Prototype Phase-6 Watershed Model

Watershed Model Calibration

Gopal Bhatt [gopal.bhatt@psu.edu]
Modeling Workgroup
4/1/2014
Presented by: Gary Shenk

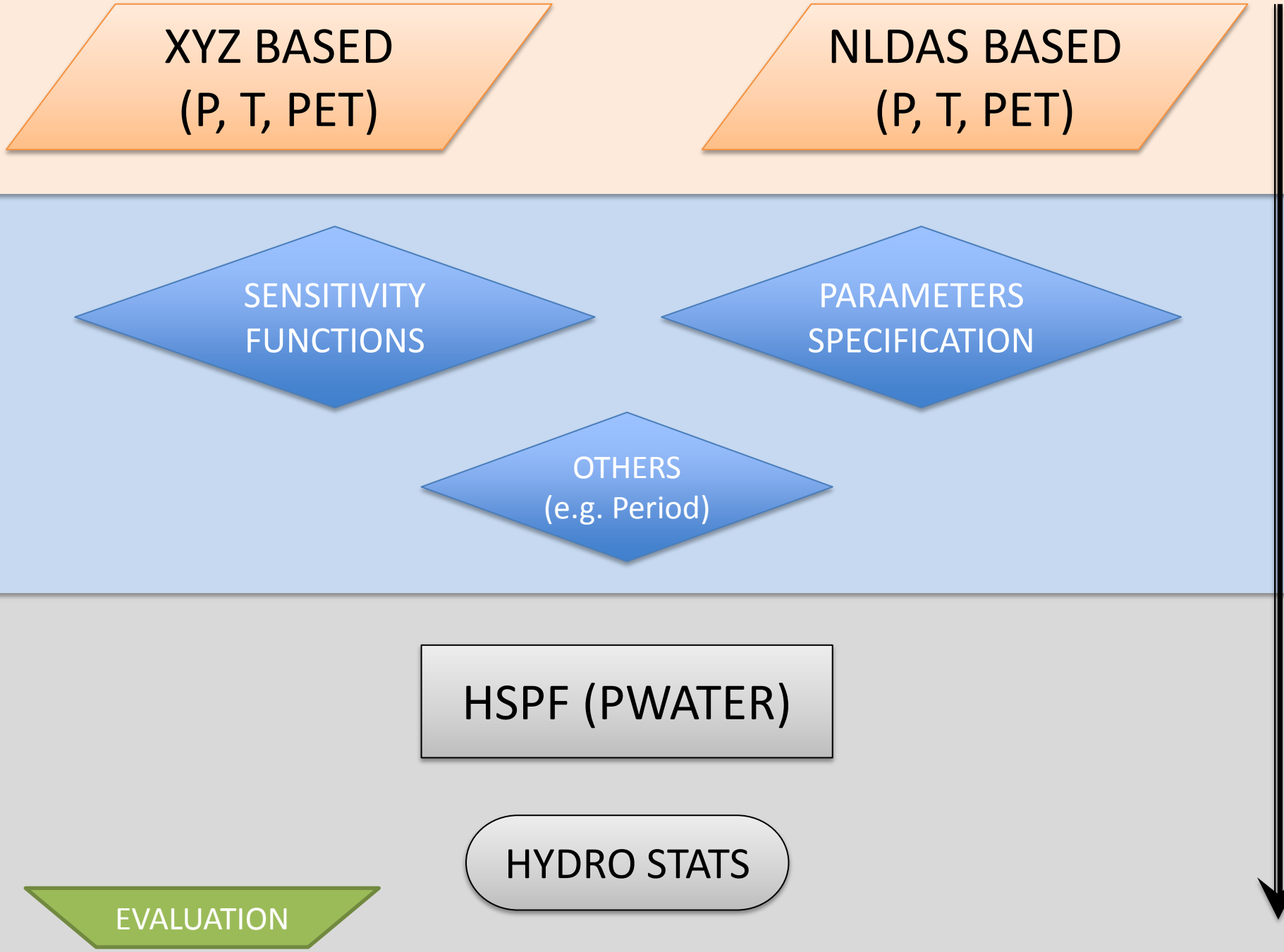
Objectives

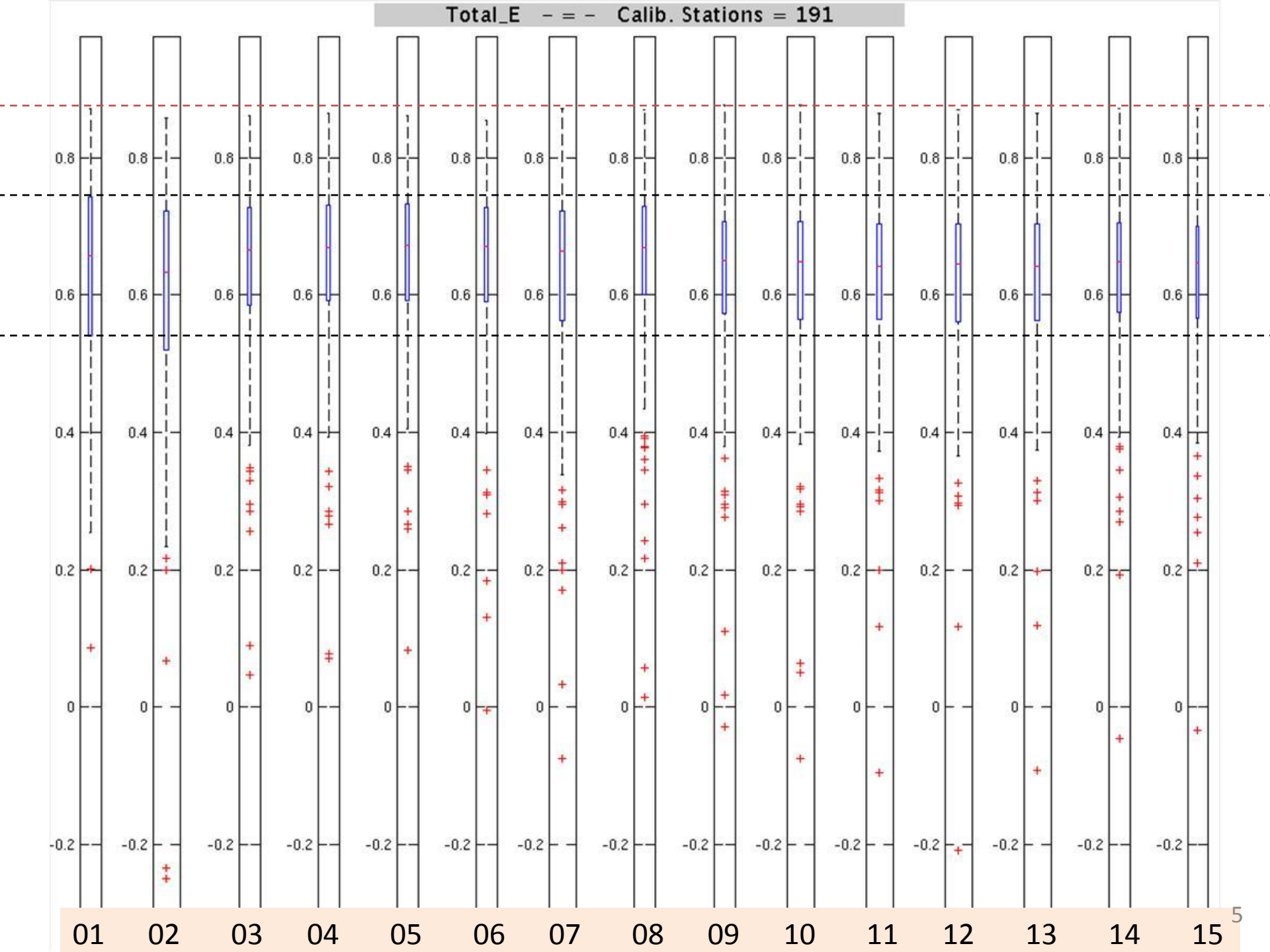
- Replace Phase 5 precipitation and meteorological data with NLDAS-2
- Replace AGCHEM based simulation of nutrients with PQUAL

- Refine calibration methodology and improve operational aspects
- Establish and demonstrate incremental changes starting with Phase 5.3.2 as base

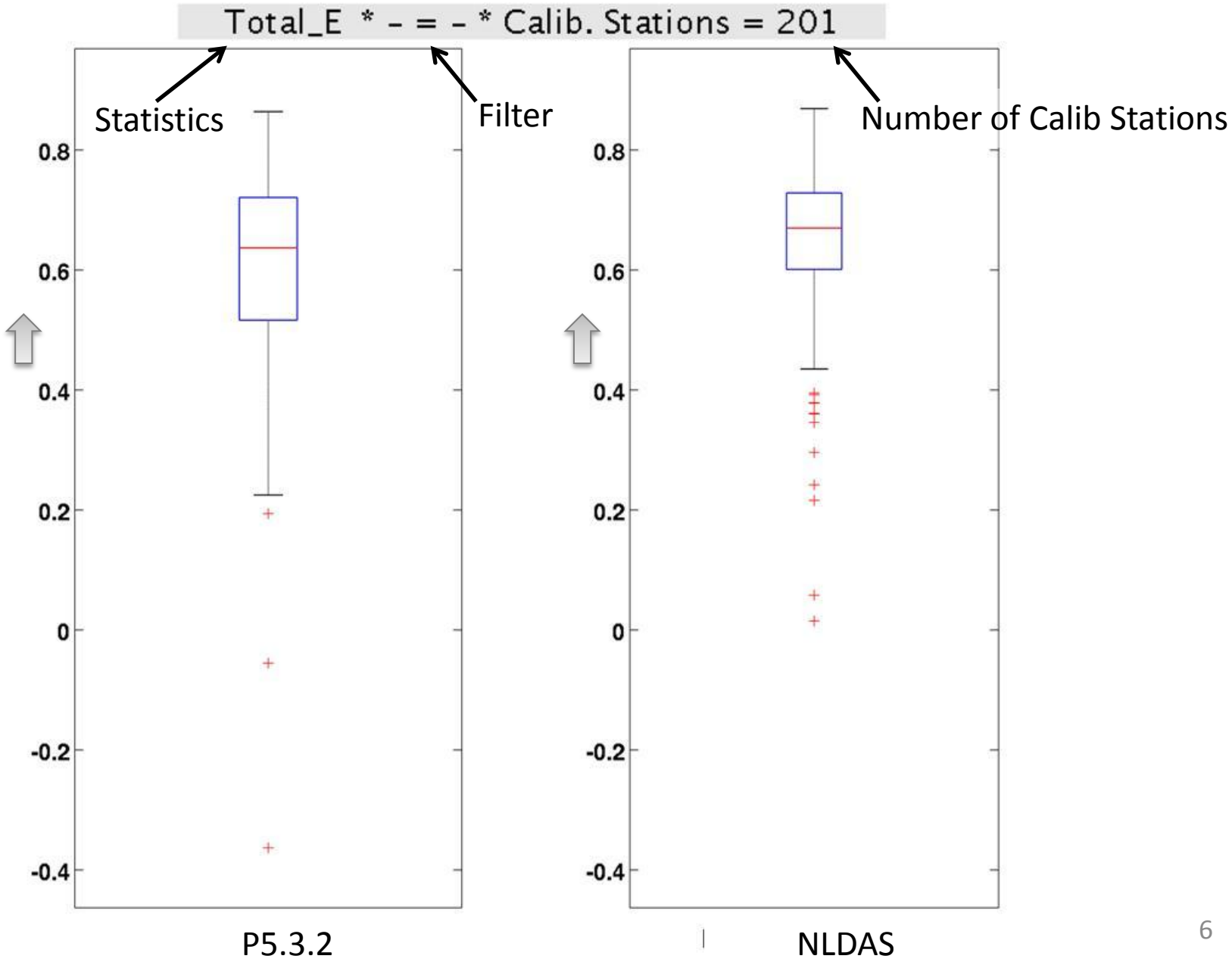
HYDROLOGY CALIBRATION

NLDAS and Calibration Method


XYZ BASED
(P, T, PET)
NLDAS BASED
(P, T, PET)
SENSITIVITY
FUNCTIONS
PARAMETERS
SPECIFICATION
OTHERS
(e.g. Period)
HSPF (PWATER)
HYDRO STATS
EVALUATION

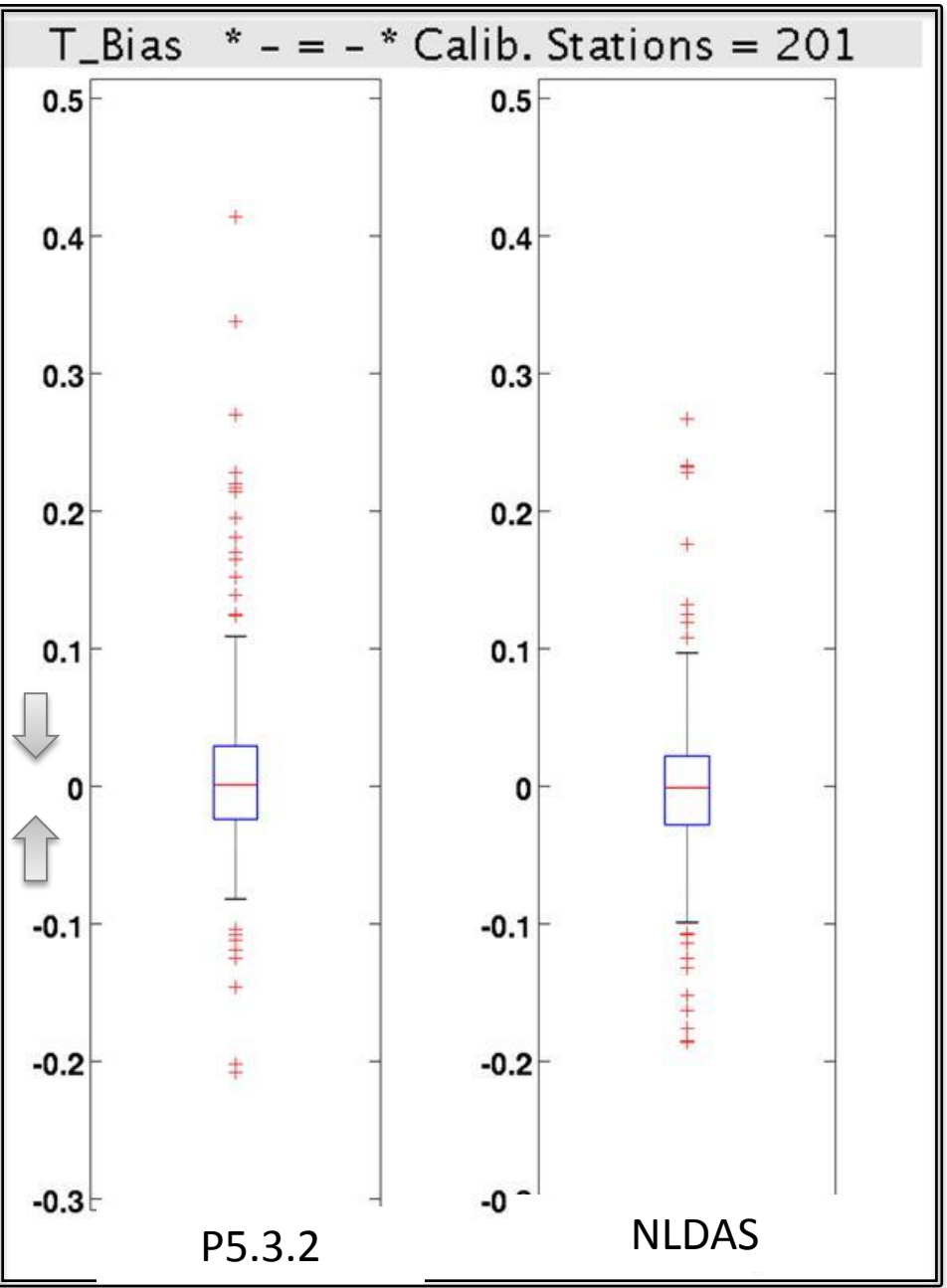

Total_E - = - Calib. Stations = 191
0.8
0.6
0.4
0.2
0
-0.2
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15

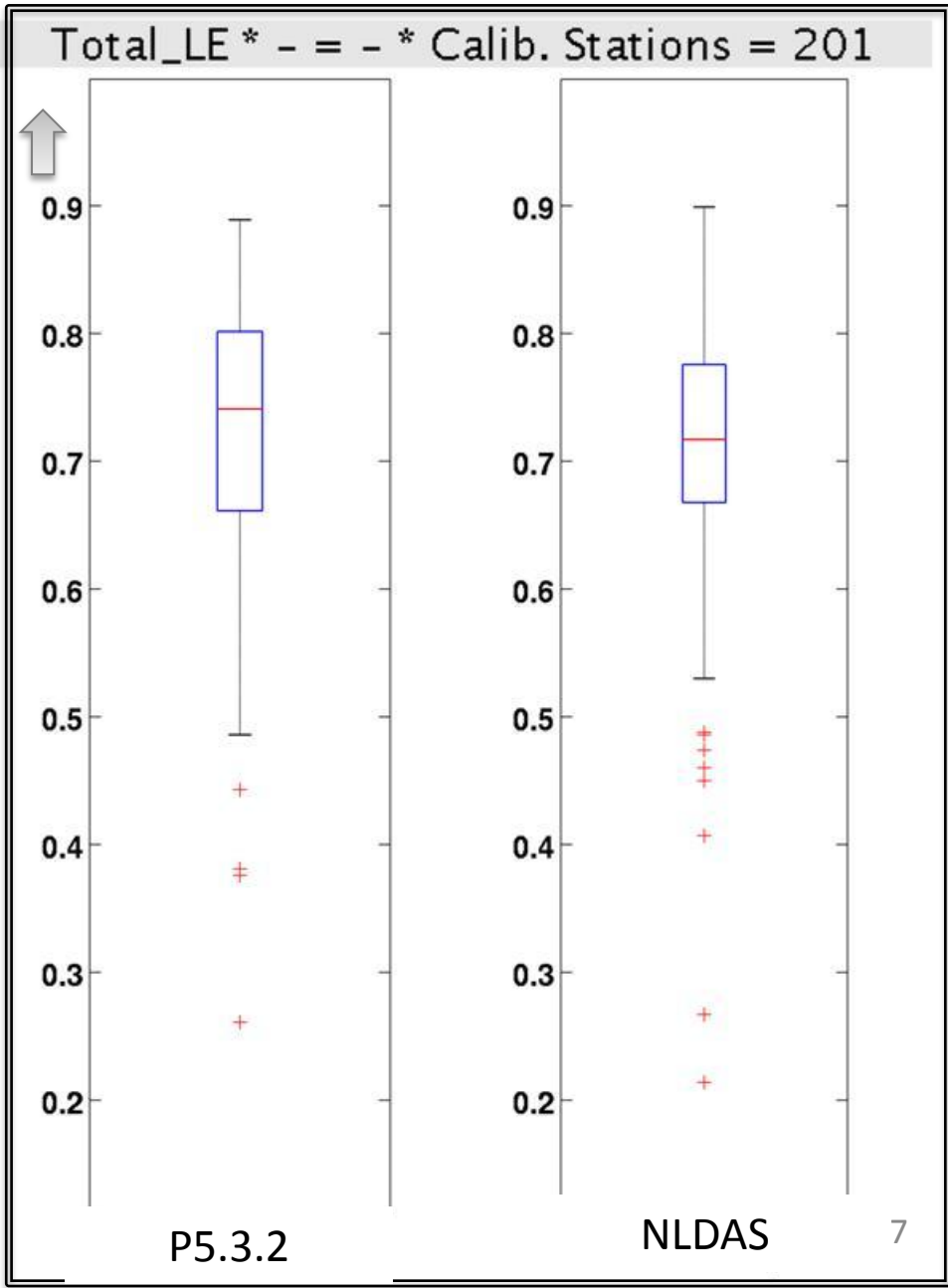
Nash-Sutcliff Efficiency $(NSE) = 1 - \sum (Q_o - Q_s)^2 / \sum (Q_o - \bar{Q}_o)^2$



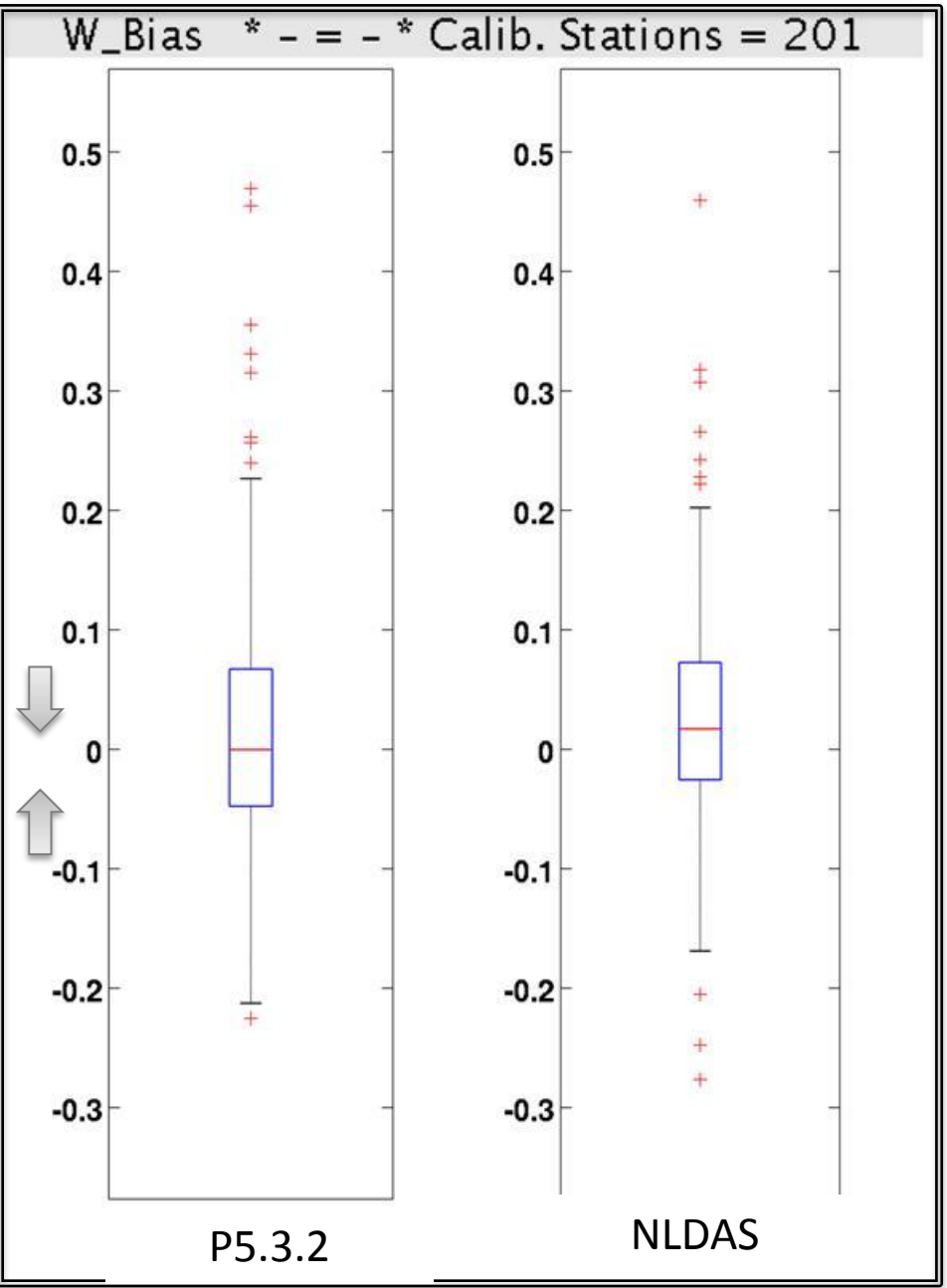
Total Bias = $\left(\sum Q_S - \sum Q_O\right) / \sum Q_O$

Nash-Sutcliff Efficiency of $Log(Q)$

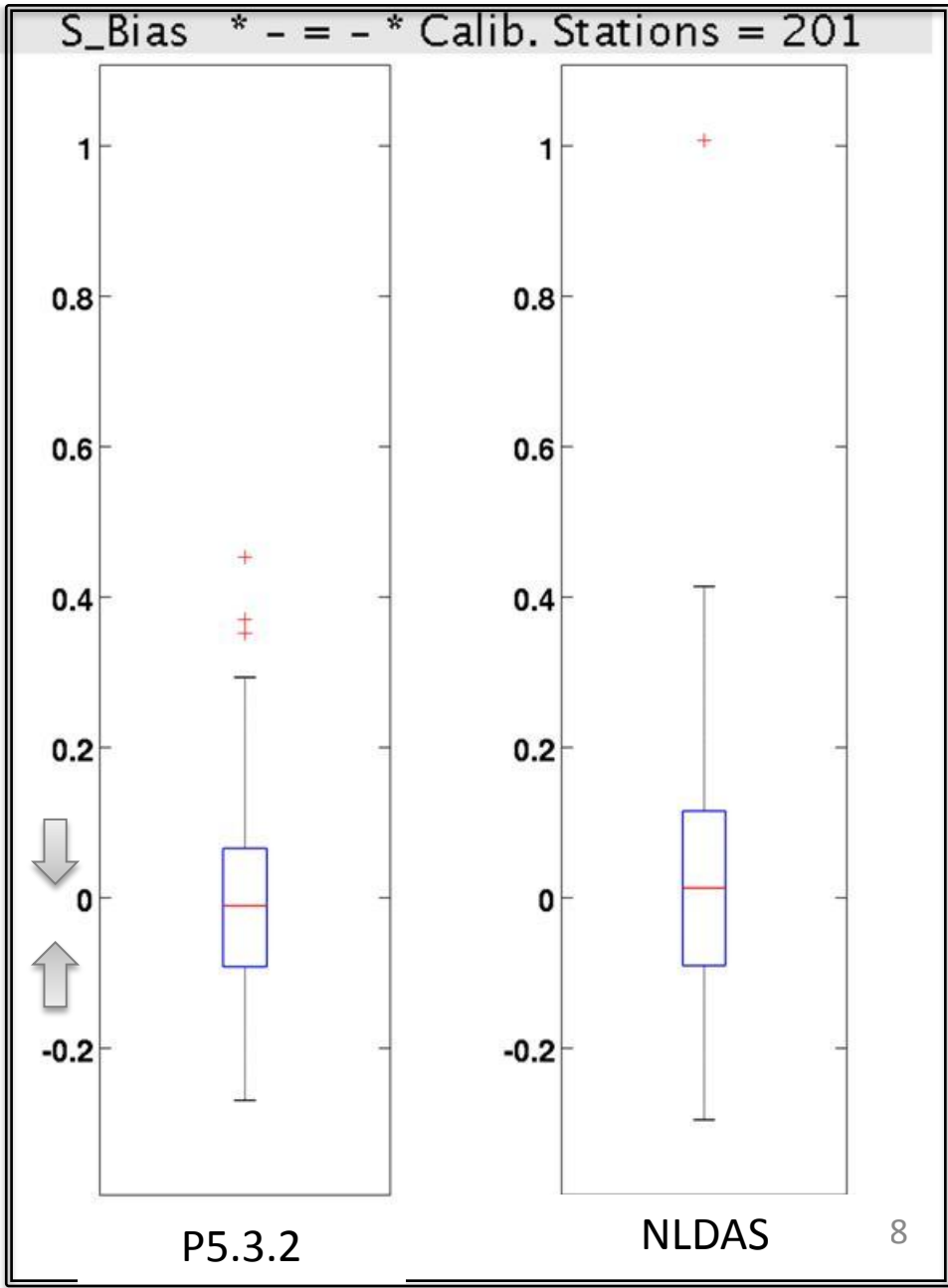




Winter (Dec-Feb) Bias = $\left(\sum Q_S - \sum Q_O\right) / \sum Q_O$

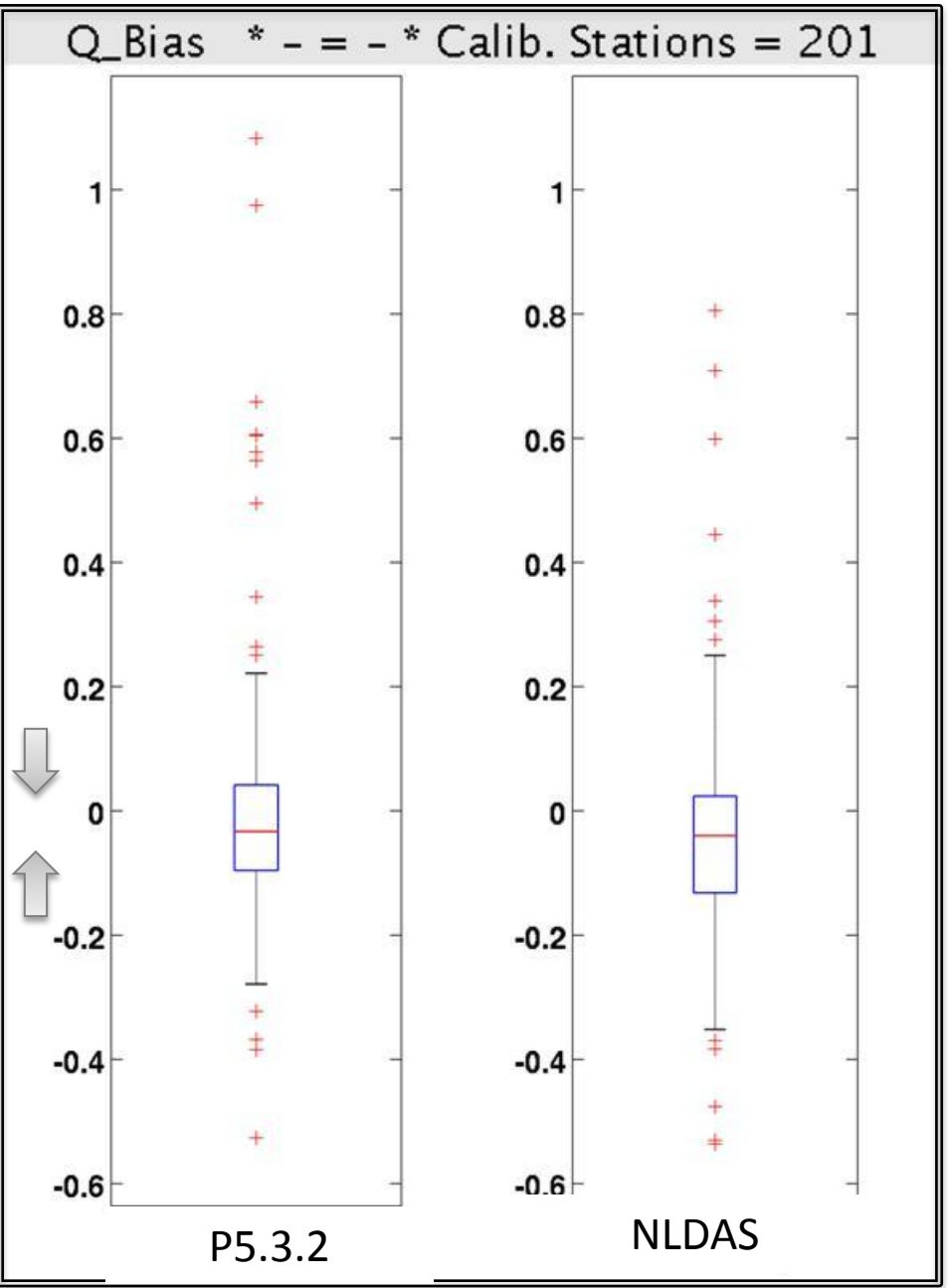


Summer (Jun-Aug) Bias = $\left(\sum Q_S - \sum Q_O\right) / \sum Q_O$

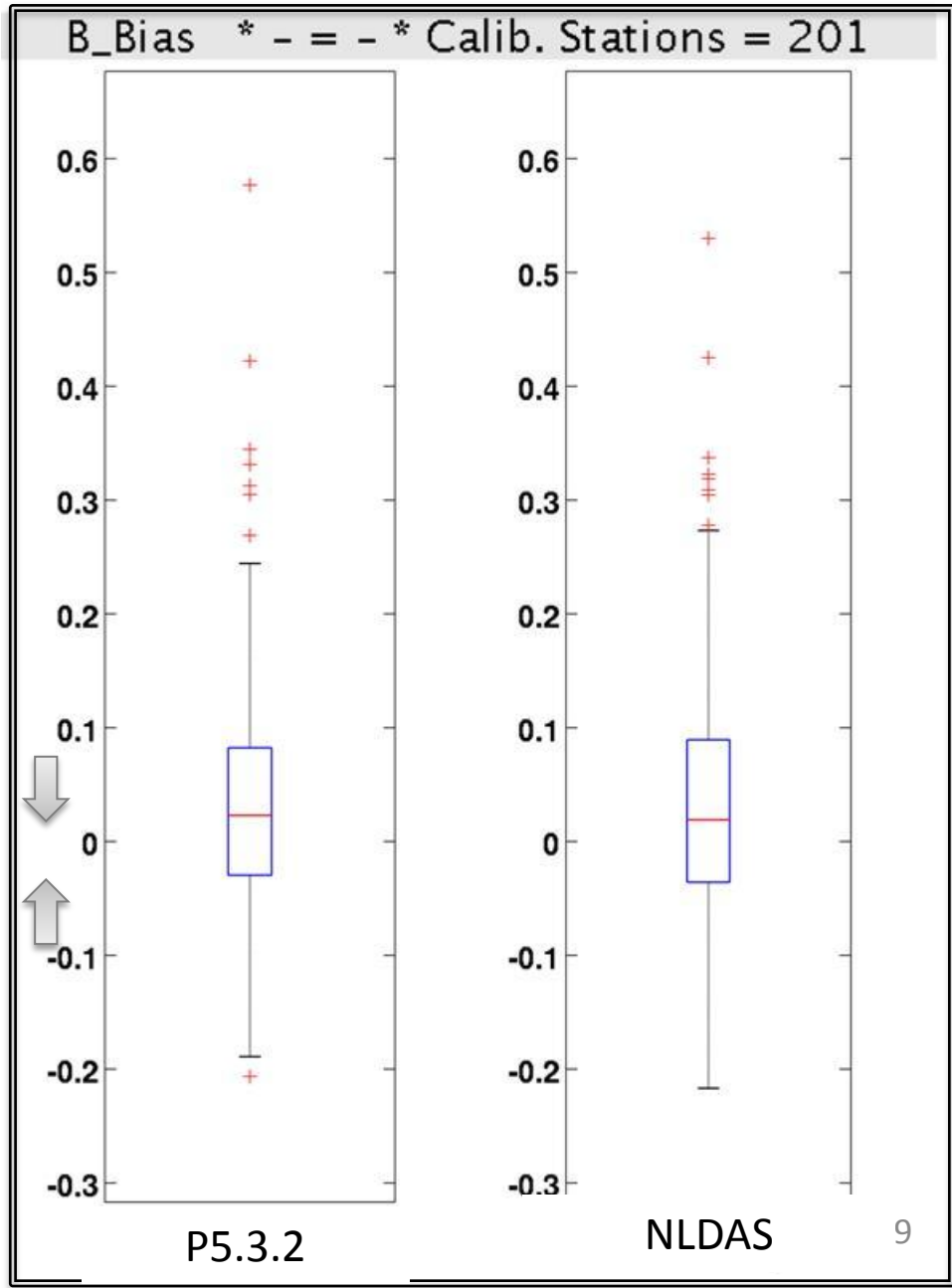


* based on USGS PART

Surface Runoff* Bias

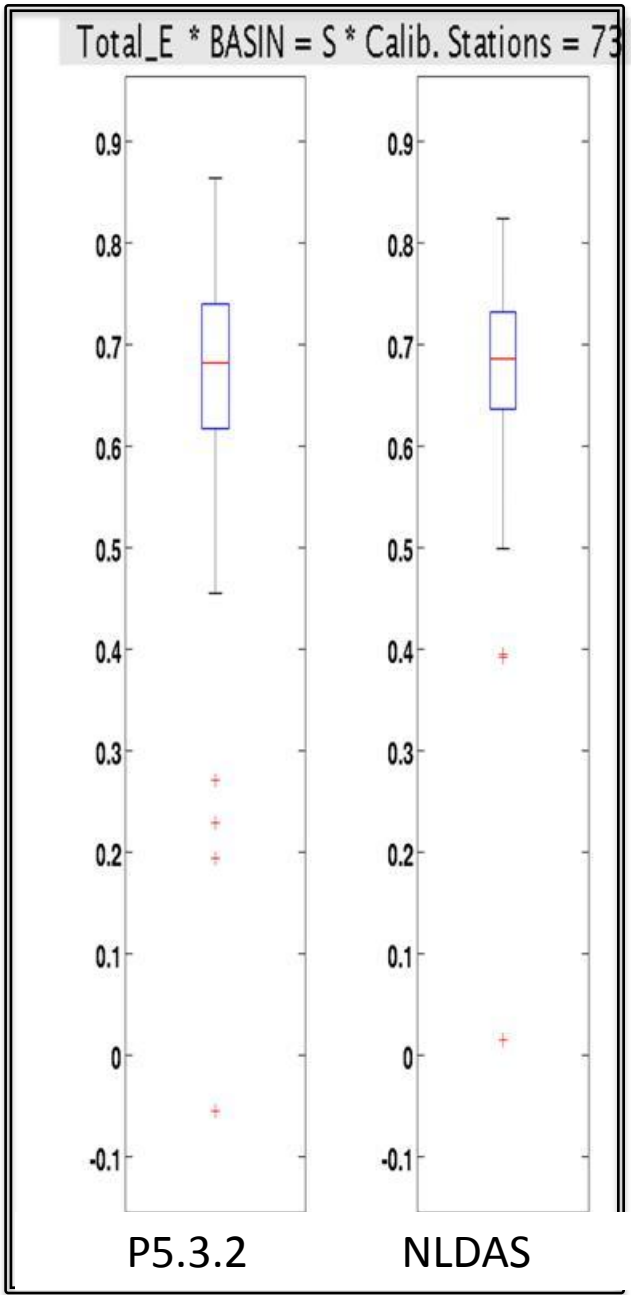


Baseflow* Bias

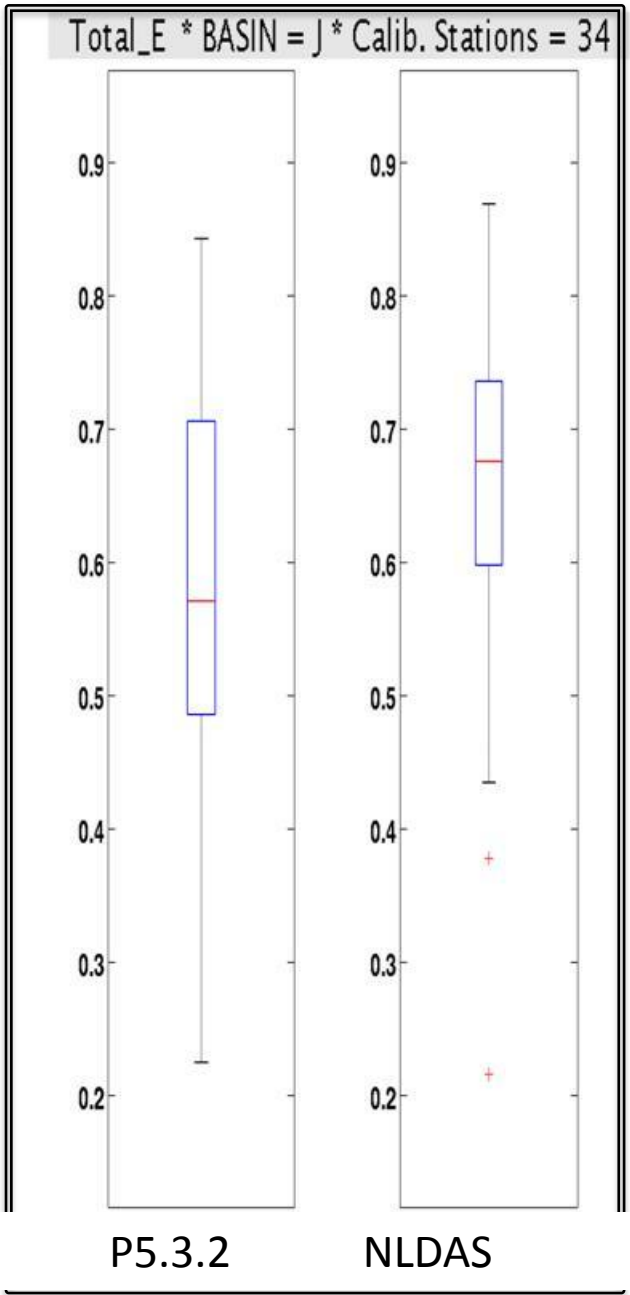


Model Performance at River Basin Scale

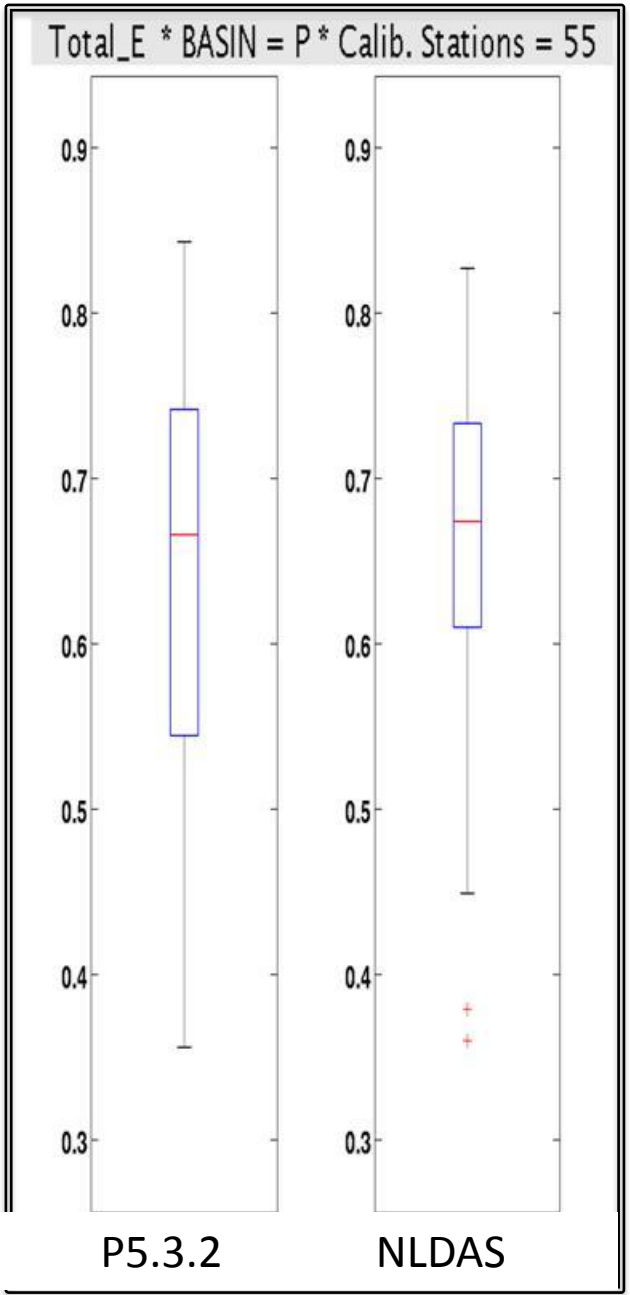
Susquehanna



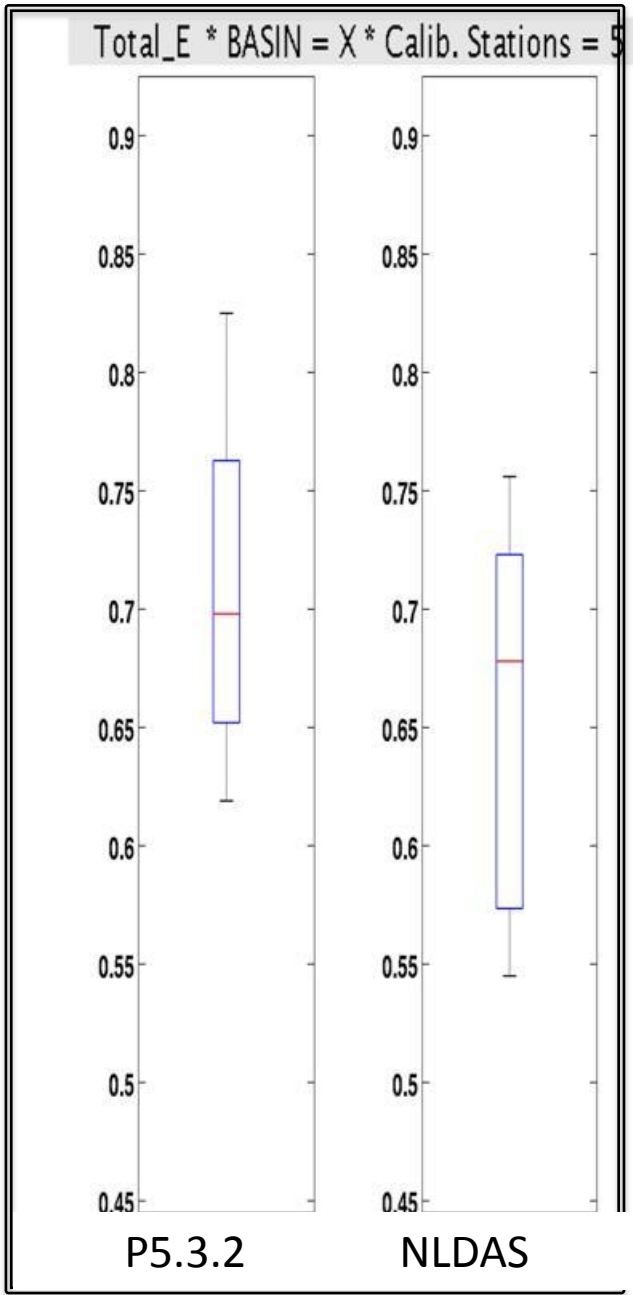
James



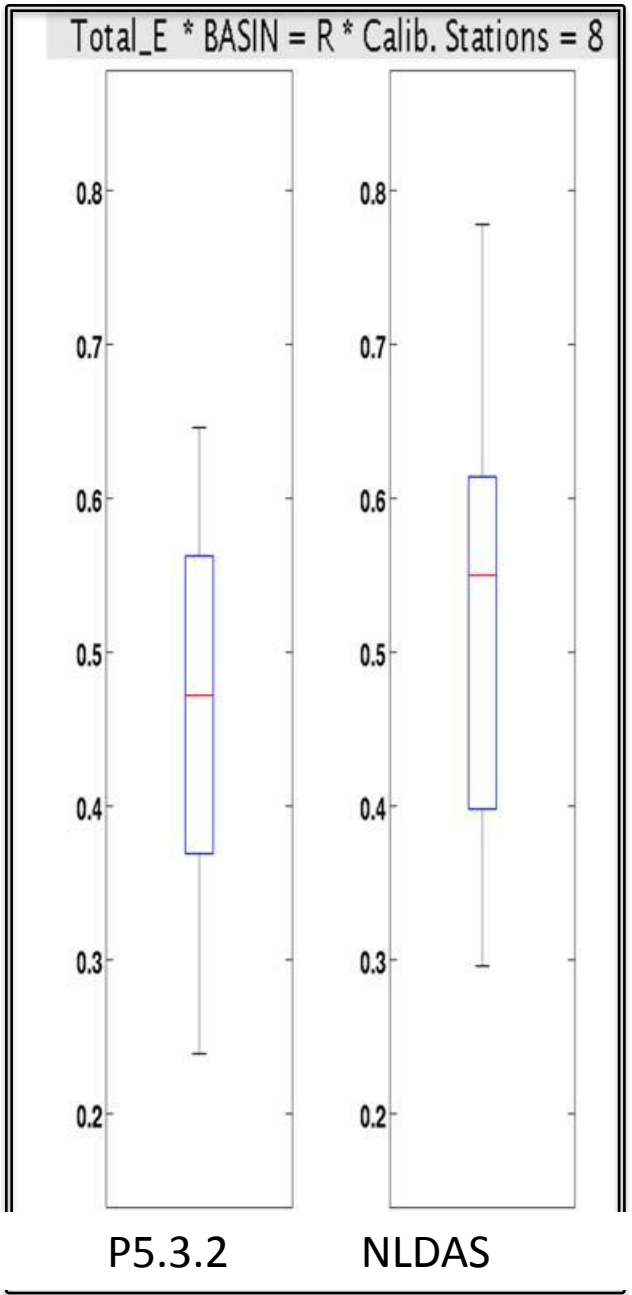
Potomac



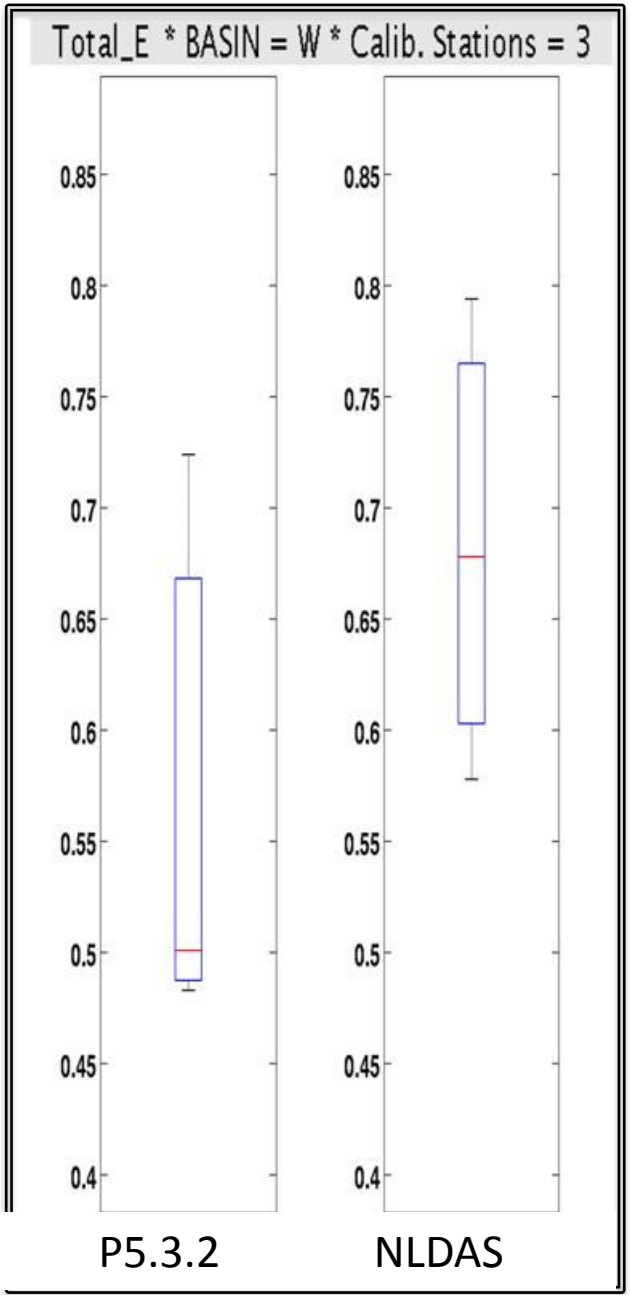
Patuxent



Rappahannock

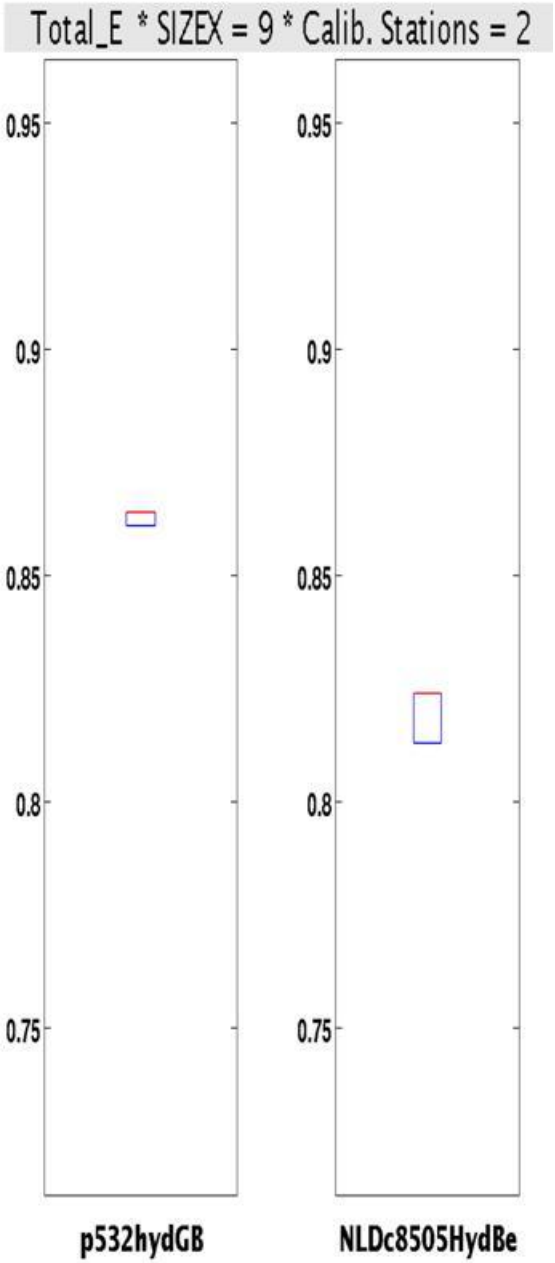


Western Shore

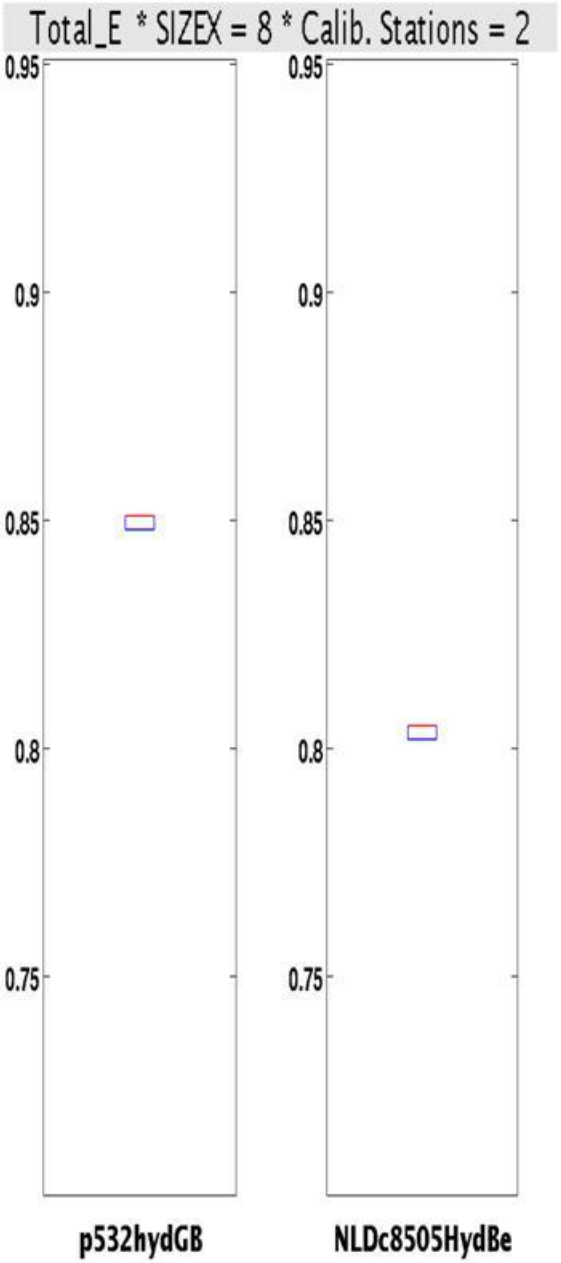


Model Performance at Flow Sizes

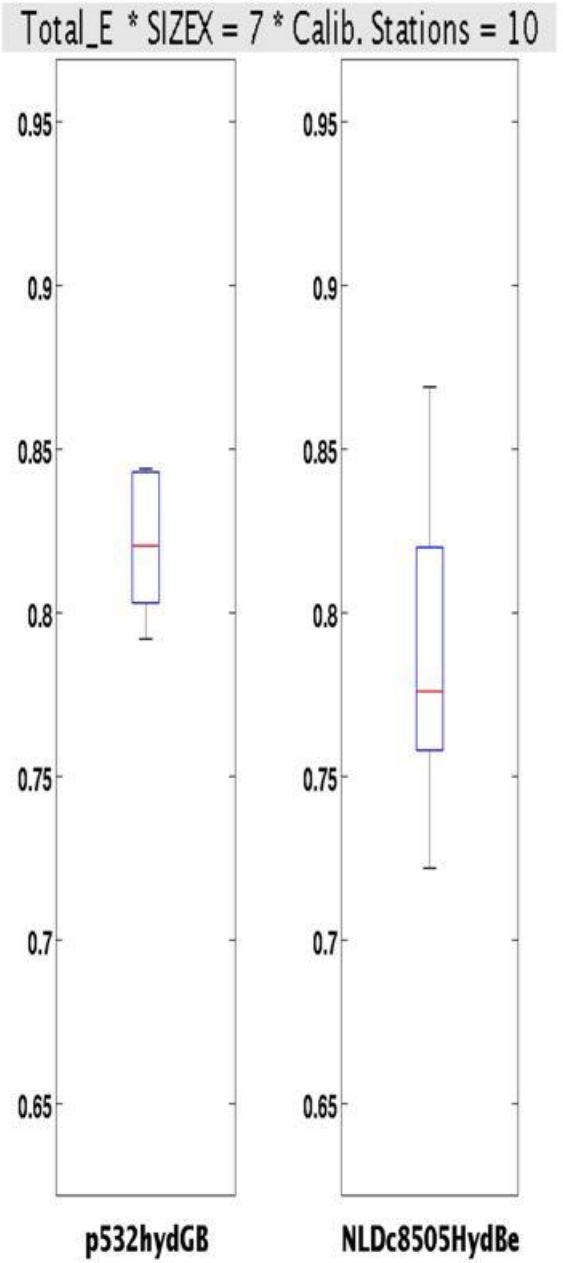
Susq Only



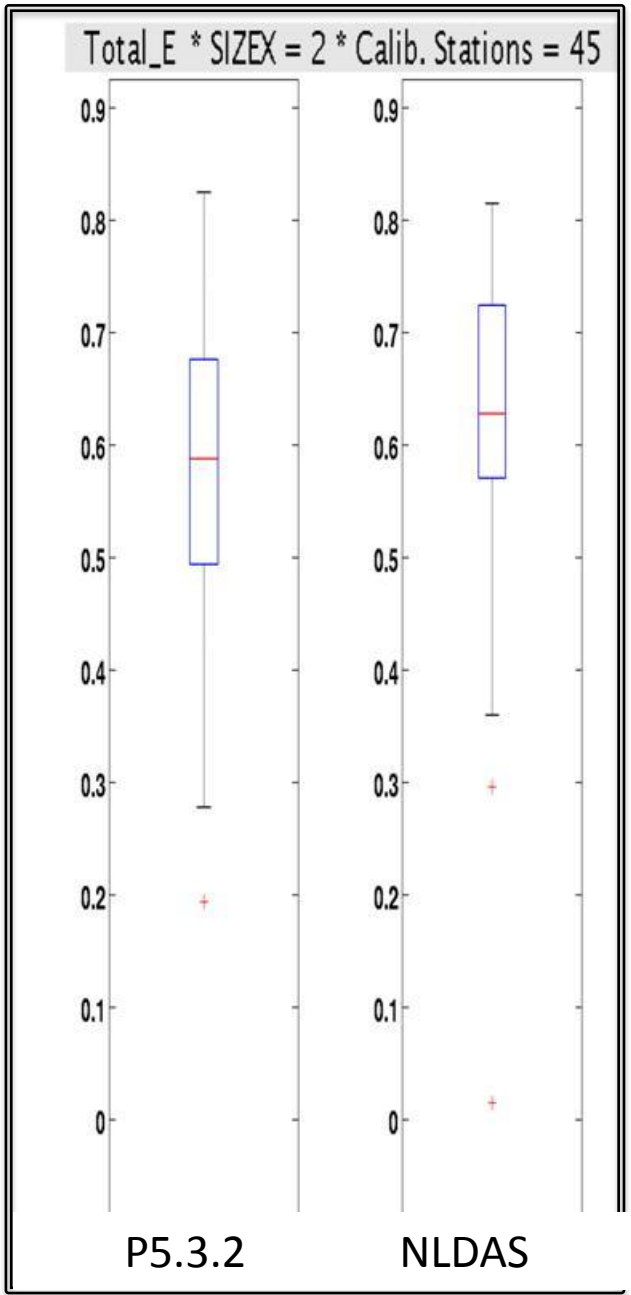
Susq Only



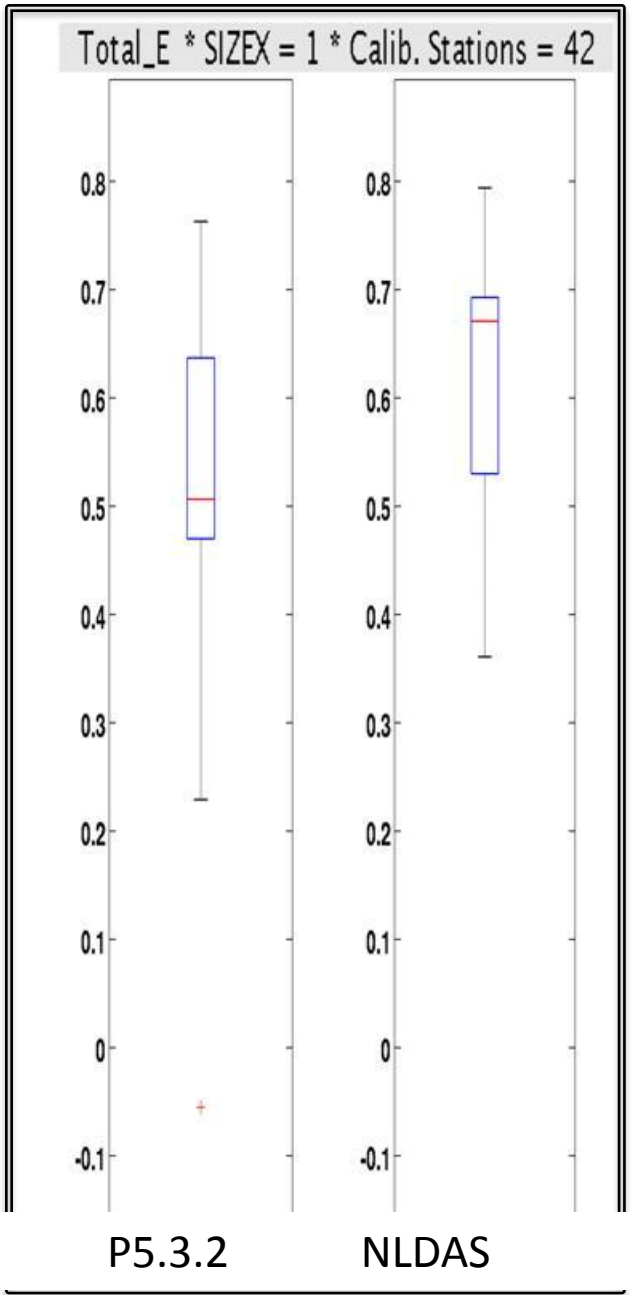
8 in Susq



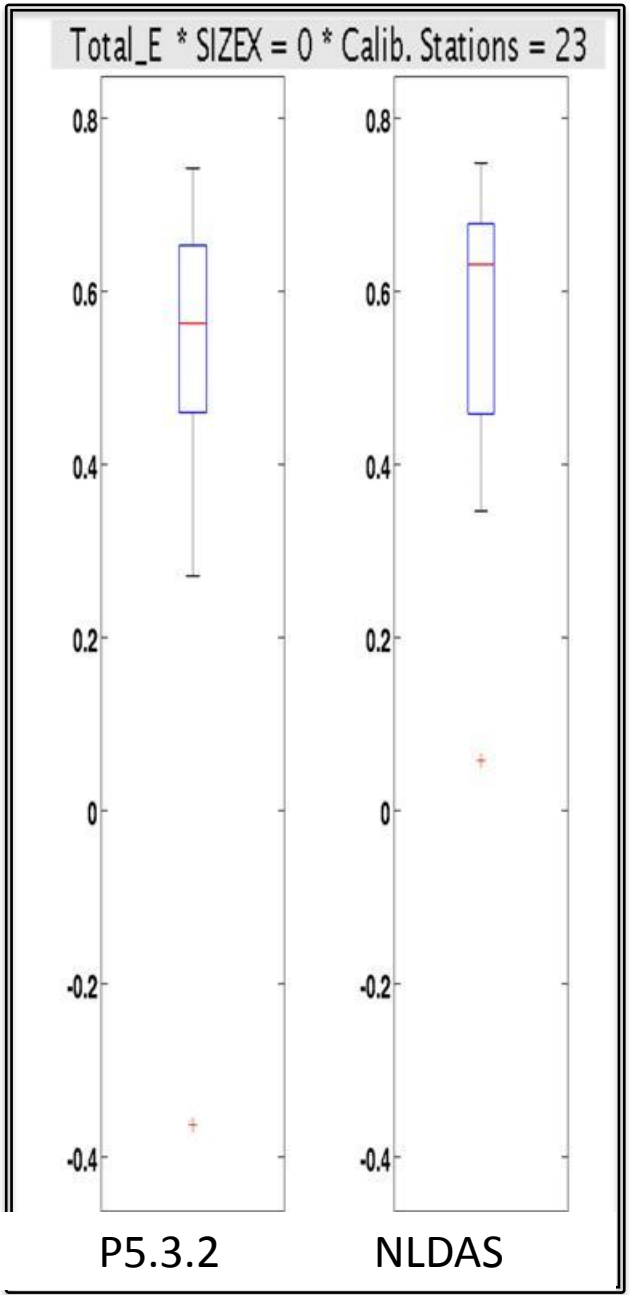
215 < CFS < 464



100 < CFS < 215



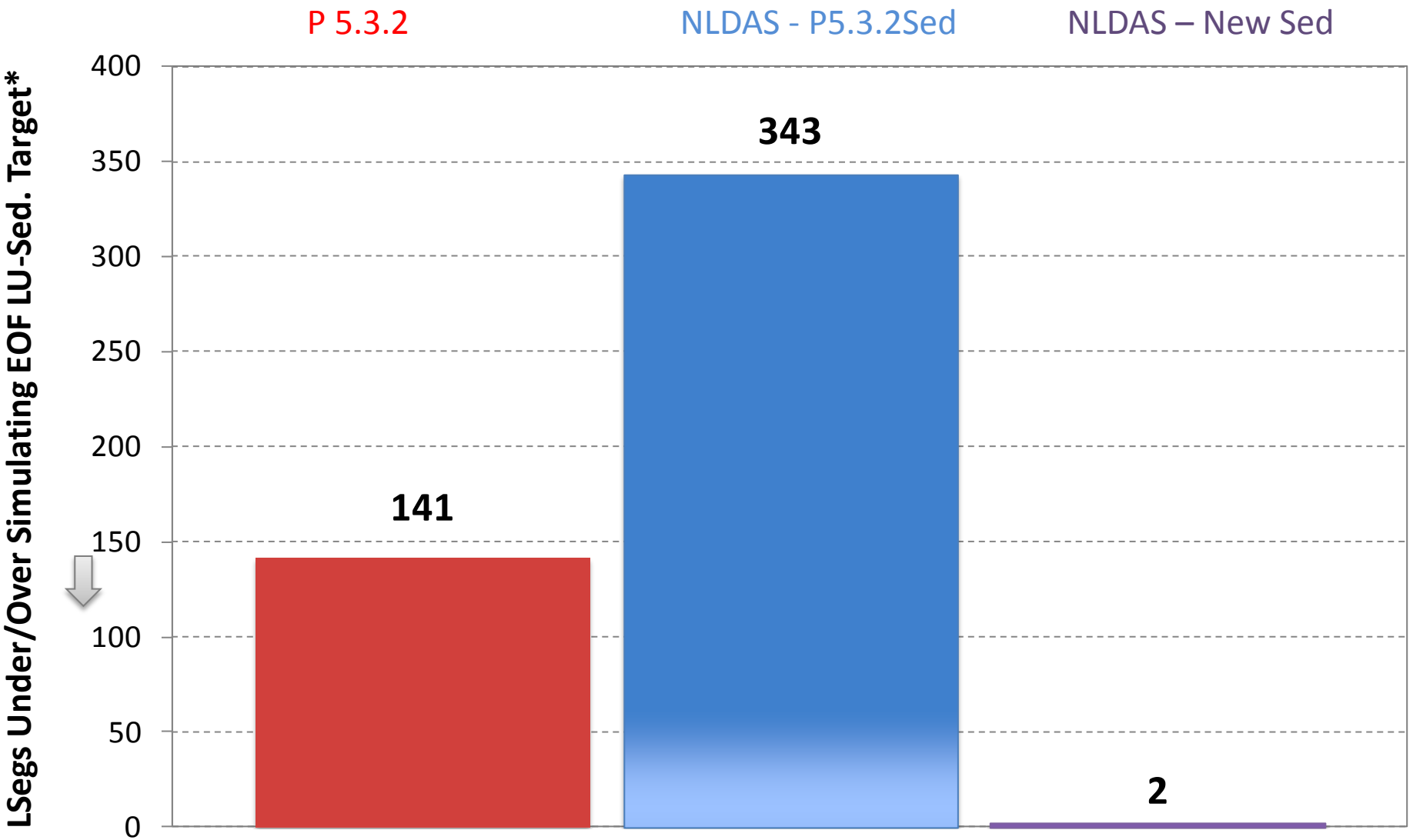
50 < CFS < 100



EOF LAND SEDIMENT CALIBRATION

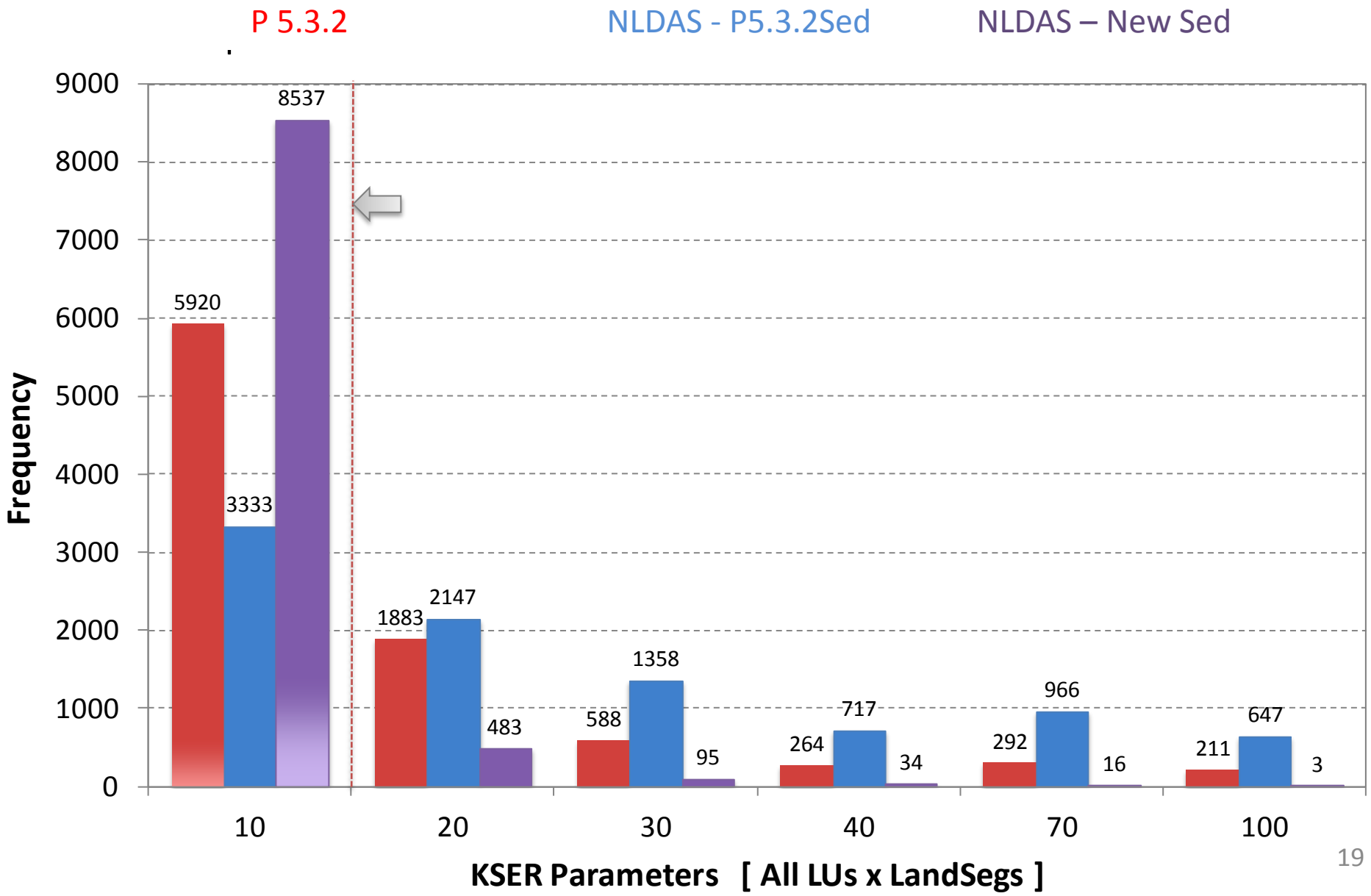
Pervious Land Uses (SEDMNT)

Improvement in Matching the a-priori *Targets**

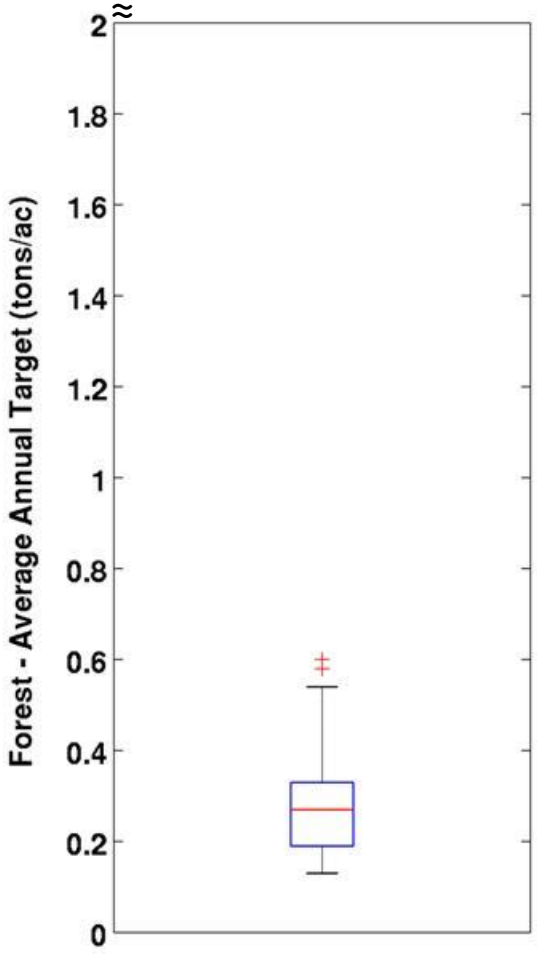


*Total Number of Land Segments (367) x Number of **Pervious** Land Uses (25) = 9175

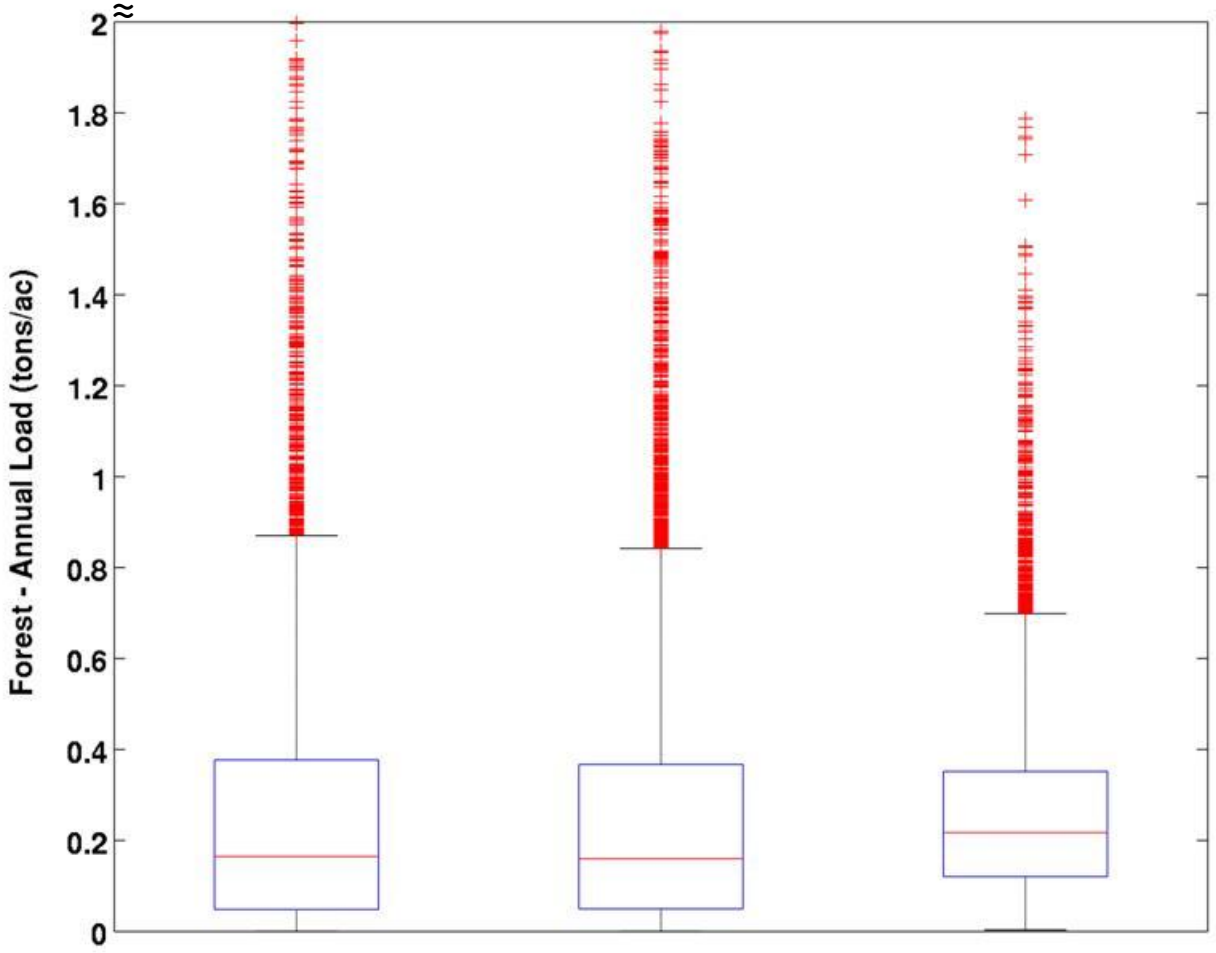
Improvement in Optimized Parameters



‘Avg. Annual’ Target *vs.* Simulated ‘Annual’ Load
Land Use = Forest



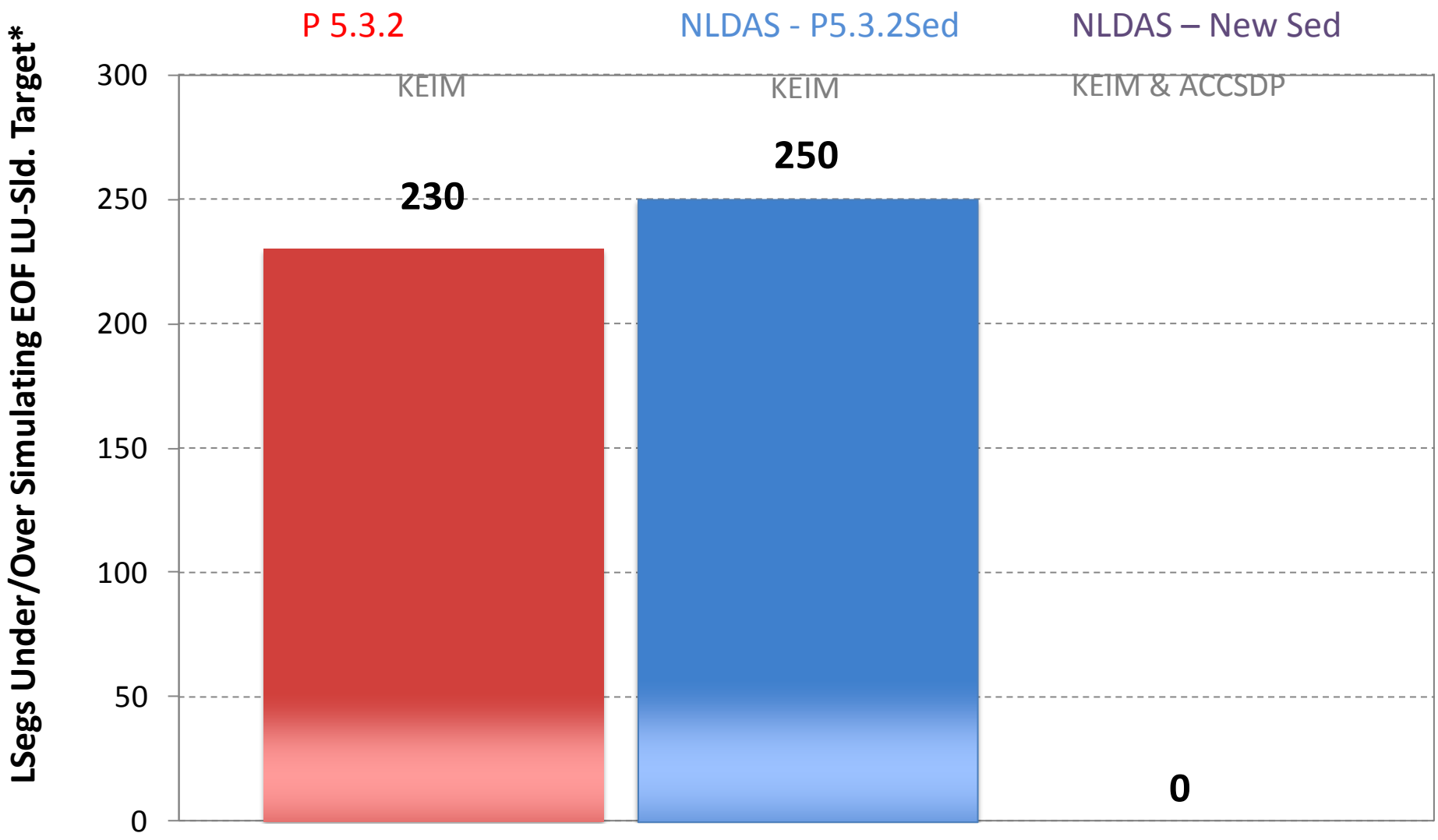
Target



P 5.3.2 NLDAS - P5.3.2Sed NLDAS – New Sed

Impervious Land Uses (SOLIDS)

Improvement in Matching the a-priori *Targets**



* Total Number of Land Segments (367) x Number of **Impervious** Land Uses (5) = 1835

PQUAL/IQUAL CALIBRATION

Replacing ACHEM based simulation with PQUAL

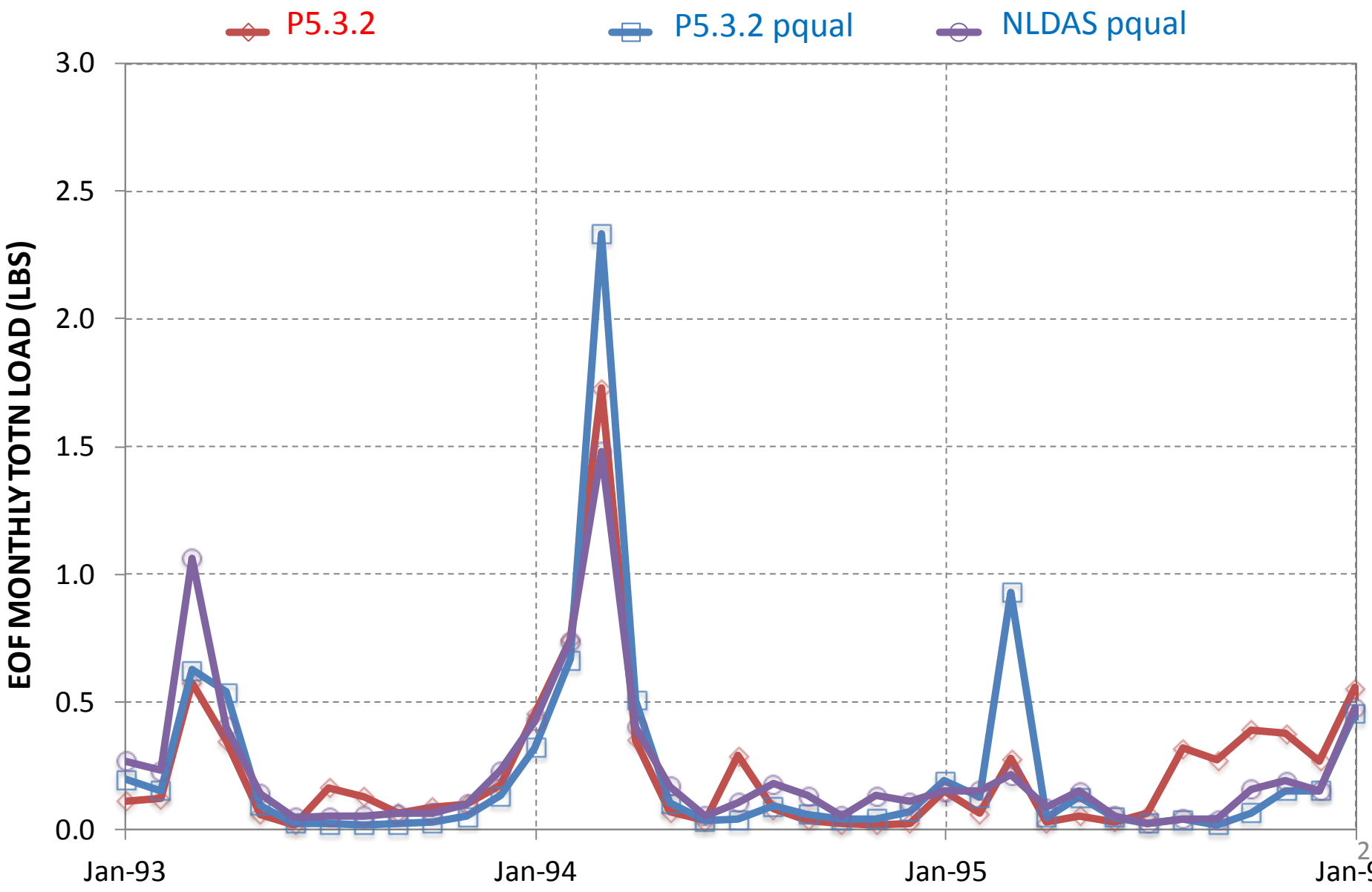
- Annual average nutrient load *targets* were derived from AGCHEM based Phase 5.3.2 for each land-segments

- Land segment scale targets include separate loading rates for nutrient constituents (i.e. NH4, NO3, LON, RON, and PO4) from surface and subsurface flow regime.

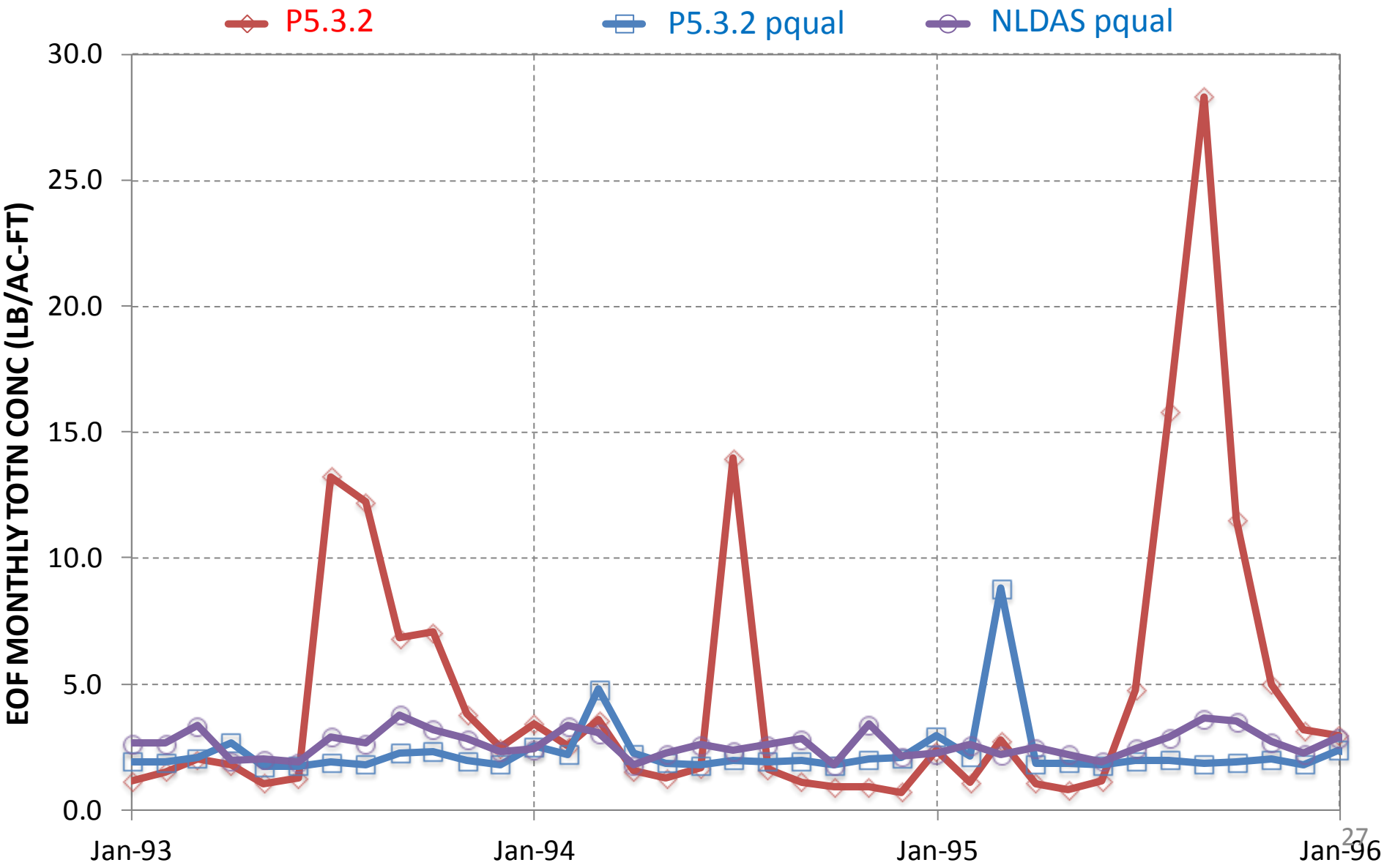
SCENARIOS	CHARACTERISTICS
P532cal_102413	Existing AGCHEM based Phase-5.3.2 Model
P532qual_GB	Replace AGCHEM with PQUAL
NLDc8505HydBeQual	Replace AGCHEM with PQUAL Replace Precipitation & Meteorology

a-priori nutrient export targets for all land-uses at land-segment scales were satisfied in both: **P532qual_GB** and **NLDc8505HydBeQual**

Monthly EOF TOTN *Load*
A10001_to_EL0_4560_4562_for

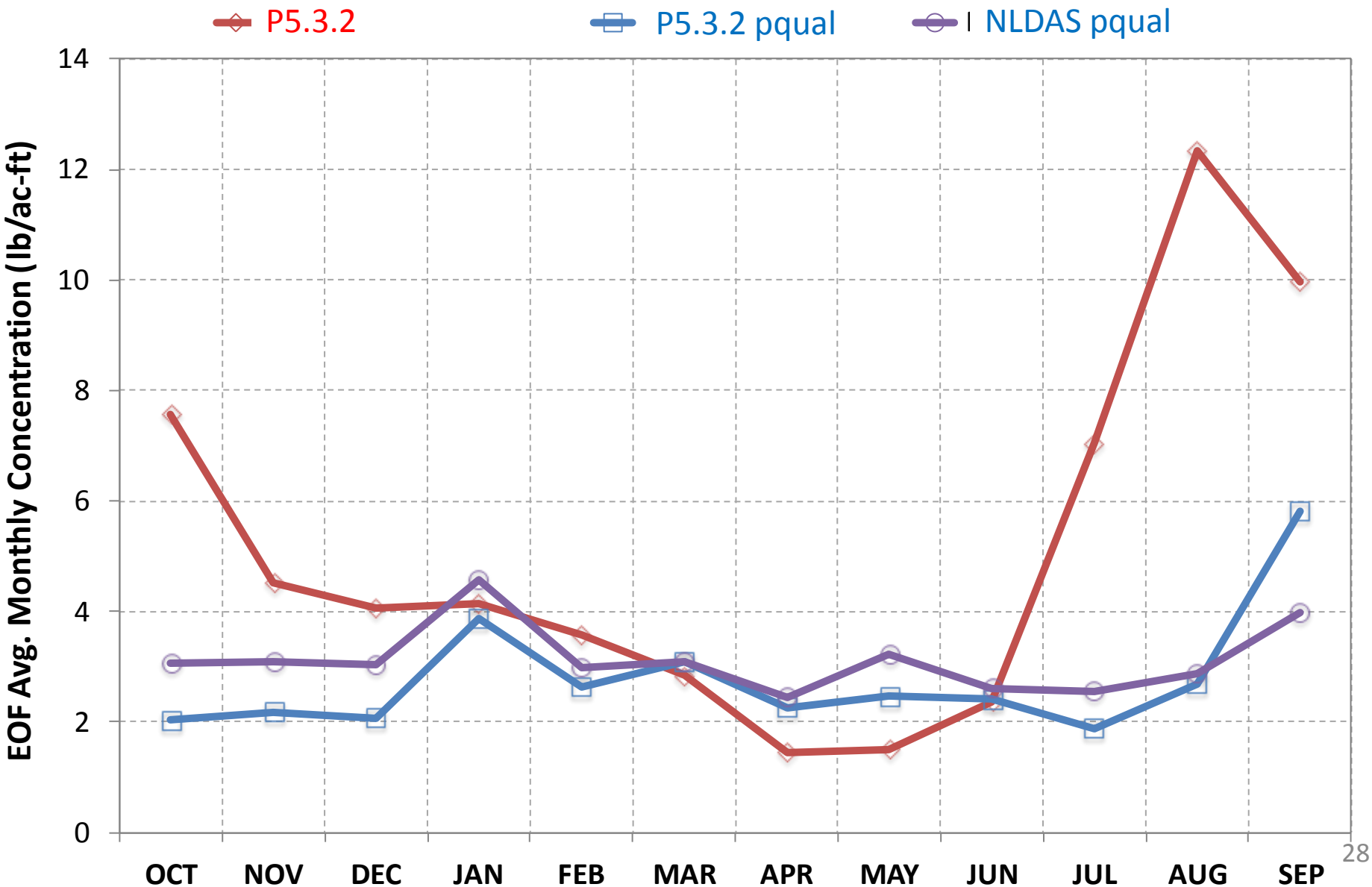


Monthly EOF TOTN *Conc*
A10001_to_EL0_4560_4562_for



Average Monthly Conc. (1991-2000)

A10001_to_EL0_4560_4562_for



Average Monthly Conc. (1991-2000)
A10001_to_EL0_4560_4562_for

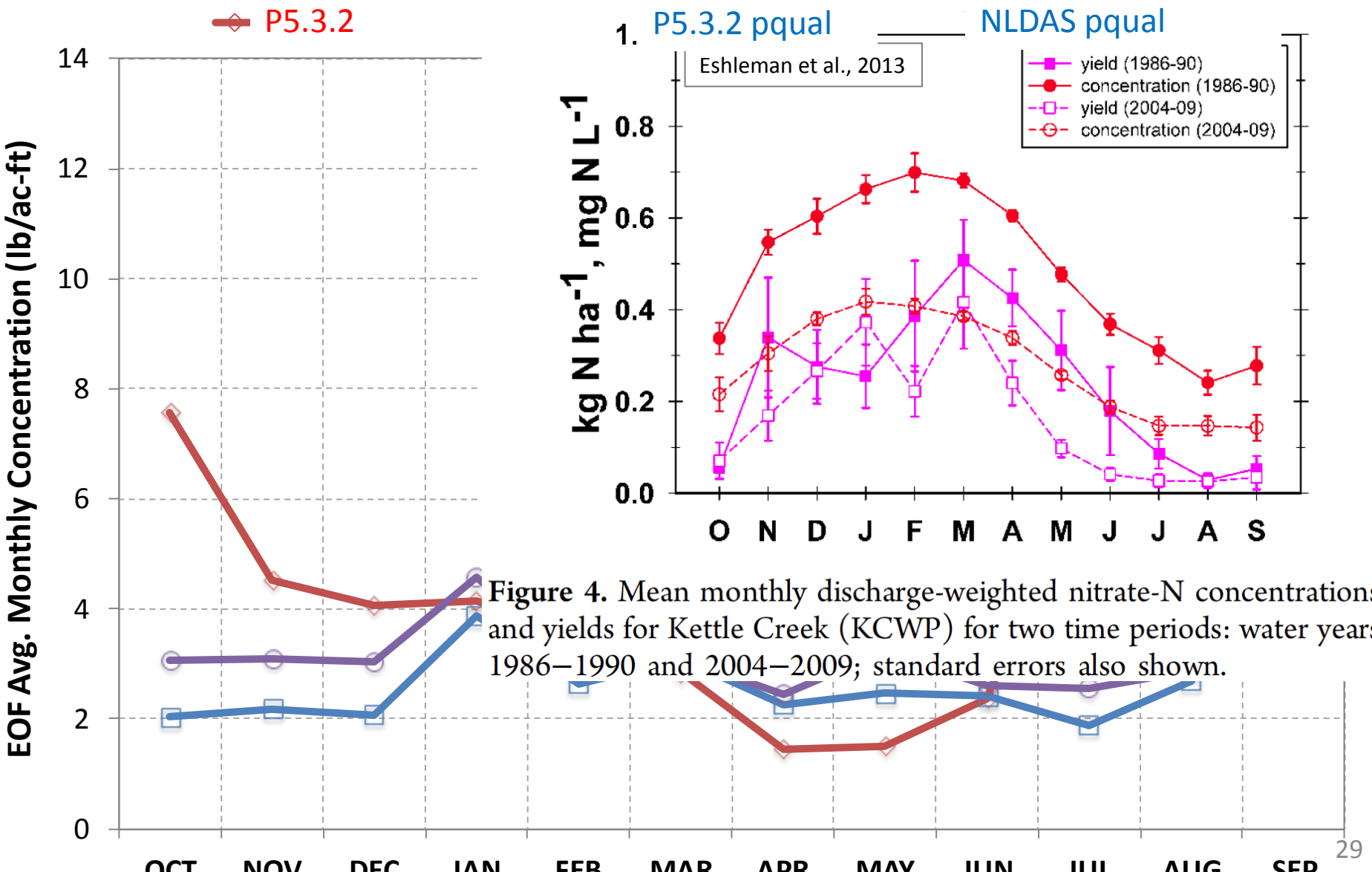
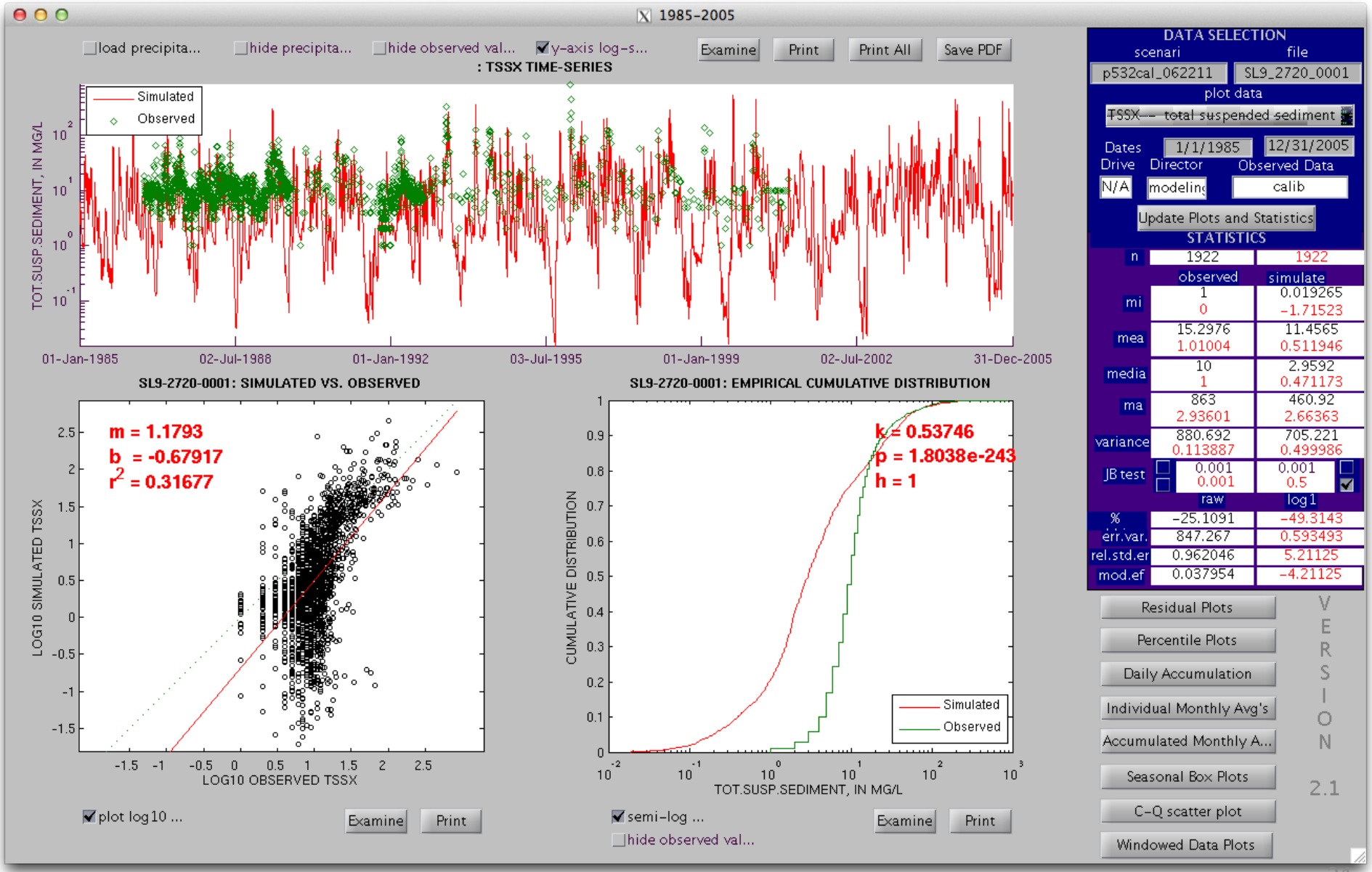


Figure 4. Mean monthly discharge-weighted nitrate-N concentrations and yields for Kettle Creek (KCWP) for two time periods: water years 1986–1990 and 2004–2009; standard errors also shown.

RIVER WATER QUALITY CALIBRATION

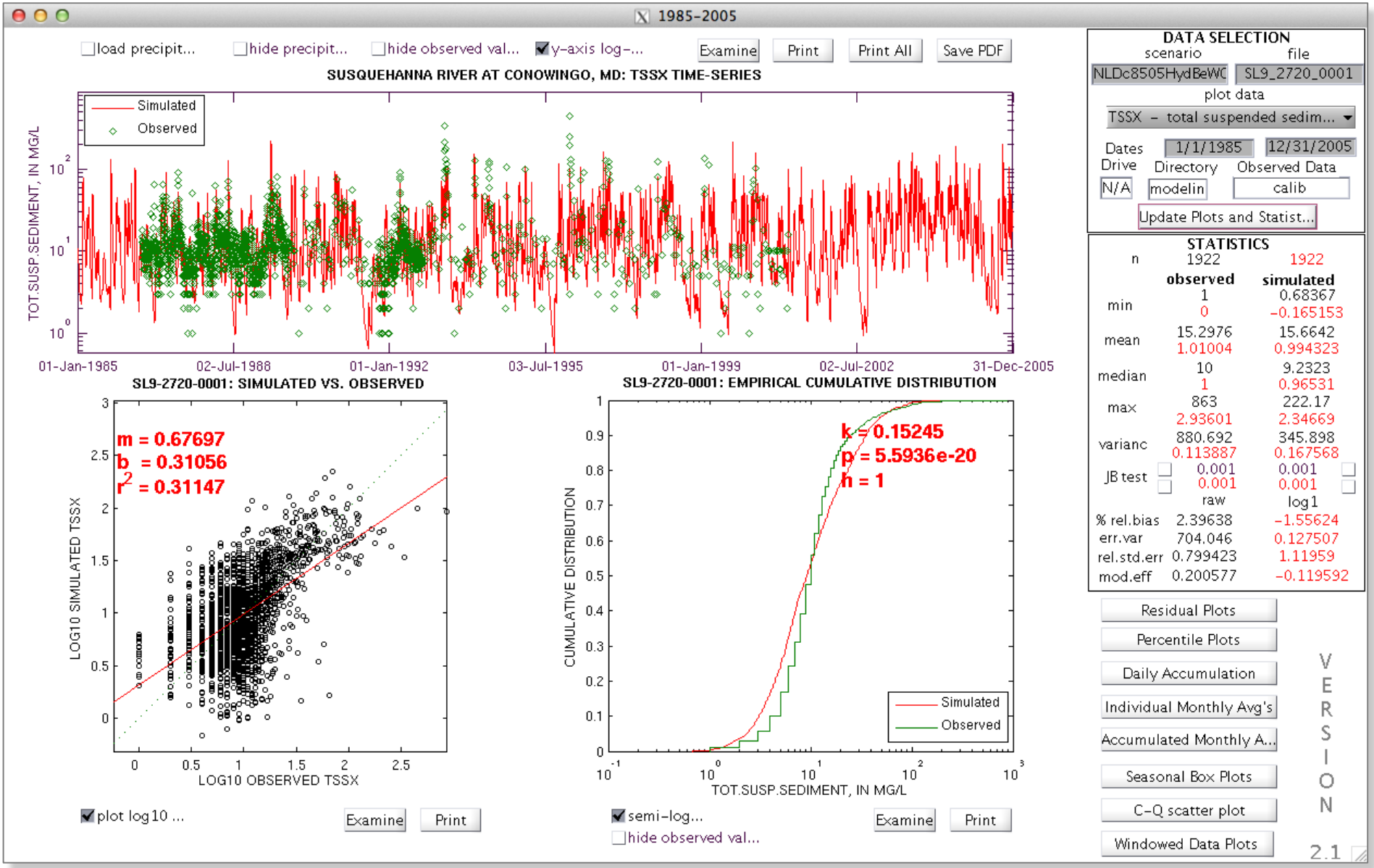
Phase 5.3.2 – TSSX : : 1985 – 2005

Susquehanna River near Conowingo, MD



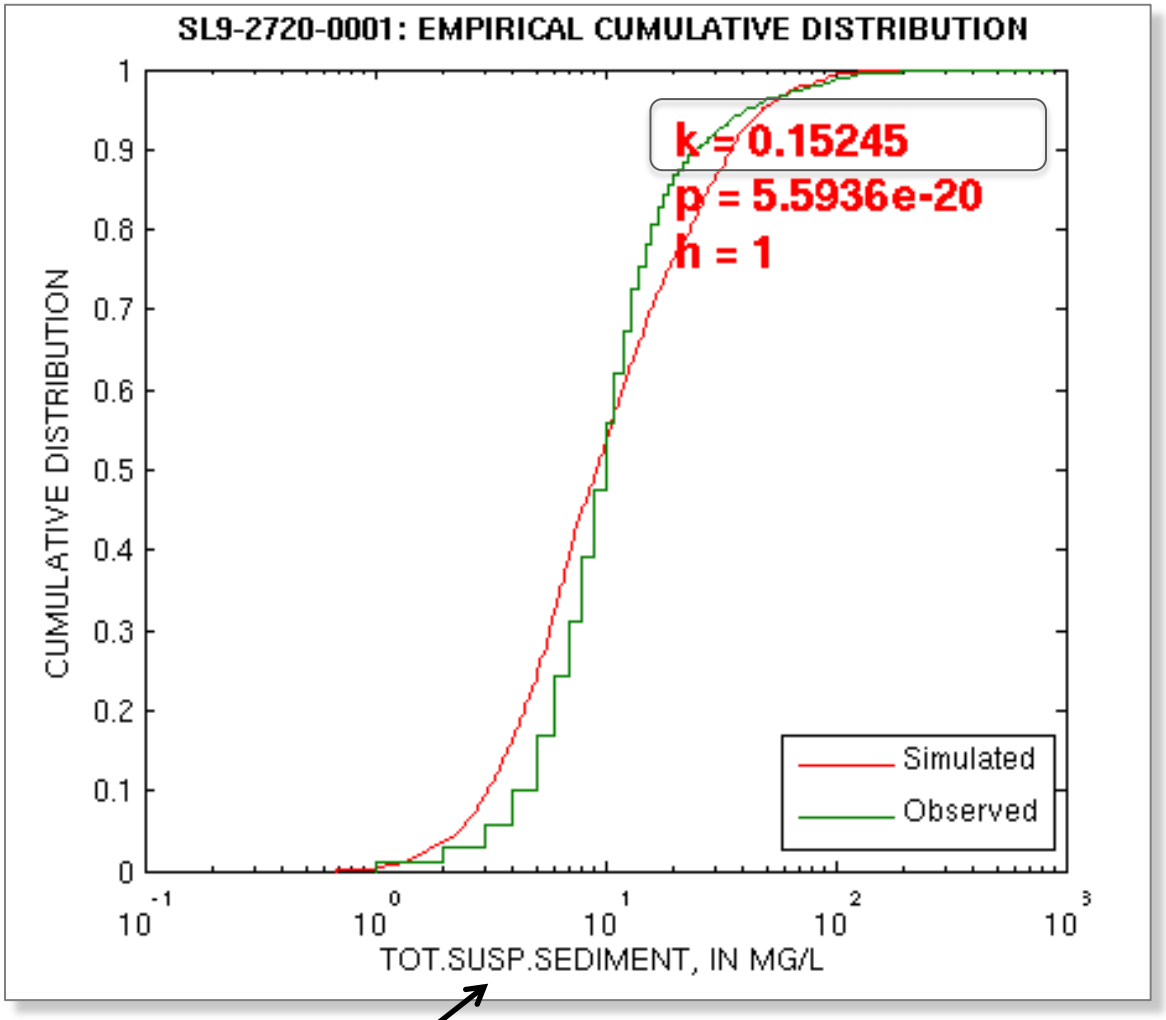
Prototype Phase 6 – TSSX : : 1985 – 2005

Susquehanna River near Conowingo, MD

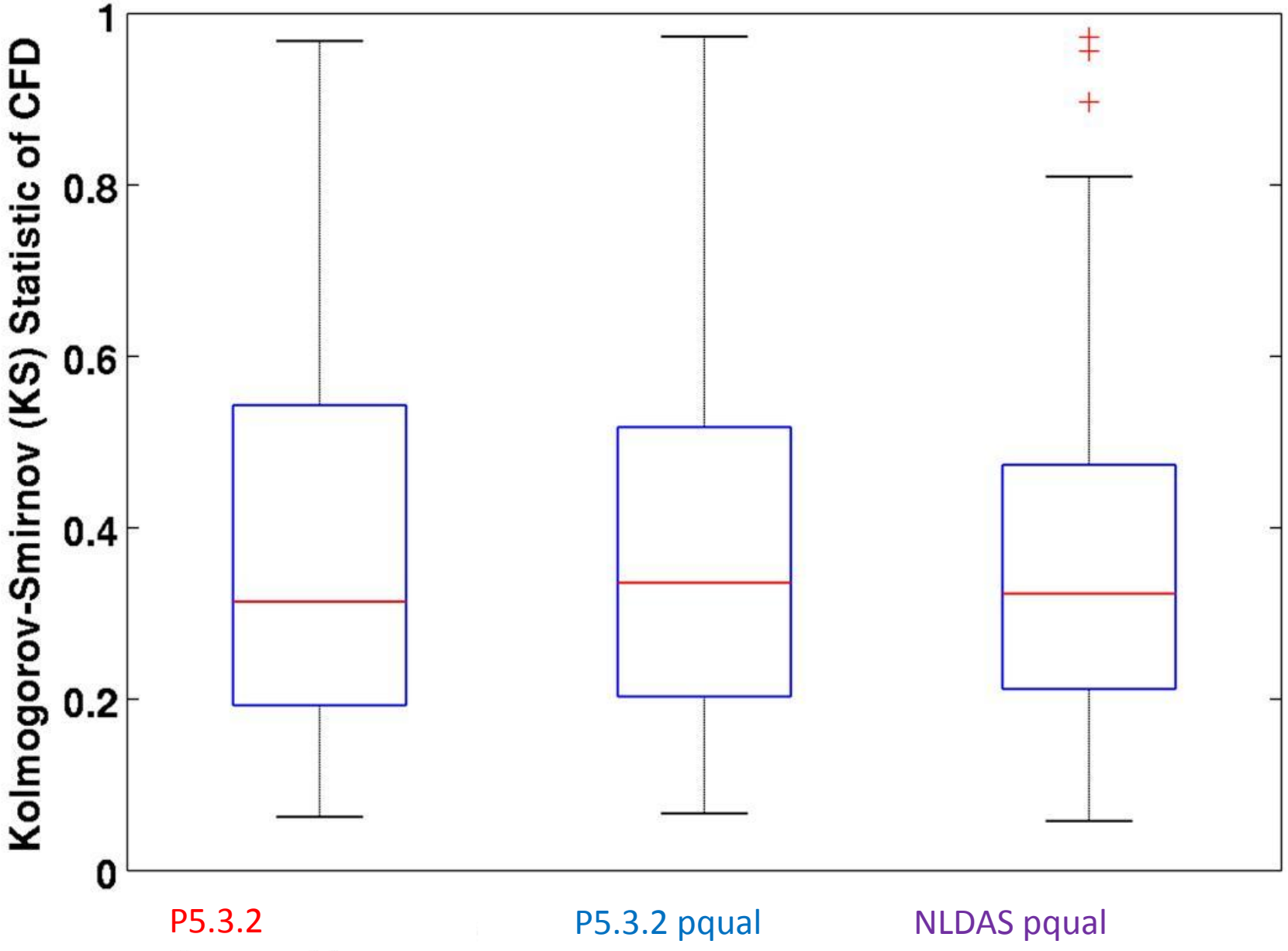


Kolmogorov-Smirnov (K-S) Statistics

River Water Quality Calibration Approach

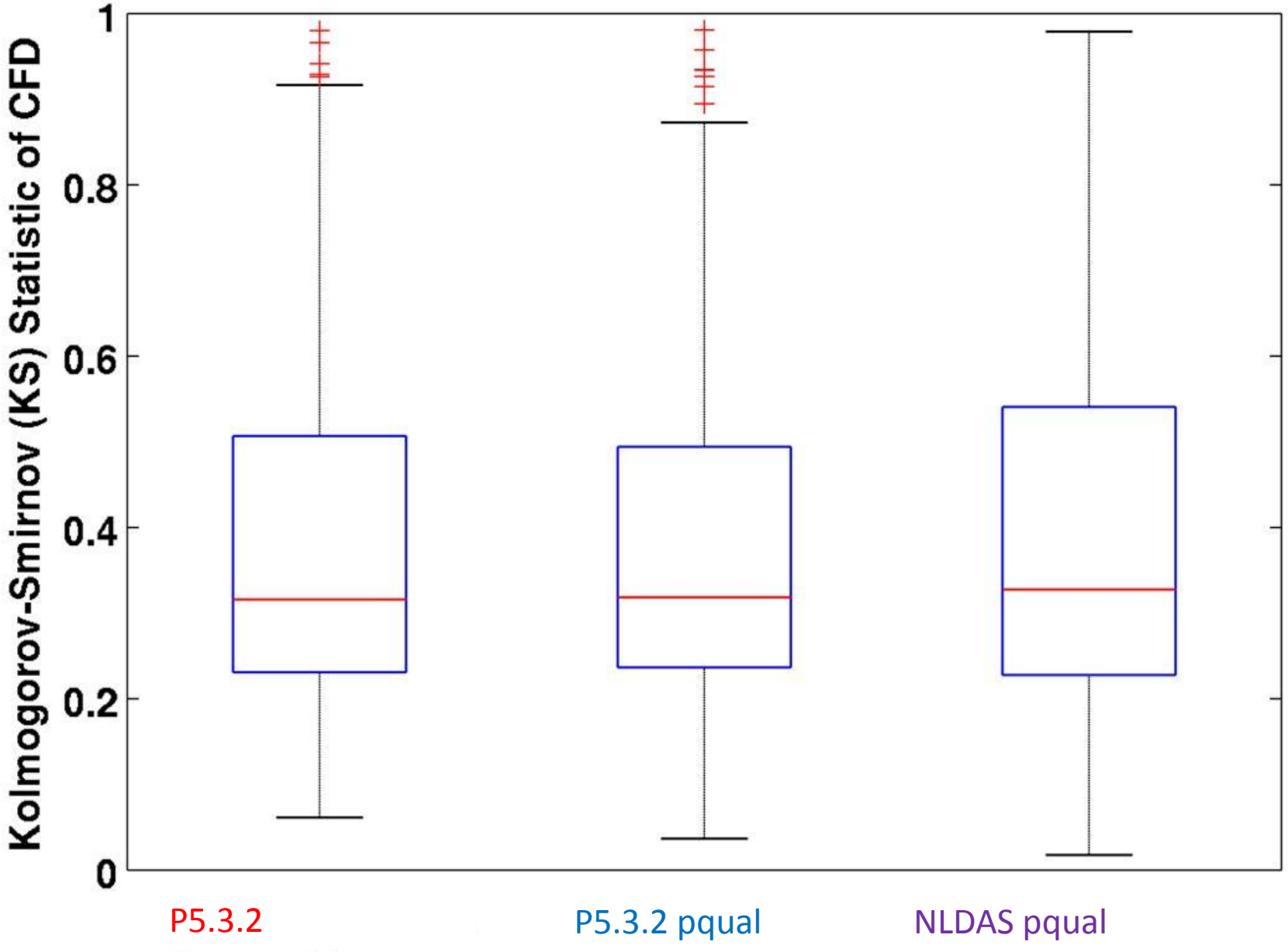


Total Nitrogen (TOTN)



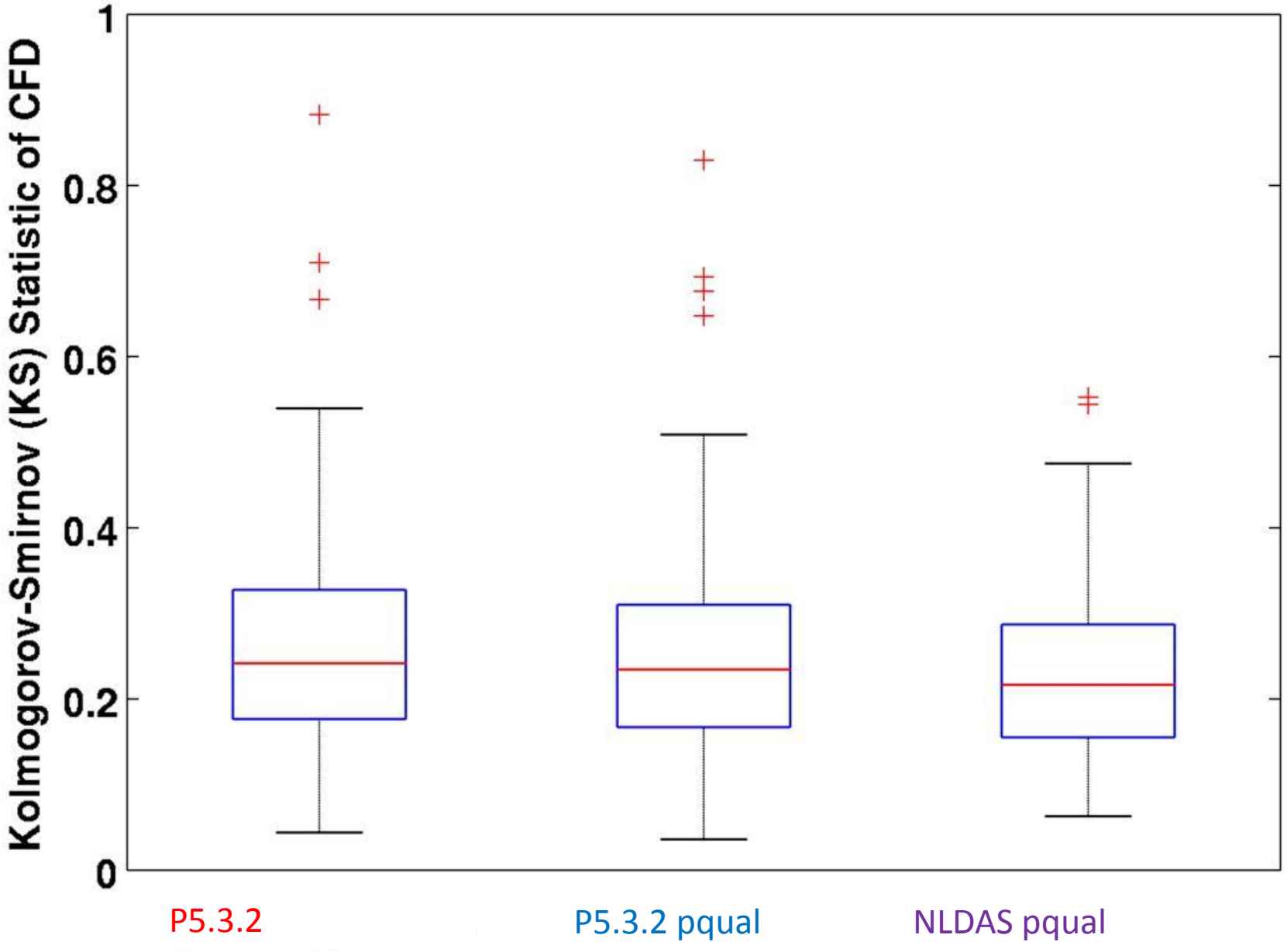
149 gage stations

Total Phosphorus (TOTP)



209 gage stations

Total Suspended Sediment (TSSX)



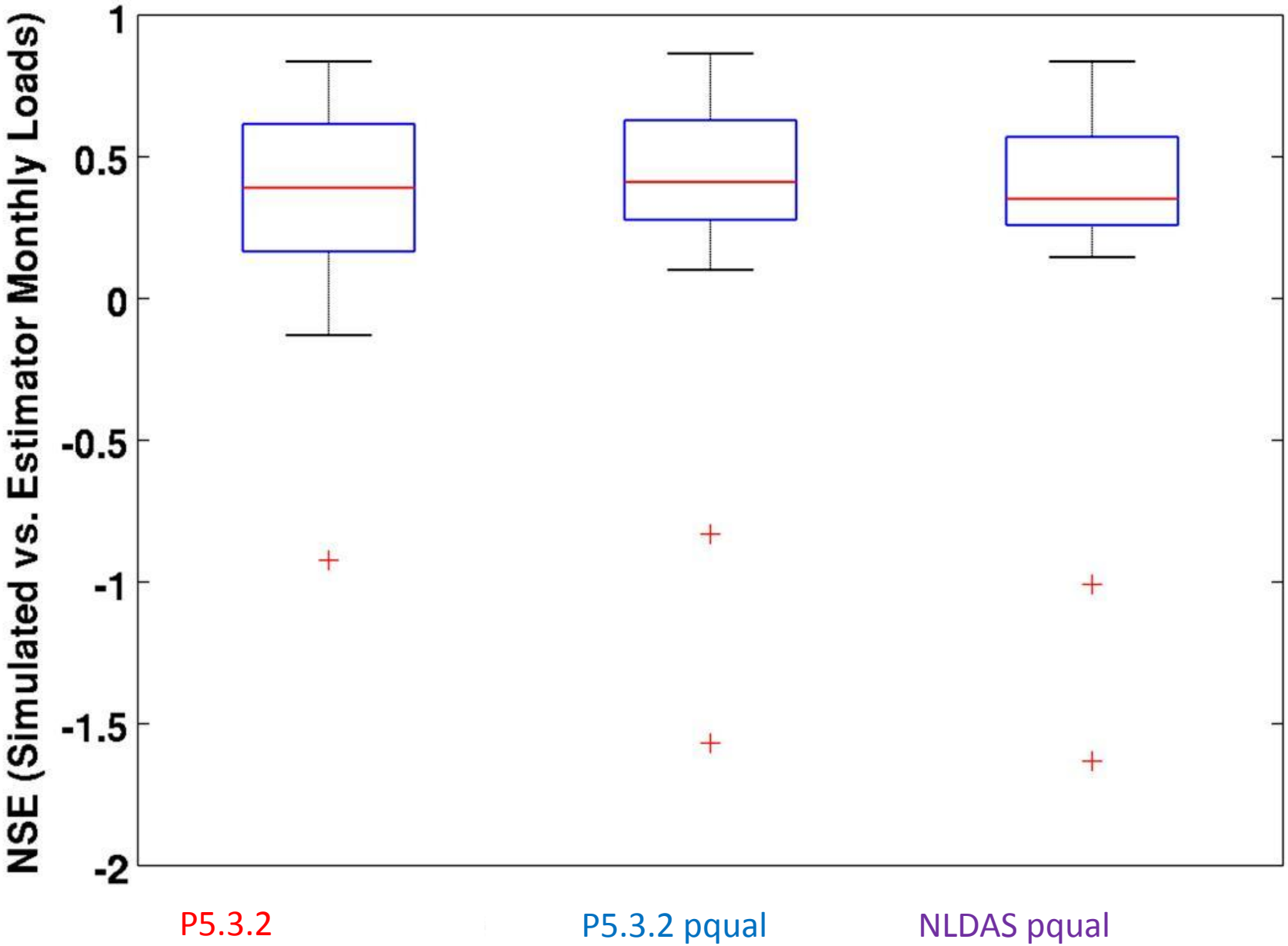
193 gage stations

Model Simulated Loads vs. USGS LOADEST*

* LOADEST data at 30 gage stations

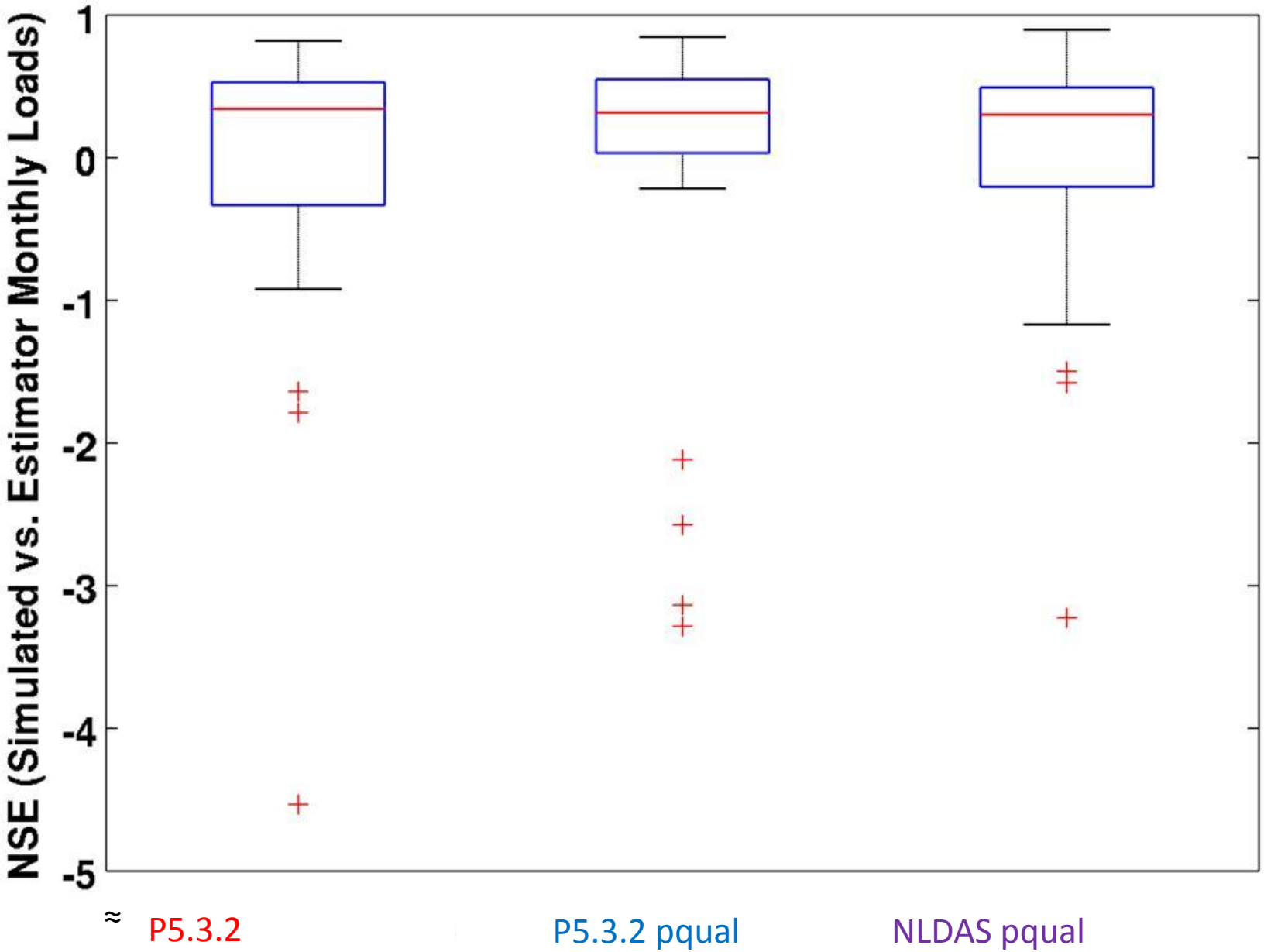
http://water.usgs.gov/software/loadest/

TOTN



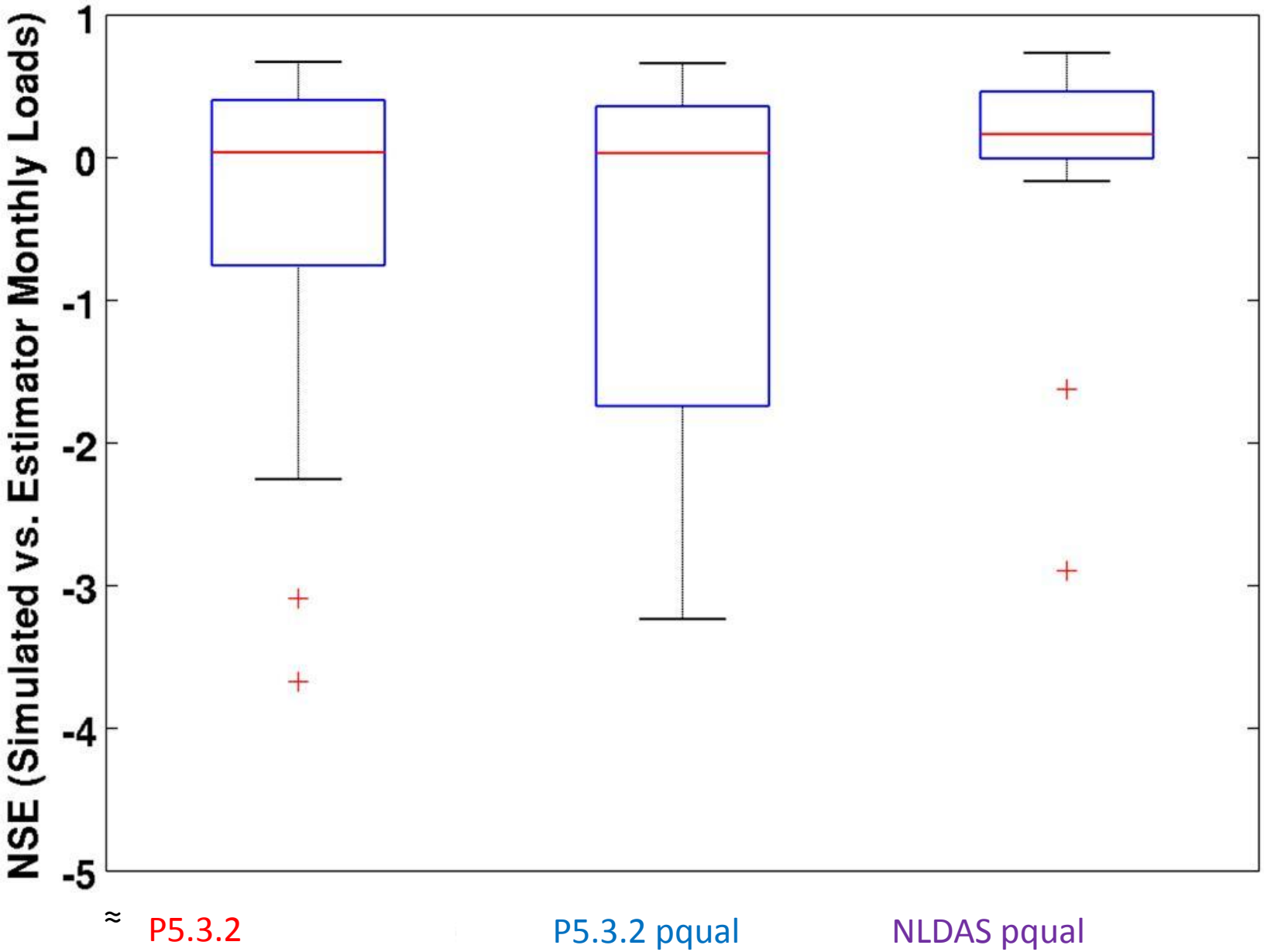
30 gage stations

TOTP



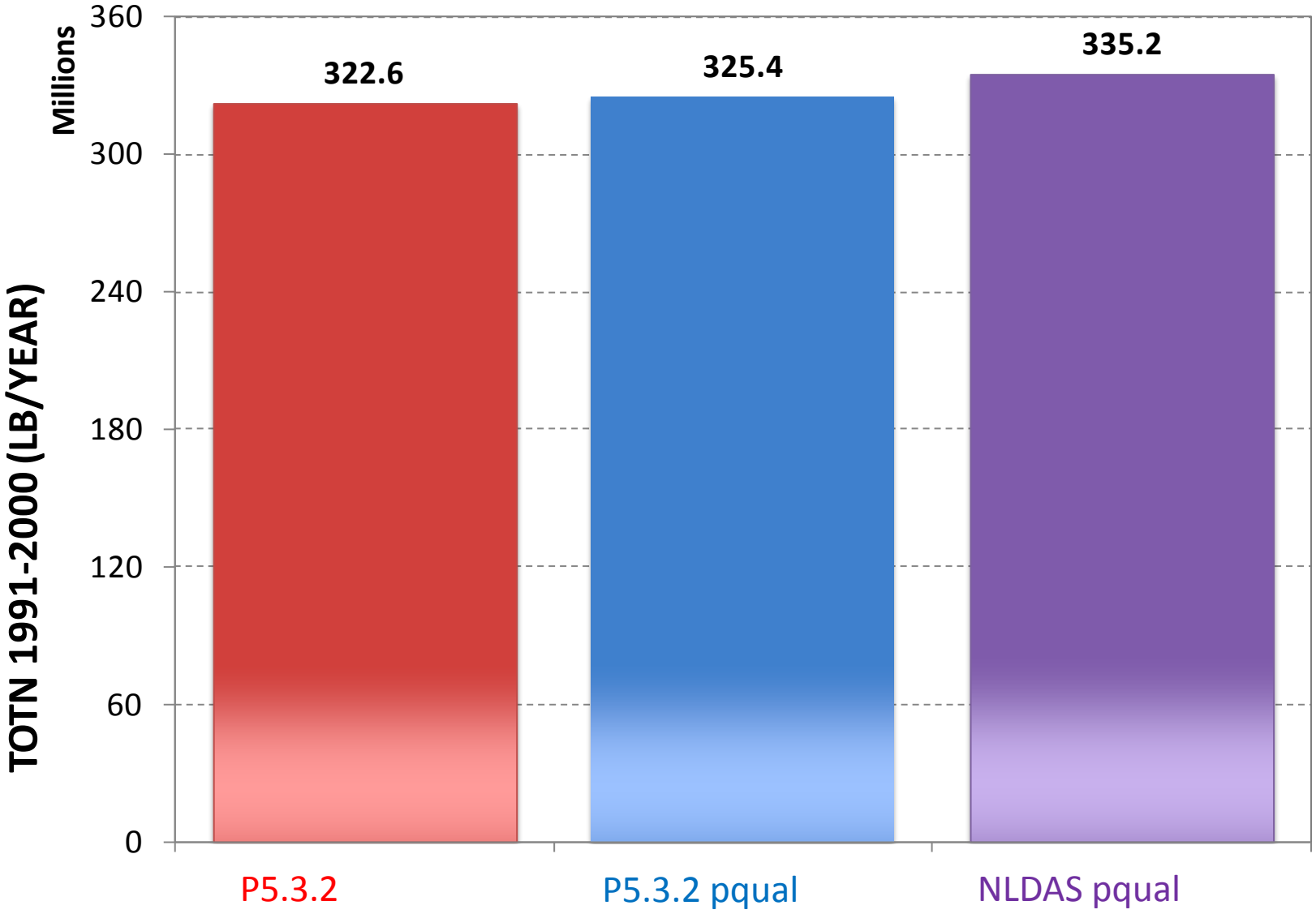
30 gage stations

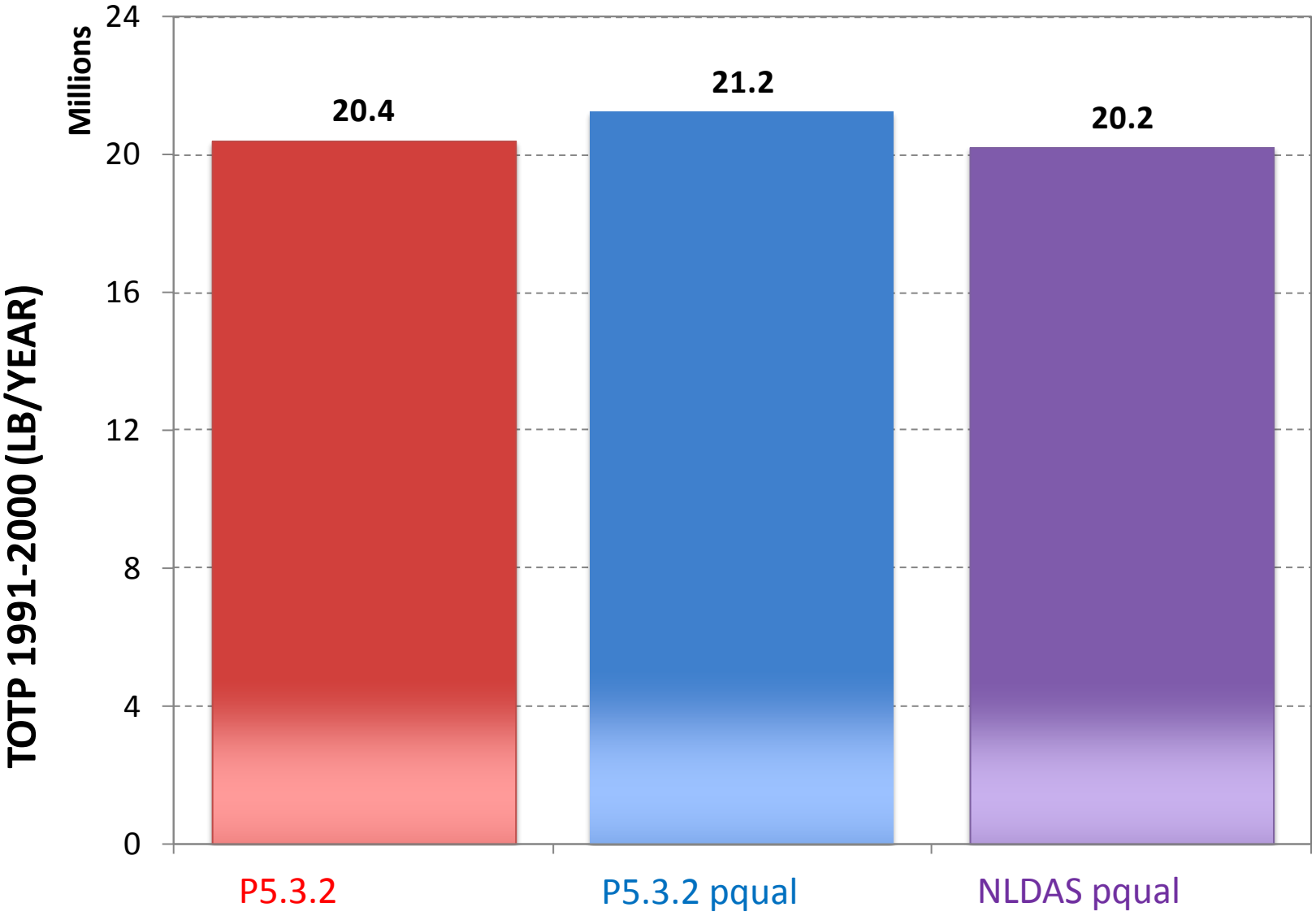
TSSX

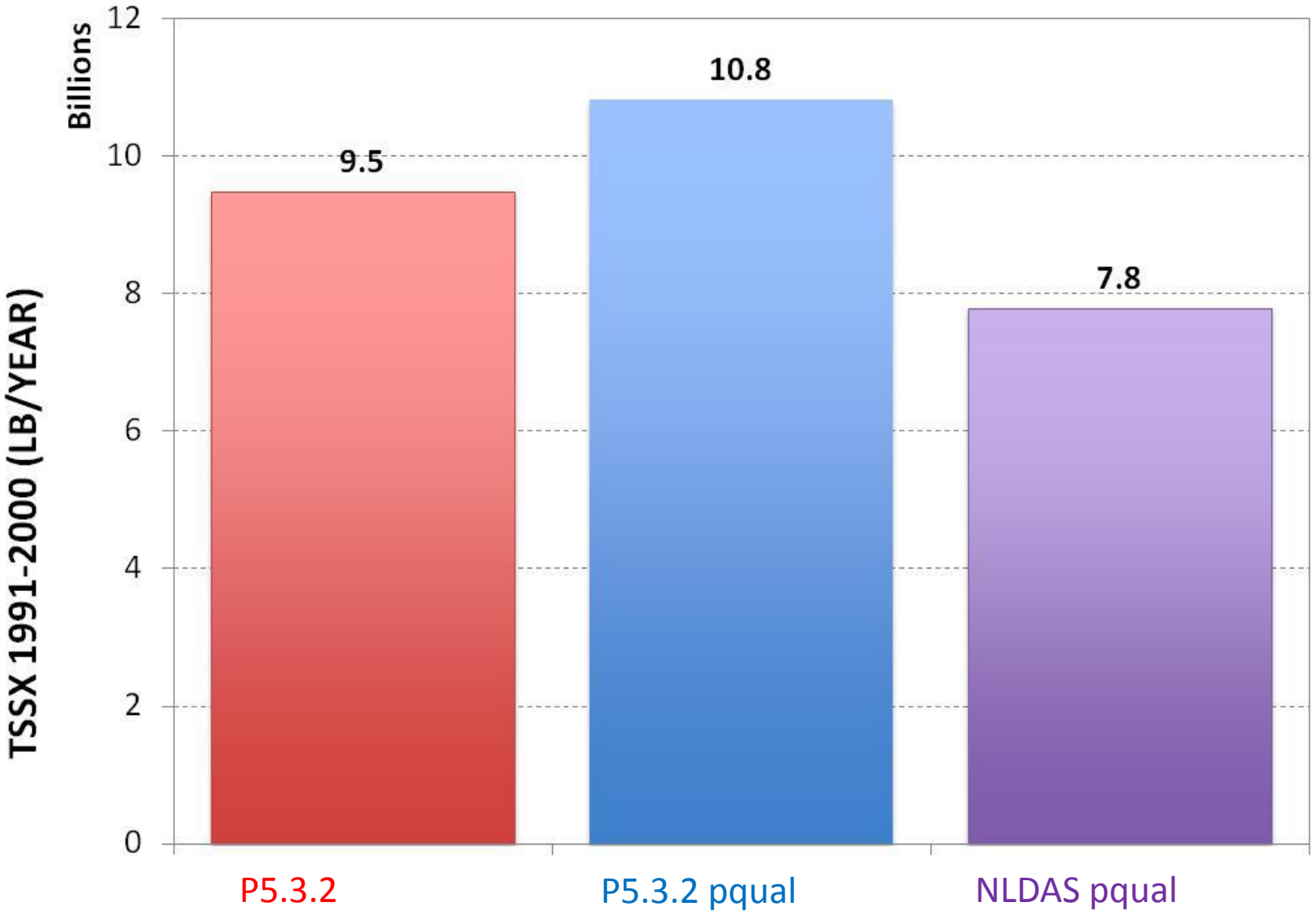


30 gage stations

Total Loading to the Bay (Yrs: 1991 – 2000)


TOTN 1991-2000 (LB/YEAR)
Millions
360
300
240
180
120
60
0
322.6
325.4
335.2
P5.3.2
P5.3.2 pqual
NLDAS pqual


TOTP 1991-2000 (LB/YEAR)
Millions
24
20
16
12
8
4
0
20.4
21.2
20.2
P5.3.2
P5.3.2 pqual
NLDAS pqual


TSSX 1991-2000 (LB/YEAR)
Billions
12
10
8
6
4
2
0
9.5
10.8
7.8
P5.3.2
P5.3.2 pqual
NLDAS pqual

Next Steps …

- …

- Incorporate Nutrient Sensitivity in the Phase-6 framework
- Test developed framework on ‘key’ scenarios