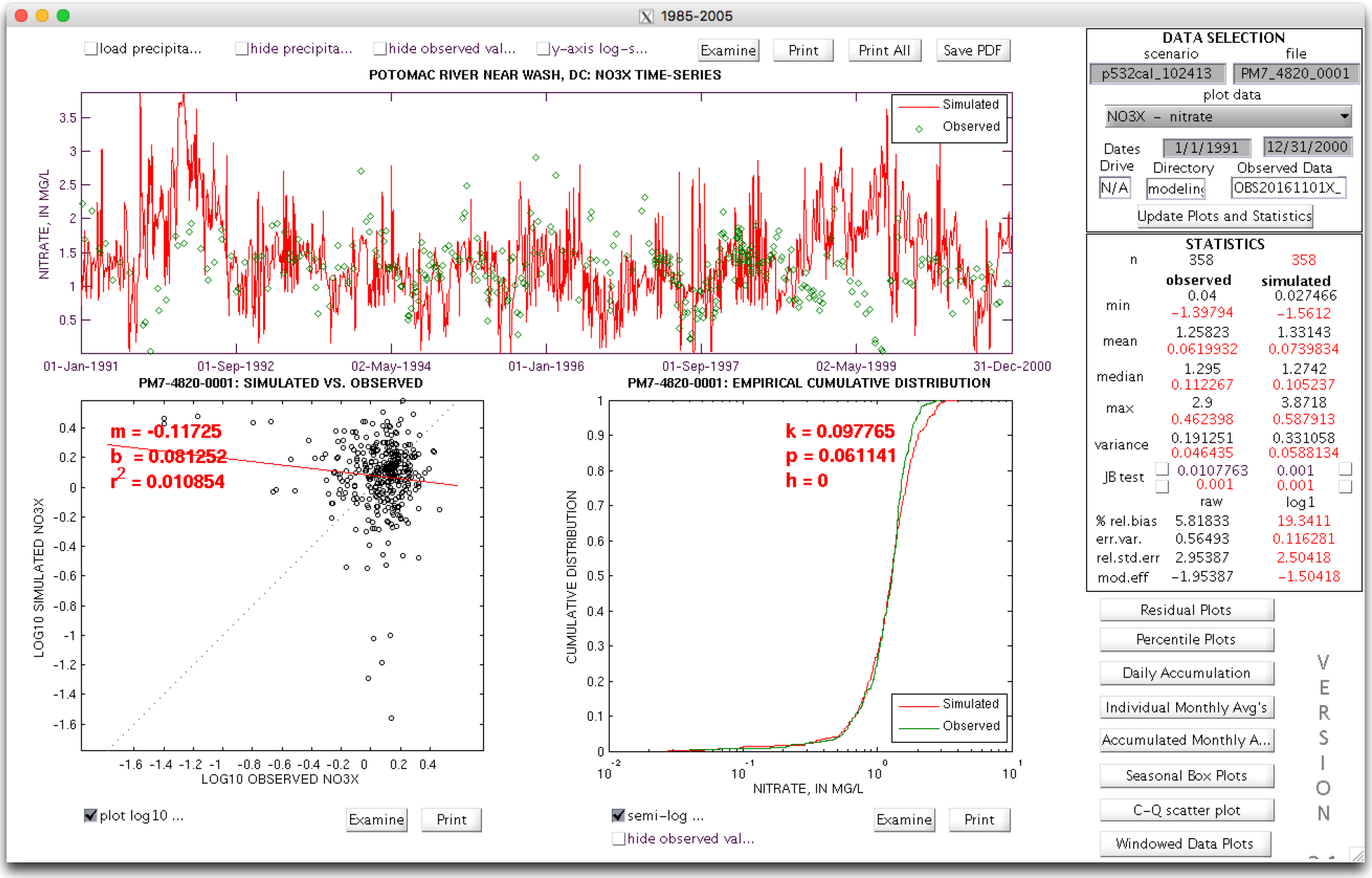


Nash-Sutcliffe Efficiency (NSE)

PHASE 5

POTOMAC RIVER

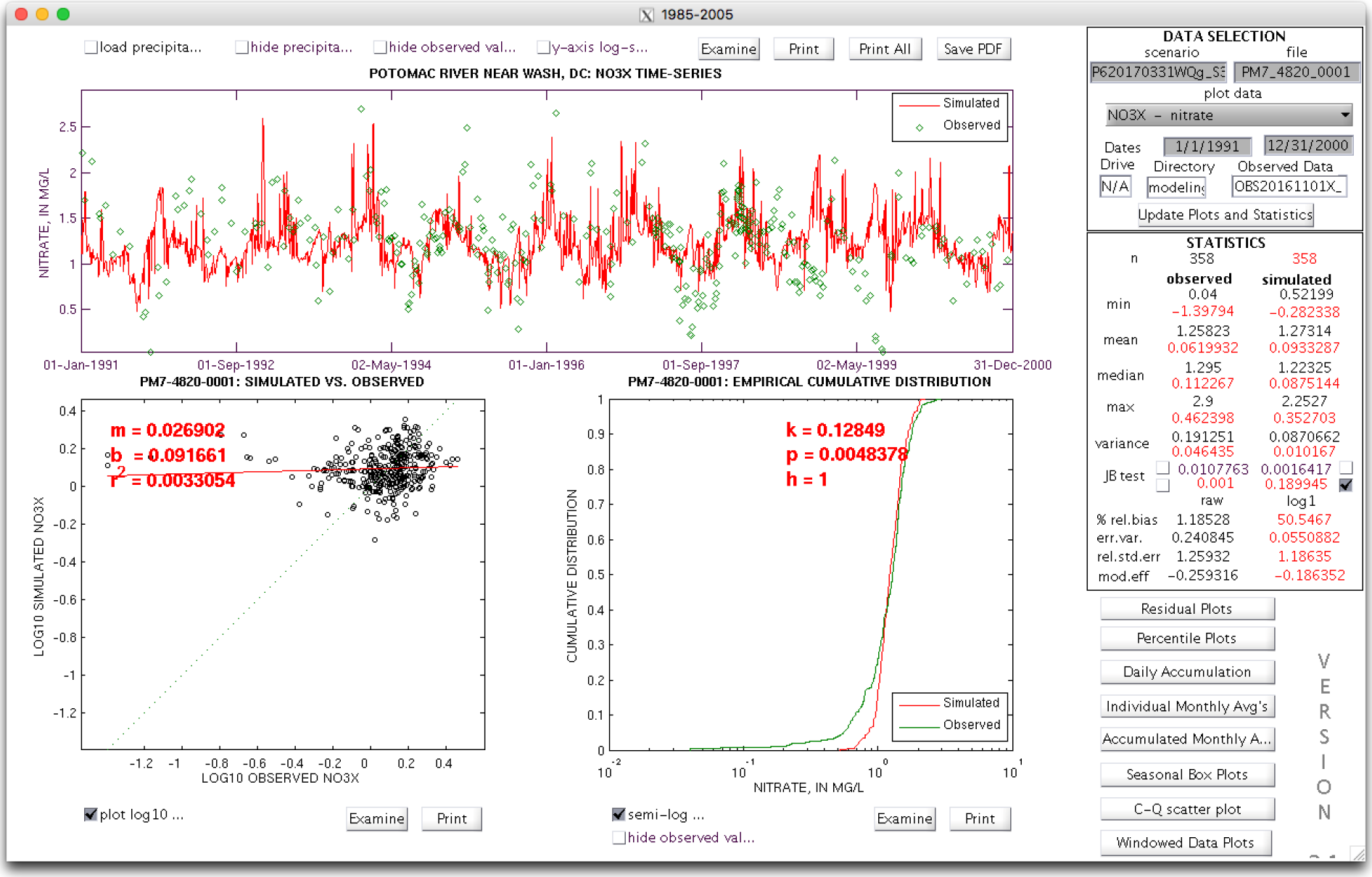
NITRATE



DRAFT P6

POTOMAC RIVER

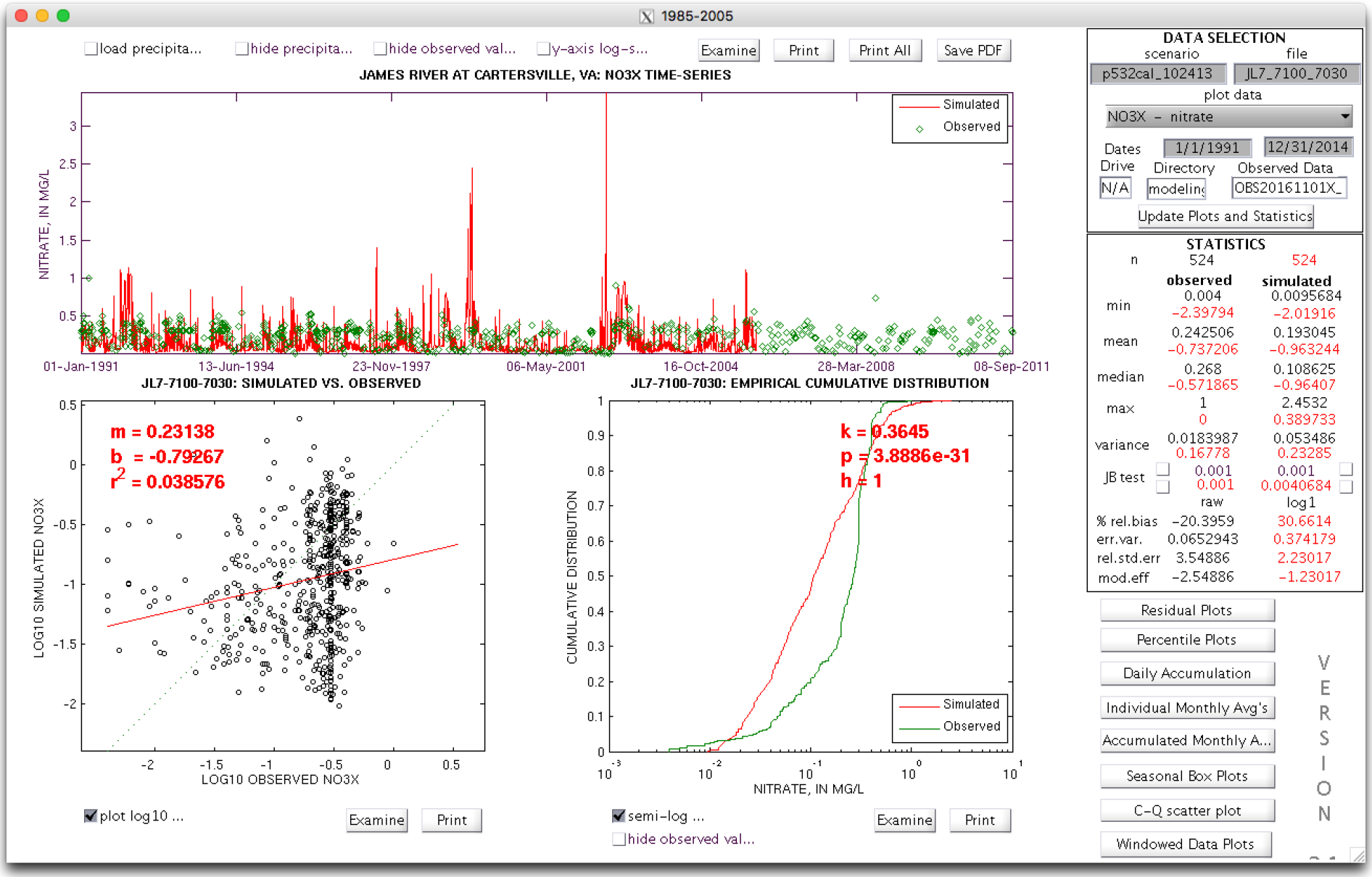
NITRATE



PHASE 5

JAMES RIVER

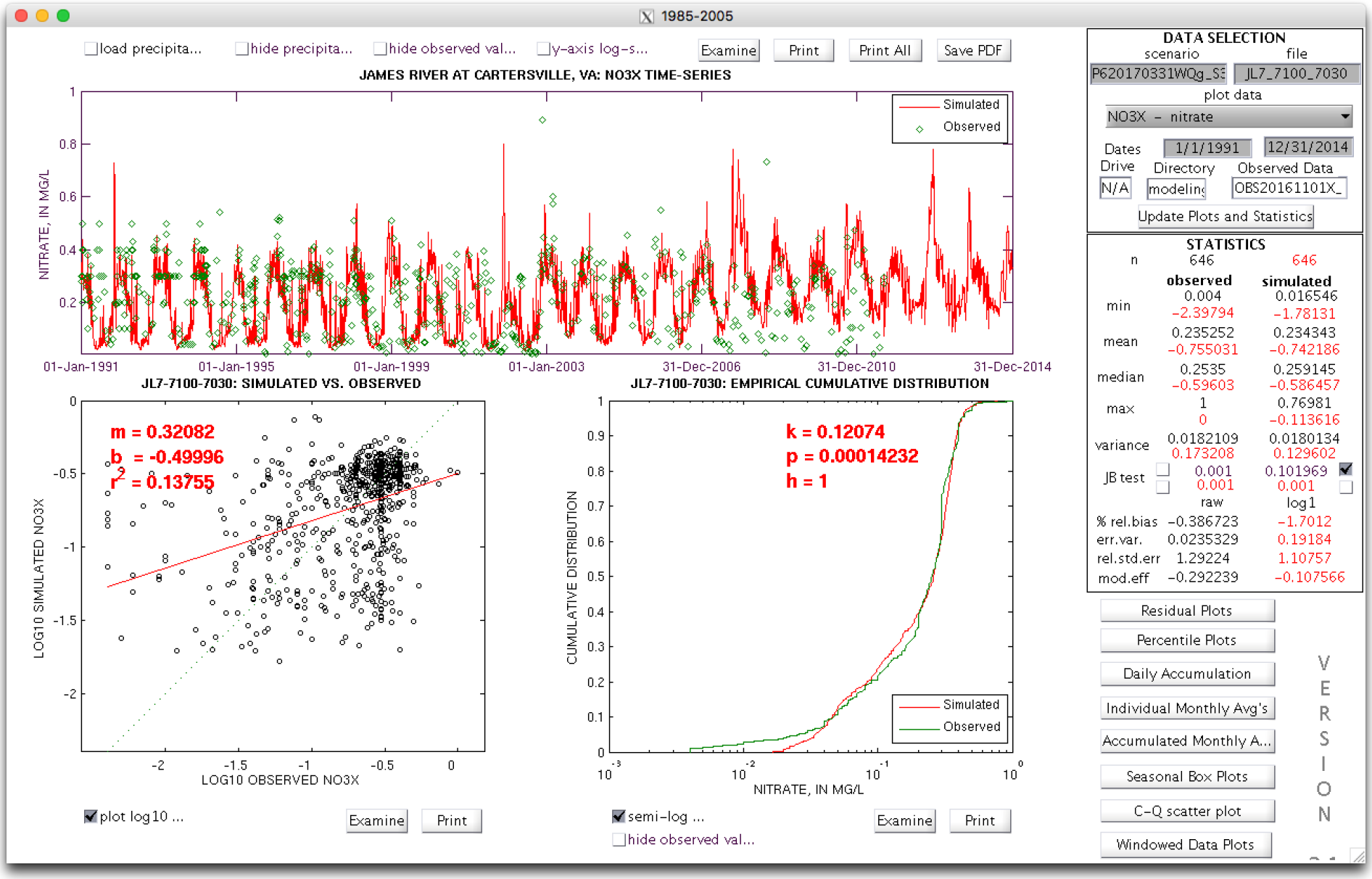
NITRATE



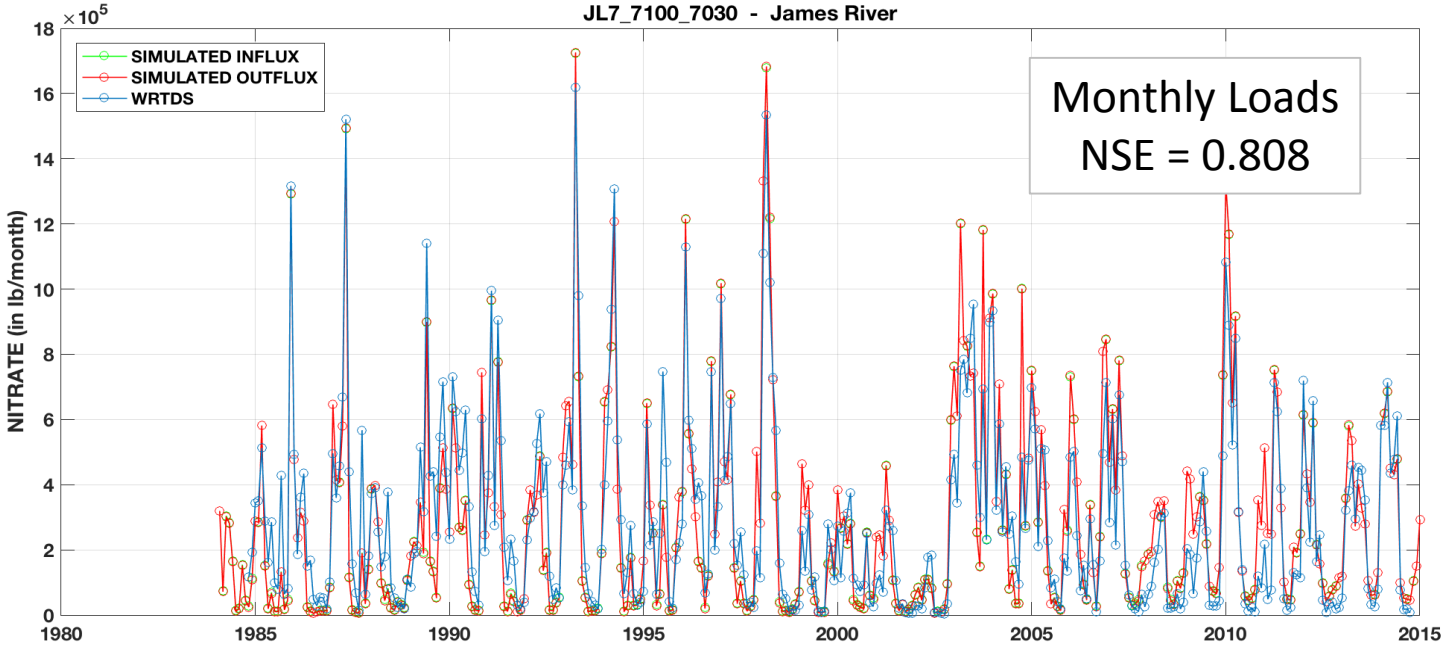
DRAFT P6

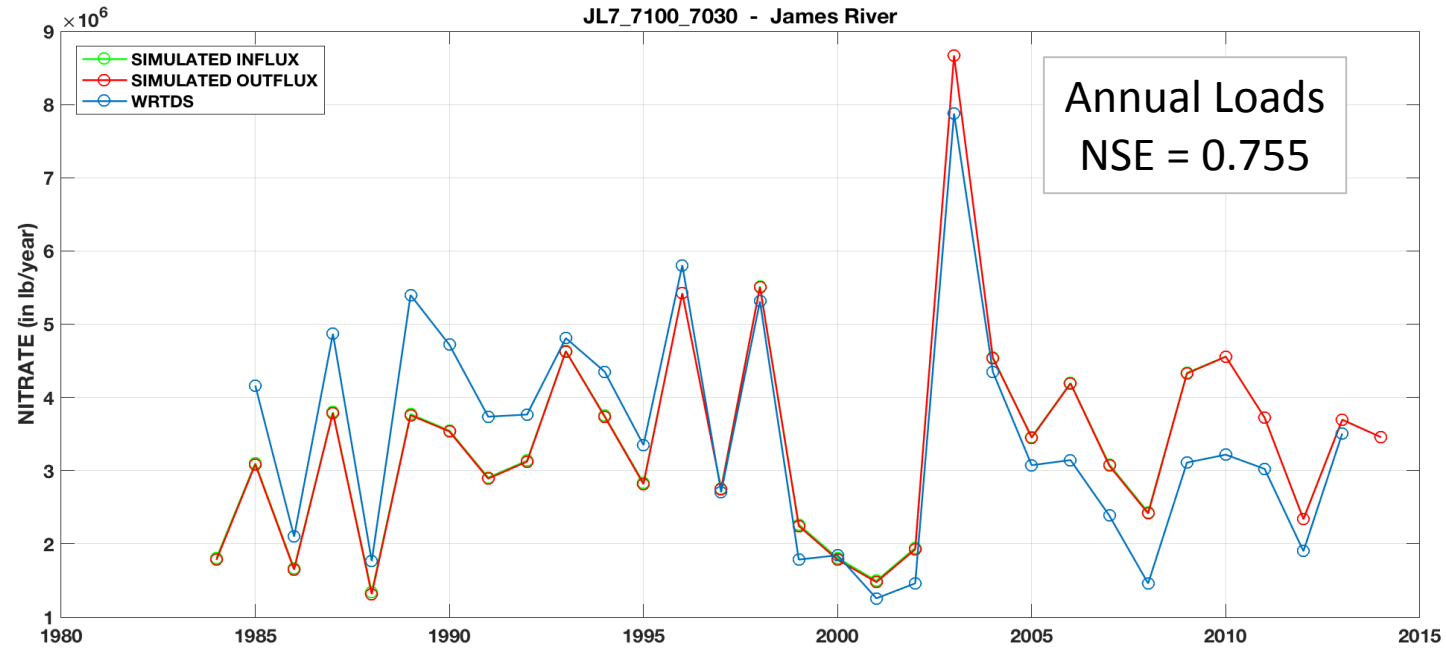
JAMES RIVER

NITRATE

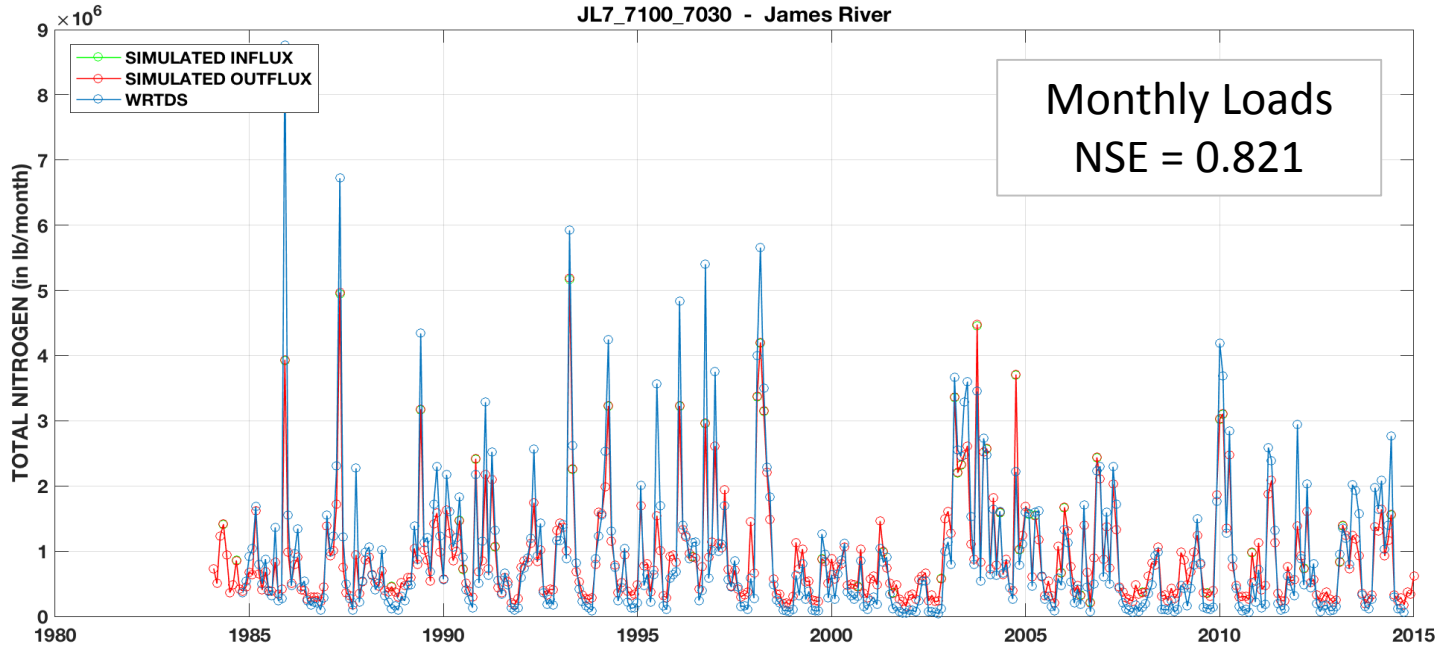


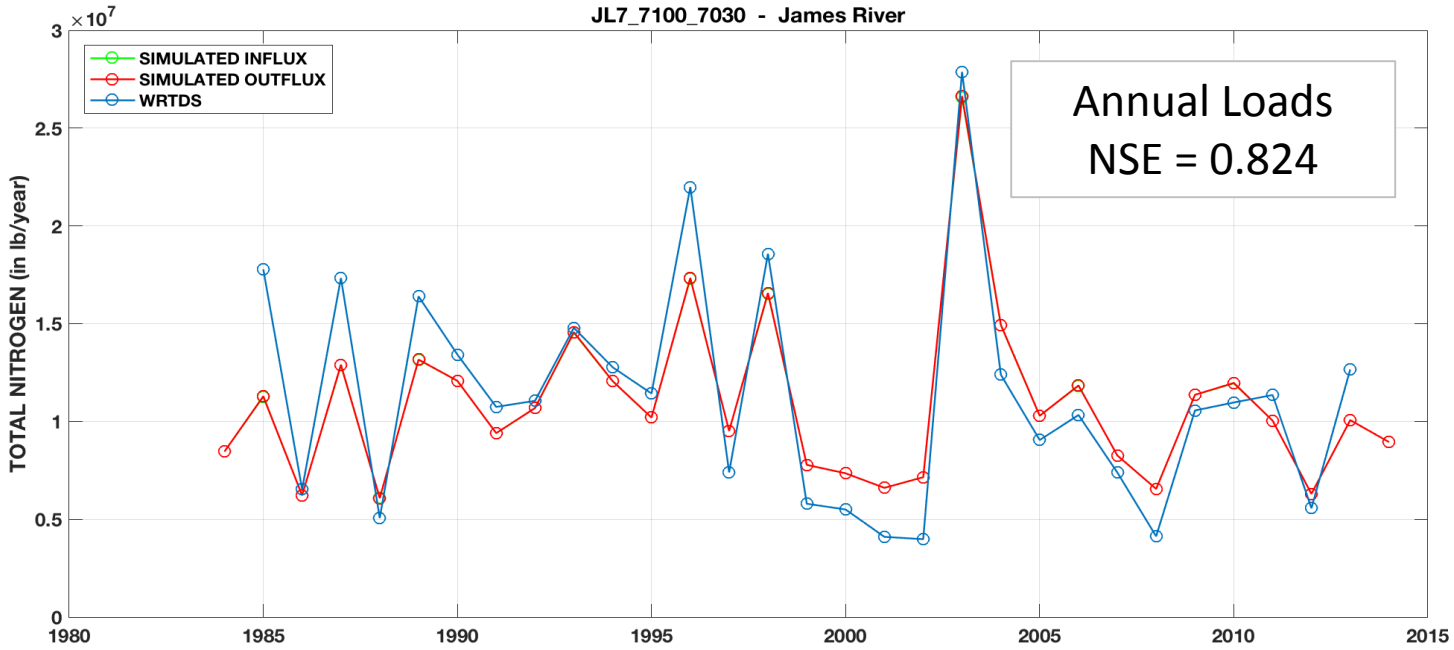
NITRATE


JL7_7100_7030 - James River
×10^5
SIMULATED INFLUX
SIMULATED OUTFLUX
WRTDS
Monthly Loads
NSE = 0.808
NITRATE (in lb/month)
0
2
4
6
8
10
12
14
16
18
1980
1985
1990
1995
2000
2005
2010
2015


JL7_7100_7030 - James River
×10^6
SIMULATED INFLUX
SIMULATED OUTFLUX
WRTDS
Annual Loads
NSE = 0.755
NITRATE (in lb/year)
1
2
3
4
5
6
7
8
9
1980
1985
1990
1995
2000
2005
2010
2015

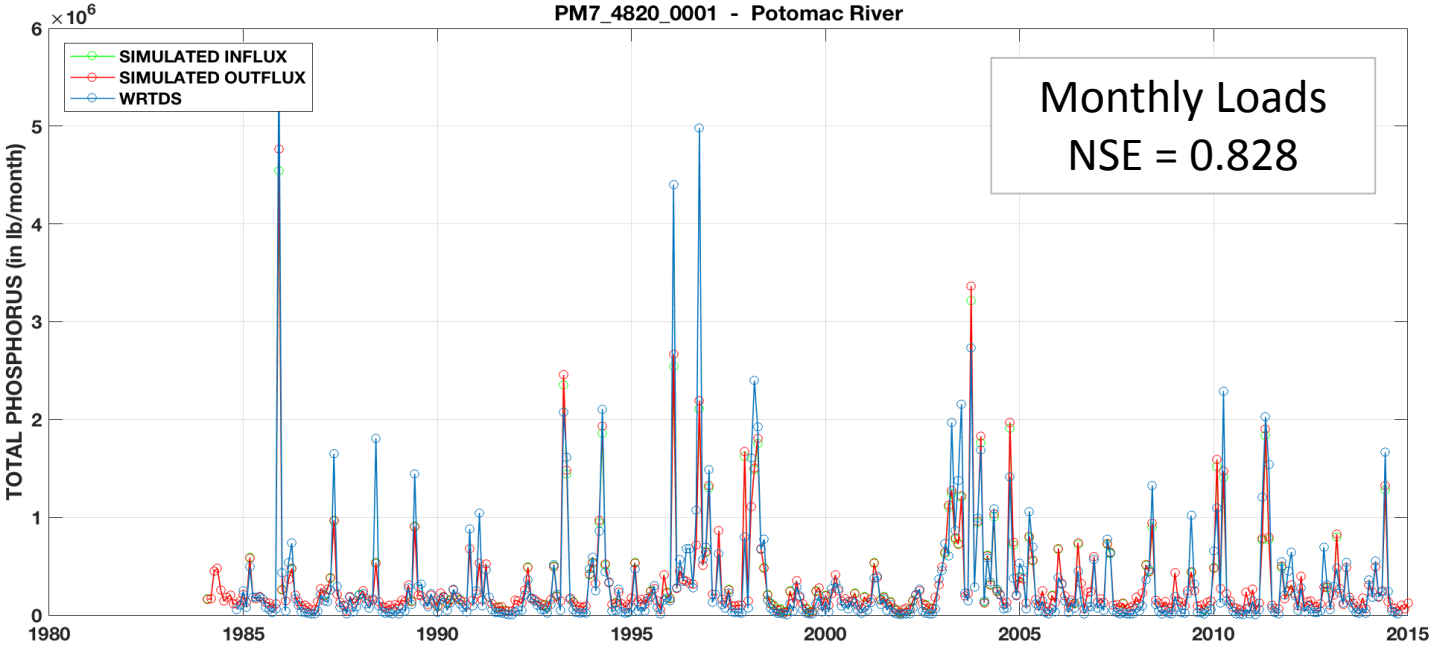
NITROGEN

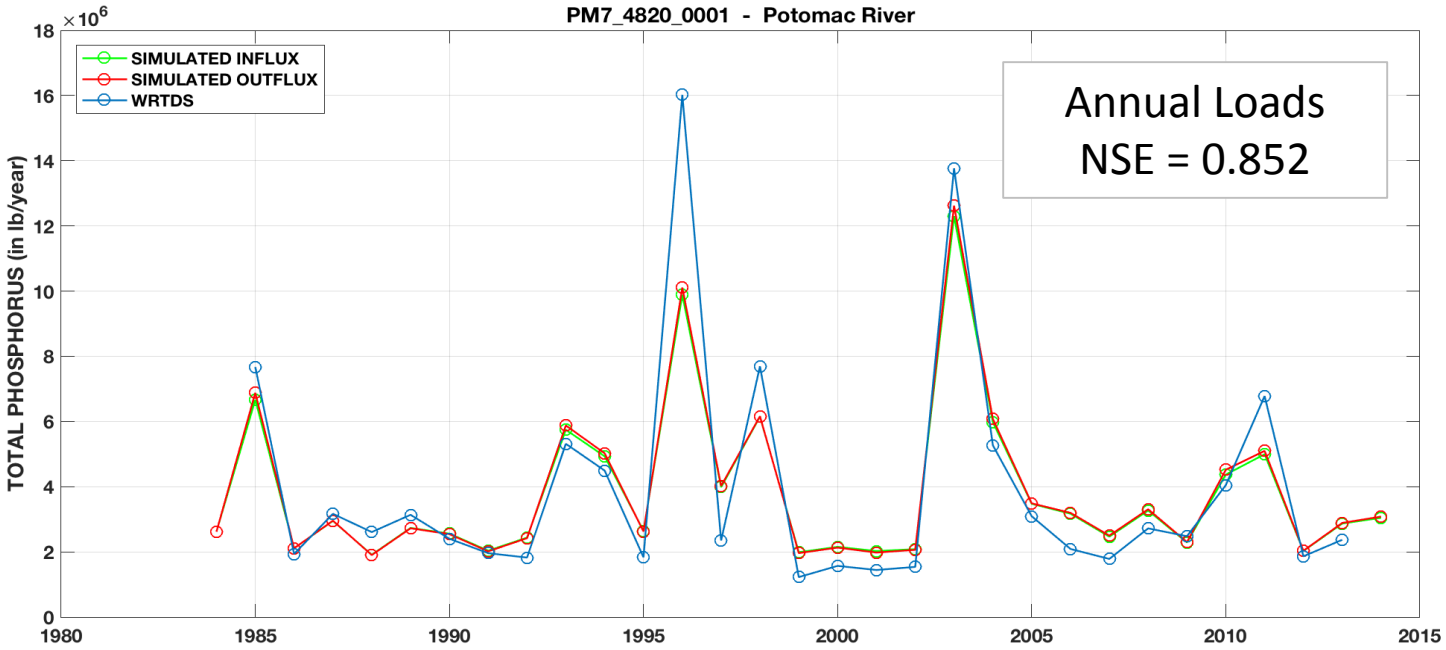




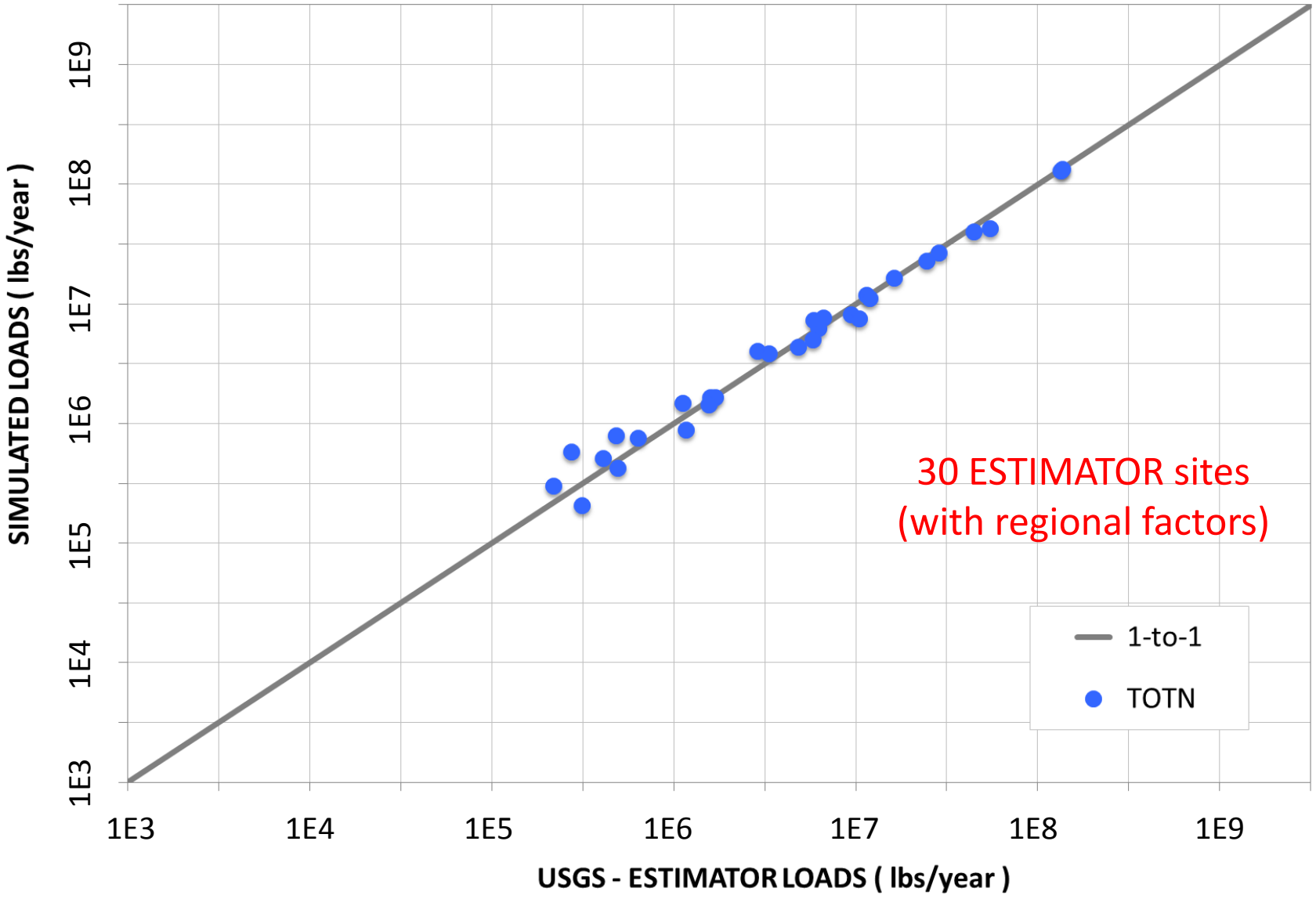
http://cast-beta.chesapeakebay.net/documentation/NonTidalWaterQualityDashboard

PHOSPHOURS





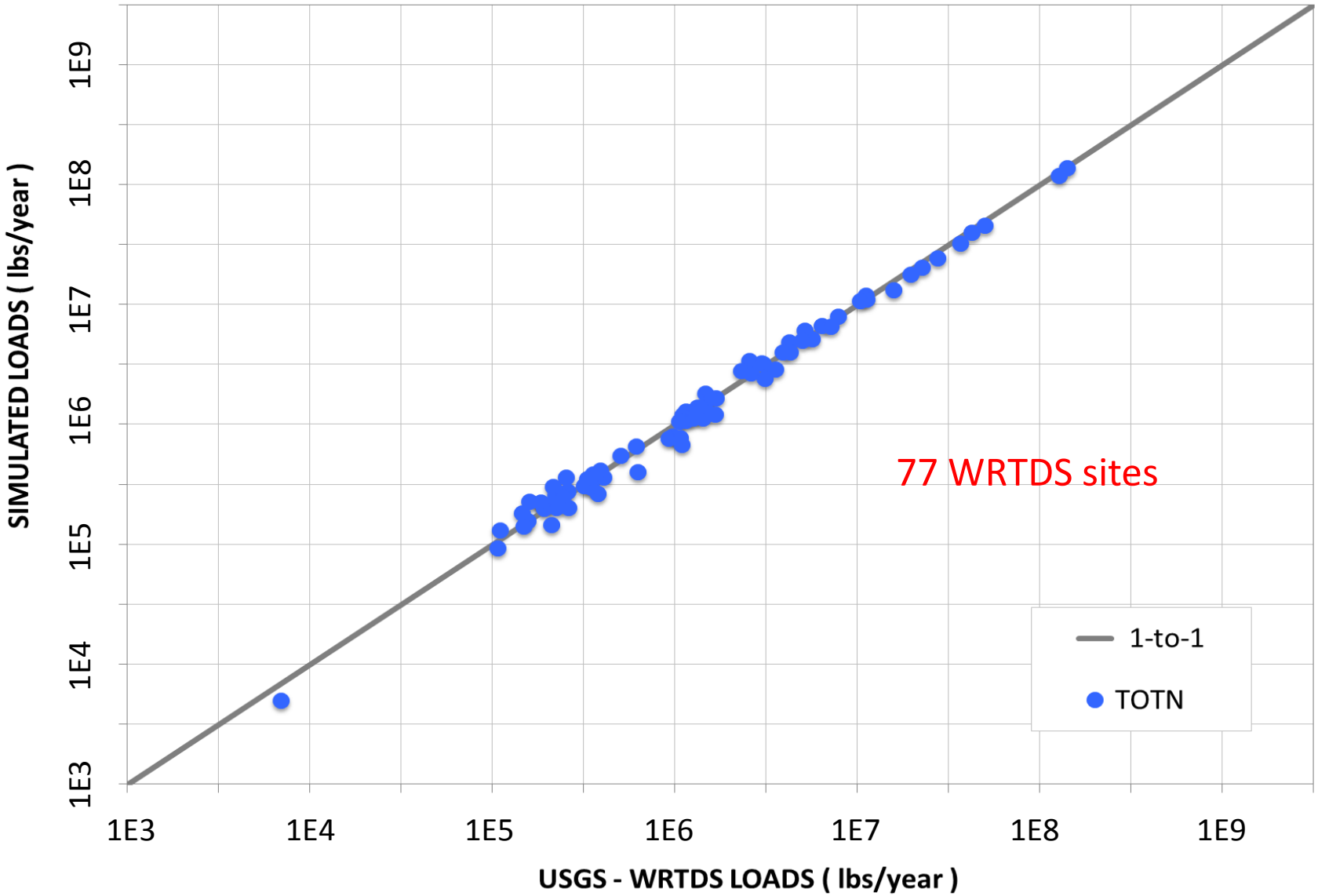
http://cast-beta.chesapeakebay.net/documentation/NonTidalWaterQualityDashboard


SIMULATED LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
USGS - ESTIMATOR LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
30 ESTIMATOR sites
(with regional factors)
1-to-1
TOTN

DRAFT G

Revised inputs, model refinements, and calibration methods

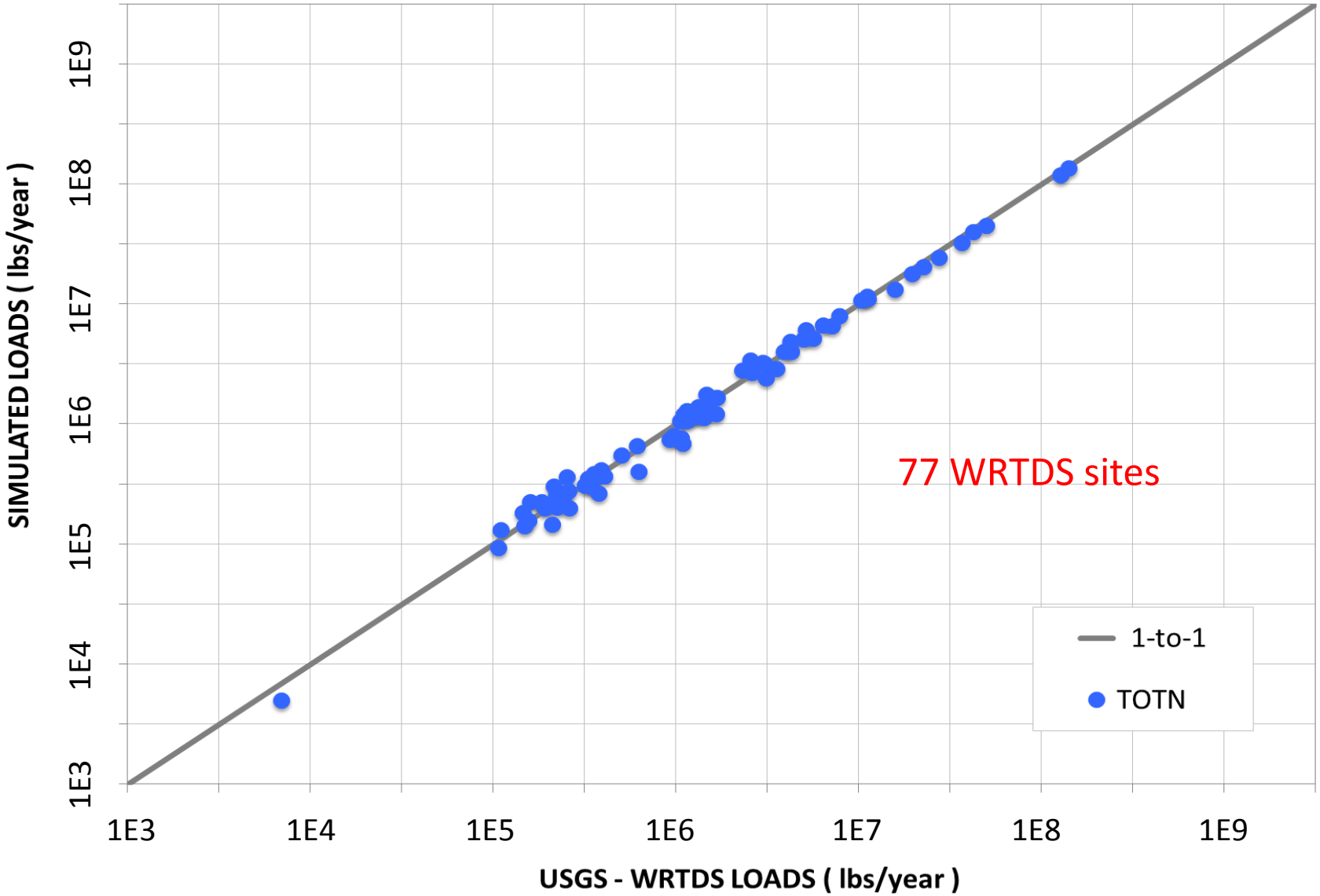
NITROGEN

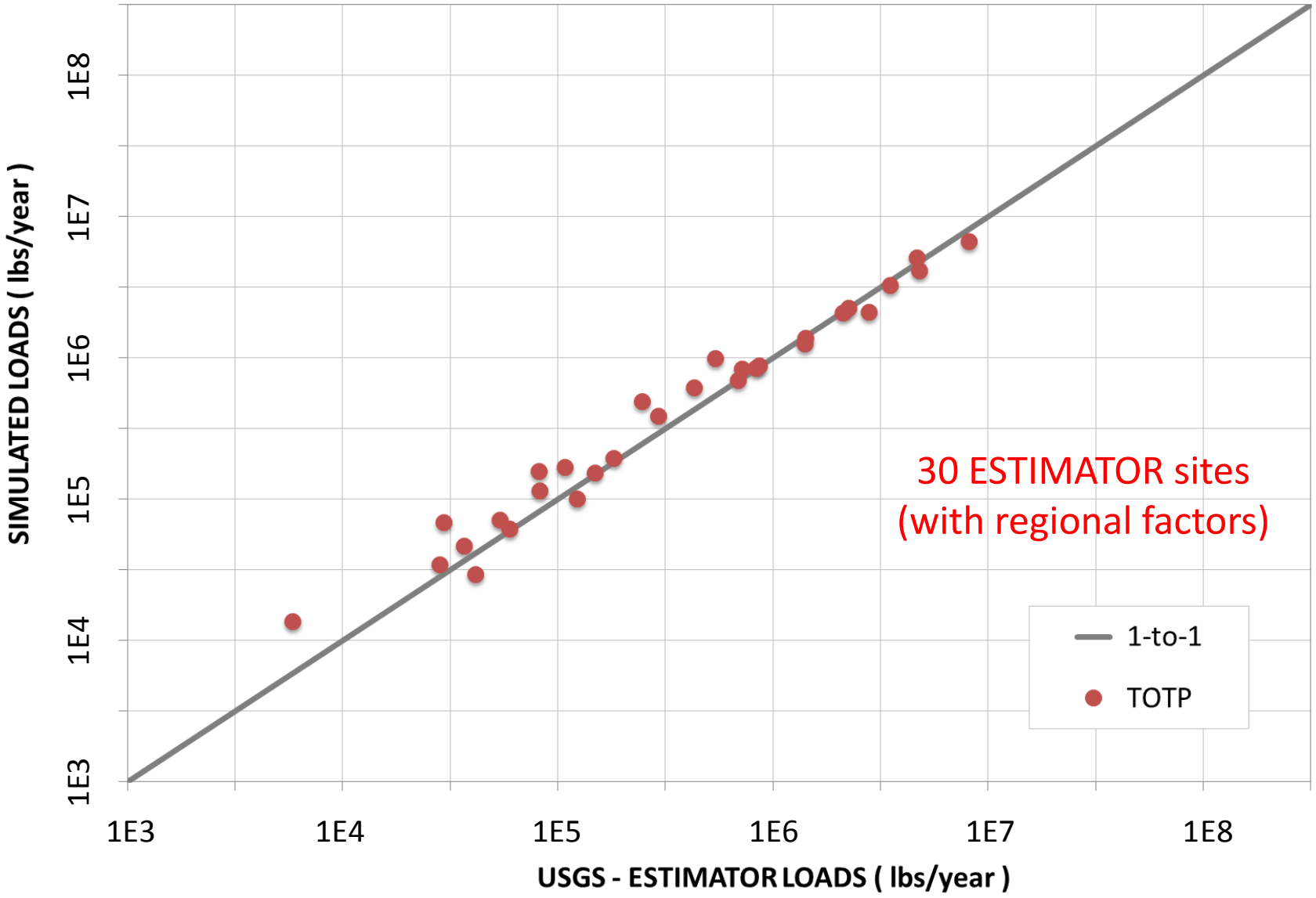


DRAFT P6

Lower Susquehanna Reservoirs, Conowingo Infill, and point-sources

NITROGEN

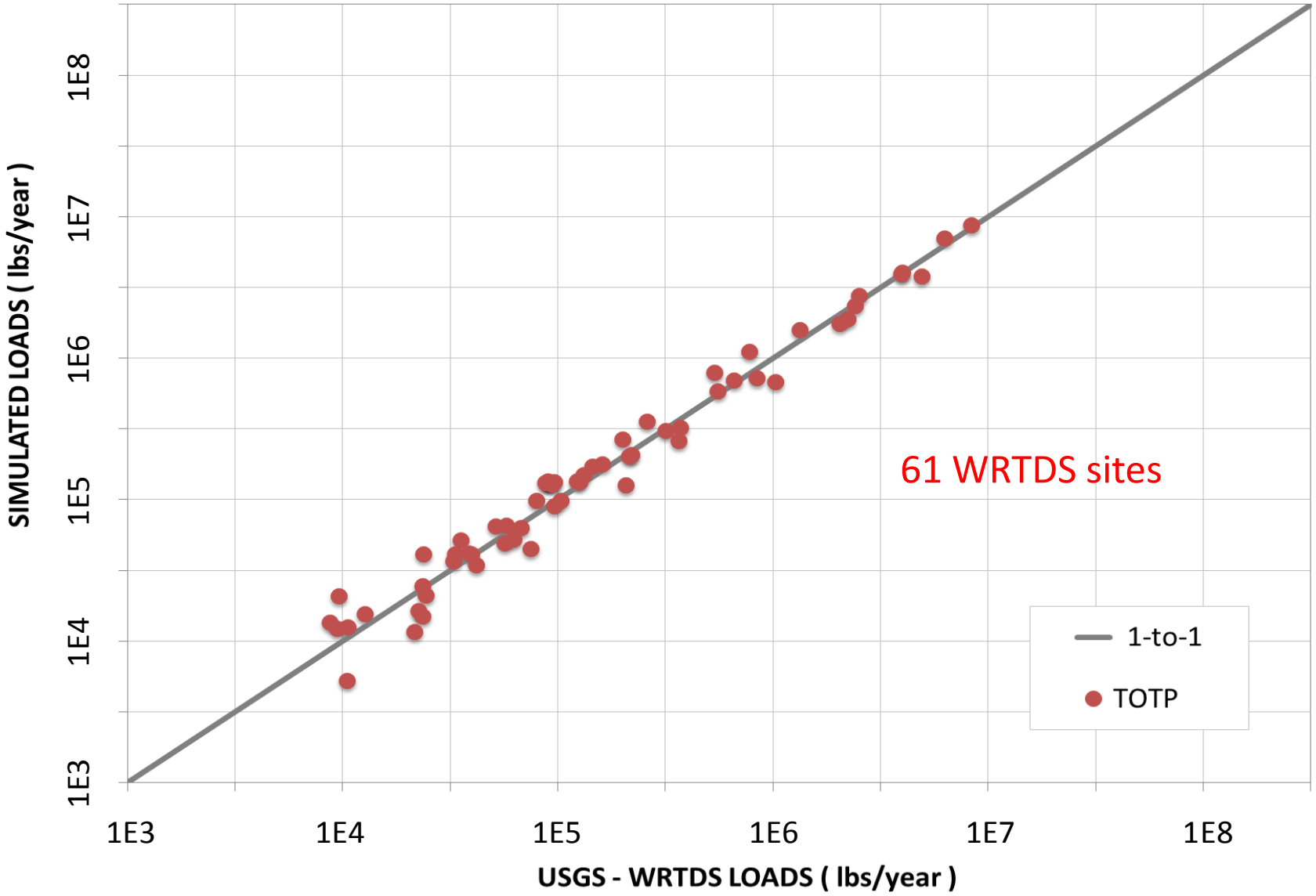



SIMULATED LOADS (lbs/year)
1E8
1E7
1E6
1E5
1E4
1E3
1E3
1E4
1E5
1E6
1E7
1E8
USGS - ESTIMATOR LOADS (lbs/year)
30 ESTIMATOR sites
(with regional factors)
1-to-1
TOTP

DRAFT G

Revised inputs, model refinements, and calibration methods

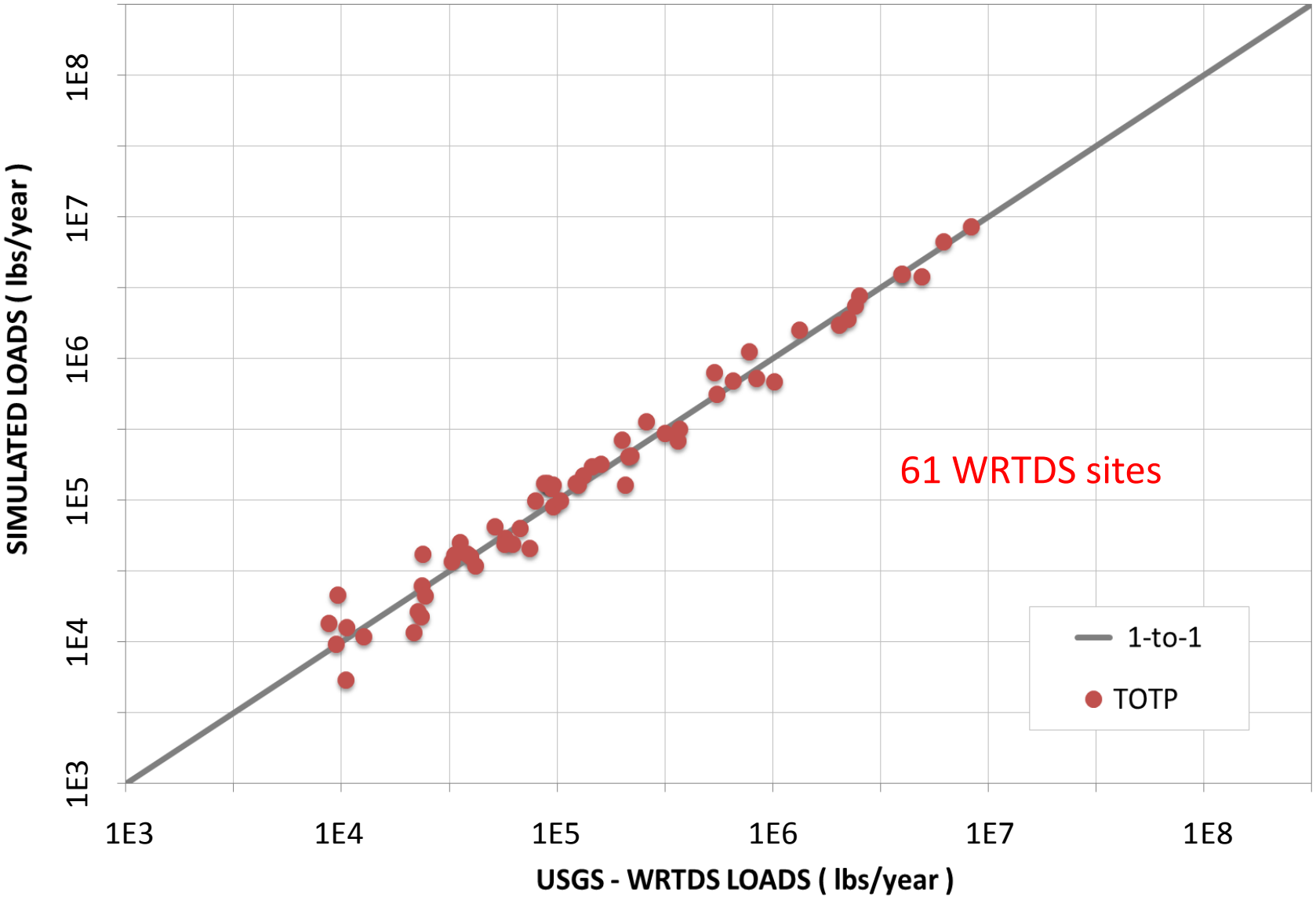
PHOSPHORUS

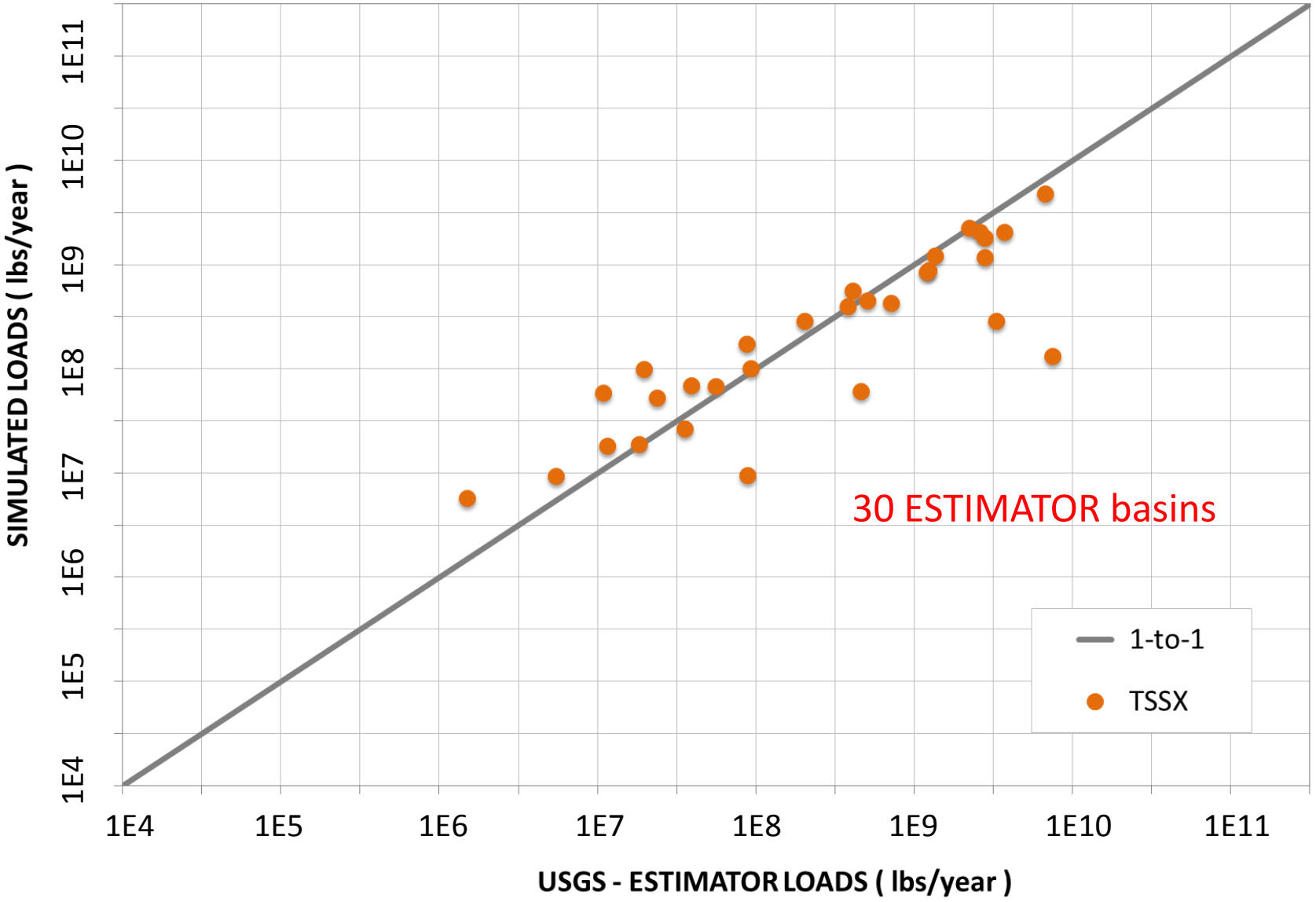


DRAFT P6

Lower Susquehanna Reservoirs, Conowingo Infill, and point-sources

PHOSPHORUS

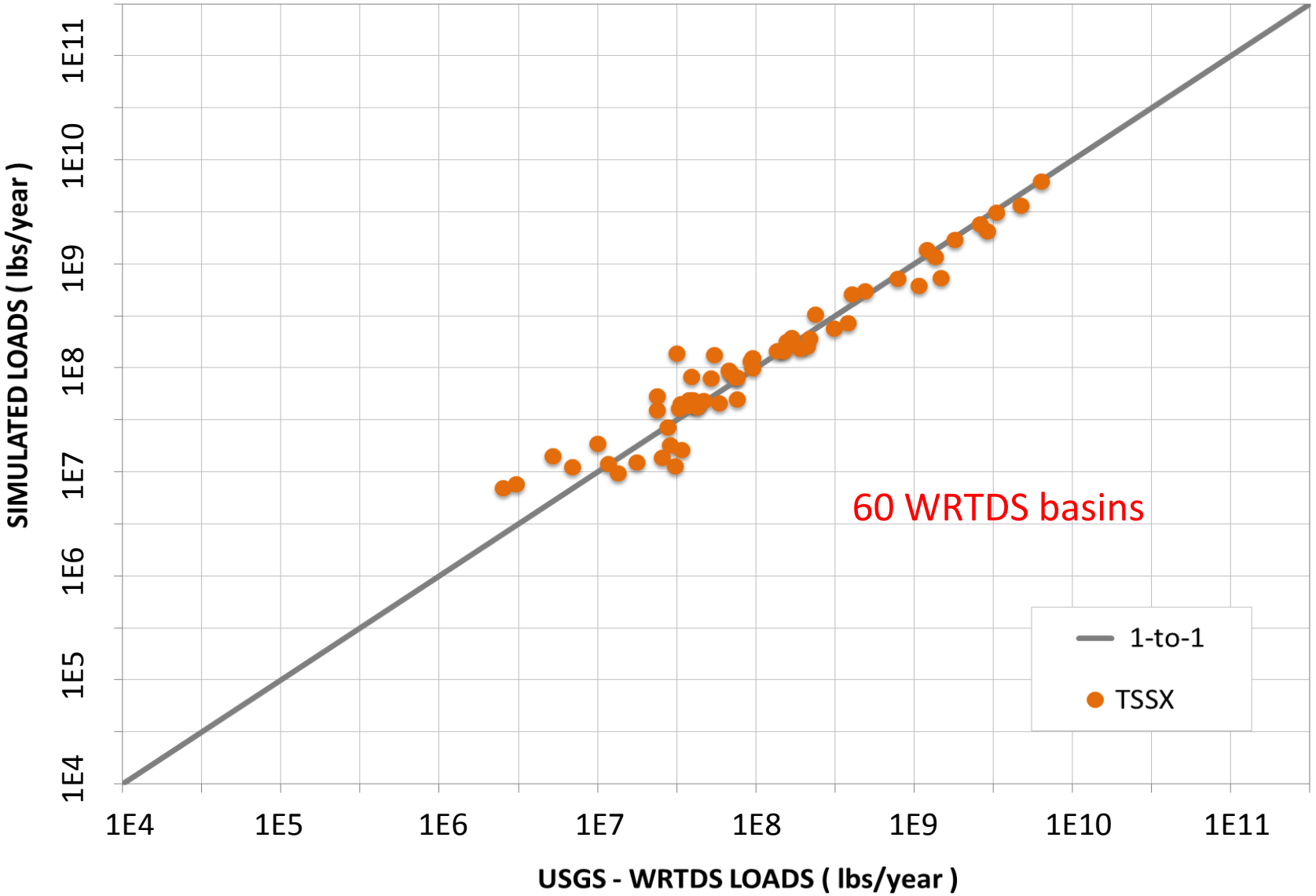


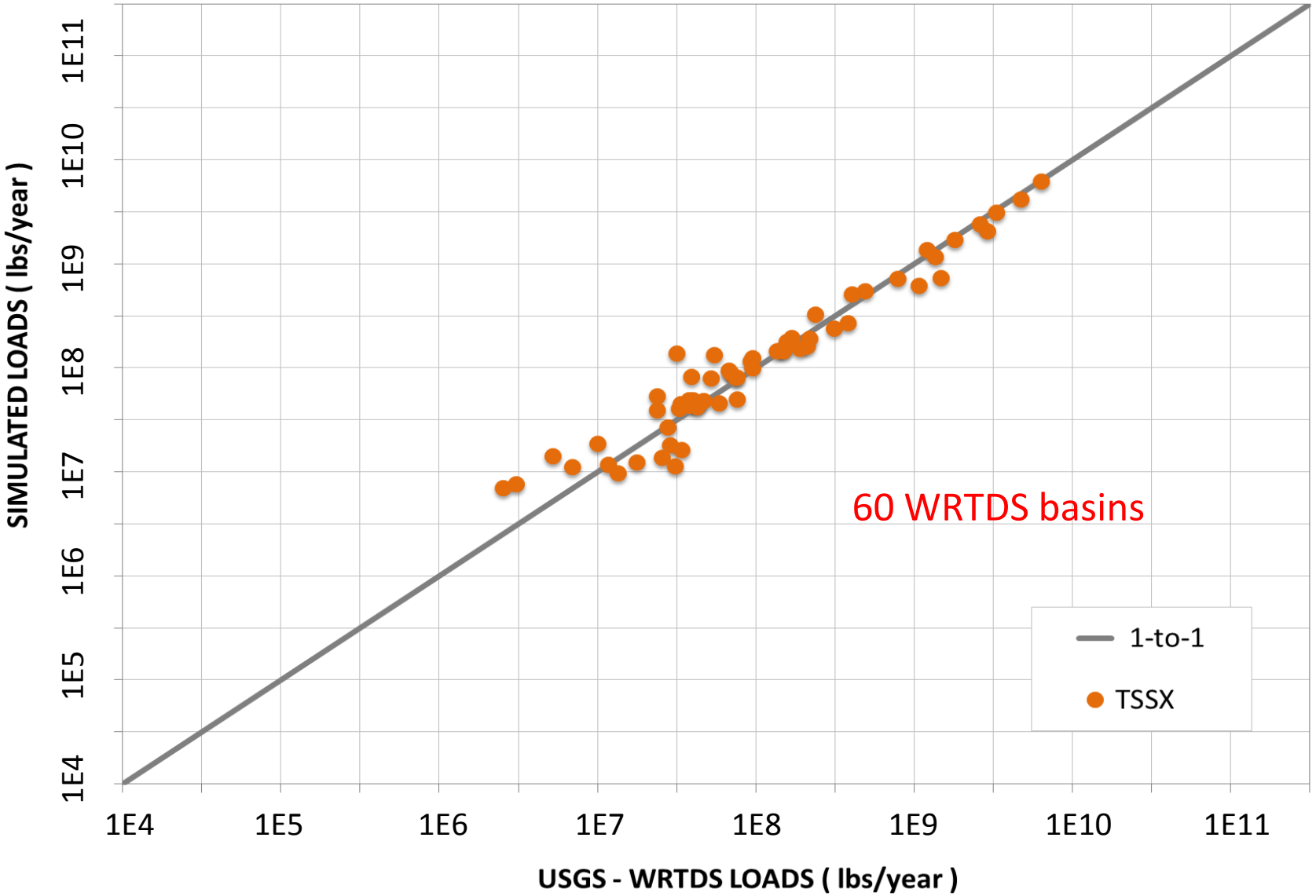

SIMULATED LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
USGS - ESTIMATOR LOADS (lbs/year)
30 ESTIMATOR basins
1-to-1
TSSX

DRAFT G

Revised inputs, model refinements, and calibration methods

SEDIMENT

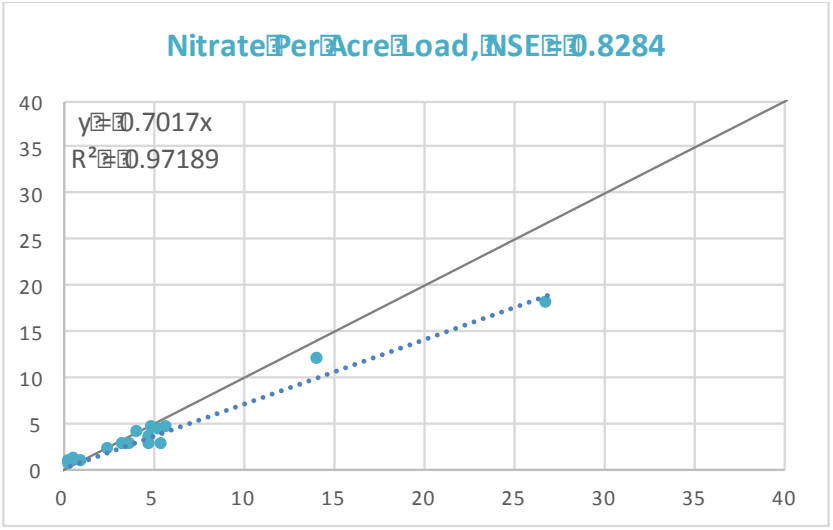


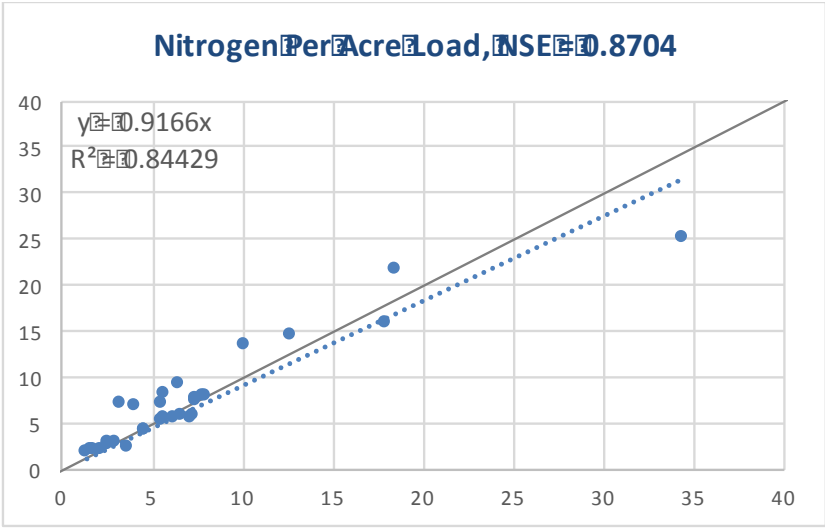

SIMULATED LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
USGS - WRTDS LOADS (lbs/year)
1E4
1E5
1E6
1E7
1E8
1E9
1E10
1E11
60 WRTDS basins
1-to-1
TSSX

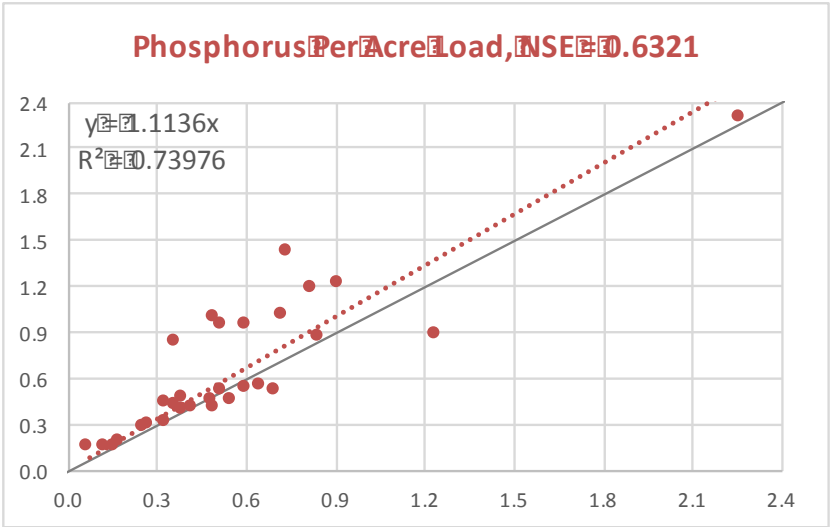
Review of geographic efficiencies

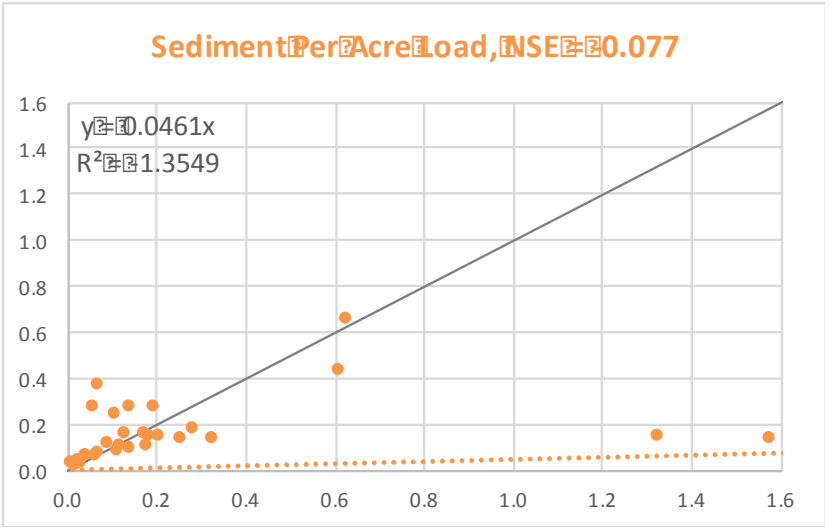
- WRTDS and simulated per acre loads are compared.
- The Nash-Sutcliffe model efficiency was used to quantify the predictive power of the model across the watershed.
- An efficiency of 1 would indicate a perfect match in loads for all river basins (where WRTDS estimates are available).

Phase 5 – geographic efficiencies





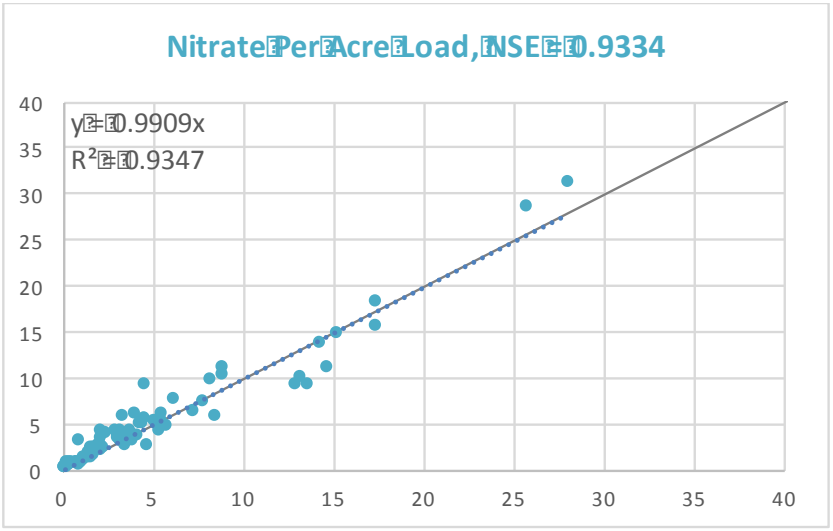


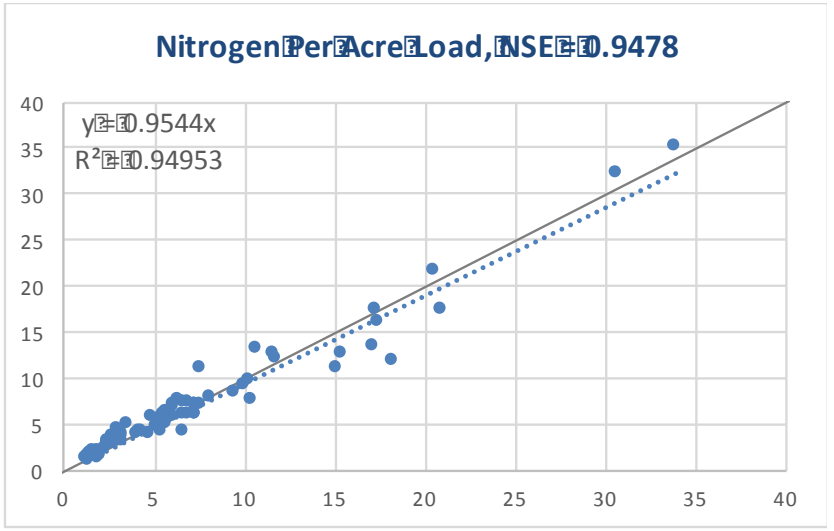


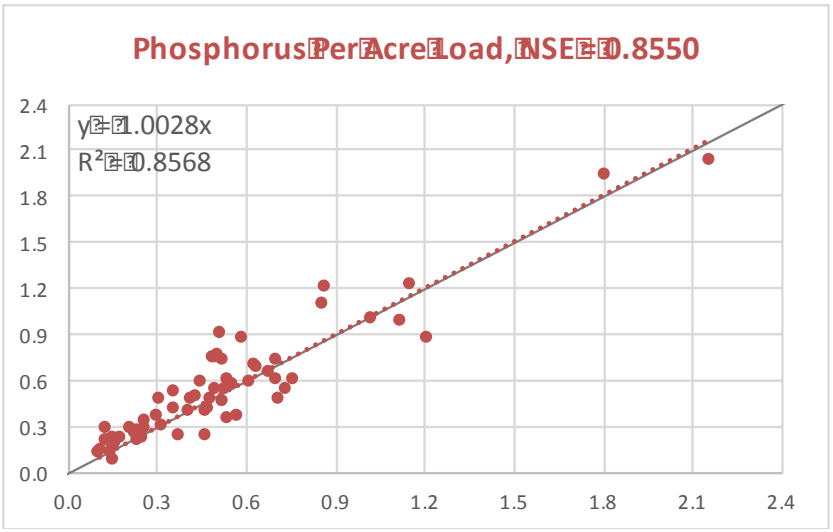
Simulated Per Acre Load

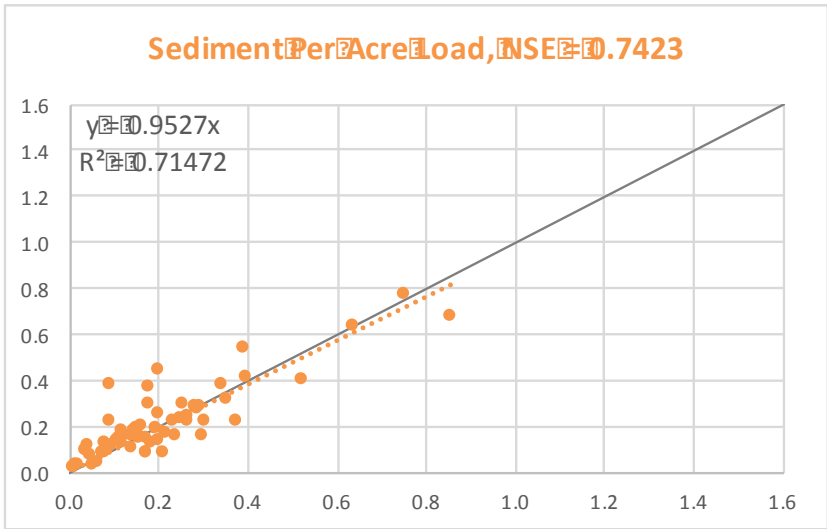
WRTDS Per Acre Load

DRAFT G – geographic efficiencies





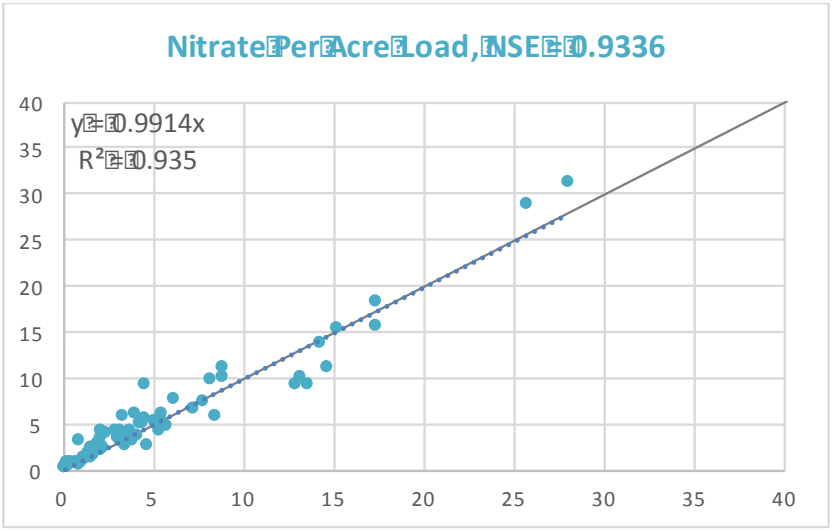


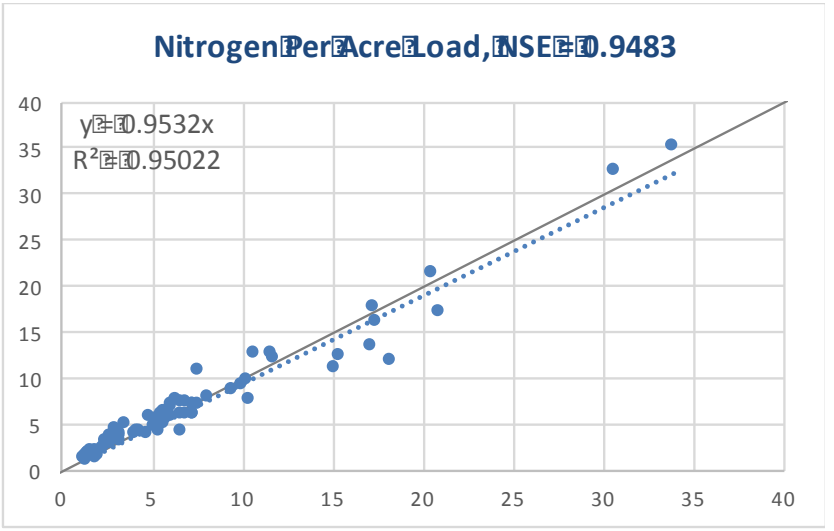


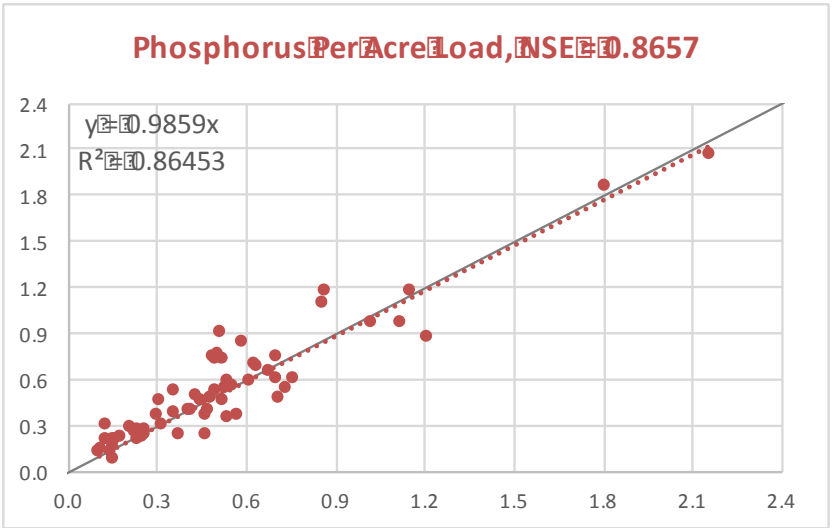
Simulated Per Acre Load

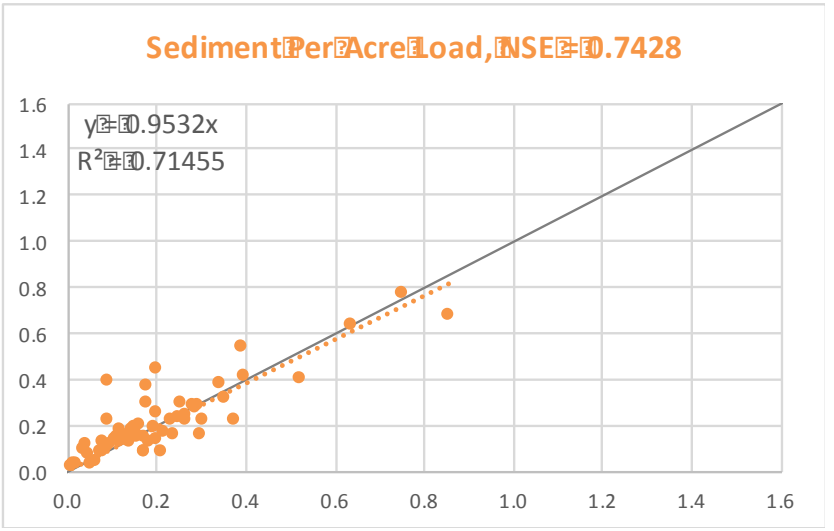
WRTDS Per Acre Load

DRAFT P6 – geographic efficiencies









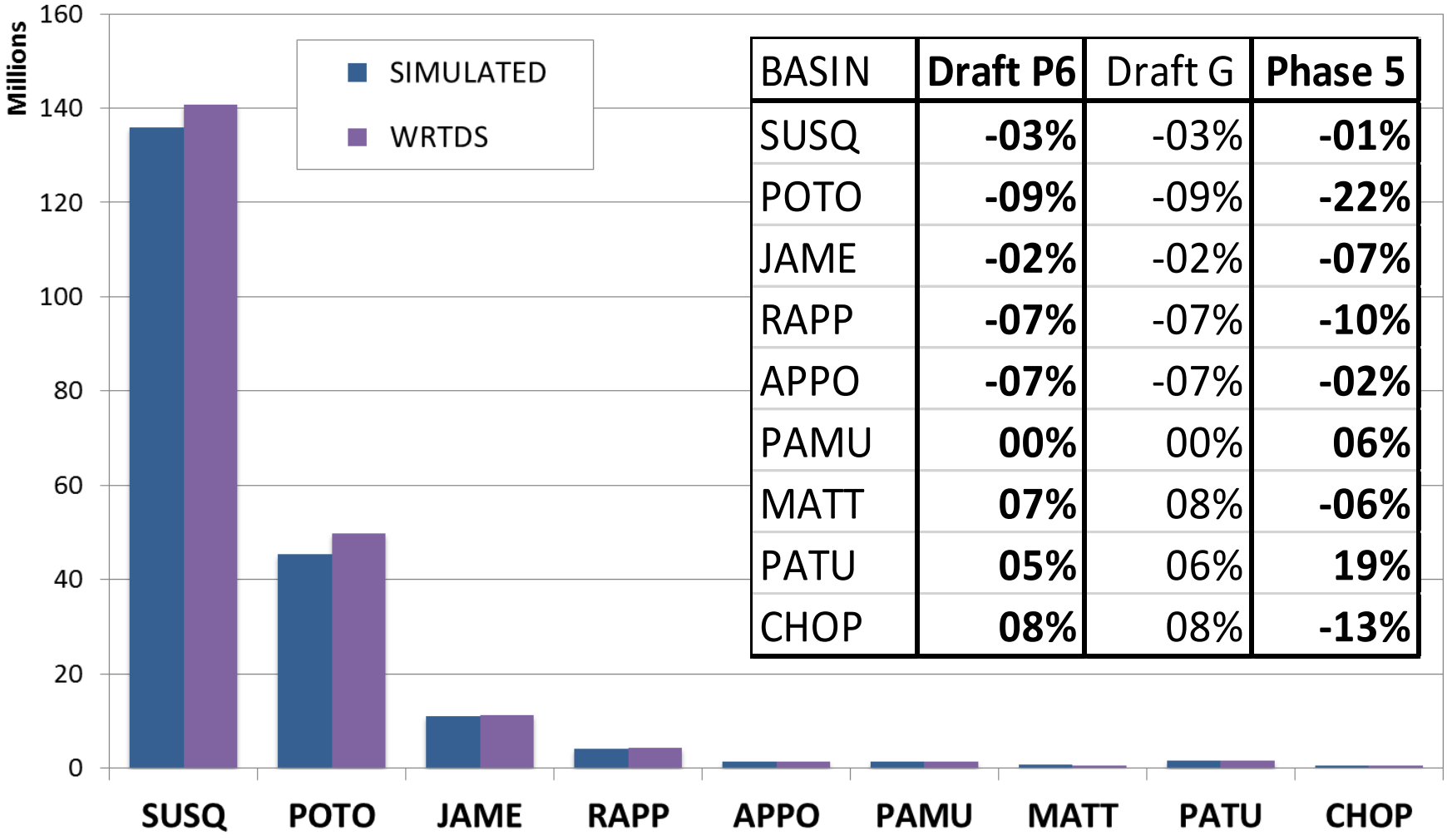
Simulated Per Acre Load

WRTDS Per Acre Load

The summary of geographic efficiencies

Constituents	**Phase 5**	**Draft G**	**Draft P6**
Nitrate	0.8284	0.9334	0.9336
Nitrogen	0.8704	0.9478	0.9483
Phosphorus	0.6321	0.8550	0.8657
Sediment	-0.0770	0.7423	0.7428

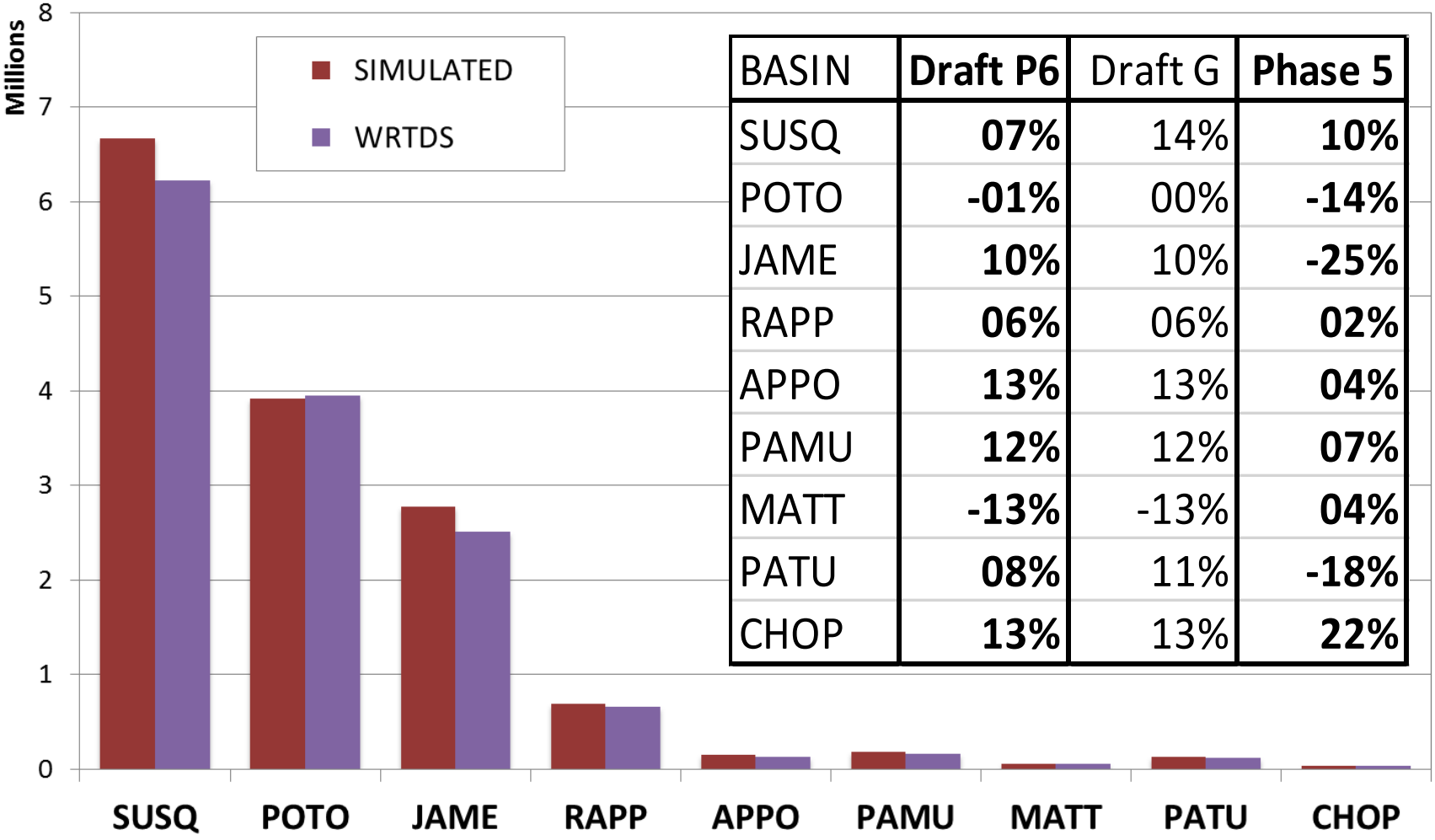
RIM loads: total nitrogen



BASIN	**Draft P6**	Draft G	**Phase 5**
SUSQ	**-03%**	-03%	**-01%**
POTO	**-09%**	-09%	**-22%**
JAME	**-02%**	-02%	**-07%**
RAPP	**-07%**	-07%	**-10%**
APPO	**-07%**	-07%	**-02%**
PAMU	**00%**	00%	**06%**
MATT	**07%**	08%	**-06%**
PATU	**05%**	06%	**19%**
CHOP	**08%**	08%	**-13%**

assuming +/- 10% uncertainty in WRTDS estimates

RIM loads: total phosphorus



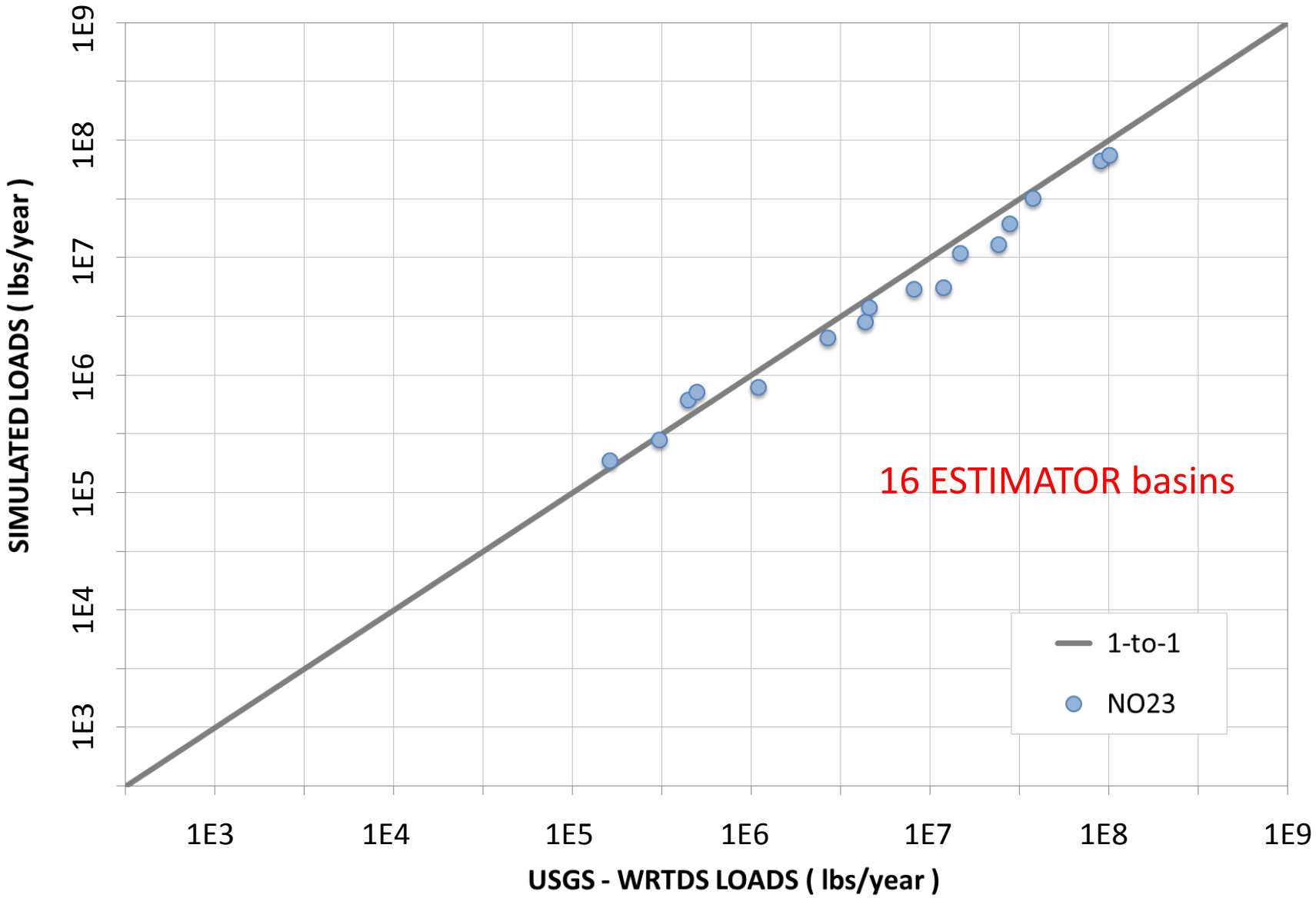
BASIN	**Draft P6**	Draft G	**Phase 5**
SUSQ	**07%**	14%	**10%**
POTO	**-01%**	00%	**-14%**
JAME	**10%**	10%	**-25%**
RAPP	**06%**	06%	**02%**
APPO	**13%**	13%	**04%**
PAMU	**12%**	12%	**07%**
MATT	**-13%**	-13%	**04%**
PATU	**08%**	11%	**-18%**
CHOP	**13%**	13%	**22%**

assuming +/- 15% uncertainty in WRTDS estimates

Summary and Conclusions

- The development of the Draft Phase 6 Watershed Model was completed, and overall improvements in the model performance were reviewed.
- The watershed model outputs were processed and shipped off for the Water Quality and Sediment Transport Model calibration, along with the updated atmospheric deposition data.
- The modeling team is reviewing the Draft Phase 6 calibration, and review comments are awaited to assess necessary updates.

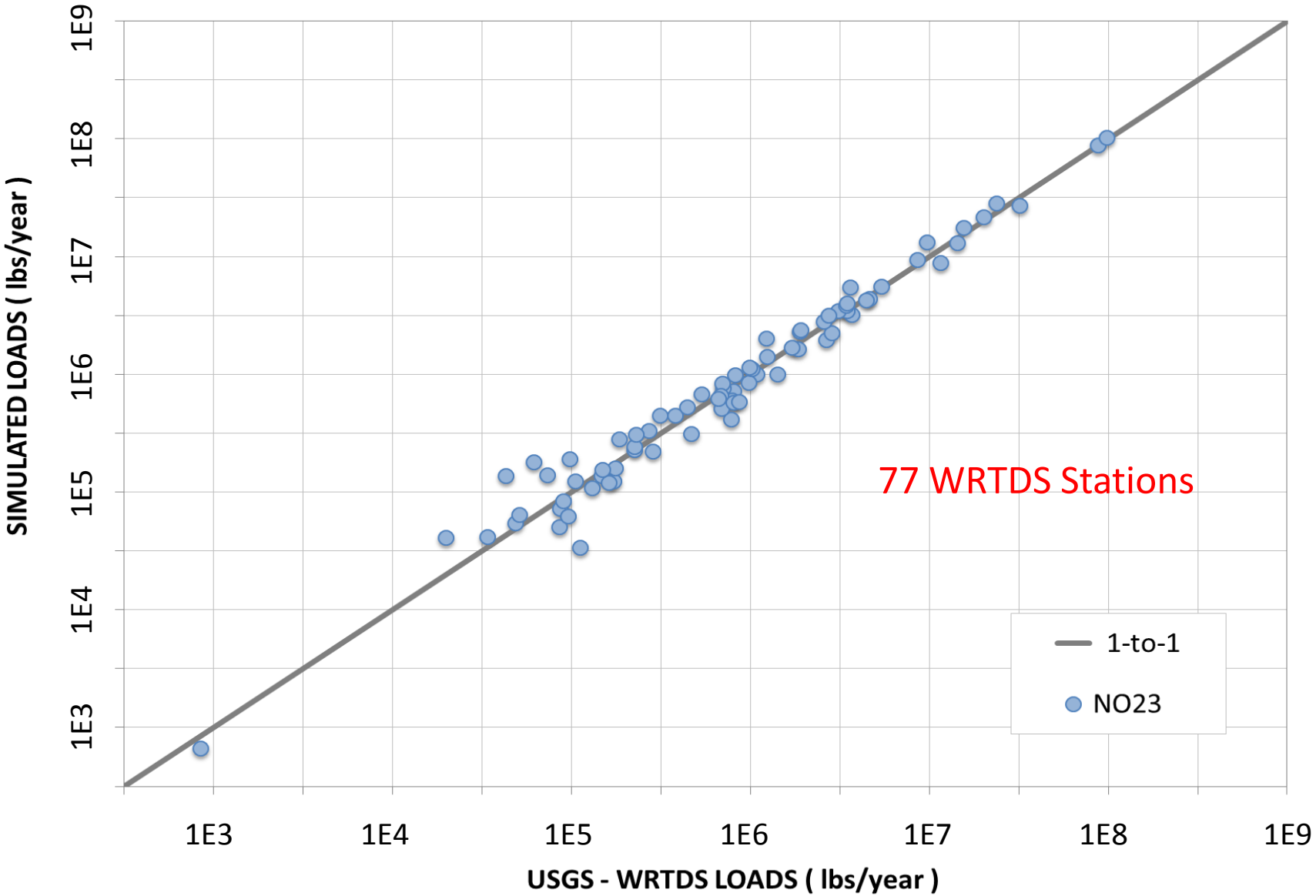
Appendices


SIMULATED LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
USGS - WRTDS LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
16 ESTIMATOR basins
1-to-1
NO23

DRAFT G

Revised inputs, model refinements, and calibration methods

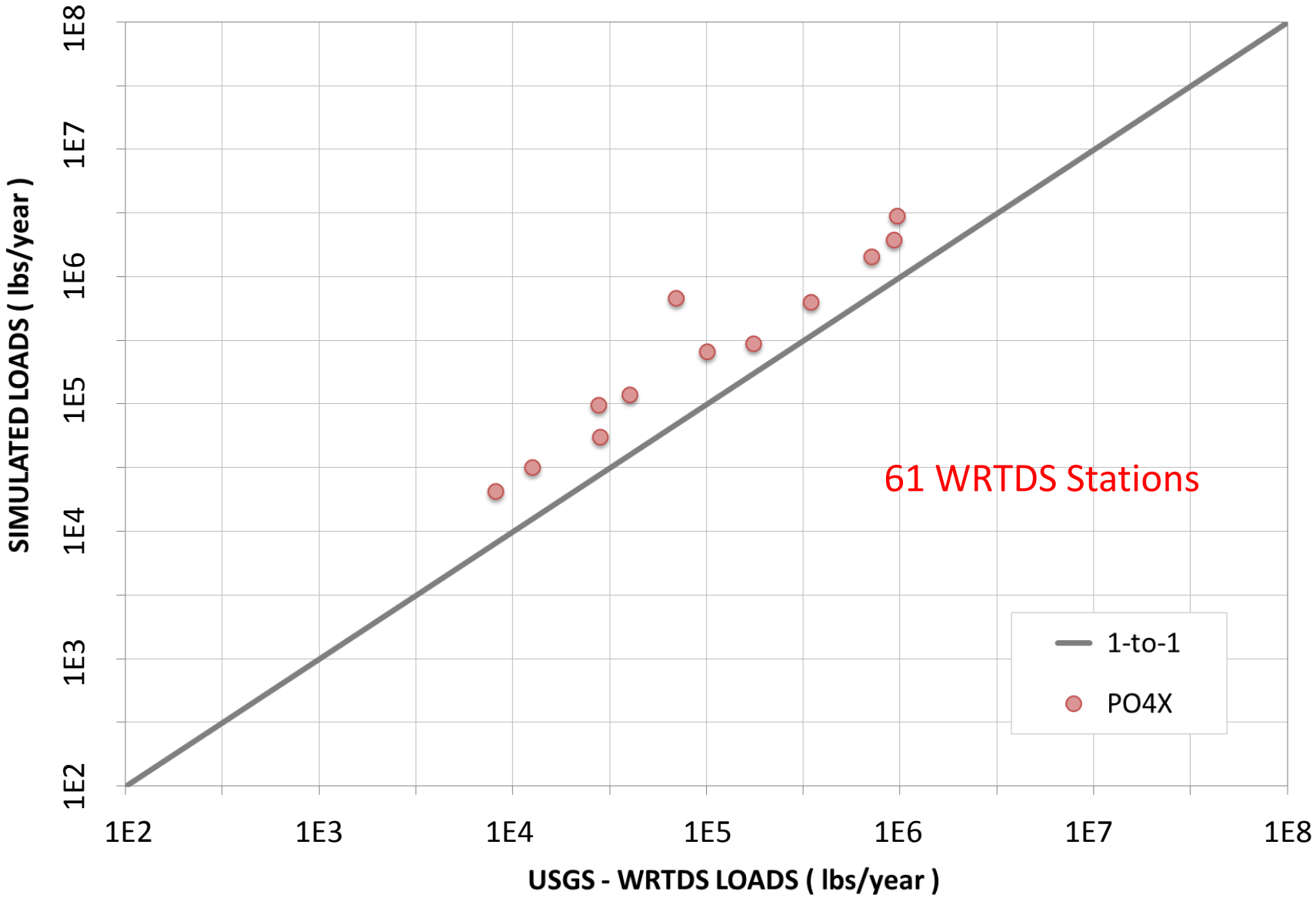
NITRATE



PHASE 5

Phase 5.3.2

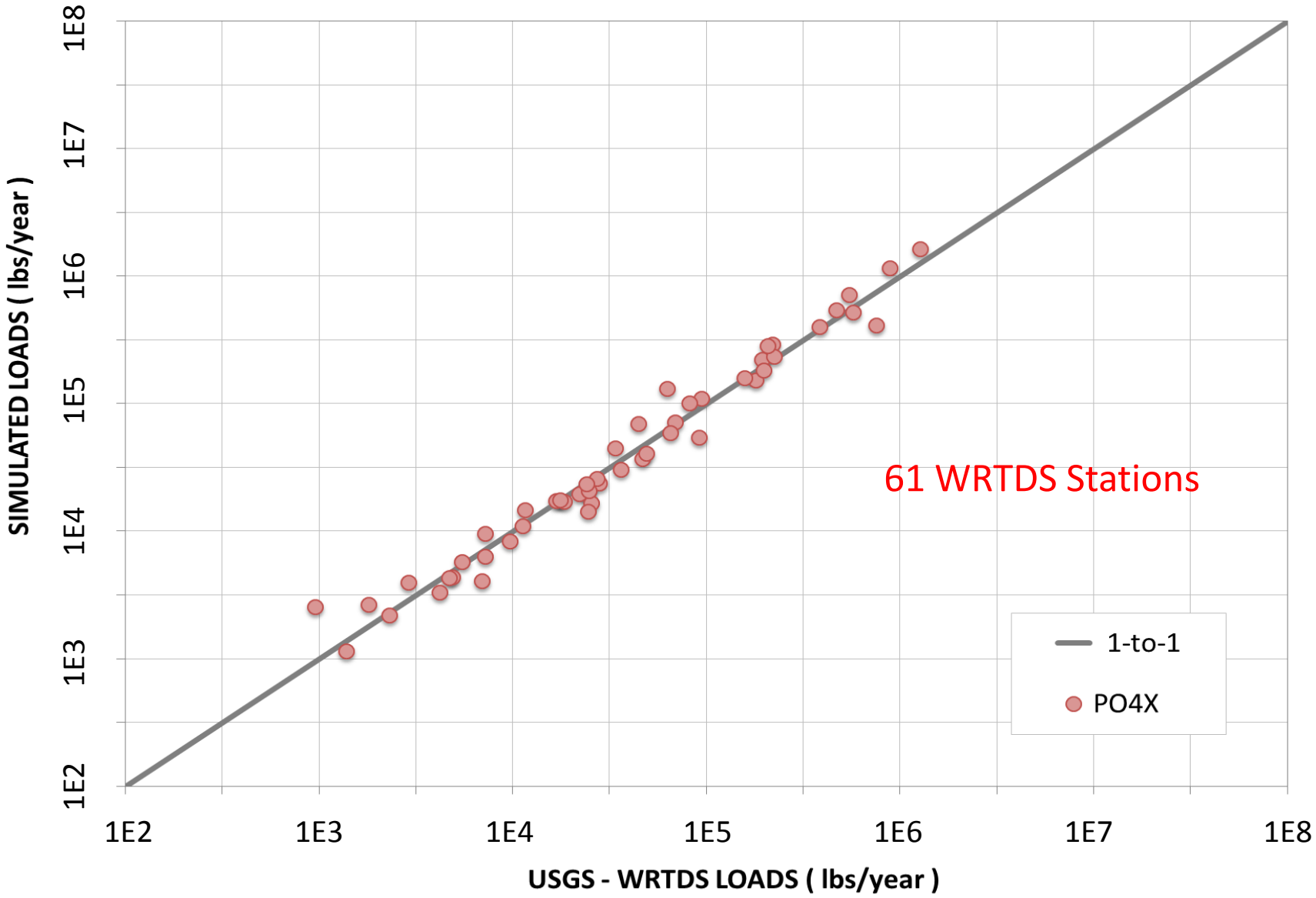
DISSOLVED PHOSPHATE



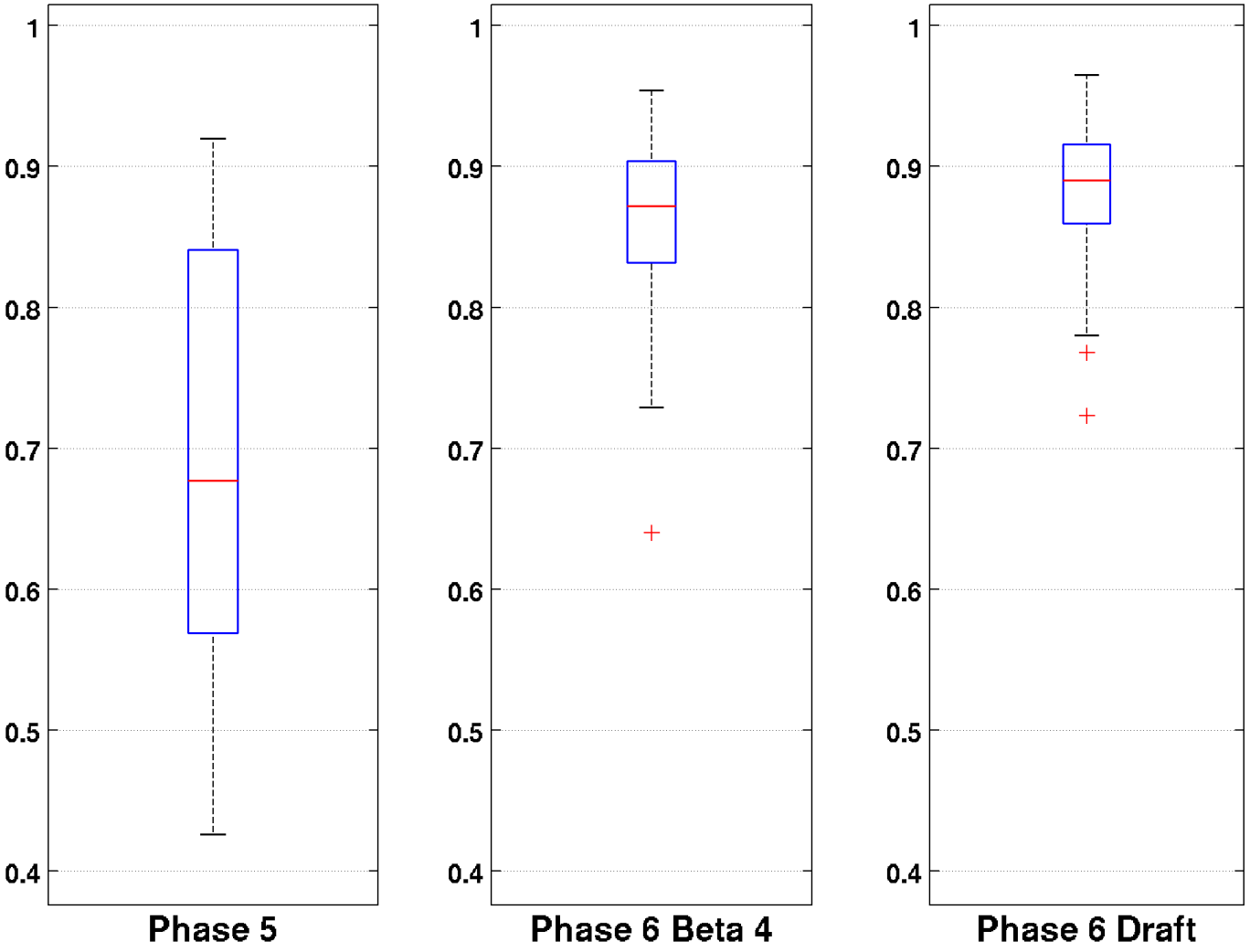
DRAFT G

Revised inputs, model refinements, and calibration methods

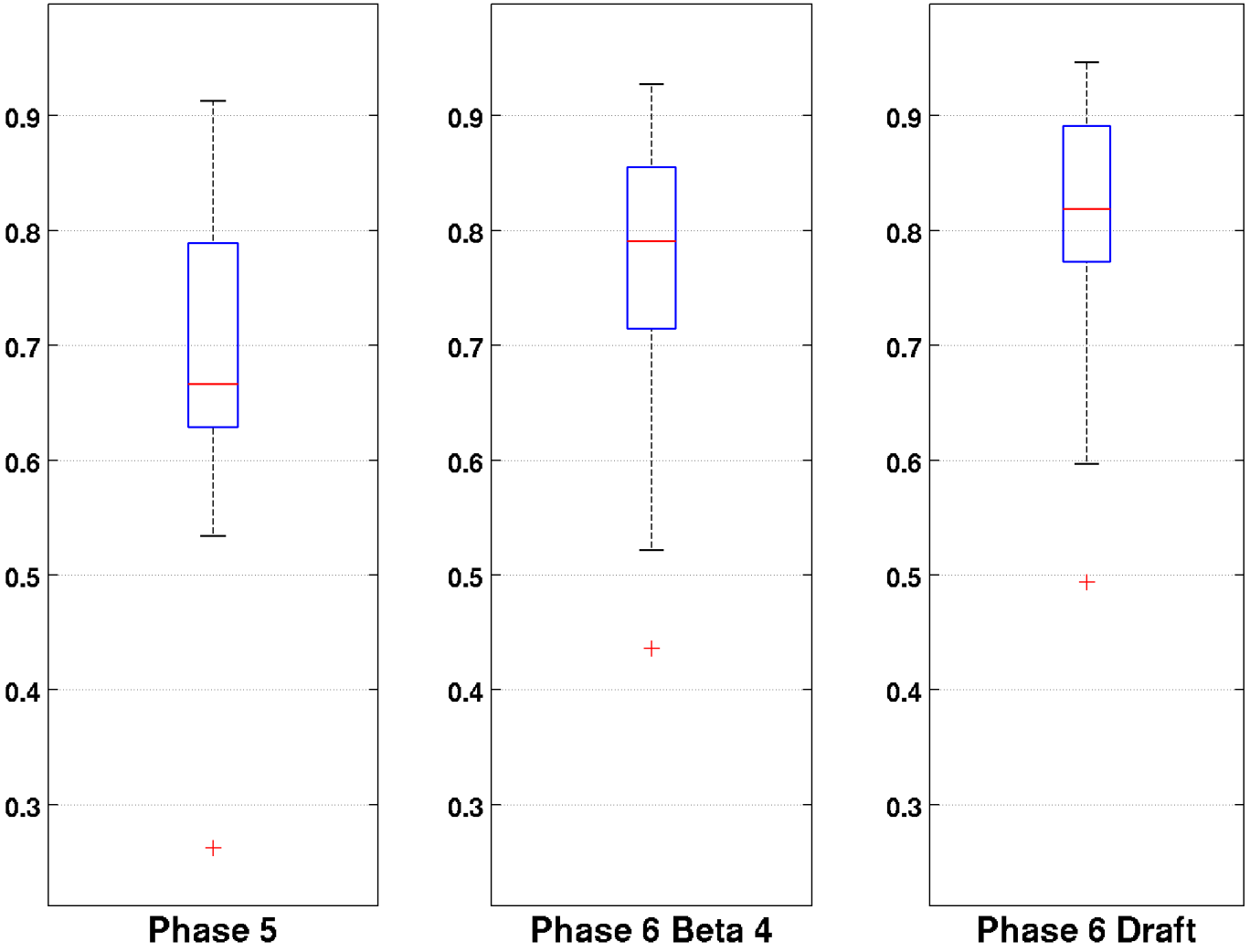
DISSOLVED PHOSPHATE



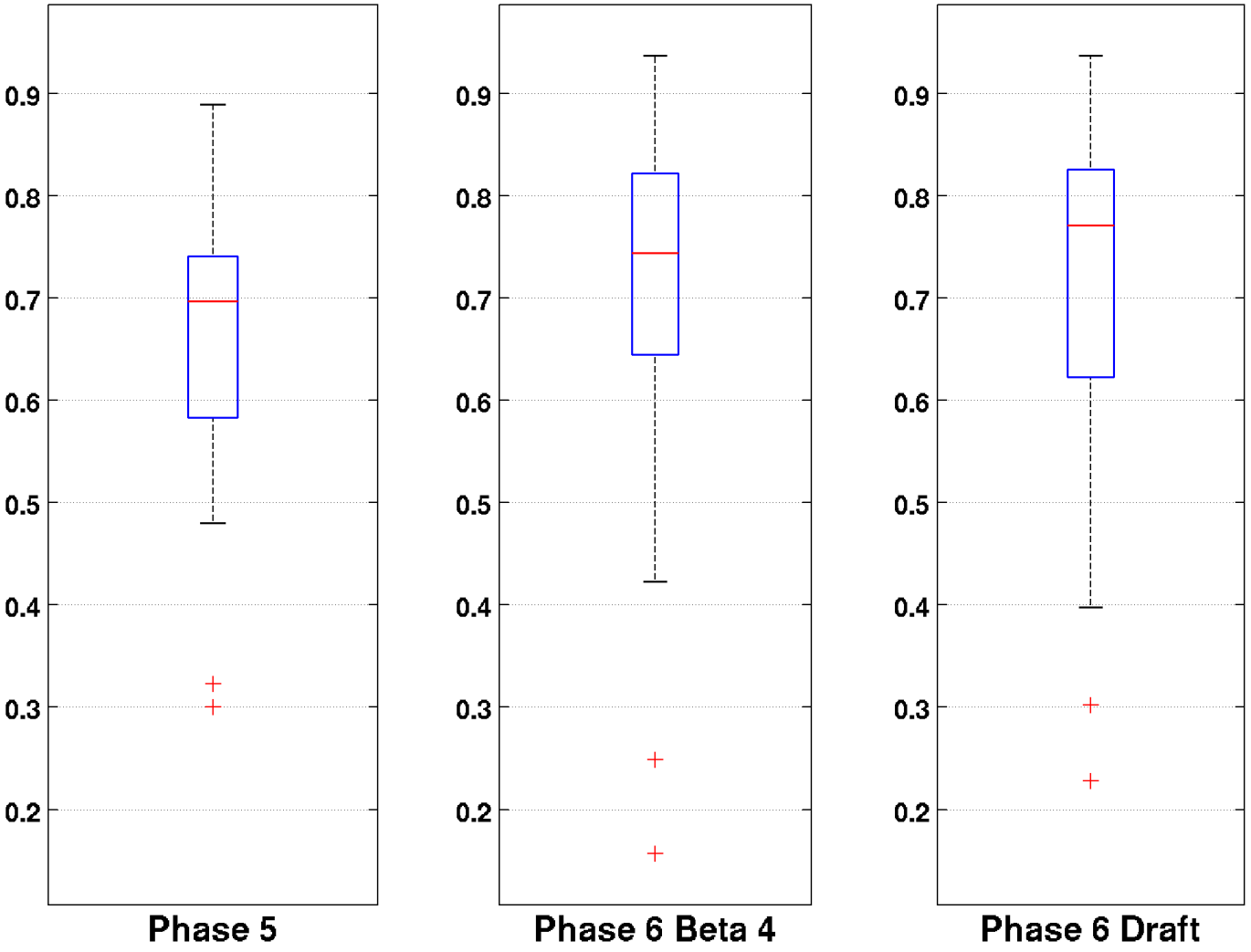
Monthly loads: total nitrogen



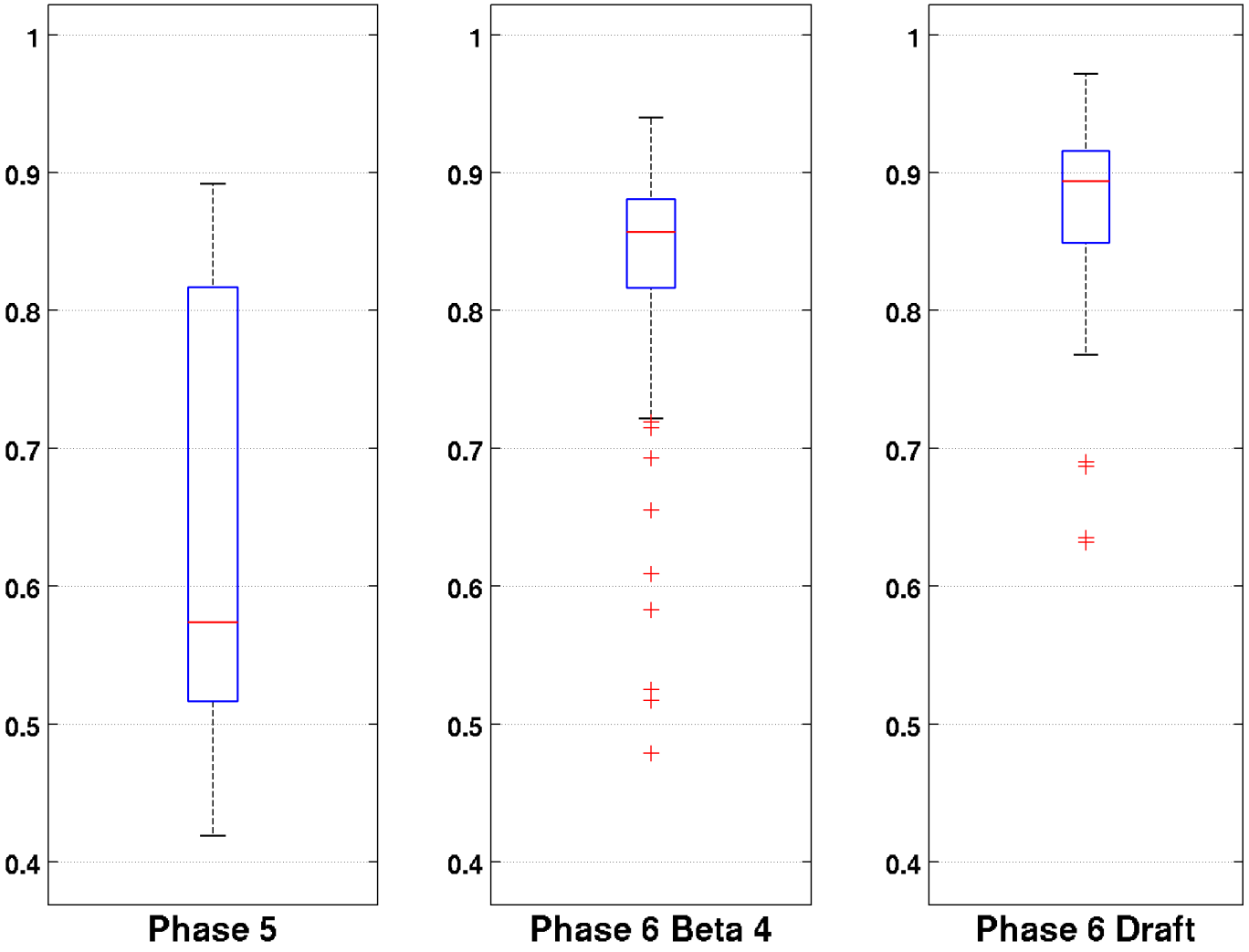
Monthly loads: total phosphorus



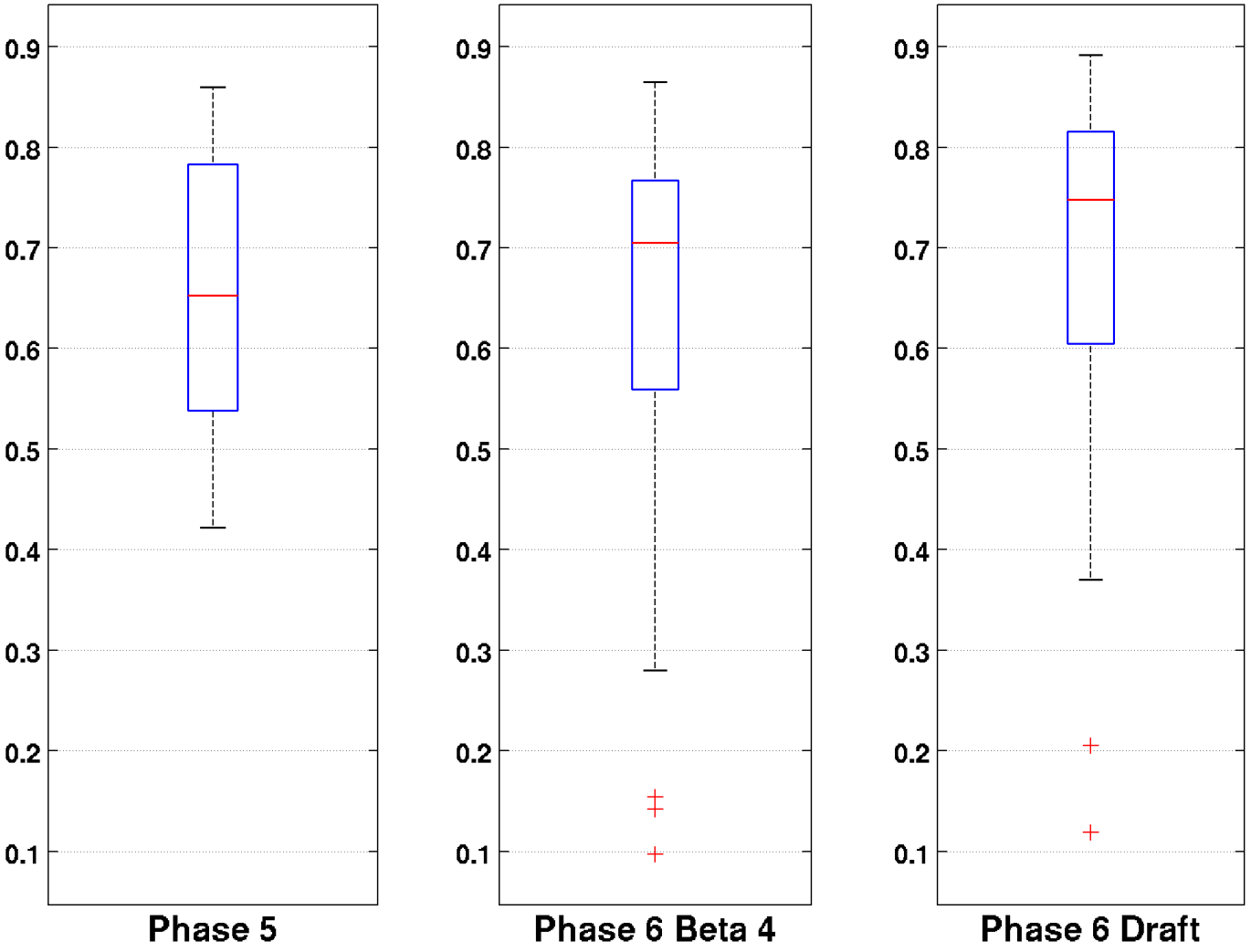
Monthly loads: sediment



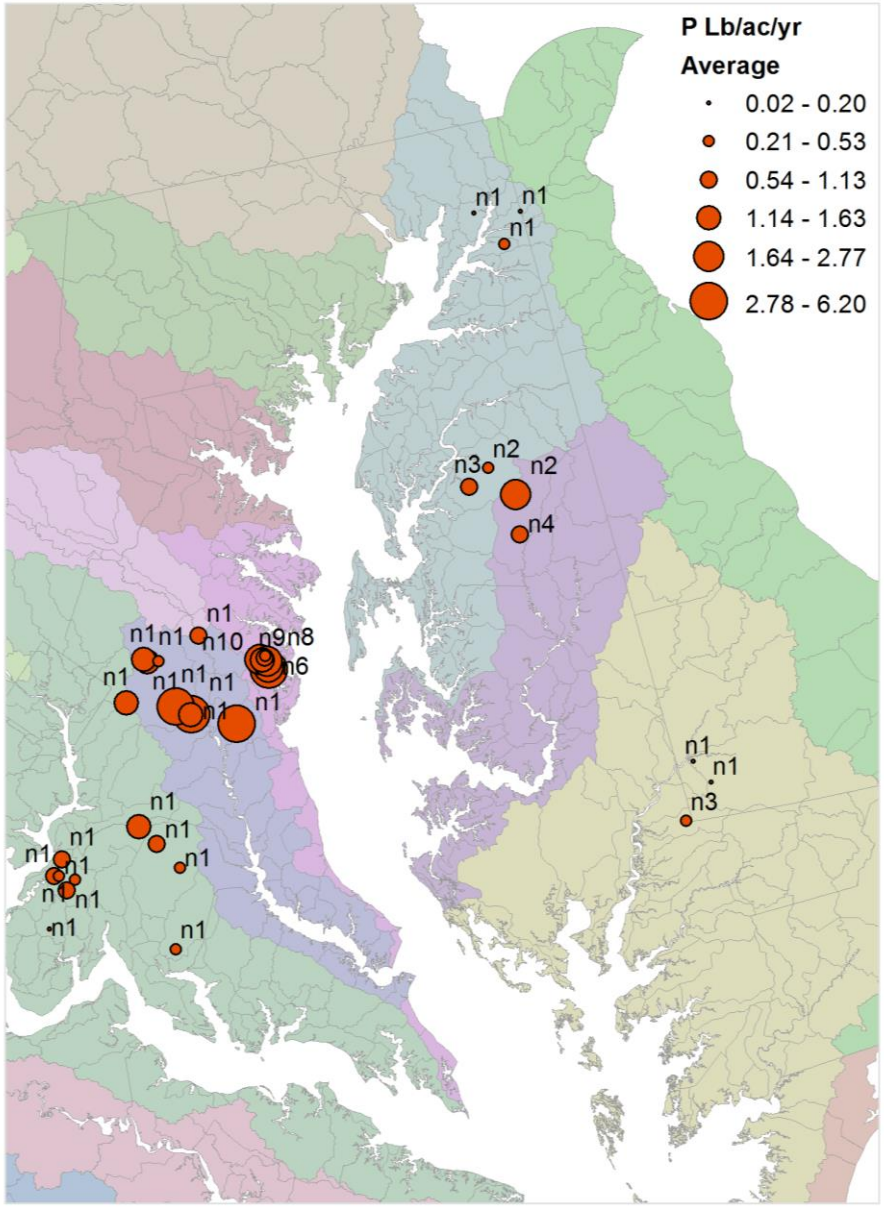
Monthly loads: nitrate



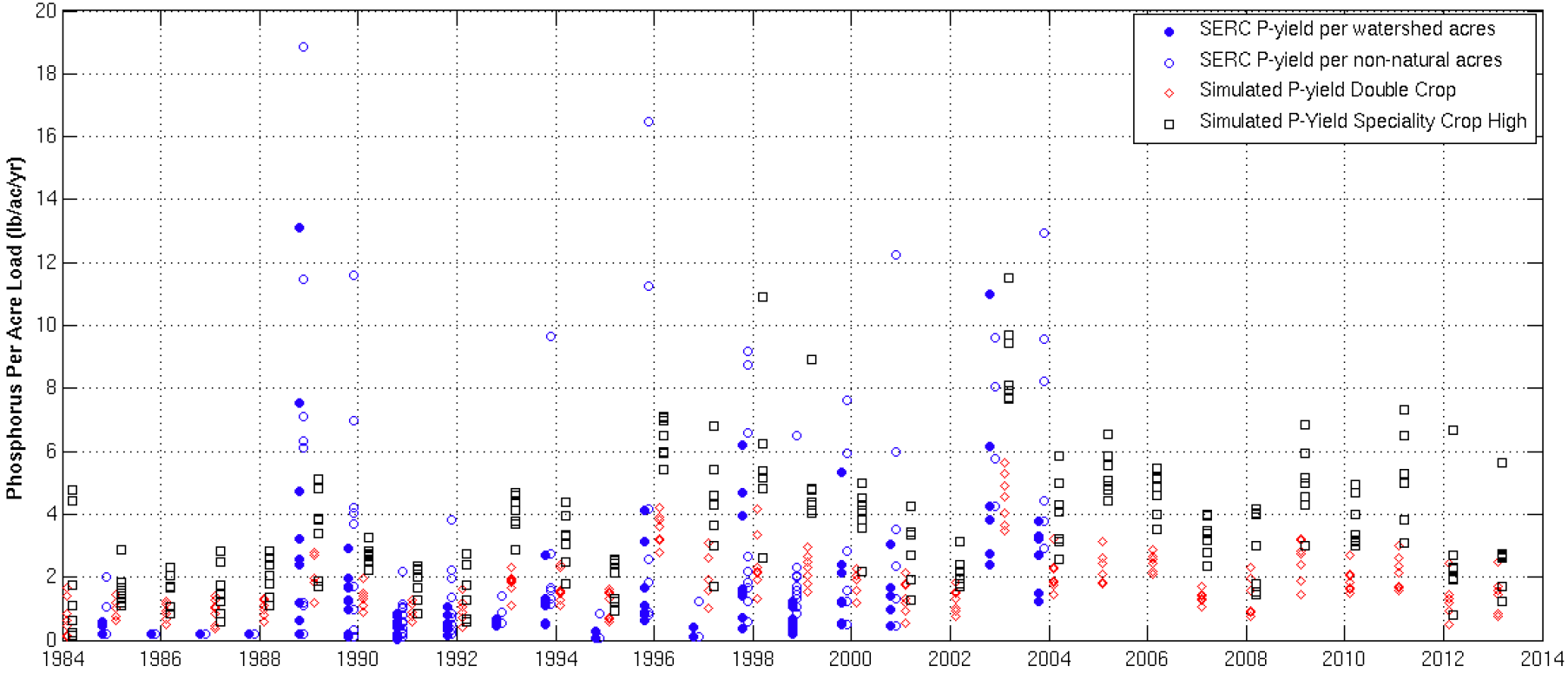
Monthly loads: dissolved phosphate



Annual Phosphorus Runoff

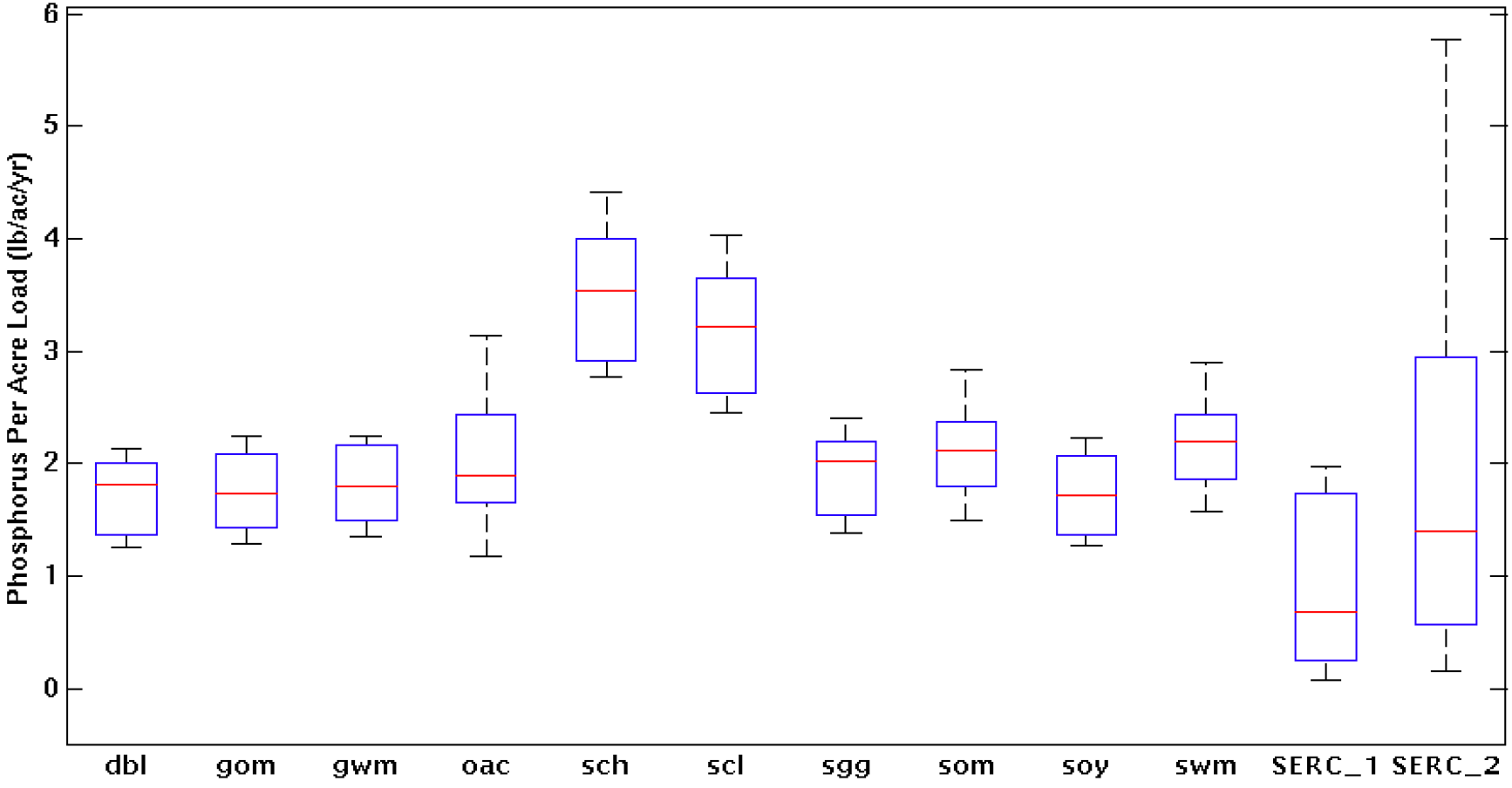


Major/Minor Basin	Nobs
Eastern Shore of Chesapeake Bay	19
Upper Eastern Shore	8
Middle Eastern Shore, including Choptank River	6
Lower Eastern Shore	5
Western Shore of Chesapeake Bay	71
Lower Western shore	71
Patuxent River Basin	9
Patuxent River below Bowie, Maryland	9
Potomac River Basin	10
Lower Potomac River, below Chain Bridge	10



- SERC data include estimates for phosphorus loads from 36 catchment
- These catchment intersect with 7 P6 land segments

  N10005,DE,SUSSEX
  N24003,MD,ANNE ARUNDEL
  N24015,MD,CECIL
  N24017,MD,CHARLES
  N24033,MD,PRINCE GEORGES
  N24035,MD,QUEEN ANNES
  N24045,MD,WICOMICO



SERC_1 – phosphorus per watershed acres

SERC_2 – phosphorus per non-natural acres