Relations between meteorological, soil moisture and hydrological drought in a region with complex regional groundwater flow (Gelderland, The Netherlands)

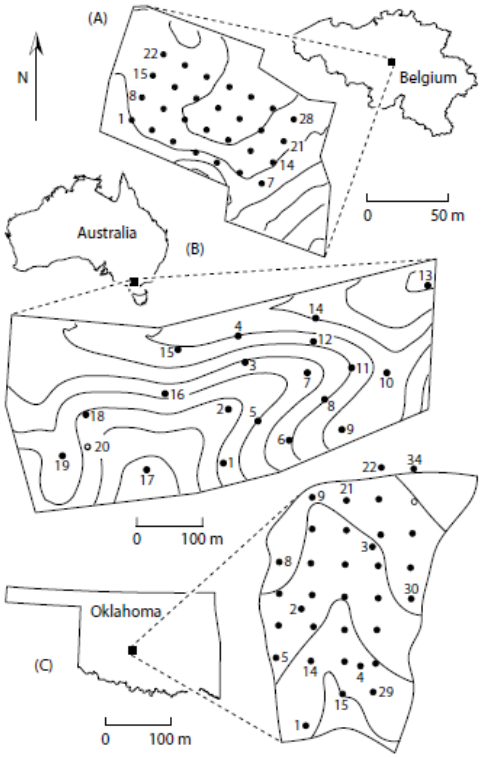
11/7/2014, Ryan Teuling

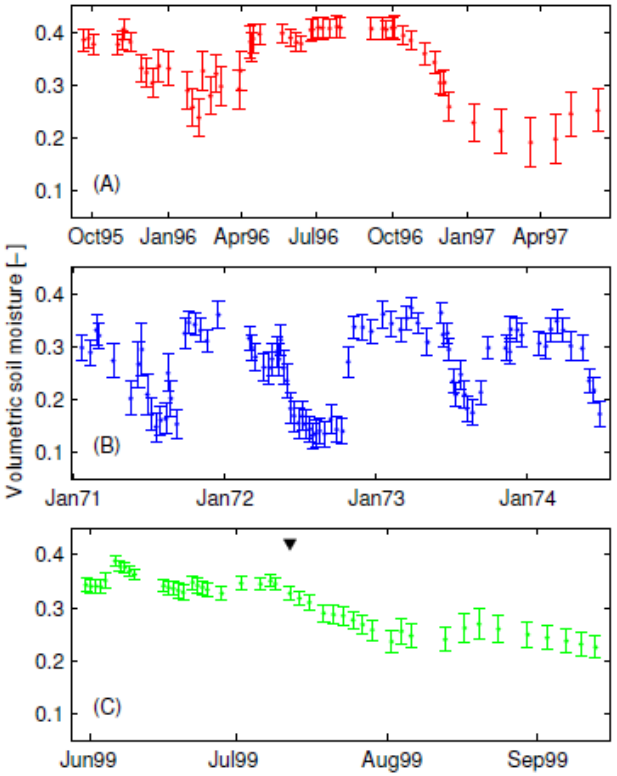
WAGENINGEN UNIVERSITY
WAGENINGEN UR

A note on soil moisture sampling

Uncertainty of mean soil moisture versus uncertainty of dynamics

$$\mathrm{E}\{\mathrm{Var}\left[\delta(x_i) - \overline{\delta}_i\right]\} = \frac{1}{m}\sum_{j=1}^{m}\mathrm{Var}\left[\delta(x_i, t_j)\right]$$





0.027 vs 0.016

0.026 vs 0.016

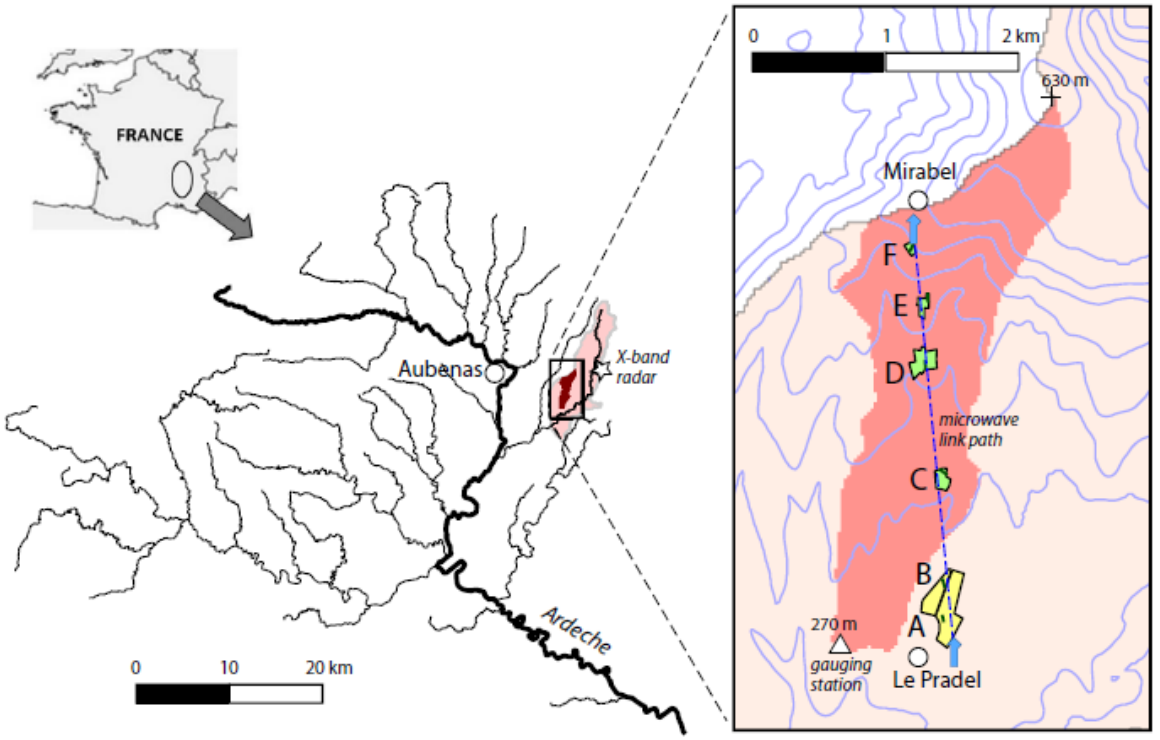
0.017 vs 0.011

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Teuling et al. (2006). Estimating spatial mean root-zone soil moisture from point-scale observations. *Hydrol. Earth Syst. Sci.*. **10**

HyMeX SOP1 Soil moisture observations

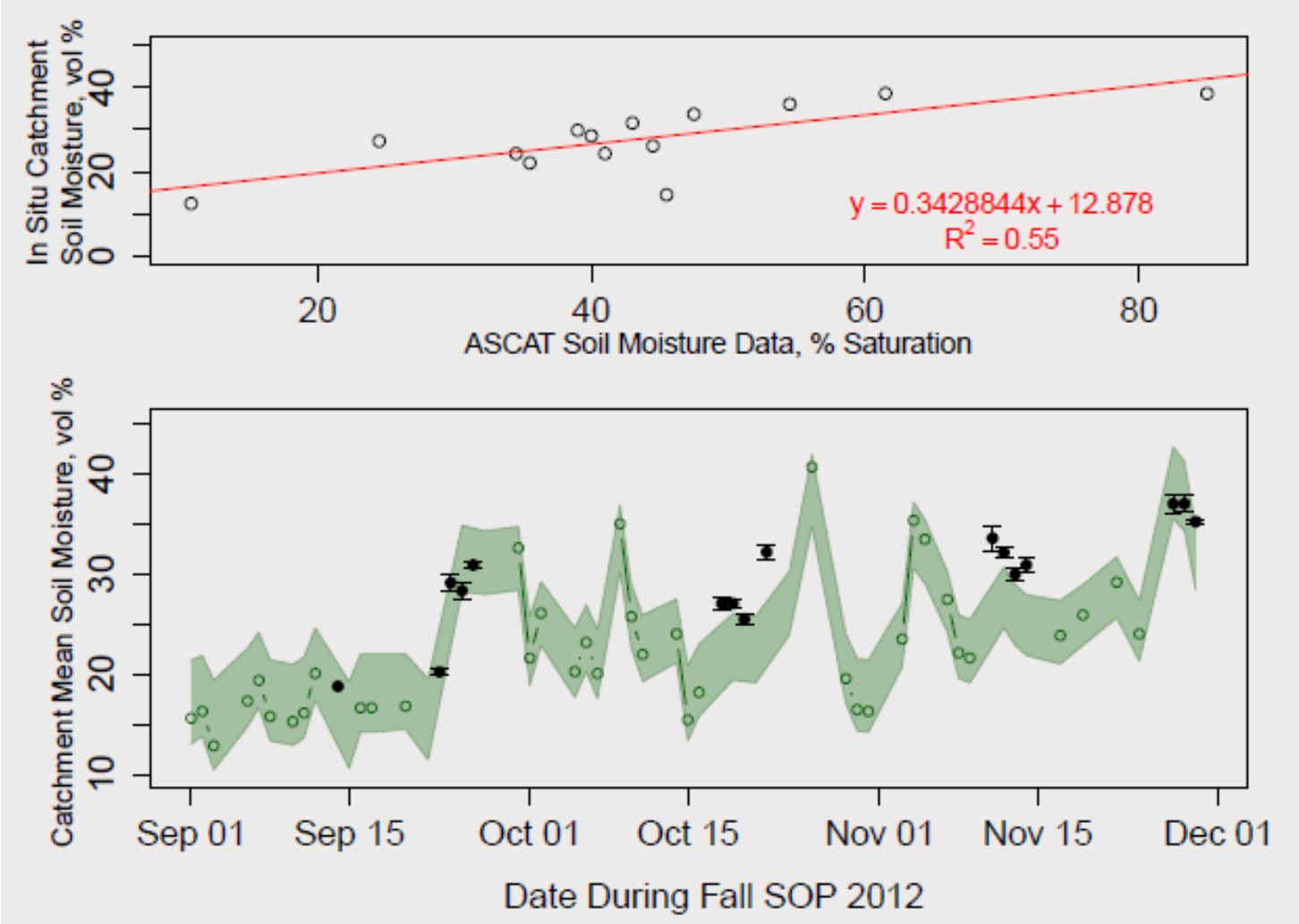
Surface soil moisture variability (0-5 cm) was measured intensively along 50 m transects in 5 fields



Huza et al. (2014). Precipitation, soil moisture and runoff variability in a small river catchment (Ardèche, France) during HyMeX Special Observation Period 1. *J. Hydrol.* **516**

WAGENINGEN UNIVERSITY
WAGENINGEN UR

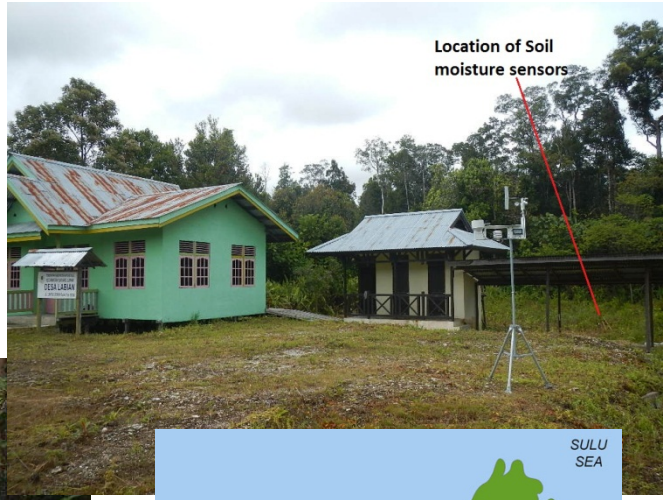
HyMeX Soil moisture vs ASCAT



Huza et al. (2014). Precipitation, soil moisture and runoff variability in a small river catchment (Ardèche, France) during HyMeX Special Observation Period 1. *J. Hydrol.* **516**

Soil moisture in Kapuas river basin, Kalimantan

- Aim: at least 2 full years of data
- 4 profile soil moisture sites incl. groundwater



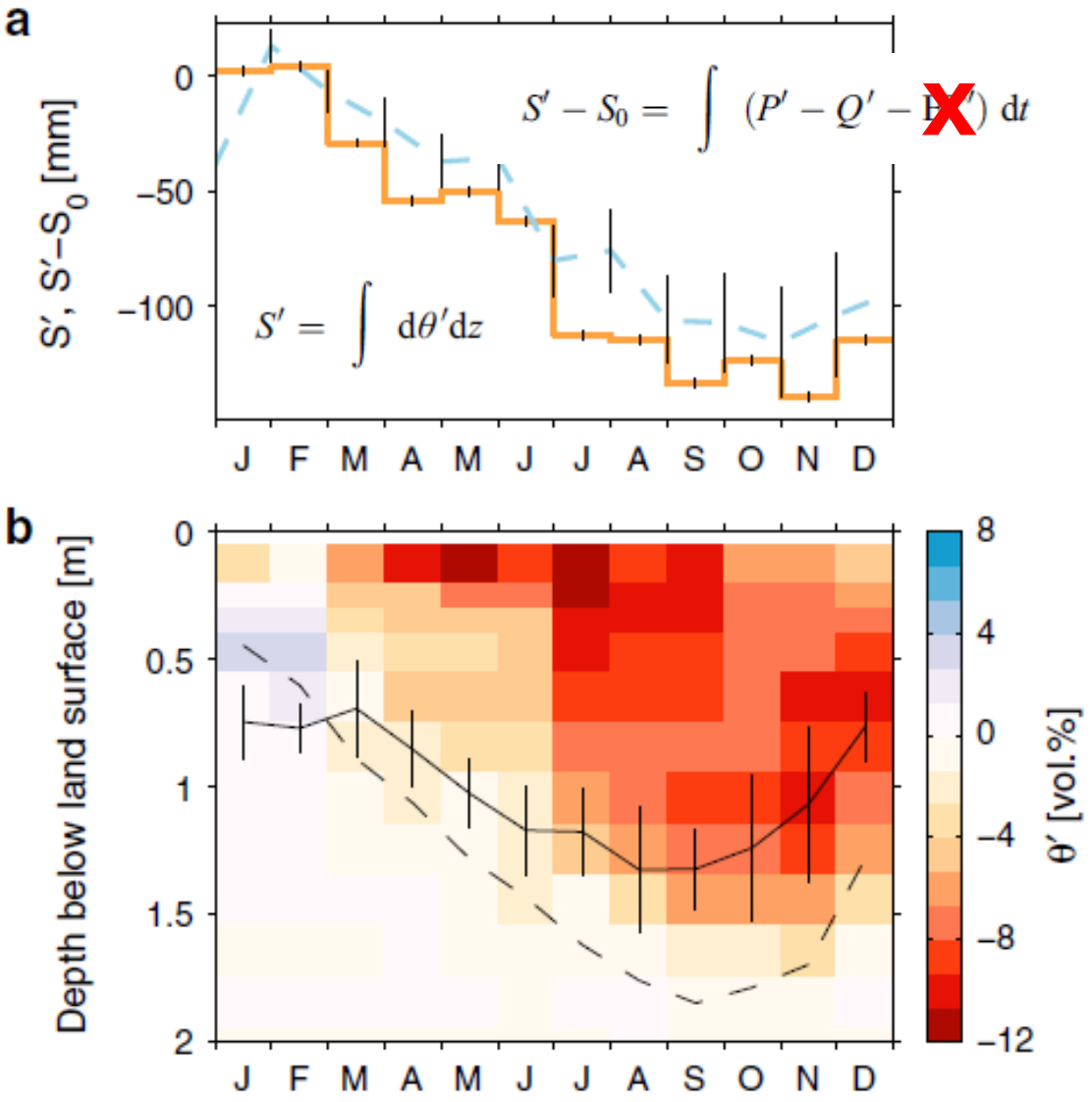
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Drought monitoring: challenges

- Standardized meteorological indices (SPI/PDSI) often used for (global) drought analysis
- Simplification of role of ET and subsurface hydrology
- What is the relation between meteorological drought and hydrological (groundwater) drought?
- IPCC SREX: "*SPI can be computed over several time scales (e.g., 3, 6, 12, or more months) and thus indirectly considers effects of accumulating precipitation deficits, which are critical for soil moisture and hydrological droughts*". (p. 168)
- Is satellite surface soil moisture a good indicator for agricultural and hydrological drought?

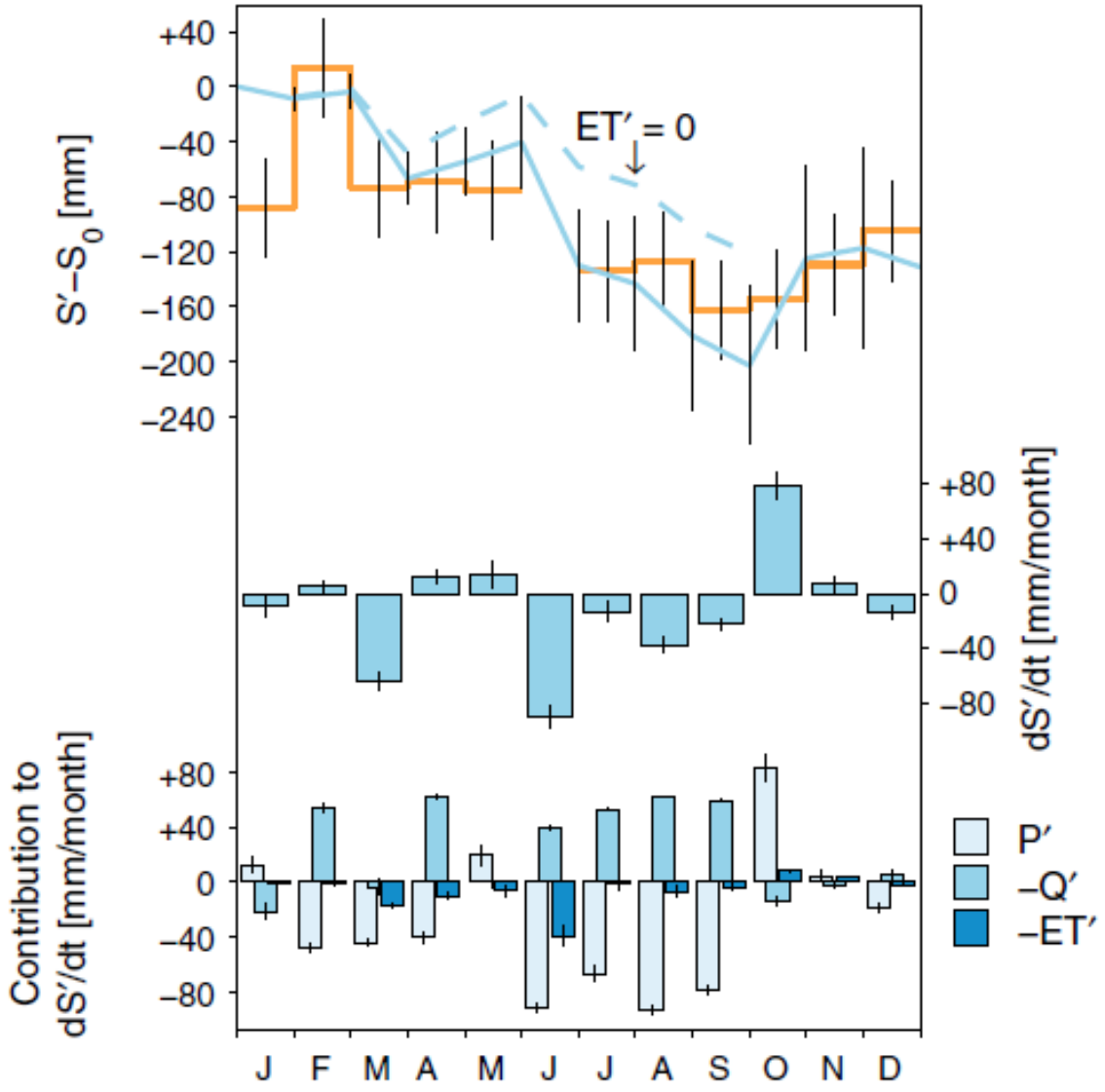
1976 summer drought: soil moisture & ET

- Hupsel brook catchment
- 9-year neutron probe dataset
- 5 sites
- 12 depths
- Bimonthly
- 1976-1984
- Including groundwater levels



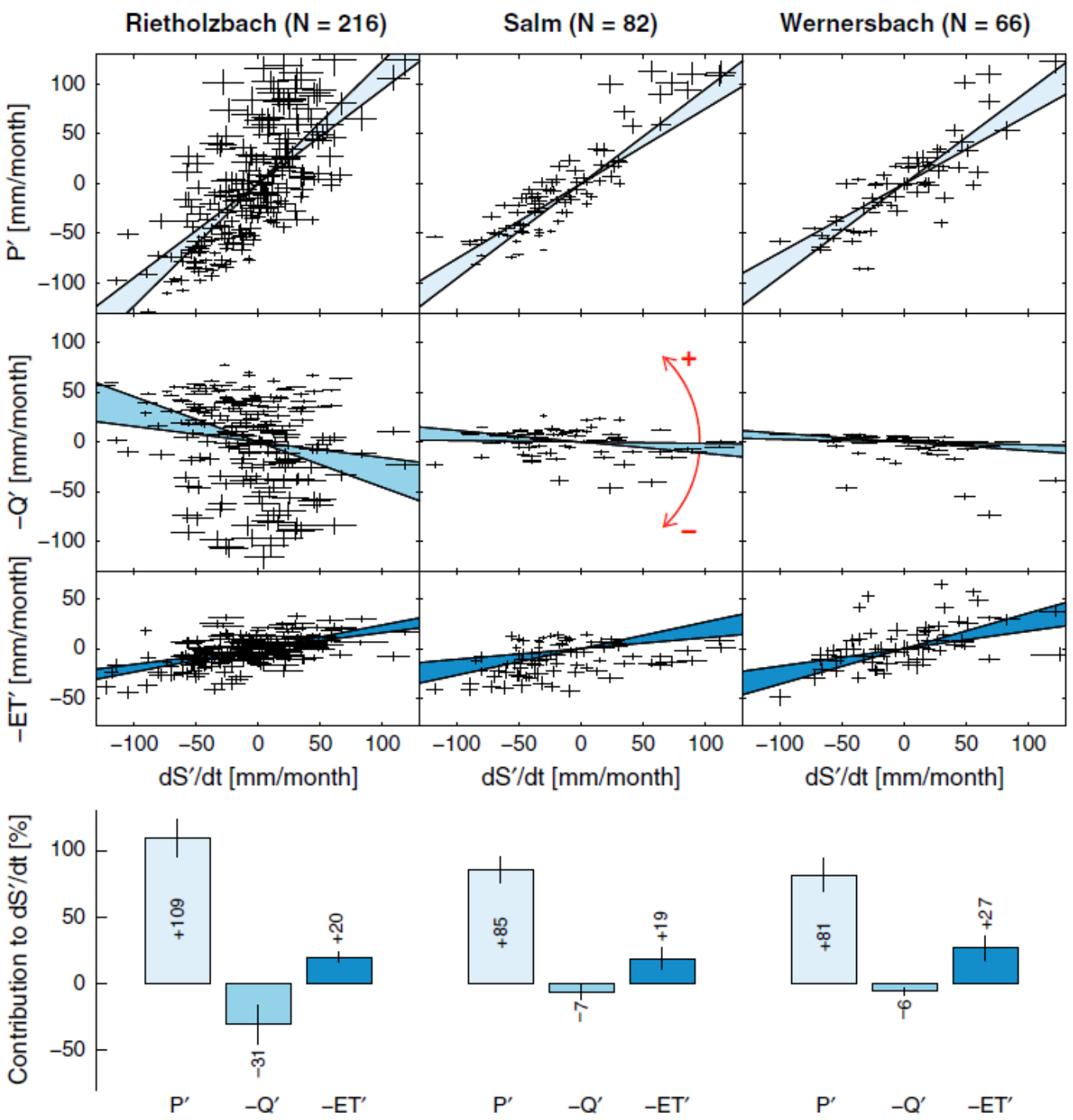
2003 summer drought: role of ET

- Rietholzbach catchment
- 35-year weighing lysimeter dataset
- Strong positive contribution of ET anomalies to storage anomaly



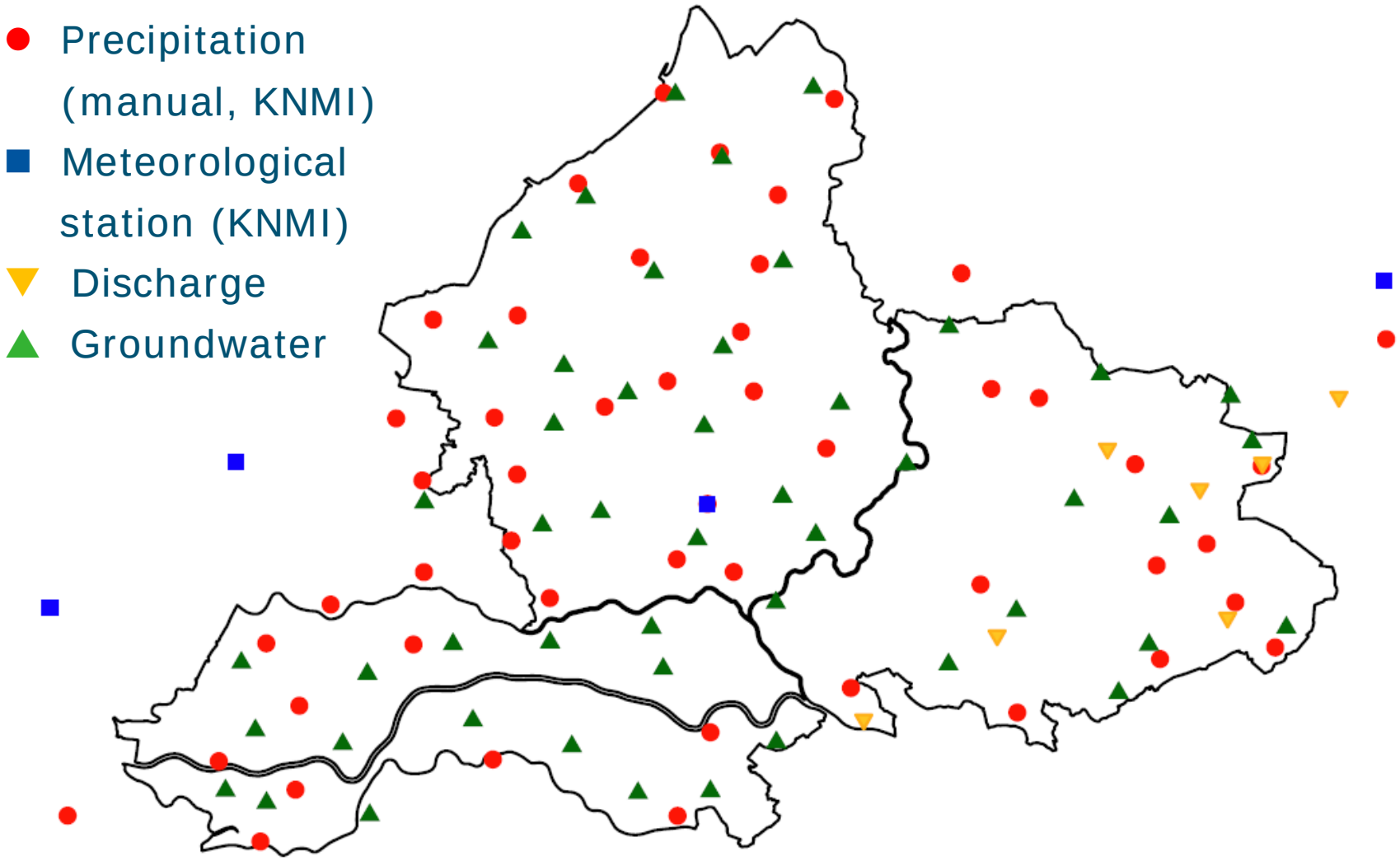
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Robust positive contribution of ET anomalies to storage anomaly development for 3 catchments with observations of al fluxes

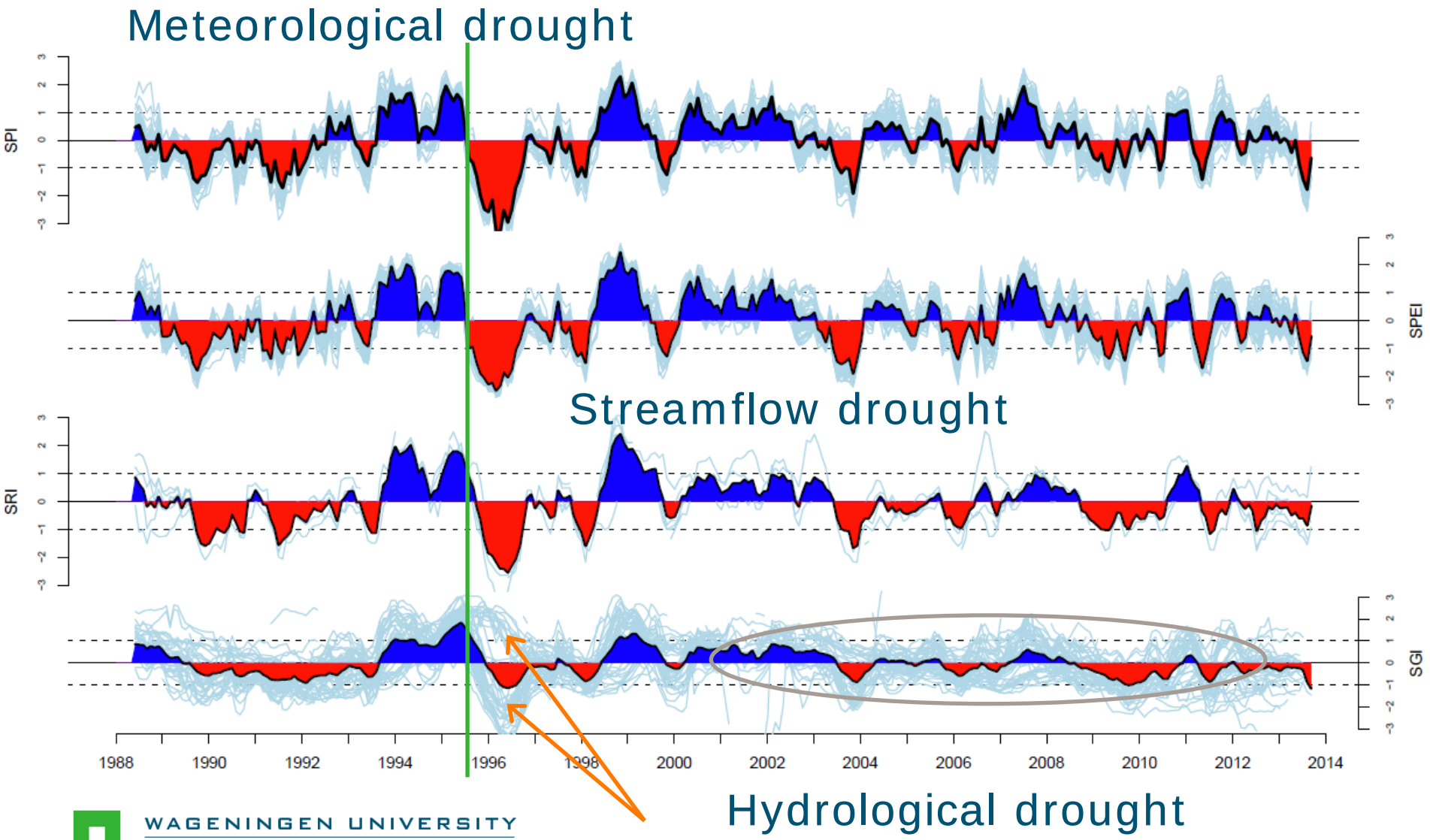


WAGENINGEN U
WAGE

Groundwater and precipitation network

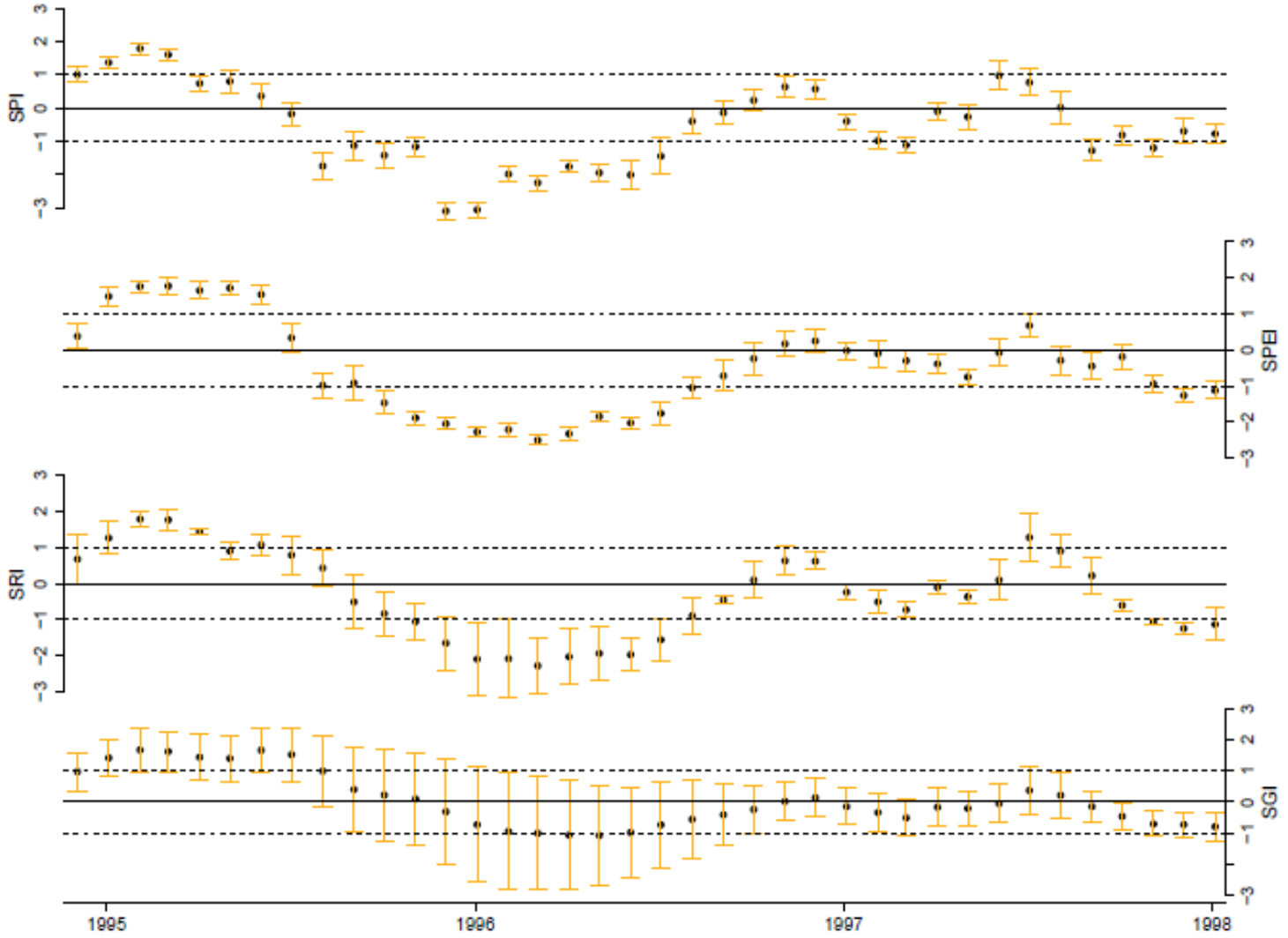


Analysis for period 1988-2014



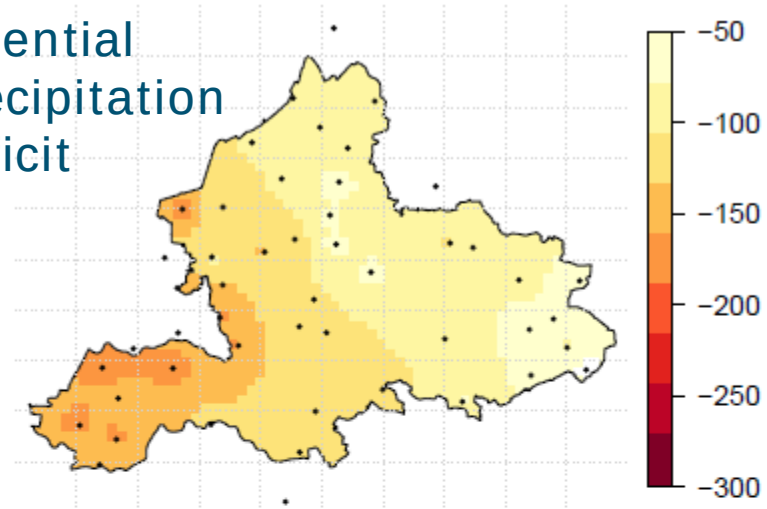
WAGENINGEN UNIVERSITY
WAGENINGEN UR

Complexity in groundwater drought signal

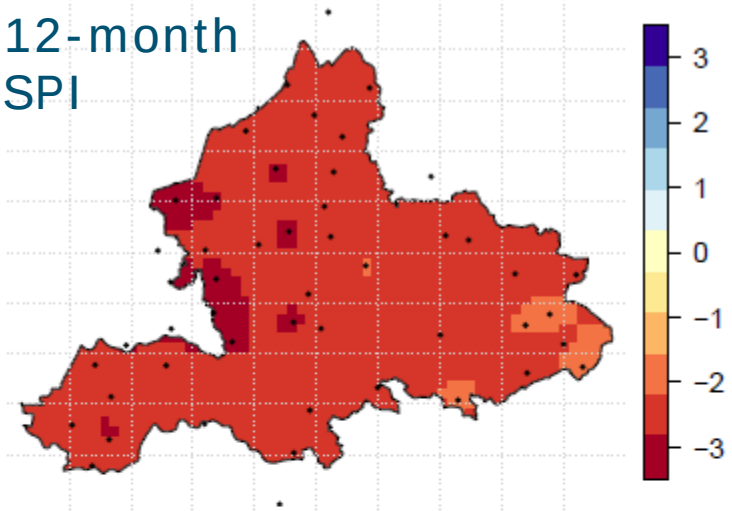


Spatial distribution of drought (Aug 1996)

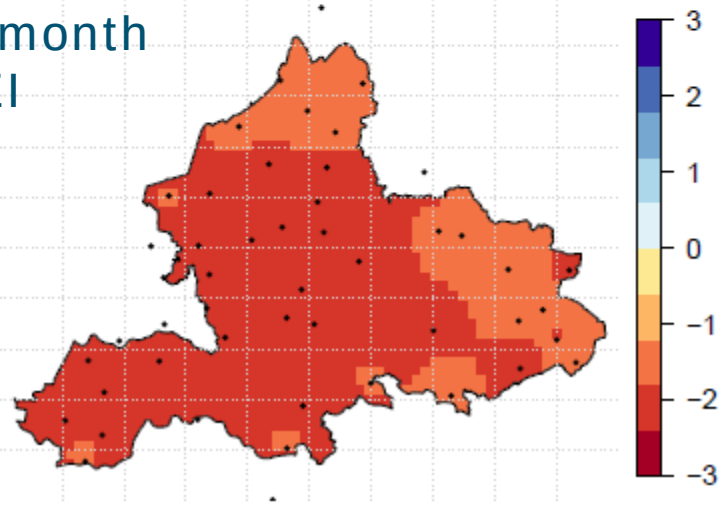
Potential precipitation deficit



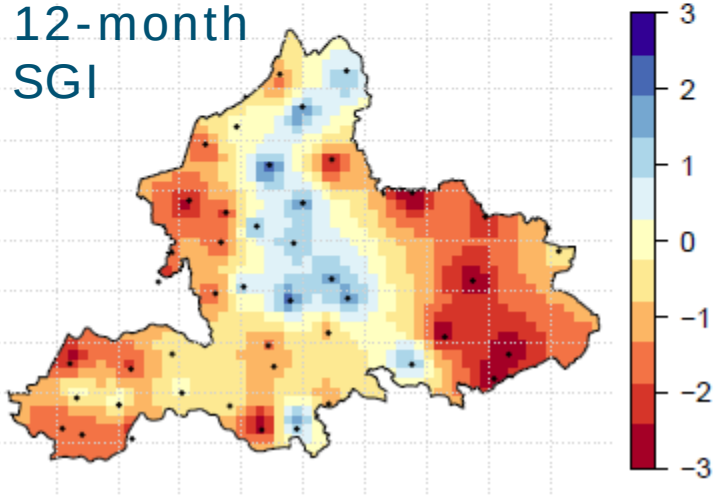
12-month SPI



12-month SPEI

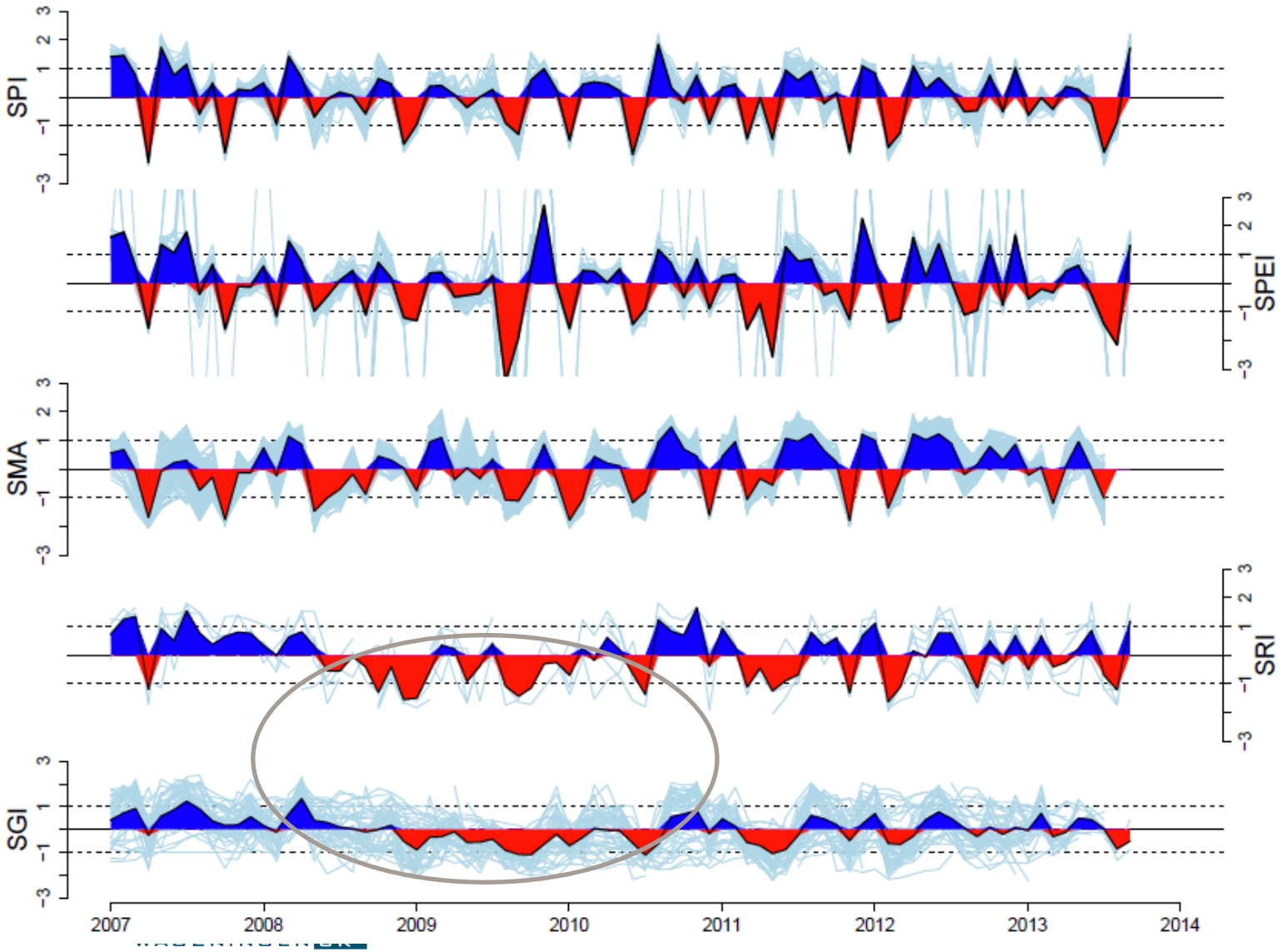


12-month SGI

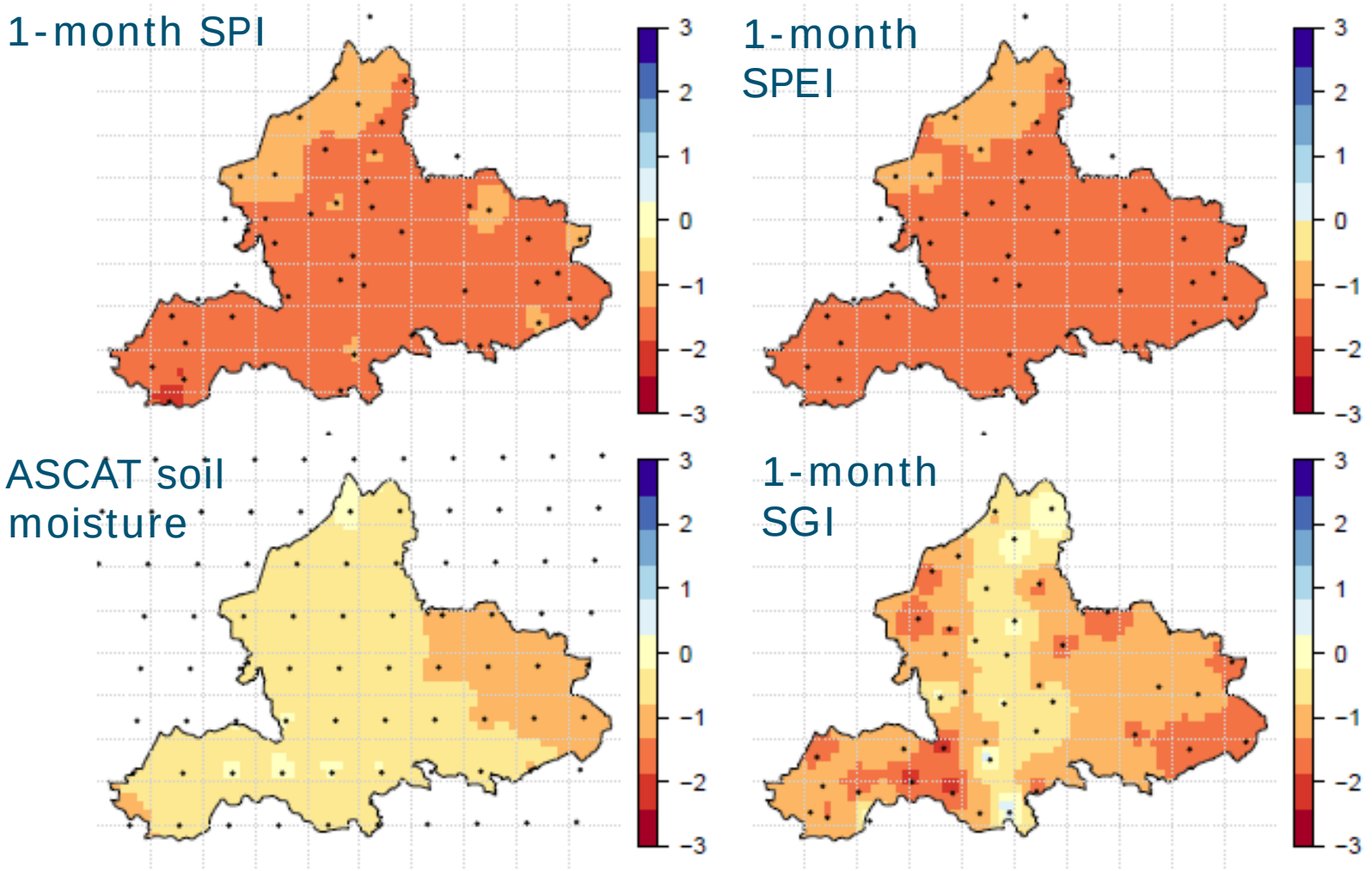


Analysis for period 2007-2014

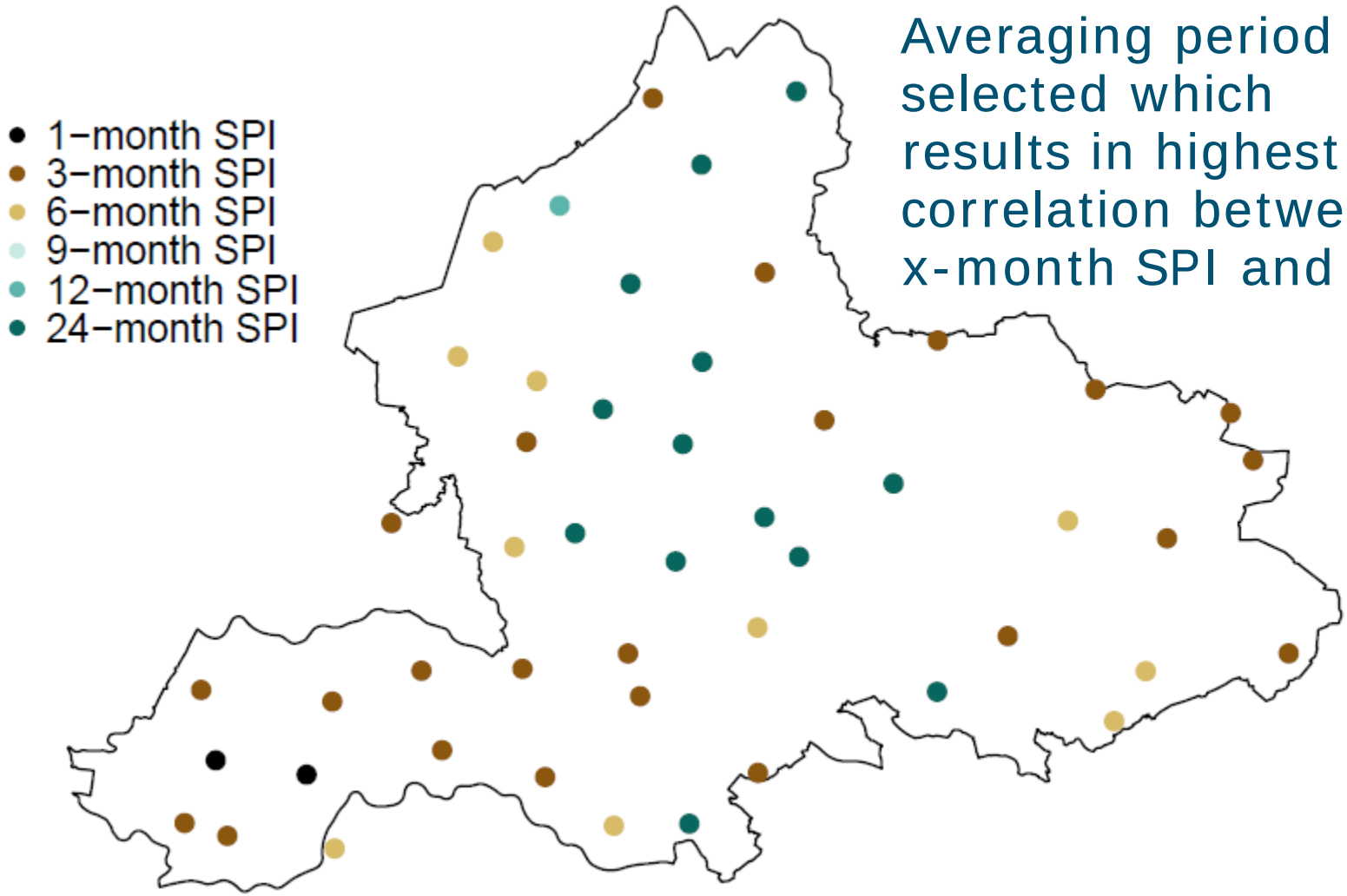
ASCAT



Drought indices vs ASCAT (May 2011)



SPI averaging period as proxy for SGI?



Averaging period selected which results in highest correlation between x-month SPI and SGI

Conclusions

- Important role for ET and subsurface storage in drought development
- Regional distribution of hydrological/groundwater drought not captured by ASCAT soil moisture
- Groundwater drought cannot be captured by a single averaging period for SPI

Thank you for your attention

ryan.teuling@wur.nl

Teuling et al. (2006). Estimating spatial mean root-zone soil moisture from point-scale observations. *Hydrol. Earth Syst. Sci.*. **10**

Huza et al. (2014). Precipitation, soil moisture and runoff variability in a small river catchment (Ardèche, France) during HyMeX Special Observation Period 1. *J. Hydrol.* **516**

Teuling et al. (2013), Evapotranspiration amplifies European summer drought. *Geophys. Res. Lett*. **40**

Ten Broek (2014), Comparison of drought indices for the province of Gelderland, The Netherlands. MSc thesis, Wageningen University.

WAGENINGEN UNIVERSITY
WAGENINGEN UR