Two Decades of Global Water Cycle Variability

Non-Stationarity assessed by land data assimilation

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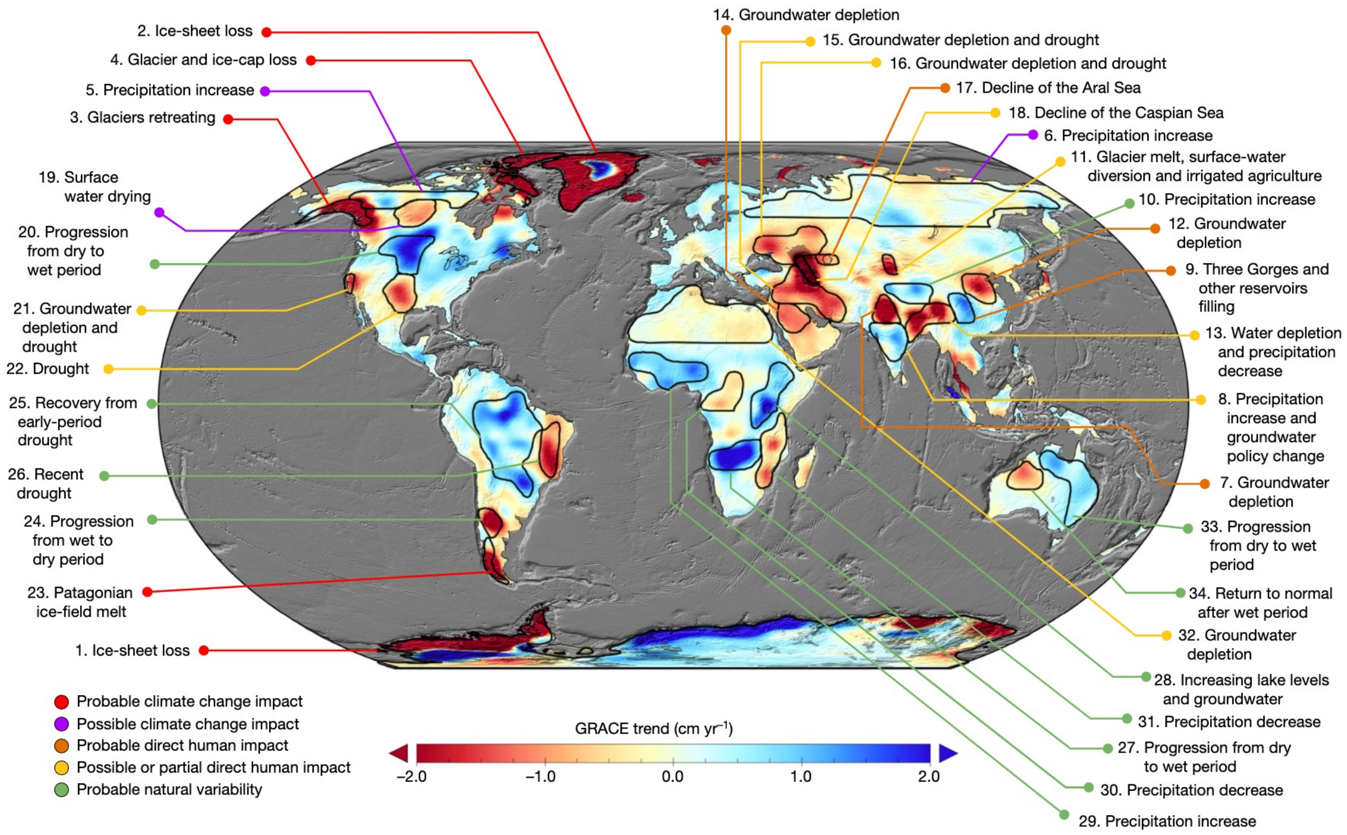
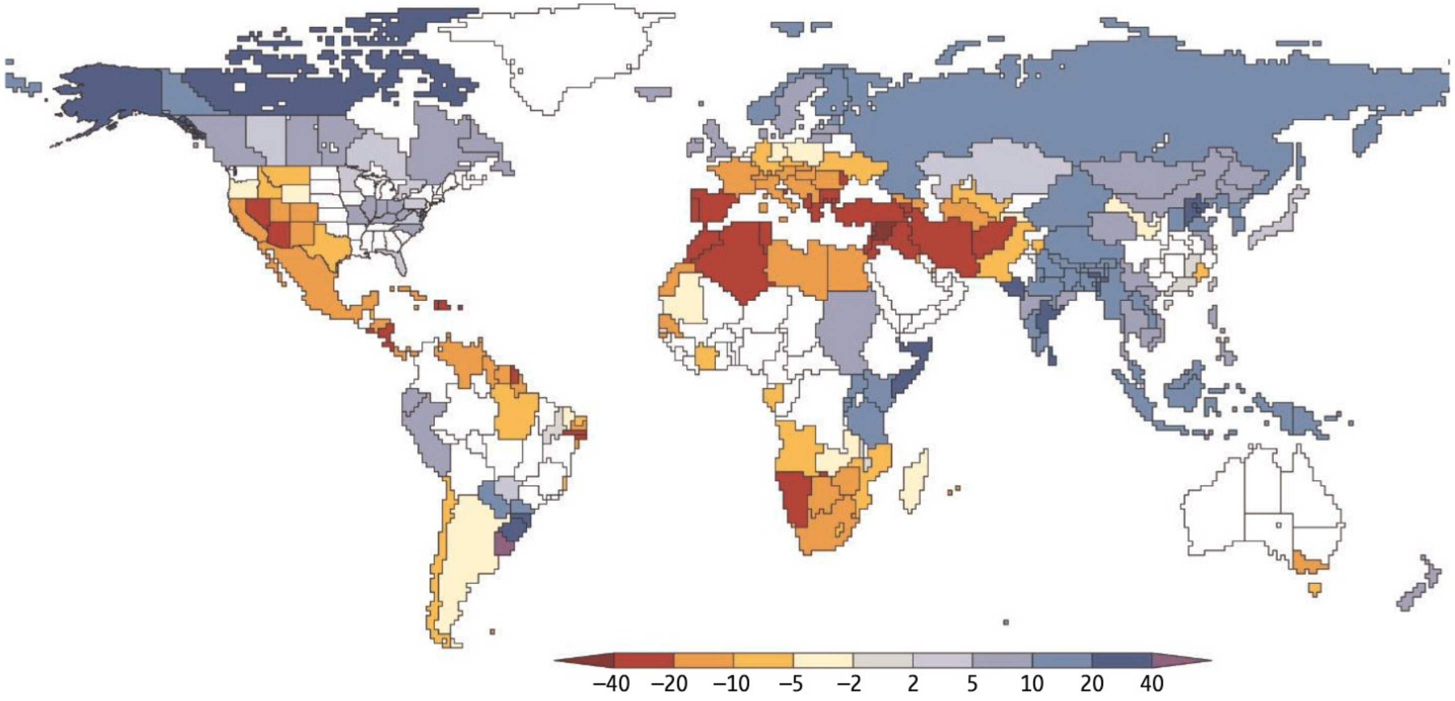
- Global land water storage is trending in response to human activities and natural variation.



Trends in land water storage for 2002-2016.

(Rodell et al., 2018; Nature)

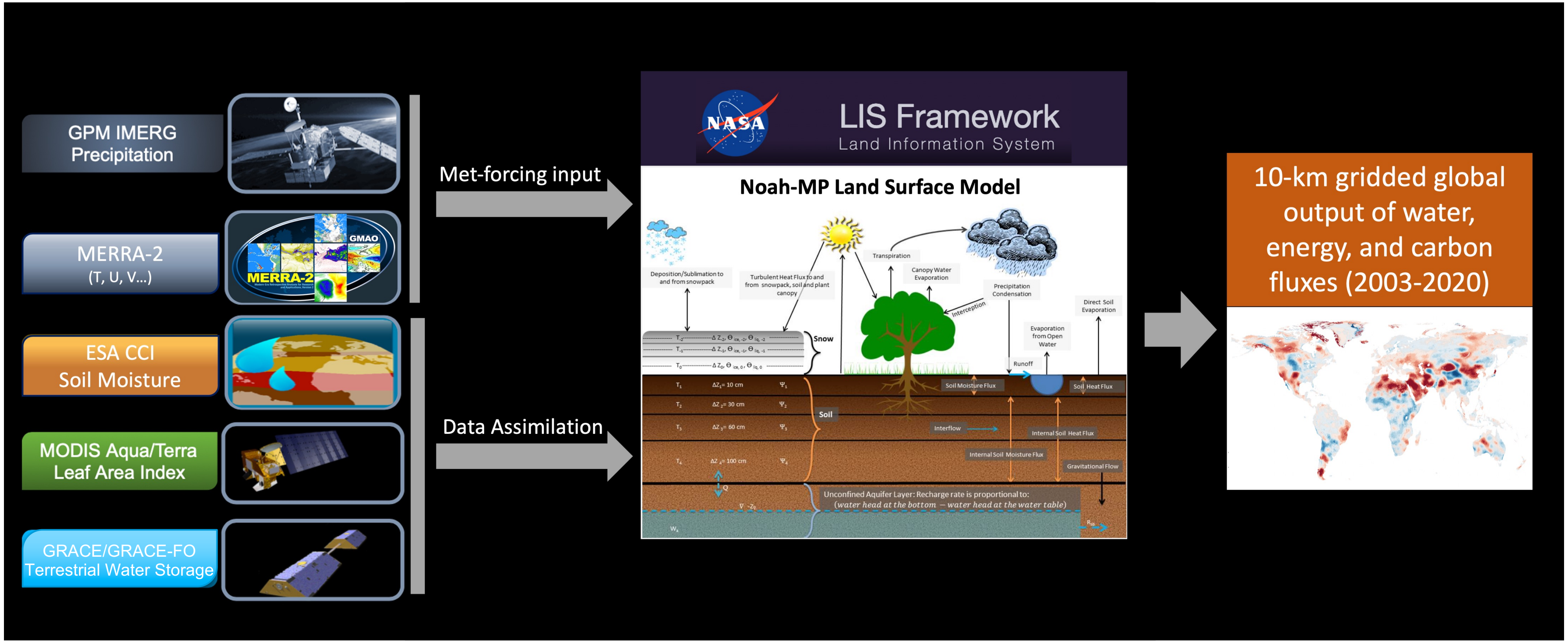
- Stationarity is dead due to anthropogenic change of Earth's climate, and we need to optimize the water systems based on non-stationary assumptions.



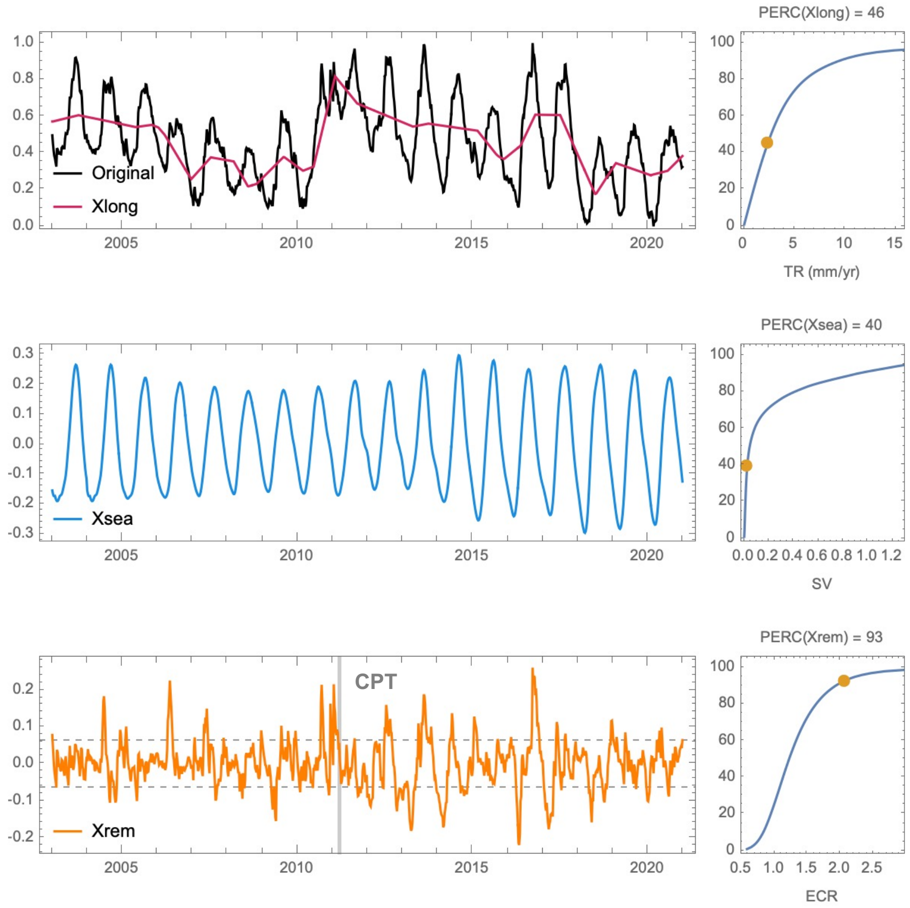
Projected changes in runoff volume by the middle of 21st century.

(Milly et al. 2008; Science)

- We integrate model and remote sensing observations to produce a 10-km global output of water, energy, and carbon fluxes.



- We developed an integrated non-stationarity index to quantify the global distribution of water storage changes.



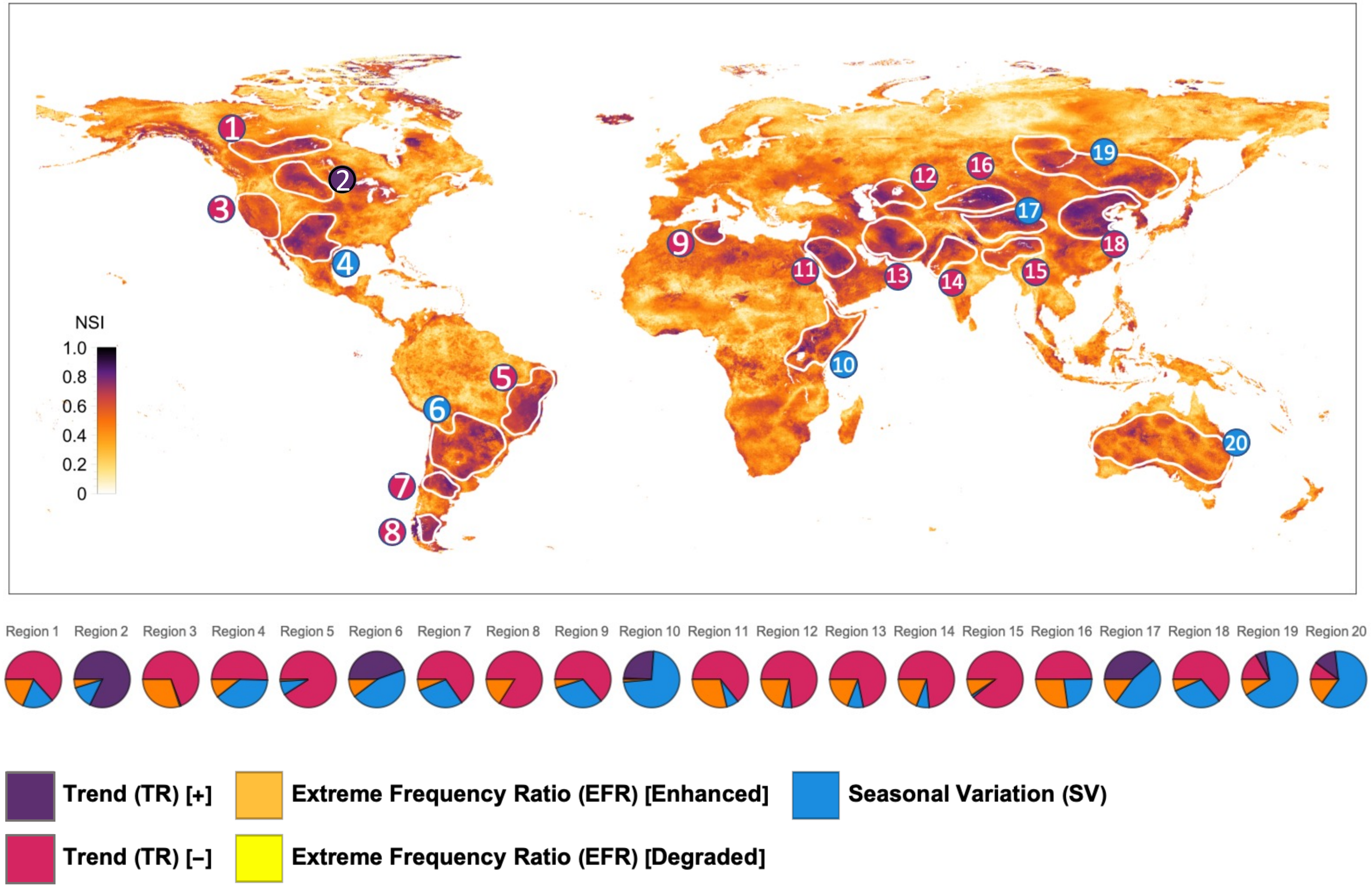
$$Non - Stationarity\ Index$$

$$\sim f\,(trend\ (X_{long}),$$

$$seasonal\ variation\ (X_{sea}),$$

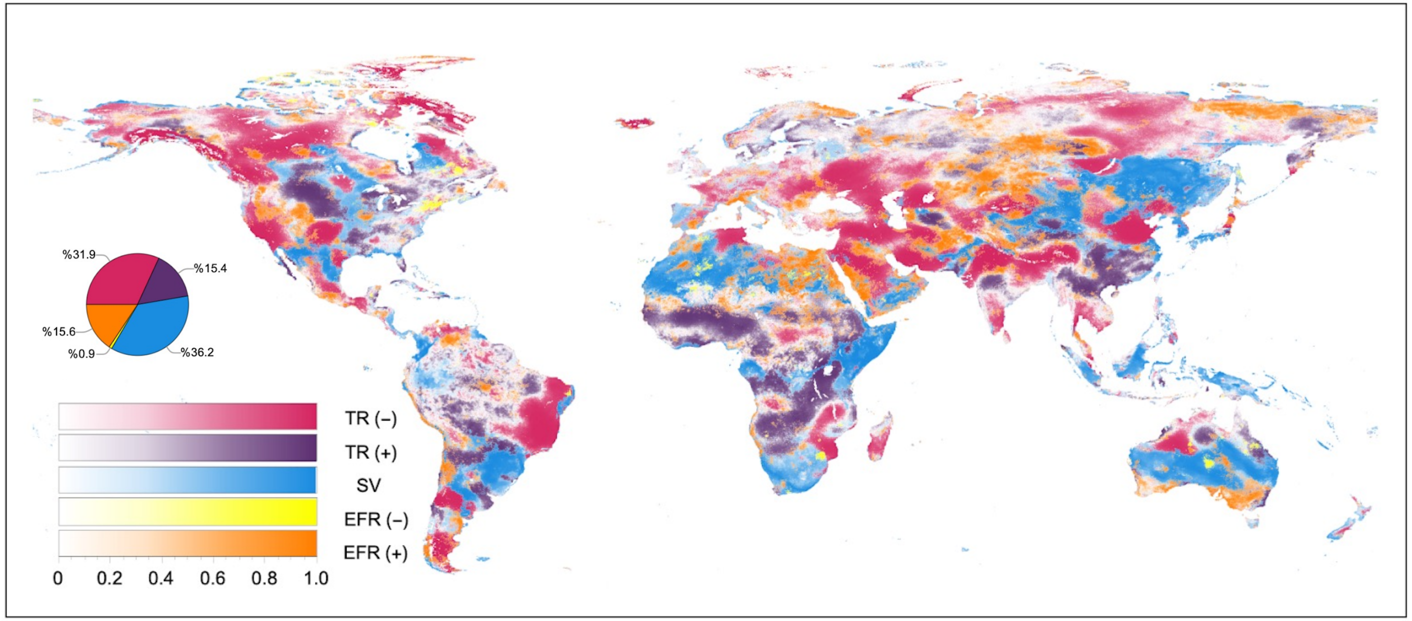
$$extreme\ frequency\ ratio\ (X_{rem})$$

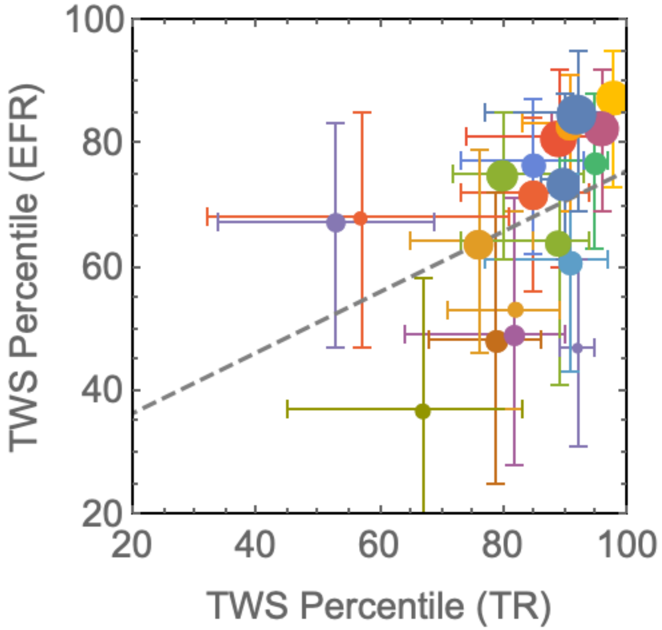
- Land water storage non-stationarity index (NSI)



- 15 out of 20 regions have non-stationary water cycle changes dominated by trend component, with 14 of them showing a depletion.
- 5 regions have non-stationarity dominated by seasonal shifting.
- Half of the regions have more than 10% area dominated by extreme frequency ratio, indicating different level of extreme increases with significant abrupt changes.

Land water storage non-stationarity relative importance map





- 47% of the land are dominated by trend, 36% are dominated by seasonal shift, and 17% dominated by extreme frequency ratio.
- For the 20 hotspot regions, we see a close relationship between TR and EFR, indicating that regions with greater long-term trend are also likely to have abrupt changes with increased extreme frequencies.

TAKE AWAY INFO

- Integrating land surface models and remote sensing constraints are valuable to reveal the non-stationary changes in global water storage.
- Nearly half of the world is dominated by trend (47%), followed by seasonal shifts (36%), and extreme changes (17%).
- Hotspot regions with intensive human disturbance show greater trends, collocating with increased extreme frequency, which together intensify the non-stationary changes in water cycles.

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