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Water cycle changes in Czechia: a multi-source water budget perspective

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Table S1. Compiled from Sahoo et al. (2011). P is precipitation, E is evapotranspiration, Q is runoff, and Δ TWS is changes in total water storage.

Name	Variable	Spatial Resolution	Temporal Resolution	Record Length	Data Type	Reference(s)
GPCP	P	1°	Daily	1997-2006	Satellite-based	Adler et al. (2003)
TMPA 3B42RT	P	0.25°	3h	1997-2019	Satellite-based	Huffman et al. (2007)
CMORPH	P	8km	30min	2003-2006	Satellite-based	Joyce et al. (2004)
PERSIANN	P	0.25°	3h	2000-2006	Satellite-based	Hong et al. (2004)
CPC PRECŁ	P	2.5°	Monthly	1950-Present	Gauge-based	Chen et al. (2002)
CRU TS3.0	P	0.5°	Monthly	1901-2006	Gauge-based	Mitchell and Jones (2005)
WM v2.01	P	0.5°	Monthly	1900-2008	Gauge-based	Willmott and Matsuura (2001)
GPCC	P	0.5°	Monthly	1900-2007	Gauge-based	Schneider et al. (2011)
PM (ISCCP)	E	2.5°	3h	1984-2005	Satellite-based	Sheffield et al. (2010)
PM (EOS)	E	5km	Daily	2003-2006	Satellite-based	Vinukollu et al. (2011)
PT (EOS)	E	5km	Daily	2003-2006	Satellite-based	Vinukollu et al. (2011)
SEBS (EOS)	E	5km	Daily	2003-2006	Satellite-based	Vinukollu et al. (2011)
VIC	E	1.0°	3h	1948-2006	Model	Sheffield and Wood (2007)
ERA-interim	E	T255	12h	1989-2006	Reanalysis	Simmons (2006)
GRACE	Δ TWS	Basin	∼Monthly	2002-2006	Satellite-based	Swenson and Wahr (2006)
GRDC	Q	Basin	Monthly	1900-2006	Station	www.bafg.de/GRDC

Table S2. Compiled from Pan et al. (2012). P is precipitation, E is evapotranspiration, Q is runoff, and Δ TWS is changes in total water storage.

Name	Variable	Spatial Resolution	Temporal Resolution	Record Length	Data Type	Reference(s)
GPCP v2.2	P	2.5°	Monthly	1950-Present	Gauge-based	Adler et al. (2003)
CRU TS3.0	P	0.5°	Monthly	1901-2006	Gauge-based	Mitchell and Jones (2005)
WM v2.01	P	0.5°	Monthly	1900-2008	Gauge-based	Willmott and Matsuura (2001)
GPCC	P	0.5°	Monthly	1900-2007	Gauge-based	Schneider et al. (2011)
MPI	E	0.5°	Monthly	1982–2008	Flux tower-based	Jung et al. (2010)
SEBS (EOS)	E	5km	Daily	2003-2006	Satellite-based	Vinukollu et al. (2011)
GRACE	Δ TWS	Basin	∼Monthly	2002-2006	Satellite-based	Swenson and Wahr (2006)
GRDC	Q	Basin	Monthly	1900-2006	Station	www.bafg.de/GRDC

Ranking	P Data	E Data	Q Data
1st	TerraClimate	TerraClimate	TerraClimate
2nd	mHM	mHM	mHM
3rd	CRU TS v4.06	TerraClimate	TerraClimate
4th	TerraClimate	TerraClimate	mHM
5th	CRU TS v4.06	TerraClimate	mHM
6th	ERA5−Land	ERA5−Land	ERA5−Land
7th	mHM	mHM	TerraClimate
8th	PREC/L	mHM	mHM
9th	mHM	TerraClimate	mHM
10th	PREC/L	TerraClimate	TerraClimate
11th	mHM	TerraClimate	TerraClimate
12th	CRU TS v4.06	mHM	mHM
13th	TerraClimate	mHM	mHM
14th	PREC/L	mHM	TerraClimate
15th	PREC/L	TerraClimate	mHM
16th	CRU TS v4.06	mHM	TerraClimate
17th	TerraClimate	mHM	TerraClimate
18th	ERA5−Land	ERA5−Land	mHM
19th	CRU TS v4.06	ERA5−Land	TerraClimate
20th	TerraClimate	ERA5−Land	TerraClimate
21st	mHM	ERA5−Land	mHM
22nd	TerraClimate	ERA5−Land	mHM
23rd	CRU TS v4.06	ERA5−Land	mHM
24th	ERA5−Land	TerraClimate	mHM
25th	ERA5−Land	TerraClimate	ERA5−Land
26th	mHM	ERA5−Land	TerraClimate
27th	ERA5−Land	ERA5−Land	TerraClimate
28th	TerraClimate	mHM	ERA5−Land
29th	CRU TS v4.06	mHM	ERA5−Land
30th	PREC/L	ERA5−Land	mHM
31st	PREC/L	ERA5−Land	TerraClimate
32nd	ERA5−Land	TerraClimate	TerraClimate
33rd	TerraClimate	TerraClimate	ERA5−Land
34th	mHM	mHM	ERA5−Land
35th	CRU TS v4.06	TerraClimate	ERA5−Land
36th	ERA5−Land	mHM	mHM
37th	mHM	TerraClimate	ERA5−Land
38th	ERA5−Land	NCEP/NCAR R1	mHM
39th	ERA5−Land	mHM	ERA5−Land
40th	mHM	ERA5−Land	ERA5−Land
41st	TerraClimate	ERA5−Land	ERA5−Land
42nd	CRU TS v4.06	ERA5−Land	ERA5−Land
43rd	ERA5−Land	NCEP/NCAR R1	TerraClimate
44th	ERA5−Land	mHM	TerraClimate
45th	mHM	NCEP/NCAR R1	mHM
46th	CRU TS v4.06	NCEP/NCAR R1	TerraClimate
47th	TerraClimate	NCEP/NCAR R1	TerraClimate
48th	PREC/L	mHM	ERA5−Land
49th	mHM	NCEP/NCAR R1	TerraClimate
50th	TerraClimate	NCEP/NCAR R1	mHM
51st	CRU TS v4.06	NCEP/NCAR R1	mHM
52nd	PREC/L	ERA5−Land	ERA5−Land
53rd	PREC/L	TerraClimate	ERA5−Land
54th	PREC/L	NCEP/NCAR R1	TerraClimate
55th	PREC/L	NCEP/NCAR R1	mHM
56th	ERA5−Land	NCEP/NCAR R1	ERA5−Land
57th	ERA5−Land	TerraClimate	NCEP/NCAR R1
58th	NCEP/NCAR R1	ERA5−Land	ERA5−Land
59th	mHM	NCEP/NCAR R1	ERA5−Land
60th	ERA5−Land	mHM	NCEP/NCAR R1
61st	TerraClimate	NCEP/NCAR R1	ERA5−Land
62nd	CRU TS v4.06	NCEP/NCAR R1	ERA5−Land
63rd	ERA5−Land	ERA5−Land	NCEP/NCAR R1
64th	PREC/L	NCEP/NCAR R1	ERA5−Land
65th	NCEP/NCAR R1	TerraClimate	NCEP/NCAR R1
66th	CRU TS v4.06	TerraClimate	NCEP/NCAR R1
67th	TerraClimate	TerraClimate	NCEP/NCAR R1
68th	mHM	TerraClimate	NCEP/NCAR R1
69th	CRU TS v4.06	ERA5−Land	NCEP/NCAR R1
70th	mHM	ERA5−Land	NCEP/NCAR R1
71st	CRU TS v4.06	mHM	NCEP/NCAR R1
72nd	mHM	mHM	NCEP/NCAR R1
73rd	TerraClimate	ERA5−Land	NCEP/NCAR R1
74th	TerraClimate	mHM	NCEP/NCAR R1
75th	NCEP/NCAR R1	mHM	NCEP/NCAR R1
76th	PREC/L	TerraClimate	NCEP/NCAR R1
77th	PREC/L	ERA5−Land	NCEP/NCAR R1
78th	NCEP/NCAR R1	TerraClimate	ERA5−Land
79th	PREC/L	mHM	NCEP/NCAR R1
80th	NCEP/NCAR R1	mHM	ERA5−Land
81st	NCEP/NCAR R1	ERA5−Land	mHM
82nd	NCEP/NCAR R1	ERA5−Land	NCEP/NCAR R1
83rd	NCEP/NCAR R1	NCEP/NCAR R1	ERA5−Land
84th	NCEP/NCAR R1	NCEP/NCAR R1	mHM
85th	NCEP/NCAR R1	ERA5−Land	TerraClimate
86th	NCEP/NCAR R1	mHM	mHM
87th	NCEP/NCAR R1	NCEP/NCAR R1	NCEP/NCAR R1
88th	NCEP/NCAR R1	NCEP/NCAR R1	TerraClimate
89th	NCEP/NCAR R1	TerraClimate	mHM
90th	NCEP/NCAR R1	mHM	TerraClimate
91st	NCEP/NCAR R1	TerraClimate	TerraClimate
92nd	PREC/L	NCEP/NCAR R1	NCEP/NCAR R1
93rd	ERA5−Land	NCEP/NCAR R1	NCEP/NCAR R1
94th	mHM	NCEP/NCAR R1	NCEP/NCAR R1
95th	TerraClimate	NCEP/NCAR R1	NCEP/NCAR R1
96th	CRU TS v4.06	NCEP/NCAR R1	NCEP/NCAR R1

Figure S1. Data set ranking as determined by Equation 3, where P is precipitation, E is evapotranspiration, and Q is runoff.

Table S3. Compiled from Rodell et al. (2015). P is precipitation, E is evapotranspiration, Q is runoff, and Δ TWS is changes in total water storage.

Name	Variable	Spatial Resolution	Temporal Resolution	Record Length	Data Type	Reference(s)
GPCP v2.2	P	1°	Daily	1997-2006	Satellite-based	Adler et al. (2003) Huffman et al. (2009)
Princeton ET	E	5km	Daily	2003-2006	Satellite-based	Vinukollu et al. (2011)
MERRA and MERRA-Land	E	0.5°x0.667°	Hourly	1980-2016	Reanalysis	Rienecker et al. (2011) Bosilovich et al. (2011) Reichle (2012)
GLDAS	E	0.25°	3h	1948-2014	Model	Roderick et al. (2014)
University of Washington runoff	Q	2°	Monthly	1998–2008	Model	Jung et al. (2010)
GRACE	Δ TWS	Basin	∼Monthly	2002-2006	Satellite-based	Swenson and Wahr (2006)

Table S4. Compiled from Zhang et al. (2016). P is precipitation, E is evapotranspiration, Q is runoff, and Δ TWS is changes in total water storage.

Name	Variable	Spatial Resolution	Temporal Resolution	Record Length	Data Type	Reference(s)
CSU	P	0.25°	3h	1998–2010	Satellite-based	Bytheway and Kummerow (2013)
PGF	P	0.25°	3h	1948–2010	Satellite-based	Sheffield et al. (2006)
CHIRPS	P	0.5°	Monthly	1981–present	Satellite-based	Funk et al. (2014)
GPCC(v6)	P	0.5°	Monthly	1901–2010	Gauge-based	Schneider et al. (2014)
TMPA-RT	P	0.25°	Monthly	2001-2019	Satellite-based	Huffman et al. (2007, 2010)
SRB–PGF–PM	E	0.5°	3h	1984–2007	Satellite-based	Vinukollu et al. (2011)
VIC	E	0.25°	3h	1948-2010	Model	Sheffield and Wood (2007)
ERA-interim	E	T255	12h	1989-2006	Reanalysis	Simmons (2006)
MERRA	E	0.5°x0.667°	Hourly	1980-2016	Reanalysis	Rienecker et al. (2011)
GLEAM	E	0.5°	3h	1984-2017	Satellite-based	Gonzalez Miralles et al. (2011)
SRB-CFSR-SEBS	E	0.5°	Daily	1984–2007	Satellite-based	Vinukollu et al. (2011)
SRB-CFSR-PM	E	0.5°	Daily	1984–2007	Satellite-based	Vinukollu et al. (2011)
SRB-CFSR-PT	E	0.5°	Daily	1984–2007	Satellite-based	Vinukollu et al. (2011)
VIC	Q	0.25°	3h	1948-2010	Model	Sheffield and Wood (2007)
VIC	Δ TWS	0.25°	3h	1948-2010	Model	Sheffield and Wood (2007)
GRACE	Δ TWS	1°	Monthly	2002-present	Satellite-based	Landerer and Swenson (2012)

Table S5. Compiled from Munier and Aires (2018). P is precipitation, E is evapotranspiration, Q is runoff, and Δ TWS is changes in total water storage.

Name	Variable	Spatial Resolution	Temporal Resolution	Record Length	Data Type	Reference(s)
TMPA	P	0.25°	Monthly	1998-2019	Satellite-based	Huffman et al. (2007)
CMORPH	P	0.25°	Daily	1998–present	Satellite-based	Sheffield et al. (2006)
NRL	P	0.25°	12h	2003–2010	Satellite-based	Turk et al. (2010)
GPCP	P	2.5°	Monthly	1979–present	Satellite-based	Schneider et al. (2014)
GLEAM	E	0.25°	3h	1980–2011	Satellite-based	Gonzalez Miralles et al. (2011)
MOD16	E	1km	8-day	2000–2012	Satellite-based	Mu et al. (2007)
NTSG	E	8km	Daily	1983–2006	Satellite-based	Zhang et al. (2010)
CSR	Δ TWS	Basin	Monthly	2002-present	Satellite-based	http://grace.jpl.nasa.gov/data/
GFZ	Δ TWS	Basin	Monthly	2002-present	Satellite-based	http://grace.jpl.nasa.gov/data/
JPL	Δ TWS	Basin	Monthly	2002-present	Satellite-based	http://grace.jpl.nasa.gov/data/
GRGS	Δ TWS	Basin	Monthly	2002-present	Satellite-based	http://grgs.obs-mip.fr/grace/
GRDC	Q	Basin	Monthly	1900-present	Station	http://www.grdc.sr.unh.edu/

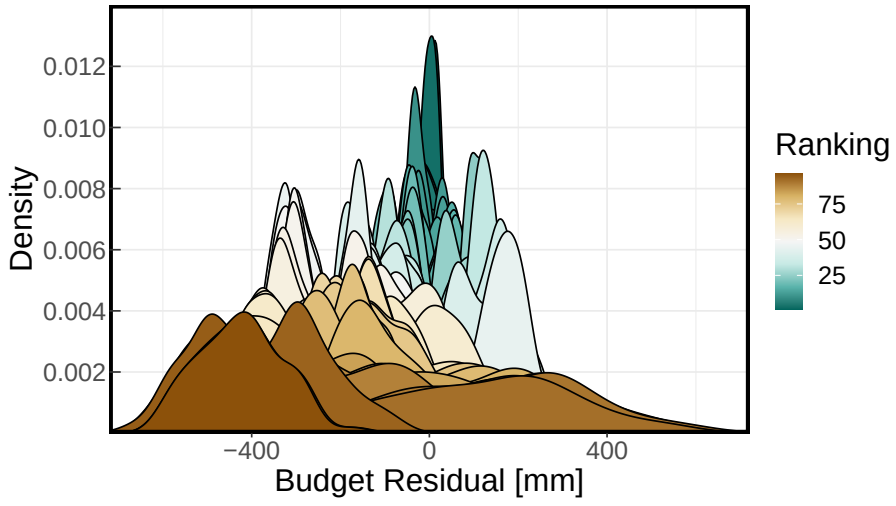

Figure S2. Empirical distribution of all possible 96 data set combinations colored based on their ranking as determined by Equation 3. The color gradient goes from higher ranked combinations colored in shades green to lower ranked combinations colored in shades of brown.

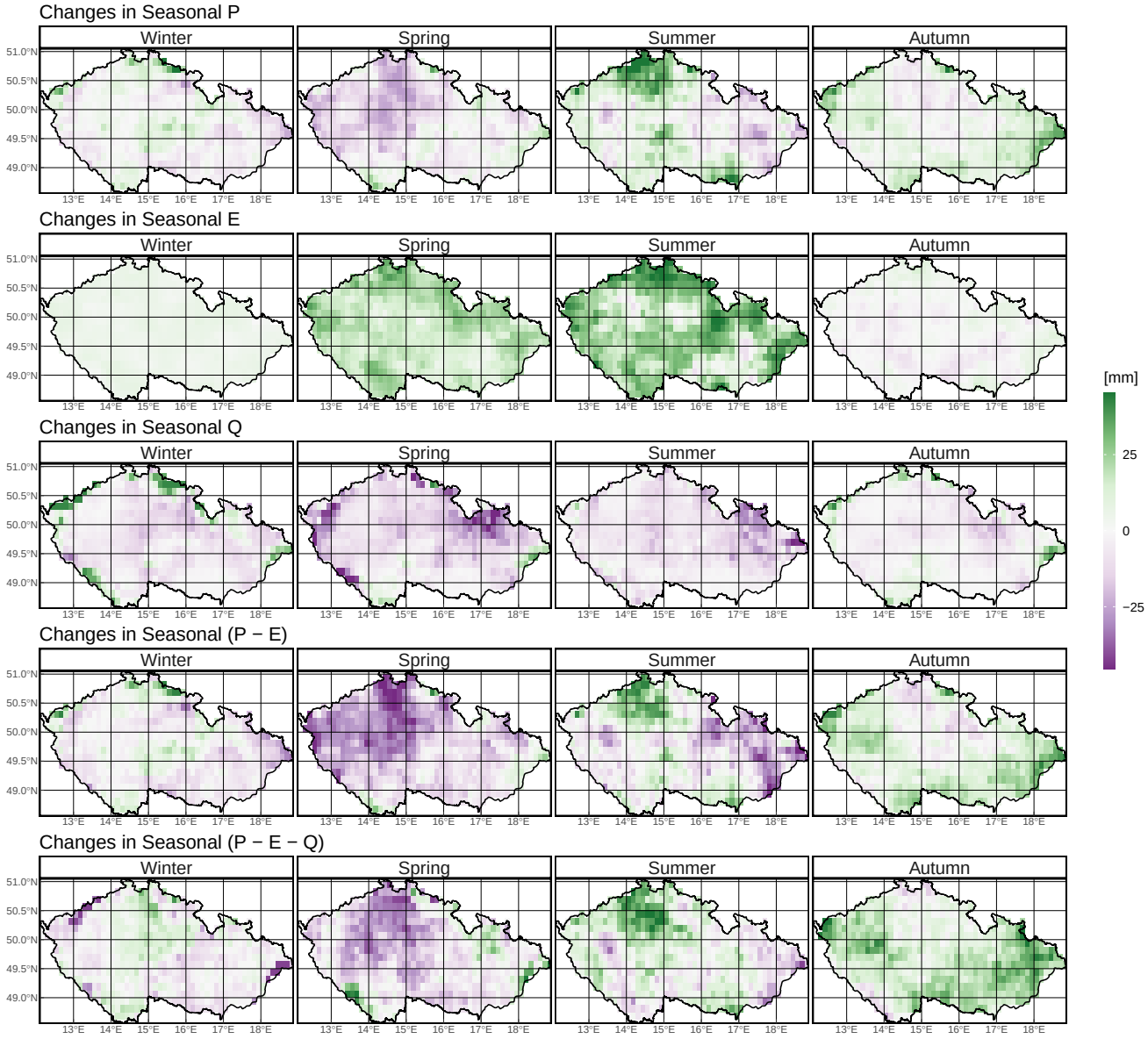

Figure S3. mHM spatial pattern of changes in seasonal median water fluxes over Czechia between two 30-year periods: 1961-1990 and 1991-2020. I.e., the value of each grid cell is equal to the seasonal median value of 1991-2020 minus the seasonal median value of 1961-1990. P is precipitation, E is evapotranspiration, and Q is runoff. The seasons are defined as follows: winter as December, January, and February; spring as March, April, and May; summer as June, July, and August; autumn as September, October, and November.

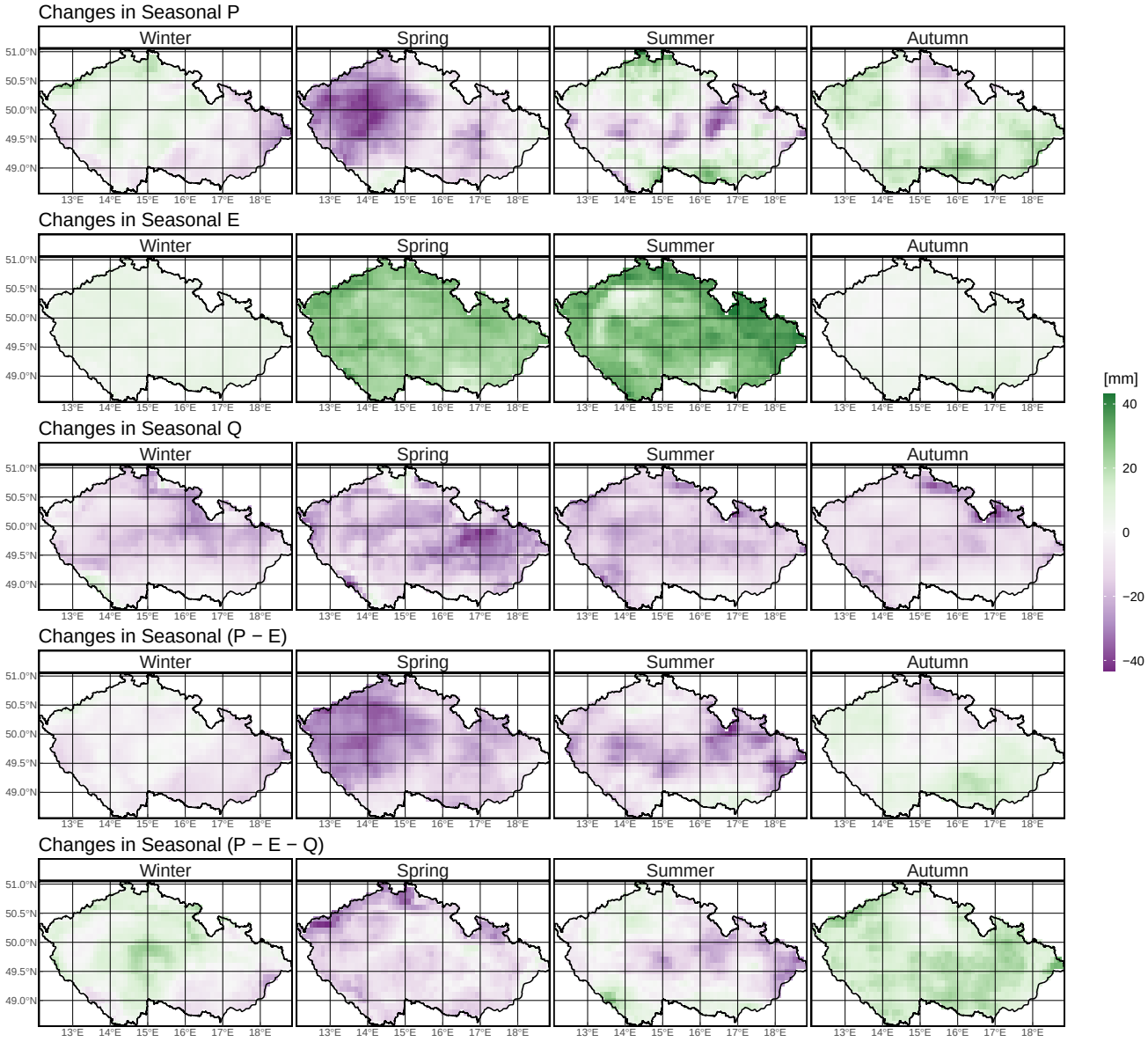

Figure S4. ERA5-Land spatial pattern of changes in seasonal median water fluxes over Czechia between two 30-year periods: 1961-1990 and 1991-2020. I.e., the value of each grid cell is equal to the seasonal median value of 1991-2020 minus the seasonal median value of 1961-1990. P is precipitation, E is evapotranspiration, and Q is runoff. The seasons are defined as follows: winter as December, January, and February; spring as March, April, and May; summer as June, July, and August; autumn as September, October, and November.

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