Multi-site evaluation of APEX for crop and grazing land in the Heartland region of the US

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In an ideal world…

- We would have tools to:
  - Give feed-back on agricultural management
  - Document water quality benefits from agricultural practices
  - Select practices based on what happens with each of them

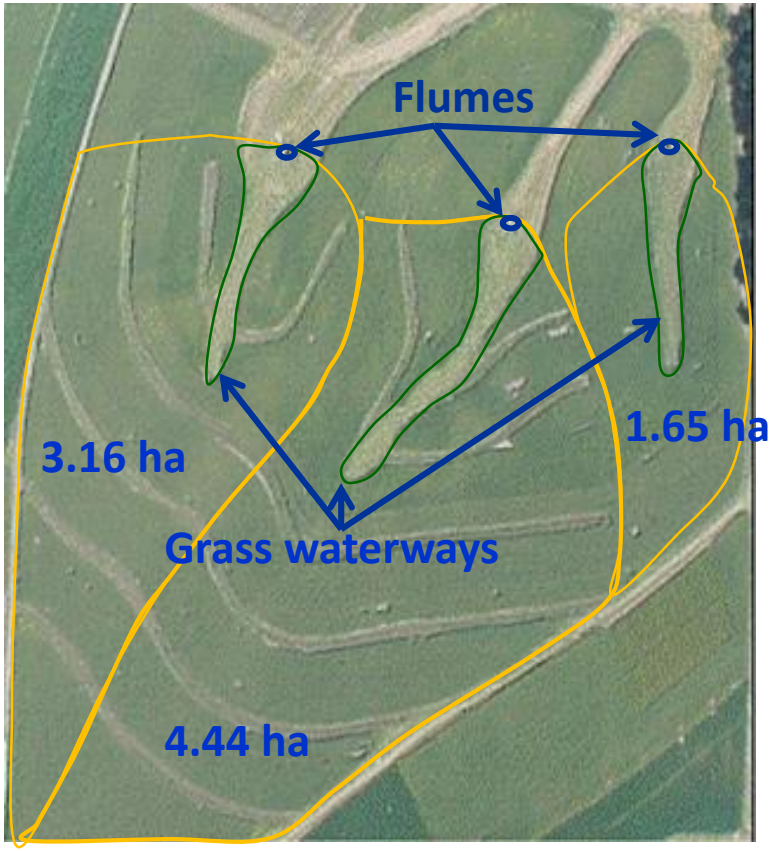
APEX has been promoted for use with limited data

Can we use APEX to do this?

Is APEX reliable without calibration?

What is APEX?

- Agricultural Policy / Environmental eXtender
- Field- to small watershed-scale model
- Daily time step
  - Daily temperature and rainfall as inputs
- Simulates
  - Crop growth
  - Nutrient & carbon cycling
  - Runoff
  - Erosion
  - Nutrient losses

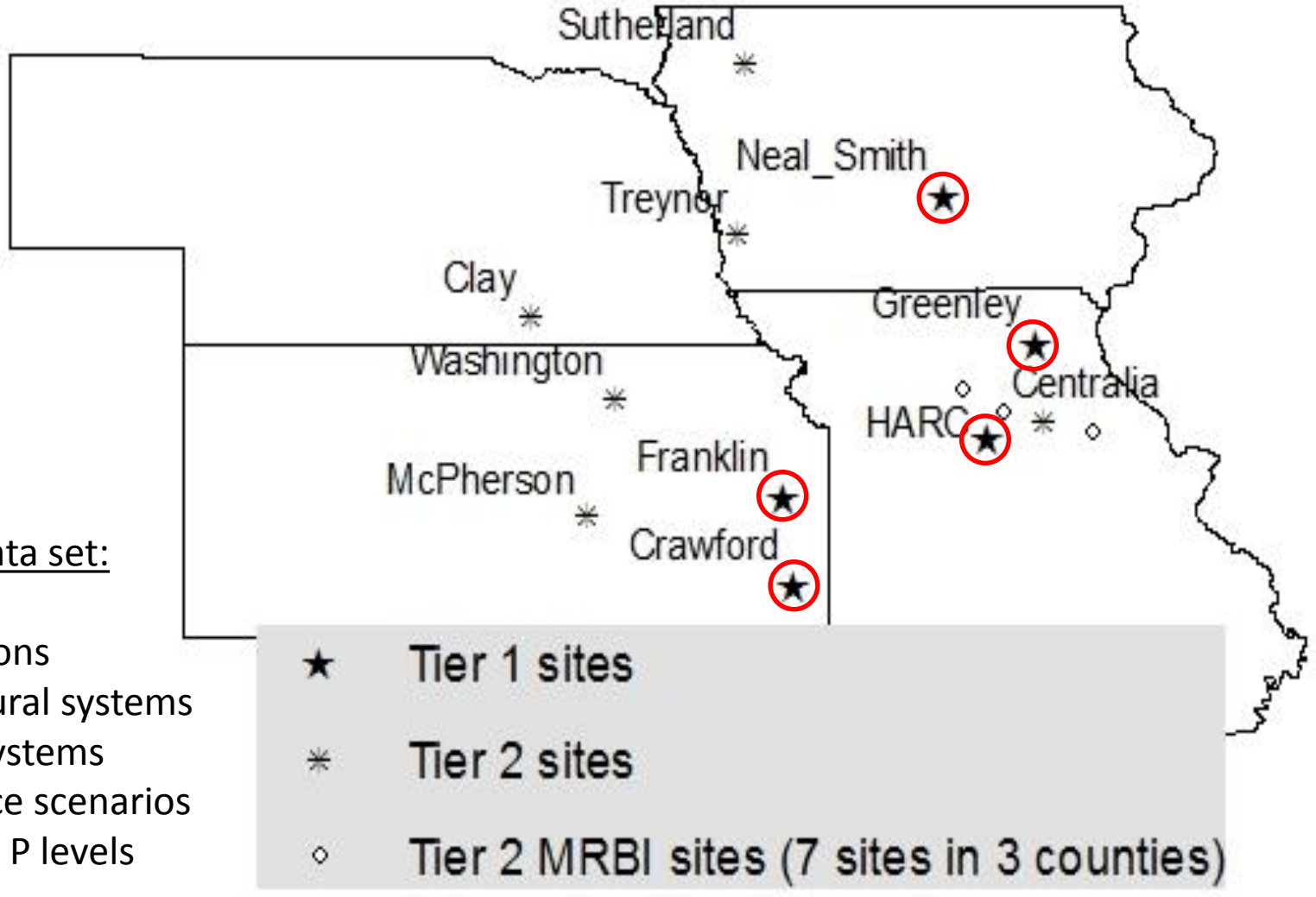


Novelty Watersheds
Greenley, MO

APEX Evaluation Objectives

- Can APEX predict Q, Sed and P loss without calibration?
  - Best professional parameterization
- How well can APEX predict Q, Sed and P with calibration?
  - Full calibration
- Can we develop a regional calibration for APEX?

Evaluation Datasets



Diverse data set:

4 states
5 soil regions
5 agricultural systems
4 tillage systems
18 P source scenarios
5 soil test P levels

Tier 1 Evaluation Datasets

- Size: 1 – 5 ha.
- Crops
  - Corn / Soybean / Sorghum
  - Pasture
- Tillage
  - No-till / Reduced till
- Fertility
  - Fertilizer
  - Poultry litter
- Structures
  - Grassed waterway
  - Buffers

Best professional judgment parameterization

- Options selected through best professional judgment
- SSURGO soils data (from web soil survey)
- Management data from the site
- Measured soil test P, total C, and total N.
- Parameter file based on best professional judgment, recommendations from model developers, and published reports.

Full Model calibration

- Start with the best professional judgment parameterization
- Add site-specific soils data
  - Site-specific soil investigation, measured horizon depths
  - Measured soil test P, total C, total N, and total P by horizon
  - Measured texture
  - Measured bulk density and hydraulic properties if possible
- Sensitivity analysis based on model performance
  - r^2, Nash-Sutcliffe, percent bias, regression slope, minimum square error
- Manual calibration followed by automated parameter optimization.

Autocalibration

- PAROPT

- Stepwise
- Multi-variable
- Multi-objective
- Parm file parameters

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ENVIRONMENTAL MODELS, MODULES, AND DATASETS

Evaluation of a Stepwise, Multiobjective, Multivariable Parameter Optimization Method for the APEX Model

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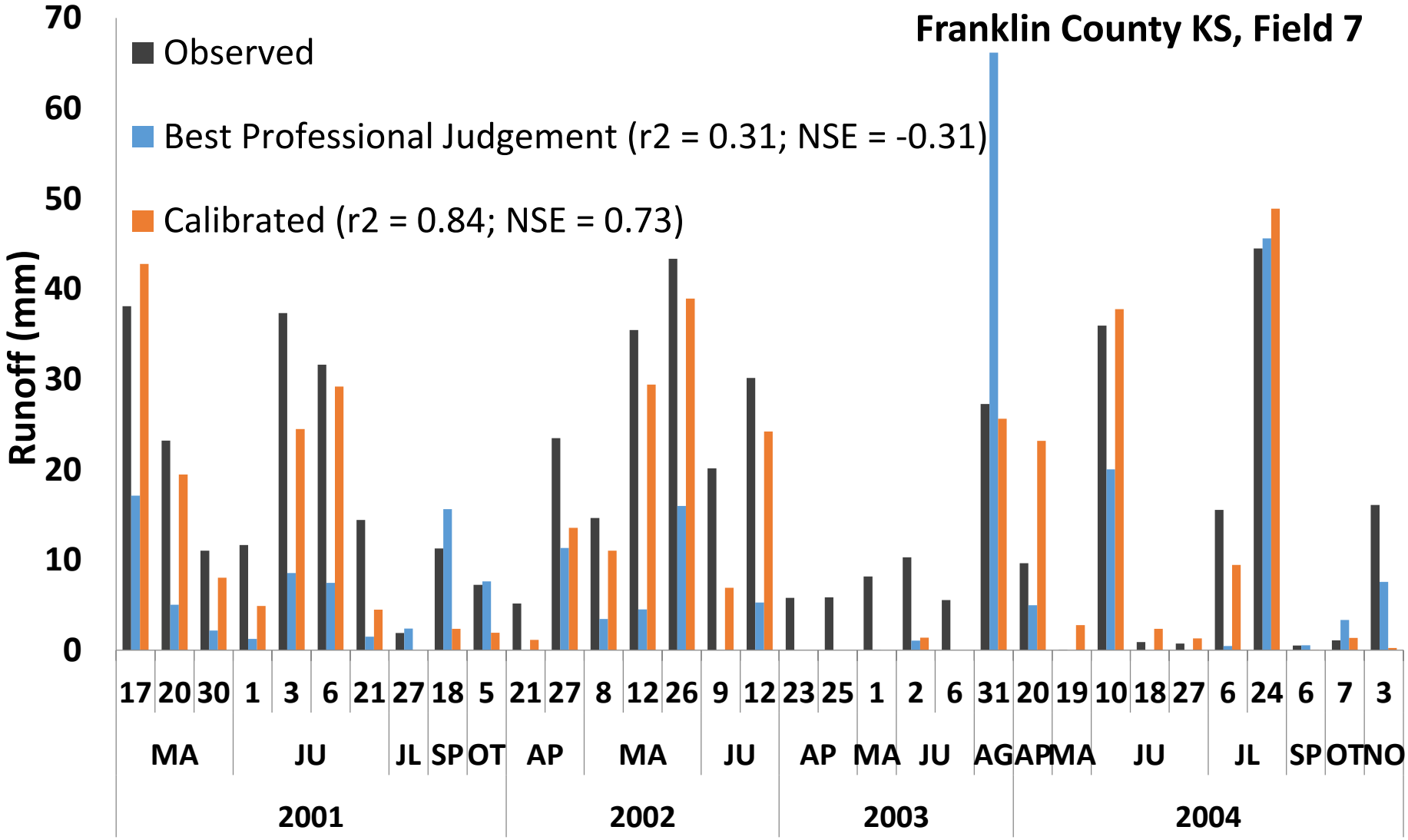
Abstract

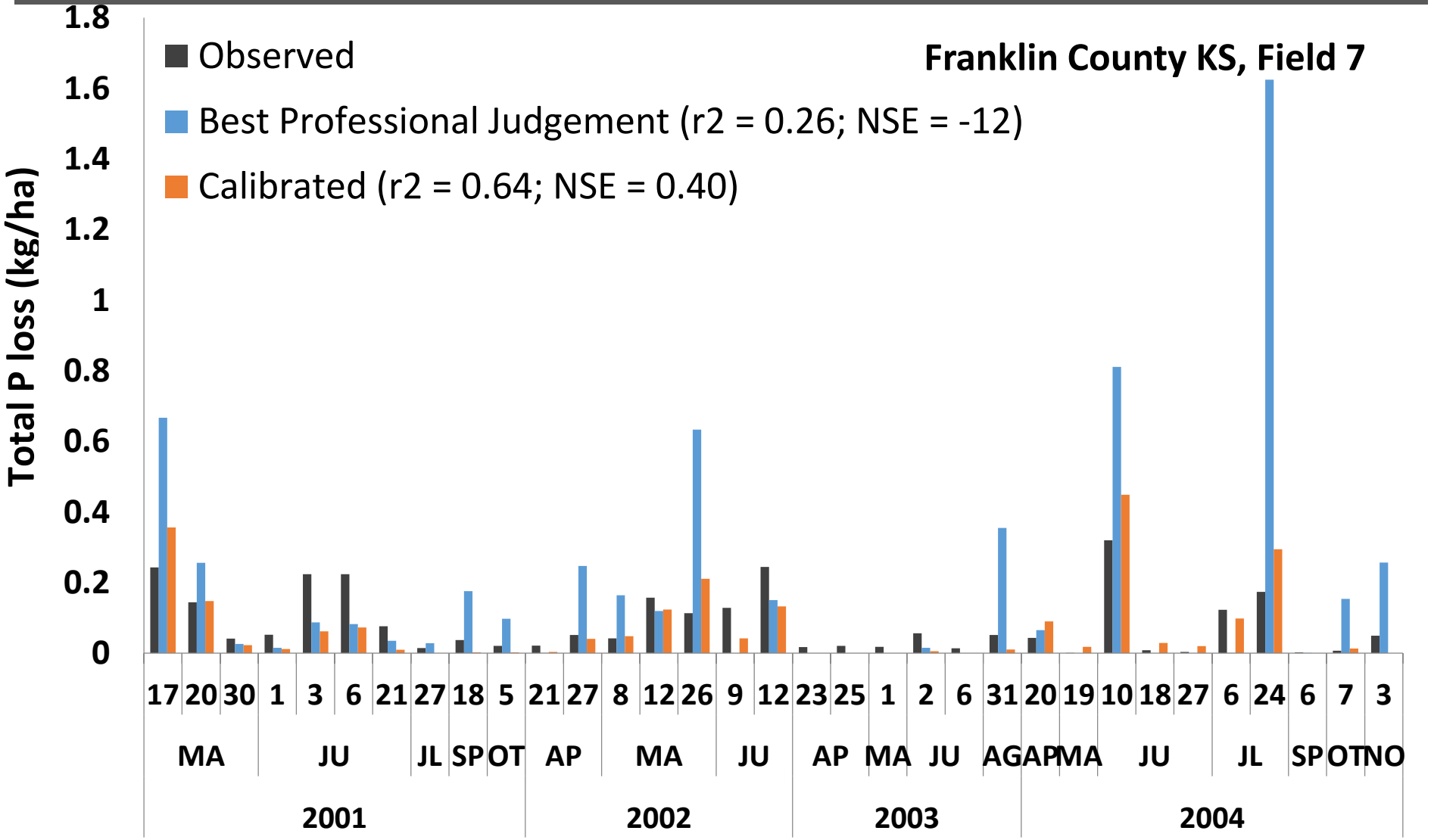
Hydrologic models are essential tools for environmental assessment of agricultural nonpoint-source pollution. The automatic calibration of hydrologic models, though efficient, demands significant computational power limiting their

PHYSICALLY BASED distributed hydrologic models have become useful and efficient alternatives to in situ experiments at the watershed scale for environmental assessments. However, hydrologic models often contain parameters that cannot be measured directly due to limitations in mea-

Event-based Model Calibration - Runoff



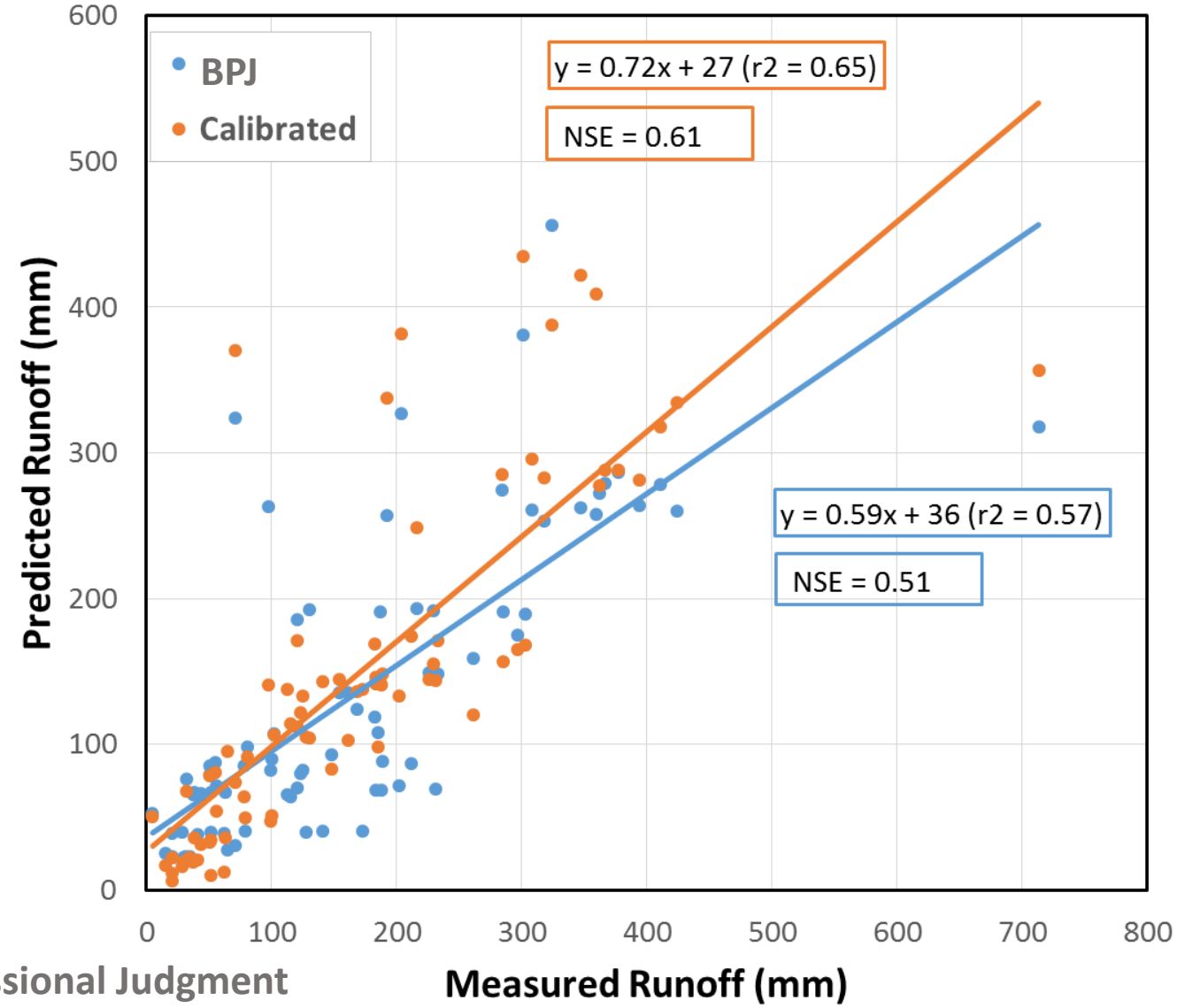
Event-based Model Calibration – P Loss



“Annual” Comparisons

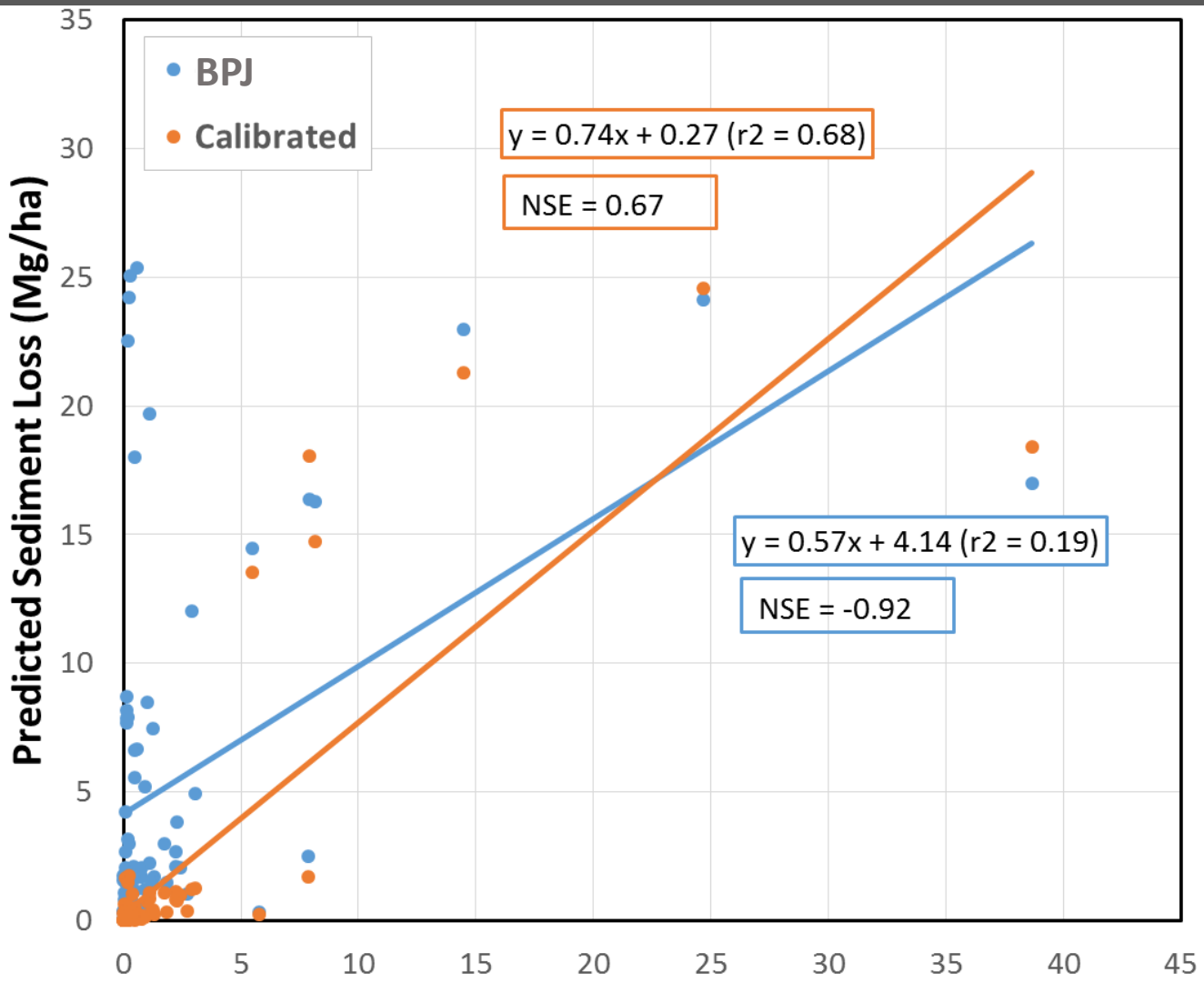
- Event-based calibration is complete for 18 watersheds at 5 locations
  - Close communication with model developers to improve APEX
- Data were summed at each location by year
  - 80 site years of data
- Evaluate accuracy of APEX predictions across multiple sites and management

Runoff



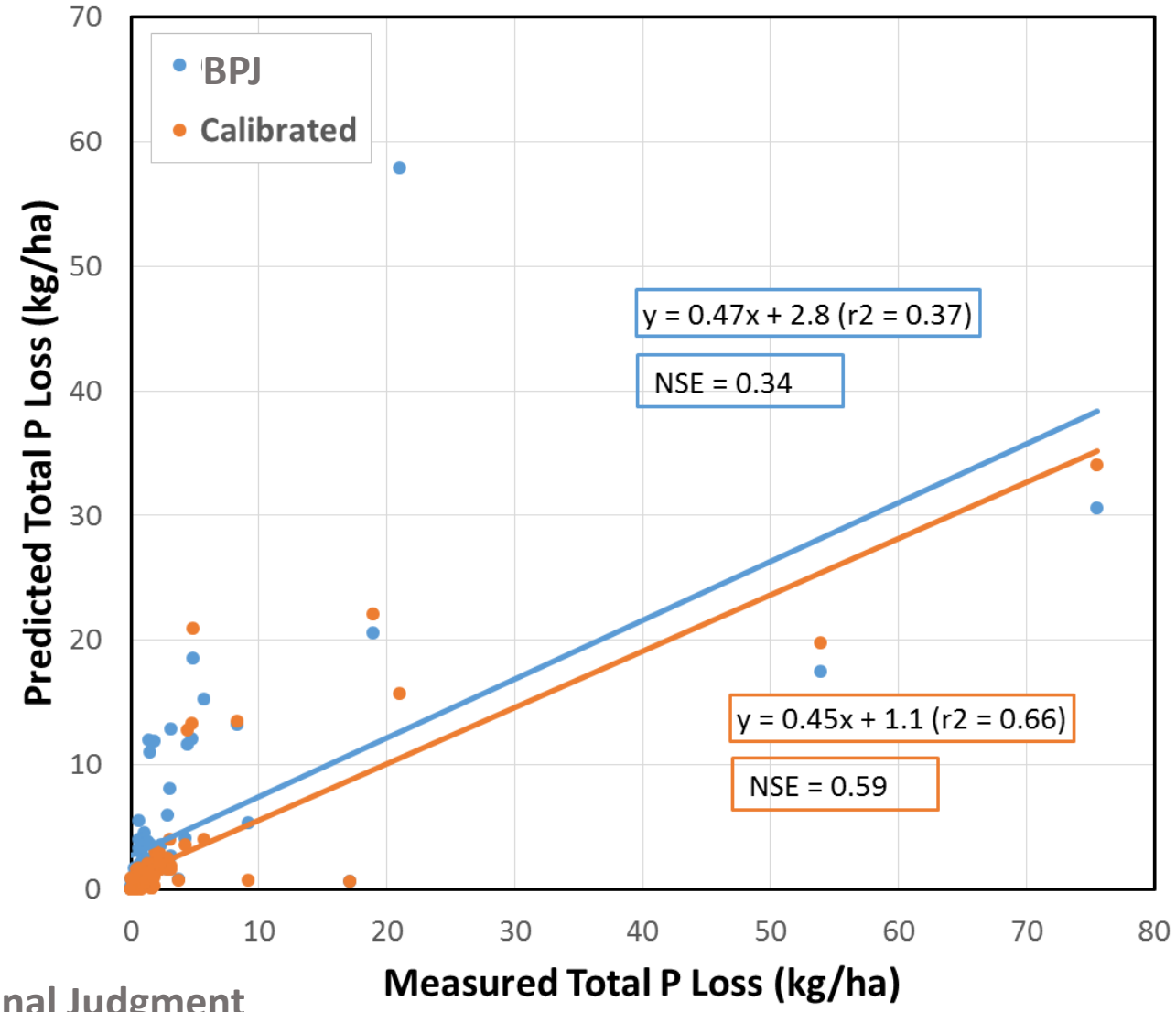
BPJ: Best Professional Judgment

Erosion



BPJ: Best Professional Judgment

P Loss



BPJ: Best Professional Judgment

Conclusions

- Best professional judgment parameterization provided satisfactory runoff estimates
- Best professional judgment parameterization did not provide satisfactory sediment loss or P loss estimates
  - Over-prediction of low sediment and P loss
- Calibrated APEX greatly improved sediment and P loss estimates

Future Work

- Finalize a regional calibration
  - 6 control parameters
  - 7 parameters of the parm file
  - Still 8 parameters undefined
- Evaluate regional calibration on all the sites: Tier 1 and 2

The Team

Modeling team

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