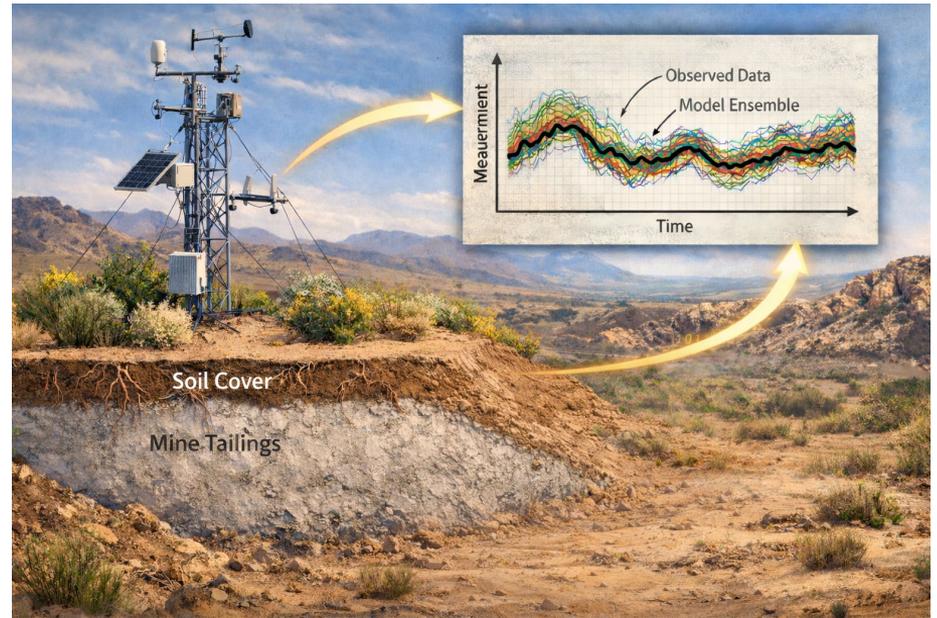


Constraining Recharge to TSFs via Model Calibration to Transient Evaporation and Soil Moisture Data

Assaf Wunsch

February 24, 2026



Aya
Mohamed



Philine
Tullius



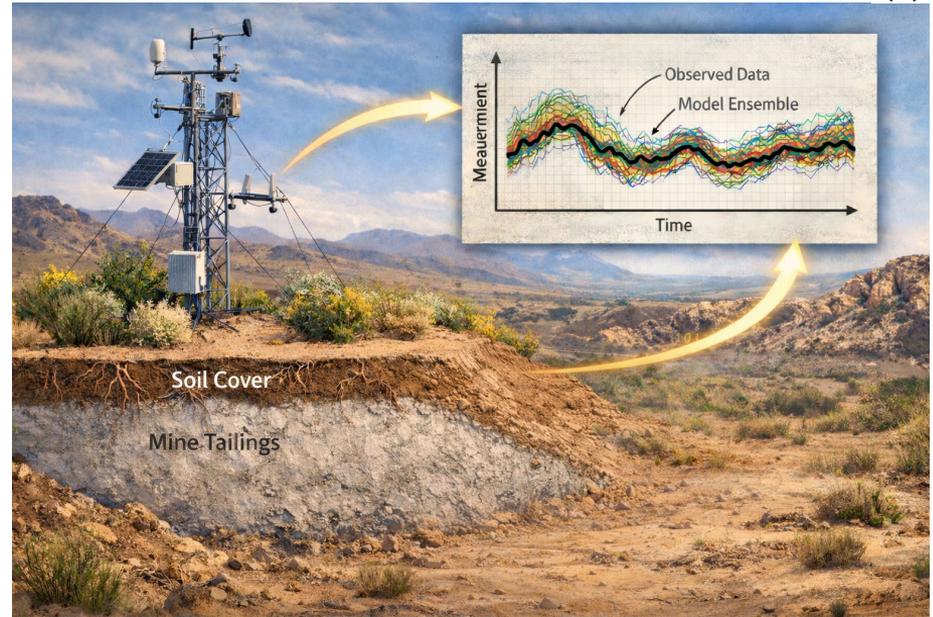
Kyle
Williams

RATED N

minor use of equations, metric units, unnecessary flow charts, adult language, nudity

Objective and Scope of this Talk

- Demonstrate the use of site-specific, transient data for automatic calibration of a TSF infiltration model
- (A bit about data pitfalls)



* Illustration generated by AI



Site Setting and Study Objective

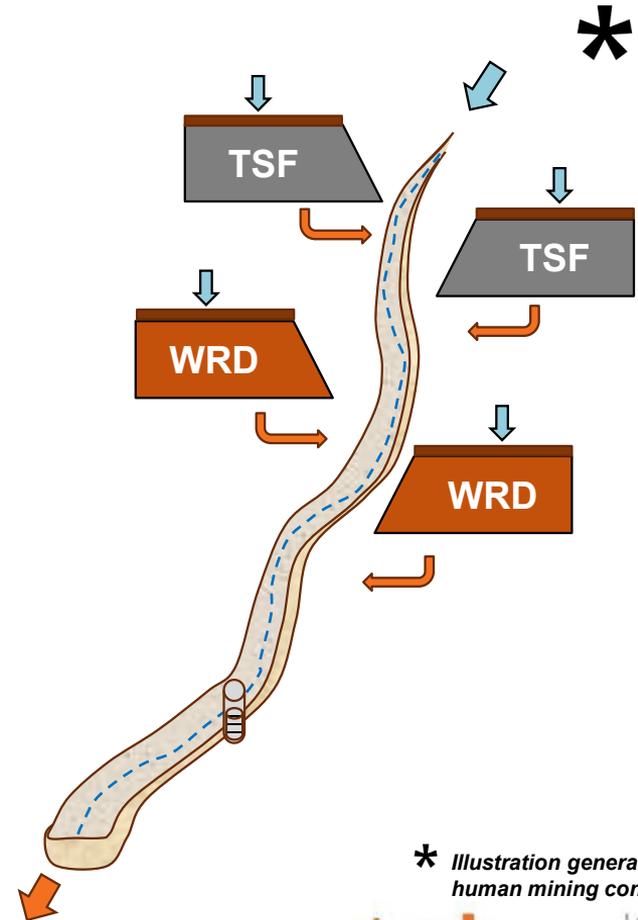
- Multiple closed mining facilities – TSFs, WRDs – near a dry wash and alluvial aquifer

Geotechnical

Effect of infiltration on TSF stability?

Environmental

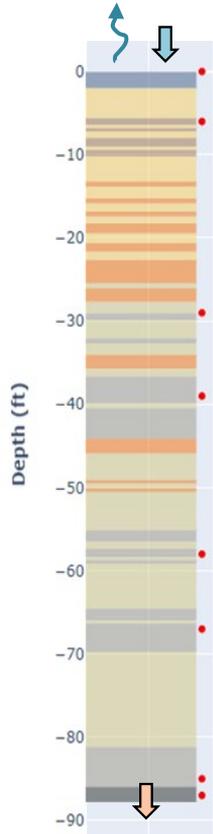
Close mass balance loop on entire watershed – how much do facilities “leak” to groundwater?



* Illustration generated by a human mining consultant



Numerical Simulator



**Raoul
Collenteur**

HYDRUS-1D



PHYDRUS



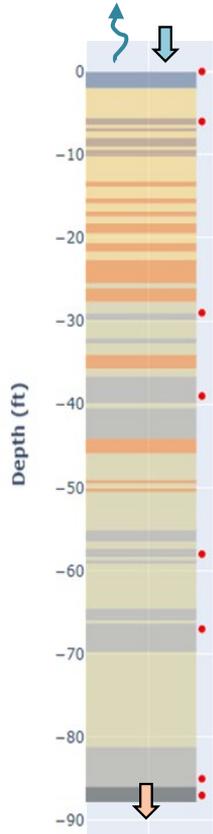
“SRK-PHYDRUS”



**Jirka
Šimunek**



State of Data



- **Hydraulic stress:**
 - Daily precipitation data
- **TSF stratigraphy:**
 - Detailed CPT



- **Hydraulic stress:**
 - No site-specific PET
- **Calibration data:**
 - Facilities are completely drained down (unsaturated)
- **Characterization data:**
 - No hydraulic properties (almost)

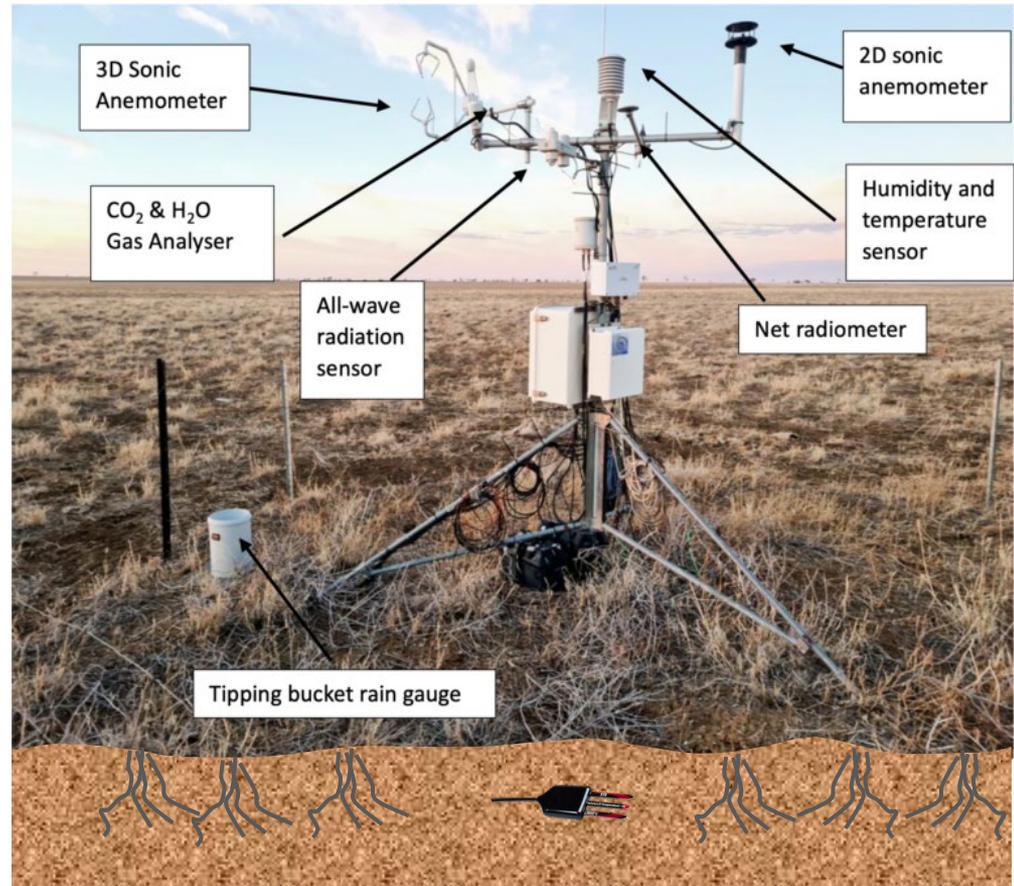


Fast Forward...



Calibration Data

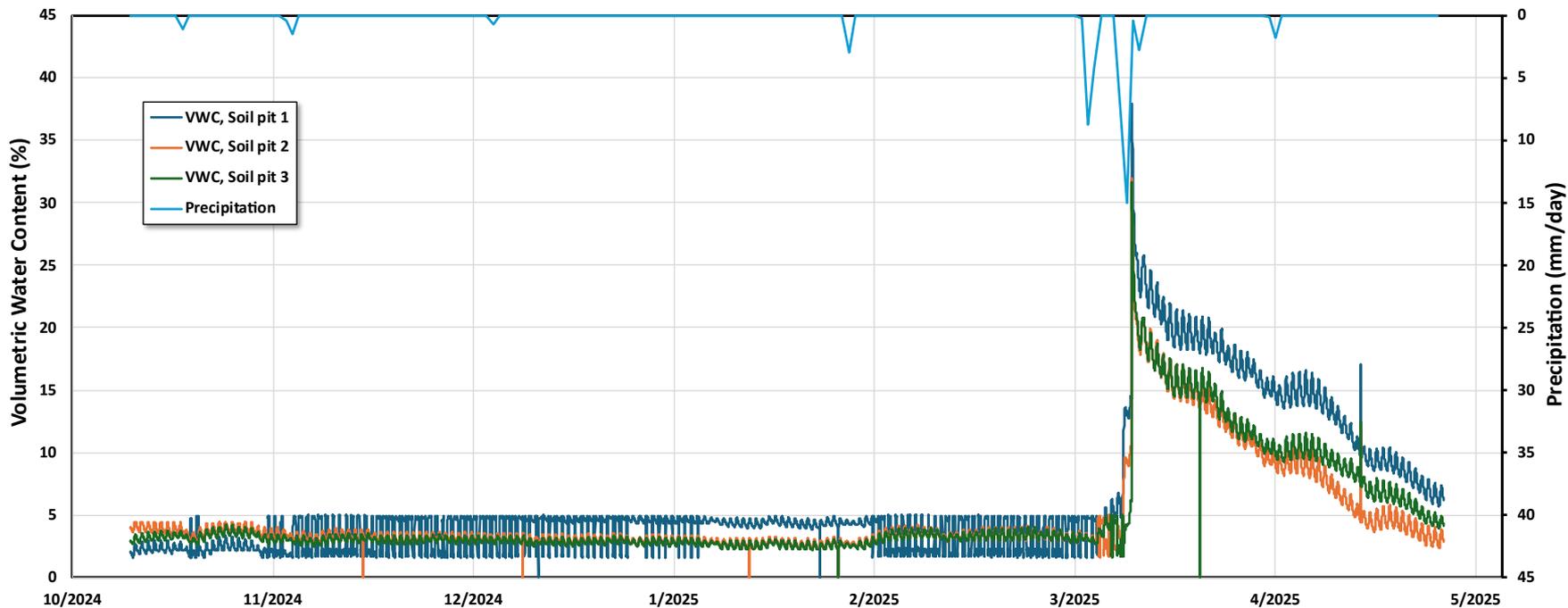
- Eddy covariance tower:
 - Potential evapotranspiration
 - Actual evapotranspiration
- Soil moisture (3" bgs)



<https://www.tern.org.au/news/what-is-an-eddy-covariance-flux-tower/>

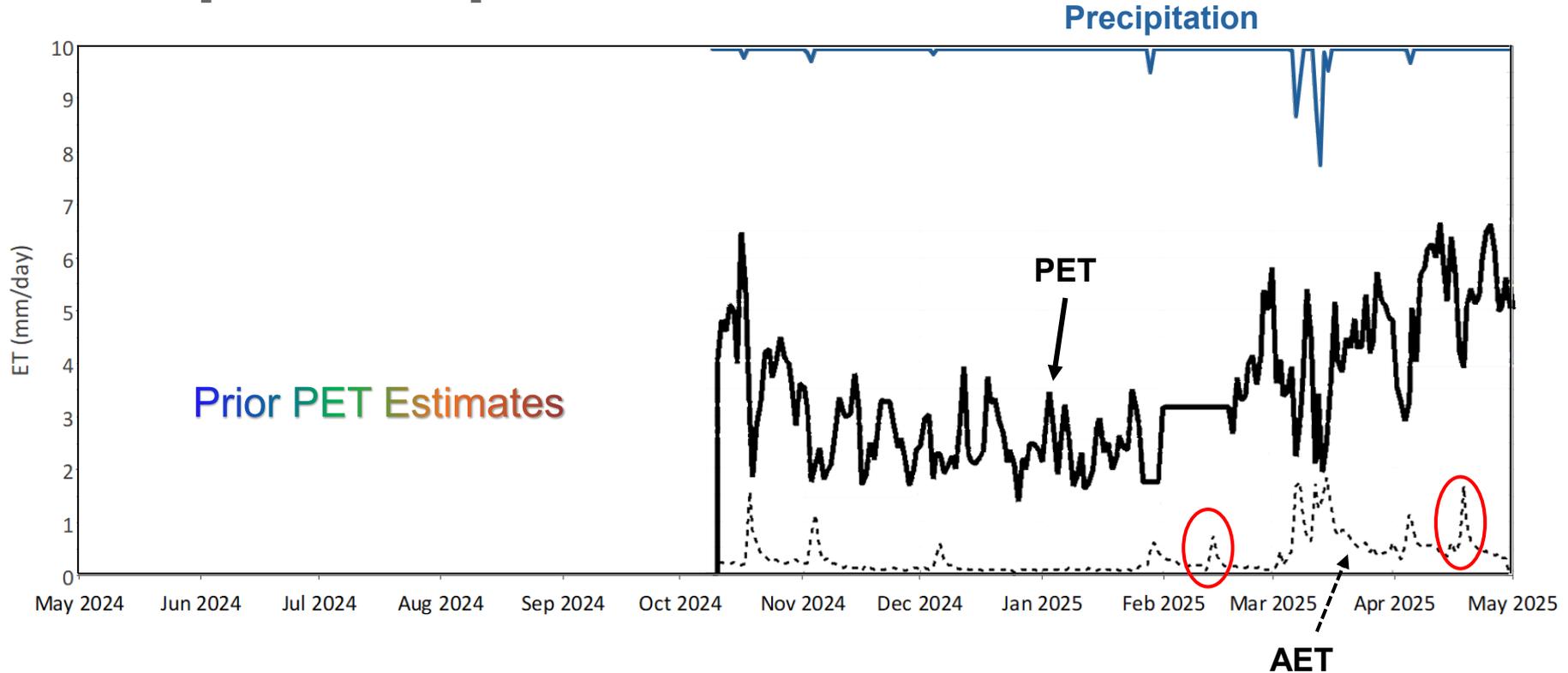


Soil Moisture





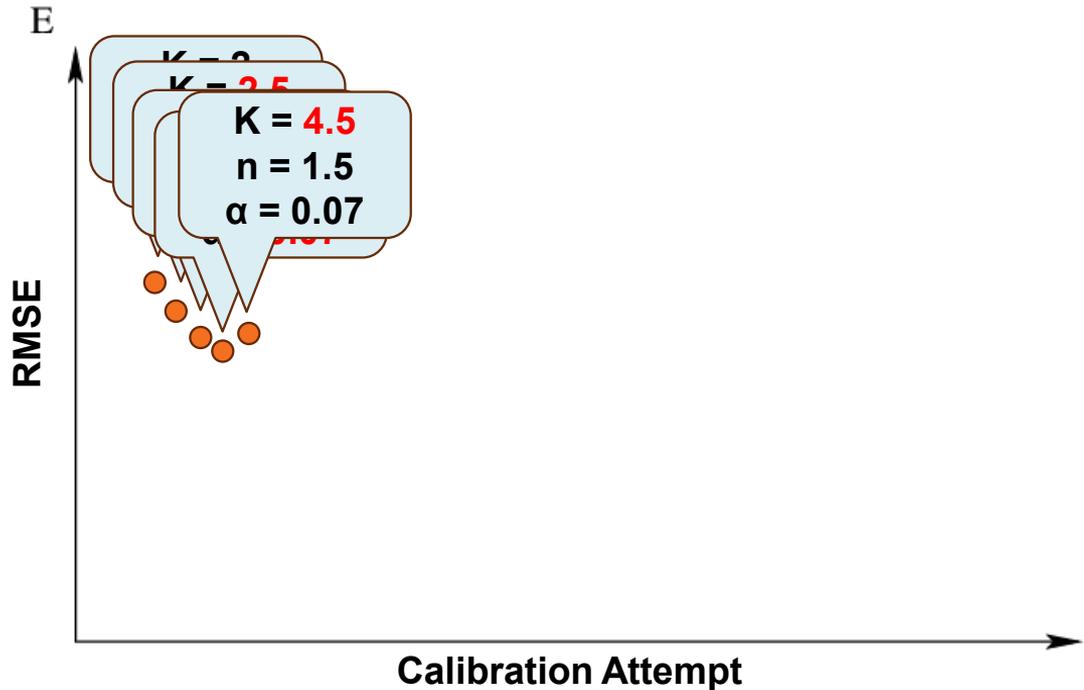
Evapotranspiration



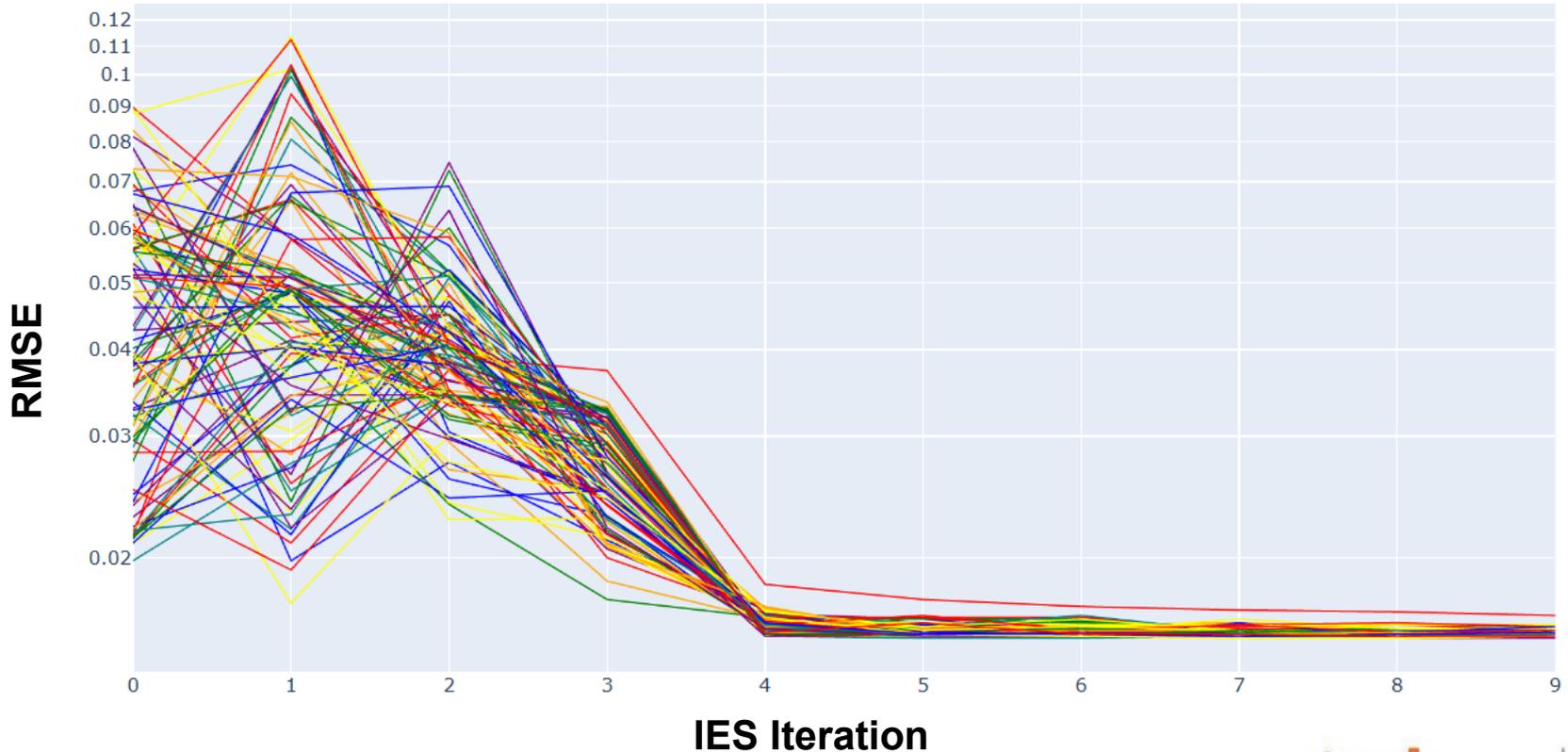
Model Calibration: IES – Iterative Ensemble Smoother

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2}$$

where: n = number of observations, y_i = observed value, \hat{y}_i = predicted value

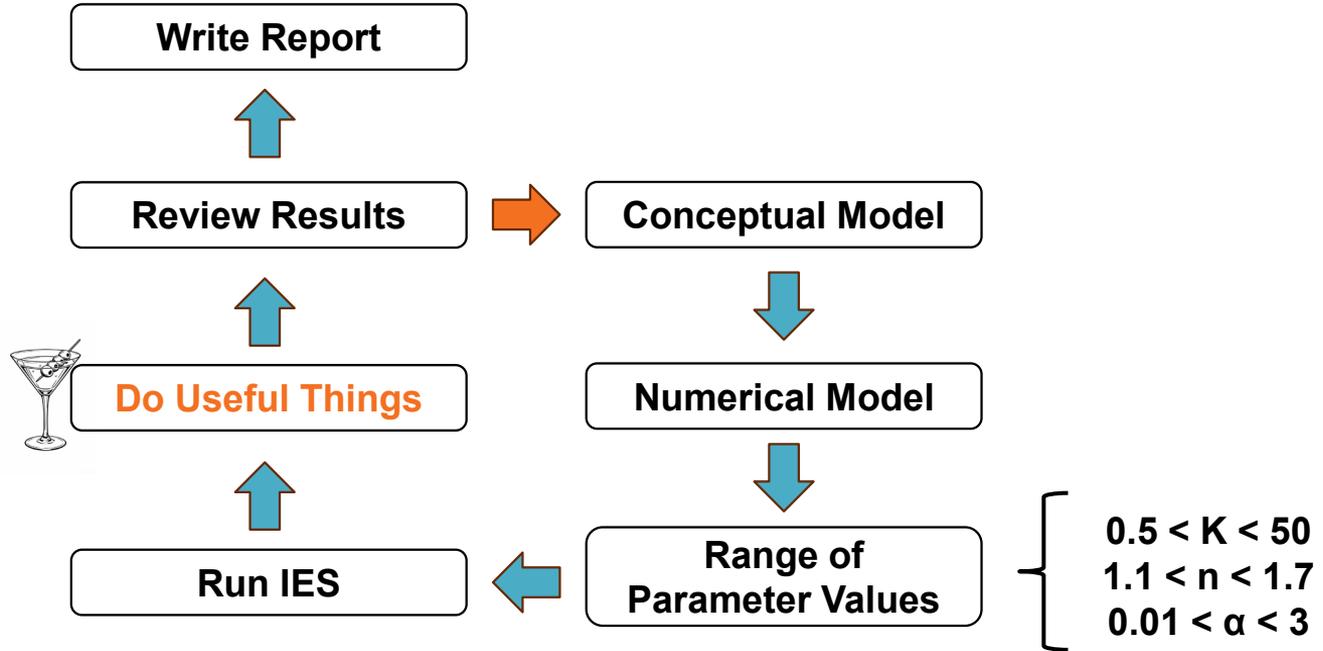
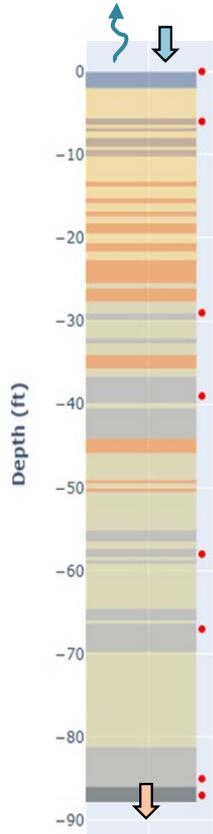


IES Calibration Results: RMSE

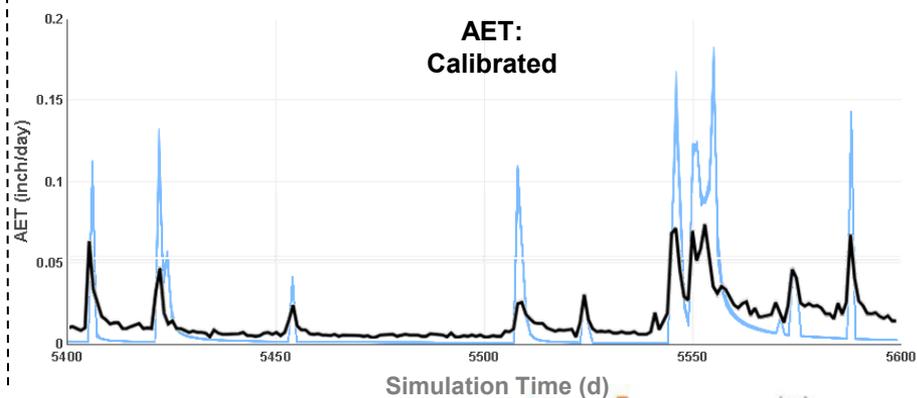
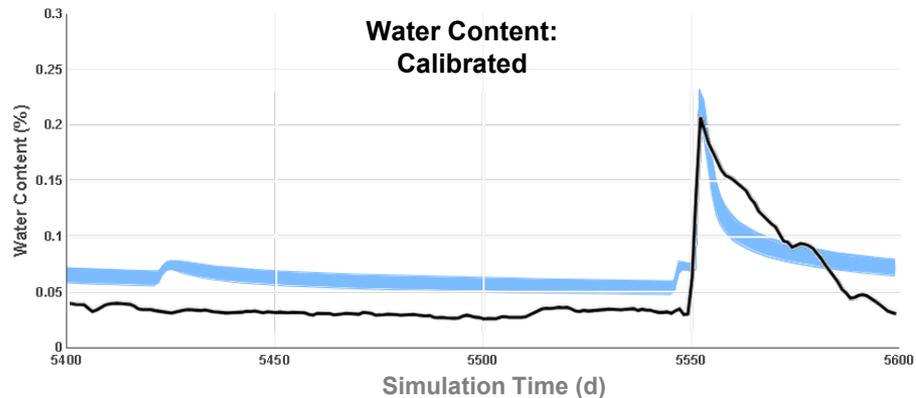
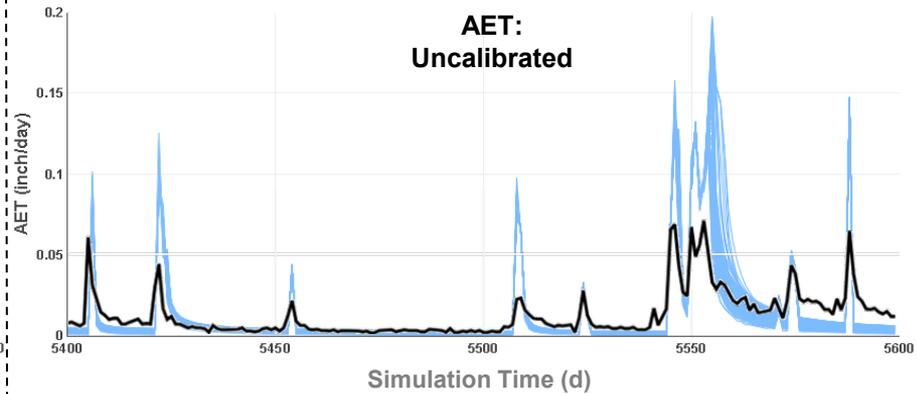
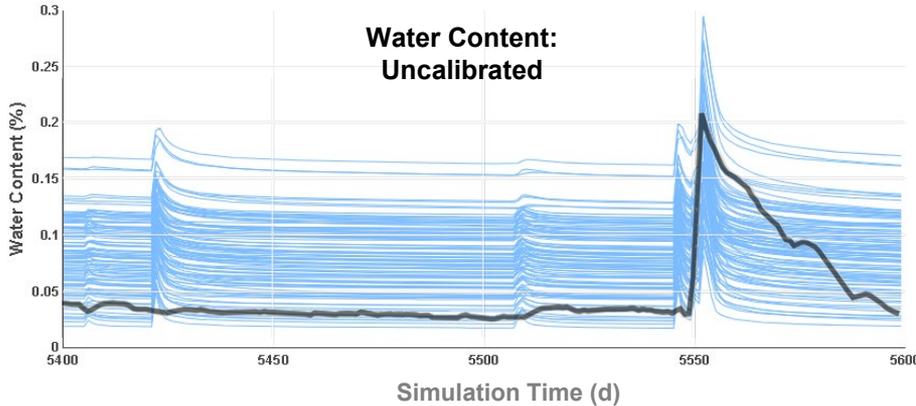




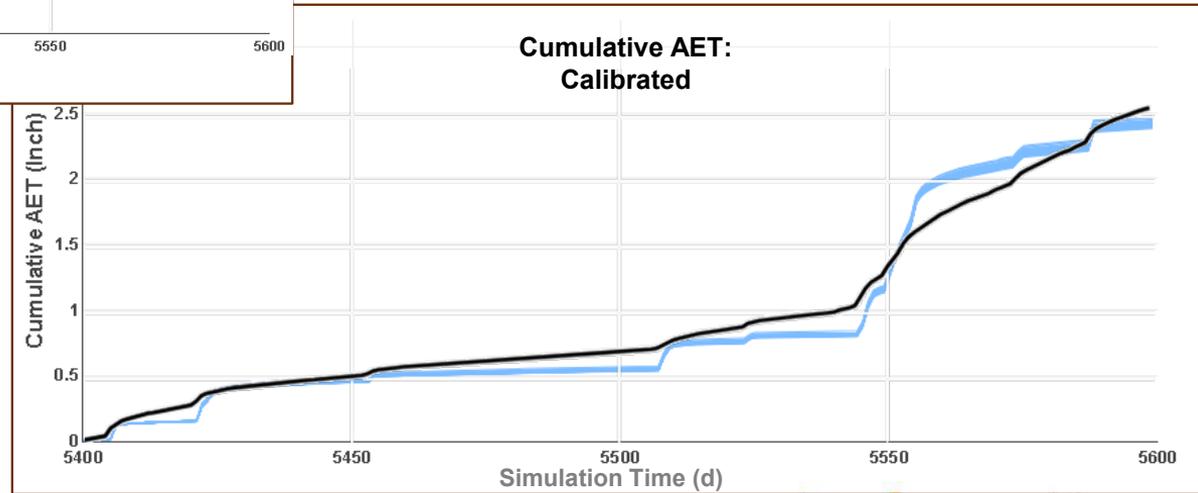
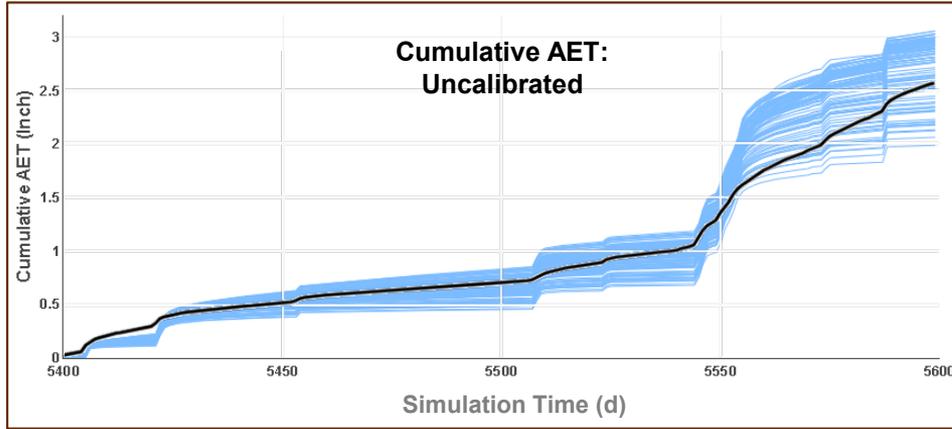
IES – Modeling Approach



IES Calibration Results: Observed vs Simulated

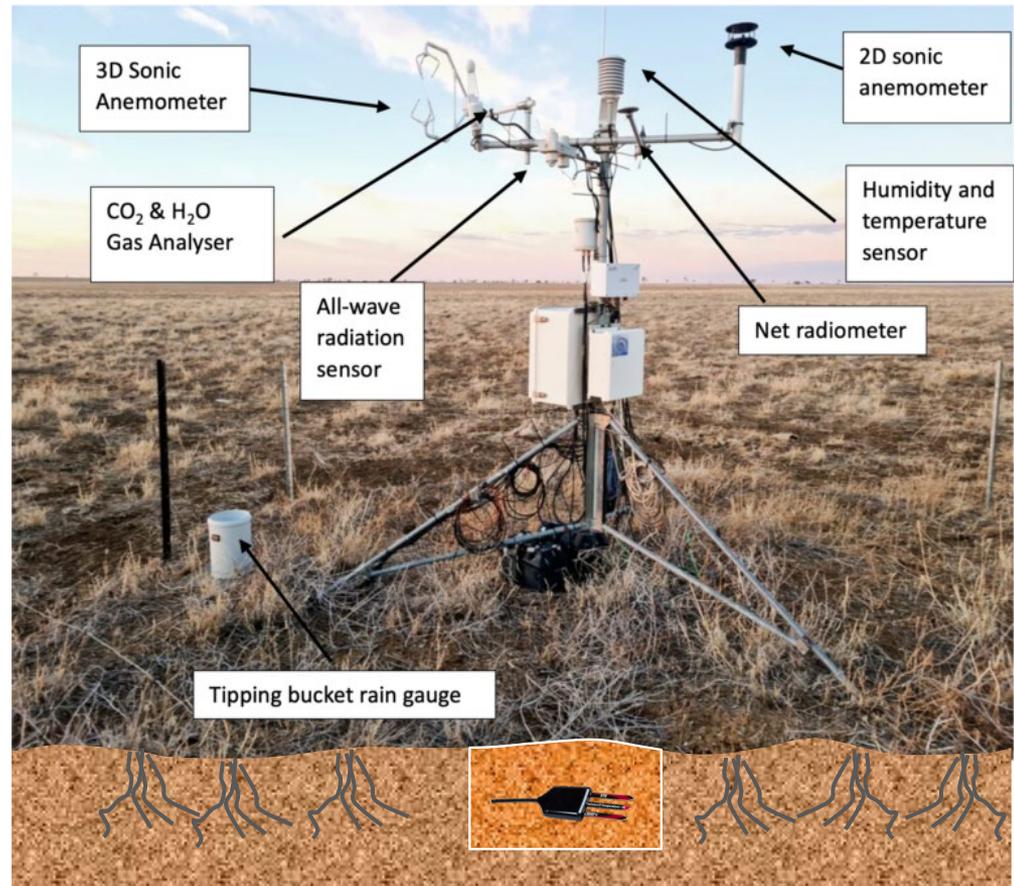


IES Calibration Results: Observed vs Simulated



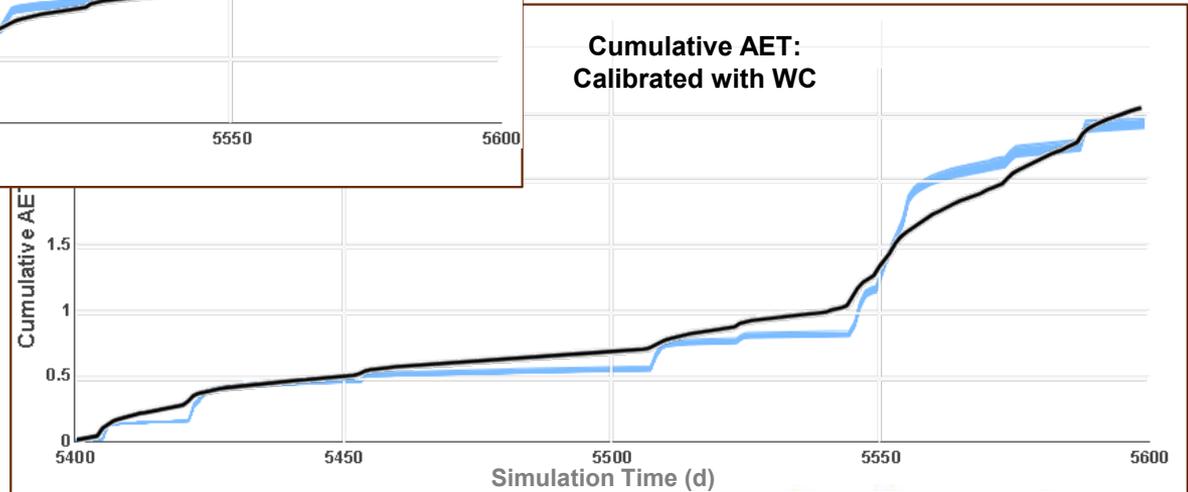
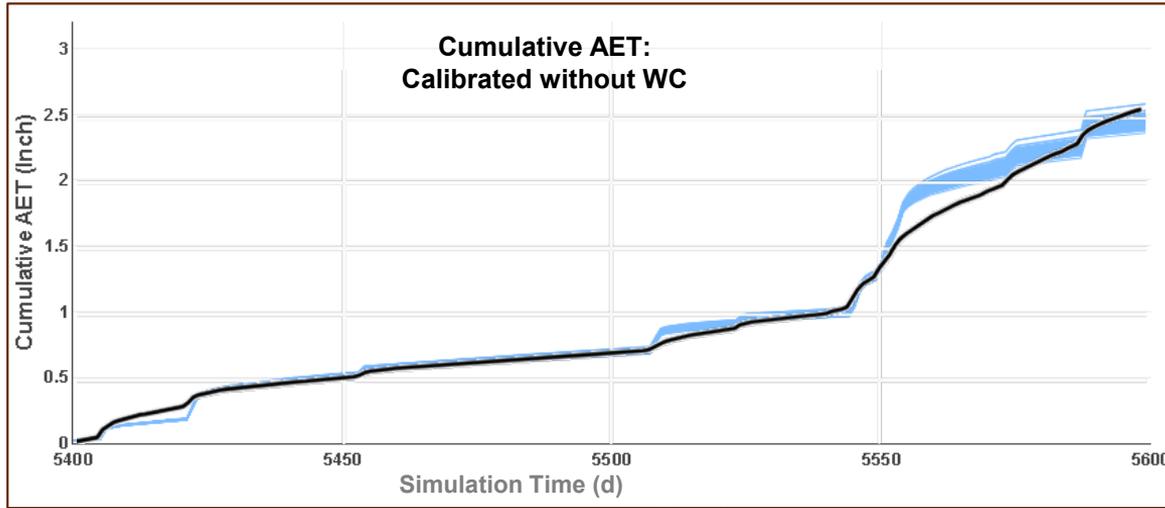


Exclude Water Content Data?



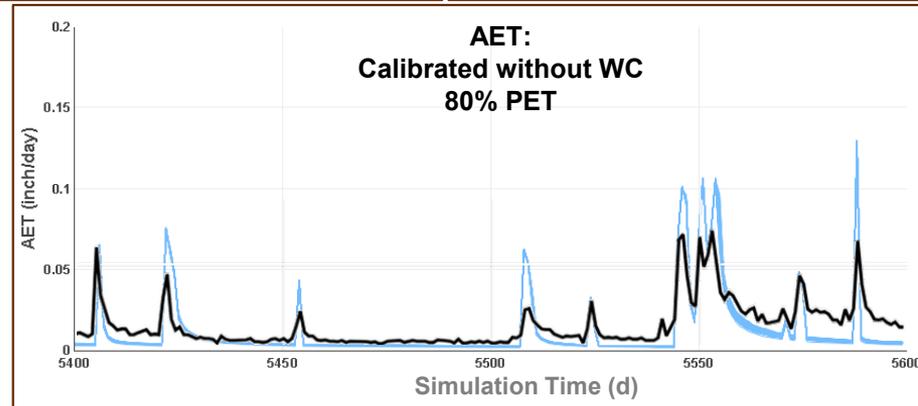
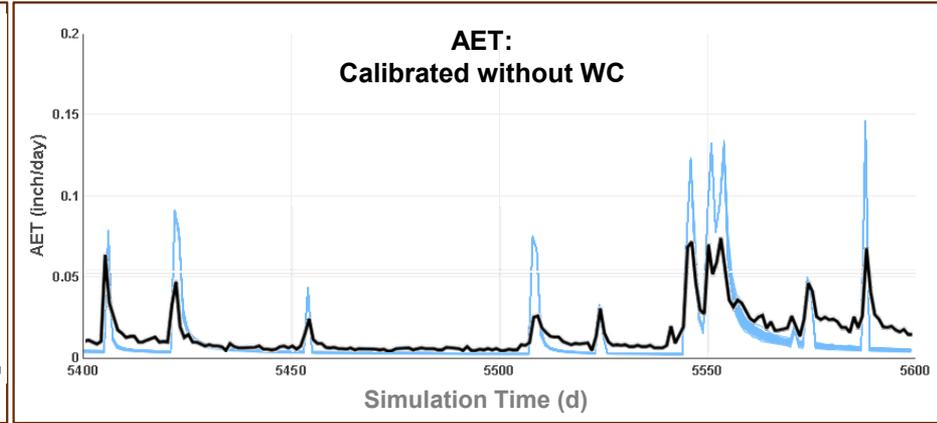
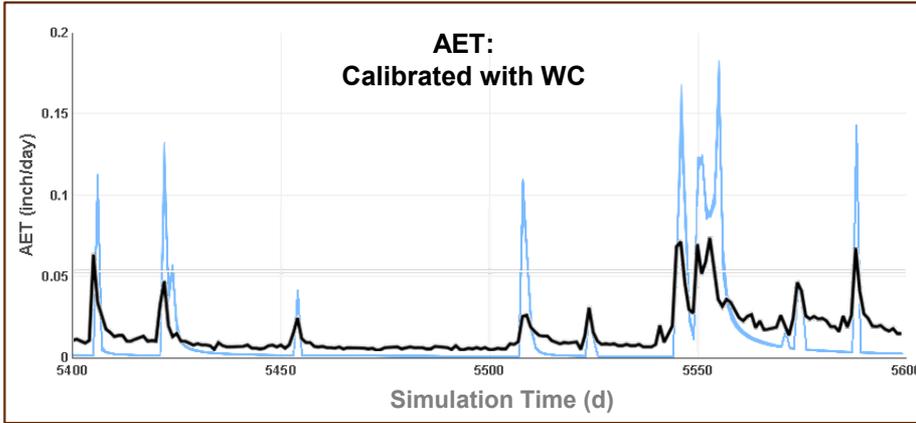
<https://www.tern.org.au/news/what-is-an-eddy-covariance-flux-tower/>

IES Calibration Results: Excluding Water Content Data





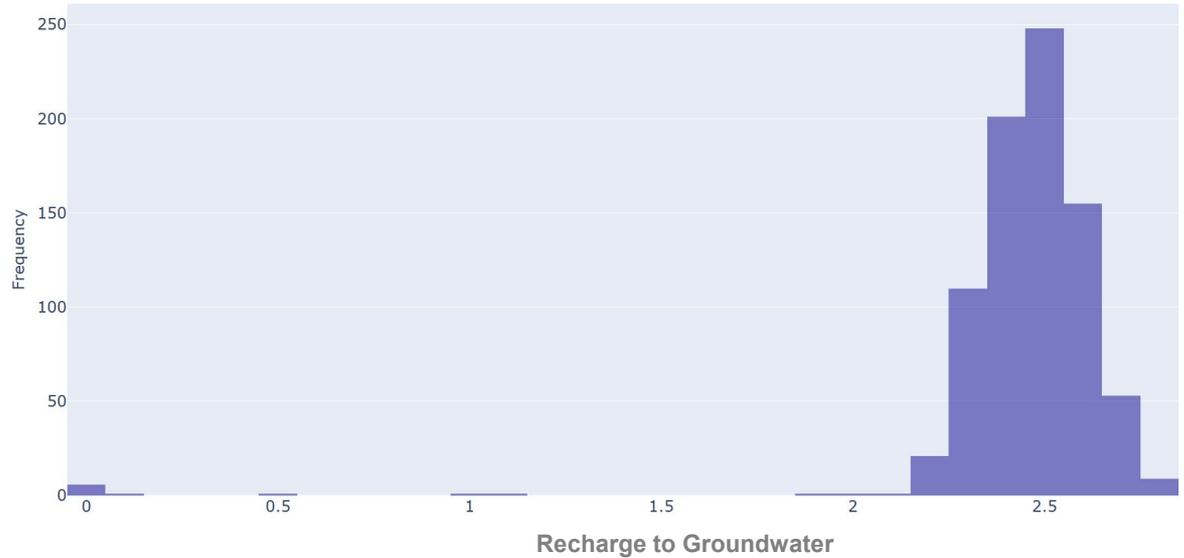
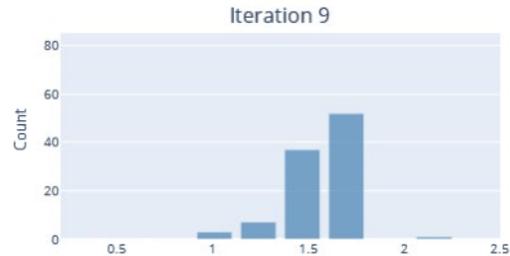
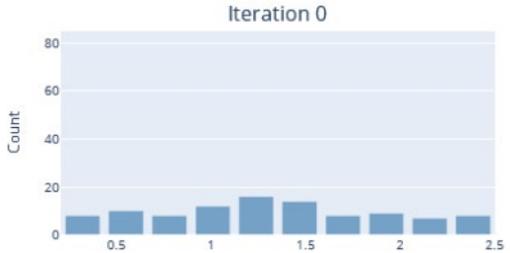
IES Calibration Results: Additional Conceptual Models





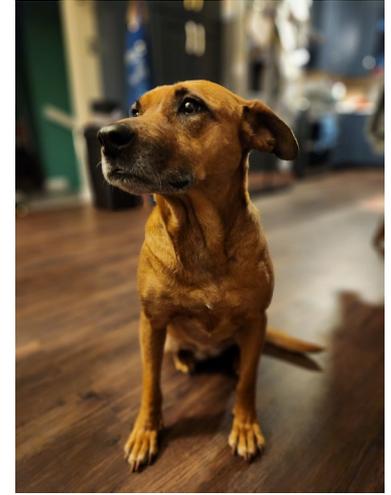
Practicality of IES

“What’s the worst case?”



Summary

- “Upgraded” HYDRUS-1D:
 - Pre / post processing
 - IES calibration
- Eddy covariance data can be used to:
 - Infer hydraulic properties (shallow subsurface)
 - Constrain infiltration rates to mining facilities
- IES allows quick exploration of alternative models
- Scrutinize data
- Scrutinize data
- Scrutinize data



groundwater

The Current State of Modeling

Randall J. Hunt  Chunmiao Zheng

First published: 27 April 2012 | <https://doi.org/10.1111/j.1745-6584.2012.00936.x> |

IES Calibration Results: Parameter Value Evolution

