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Multi-type global drought projection using multi-model hydrological simulations

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1: Introduction

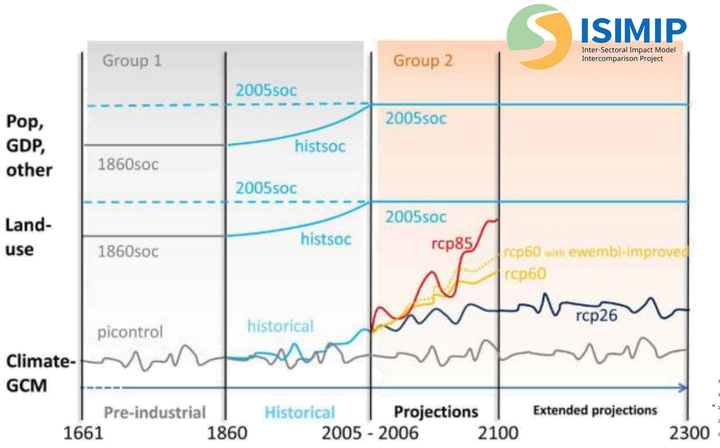
It is anticipated that climate change will exacerbate future drought. However, very few studies with bias-correction have comprehensively discussed future drought considering several drought types within a single study, hence leaving a gap on the holistic picture of change in drought. A multi-drought study that covers several draught types is required to better understand future drought.

2: This study presents

a comprehensive multi-drought-type assessment on a global-scale from 1861 until 2099. Meteorological (precipitation), agricultural (soil moisture) and hydrological (runoff) droughts are investigated by using the Standardized method, and four drought features; drought intensity, spatial extent, the number of events, dry spell length, are studied, compared to those of the period before the 1960s. To explore potential pathways of drought changes, this study examined the Representative Concentration Pathways (RCP) 2.6, 6.0 and 8.5 scenarios.

3: ISIMIP2b multi-model data set

We use the multi-model data set, which was developed in the Inter-Sectoral Impact Model Inter-comparison Project phase2b. Using a set of multiple state-of-art global hydrological model (GHM) simulations forced by four bias-corrected GCM projections.

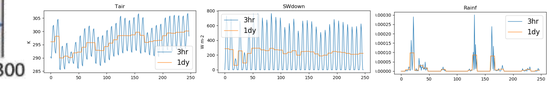


Bias-corrected climate projection:
GFDL-ESM2M, HadGEM2-ES,
IPSL-CM5A-L, MIROC5

4: 3-hourly ISIMIP2b forcing data

We temporally downscaled ISIMIP forcing data into 3 hourly because land surface model MATSIRO, which is a core component of MIROC-INTEG, at every hourly time step.

(ex. @Vienna, in August, 2005, HadGEM2-ES)



5: Models

Results in this poster derive from selected three global hydrological models.

Yokohata et al. 2019

MIROC-INTEG1 (NIES)

TOUGOU Integrated Research Program for Advancing Climate Models

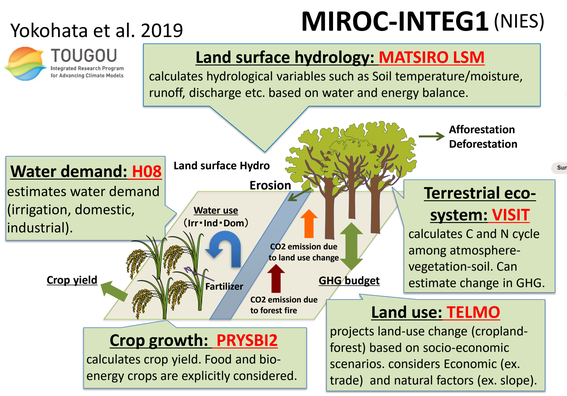
Land surface hydrology: MATSIRO LSM
calculates hydrological variables such as Soil temperature/moisture, runoff, discharge etc. based on water and energy balance.

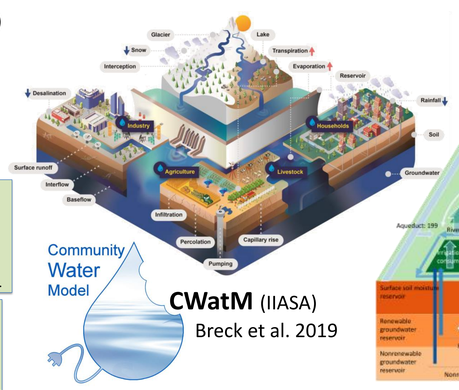
Water demand: H08
estimates water demand (irrigation, domestic, industrial).

Terrestrial eco-system: VISIT
calculates C and N cycle among atmosphere-vegetation-soil. Can estimate change in GHG.

Land use: TELMO
projects land-use change (cropland-forest) based on socio-economic scenarios. considers Economic (ex. trade) and natural factors (ex. slope).

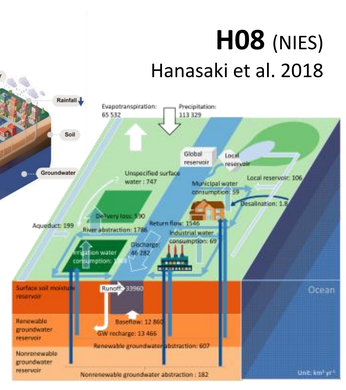
Crop growth: PRYSBI2
calculates crop yield. Food and bio-energy crops are explicitly considered.



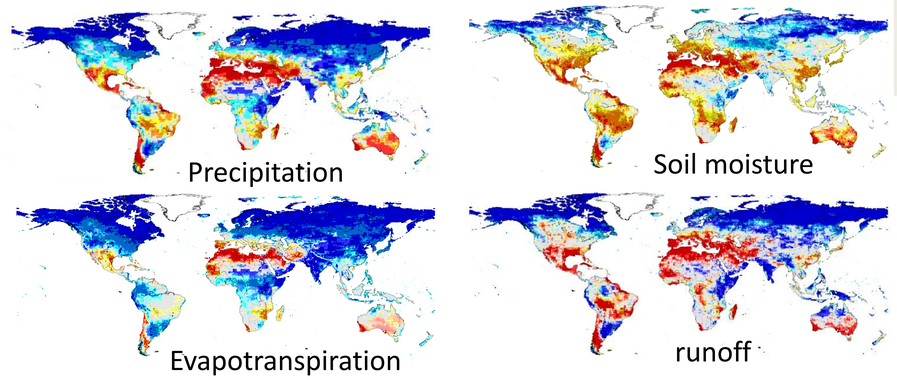


CWatM (IIASA)
Breck et al. 2019

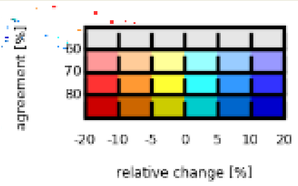
H08 (NIES)
Hanasaki et al. 2018



6: The impact on climate change on hydrological cycle

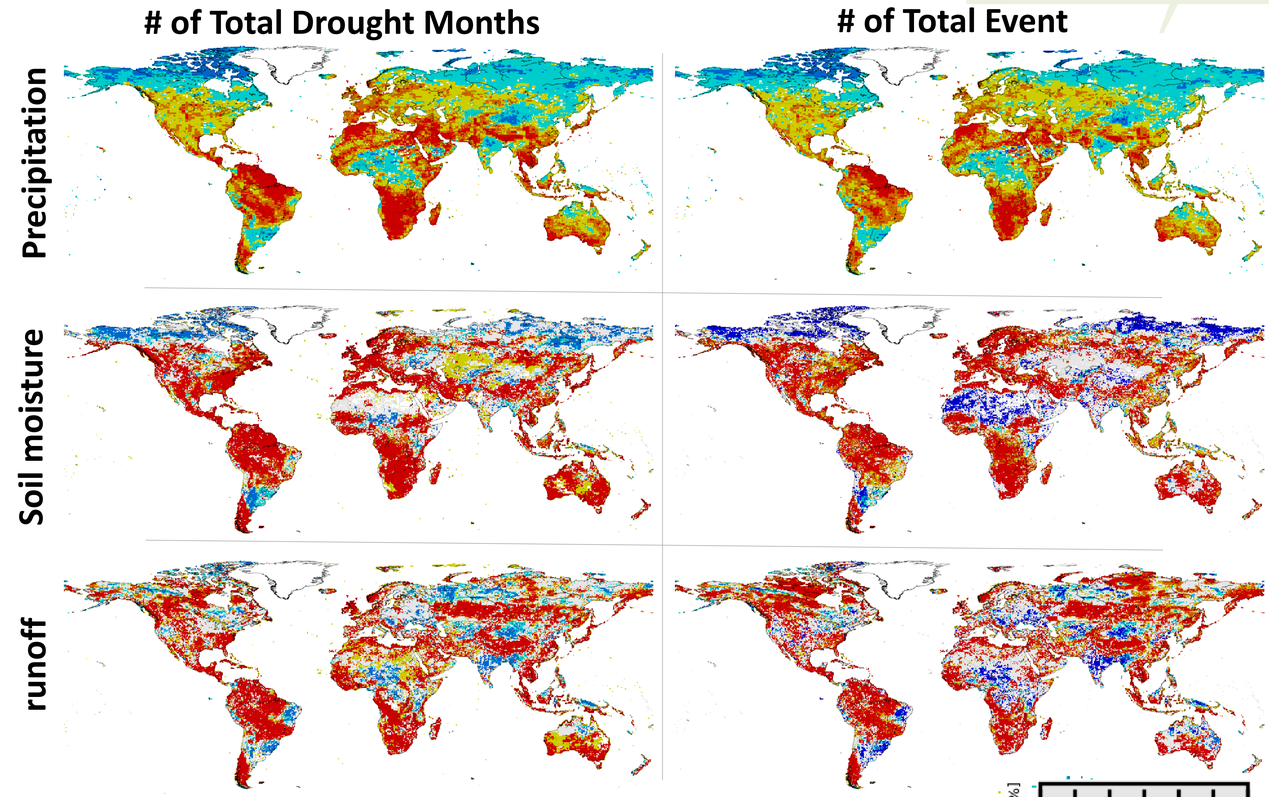


(Example)
***RCP6.0* (2071-2099) v.s. base-period (1861-1960)**



Ex)
Standardized index:
Gamma, scale 3,
Severe drought

7: Percent changes in drought proxies of three drought types



8: Summary and Future works

Results demonstrate that the sign of the change (decrease/increase) can differ among drought types in some regions. These inconsistencies and relations need to be sorted out to better understand future drought. Satoh et al. (in prep) further comprehensively assesses future changes in multi-type droughts with more scenarios, GHMs, and drought metrics at the seasonal scale as well.

■ Yokohata, T. et al. MIROC-INTEG1 : A global bio-geochemical land surface model with human water management , crop growth , and land-use change. 1–57 (2019).
■ Burek, P. et al. Development of the Community Water Model (CWatM v1.04) A high-resolution hydrological model for global and regional assessment of integrated water resources management. Geosci. Model Dev. Discuss. 08, 1–49 (2019).
■ Hanasaki, N., Yoshikawa, S., Pokhrel, Y. & Kanae, S. A global hydrological simulation to specify the sources of water used by humans. Hydrol. Earth Syst. Sci. 22, 789–817 (2018).

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