Draft Phase 6 Watershed Model – Updates

Modeling Workgroup Conference Call – May 2017

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[1] Penn State, [2] USGS

Presentation Outline

- Brief overview of the Phase 6 draft calibration
- Refinements in the calibration methods
- Comparison of simulated vs. WRTDS loads
- Geographic efficiencies of the simulation
- Simulated monthly loads
- RIM loads

P6 draft – River water quality calibration

- On the May 4 conference call, the improvements in the the Phase 6 draft hydrology and sediment calibrations were reviewed – http://www.chesapeakebay.net/calendar/event/25078/

- The revised draft inputs, hydrology, and sediment were used for the river water quality calibration.

- The calibration methods were revised to improve the representation of nitrate and nitrogen as well as phosphorus transport processes.

Key versions of river water quality calibrations

- The first draft was based on revised inputs and model refinements.

DRAFT A

- To improve the nitrate and total nitrogen balance, a regression model was developed and incorporated to simulate nutrient spiraling processes.
- To improve the riverine sediment and phosphorus transport, the concentration quantiles used in the model calibration were updated.
- Some of the model parameters (initial, minimum, and maximum) were updated, as well as limited hand calibration was performed.

DRAFT G, Draft P6

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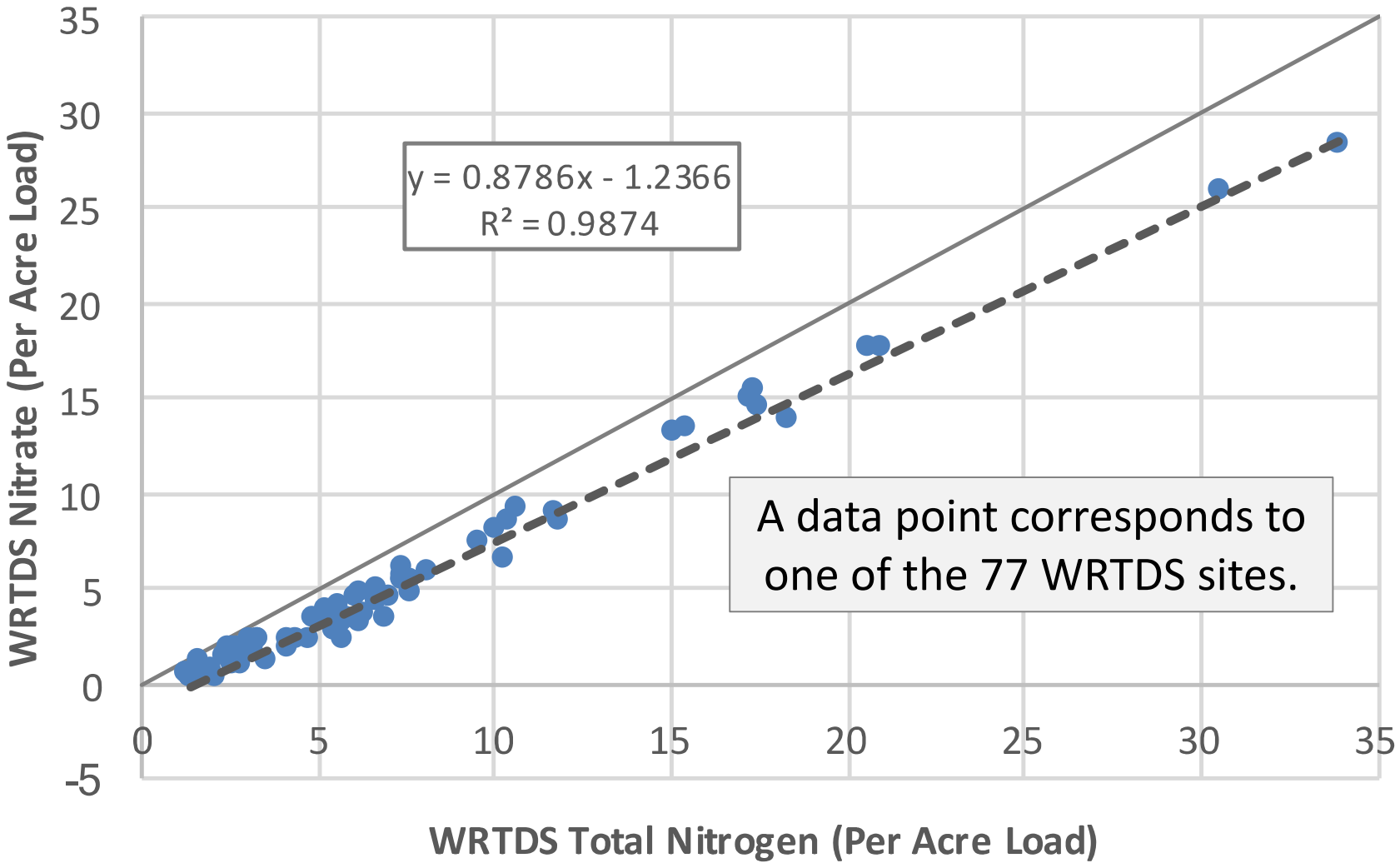

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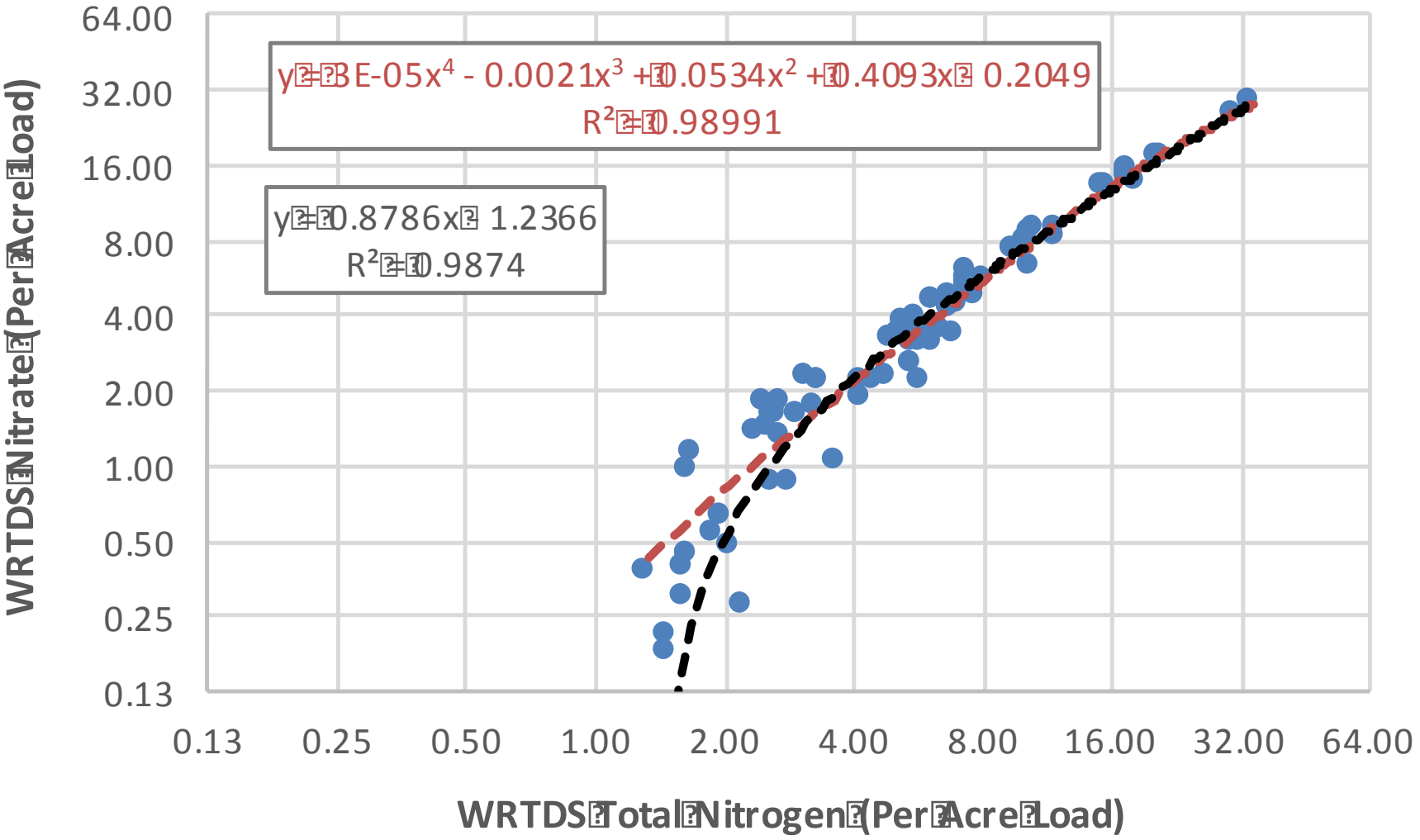
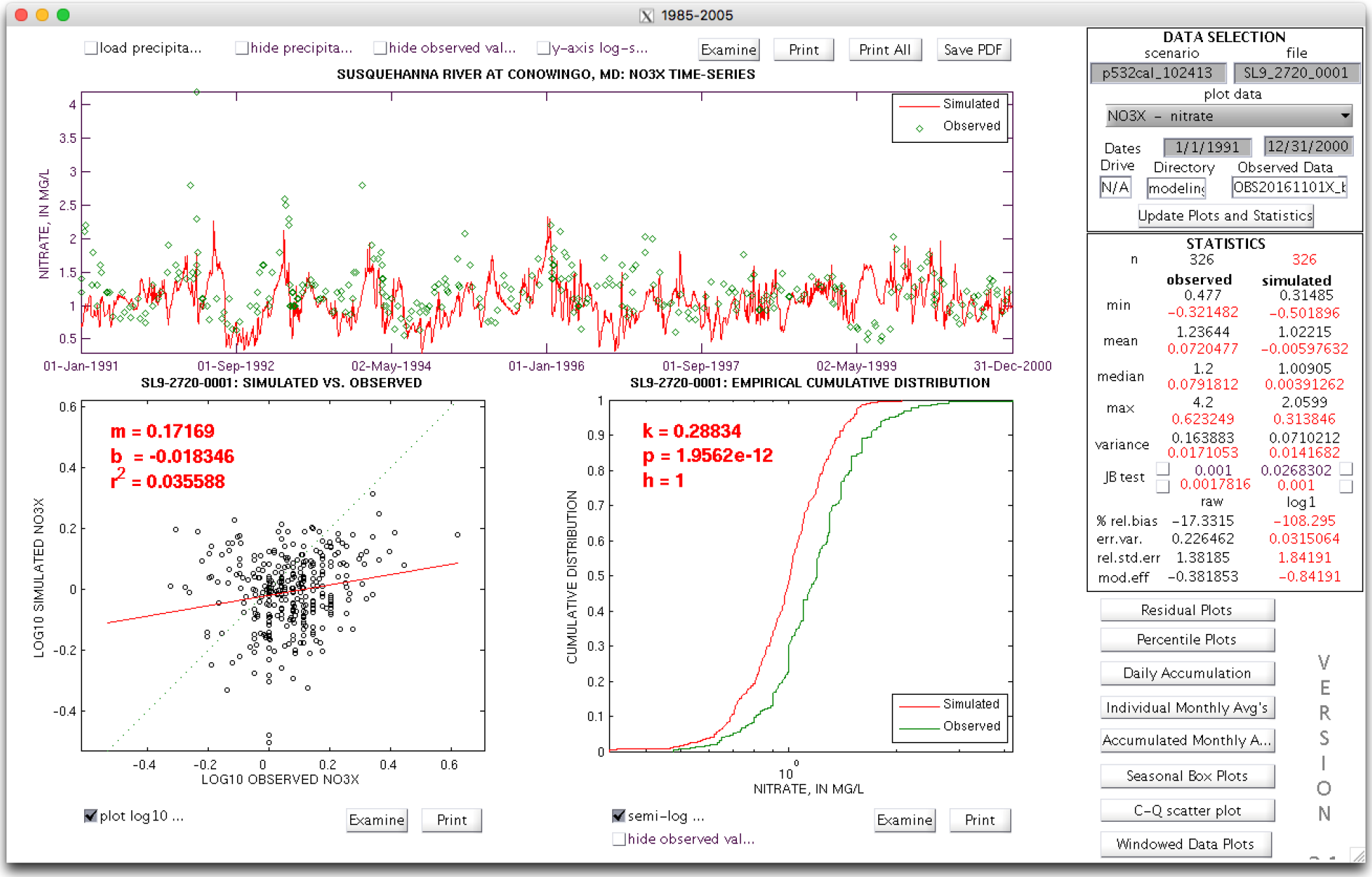


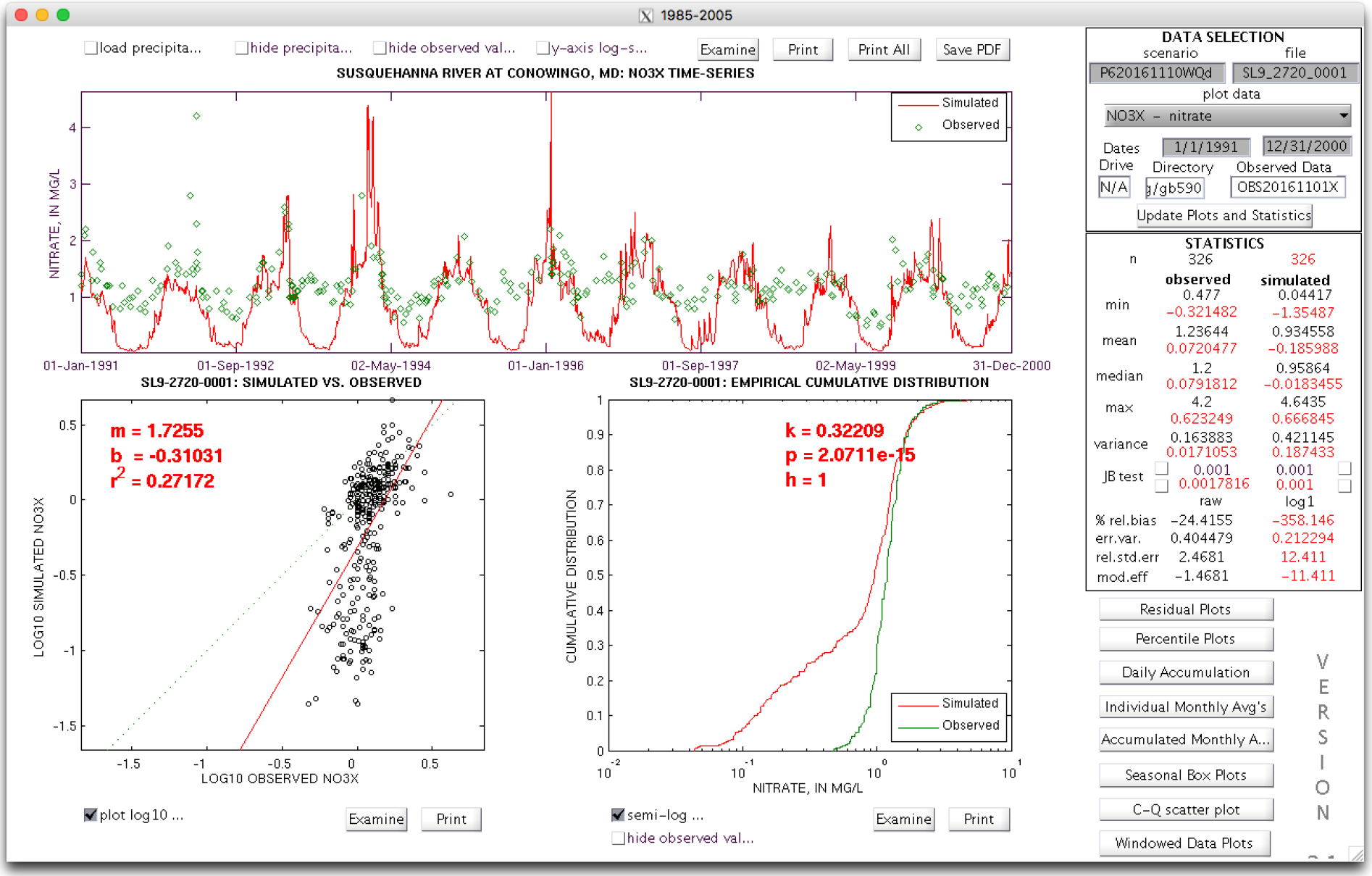
PHASE 5

NITRATE



BETA 4

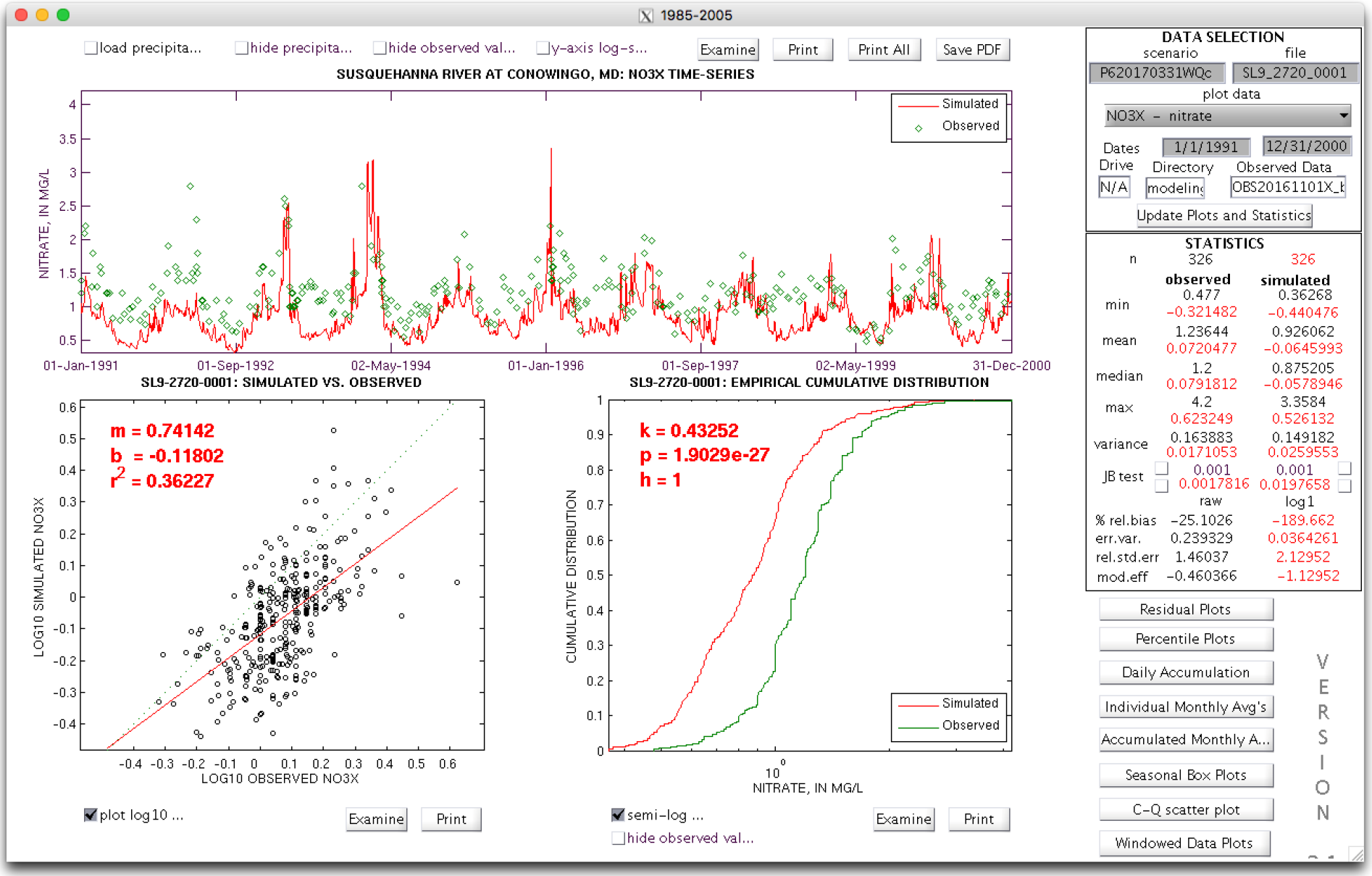
NITRATE



DRAFT C

Revised inputs, model refinements, and parametrization

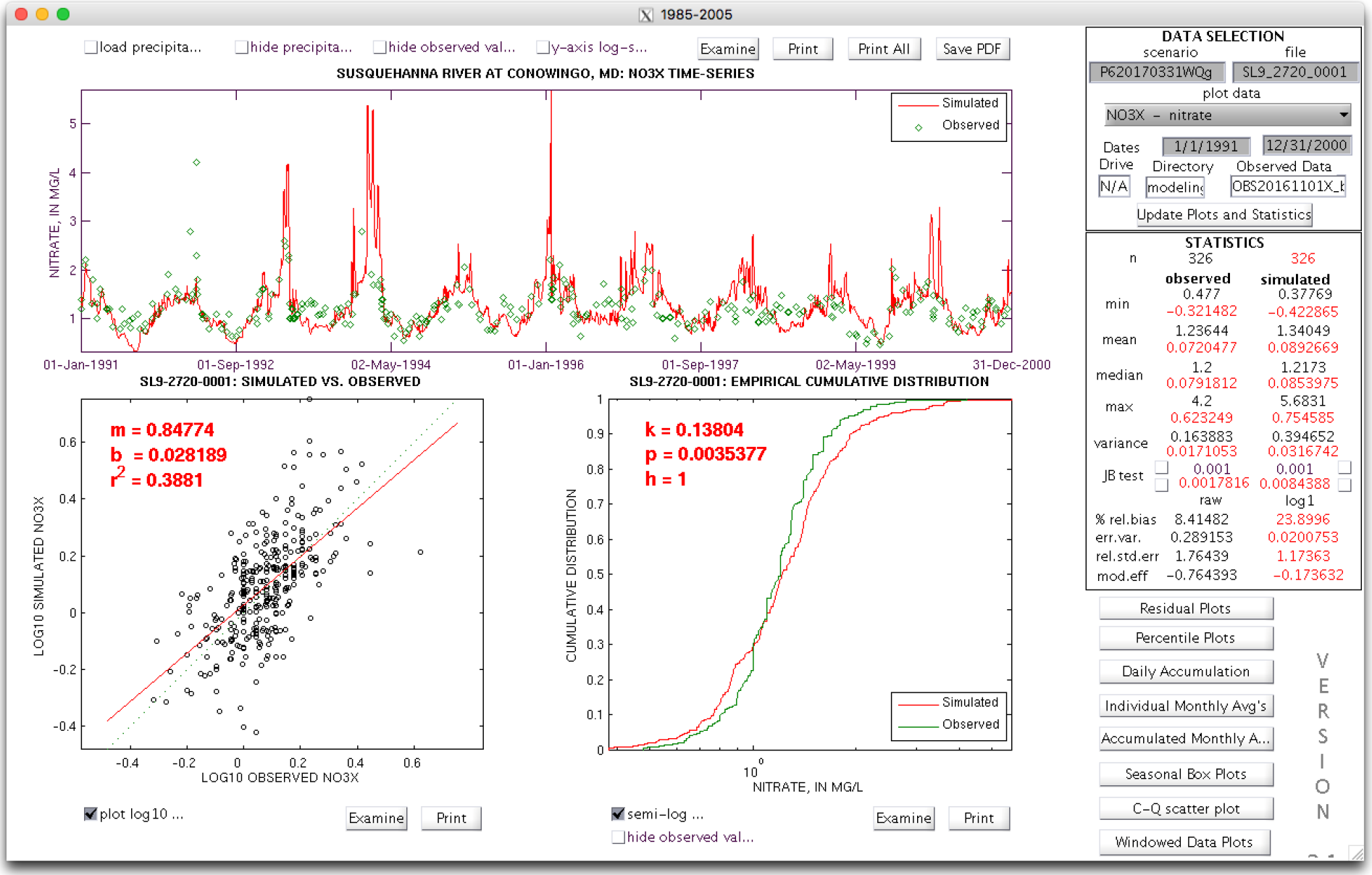
NITRATE



DRAFT G

With a regression model for land/small-stream processes

NITRATE



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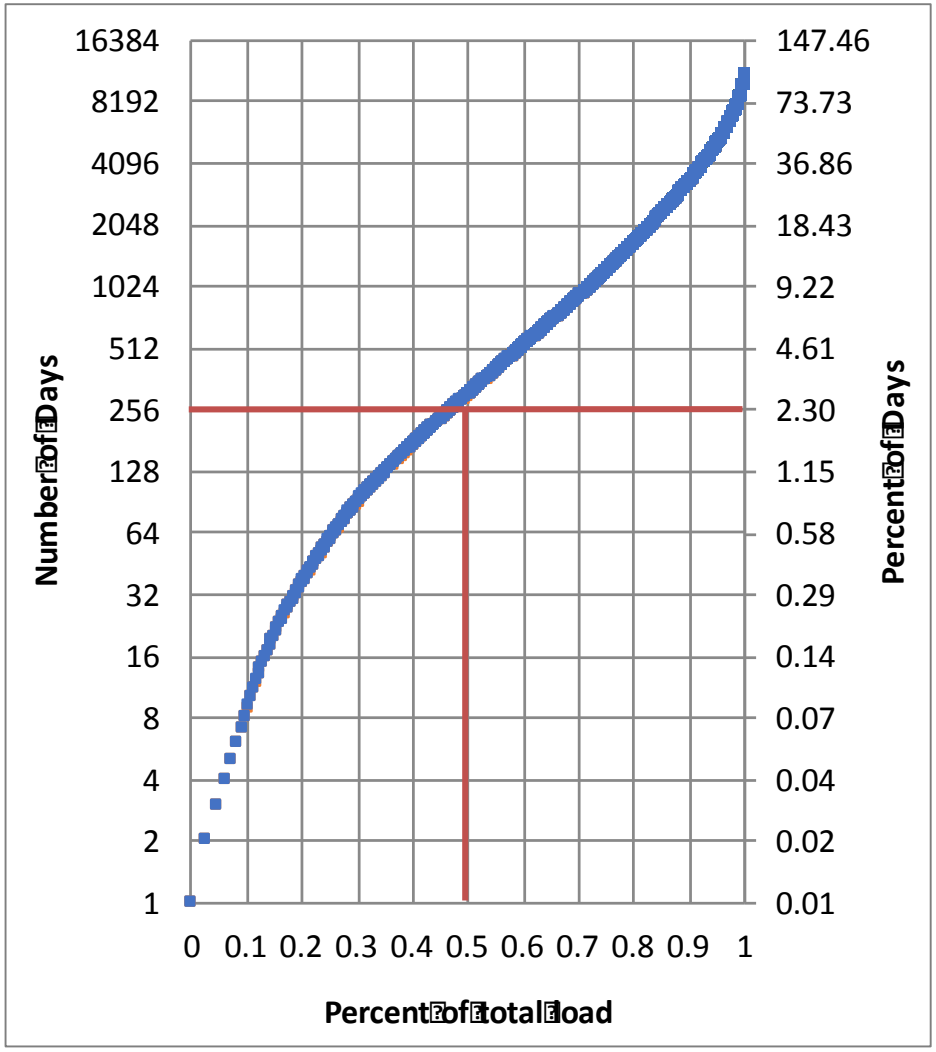
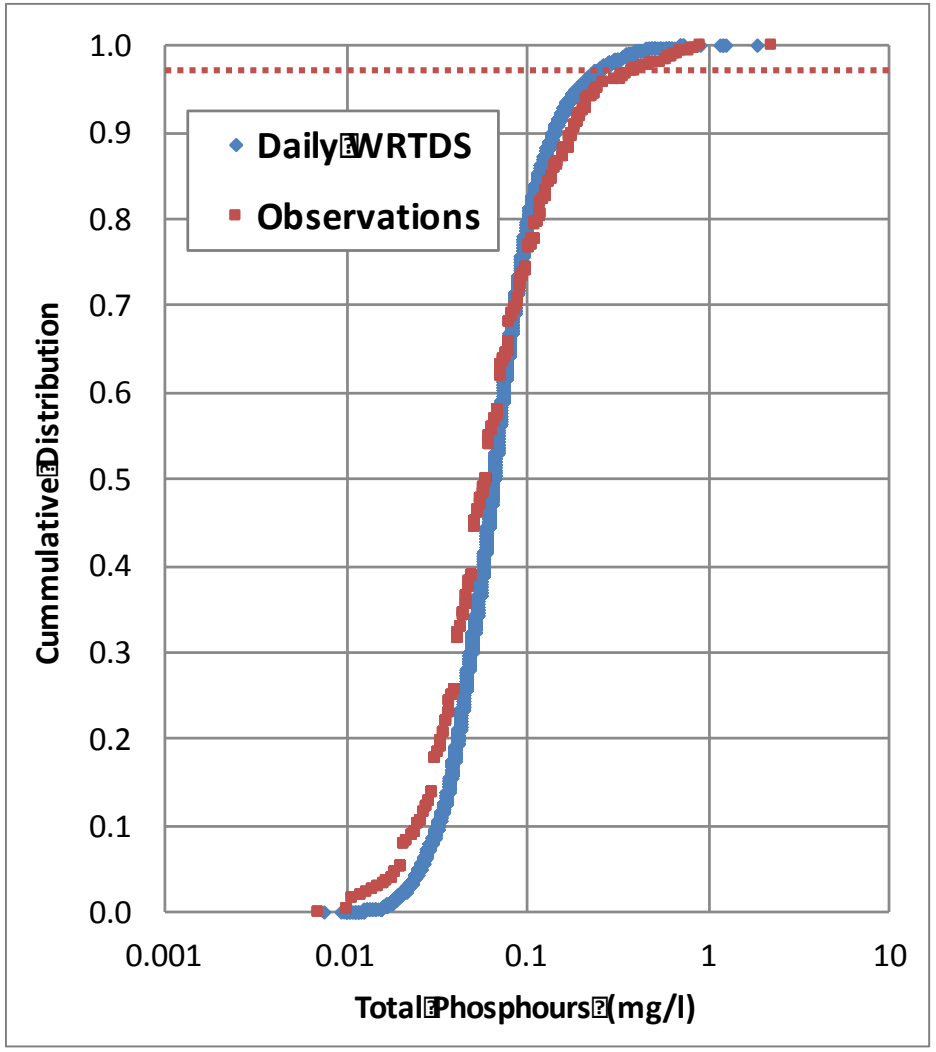
Transport of sediment and phosphorus





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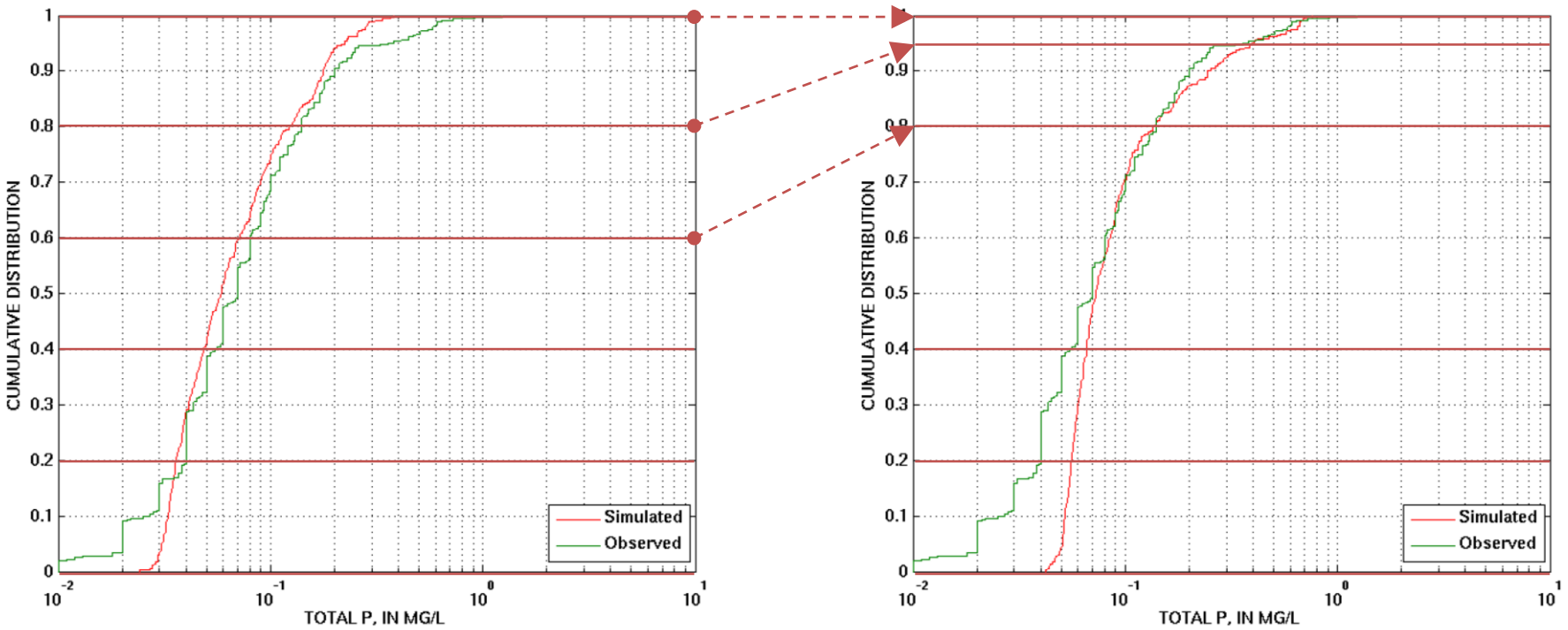
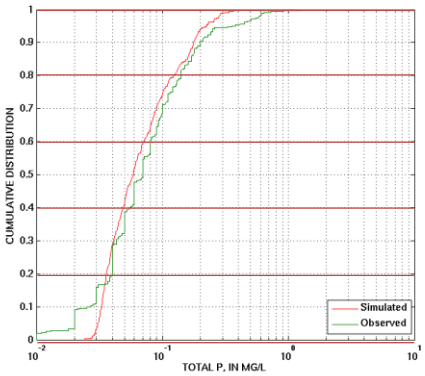
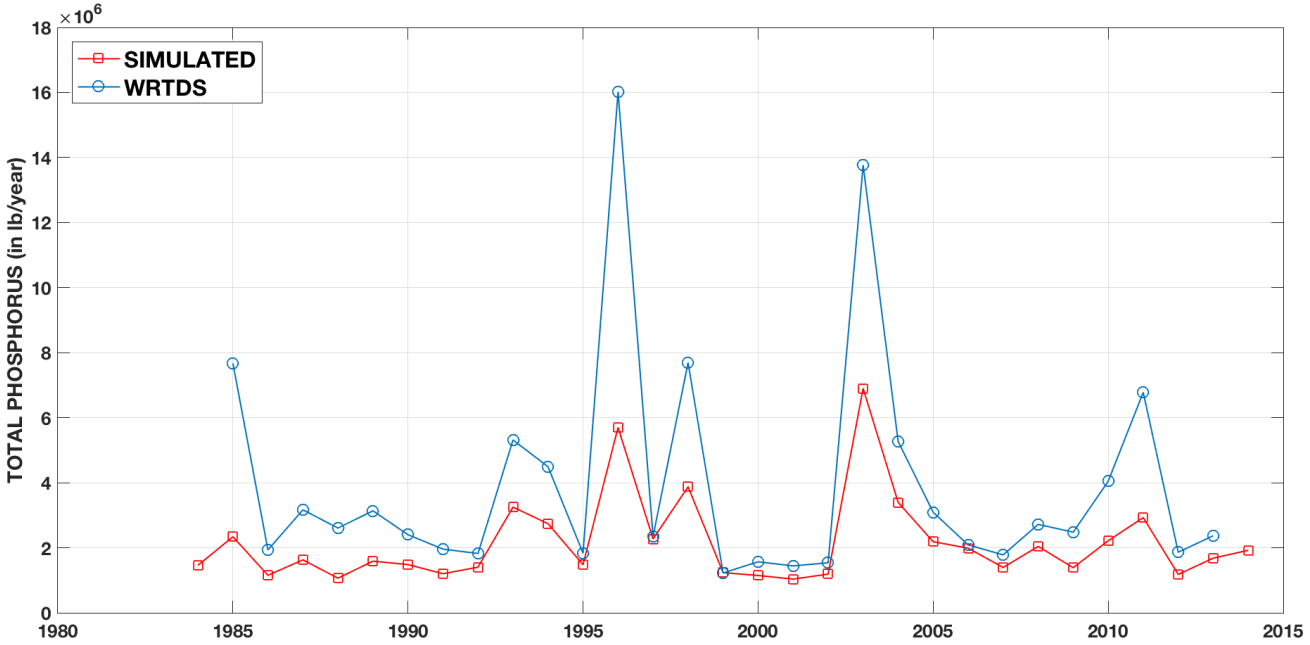
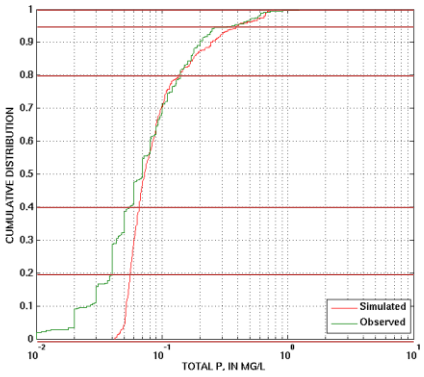


- Scour was limited to the top 2% flow events.
- The erodibility and bed concentration parameters were calibrated based on the biases in the top 5% of the observation samples.


CUMULATIVE DISTRIBUTION
TOTAL P, IN MG/L
Simulated
Observed


×10^6
SIMULATED
WRTDS
TOTAL PHOSPHORUS (in lb/year)
0
2
4
6
8
10
12
14
16
18
1980
1985
1990
1995
2000
2005
2010
2015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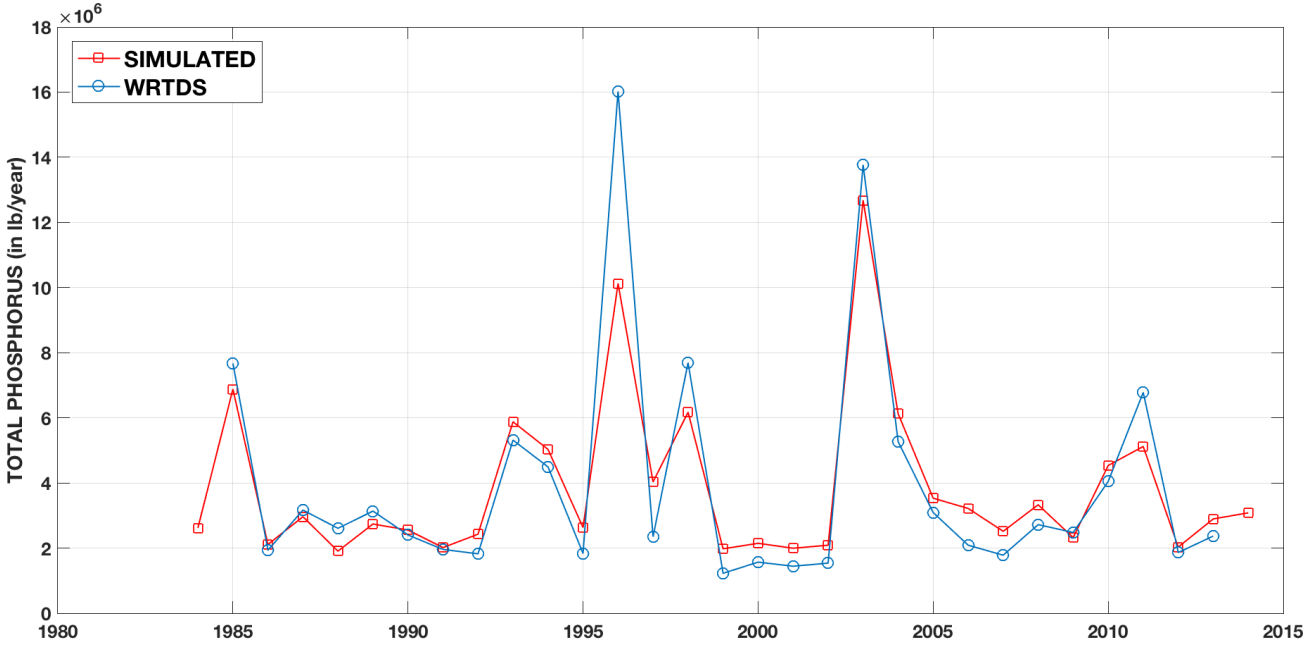
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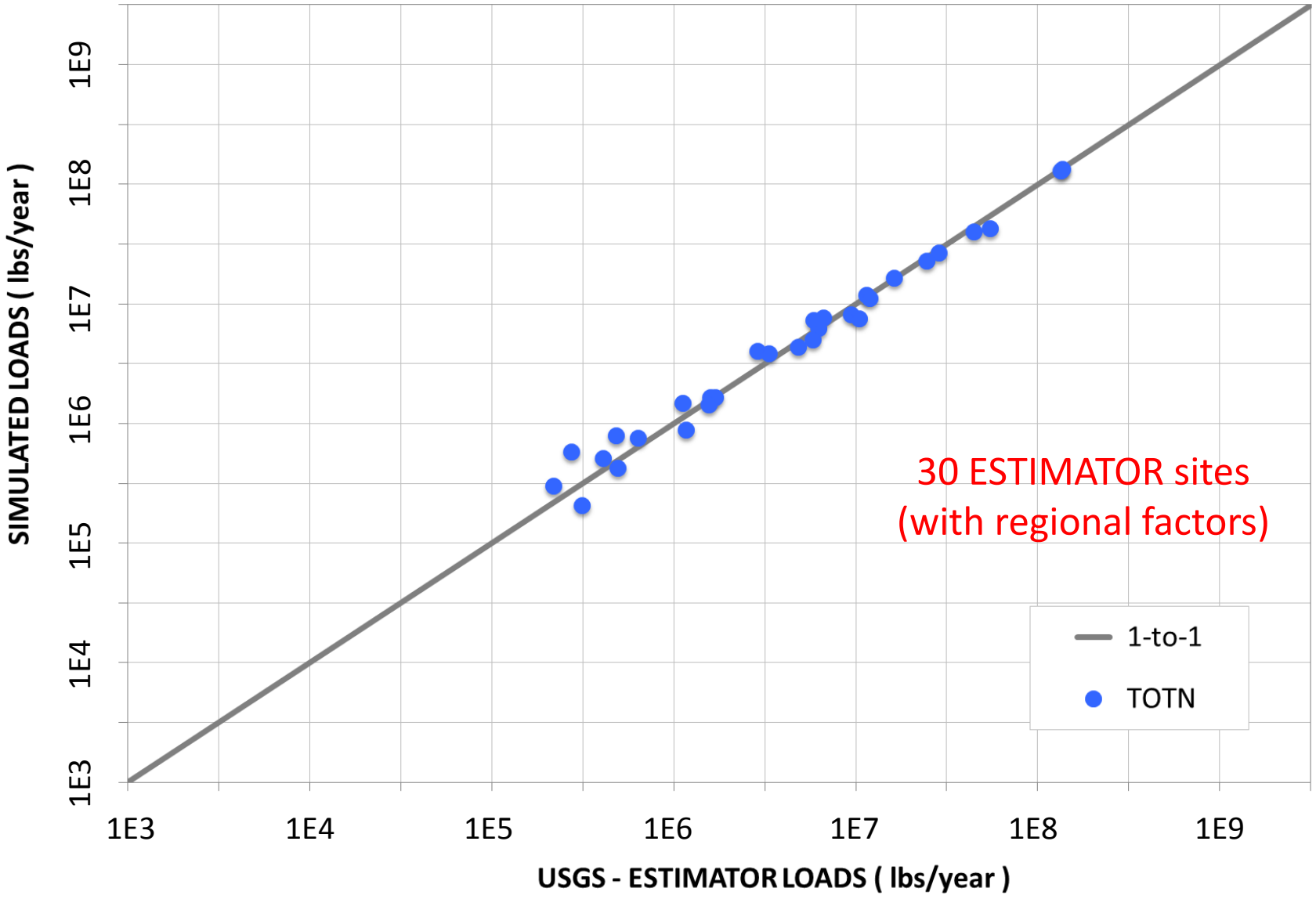
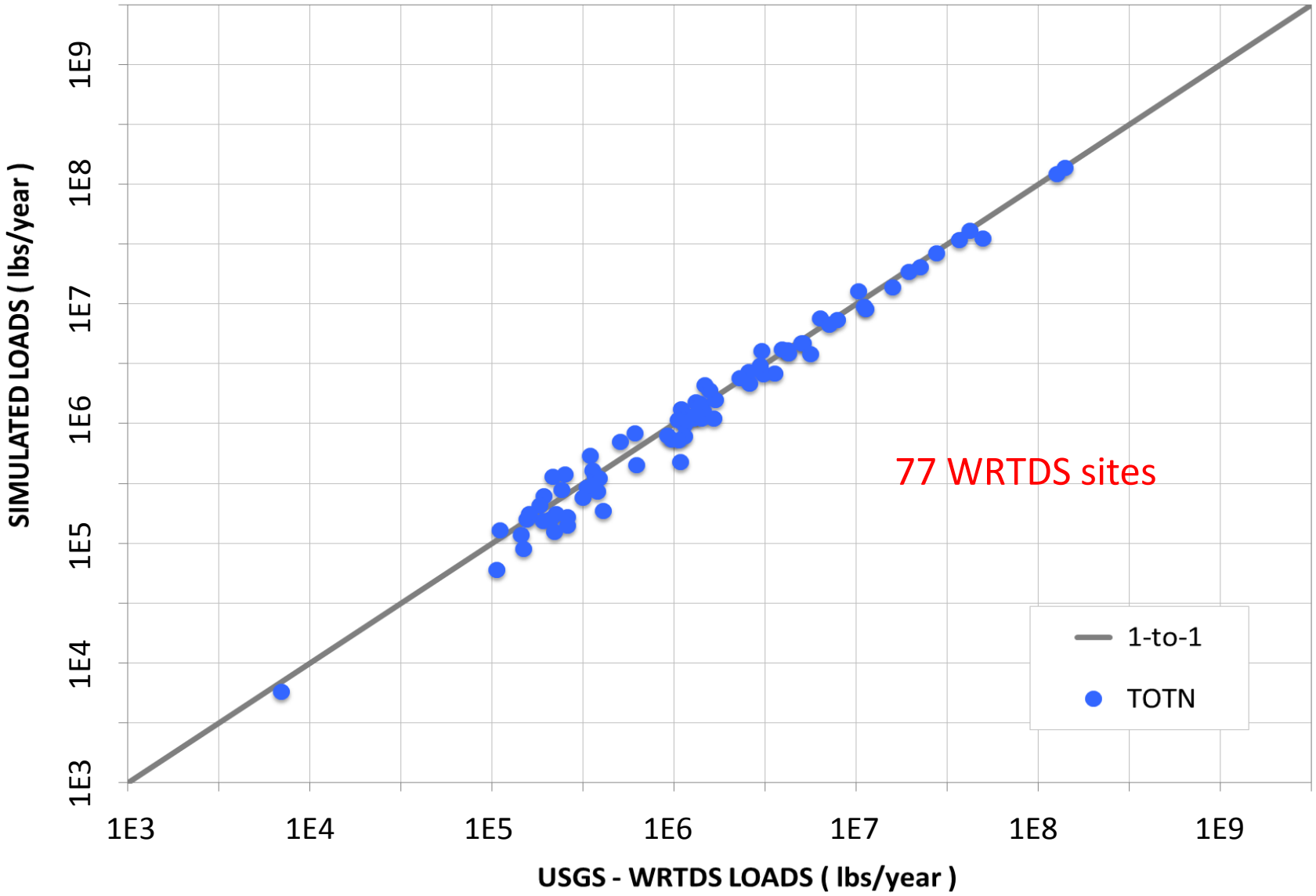

SIMULATED LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
USGS - ESTIMATOR LOADS (lbs/year)
1E3
1E4
1E5
1E6
1E7
1E8
1E9
30 ESTIMATOR sites
(with regional factors)
1-to-1
TOTN

BETA 4C

Beta 4 calibration

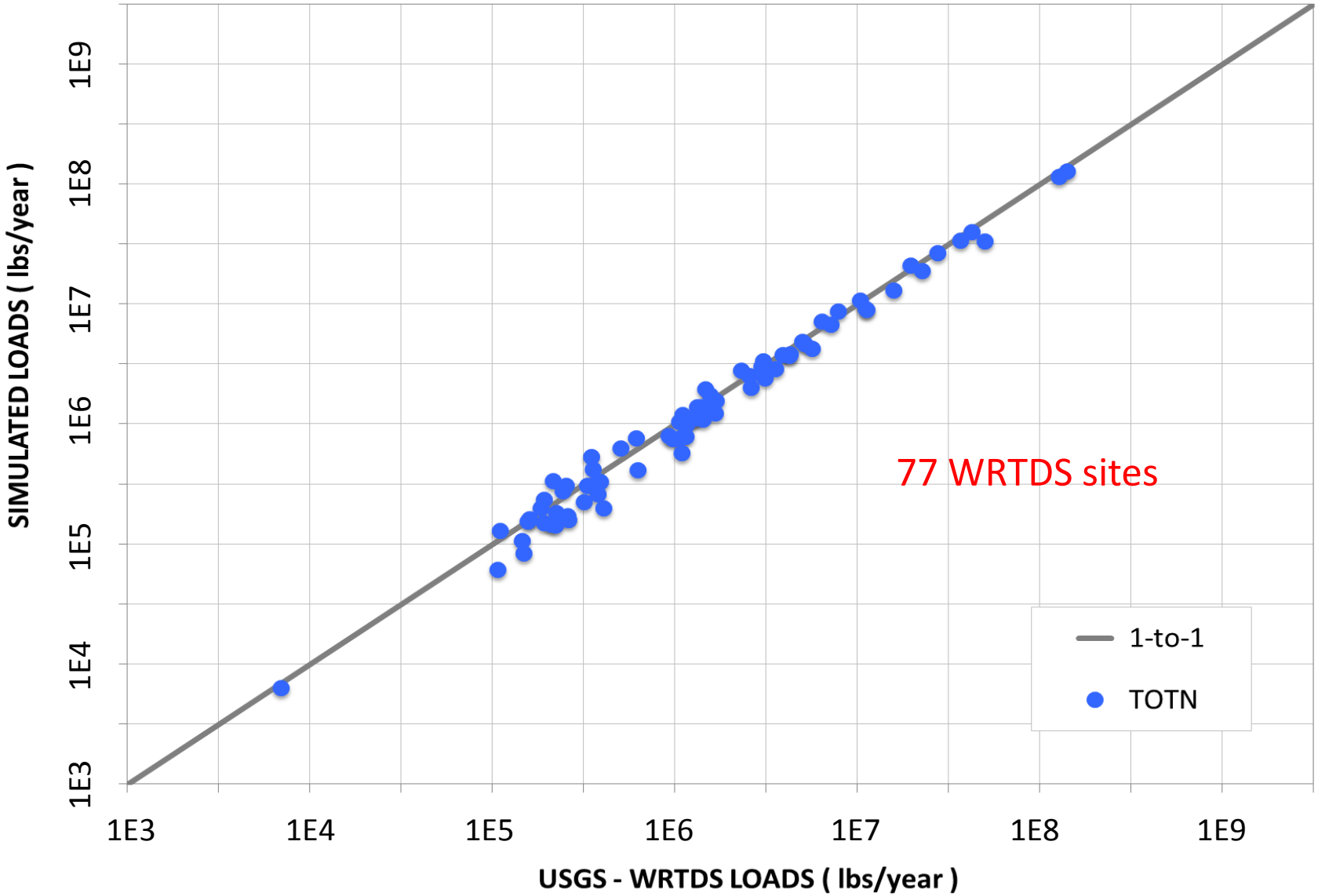
NITROGEN



DRAFT A

Revised inputs and model refinements

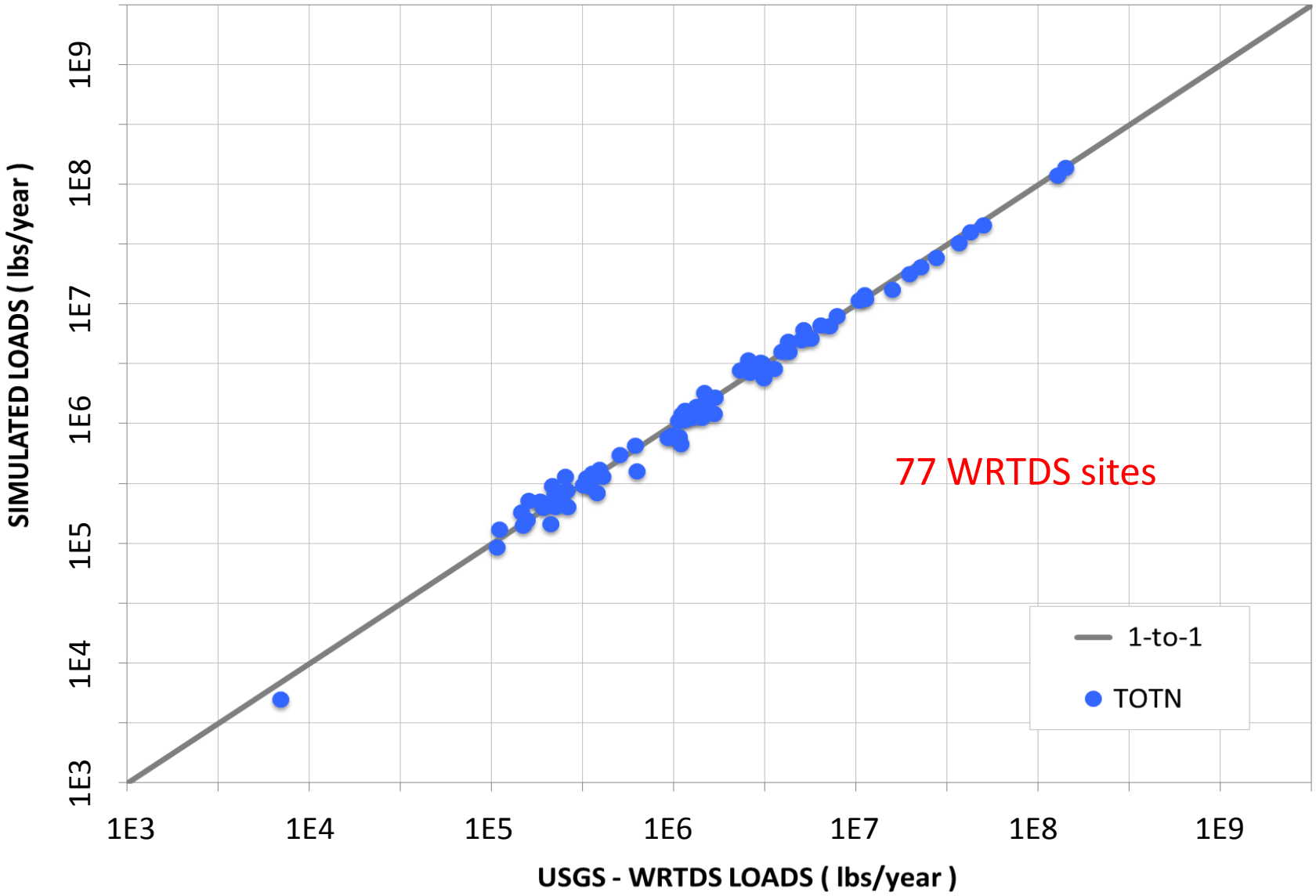
NITROGEN

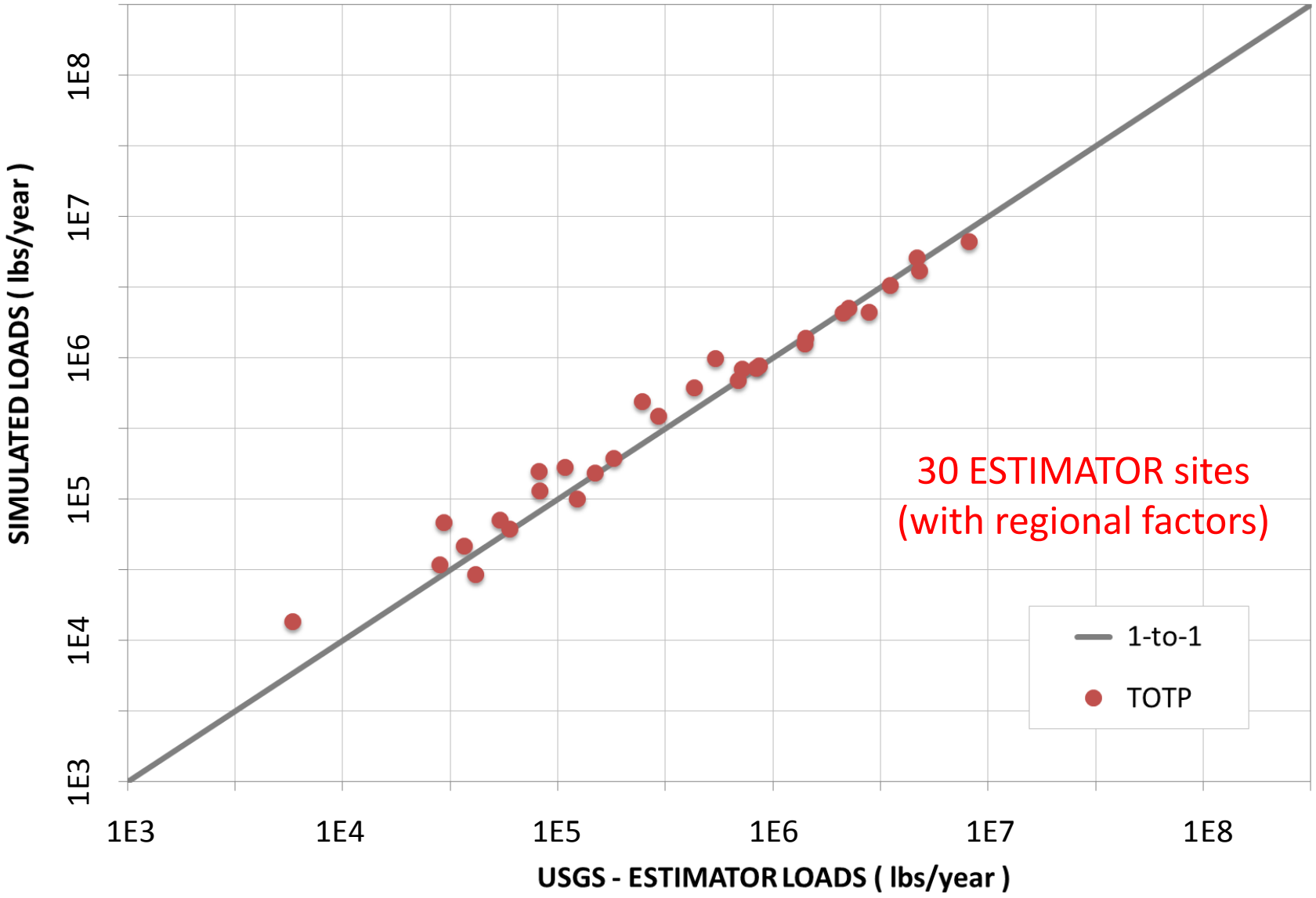


DRAFT G

Revised inputs, model refinements, and calibration methods

NITROGEN




SIMULATED LOADS (lbs/year)
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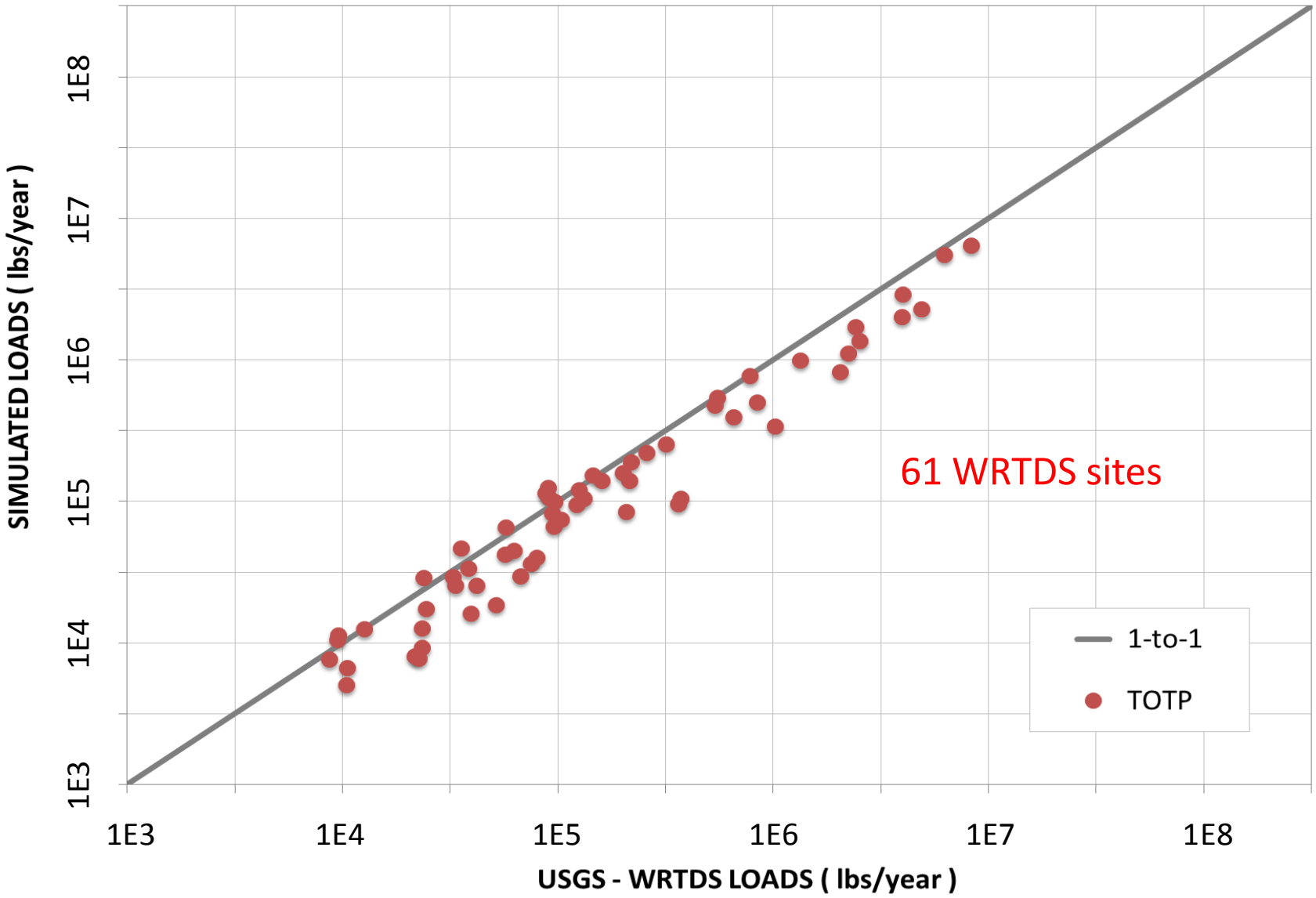
BETA 4C

Beta 4 calibration

PHOSPHORUS



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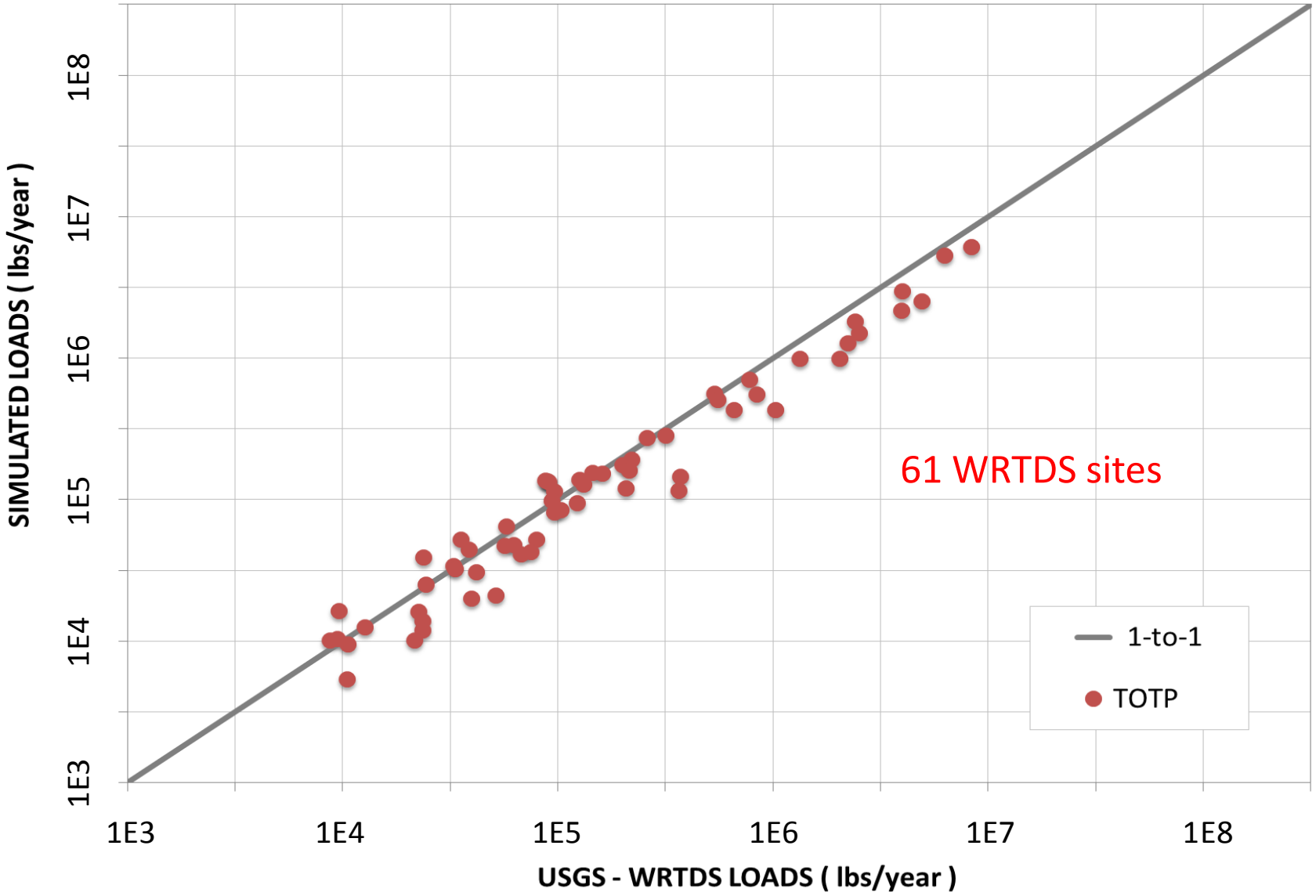

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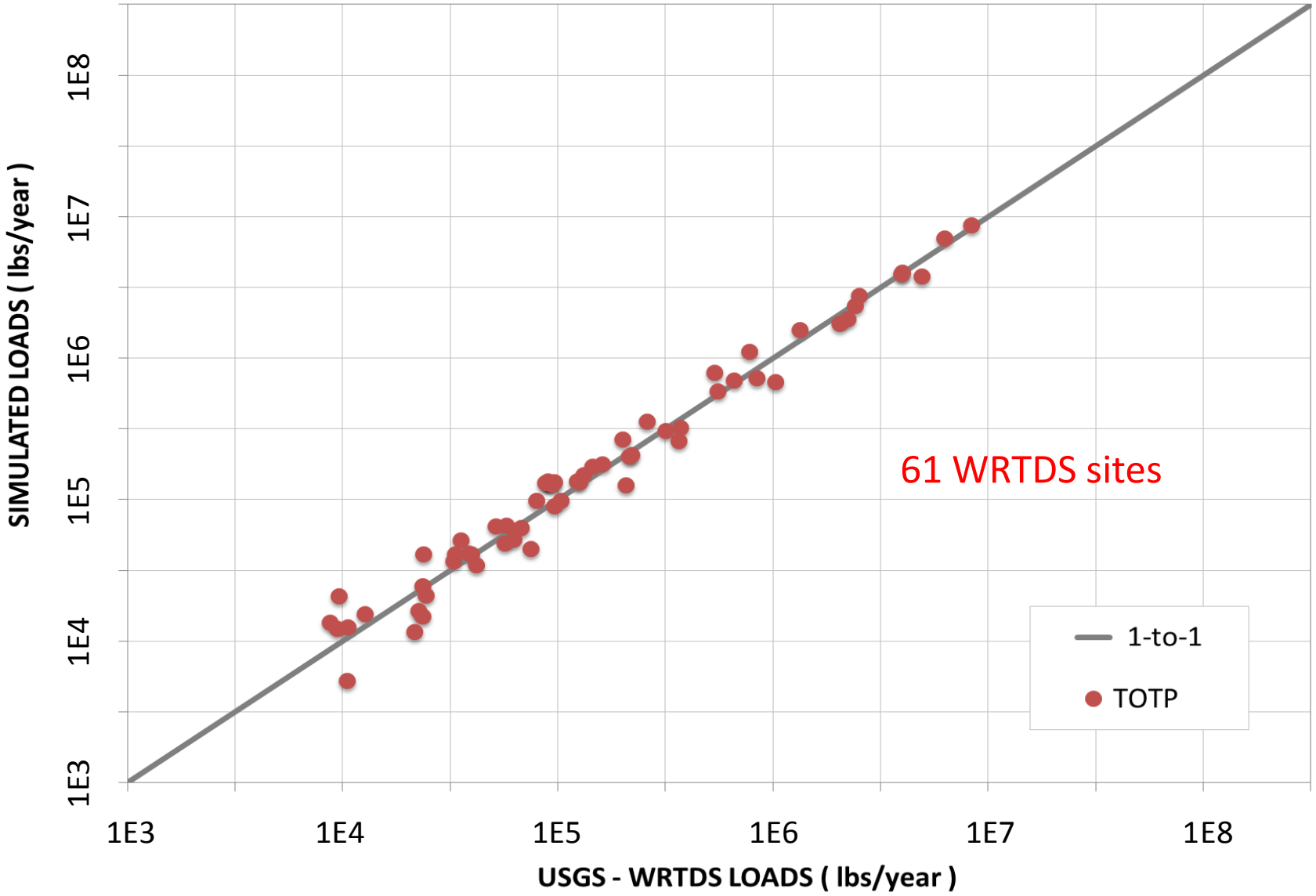

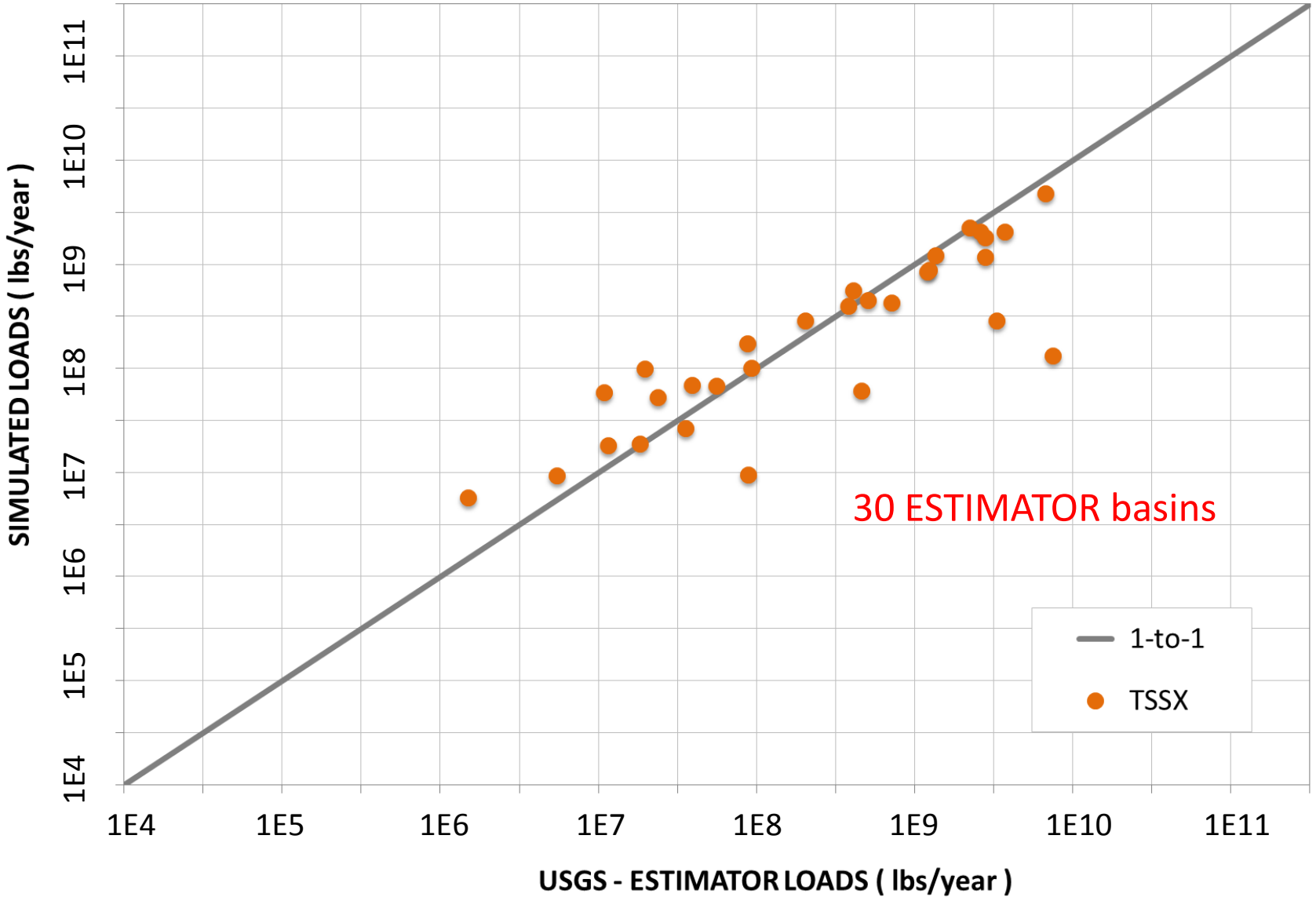
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BETA 4C

Beta 4 calibration

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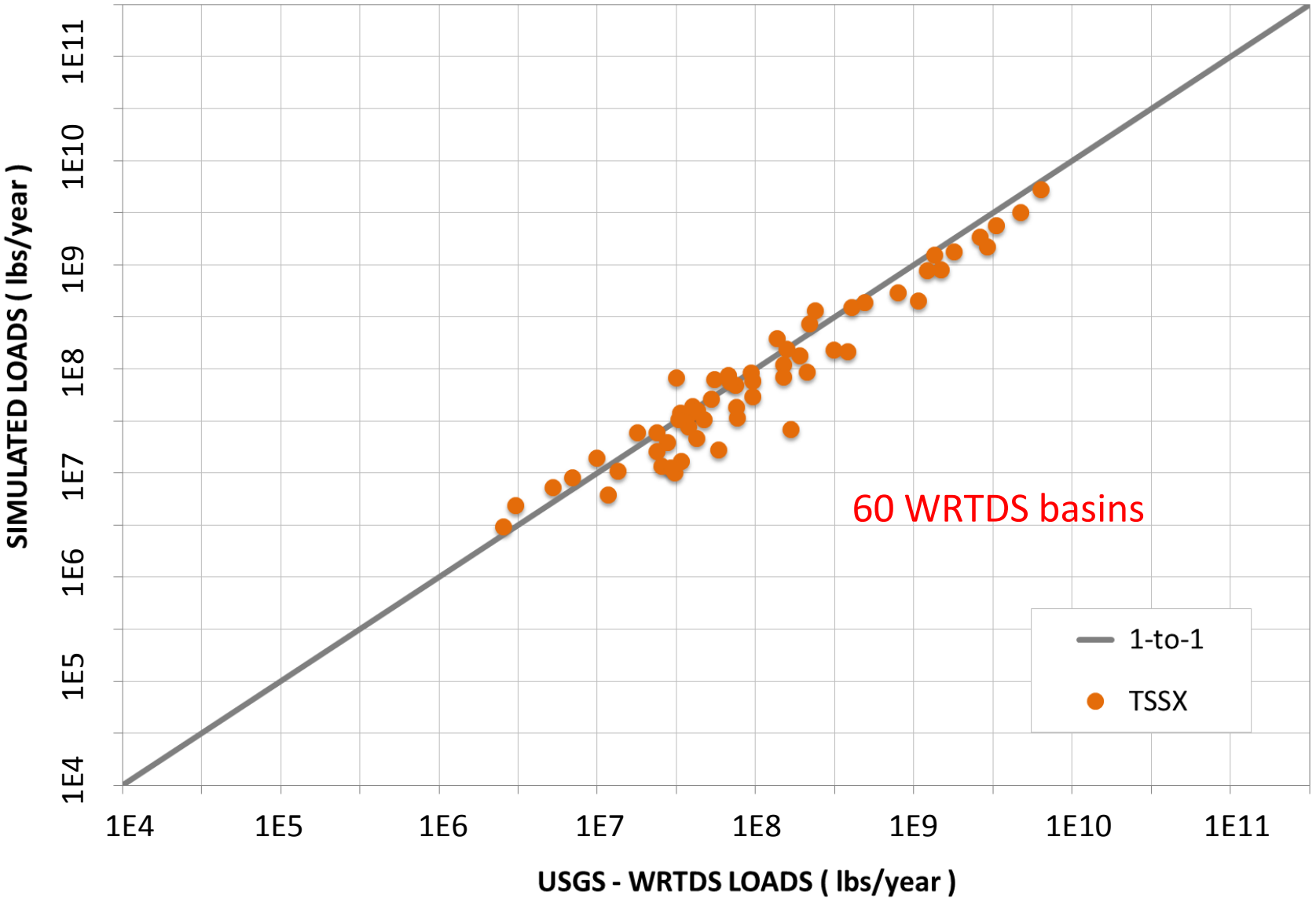

DRAFT A

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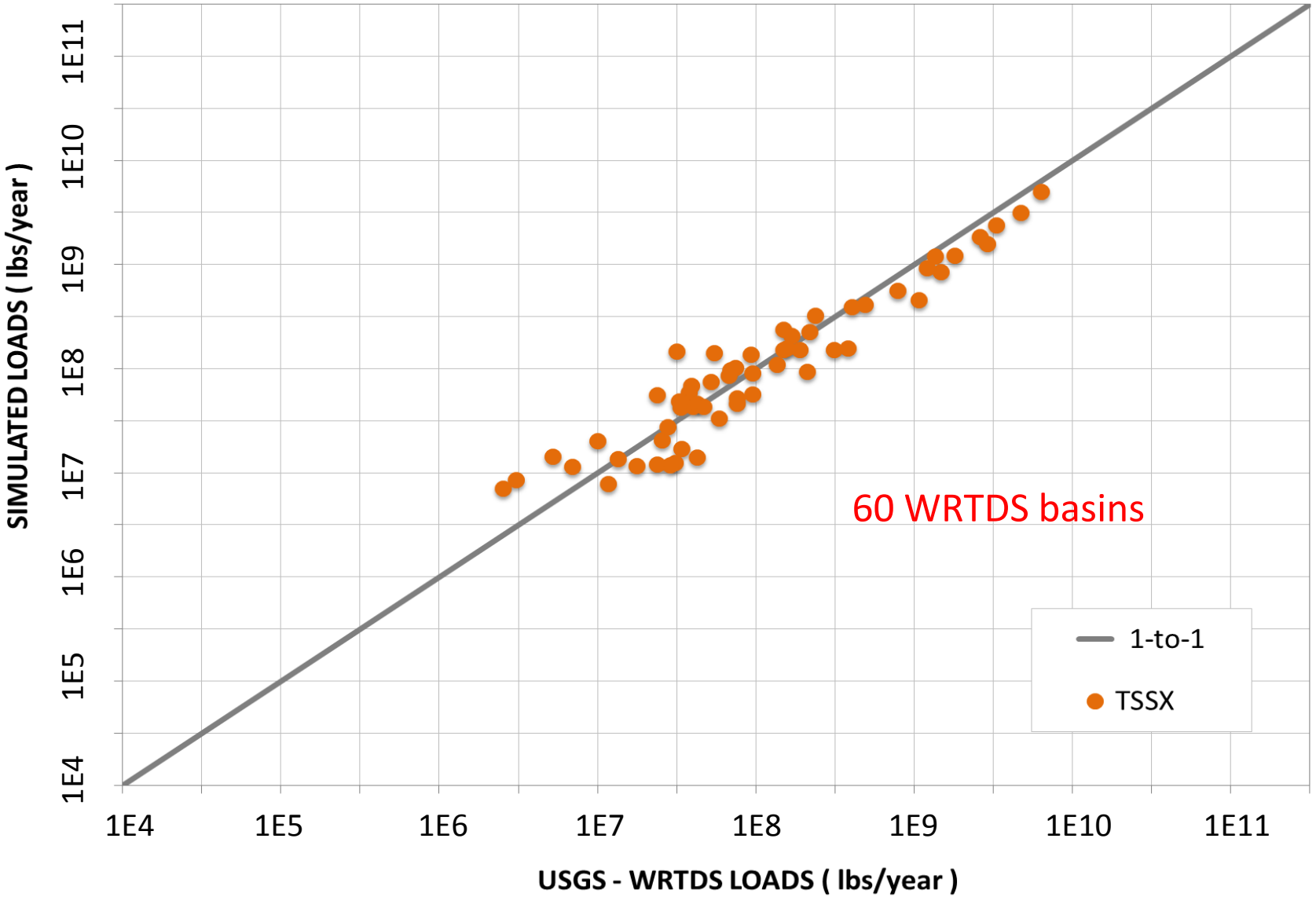

DRAFT G

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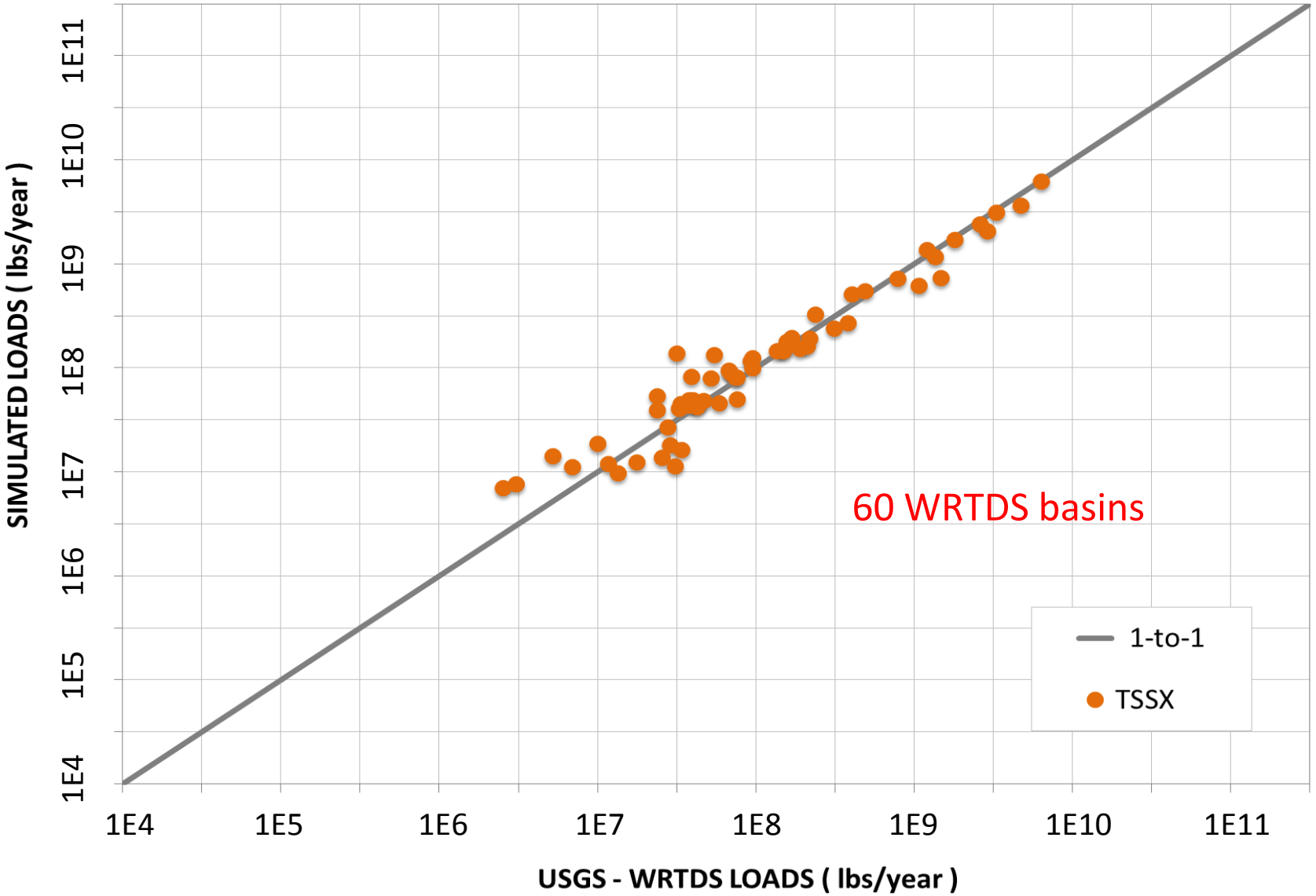
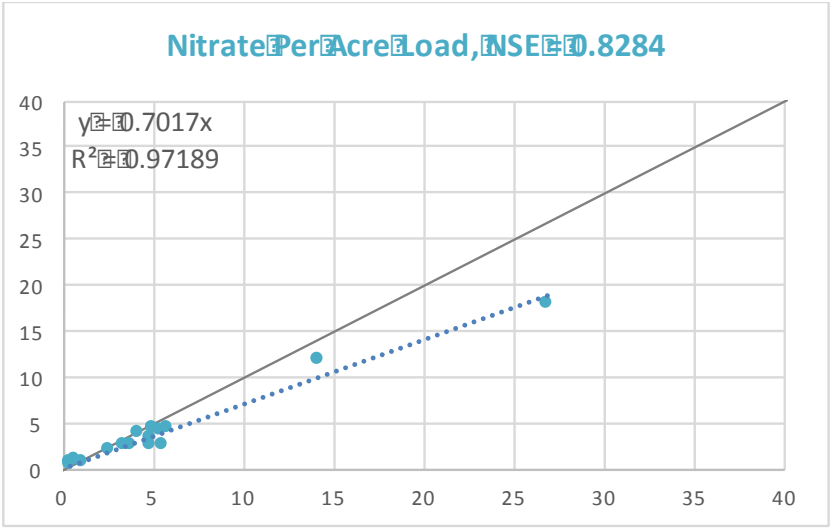
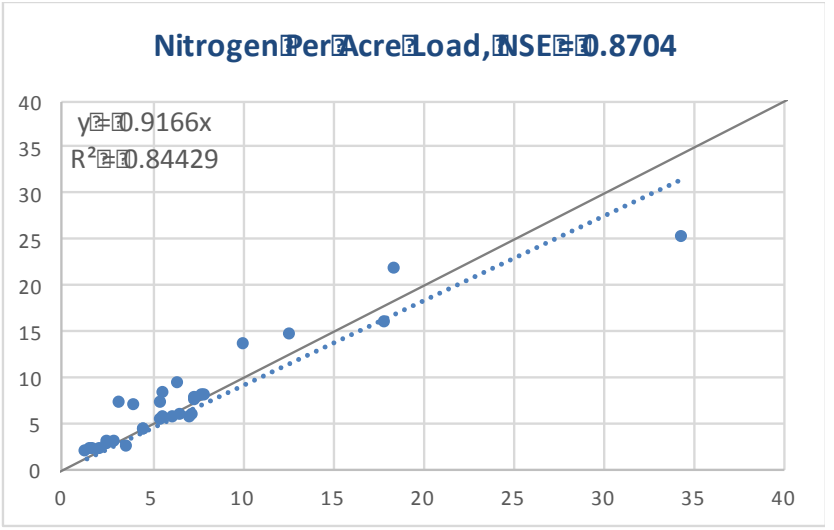


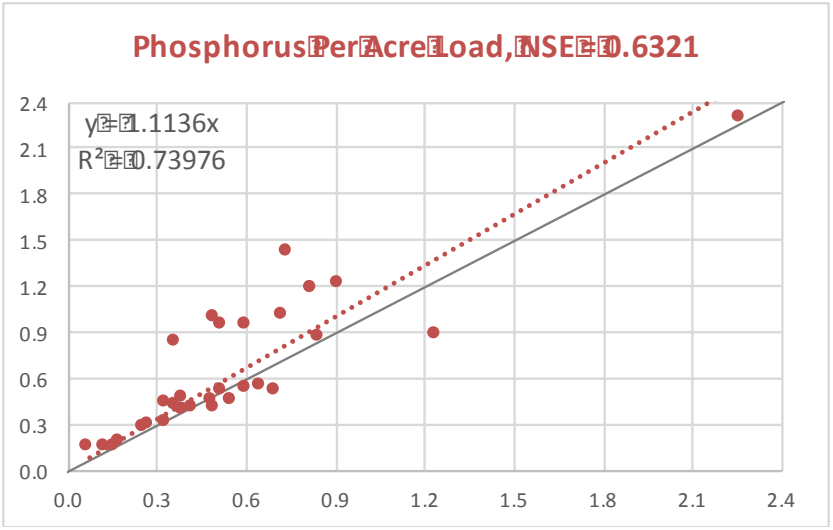
Review of geographic efficiencies

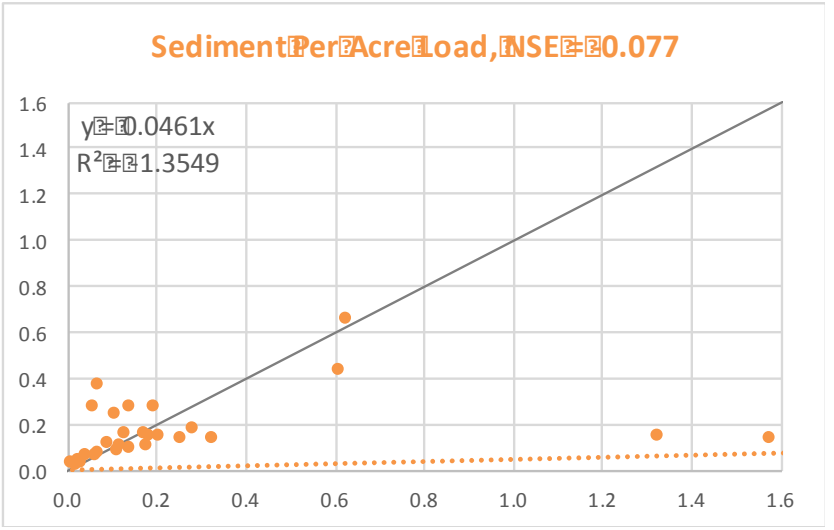
- WRTDS and simulated per acre loads are compared.
- Nash-Sutcliffe model efficiency was used to quantify the predictive power of the model across the watershed.
- An efficiency of 1 would indicate a perfect match in loads for all river basins (where WRTDS estimates are available).

Phase 5 – geographic efficiencies





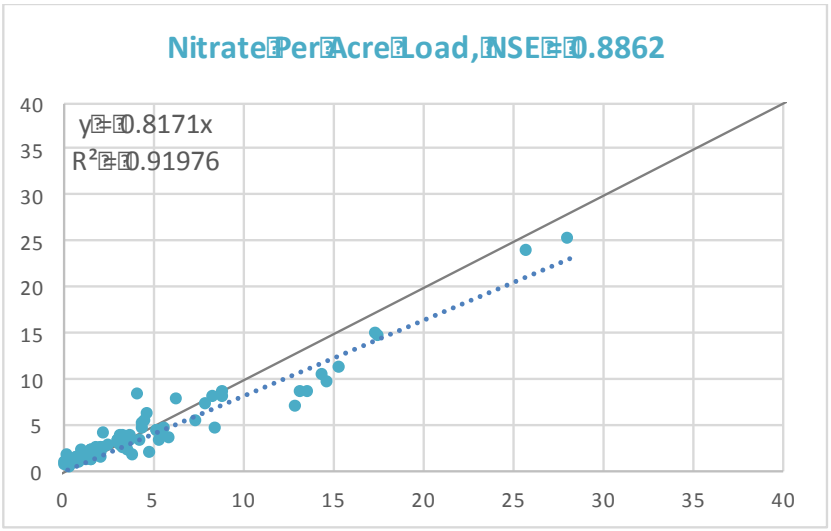


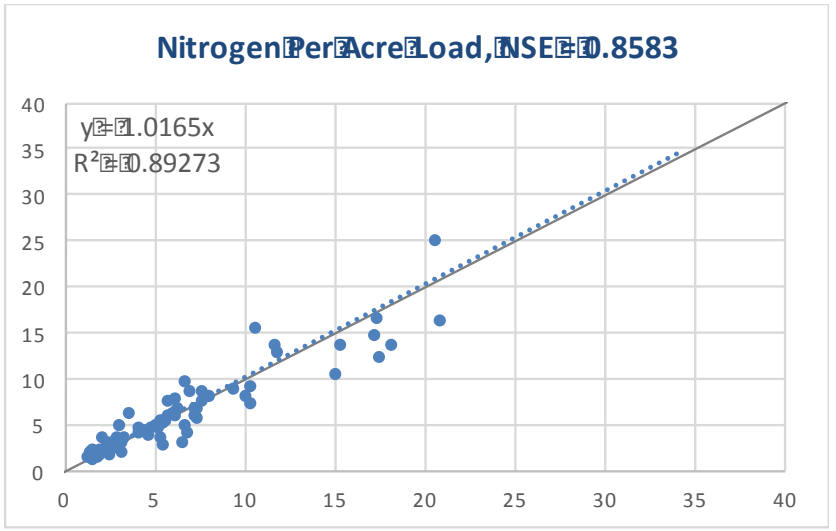


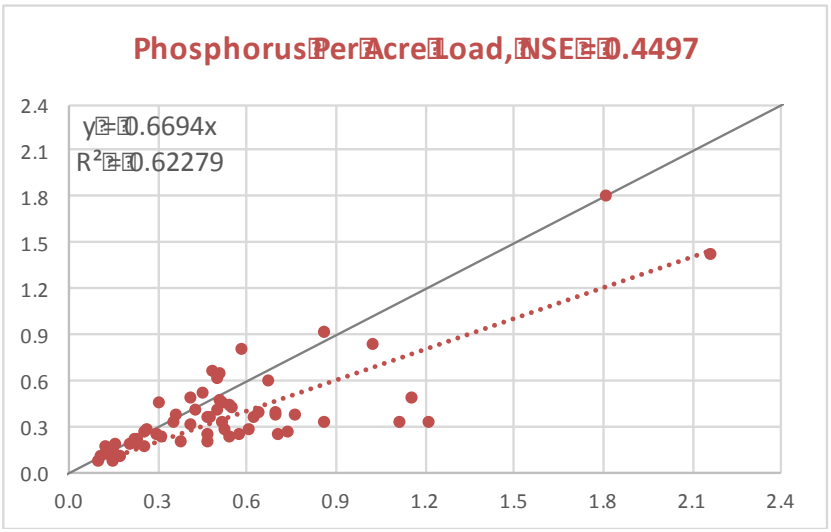
Simulated Per Acre Load

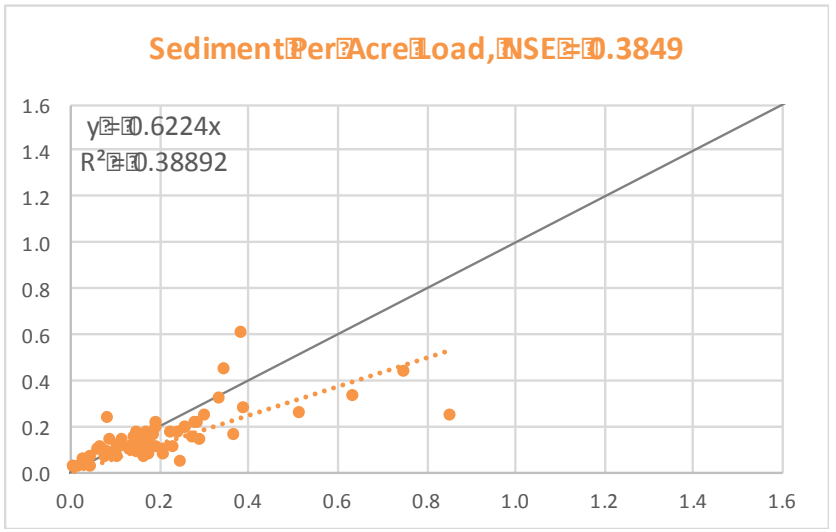
WRTDS Per Acre Load

Beta 4 – geographic efficiencies





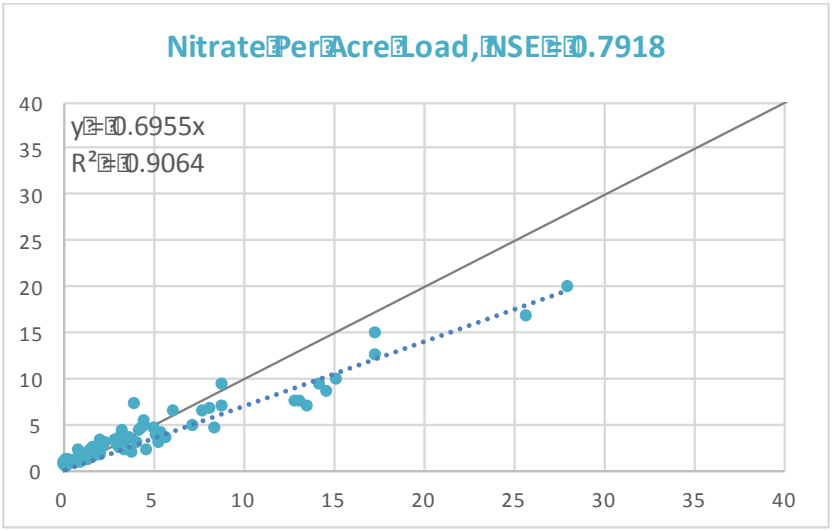


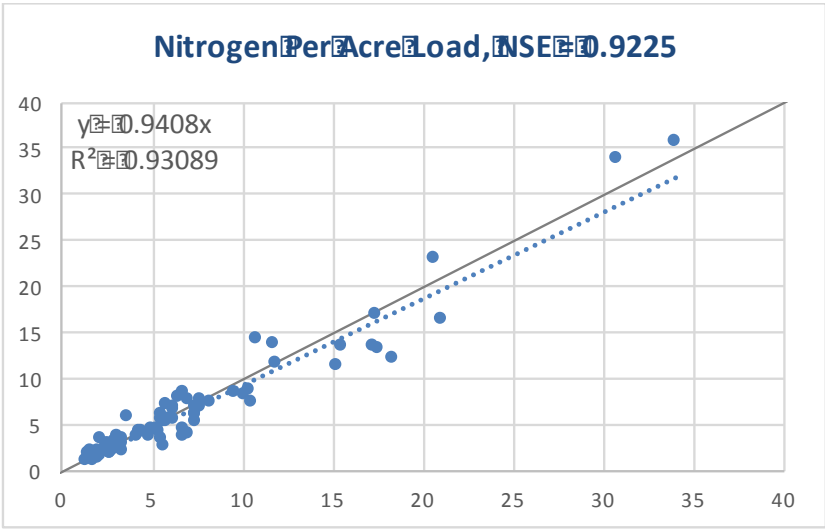


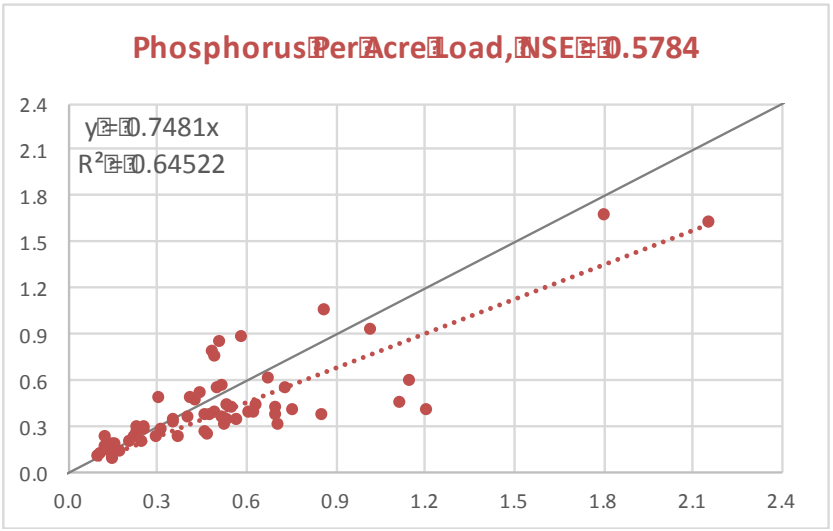
Simulated Per Acre Load

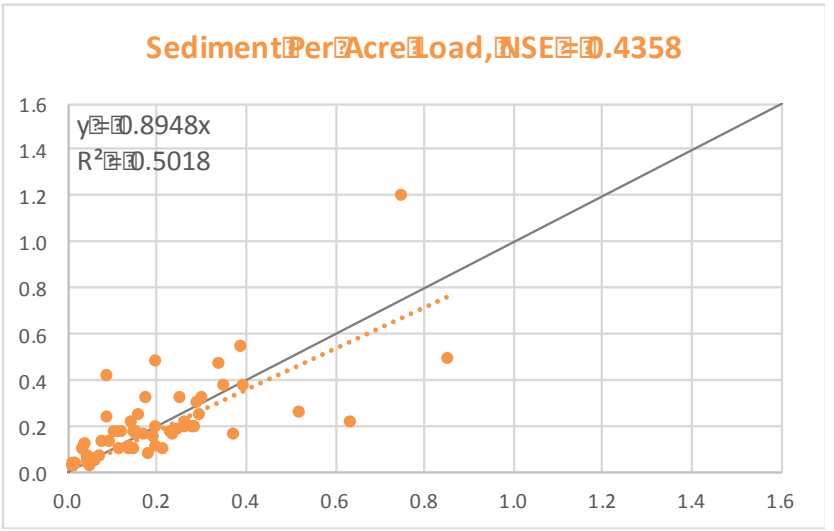
WRTDS Per Acre Load

DRAFT A – geographic efficiencies





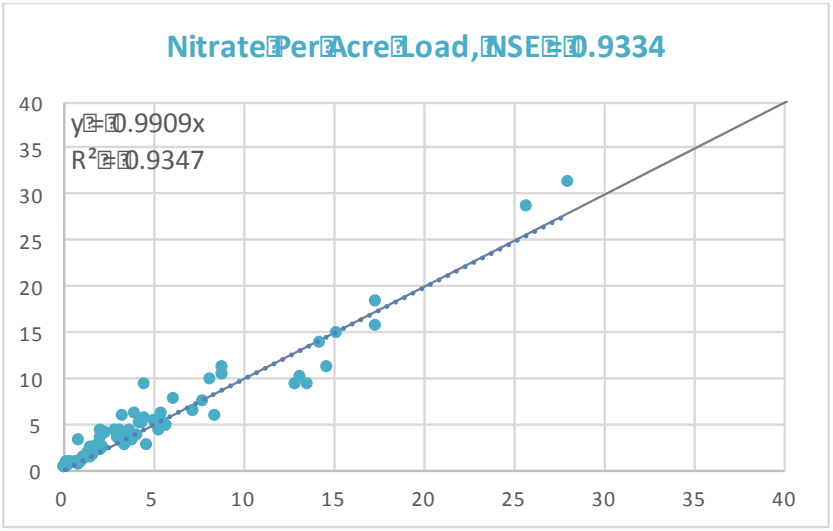


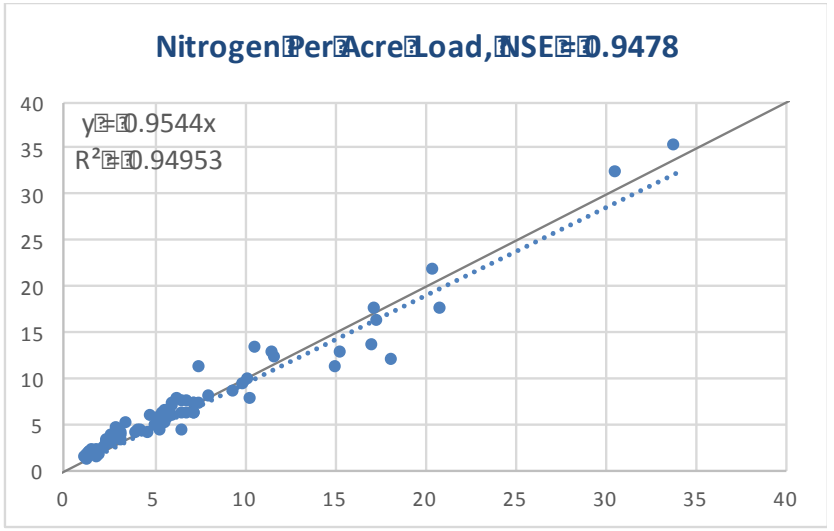


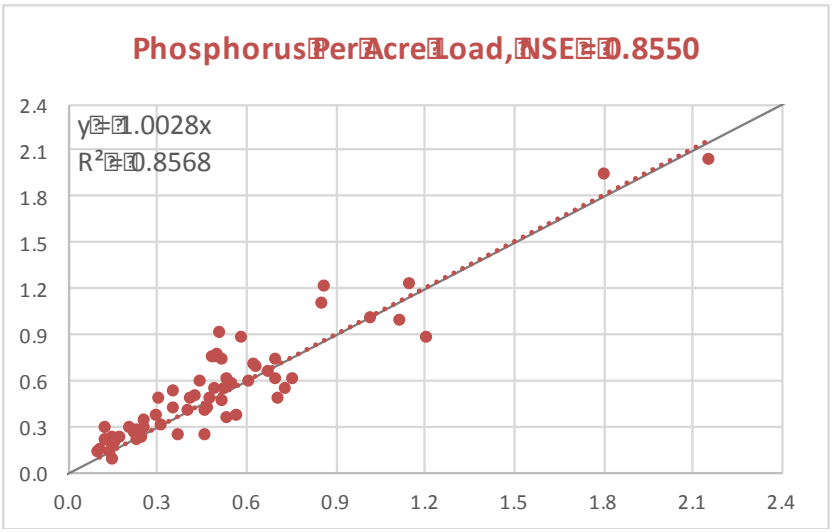
Simulated Per Acre Load

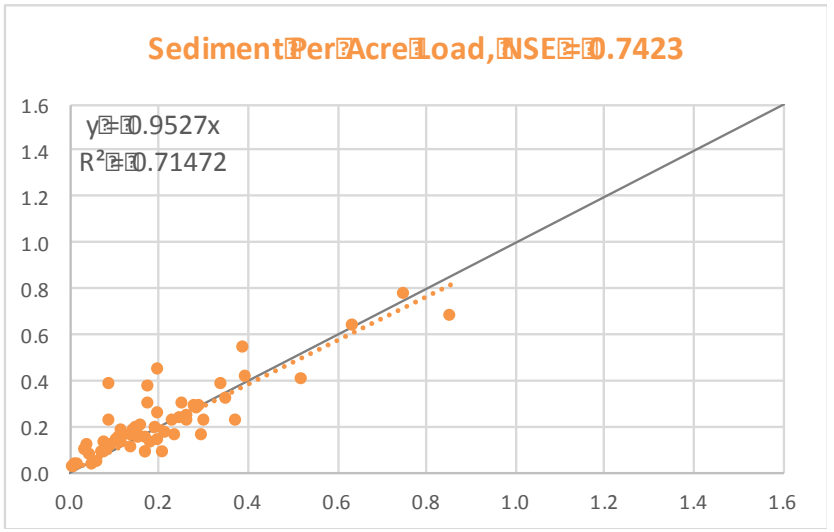
WRTDS Per Acre Load

DRAFT G – geographic efficiencies









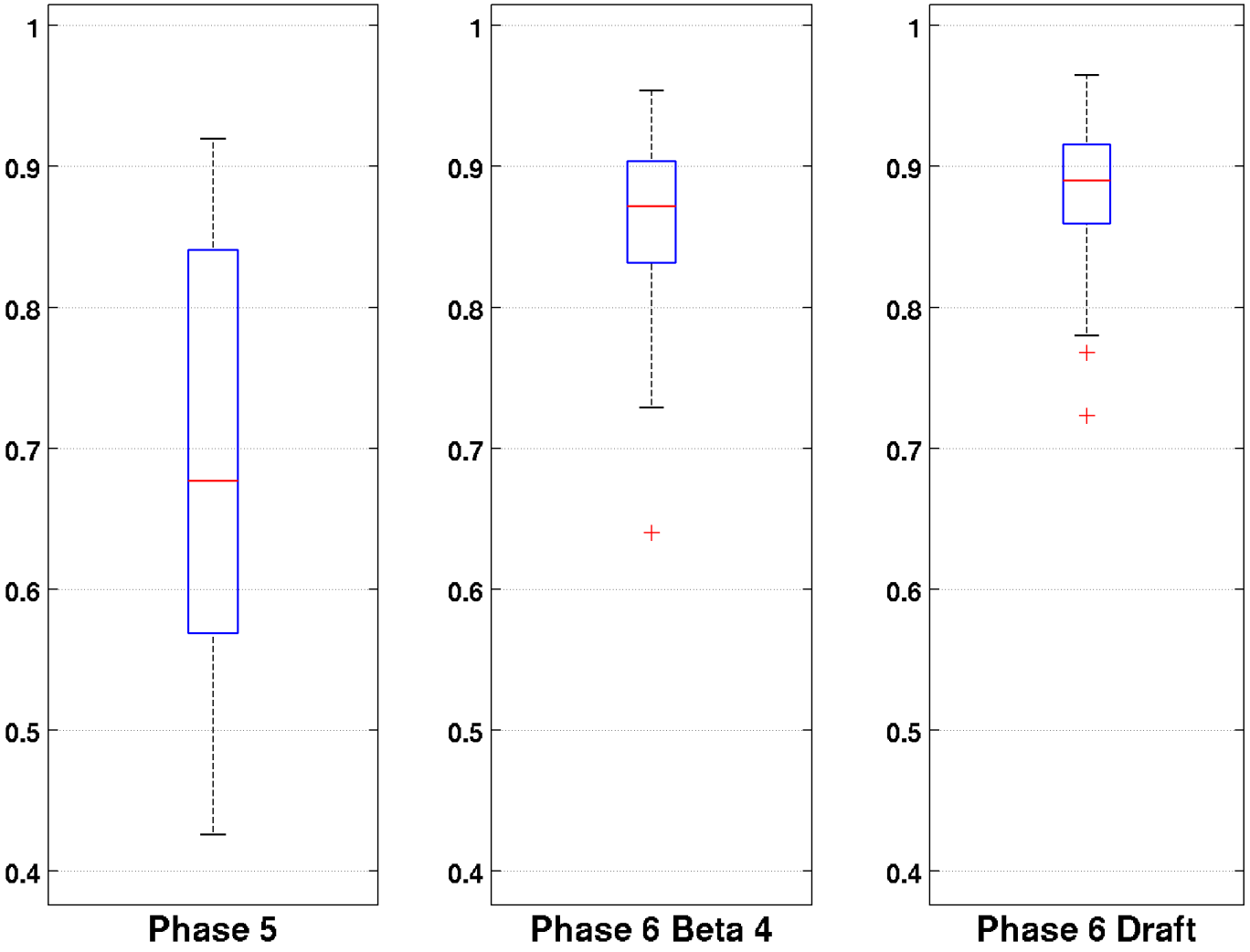
Simulated Per Acre Load

WRTDS Per Acre Load

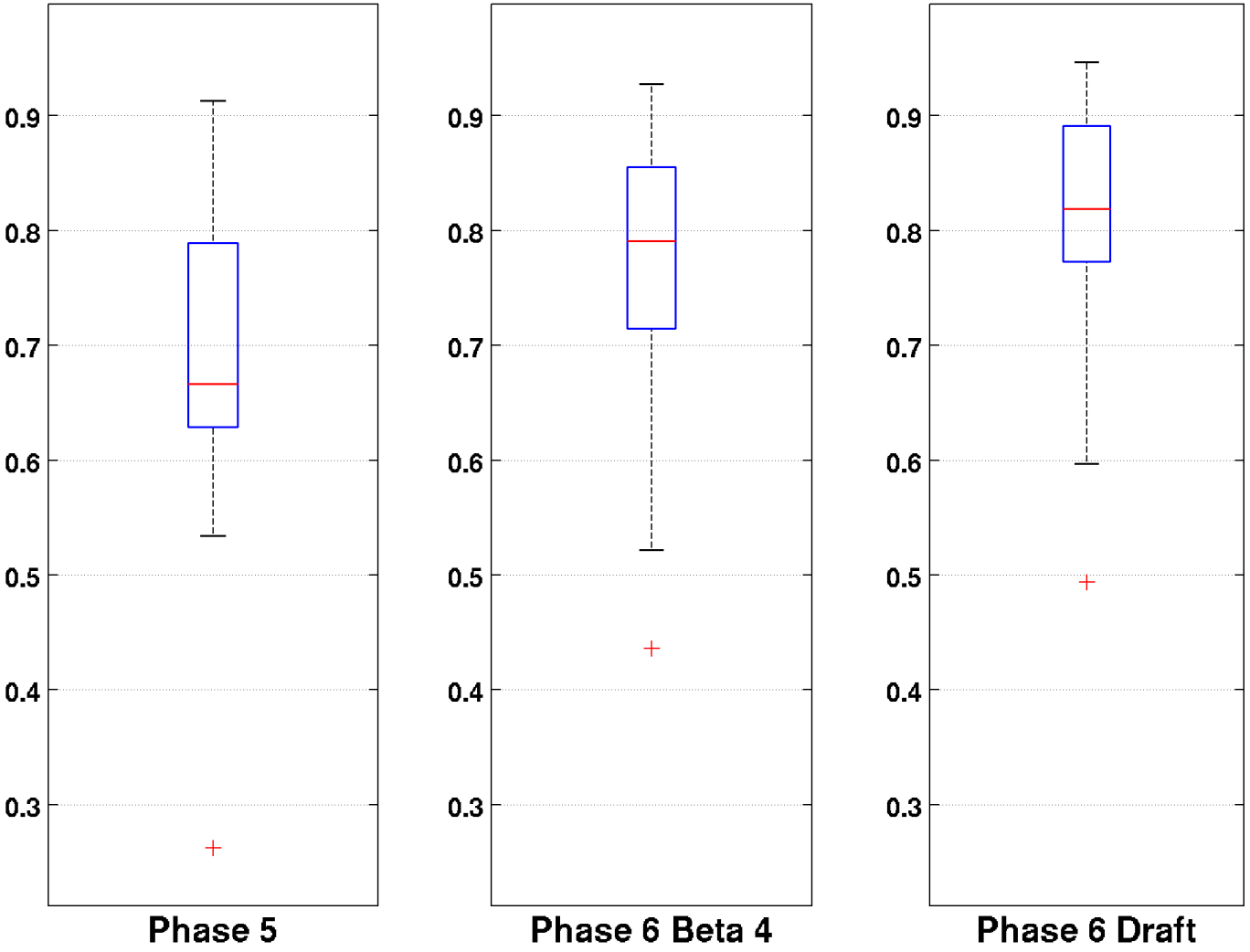
Summary of geographic efficiencies

Constituents	**Phase 5**	**Beta 4**	**Draft A**	**Draft G**
Nitrate	0.8284	0.8862	0.7918	0.9334
Nitrogen	0.8704	0.8583	0.9225	0.9478
Phosphorus	0.6321	0.4497	0.5784	0.8550
Sediment	-0.0770	0.3849	0.4358	0.7423

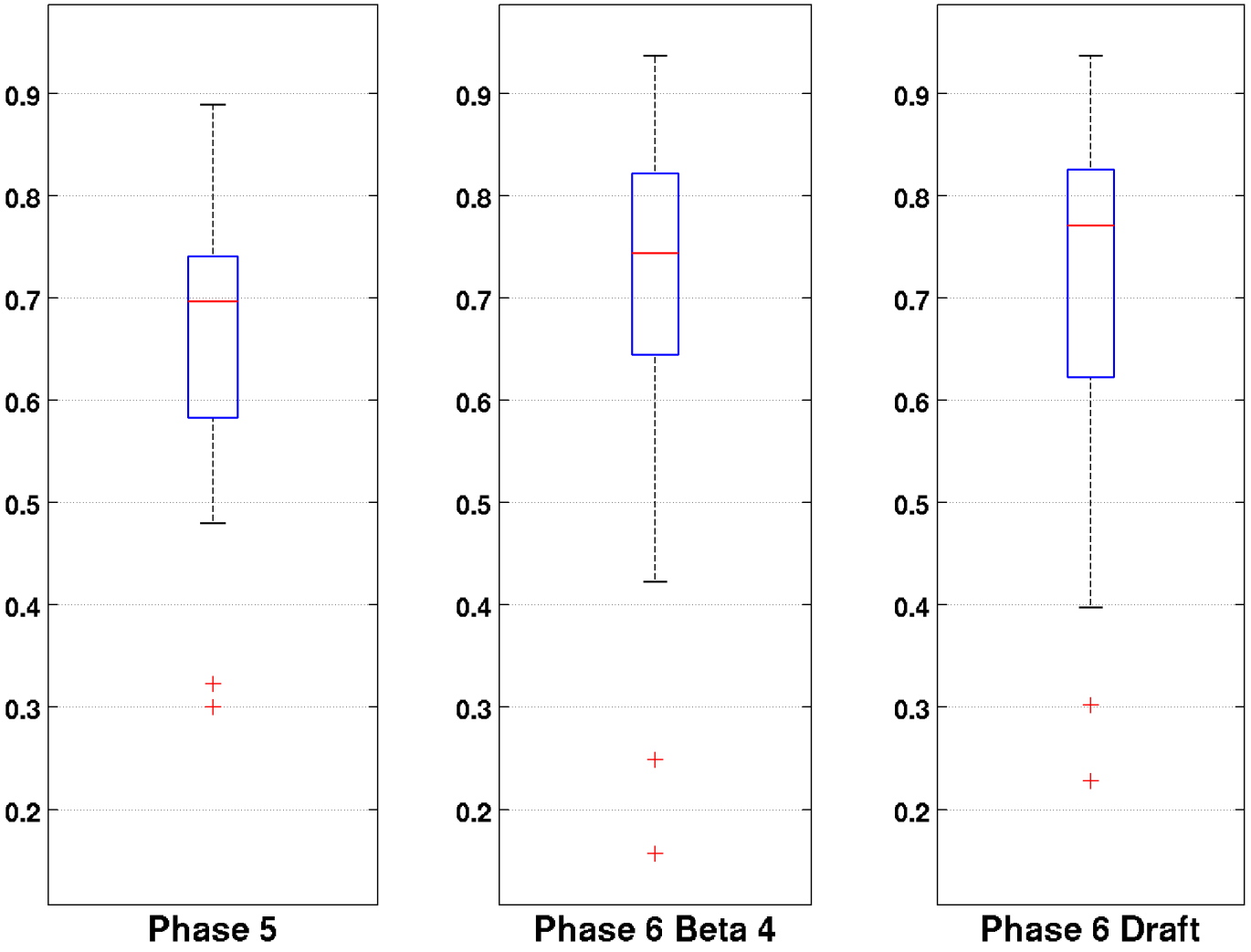
Monthly loads: total nitrogen



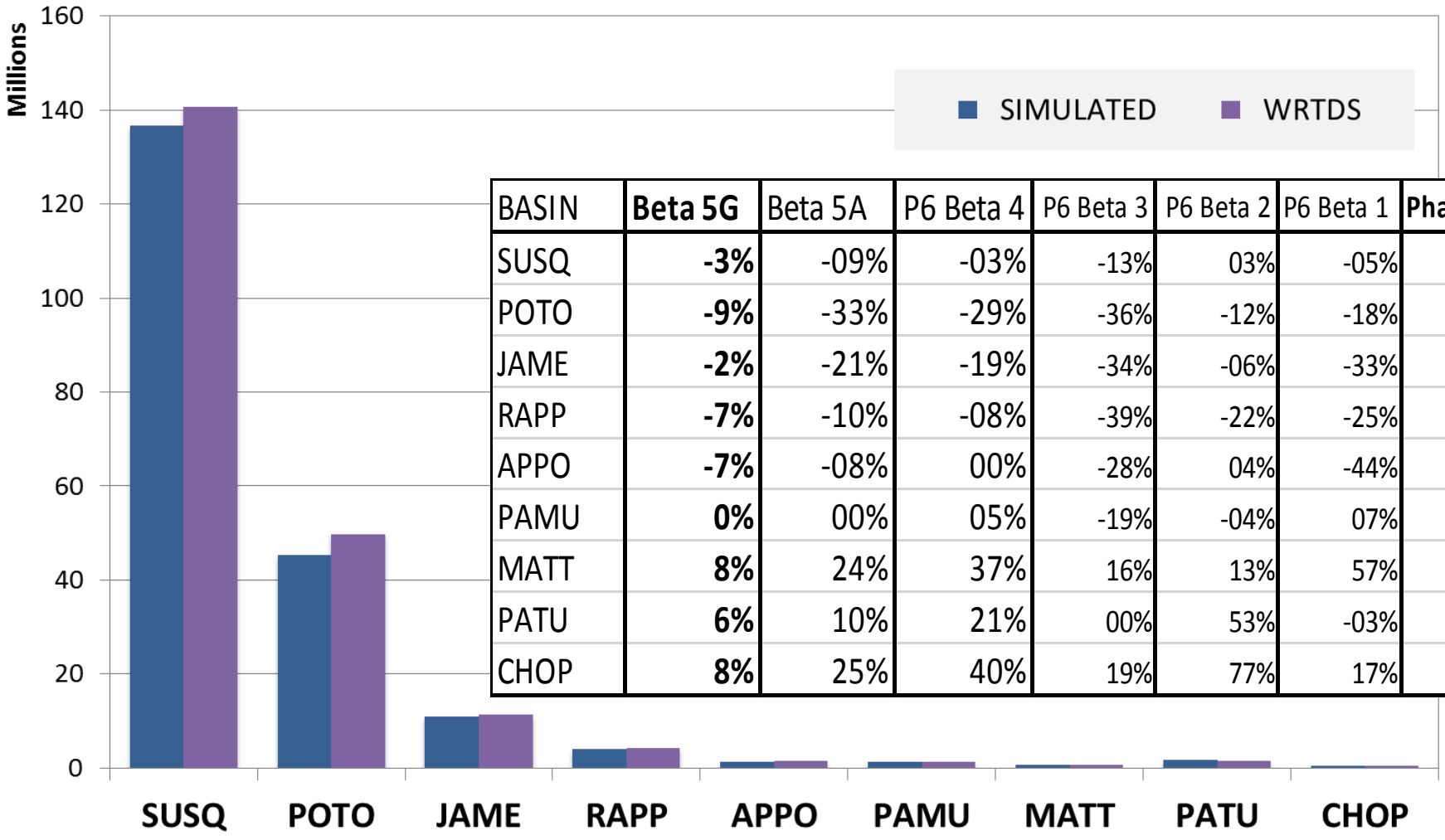
Monthly loads: total phosphorus



Monthly loads: sediment



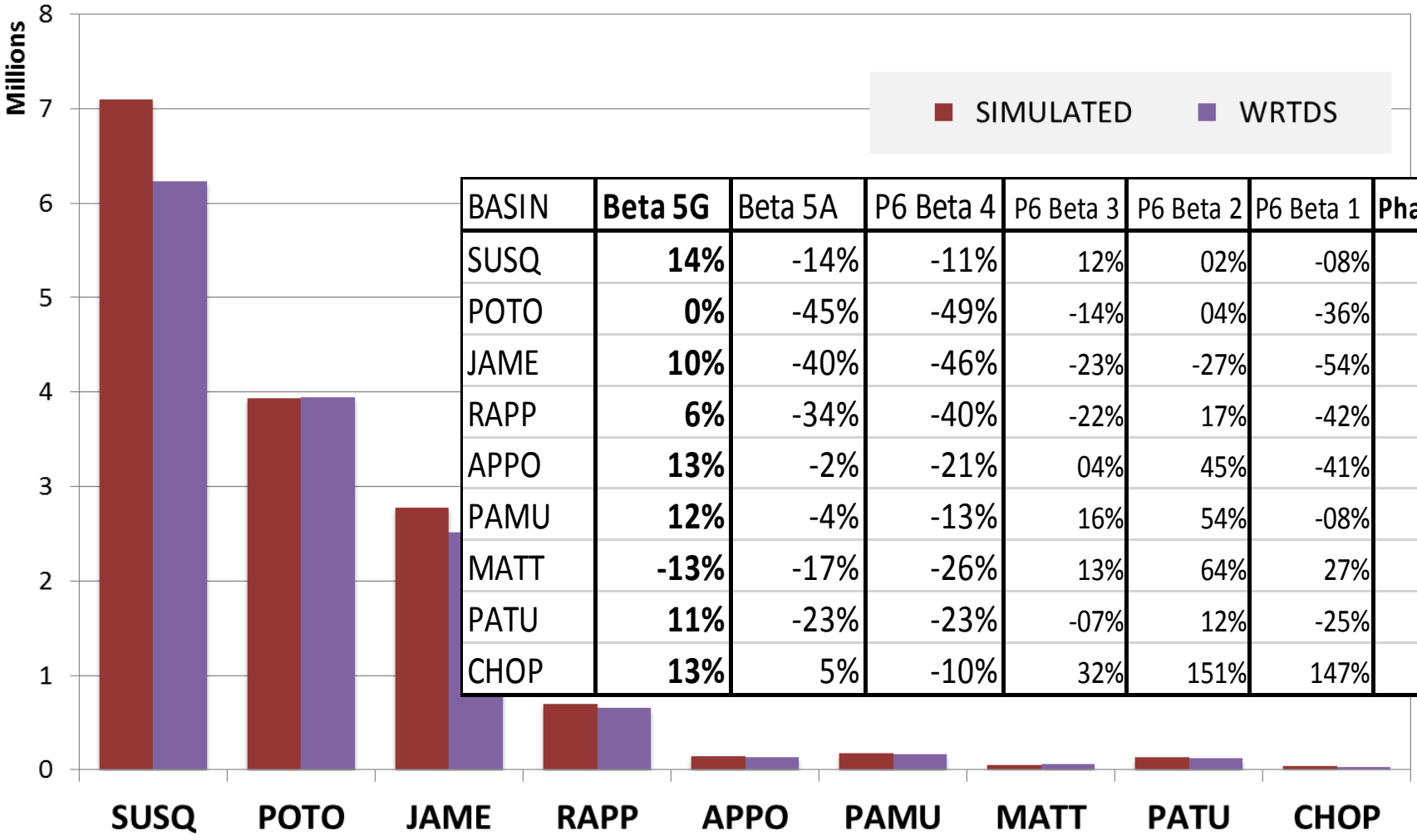
RIM loads: total nitrogen



BASIN	**Beta 5G**	Beta 5A	P6 Beta 4	P6 Beta 3	P6 Beta 2	P6 Beta 1	**Phase 5**
SUSQ	**-3%**	-09%	-03%	-13%	03%	-05%	**-1%**
POTO	**-9%**	-33%	-29%	-36%	-12%	-18%	**-22%**
JAME	**-2%**	-21%	-19%	-34%	-06%	-33%	**-7%**
RAPP	**-7%**	-10%	-08%	-39%	-22%	-25%	**-10%**
APPO	**-7%**	-08%	00%	-28%	04%	-44%	**-2%**
PAMU	**0%**	00%	05%	-19%	-04%	07%	**6%**
MATT	**8%**	24%	37%	16%	13%	57%	**-6%**
PATU	**6%**	10%	21%	00%	53%	-03%	**19%**
CHOP	**8%**	25%	40%	19%	77%	17%	**-13%**

assuming +/- 10% uncertainty in WRTDS estimates

RIM loads: total phosphorus



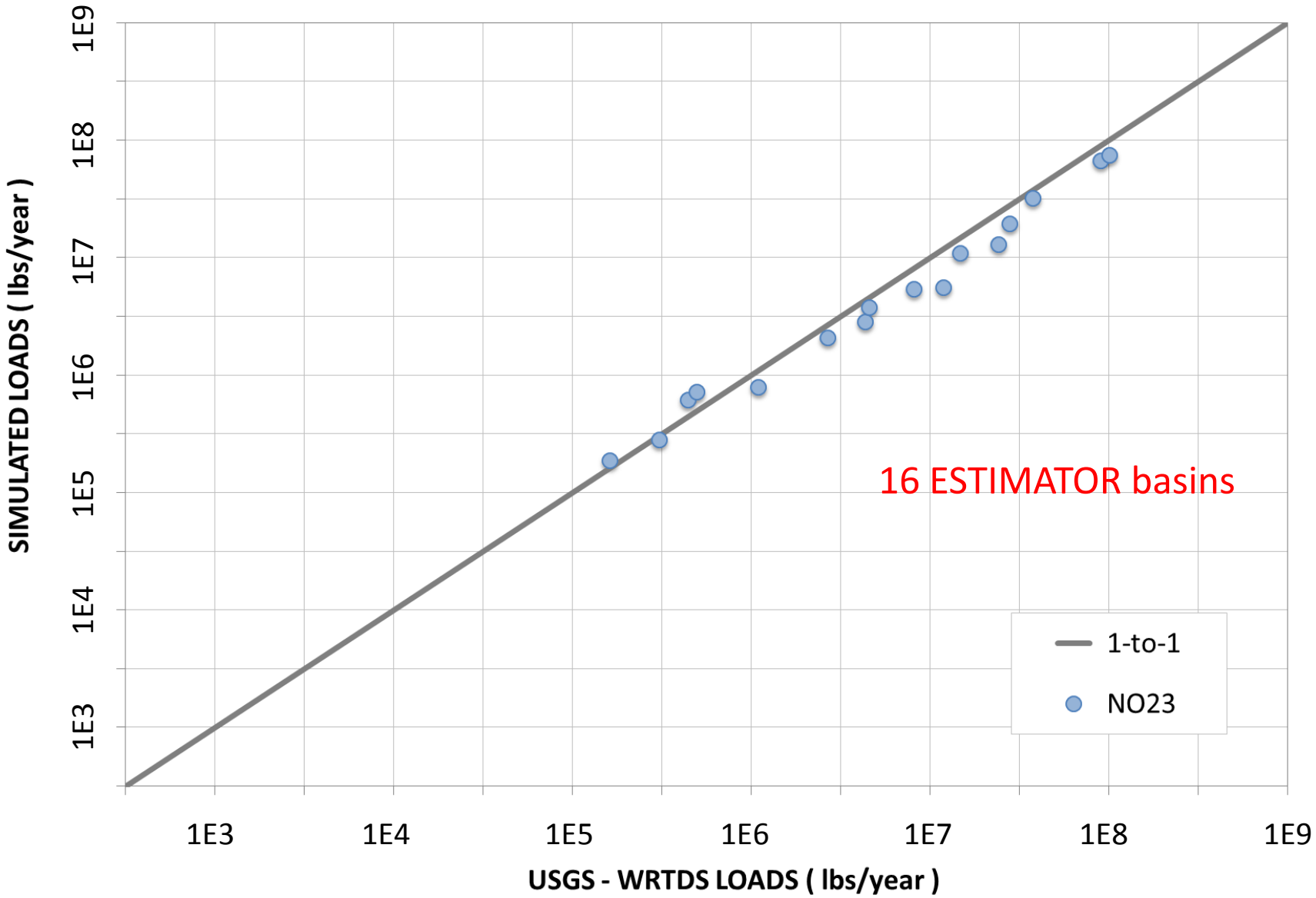
BASIN	**Beta 5G**	Beta 5A	P6 Beta 4	P6 Beta 3	P6 Beta 2	P6 Beta 1	**Phase 5**
SUSQ	**14%**	-14%	-11%	12%	02%	-08%	**10%**
POTO	**0%**	-45%	-49%	-14%	04%	-36%	**-14%**
JAME	**10%**	-40%	-46%	-23%	-27%	-54%	**-25%**
RAPP	**6%**	-34%	-40%	-22%	17%	-42%	**2%**
APPO	**13%**	-2%	-21%	04%	45%	-41%	**4%**
PAMU	**12%**	-4%	-13%	16%	54%	-08%	**7%**
MATT	**-13%**	-17%	-26%	13%	64%	27%	**4%**
PATU	**11%**	-23%	-23%	-07%	12%	-25%	**-18%**
CHOP	**13%**	5%	-10%	32%	151%	147%	**22%**

assuming +/- 15% uncertainty in WRTDS estimates

Questions to be asked today

- Were we successful in our attempt to avoid using calibrated regional factors?
- Is the calibration without calibrated regional factors as good as the Phase 5 calibration with calibrated regional factors?
- Would any gain in load accuracy with the addition of calibrated regional factors be worth the loss in explanatory power?

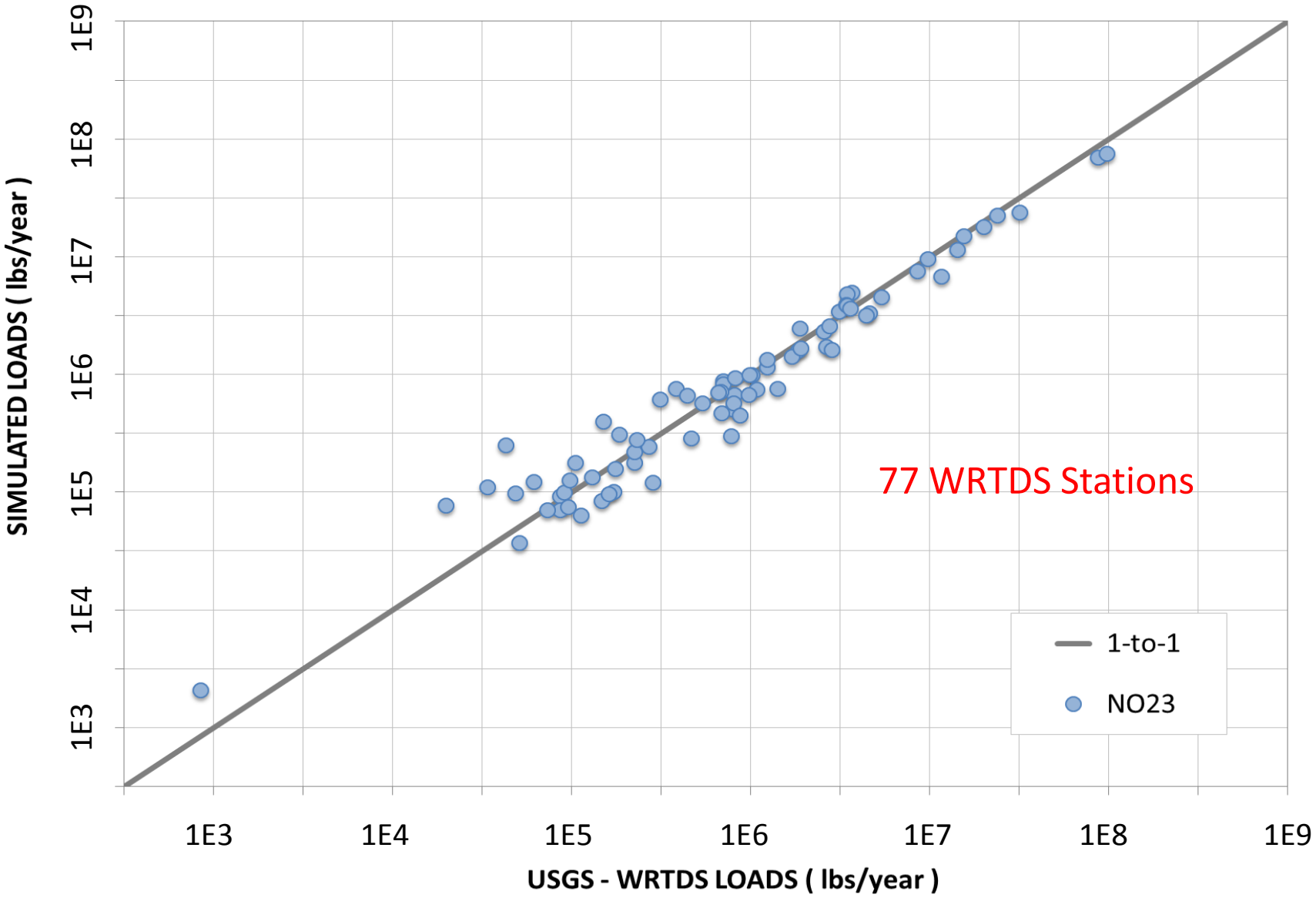
Appendices


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

BETA 4C

Beta 4 calibration

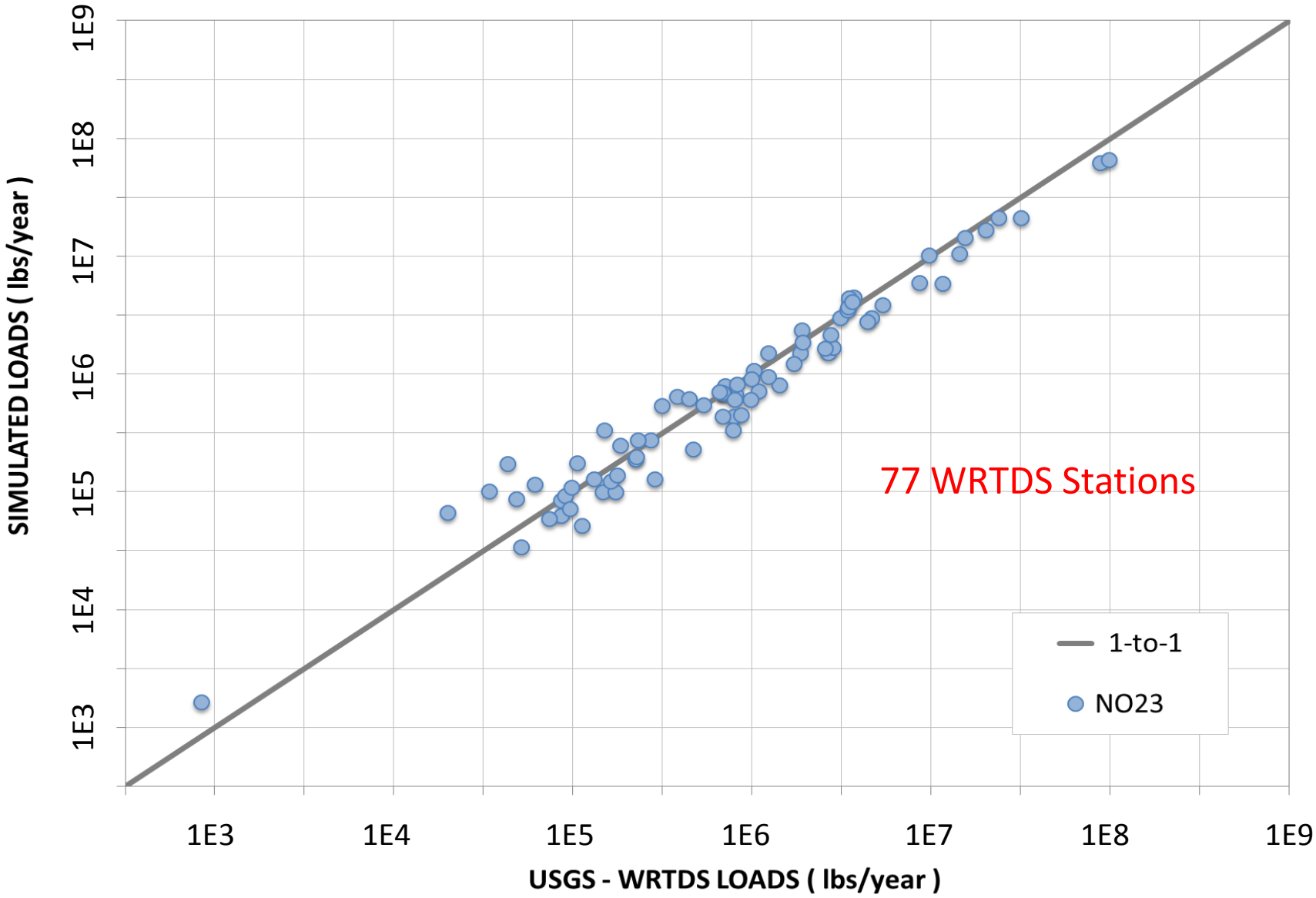
NITRATE



DRAFT A

Revised inputs and model refinements

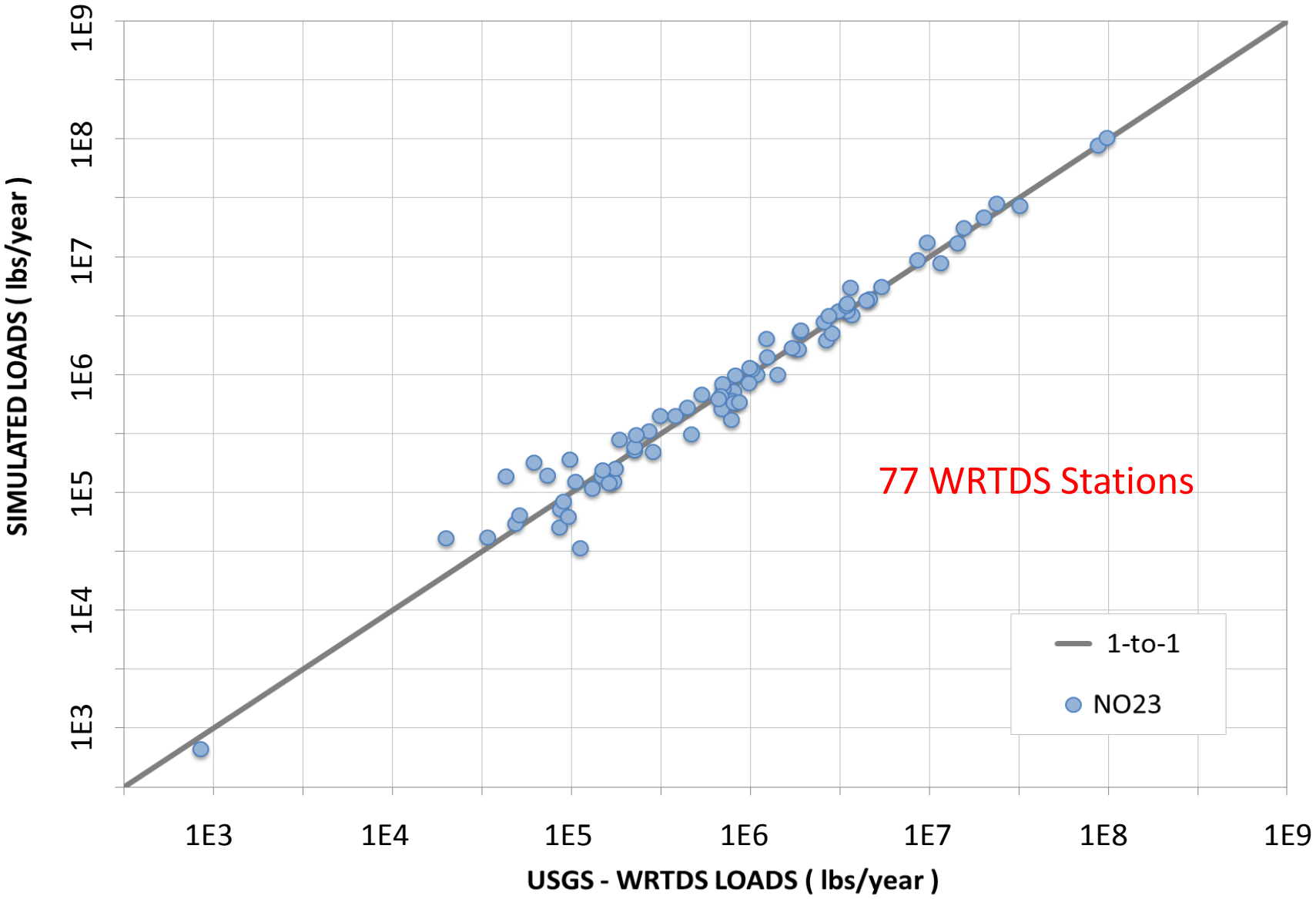
NITRATE



DRAFT G

Revised inputs, model refinements, and calibration methods

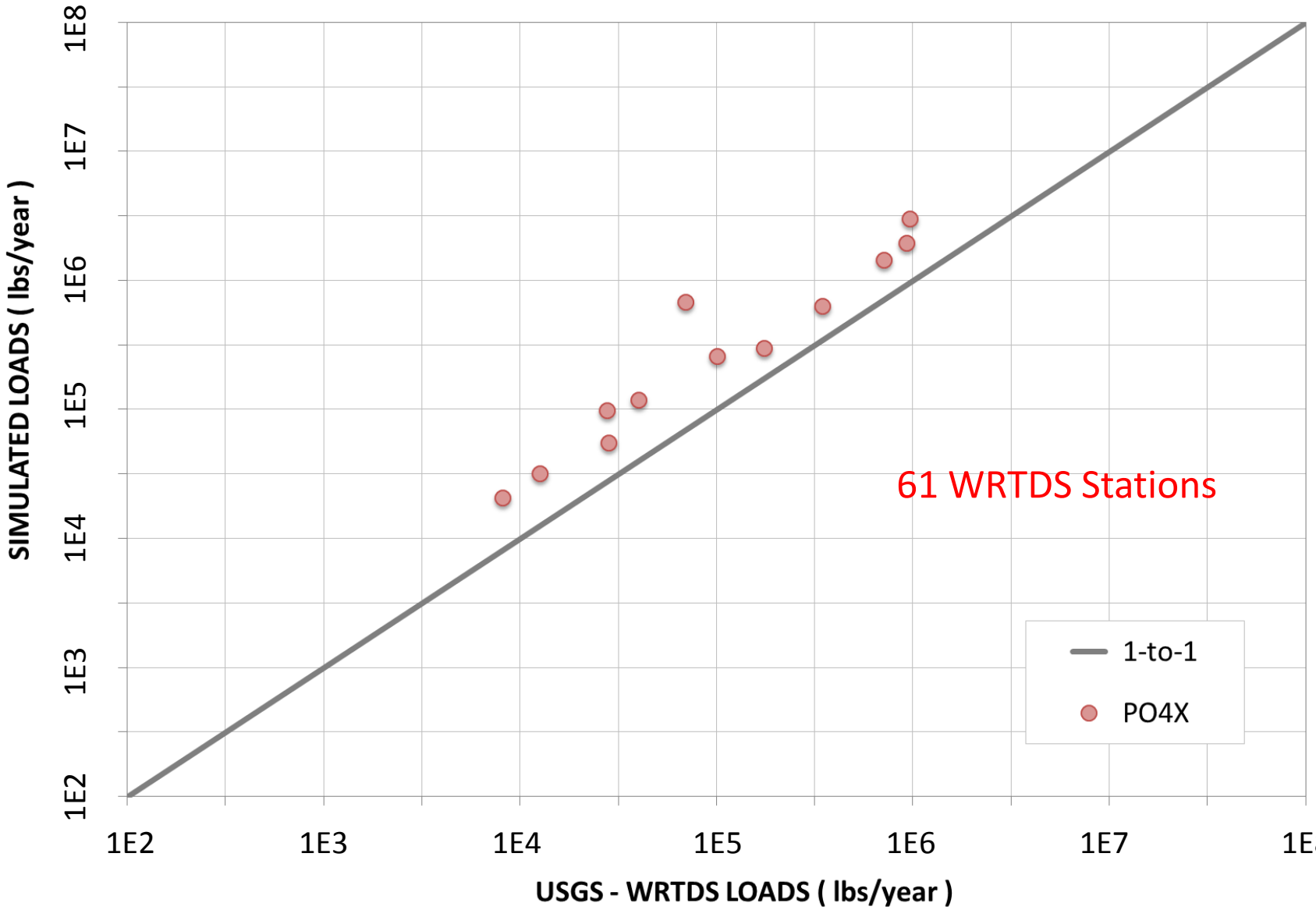
NITRATE



PHASE 5

Phase 5.3.2

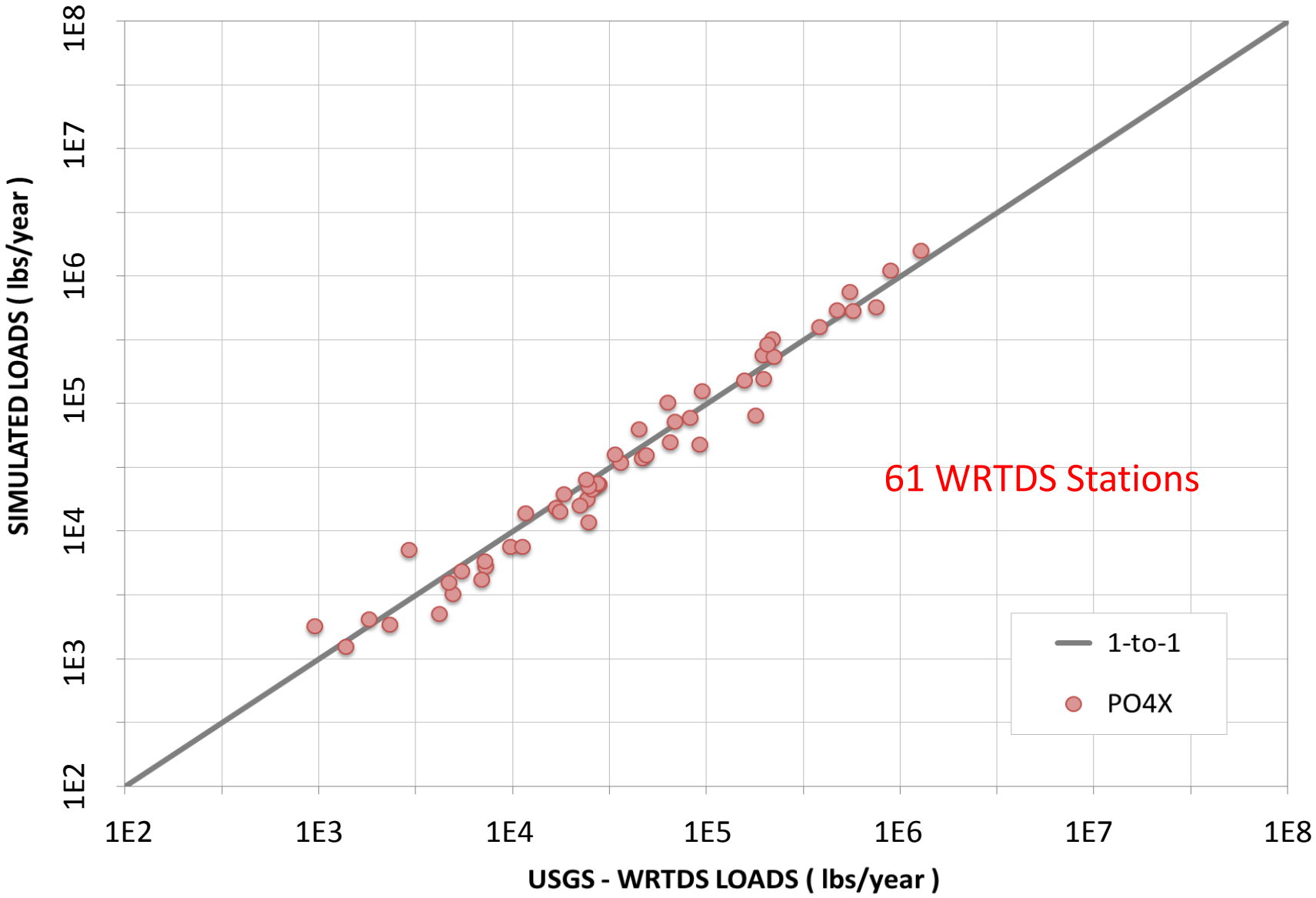
DISSOLVED PHOSPHATE



BETA 4C

Beta 4 calibration

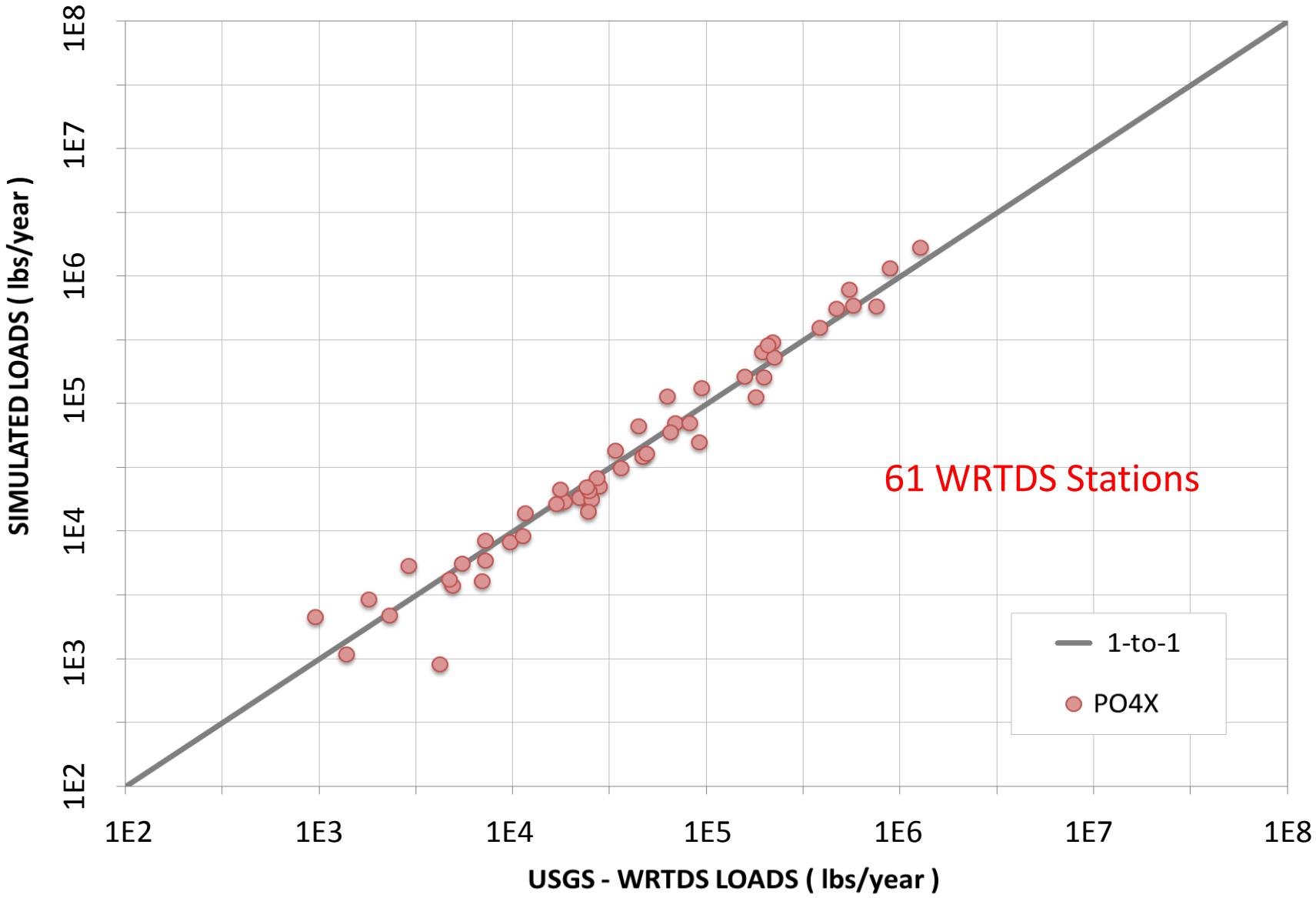
DISSOLVED PHOSPHATE



DRAFT A

Revised inputs and model refinements

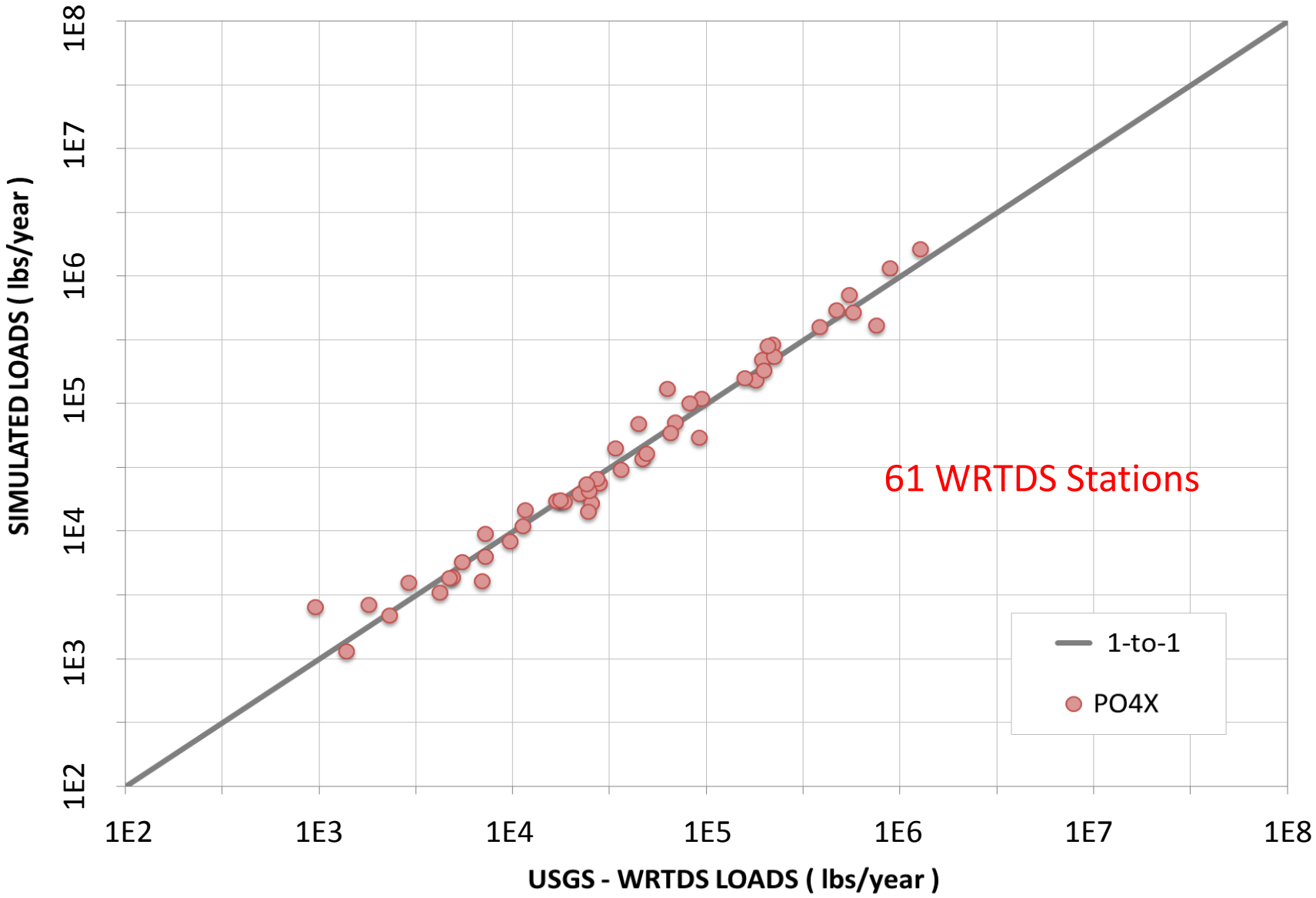
DISSOLVED PHOSPHATE



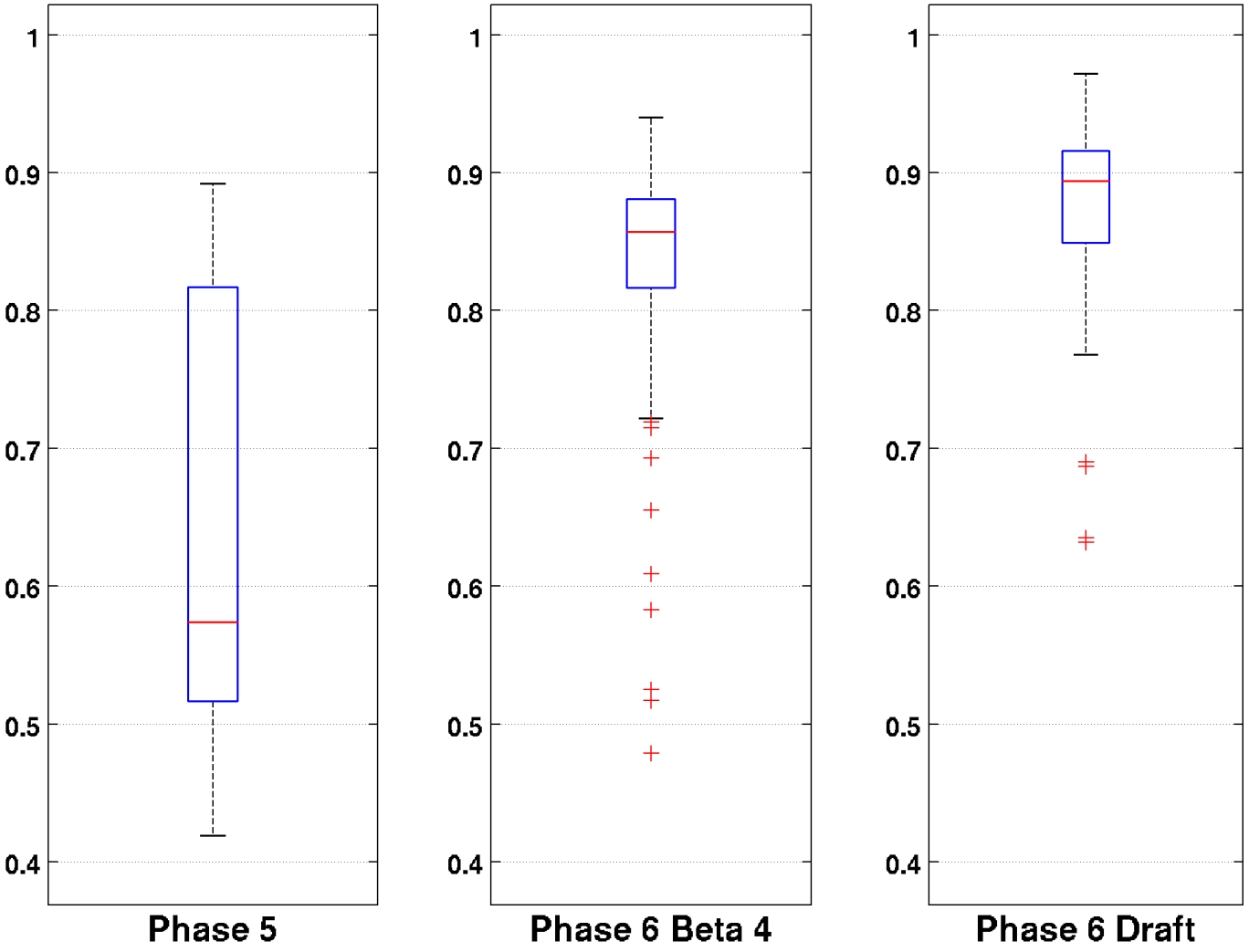
DRAFT G

Revised inputs, model refinements, and calibration methods

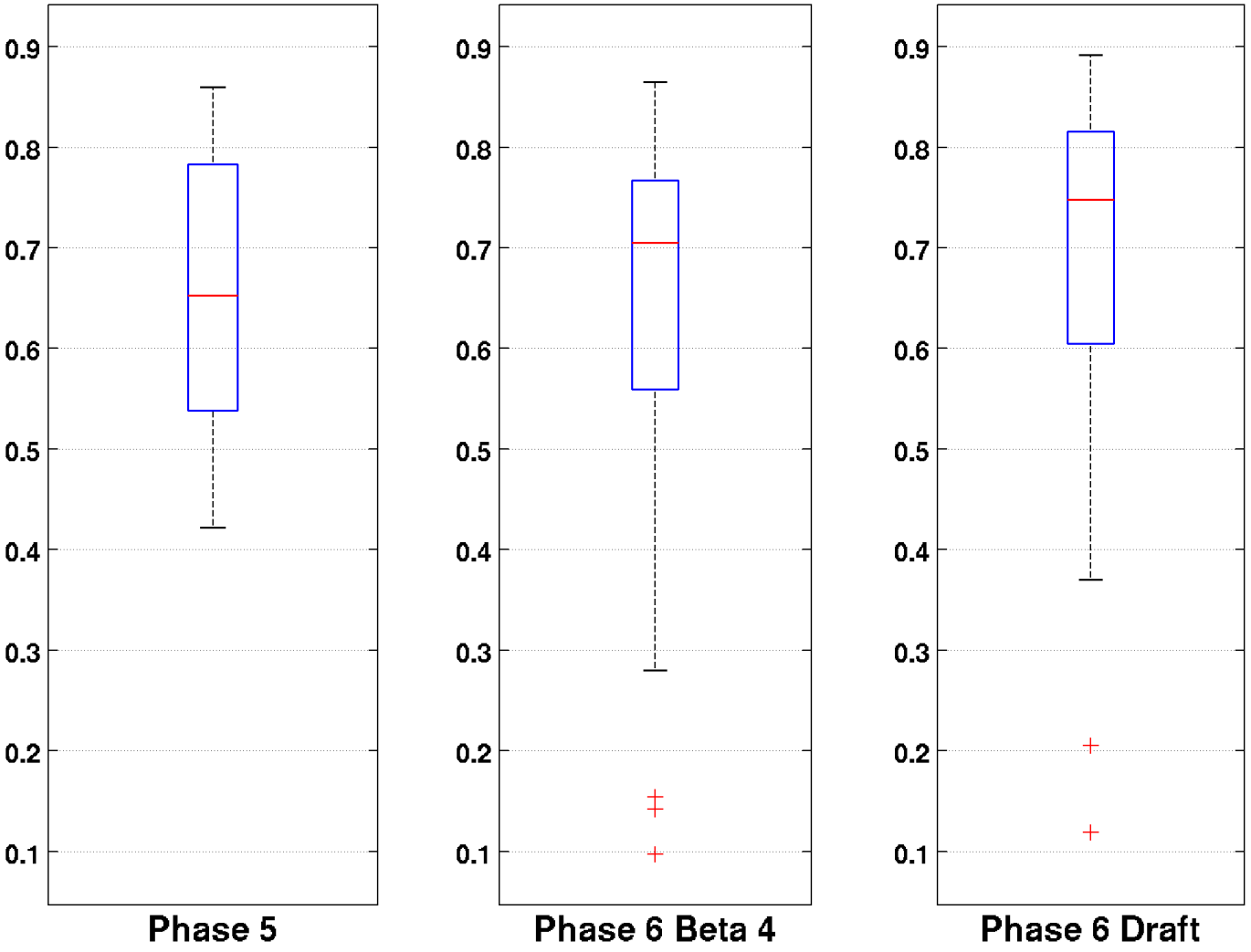
DISSOLVED PHOSPHATE



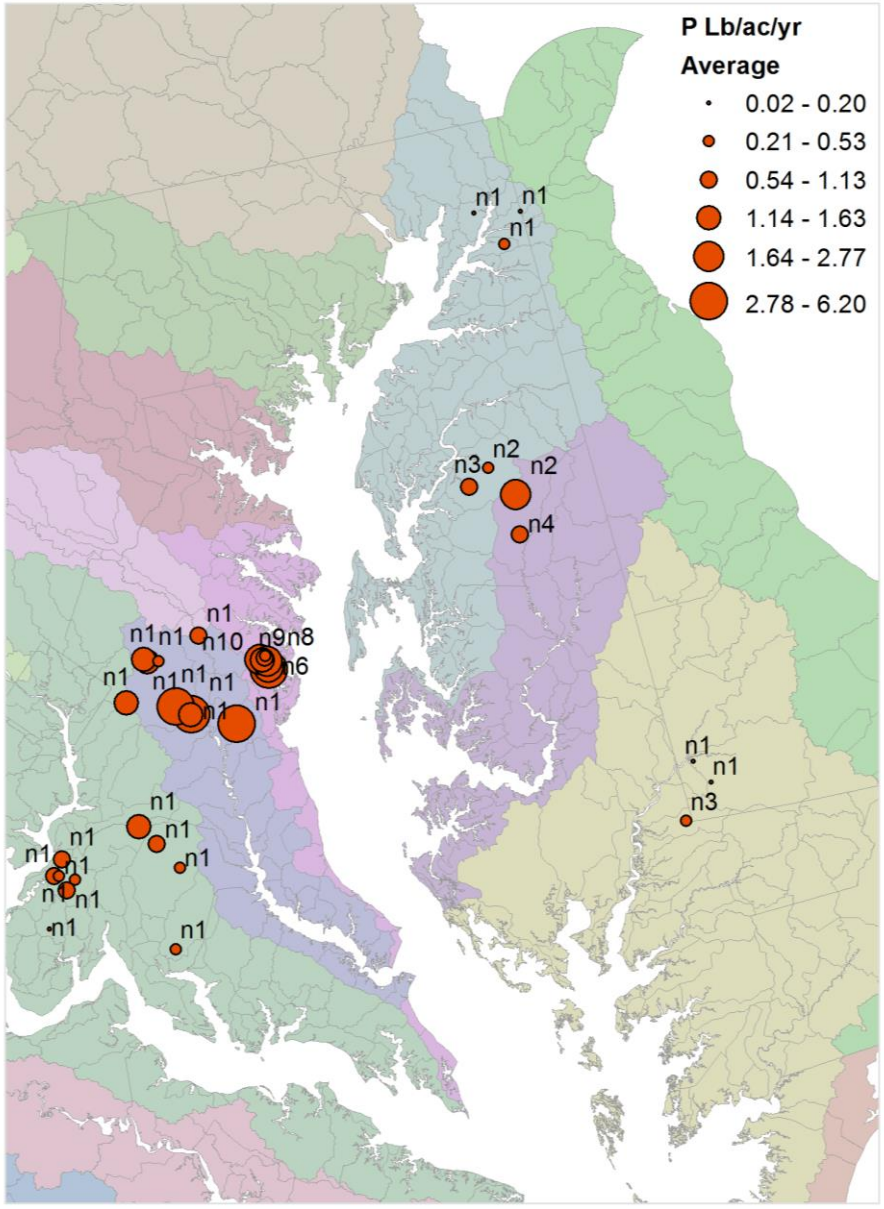
Monthly loads: nitrate



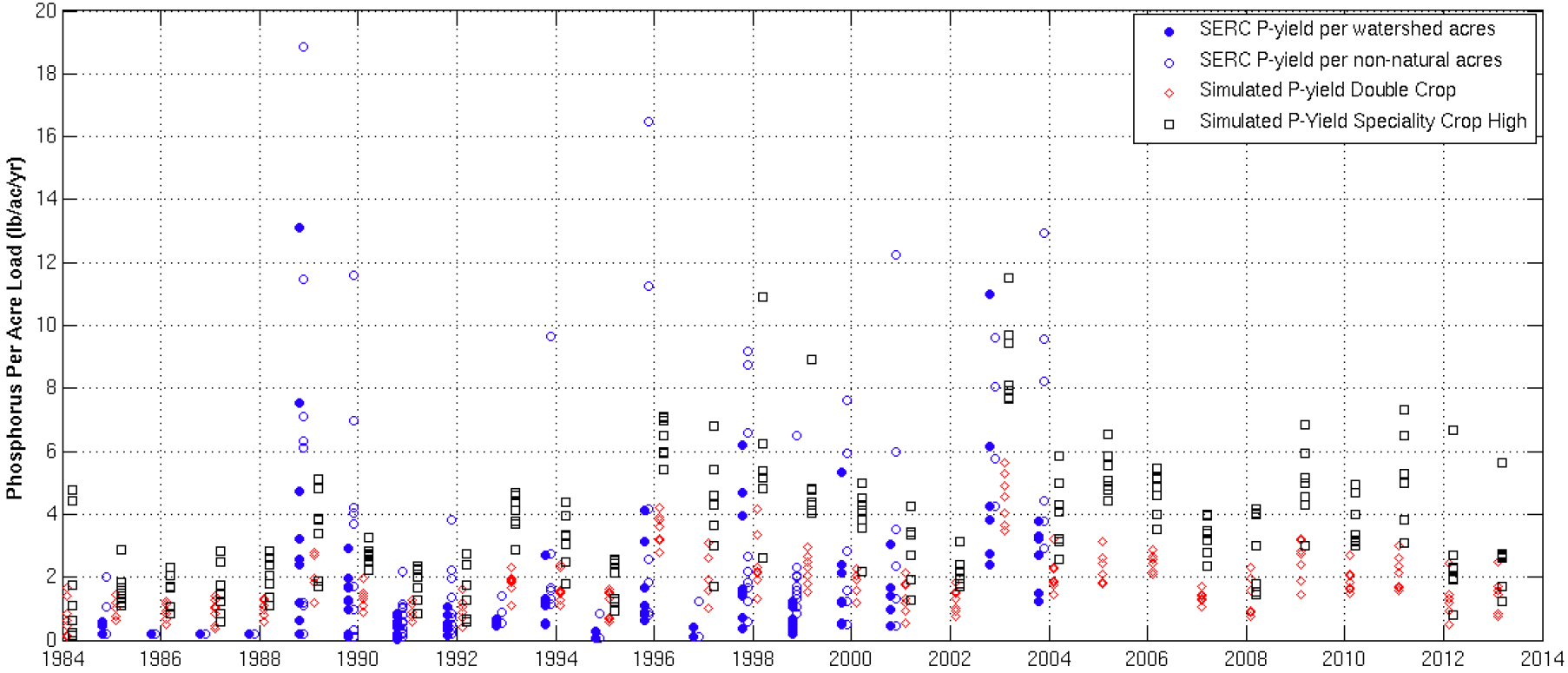
Monthly loads: dissolved phosphate



Annual Phosphorus Runoff

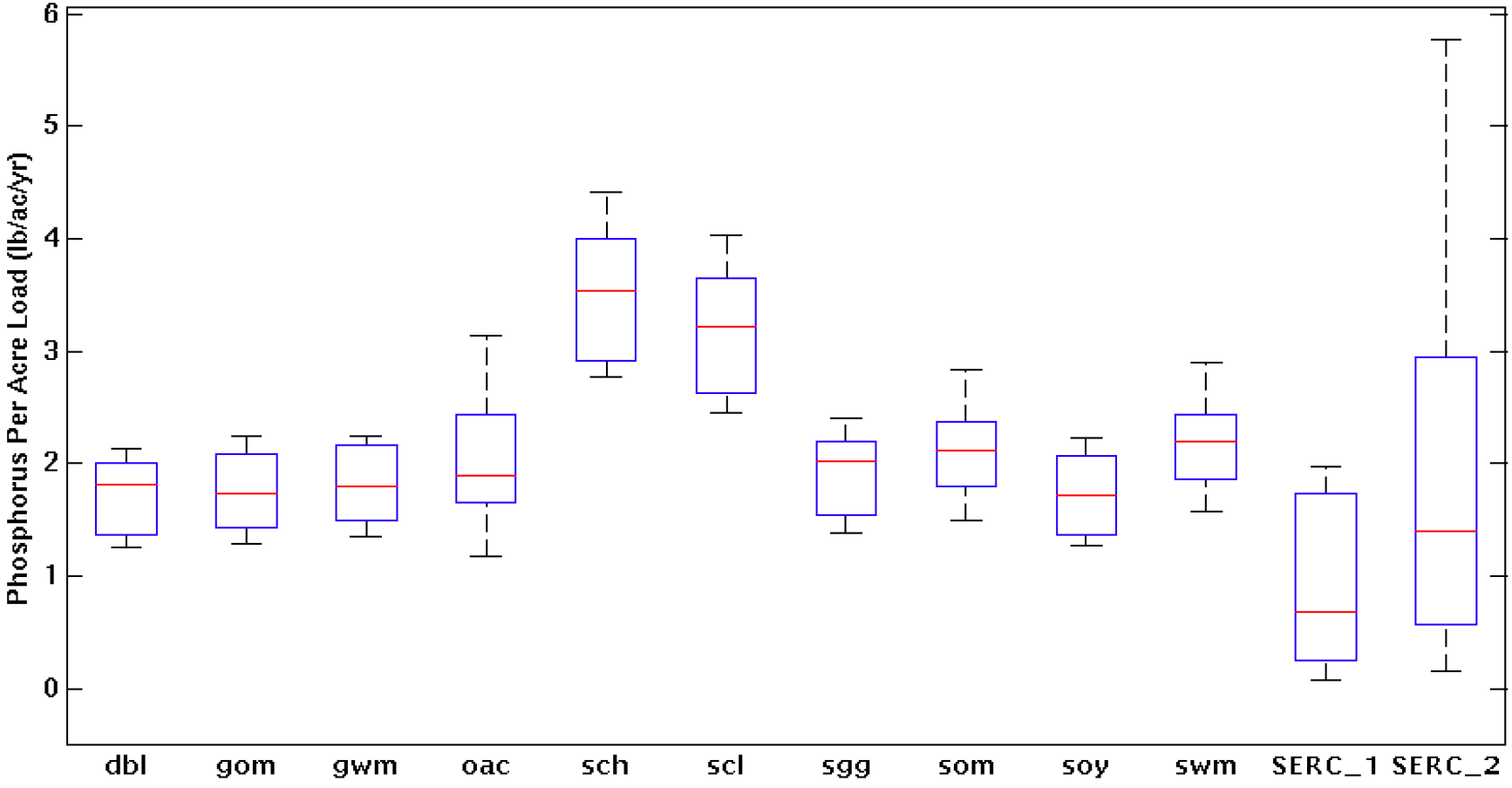


Major/Minor Basin	Nobs
Eastern Shore of Chesapeake Bay	19
Upper Eastern Shore	8
Middle Eastern Shore, including Choptank River	6
Lower Eastern Shore	5
Western Shore of Chesapeake Bay	71
Lower Western shore	71
Patuxent River Basin	9
Patuxent River below Bowie, Maryland	9
Potomac River Basin	10
Lower Potomac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