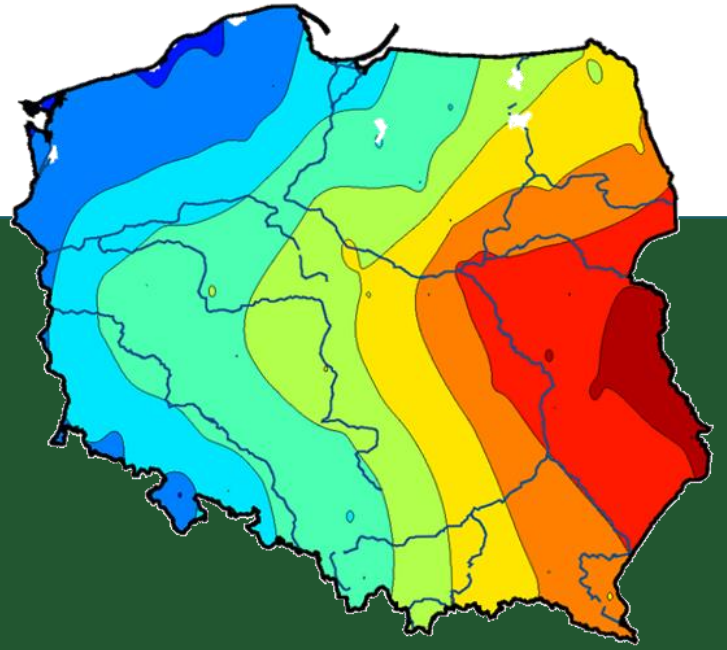
Military University of Technology

GNSS data Research Infrastructure Centre



GPS-BASED MULTI-ANNUAL VARIATION OF THE PRECIPITABLE WATER OVER POLAND TERRITORY

A. Araszkiewicz, M. Mierzwiak, D. Kiliszek, J. Nowak Da Costa, M. Szołucha

G3.1 Geodesy for Climate Research (EGU22-7081)

EGU General Assembly 2022

Vienna, Austria & Online | 23–27 May 2022

A few words about Poland climate

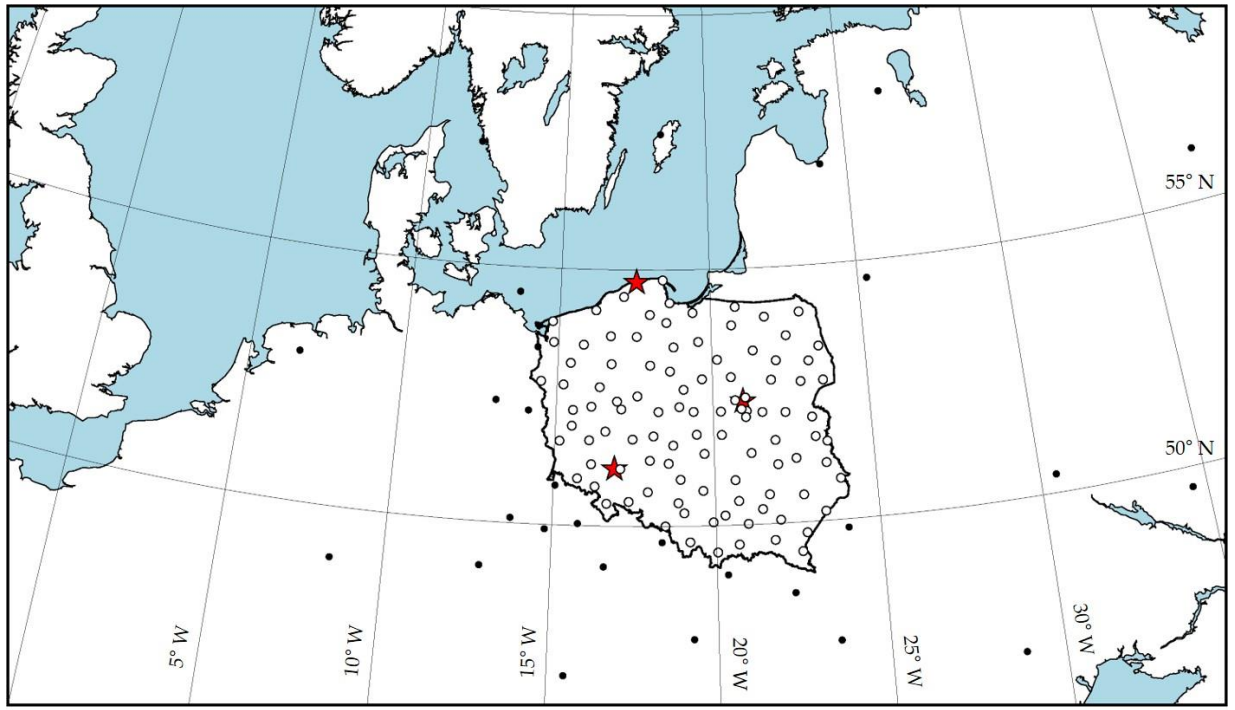
Poland lies on the border of two climatic zones (Dfb and Cfb) — *Kottek, M.; Grieser, J. (2006)*

Precipitable water (PW) in Poland is about 15 mm — *Kożuchowski K. (2016)*

Lowest PW during winter (Jaunary), highest during summer (June) — *Kożuchowski K. (2016)*

GPS DATA

available online: http://www.gnss.wat.edu.pl/products/EPNDEN_ASG



Group	Parameter notes
Software	GAMIT
Observations	GPS, ionosphere-free code and phase combination
Orbits	IGS08[1], IGS14
Antenna models	transmitters: IGS08[1], IGS14 receivers: individual calibrations for ASG-EUPOS and selected EPN stations, IGS08[1], IGS14 for rest
Clocks	Estimated
Ionosphere	"iono-free" + higher order
Troposphere	VMF1 as an a priori, 1h ZTD estimated and 24h gradient
Tide displacement	IERS2010, FES2004

Processing starts — IGS08/IGS14 — Processing ends

JUN, 2008 — **JAN, 2017** — **DEC, 2020**

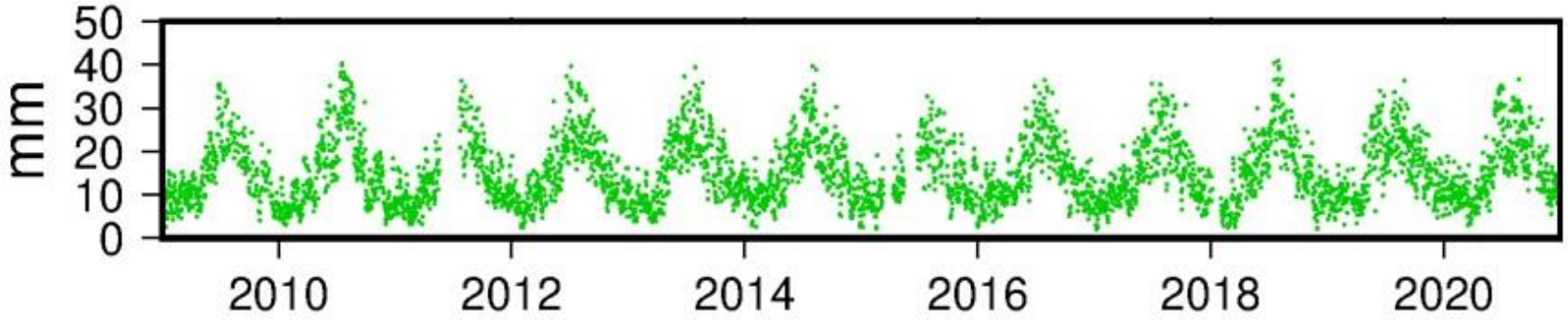
PRECIPITABLE WATER DATA PREPARATION

monthly mean; seasonal mean; anomalous periods; rate of changes (LSA); seasonal signal (LSA)

$$T(e,a) = mf_h(e) \cdot ZHD + mf_w(e) \cdot ZWD + mf_g(e) \cdot [\cos(a) \cdot G_N + \sin(a) \cdot G_E]$$

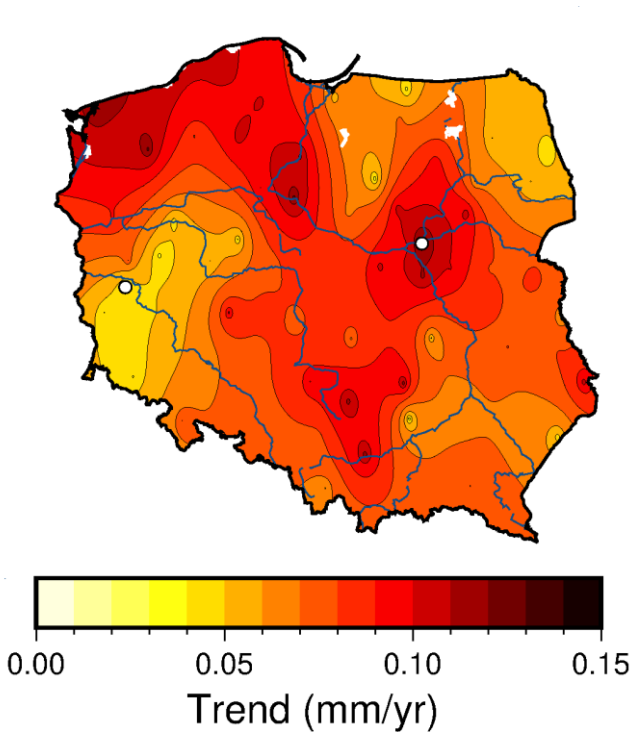
$$PW = \frac{ZWD}{\rho_{H_2O} \cdot 10^{-6} \cdot \left(k_2' + \frac{k_3'}{70.2 + 0.72T_s}\right) \cdot R_W}$$

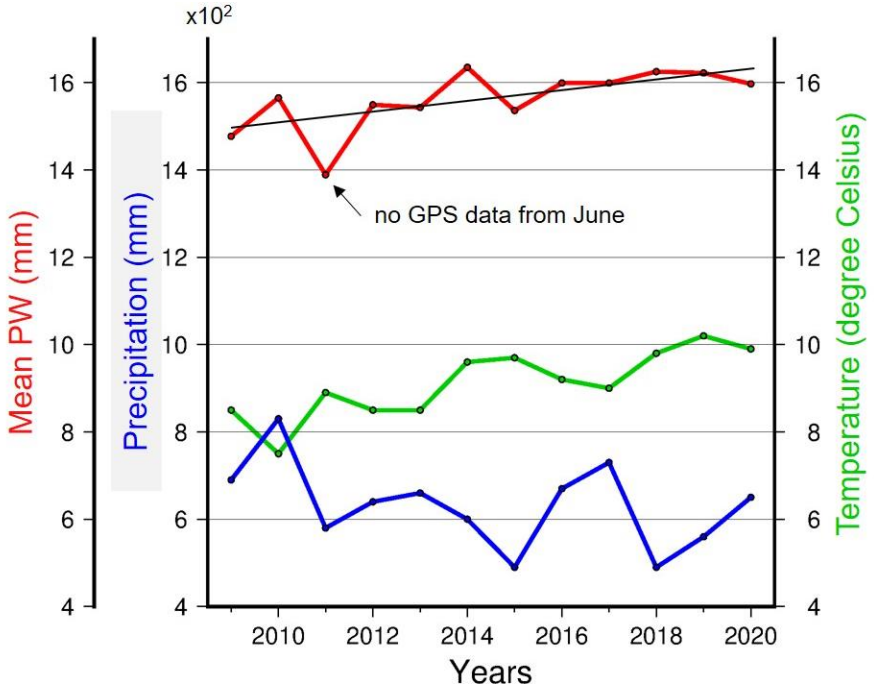
T_s was taken from the ERA5;
k'_2 and k'_3 from Bavis et al. (1992)

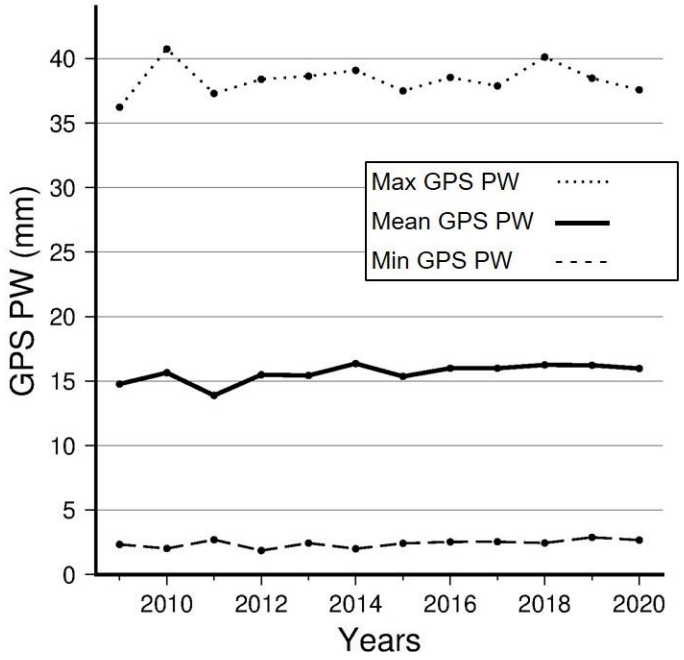


RESULTS

a positive trend in the entire area



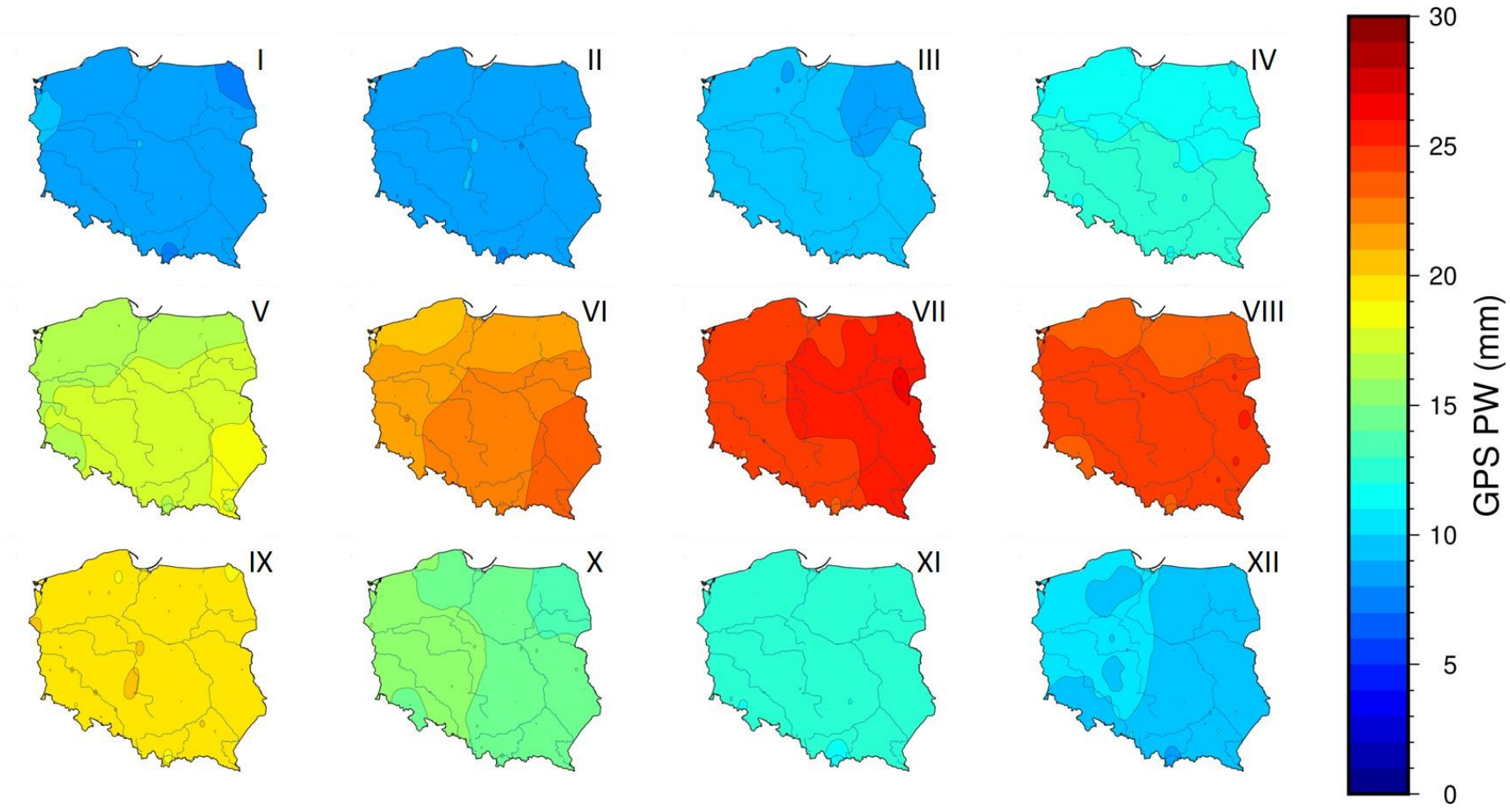




Parameters	GPS: REDZ RS: 12,120		GPS: BOGI RS: 12,374		GPS: BOGO RS: 12,374		GPS: WROC RS: 12,425	
	GNSS	RS	GNSS	RS	GNSS	RS	GNSS	RS
St. dev. (mm)	4.76	4.03	5.17	4.13	5.18	4.13	4.85	3.97
Annual (mm)	7.64	7.61	8.61	7.61	8.54	7.61	8.23	7.33
Semi-annual (mm)	1.57	1.41	1.78	1.30	1.76	1.30	1.56	1.16
Linear trend (mm/year)	0.105	0.004	0.124	0.001	0.138	0.001	0.058	0.022

RESULTS

multi-annual maps (2009-2020) of GPS precipitable water by month

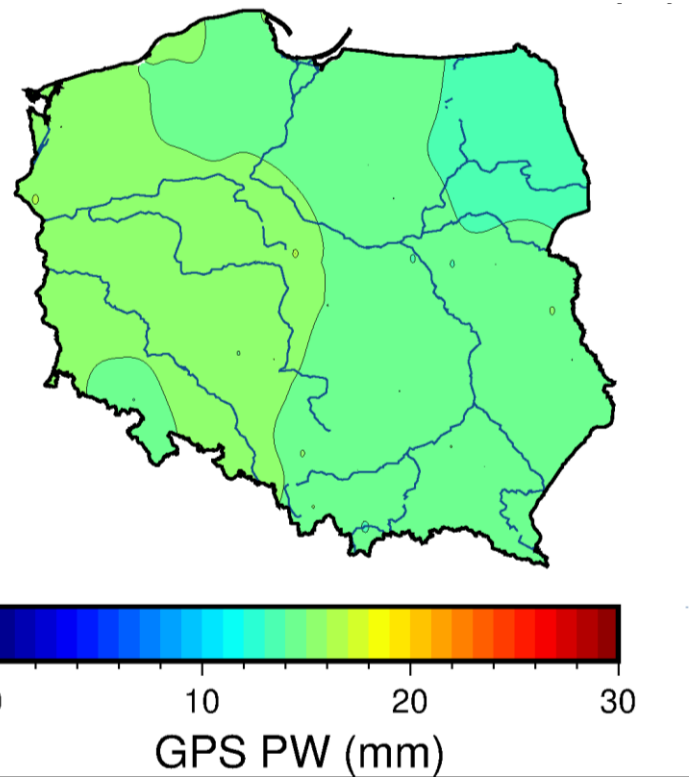


January	8.48 mm
February	**8.06 mm**
March	9.92 mm
April	11.32 mm
May	16.48 mm
June	21.21 mm
July	**23.83 mm**
August	23.04 mm
September	18.05 mm
October	13.58 mm
November	11.29 mm
December	8.88 mm

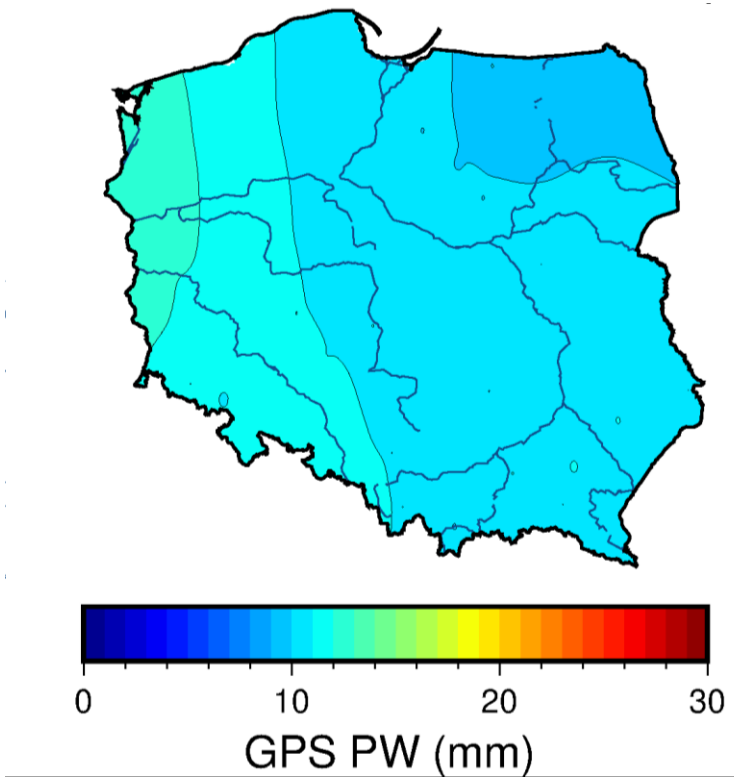
RESULTS

GPS precipitable water confirms an unusually dry and cold October in 2010

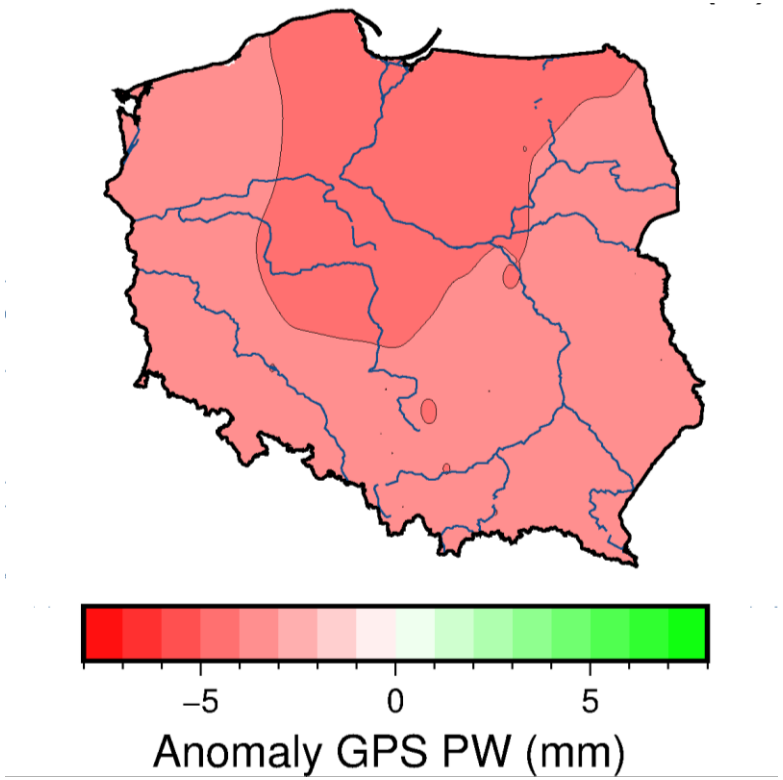
October
(multi-anual mean)



October 2010



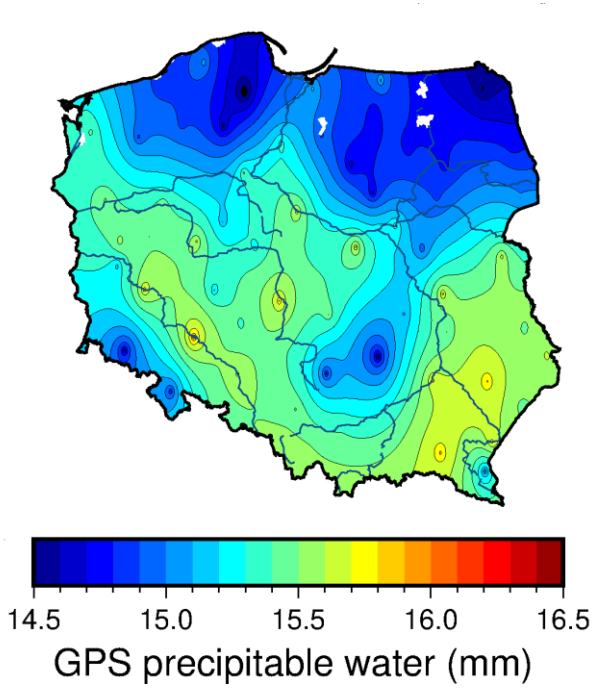
Difference



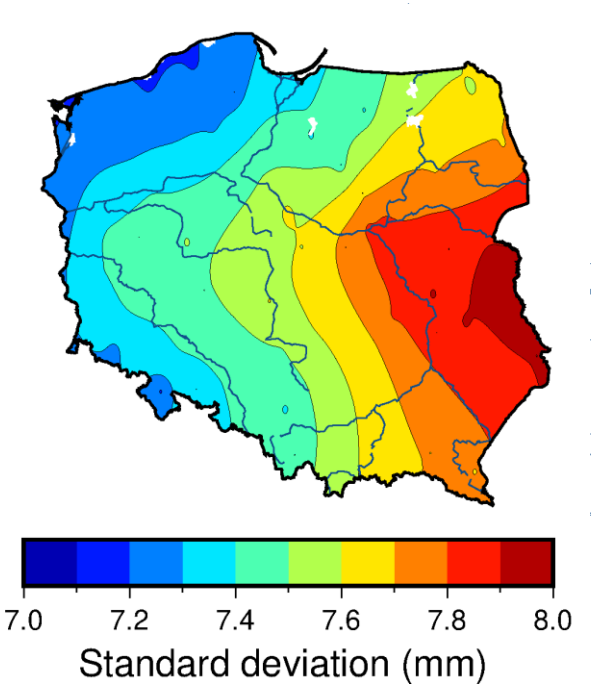
RESULTS

the higher spatial resolution makes it possible to see the complexity of the precipitable water distribution

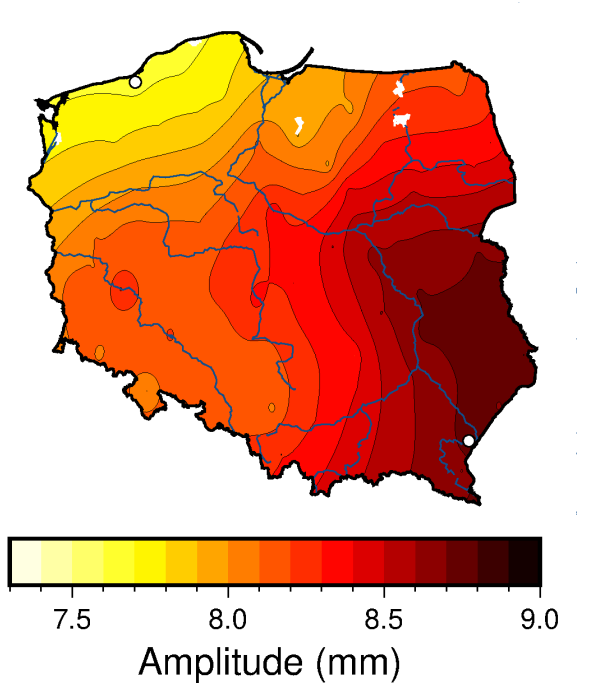
Multi-annual mean



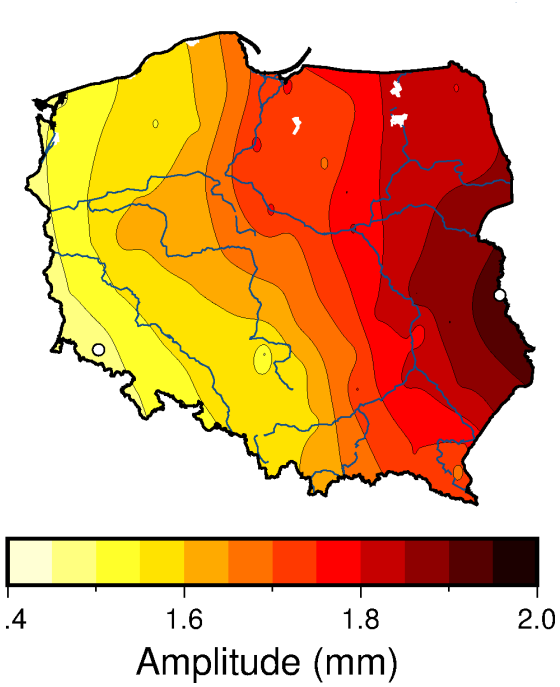
Multi-annual variations



Annual signal



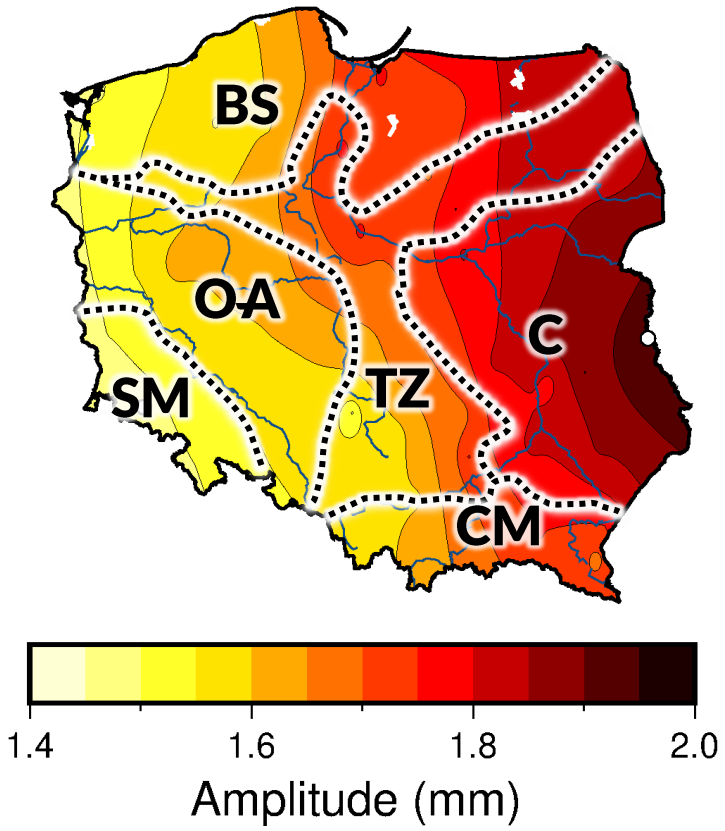
Semi-annual signal



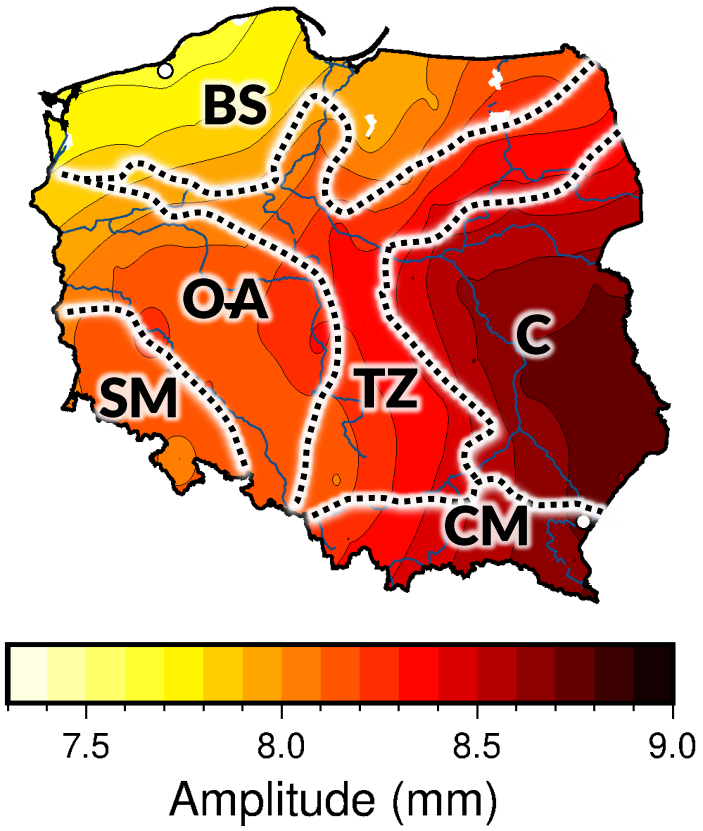
RESULTS

the higher spatial resolution makes it possible to see the complexity of the precipitable water distribution

Semi-annual signal



Annual signal



DOMAINS OF INFLUENCE

Okołowicz and Martyn (1979)

AO	Atlantic Ocean
C	Continent
BS	Baltic Sea
TZ	Transition
SM	Sudeten Mountain
CP	Carpathian Mountain

Summary

The multi-year average PW value is 15.05 mm

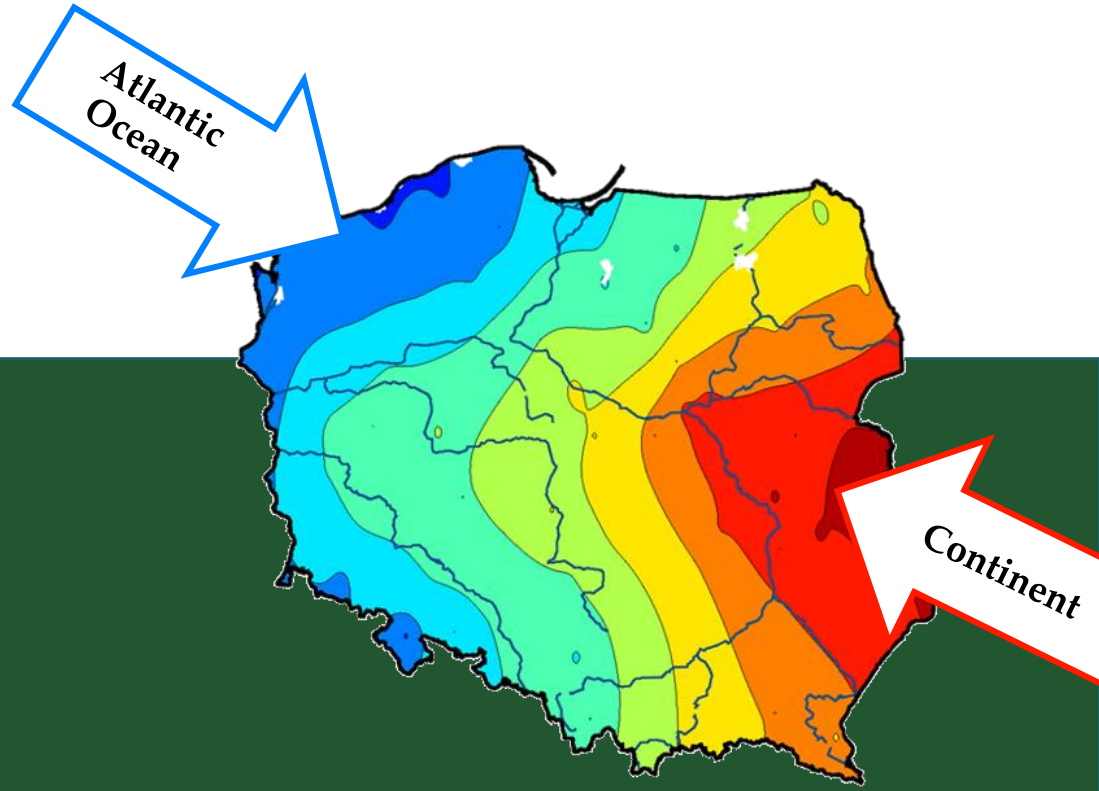
Three times higher PW in the summer season.

Apositive trend in PW change over entire region (0.078 mm/year).

A clear picture of the influence of two climate zones

Military University of Technology

GNSS data Research Infrastructure Centre



THANK YOU!

Contact:

andrzej.araszkiewicz@wat.edu.pl

Data availability:

http://www.gnss.wat.edu.pl/products/EPNDEN_ASG

Military University of Technology
Faculty of Civil Engineering and Geodesy
gen. S. Kaliskiego 2, 00-908 Warsaw, Poland