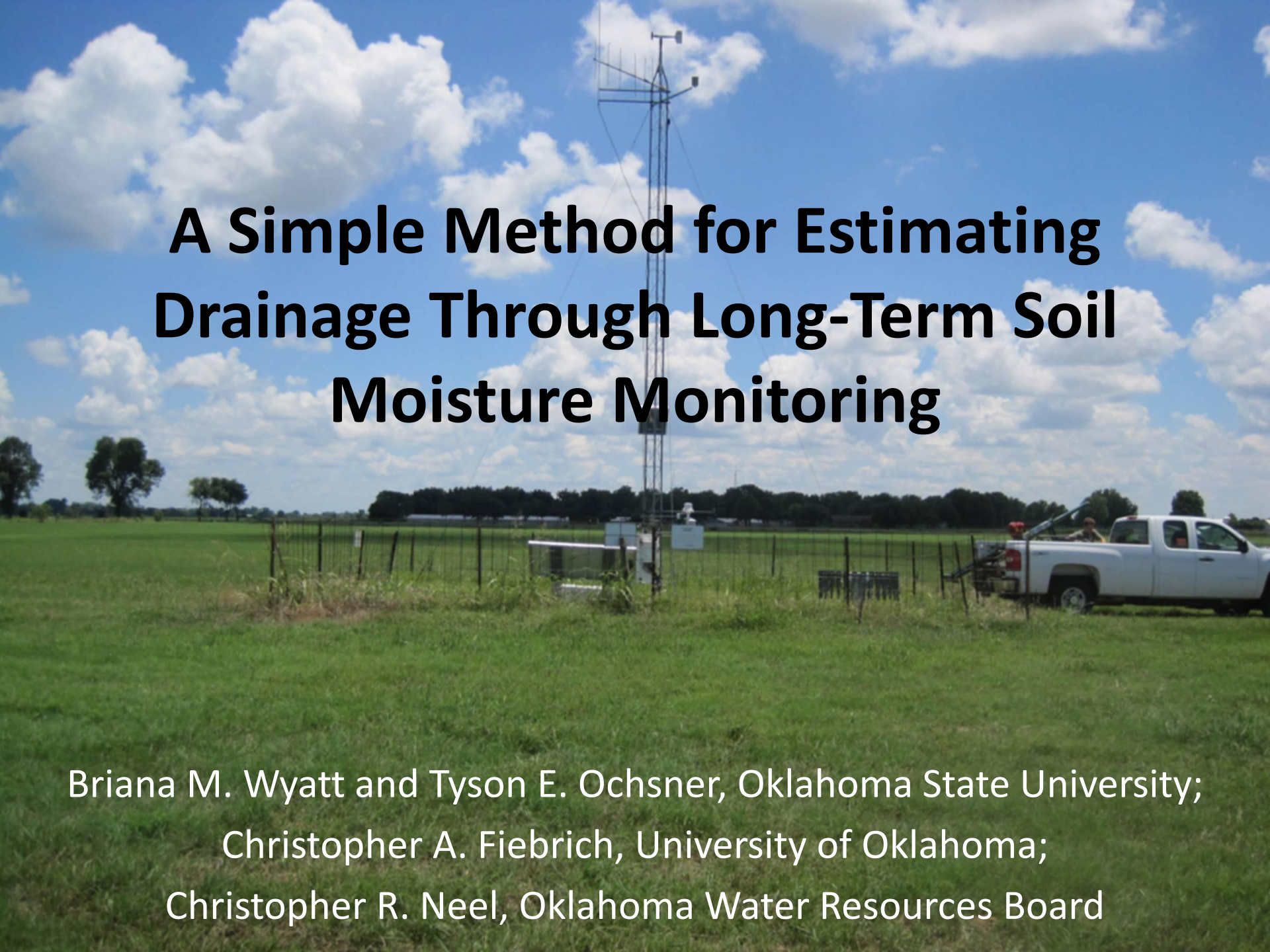
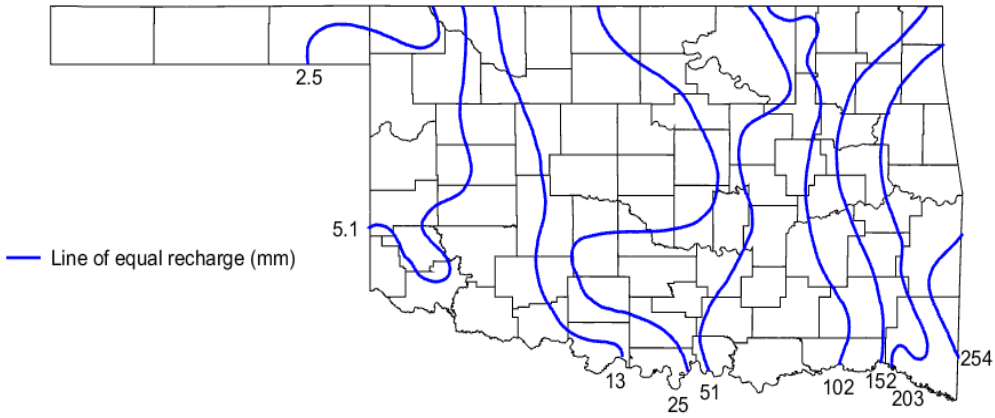


A Simple Method for Estimating Drainage Through Long-Term Soil Moisture Monitoring

Briana M. Wyatt and Tyson E. Ochsner, Oklahoma State University;
Christopher A. Fiebrich, University of Oklahoma;
Christopher R. Neel, Oklahoma Water Resources Board

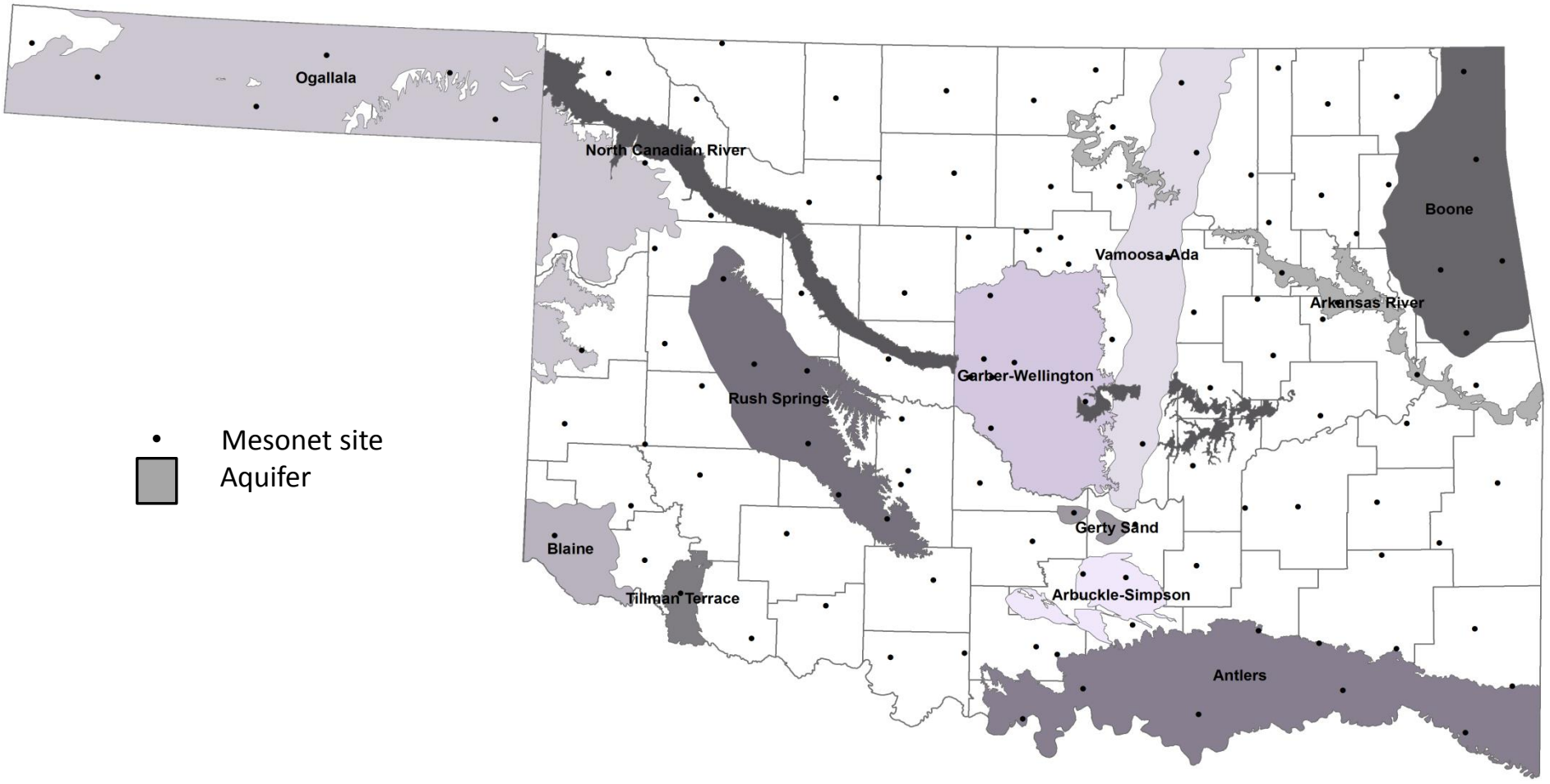
Recharge Data “Drought”

- Recharge data for Oklahoma are sparse and often decades old.
- Existing recharge estimates often don’t reflect recent climate conditions.
- Stream baseflow method may underestimate recharge
- **How can currently available data be used for recharge estimation?**



Effective regional recharge rates across Oklahoma, 1970-1979. Recreated from Pettyjohn et al. (1983).

Aquifers and the Oklahoma Mesonet



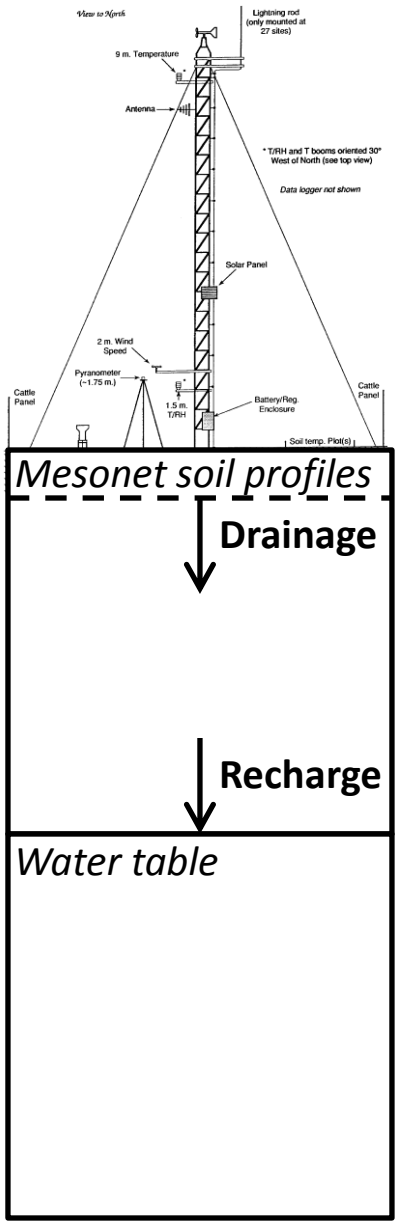
Our Approach

- Mesonet soil hydraulic properties were determined by previous research (Scott et al., 2013).

- Hydraulic conductivity + Mesonet soil moisture data → unit-gradient → drainage estimates

- **Working hypothesis:**

  drainage >= recharge



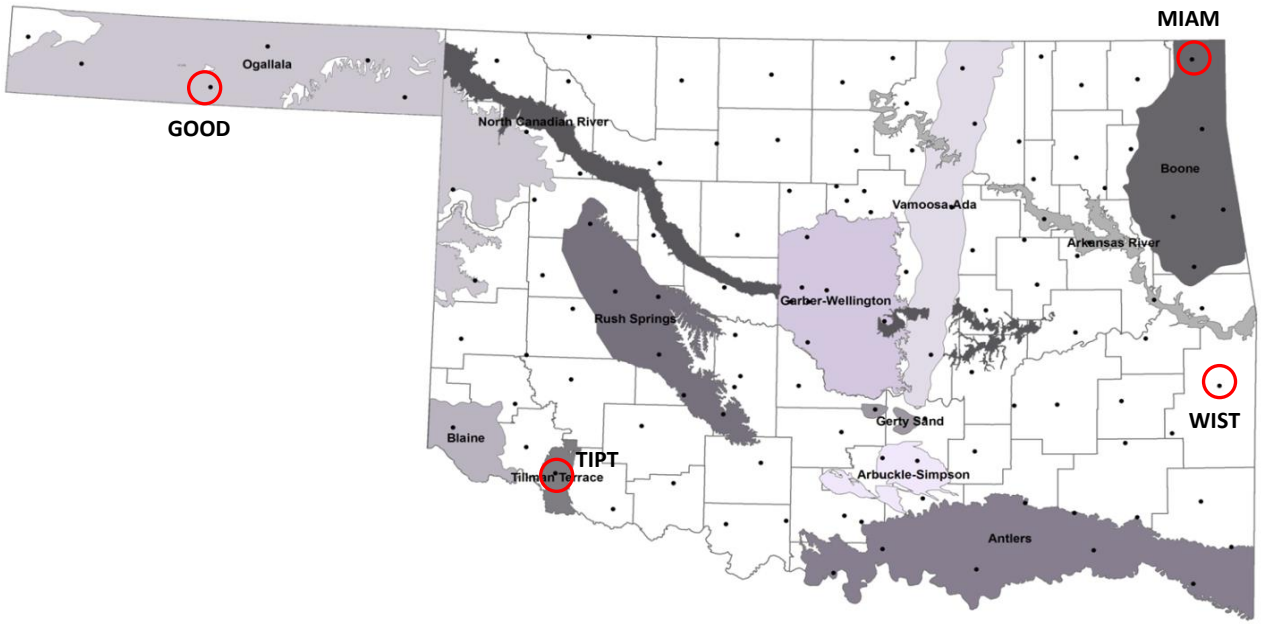
Aquifer-scale drainage rates

Table 1. Names of several major Oklahoma aquifers, number of Mesonet sites located above each aquifer, median drainage rates, range of previous recharge estimates, and the number of studies that contributed to that range.

Aquifer	No. Sites	Drainage	Recharge	No. Sources
		mm yr^{-1}	mm yr^{-1}	
Boone	3	74	2.3-267	4
Arkansas River	4	165	127	1
Garber-Wellington	3	113	0.8-211	4
Rush Springs	5	66	5.1-89	4
Antlers	5	63	7.6-76	3
Ogallala	8	19	1.5-56	4

HYDRUS1-D modeling

- Calibration of soil hydraulic properties
  - Soil moisture data for 2006-2007
- Validation of drainage rates
  - 1998-2014



Measured v. Estimated VWC - Calibration

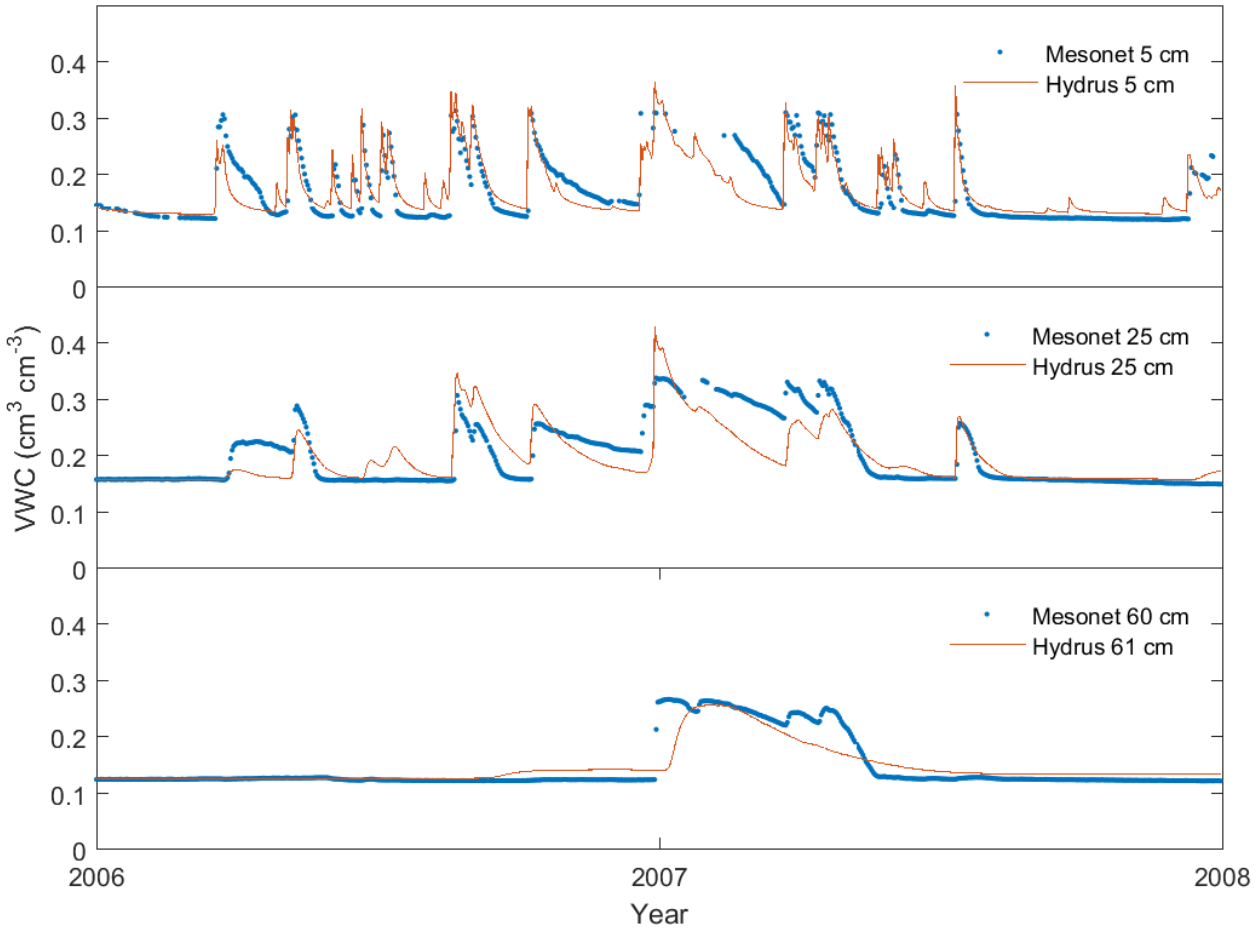


Fig 1. Measured and simulated volumetric water content for calibration period (2006-2007) at 5, 25, and 60 cm at the Goodwell Mesonet site.

Measured v. Estimated Drainage - Calibration

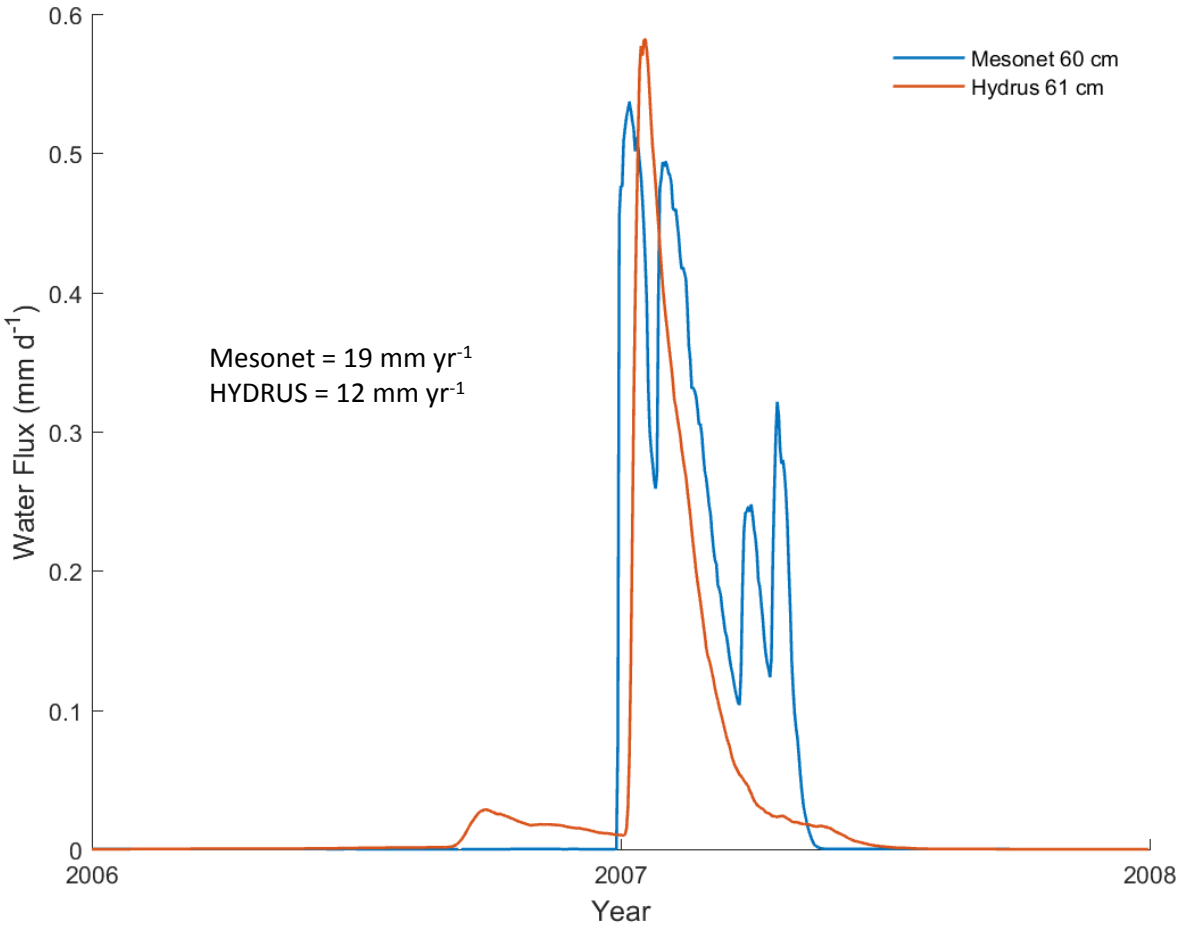


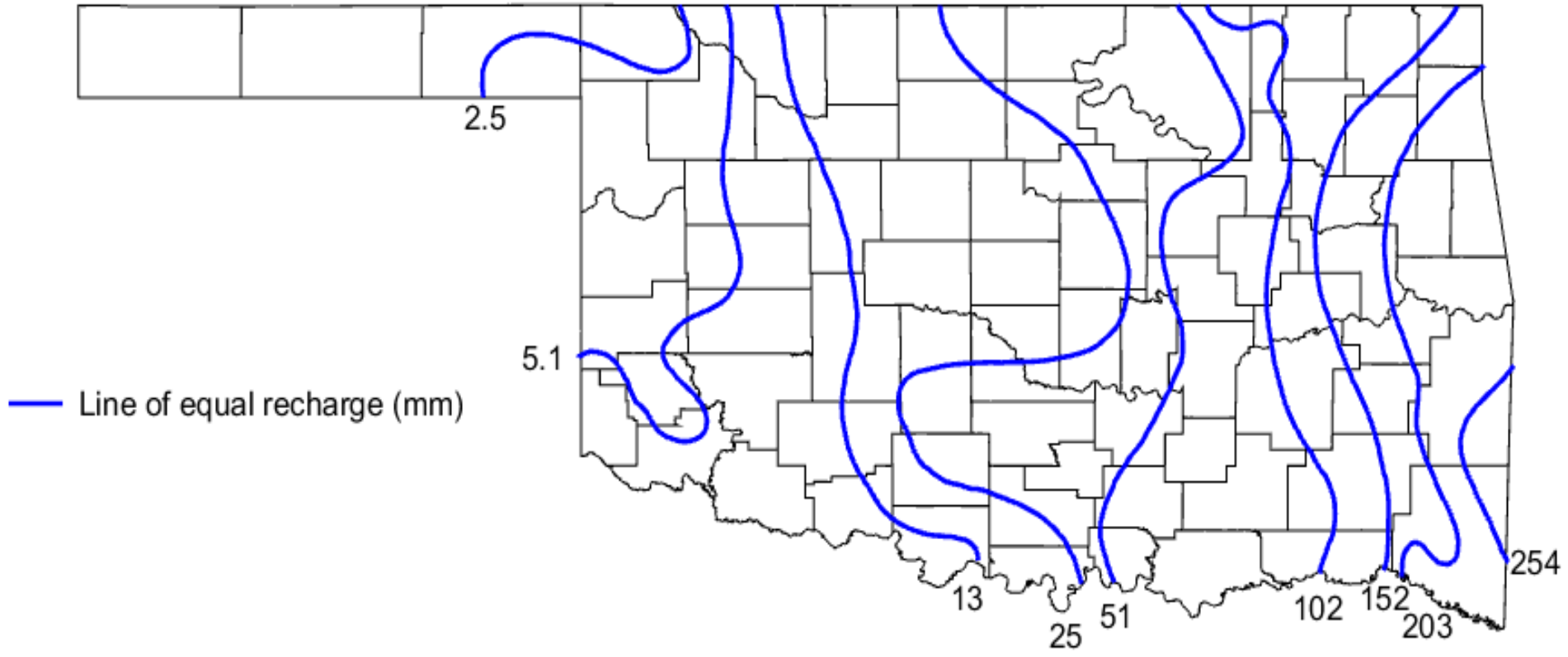
Fig 2. Mesonet-estimated and HYDRUS1-D estimated water flux at 60 cm for the calibration period at the Goodwell site.

Drainage Summary

Table 2. Mesonet site name, mean drainage rates for the validation period from the Mesonet method and HYDRUS1-D, and the percent difference associated with the Mesonet method.

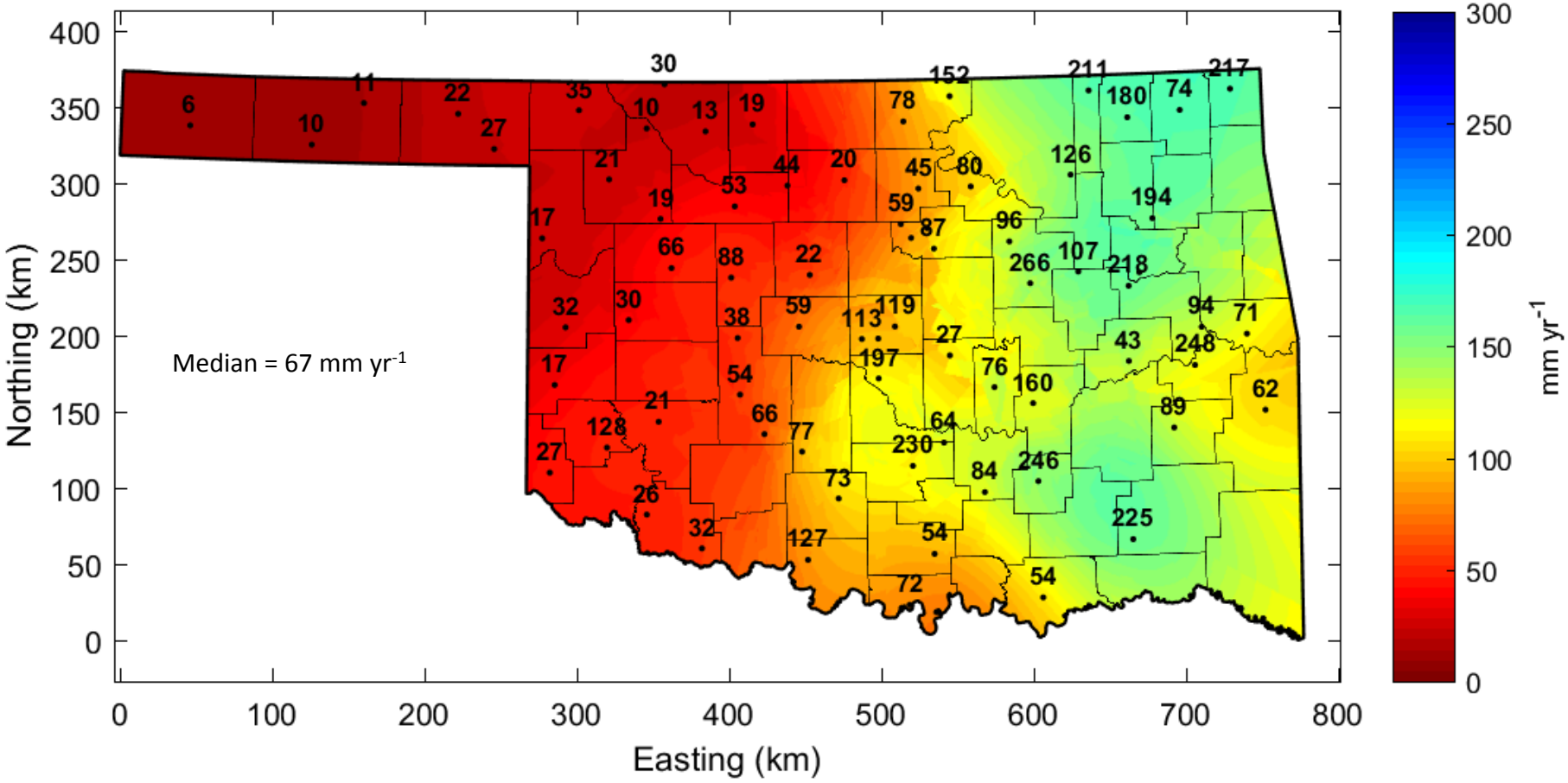
Site	**Mesonet$_{val}$**	**HYDRUS$_{val}$**	**PD$_{val}$**
	mm yr^{-1}	mm yr^{-1}	
GOOD	10	9.3	+7.5
MIAM	217	166	+31
TIPT	26	42	-38
WIST	62	115	-46

Previous map



Adapted from Pettyjohn et al. (1983)

State-wide drainage map



Conclusion

- Large-scale estimates agree well with historic groundwater recharge rates.
- HYDRUS1-D simulations show that drainage rates are accurate ± 50%.
- Unique advantages over other methods
  - Long-term soil moisture record
  - State-wide estimates
  - Drainage rates updateable
  - Low cost

Questions?

briana.wyatt@okstate.edu

soilphysics.okstate.edu

soilmoisture.okstate.edu

DEPARTMENT OF
Plant & Soil Sciences