CLOSING THE COMBINED WATER AND ENERGY BALANCE OF GLOBAL WATERSHEDS BASED ON SATELLITE DATA

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Background

- Closing the water and energy balance of watersheds from observations: A longstanding scientific challenge in Hydrolgy.
- Ground-based measurements have so far proved to be inadequate due to issues of scaling.
- Earth Observations Satellites (EOS) are a compelling alternative.
- Drawbacks of EOS for closure studies using traditional water and energy budget equations:
  - Lack of accurate data on storage changes, ground heat flux, and runoff.
  - Large variability in sensors and retrieval algorithms.

Approach

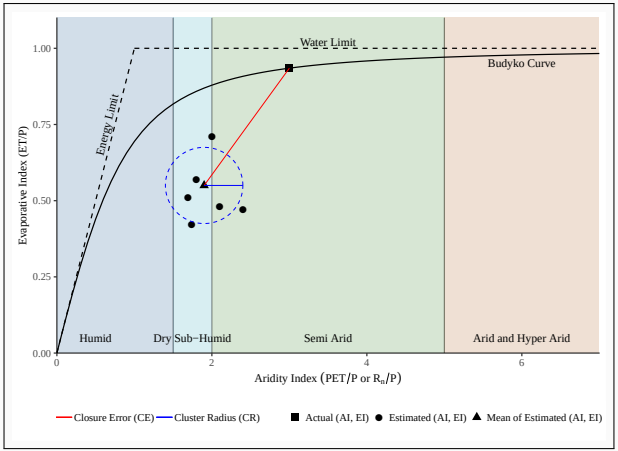

Figure 1: Budyko space showing Cluster Radius and Closure Error metrics

Budyko Hypothesis as a proxy for water-energy balance equations

- We define two metrics in the Budyko space for the appraisal of water-energy balance closure
  - Cluster Radius (CR) – Uncertainty of closure
  - Closure Error (CE) – Degree of closure

Earth Observation Datasets

We use an ensemble of precipitation (P), terrestrial evaporation (ET) and net radiation (R_n) datasets to calculate CR and CE

P Datasets	ET Datasets	R_n
CHIRPSv2.0	AVHRR.NTSG	
CMORPHv0.x.RAW	SSEBOpv4.0	
PERSIANN	MOD16A3	
PERSIANN.CCS	GLEAMv3.3a	CERESv4.0
PERSIANN.CDR	GLEAMv3.3b	
TRMM.3B42RT	CSIRO-PMLv2.0	
TRMM.3B43	BESS	
	FluxCom.RS	

Study Area

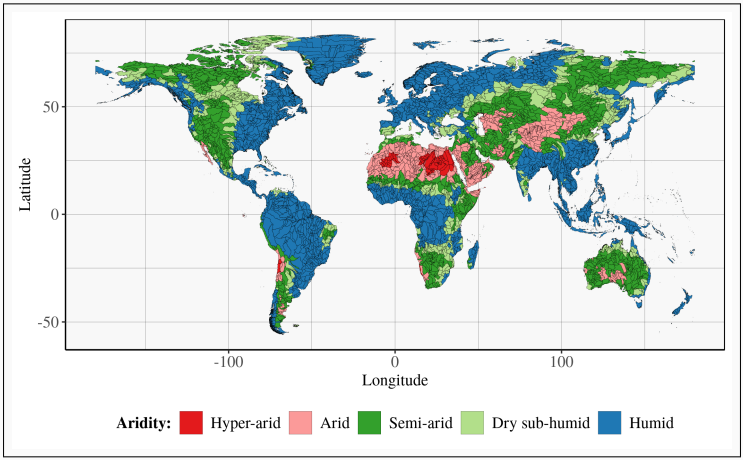

Figure 2: Study Area consisting of 4734 watersheds based on HydroBASINS (Pfafstetter level 5) and classified according to according to aridity

Results - Cluster Radius and Closure Error

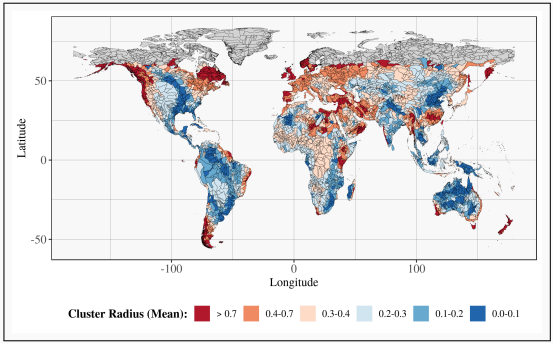

Figure 3: Global patterns of CR. Higher CR implies higher uncertainty water and energy balance closure

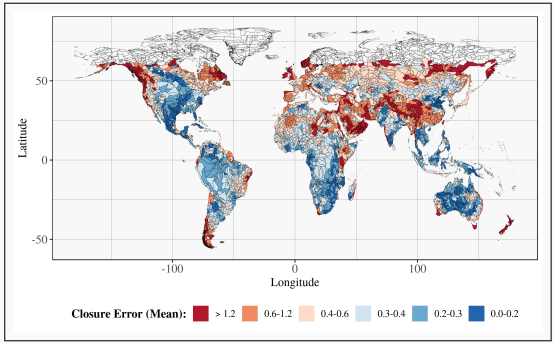

Figure 4: Global patterns of CE. Higher CE implies higher disagreement between the datasets and the Budyko hypothesis

Results - Cluster Radius and Cluster Error

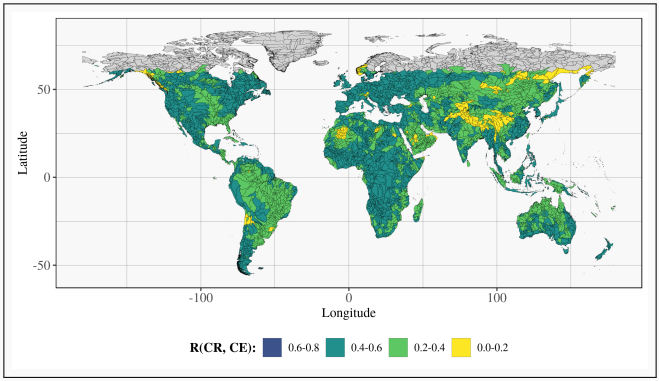

Figure 5: Ratio of CR / (CR+CE). Lower values of the ratio implies P and ET datasets agree with each other but all of them fail to close the water-energy balance. Higher values of the ratio implies high uncertainty among datasets but few datasets close the water-energy balance very well

Results - Best P and ET datasets

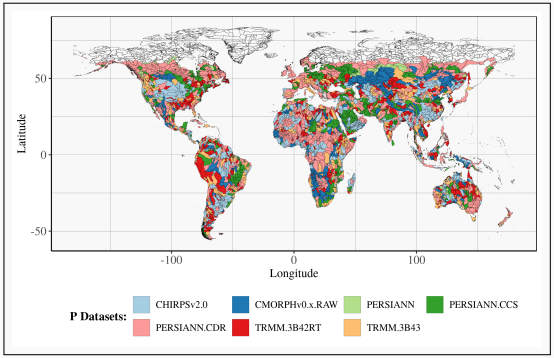

Figure 6: Global patterns of the best precipitation dataset for closure studies

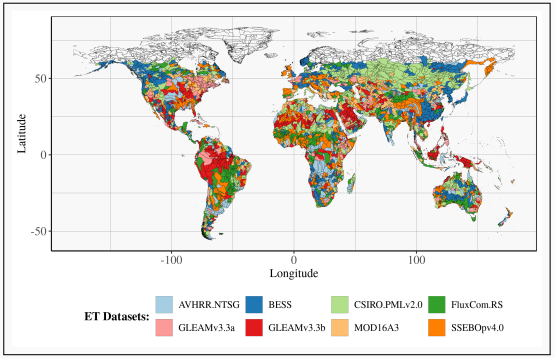

Figure 7: Global patterns of the best evaporation dataset for closure studies

Conclusions

- We quantified the potential of EOS in closing the water and energy balance of global watersheds using a novel framework
- Uncertainty (CR) and degree (CE) of closure are highly variable in space
- High uncertainty primarily due to uncertainty in ET datasets
- P and ET datasets need to be improved in mountainous watershed

Thank You