Examining the contribution of human induced climate change on global drought characteristics

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PICO Navigation

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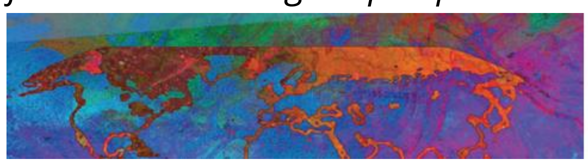
2-MINUTE MADNESS

Background

Examining the contribution of human induced climate change on global drought characteristics

"...increasing agricultural and ecological droughts trends are more evident than increasing trends in meteorological drought in several regions..."

However, the IPCC stresses that "...drought attribution studies are mainly examined from a meteorological perspective..."



"...There is, therefore, a critical knowledge gap in the attribution of changes in drought indicators more closely related to societal impacts such as soil moisture..."

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2-MINUTE MADNESS

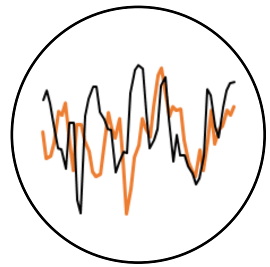
ISIMIP3a framework

JULES-W2 simulations

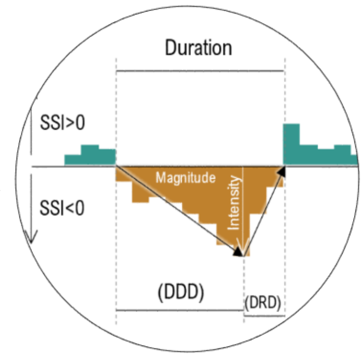
Factual soil moisture time series

Counterfactual soil moisture time series

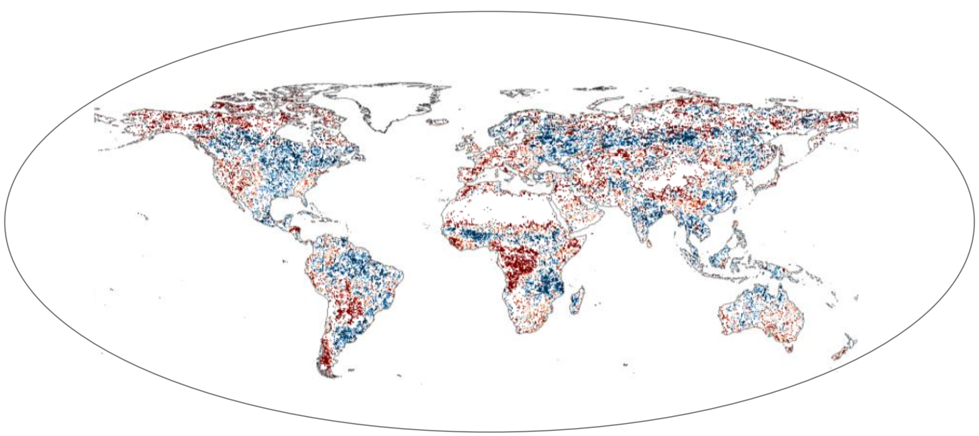
soil moisture climatology



Run theory



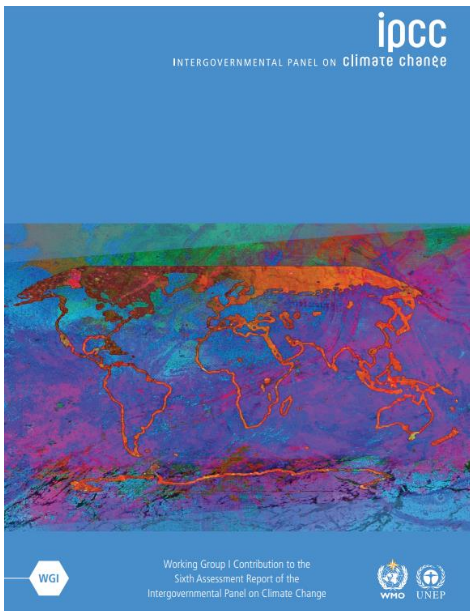
Factual and Counterfactual **drought features**



Changes in drought features

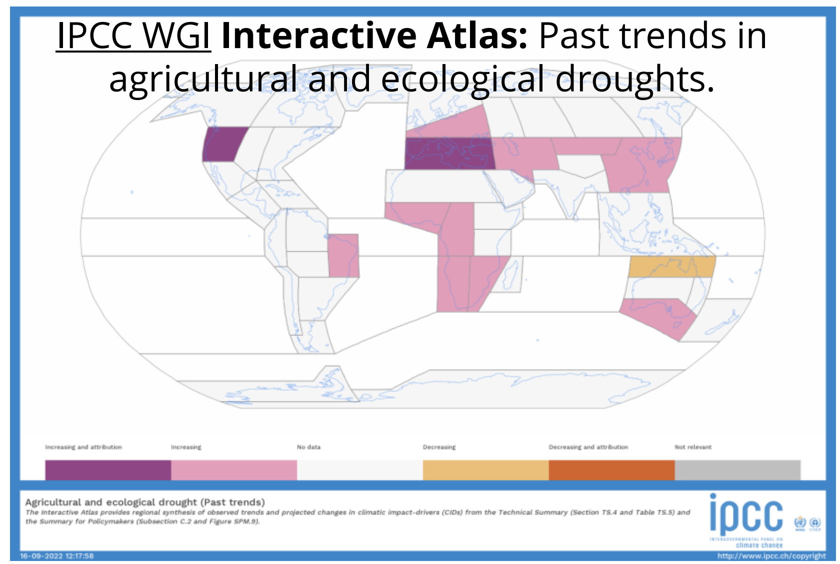
Background [1]

...increasing agricultural and ecological droughts trends are more evident than increasing trends in meteorological drought in several regions...



...A complete examination of drought relevant to societal impacts often requires consideration of hydrological and agricultural drought...

...There is, therefore, a critical knowledge gap in the attribution of changes in drought indicators more closely related to societal impacts such as soil moisture...



Increasing and attribution | Increasing | No data | Decreasing | Decreasing and attribution

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Background [2]

- Frequency
- Intensity
- Duration

nature COMMUNICATIONS
ARTICLE
https://doi.org/10.1038/s41467-022-28752-4 OPEN
Check for updates

Accelerating flash droughts induced by the joint influence of soil moisture depletion and atmospheric aridity

Shuo Wang[1,2,5], Brian C. Ancell[3] & Zong-Liang Yang[4]

Article

The challenge of unprecedented floods and droughts in risk management

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Check for updates

Heidi Kreibich[1], Anne F. Van Loon[2], Kai Schröter[1,3], Philip J. Ward[2], Maurizio Mazzoleni[2], Nivedita Sairam[1], Guta Wakbulcho Abeshu[4], Svetlana Agafonova[5], Amir AghaKouchak[6], Hafzullah Aksoy[7], Camila Alvarez-Garreton[8,9], Blanca Aznar[10], Laila Balkhi[11], Marlies H. Barendrecht[2], Sylvain Biancamaria[12], Liduin Bos-Burgering[13], Chris Bradley[14], Yus Budiyono[15], Wouter Buytaert[16], Lucinda Capewell[14], Hayley Carlson[11], Yonca Cavus[17,18,19], Anaïs Couasnon[2], Gemma Coxon[20,21], Ioannis Daliakopoulos[22], Marleen C. de Ruiter[2], Claire Delus[23], Mathilde Erfurt[19], Giuseppe Esposito[24], Didier François[23], Frédéric Frappart[25], Jim Freer[20,21,26], Natalia Frolova[5], Animesh K. Gain[27,28], Manolis Grillakis[29], Jordi Oriol Grima[10], Diego A. Guzmán[30], Laurie S. Huning[6,31], Monica Ionita[32,33,34], Maxim Kharlamov[5,35],

EurekAlert! AAAS
NEWS RELEASE 5-SEP-2022

Extreme flash droughts will continue into the future

Peer-Reviewed Publication

INSTITUTE OF ATMOSPHERIC PHYSICS, CHINESE ACADEMY OF SCIENCES

ELSEVIER
Weather and Climate Extremes
Volume 37, September 2022, 100491

Recent droughts in the United States are among the fastest-developing of the last seven decades

Virginia Iglesias[a], William R. Travis[a, b], Jennifer K. Balch[a, b]

nature climate change
PERSPECTIVE
https://doi.org/10.1038/s41558-020-0709-0
Check for updates

Flash droughts present a new challenge for subseasonal-to-seasonal prediction

Angeline G. Pendergrass[1], Gerald A. Meehl[1], Roger Pulwarty[2], Mike Hobbins[2,3], Andrew Hoell[2], Amir AghaKouchak[4], Céline J. W. Bonfils[5], Ailie J. E. Gallant[6,7], Martin Hoerling[2], David Hoffmann[6,7], Laurna Kaatz[8], Flavio Lehner[1], Dagmar Llewellyn[9], Philip Mote[10], Richard B. Neale[1], Jonathan T. Overpeck[11], Amanda Sheffield[12], Kerstin Stahl[13], Mark Svoboda[14], Matthew C. Wheeler[15], Andrew W. Wood[1] and Connie A. Woodhouse[16]

Background [3]

Questions

What are the changes in their characteristics during the recent past?

Do they develop faster as a result of anthropogenic climate change?

Do they get more harmful despite the wetting atmosphere as a result of the increase in GHG concentrations?

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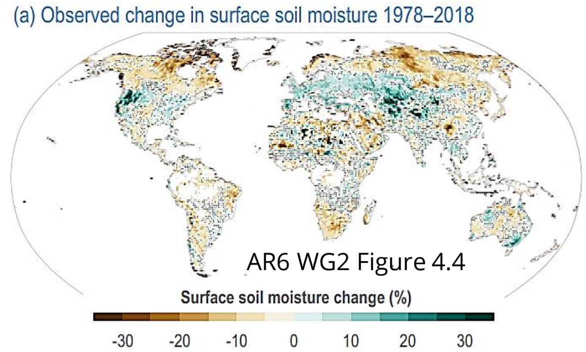
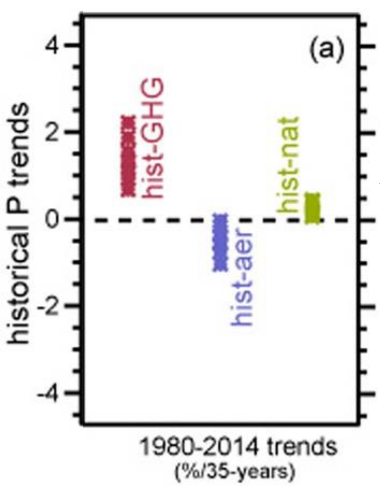
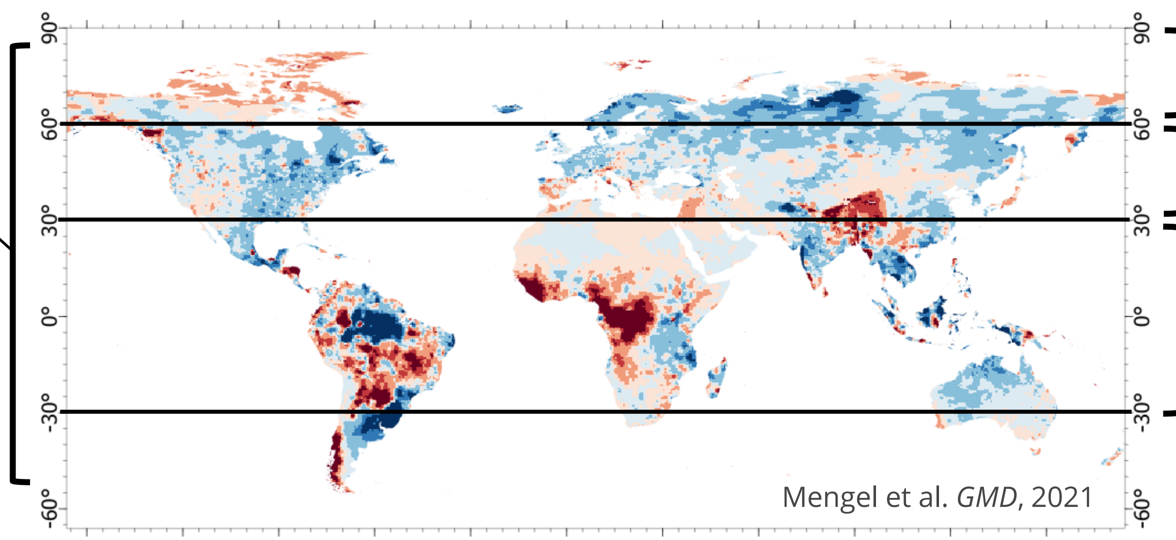
Background [4]

More drought from wetting?

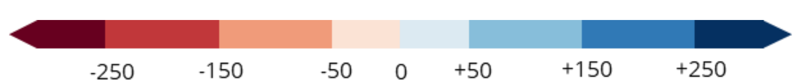


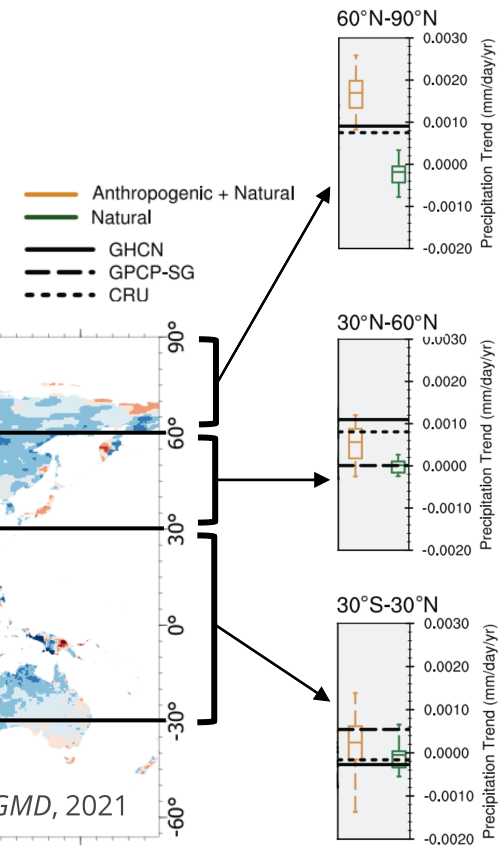


Shiogama, et al. *Nature,* 2022



Precipitation difference [mm/yr] factual (**1990-2019**) – counterfactual (**1990-2019**)





Trends from IPCC WGI Figure 3.15 | Observed and simulated time series of anomalies in zonal average annual mean precipitation, 1950–2014.

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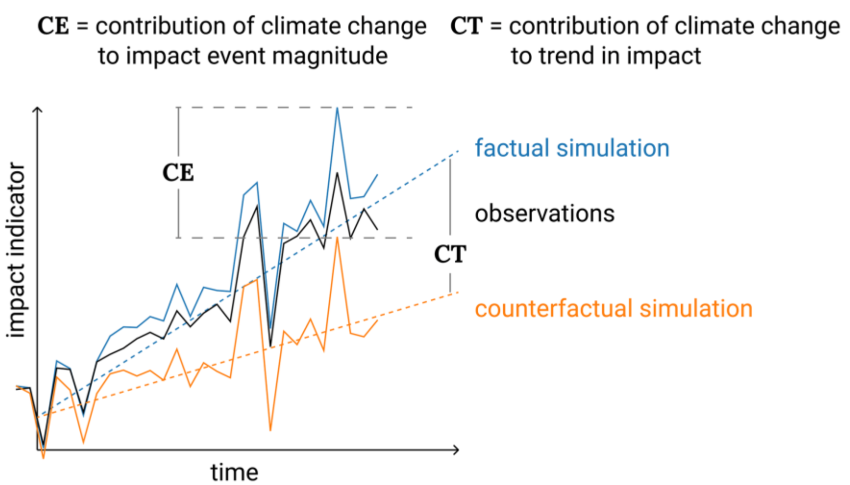
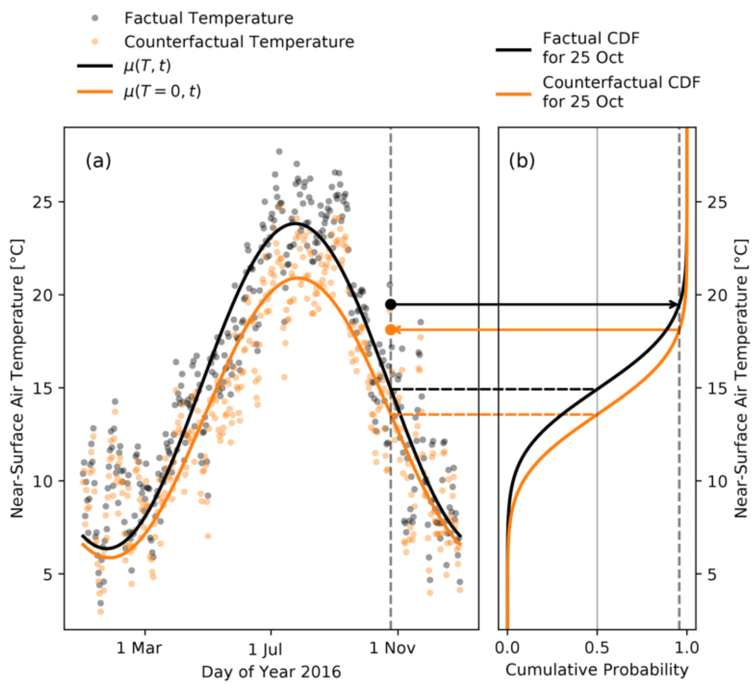
Framework [1]

Framework for attribution of observed impacts





Mengel et al. *GMD*, 2021

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Framework [2]

Framework for factual and counterfactual drought

ISIMIP3a framework

↓

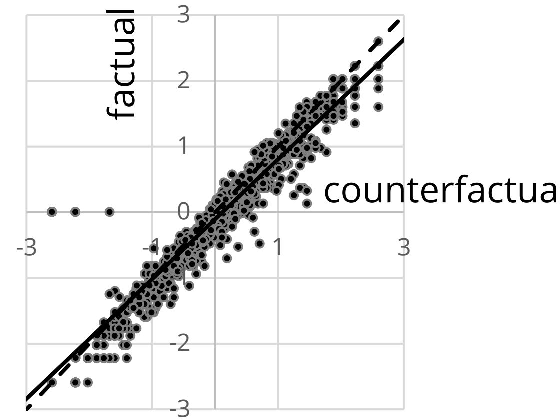
JULES-W2 simulations

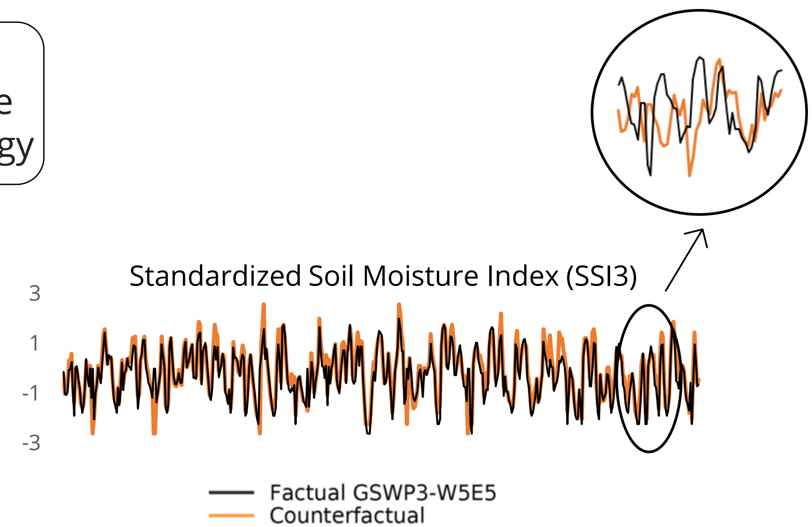
→ **Factual** soil moisture time series

→ **CounterFactual** soil moisture time series

→ CF soil moisture climatology

Farahmand and AghaKouchak *AWR*, 2015





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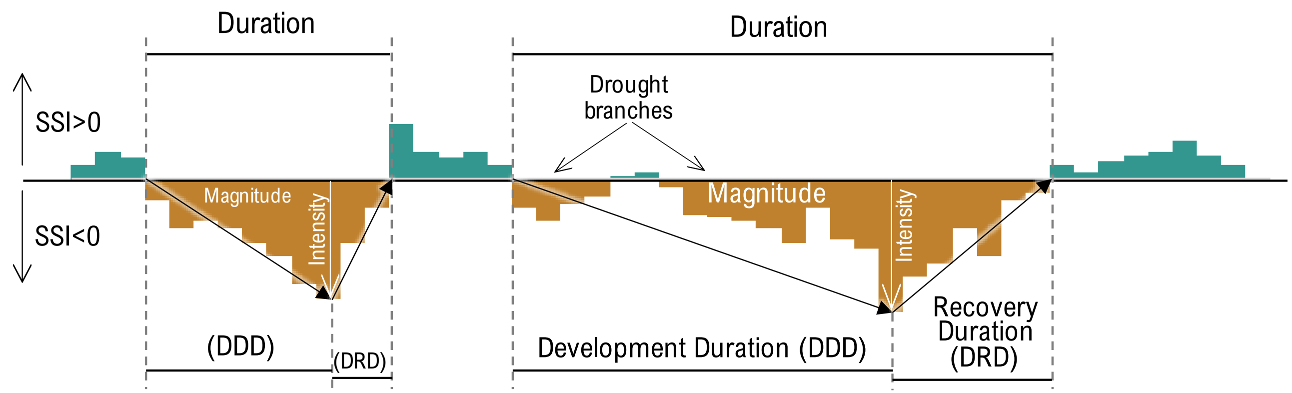
Framework [3]

Drought features



Wu et al. *WRR*, 2018

- Intensity, Development Duration, Recovery Duration, Magnitude, Development Speed, Recovery Speed
- Their trends (also regional means at AR6 SREX level)
- Difference between factual and counterfactual

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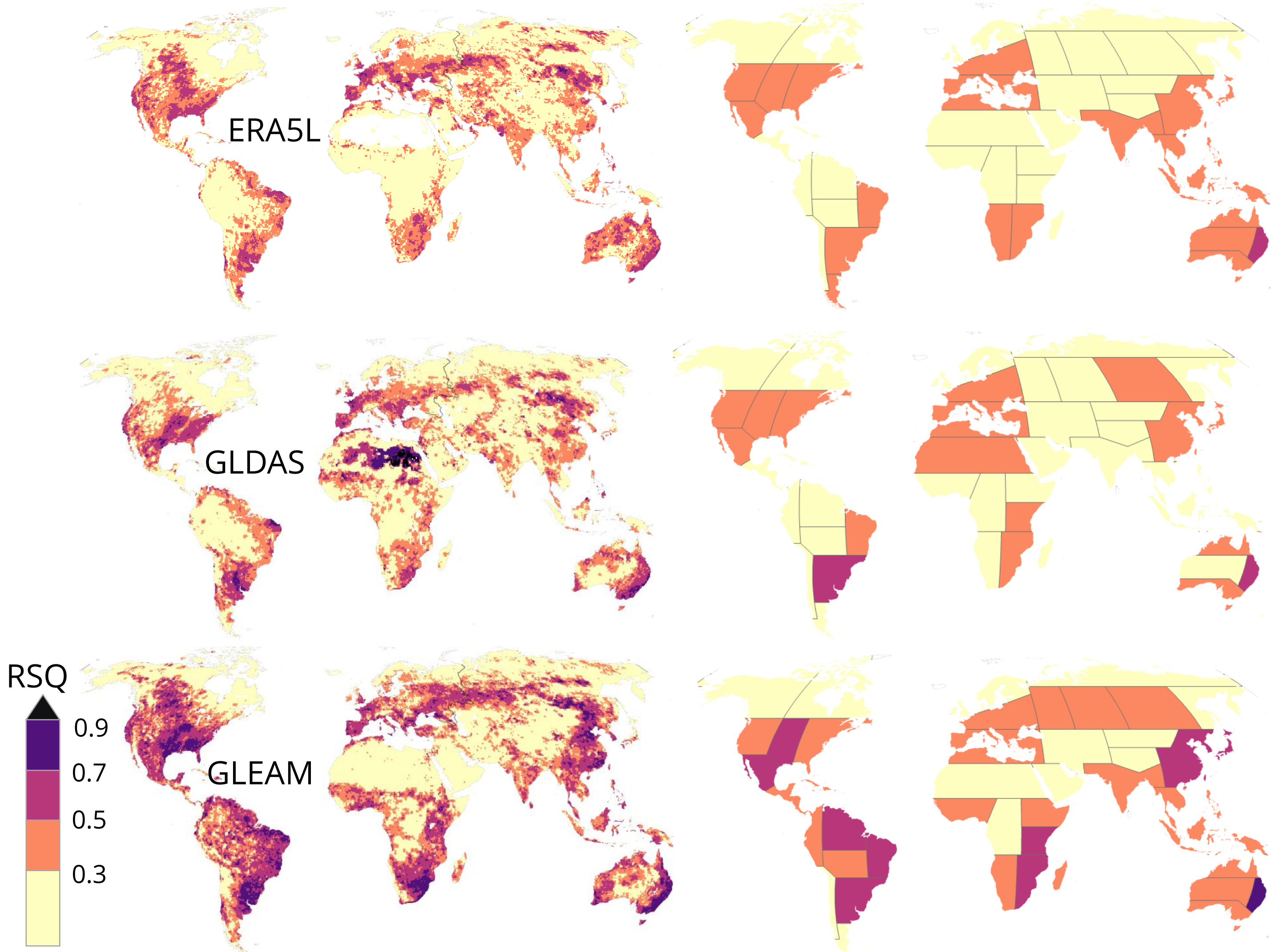
Results [1]

Comparison of factual JULES-W2 run [SSI] with ERA5L, GLEAM and GLDAS (1980-2010)

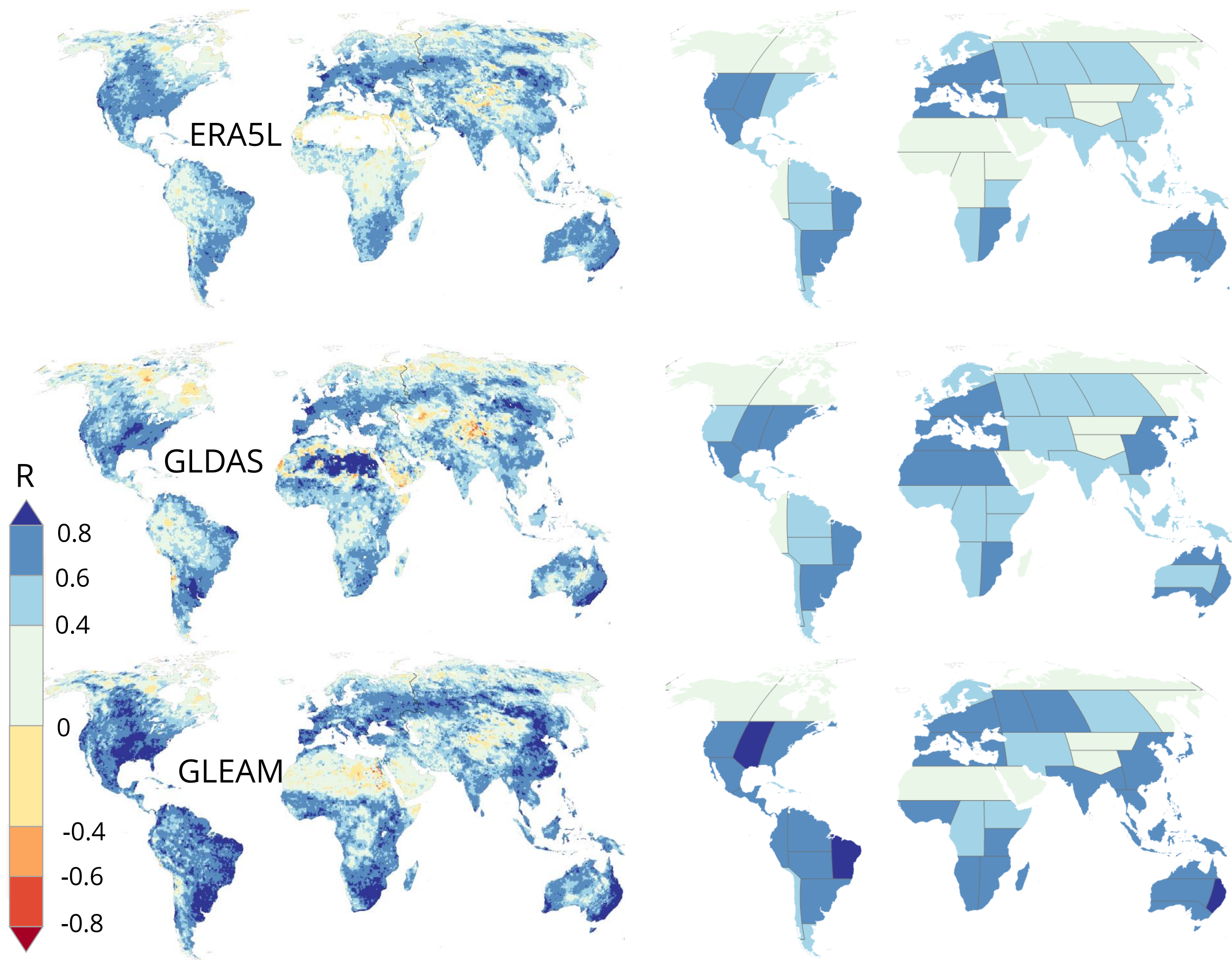
	E5L	GLDAS	GLEAM
NWN	0.16	0.12	0.16
NEN	0.09	0.05	0.06
WNA	0.41	0.33	0.50
CNA	0.49	0.45	0.65
ENA	0.32	0.41	0.43
NCA	0.39	0.46	0.56
SCA	0.26	0.18	0.44
CAR	0.29	0.17	0.31
NWS	0.13	0.14	0.42
NSA	0.23	0.23	0.51
NES	0.40	0.40	0.65
SAM	0.19	0.17	0.48
SWS	0.20	0.27	0.26
SES	0.43	0.51	0.61
SSA	0.31	0.25	0.29
NEU	0.26	0.22	0.26
WCE	0.44	0.45	0.46
EEU	0.28	0.22	0.43
MED	0.41	0.40	0.41
SAH	0.11	0.40	0.03
WAF	0.13	0.29	0.43
CAF	0.08	0.20	0.27
NEAF	0.11	0.26	0.33
SEAF	0.23	0.30	0.52
WSAF	0.30	0.28	0.45
ESAF	0.42	0.42	0.60
MDG	0.26	0.14	0.36
RAR	0.09	0.04	0.08
WSB	0.27	0.22	0.38
ESB	0.28	0.33	0.32
RFE	0.14	0.13	0.11
WCA	0.28	0.23	0.20
ECA	0.15	0.09	0.08
TIB	0.10	0.16	0.15
EAS	0.33	0.39	0.54
ARP	0.10	0.10	0.03
SAS	0.34	0.28	0.36
SEA	0.32	0.28	0.45
NAU	0.45	0.41	0.46
CAU	0.41	0.28	0.36
EAU	0.53	0.59	0.71
SAU	0.39	0.48	0.49
NZ	0.38	0.19	0.41
GLB	**0.25**	**0.26**	**0.32**



Results [2]

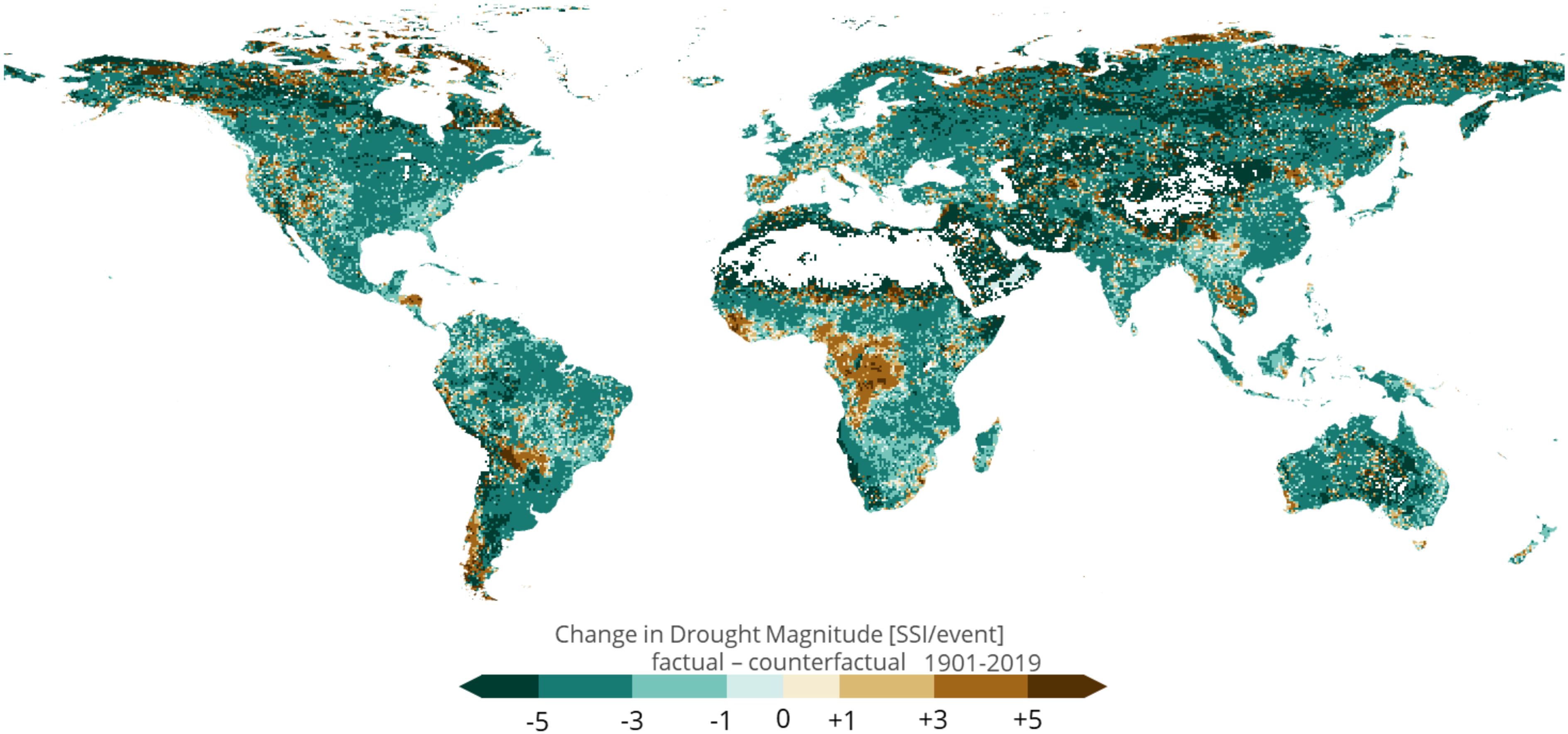
Comparison of factual JULES-W2 run [SSI] with ERA5L, GLEAM and GLDAS (1980-2010)

	E5L	GLDAS	GLEAM
NWN	0.39	0.34	0.40
NEN	0.29	0.19	0.24
WNA	0.64	0.57	0.71
CNA	0.70	0.67	0.80
ENA	0.57	0.64	0.65
NCA	0.62	0.67	0.75
SCA	0.51	0.42	0.66
CAR	0.53	0.42	0.56
NWS	0.36	0.37	0.65
NSA	0.48	0.48	0.72
NES	0.63	0.63	0.80
SAM	0.43	0.41	0.69
SWS	0.44	0.52	0.51
SES	0.66	0.71	0.78
SSA	0.55	0.50	0.54
NEU	0.51	0.47	0.51
WCE	0.67	0.67	0.68
EEU	0.53	0.47	0.66
MED	0.64	0.63	0.64
SAH	0.32	0.63	0.16
WAF	0.36	0.54	0.66
CAF	0.29	0.45	0.52
NEAF	0.33	0.51	0.57
SEAF	0.48	0.55	0.72
WSAF	0.55	0.53	0.67
ESAF	0.65	0.65	0.78
MDG	0.51	0.38	0.60
RAR	0.31	0.19	0.29
WSB	0.52	0.46	0.62
ESB	0.53	0.57	0.57
RFE	0.37	0.36	0.33
WCA	0.53	0.48	0.45
ECA	0.38	0.20	0.27
TIB	0.29	0.38	0.39
EAS	0.58	0.63	0.74
ARP	0.31	0.22	0.18
SAS	0.58	0.53	0.60
SEA	0.56	0.53	0.67
NAU	0.67	0.64	0.68
CAU	0.64	0.53	0.60
EAU	0.72	0.77	0.84
SAU	0.63	0.69	0.70
NZ	0.62	0.44	0.64
GLB	**0.49**	**0.48**	**0.53**



Results [3]

Drought Magnitude



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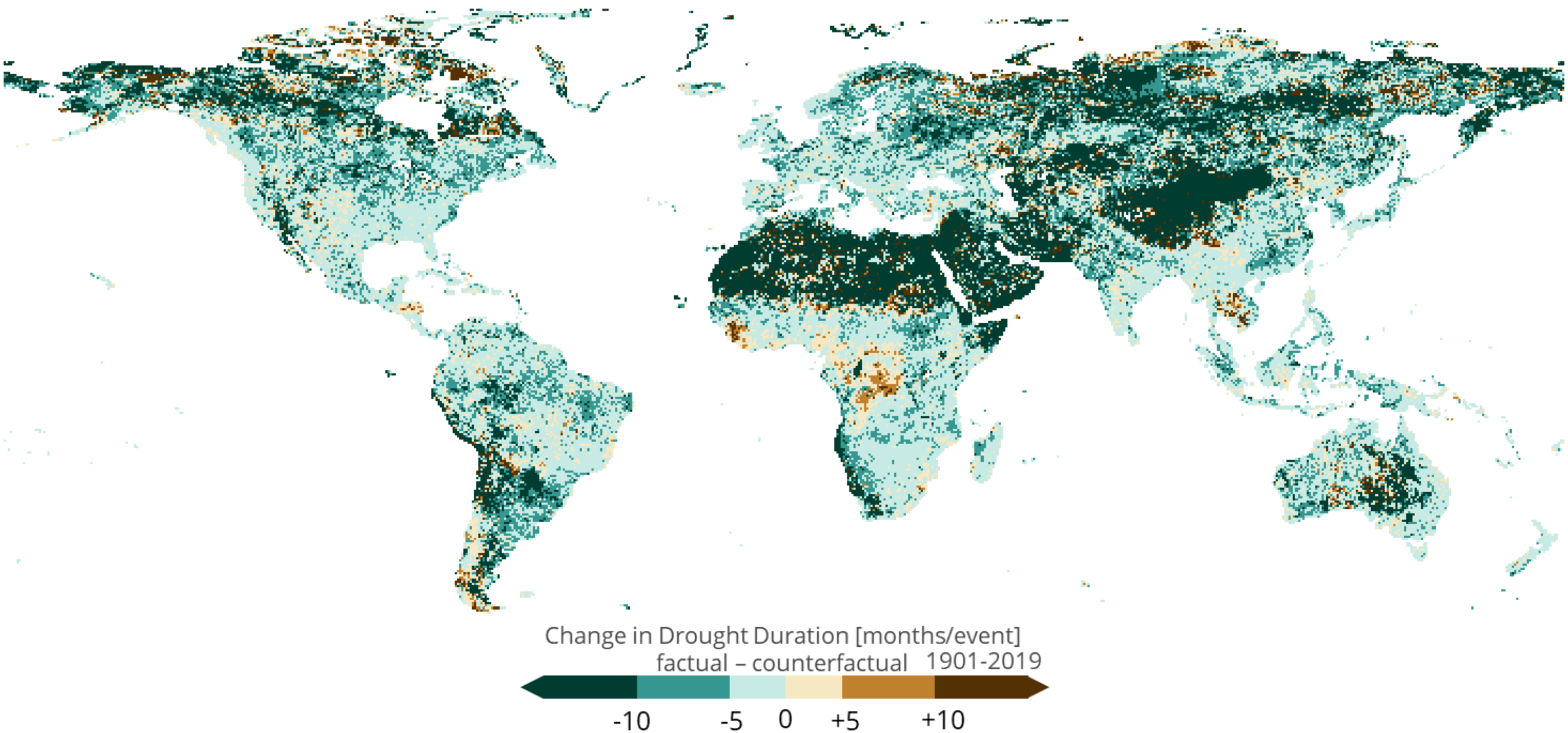
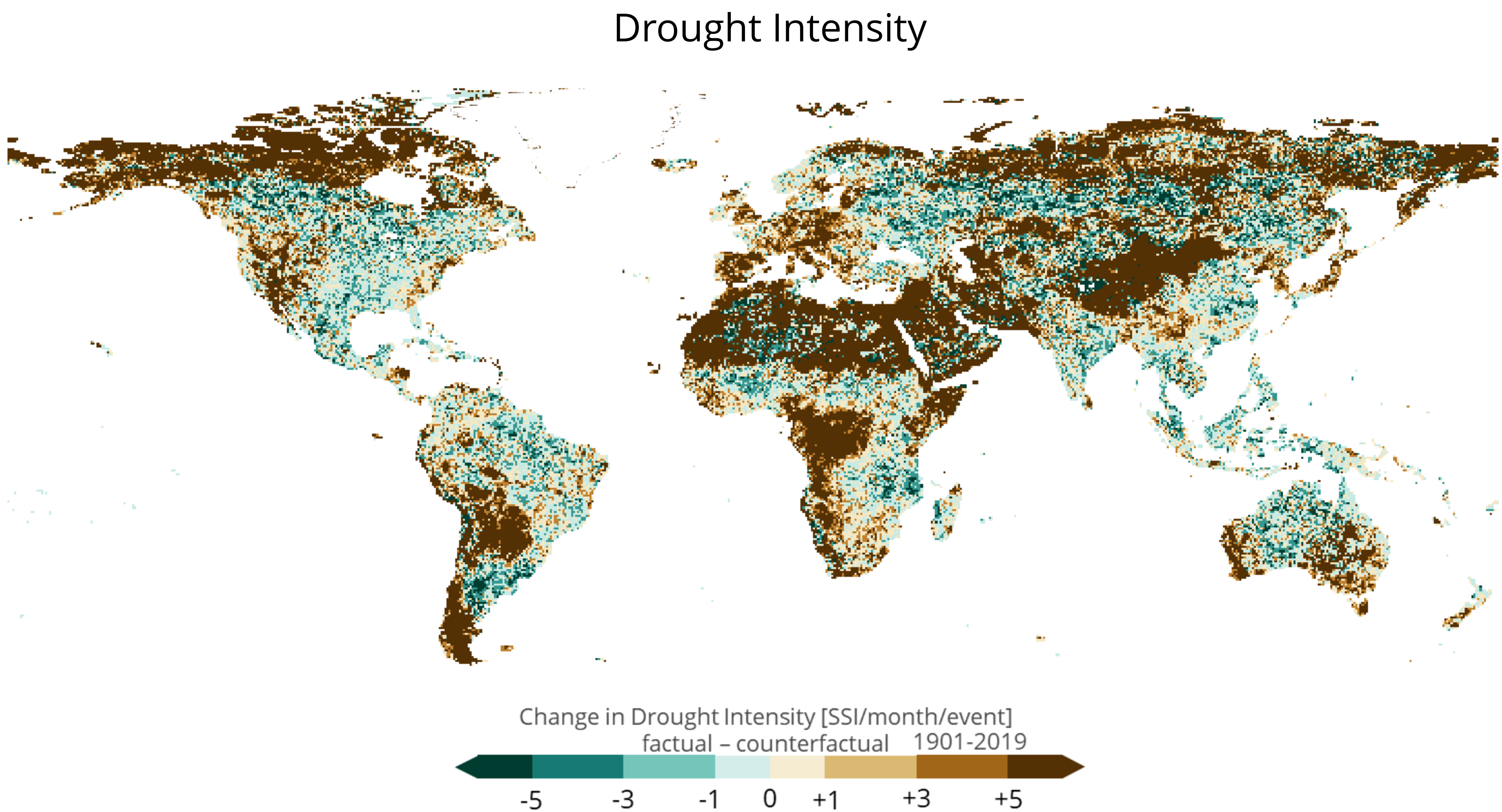
Results [4]

Drought Duration



Results [5]



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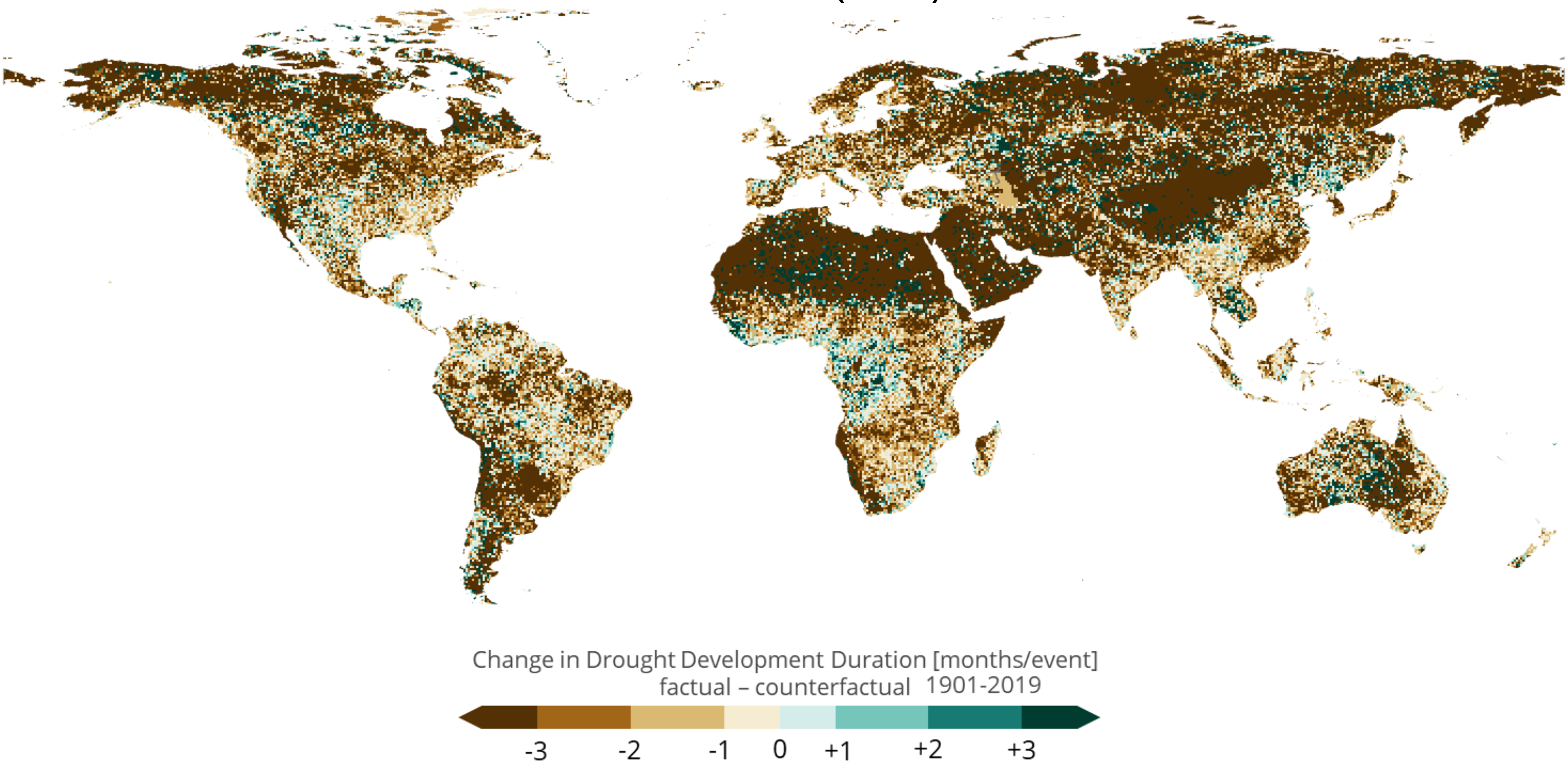
Results [6]

Drought Development Duration (DDD)



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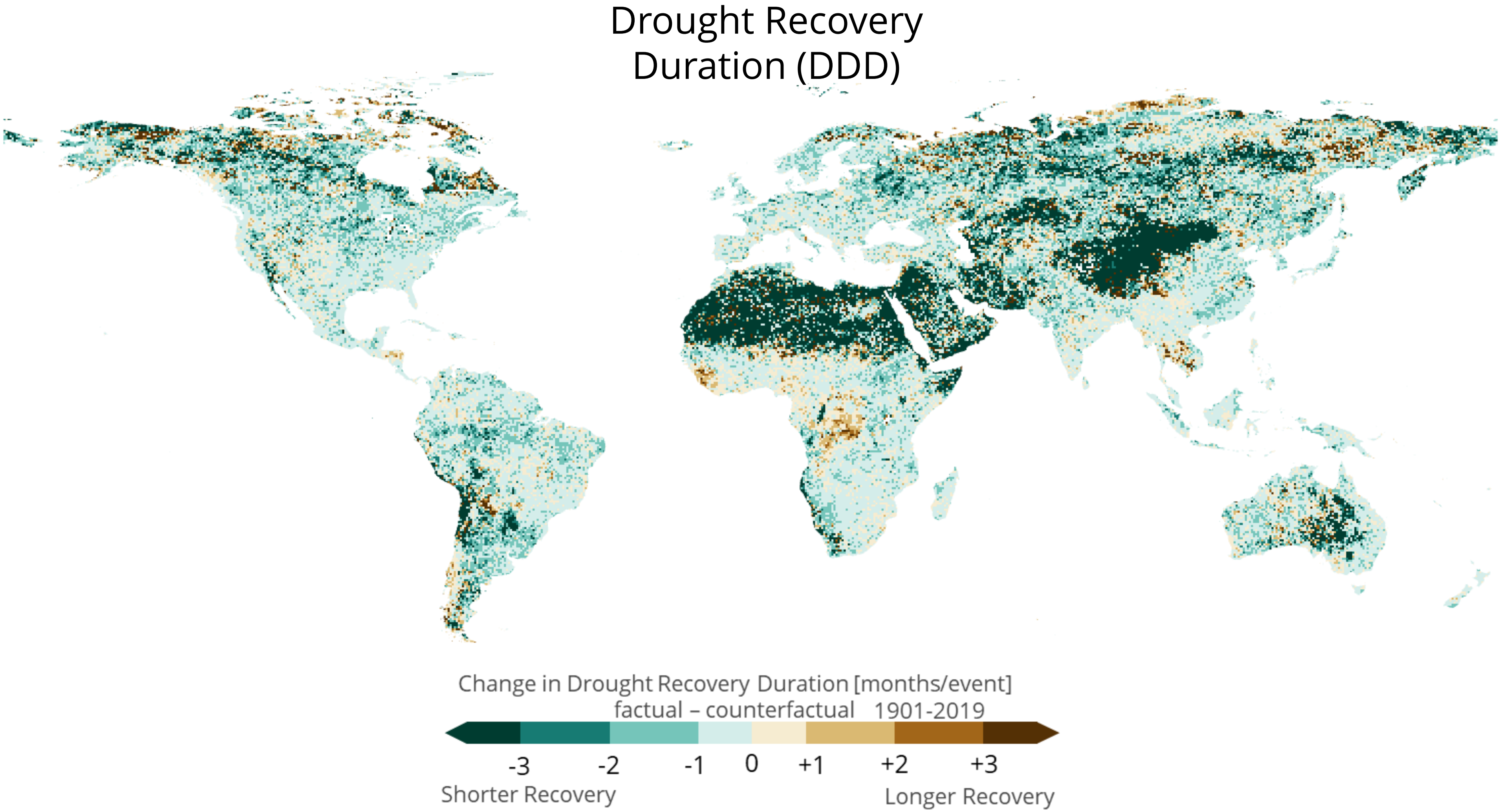
Results [7]



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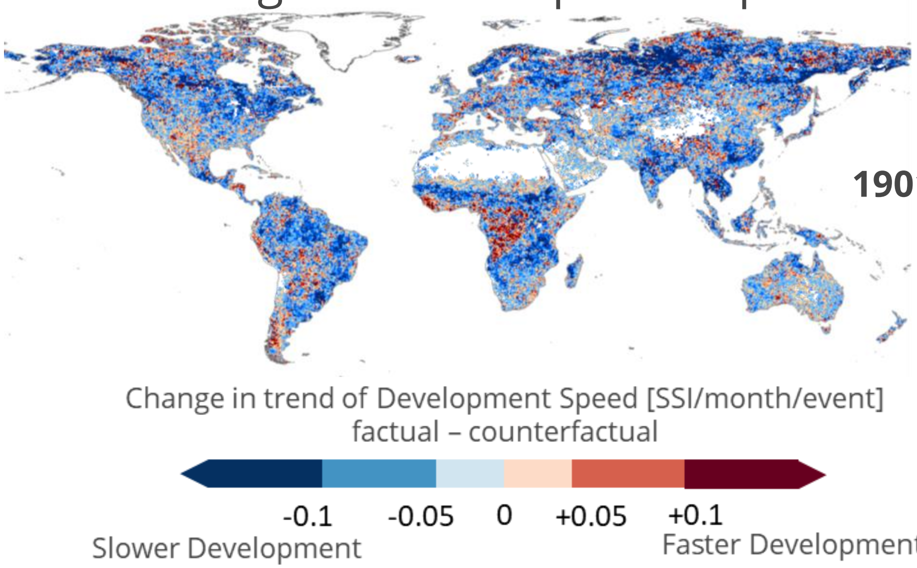
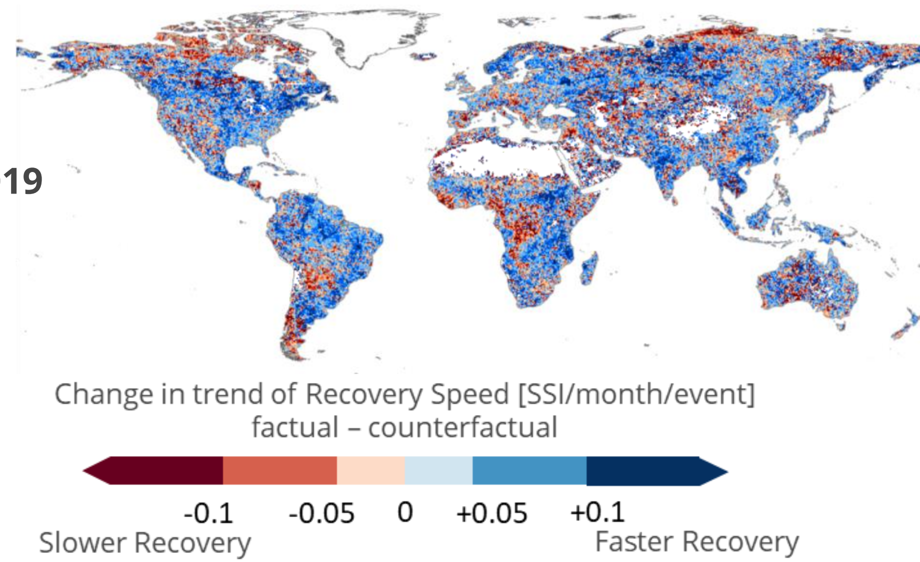
Results [8]

Changes in Development Speed



1901-2019

Changes in Recovery Speed



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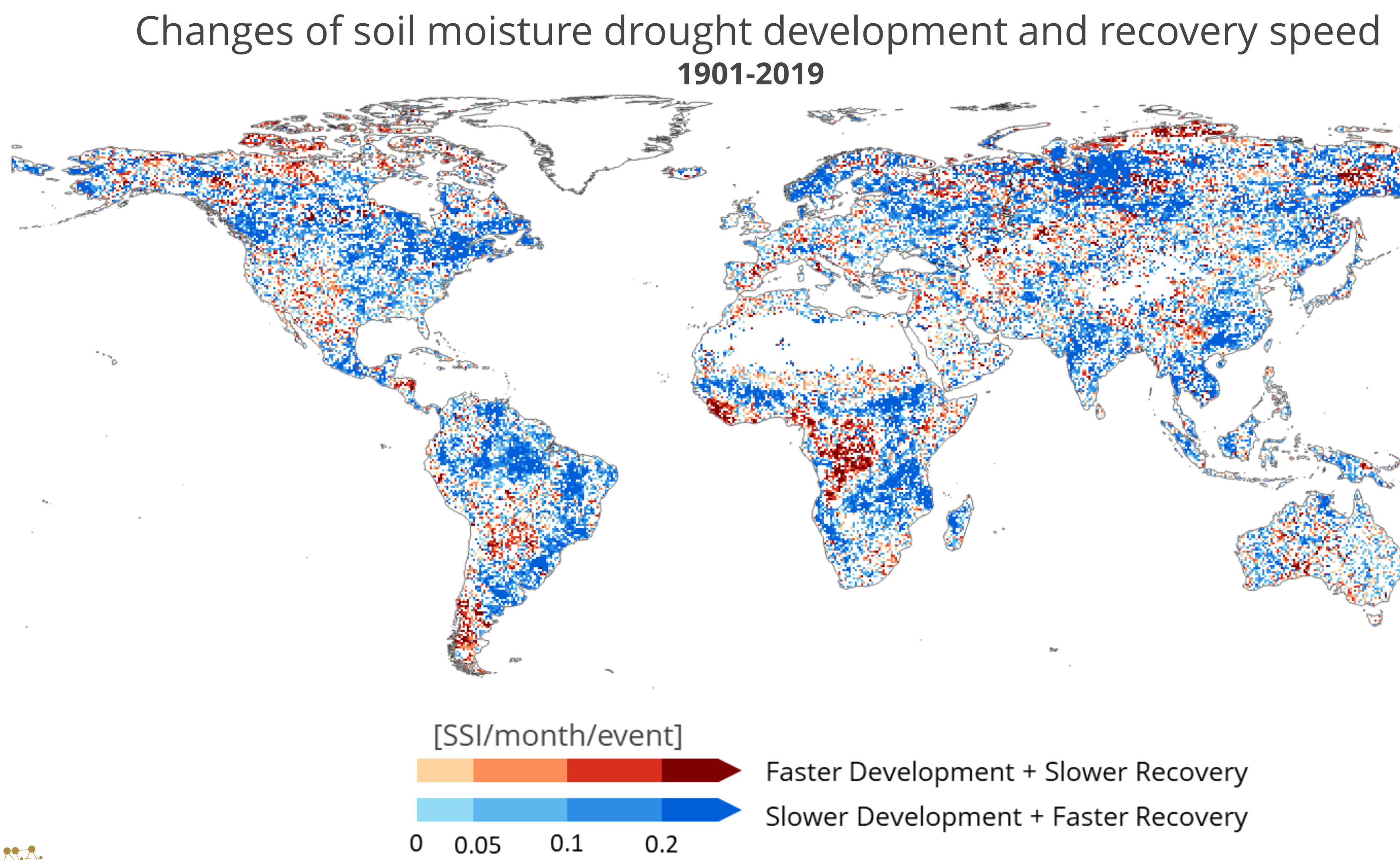
Results [9]



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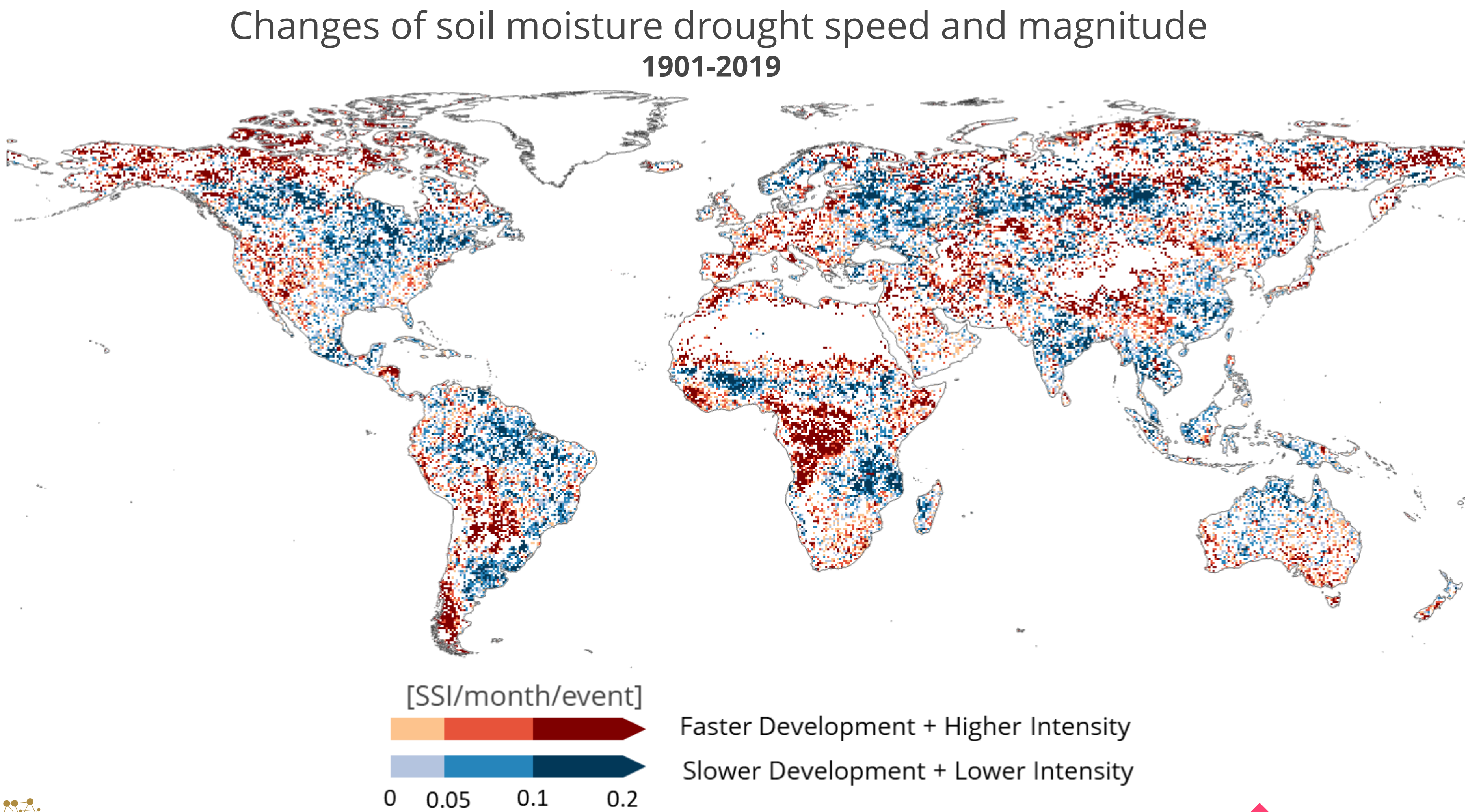
Results [10]



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Conclusions

- Soil moisture droughts accelerated from human induced CC (?).
- Some regions might have experienced benefits from increased atmospheric moisture.
- Soil drought simulations (obsclim-histsoc) align with recent research findings.
- Significant discrepancies exist among observational datasets.
- Correlations are stronger for certain geographical areas.

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