Leading Satellite-based Evapotranspiration Products Insufficiently Capture Interannual Variability: Evidence from GRACE/FO and In-Situ Observations

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Introduction

- Remote-sensing based year-to-year ET variations (IAV) inform drought monitoring, ecosystem water-use assessment, and land–atmosphere interaction studies

- The accuracy of RS-based ET IAV remains largely untested

- GRACE/FO provides an independent benchmark to assess ET IAV via the water-balance approach

GRACE/FO v.s. OpenET and GLEAM ET

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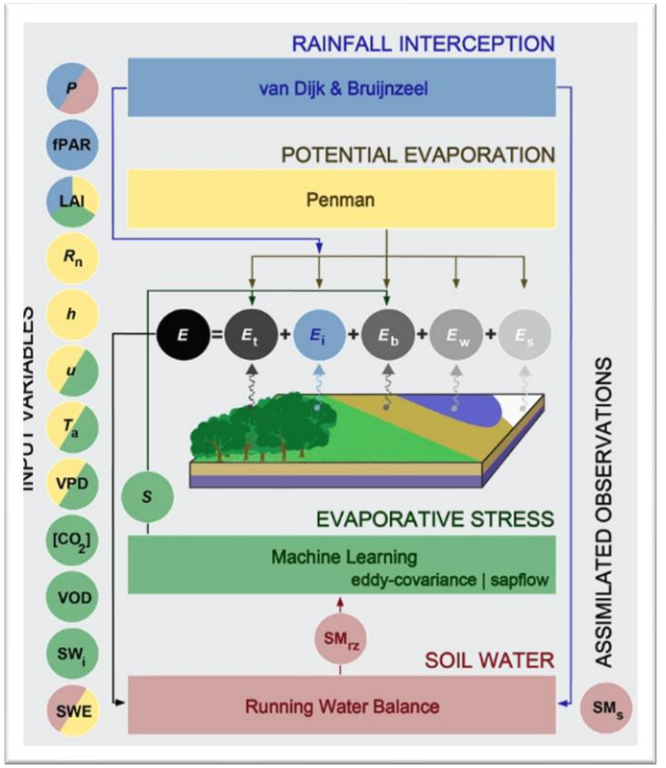
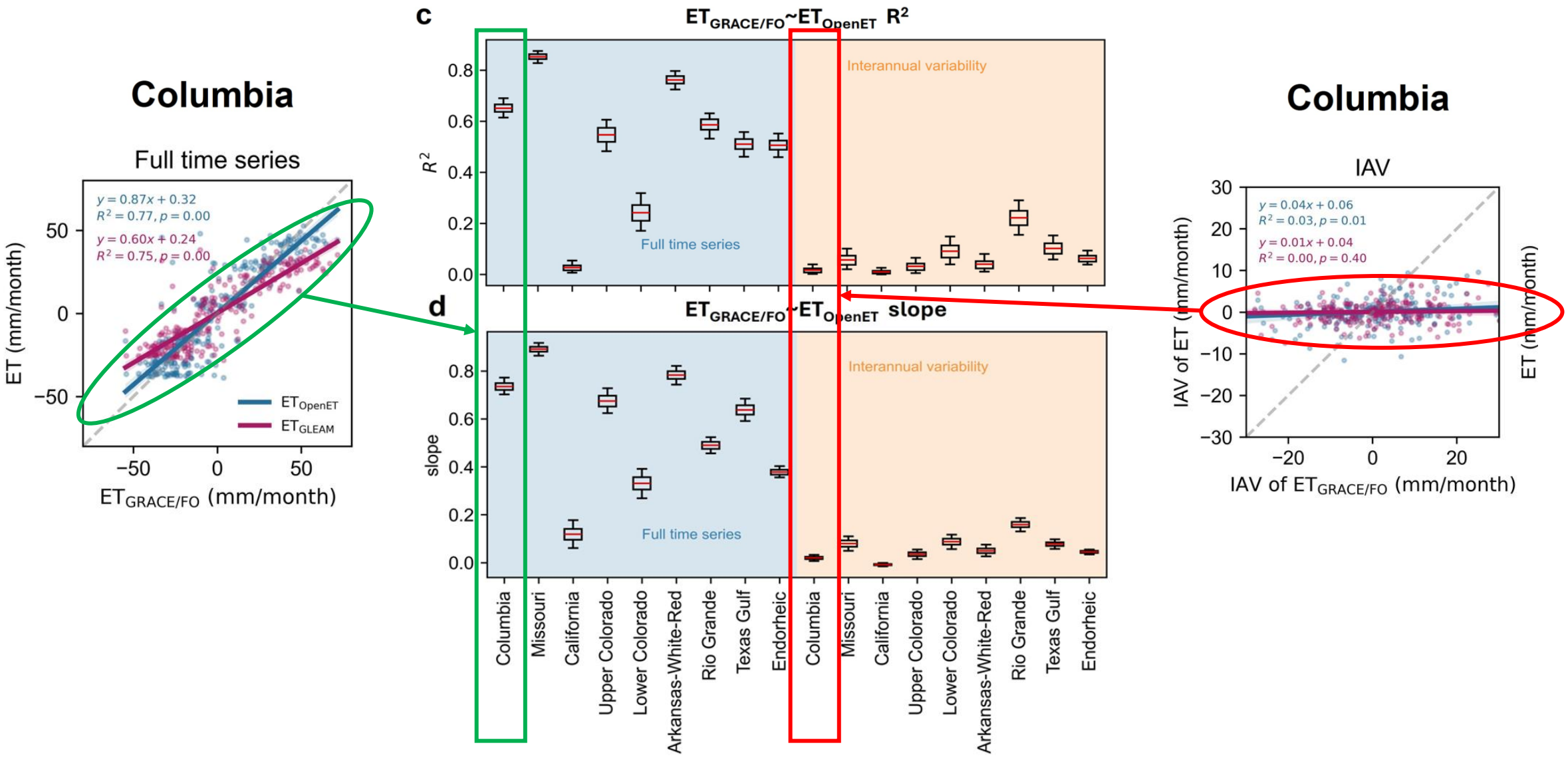
$$ET_{\mathrm{GRACE}} = P - \frac{\mathrm{d}TWS}{\mathrm{d}t} - Q$$

v.s.

GLEAM ET



Remote-sensing products underestimate ET IAV



Consistent Patterns at Basin and Site Scales

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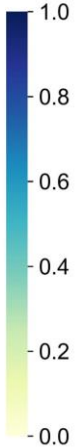
Basin scale

River basin	$ET_{GRACE/FO}$~ET_{OpenET}				$ET_{GRACE/FO}$~ET_{GLEAM}			
	R^2		slope		R^2		slope	
	Full	IAV	Full	IAV	Full	IAV	Full	IAV
Columbia	0.77	0.03	0.87	0.04	0.75	0.00*	0.60	0.01*
Missouri	0.92	0.11	0.96	0.17	0.93	0.19	0.66	0.22
California	0.04	0.02*	0.20	-0.02*	0.19	0.01*	0.28	0.02*
Upper Colorado	0.76	0.07	0.94	0.09	0.71	0.12	0.56	0.18
Lower Colorado	0.49	0.25	0.67	0.25	0.56	0.33	0.51	0.36
Arkansas-White-Red	0.88	0.09	0.91	0.12	0.90	0.17	0.57	0.18
Rio Grande	0.73	0.42	0.61	0.30	0.89	0.69	0.57	0.51
Texas Gulf	0.67	0.19	0.84	0.15	0.79	0.42	0.49	0.26
Endorheic	0.58	0.08	0.44	0.06	0.54	0.08	0.36	0.09

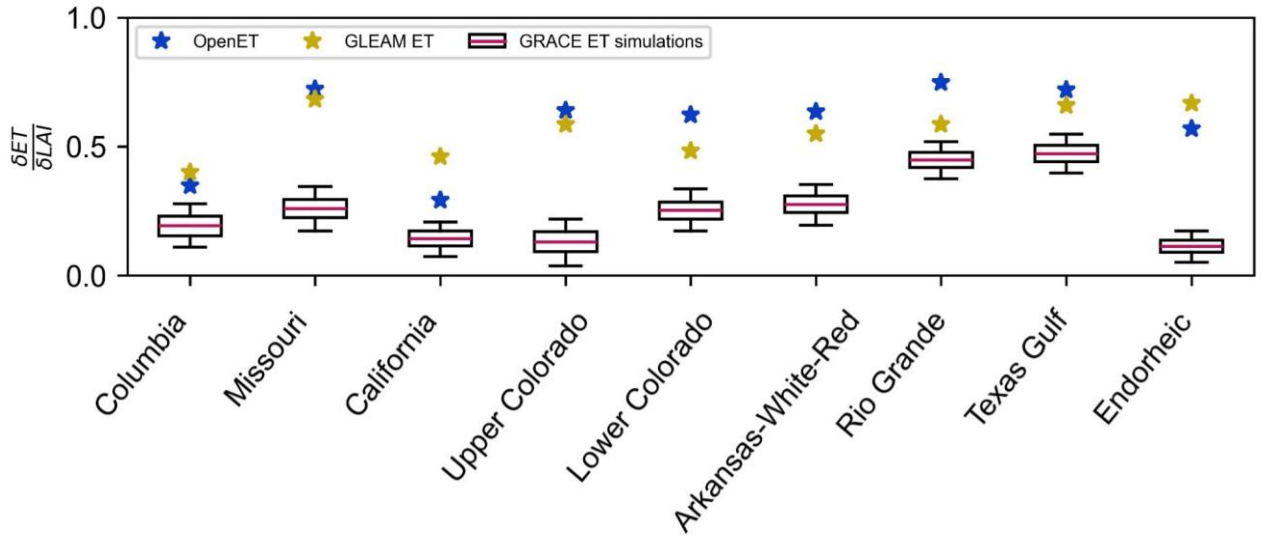
Site scale

Land cover	AmeriFlux site	$ET_{AmeriFlux}$~ET_{OpenET}				$ET_{AmeriFlux}$~ET_{GLEAM}			
		R^2		Slope		R^2		Slope	
		Full	IAV	Full	IAV	Full	IAV	Full	IAV
Croplands	US-Ne1	0.92	0.30	0.91	0.58	0.71	0.18	0.40	0.20
	US-Ne2	0.92	0.43	0.93	0.75	0.66	0.14	0.41	0.17
	US-Ne3	0.92	0.10	0.97	0.36	0.65	0.08	0.46	0.18
Evergreen Forests	US-NR1	0.73	0.00*	1.36	0.14*	0.90	0.17	0.69	0.23
	US-GLE	0.68	0.03*	1.47	0.22*	0.64	0.02*	0.51	0.07*
	US-Me2	0.70	0.01*	1.12	0.09*	0.78	0.15	0.57	0.27
Mixed Forests	US-MMS	0.90	0.14	1.01	0.49	0.80	0.20	0.52	0.26
Grasslands	US-Var	0.52	0.40	0.76	0.95	0.48	0.09	0.58	0.26
Wetland/Riparian	US-CMW	0.84	0.12	0.87	0.38	0.23	0.13	0.14	0.25



Takeaways

- OpenET and GLEAM underestimate IAV by more than 60% on average
- GRACE/FO integrates total water storage, while OpenET and GLEAM focus on aboveground fluxes
- Misrepresentation of ET IAV can affect ecosystem–climate studies and many more



Thank you!

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