

Developing a Consistent Methodology for Estimating Consumptive Use from Evapotranspiration in the Upper Colorado River Basin for the United States Bureau of Reclamation

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Needs Introduction

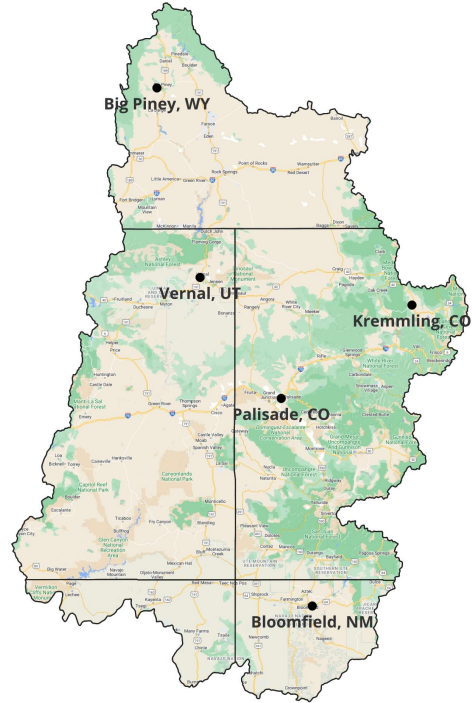
WWAO conducted a Colorado River Basin Needs Assessment and has identified Consumptive Use for Calculating Water Budgets as a Use Case, which seeks to determine consumptive use for reporting and long-term planning purposes.

Partner: The United States Bureau of Reclamation (USBR) is mandated to perform the accounting of consumptive use and loss for the Colorado River Basin.

Currently, each state in the basin relies on what is reported by water-rights users, in order to verify these reports, unbiased estimates of consumptive use are needed. Water-rights planning in the Colorado River Basin is done at the state and federal levels. This includes planning, emergency drought requirements, and Indian Water Rights Settlements.



Map of the Upper Colorado and Lower Colorado River Basins.



Map of the Upper Colorado River Basin with flux tower locations.

1. In Situ Data:

- USBR maintains a total of 5 Flux Tower sites within UCRB. All sites situated within irrigated crop field.
- Kremmling site was added in 2020.

2. OpenET data

- DRI processed timeseries of OpenET Collection 2 corresponding to the Tower footprint. Very little difference between dynamic footprint and fixed 3x3 grid for these 5 sites.
- Compared to Collection 1, the flux tower comparison showed general improvement especially for DisALEXI and SSEBOP.

State	Station	Latitude	Elevation (m)	Meas. Start	Crop Type / Irrigation
Wyoming	Big Piney	42.54°N, 110.195°W	2130	March 2018	Foxtail Grass - Flood
Colorado	Palisade	39.094°N, 108.37°W	1417	March 2018	Peach Orchard - Ground Sprinkler
Colorado	Kremmling	40.149°N, 106.451°W		June 2020	
Utah	Vernal	40.458°N, 109.562°W	1665	2017	Alfalfa-Side Roll Sprinkler
New Mexico	Bloomfield	36.691°N, 107.914°W	1694	March 2018	Alfalfa-Center Pivot (2020-)

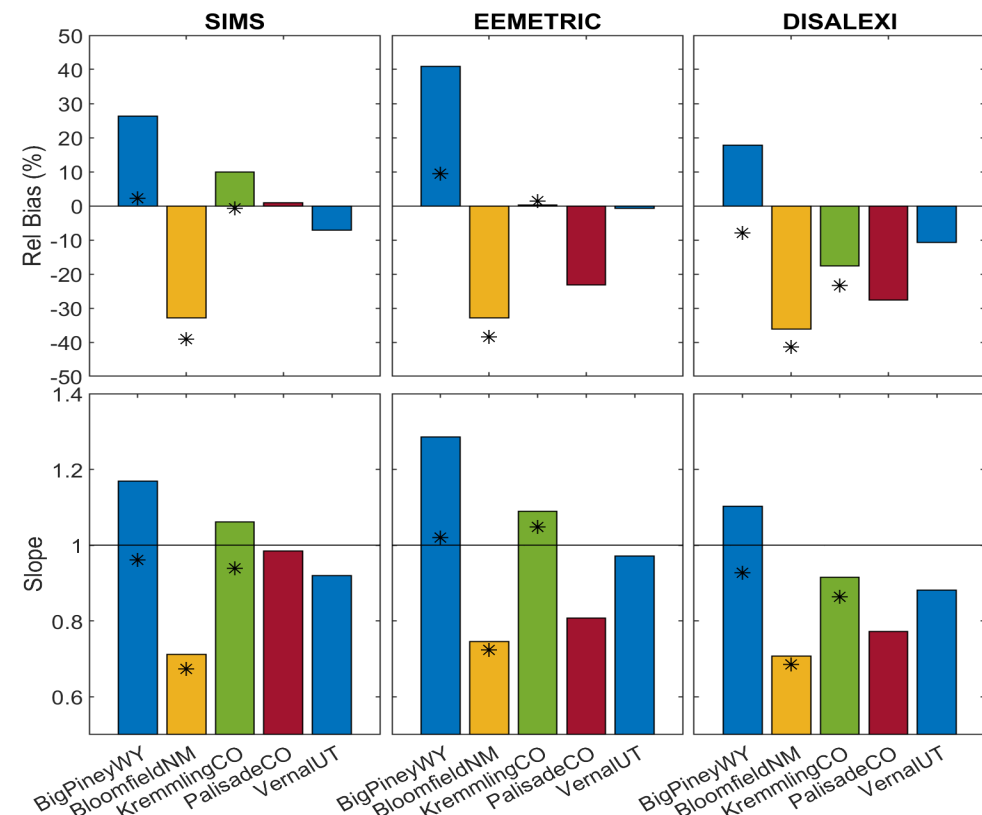
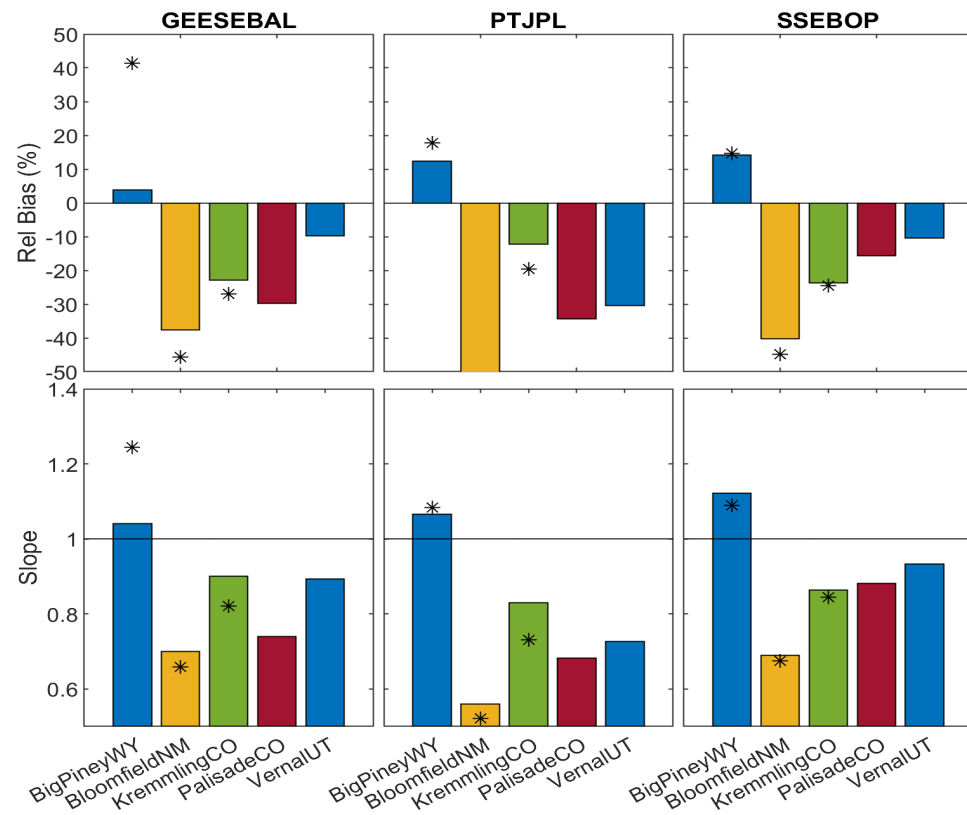
BIAS: Models - Tower data, for Irrigated sites / growing season

Notes on Flux Tower Site Characteristics

- BigPiney WY (blue). Flood Irrigation. Unclosed EC data, big year to year variation
- Bloomfield (yellow), NM. All models have less bias with uncorrected EC data.
- Kremmling. Only since mid-2020 (2.5 year). All models but SIMS and PTJPL miss June/July 2020 ET flux

Overall Takeaway for BIAS

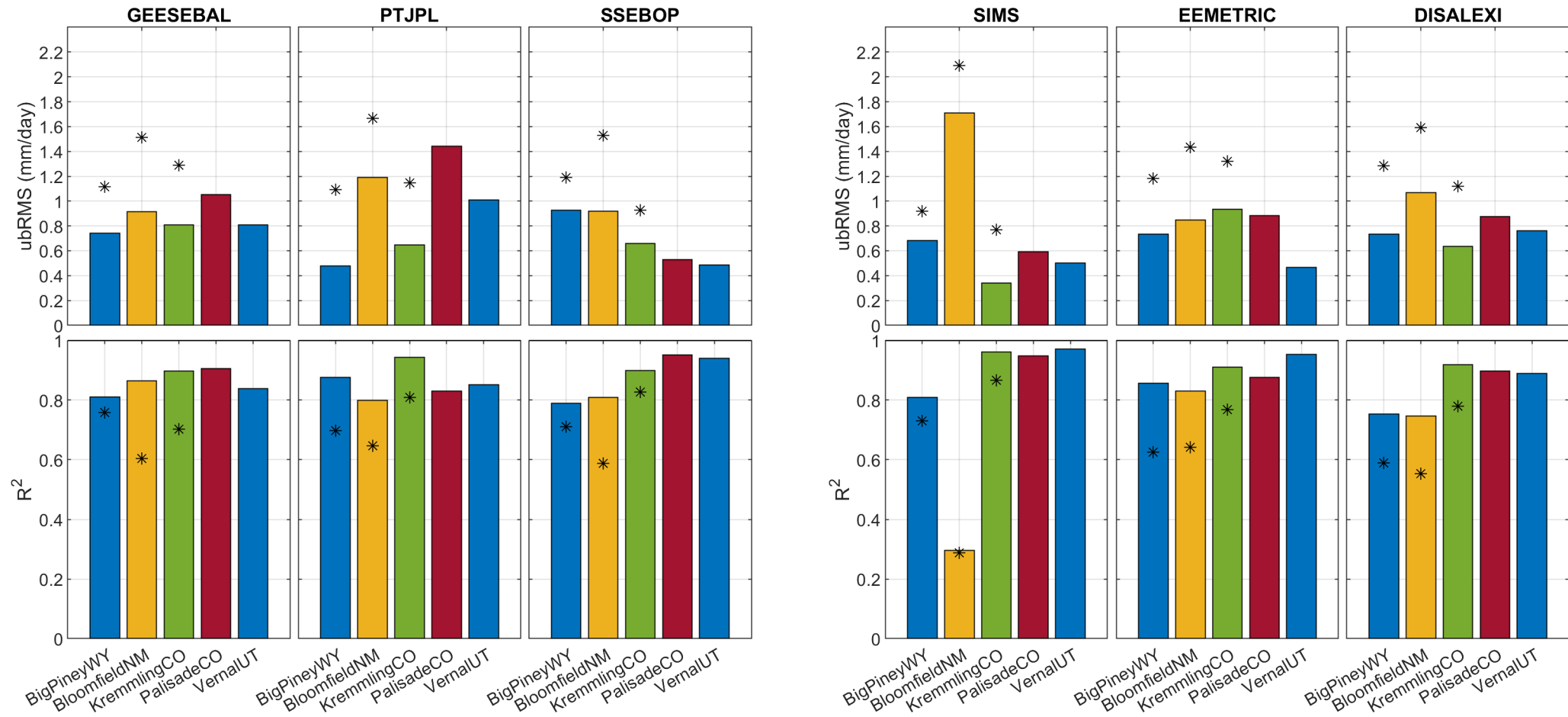
- SIMS has lowest overall bias with EC data over irrigated fields (as expected)
- EEMETRIC has next lowest bias (disregarding BigPiney, WY).
- DISALEXI, GESEBAL, PTJPL have similar bias of 10-30 % below Tower data
- Monthly Vs Daily data: Interpolated Daily values (*) compare well with Monthly data (bars) for most sites (as expected). A slightly lower slope is due to higher noise



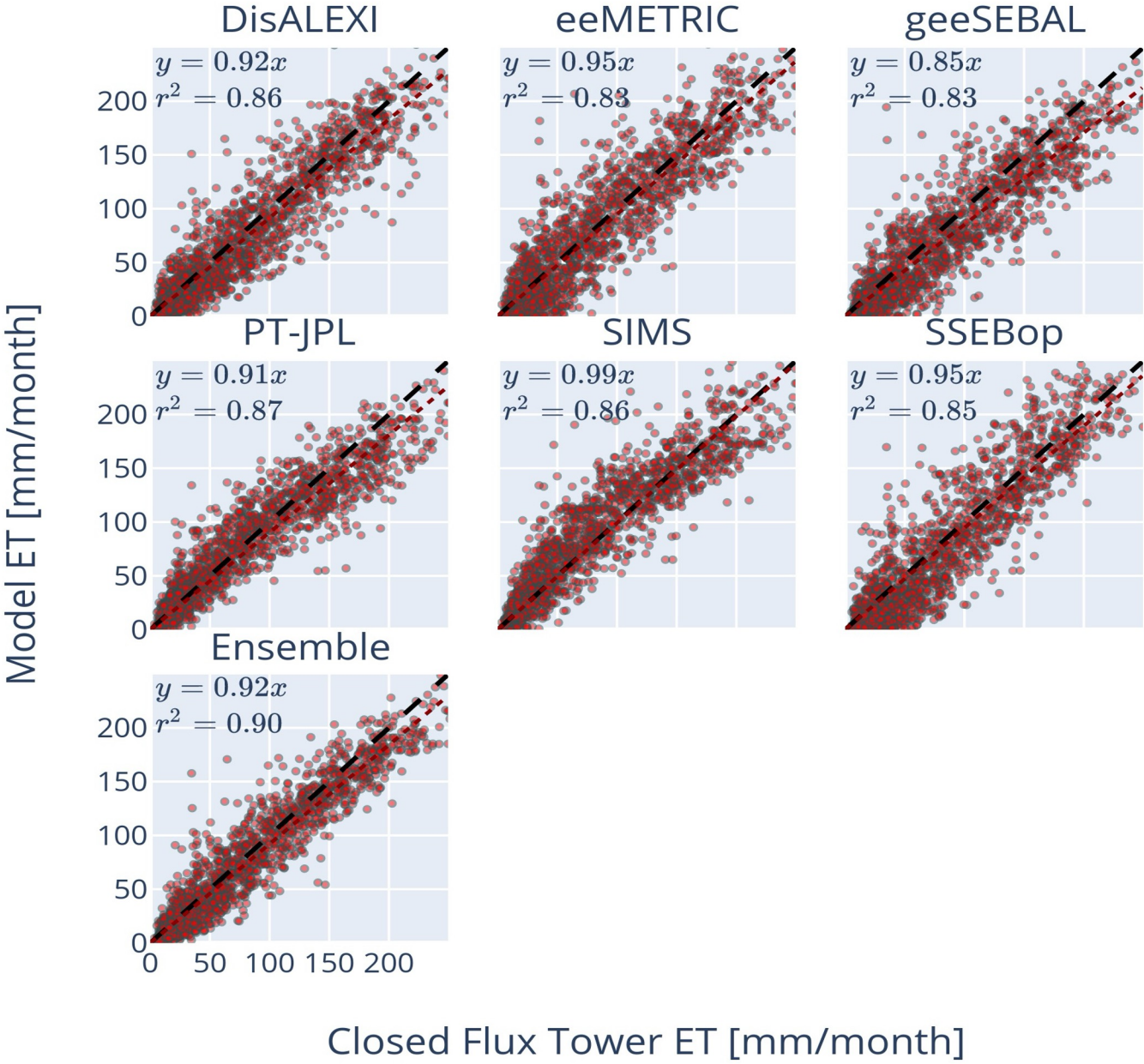
Precision: ubRMS, Correlation, for Irrigated sites / growing season

Overall Takeaway for Precision

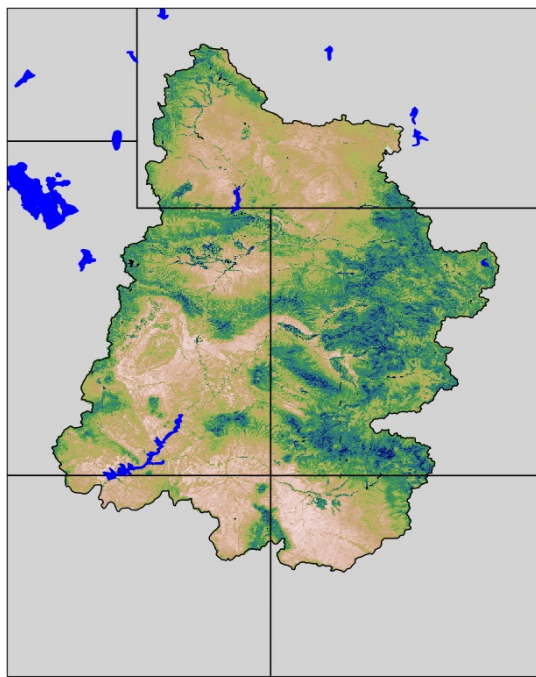
- Validation period is short for temporal correlation, especially leaving out winter season.
- SIMS has highest overall precision (even if we disregard Bloomfield/NM)
- Monthly Vs Daily data: Interpolated Daily values (*) have slightly higher uncertainty then monthly aggregates (bars) (as expected)



Accuracy at CONUS Cropland Sites



OpenET
Ensemble
Mean ET
(Apr-Oct;
2016-2023)

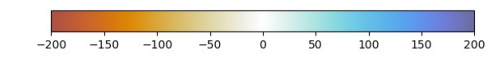
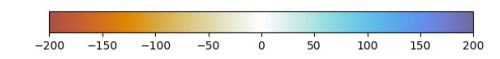
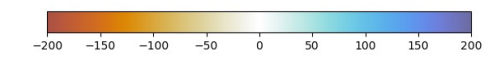
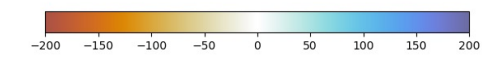
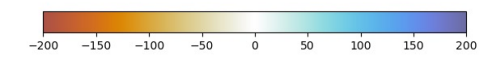
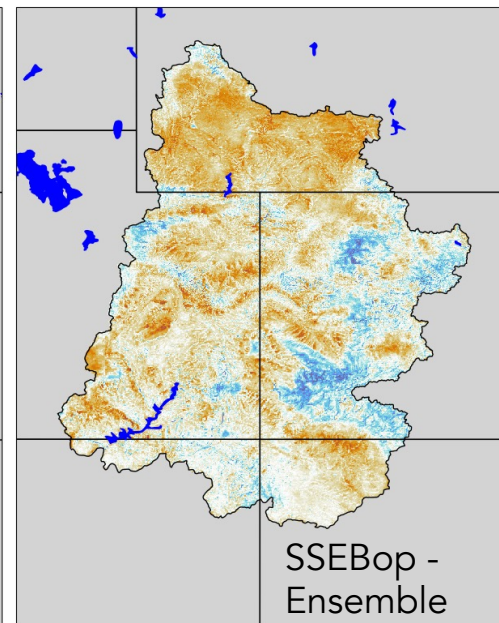
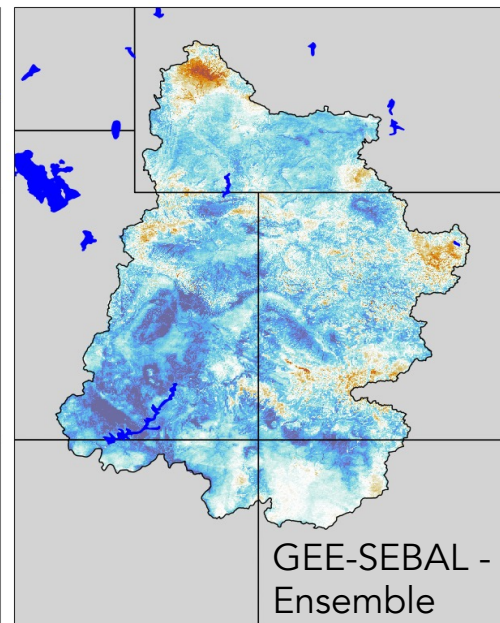
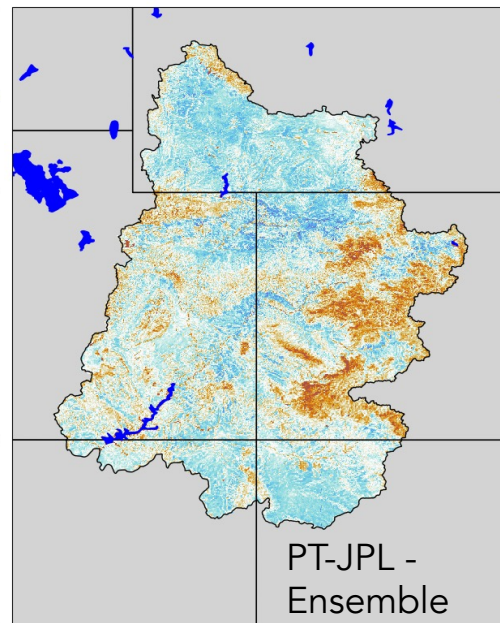
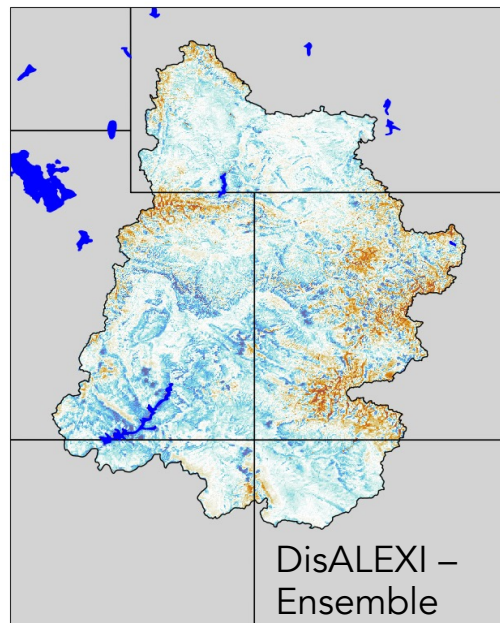
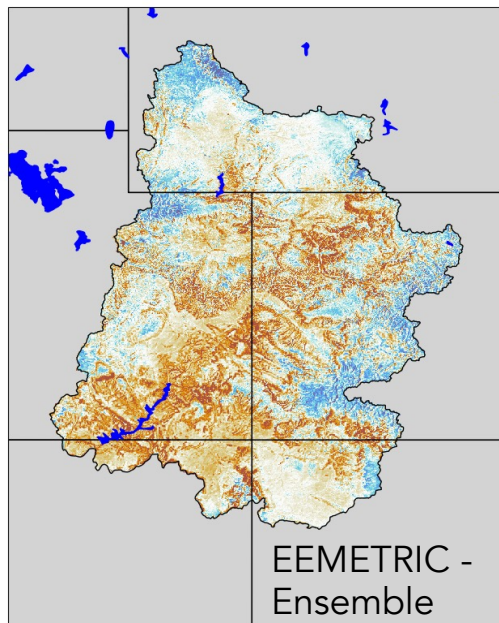


The OpenET Ensemble Mean is computed as the average of all models after flagging and removal of up to two outliers using the median absolute deviation (MAD) approach.

Model estimates that fall outside of the \pm MAD value are excluded from the ensemble mean.

Percentage of Cropland pixels excluded from Ensemble over UCRB:

EEMETRIC	DisALEXI	SSEBop	GEE-SEBAL	PT-JPL
18.2%	18.8%	17.3%	19.2%	15.8%



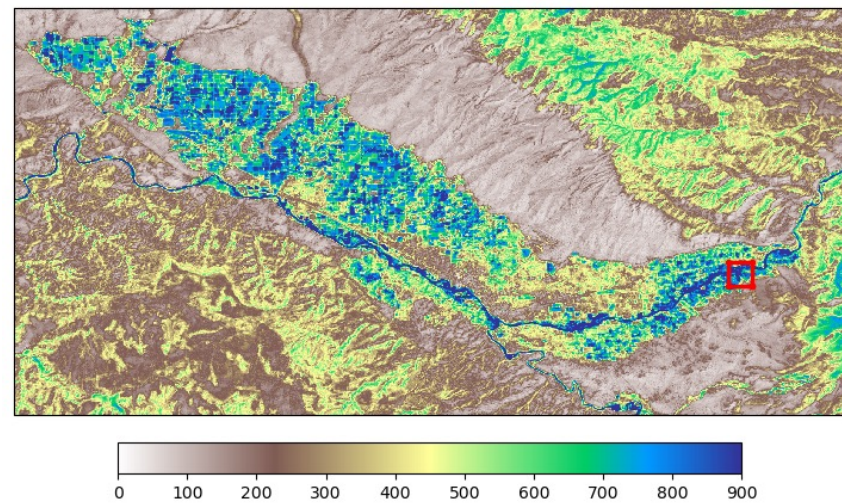
Eddy Covariance Flux Sites in the UCRB



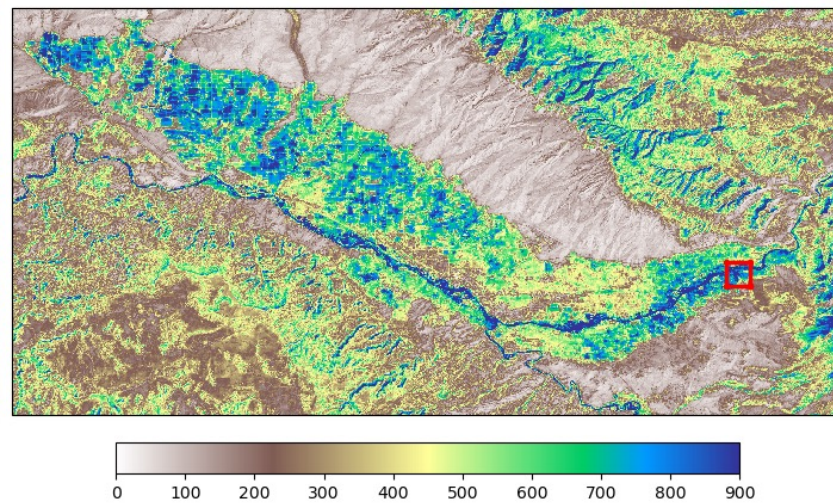
Figure 3. EC Tower Locations

State	Station	Latitude	Elevation (m)	Start of Operation	Crop Type / Irrigation
Wyoming	Big Piney	42.54°N, 110.195°W	2130	March 2018	Foxtail Grass - Flood
Colorado	Palisade	39.094°N, 108.37°W	1417	March 2018	Peach Orchard - Ground Sprinkler
Colorado	Kremmling	40.149116°N, 106.450809°W		June 2020	
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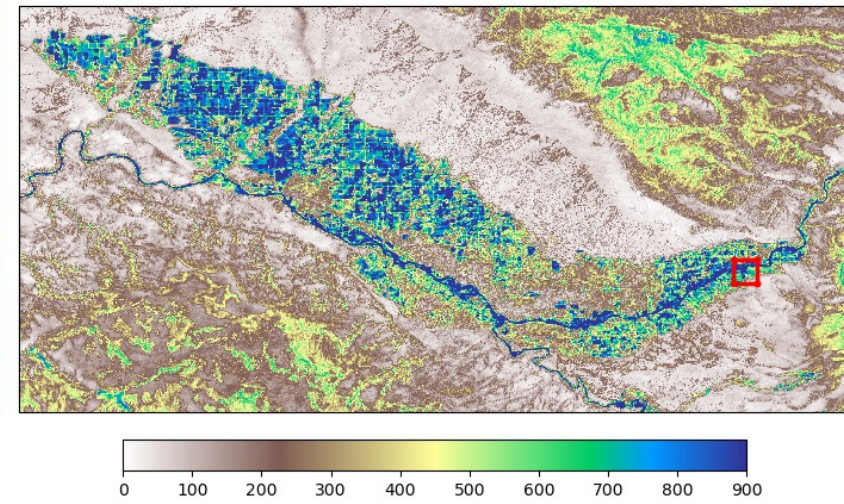
Ensemble



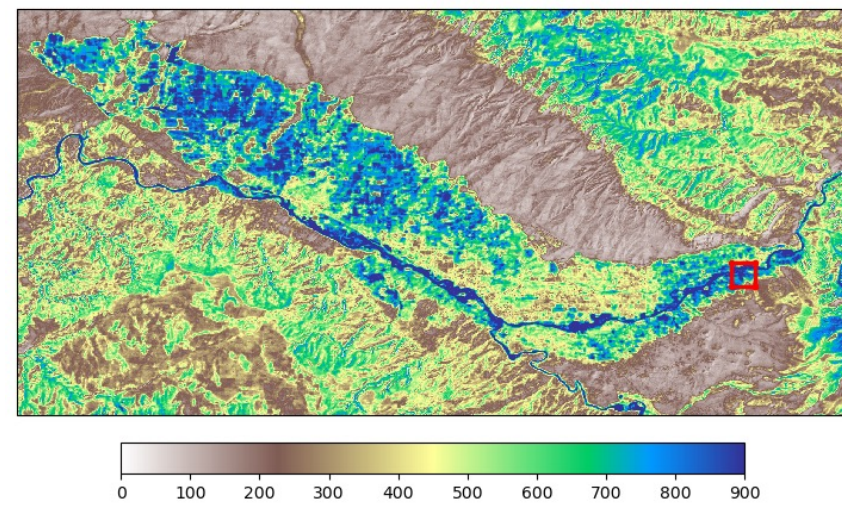
DisALEXI



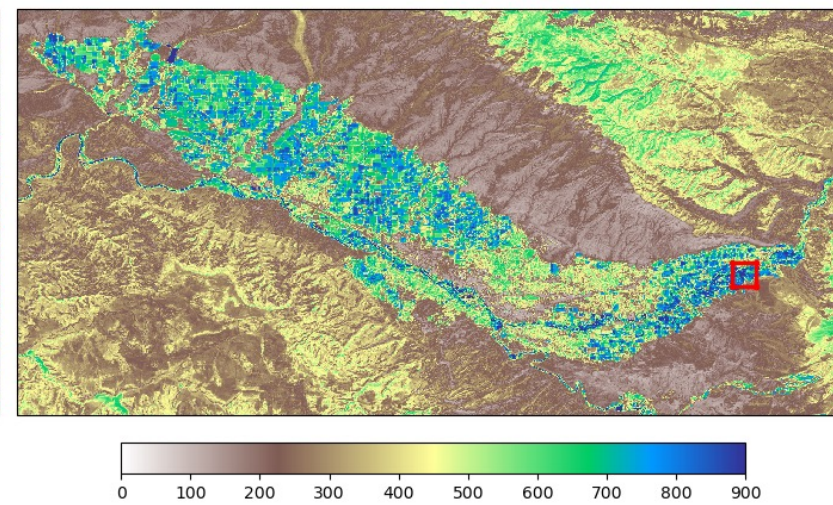
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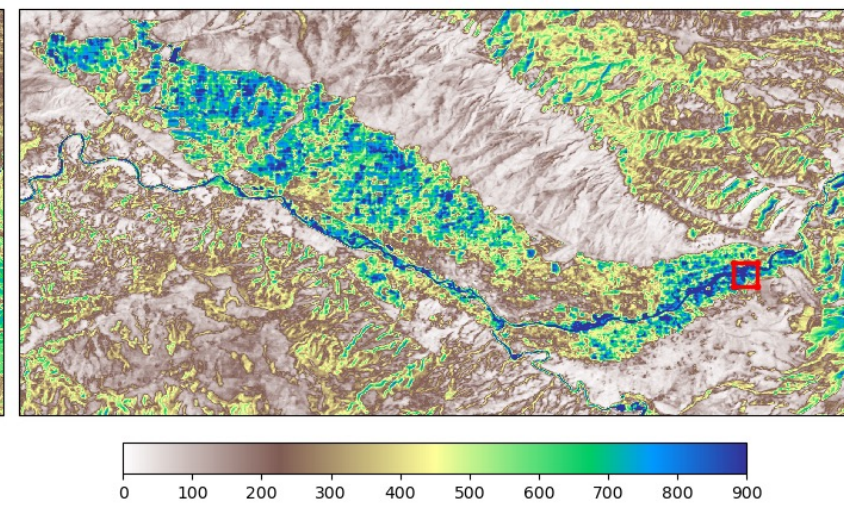
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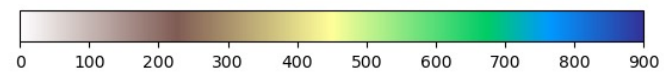
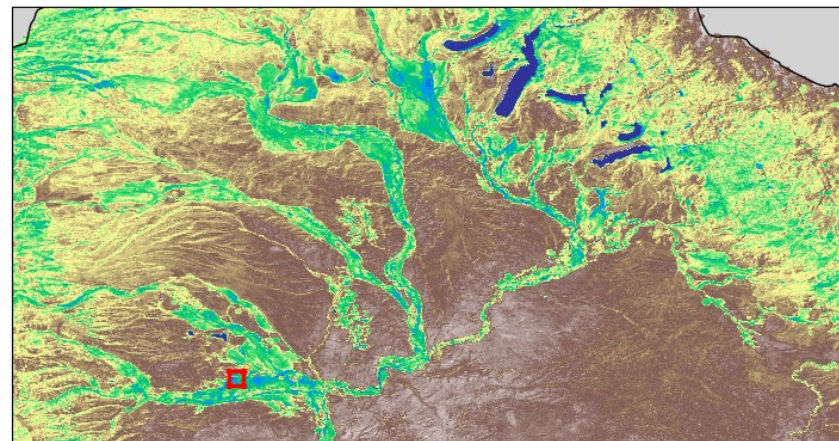
PT-JPL



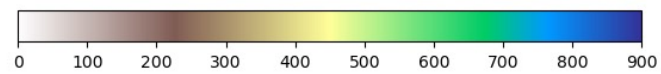
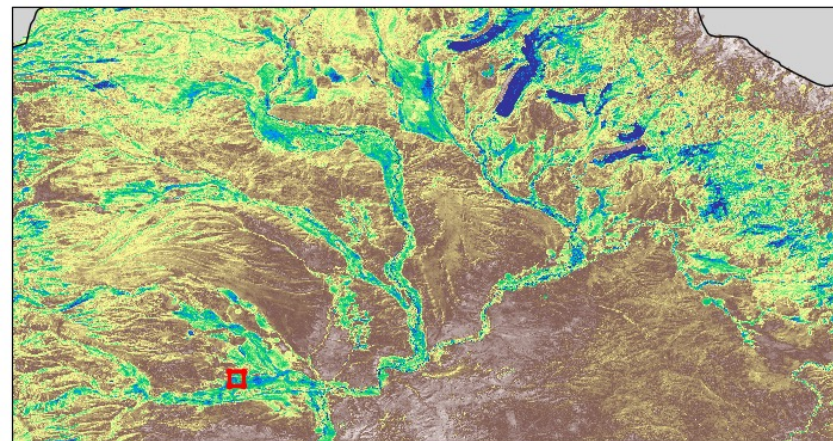
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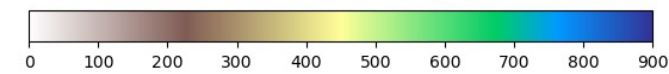
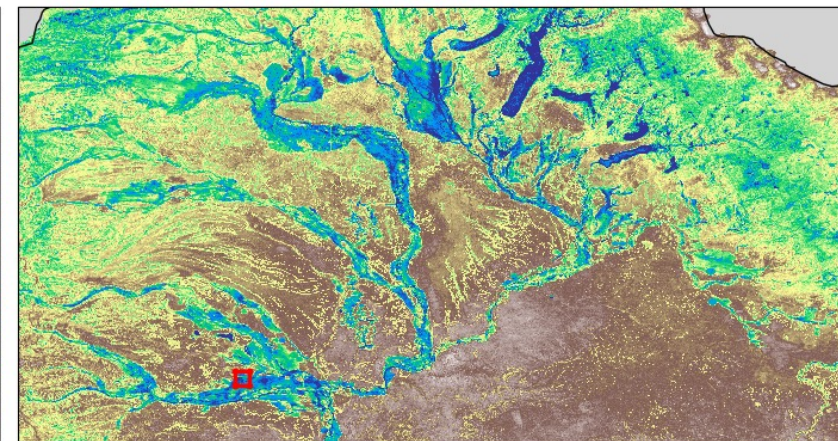
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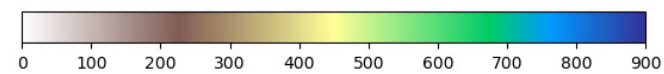
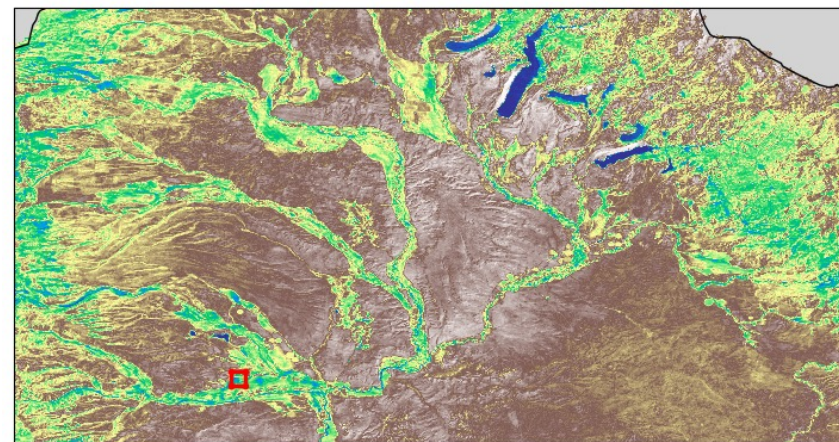
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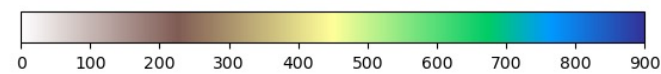
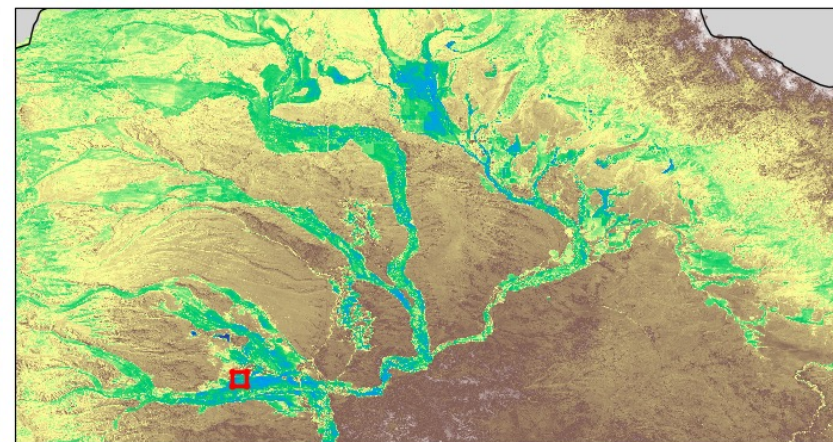
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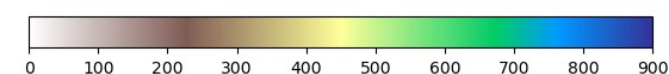
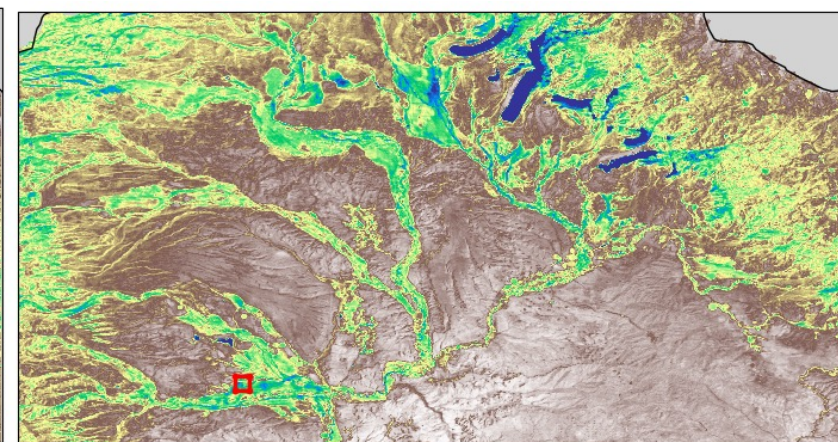
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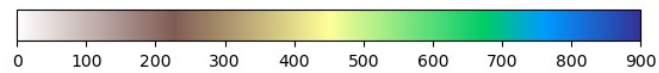
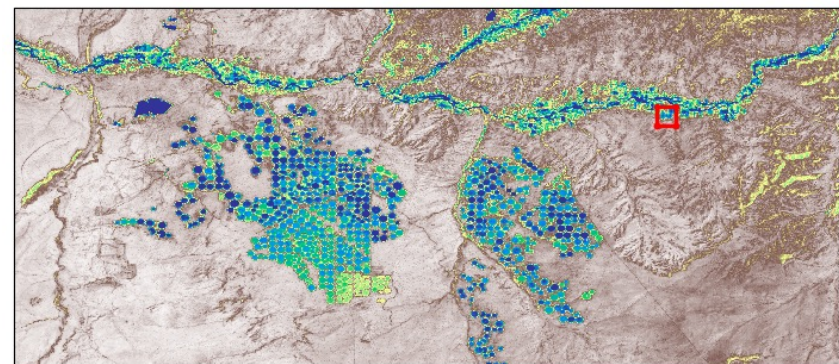
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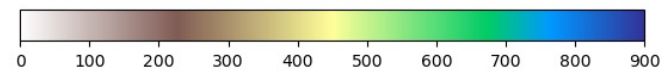
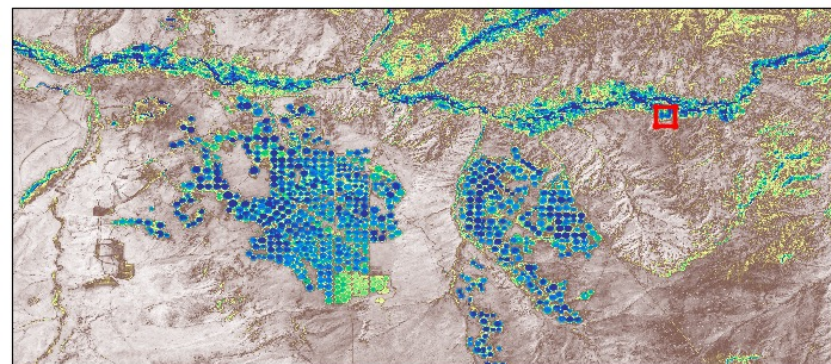
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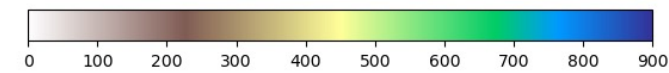
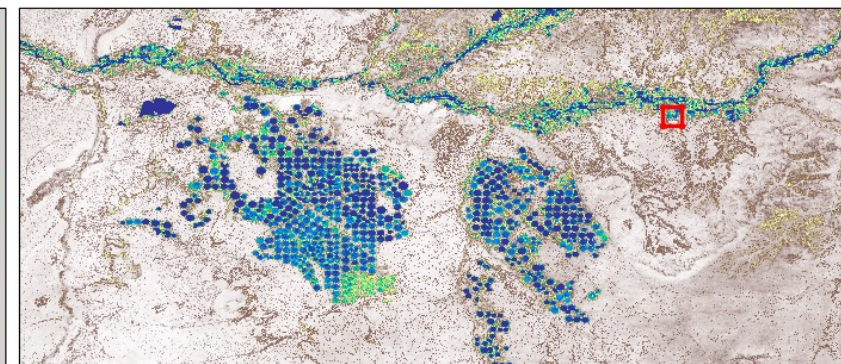
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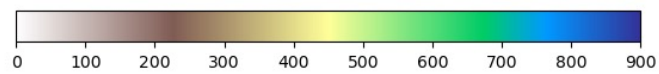
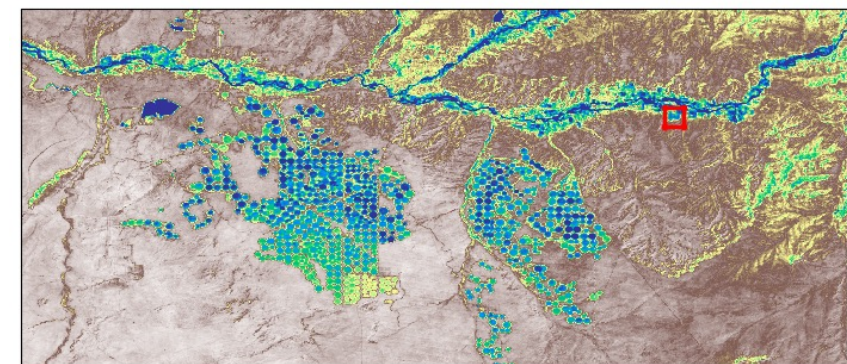
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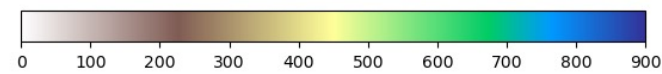
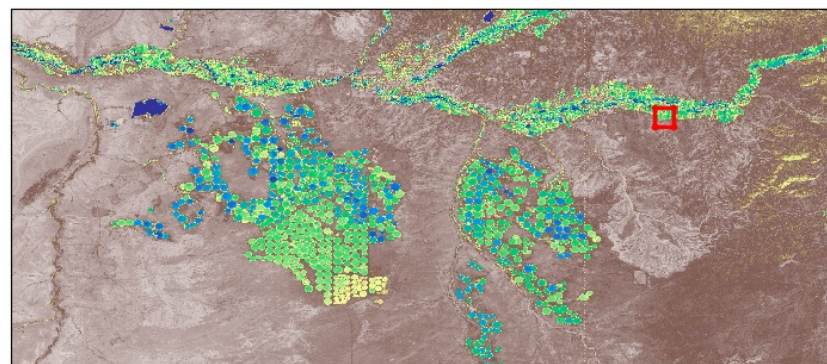
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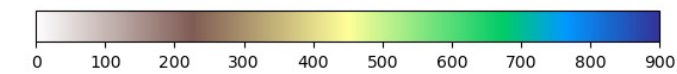
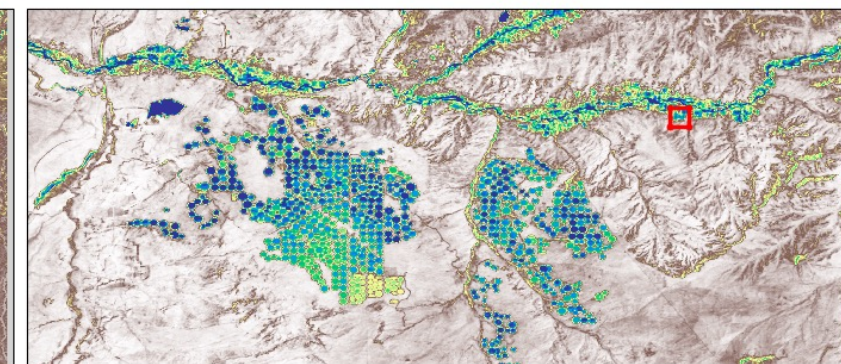
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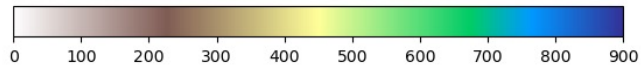
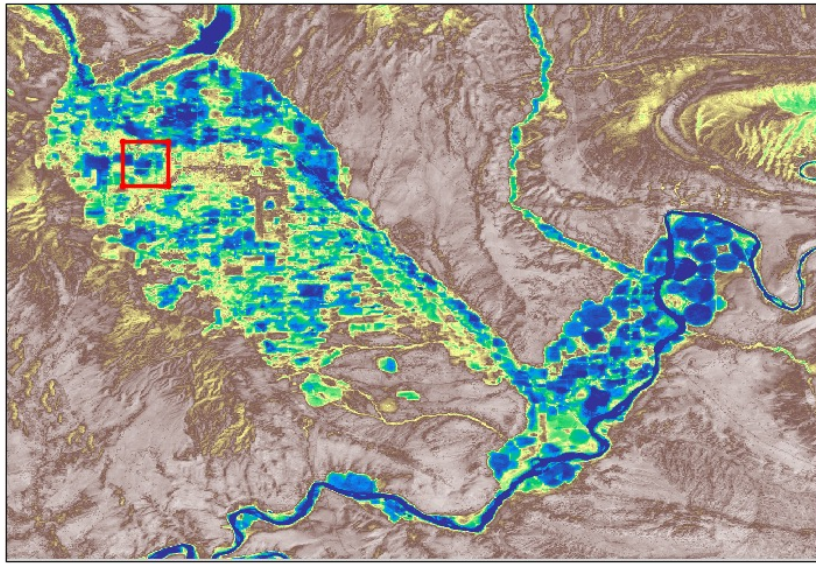
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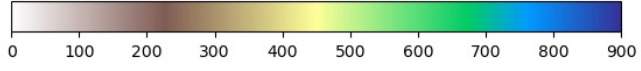
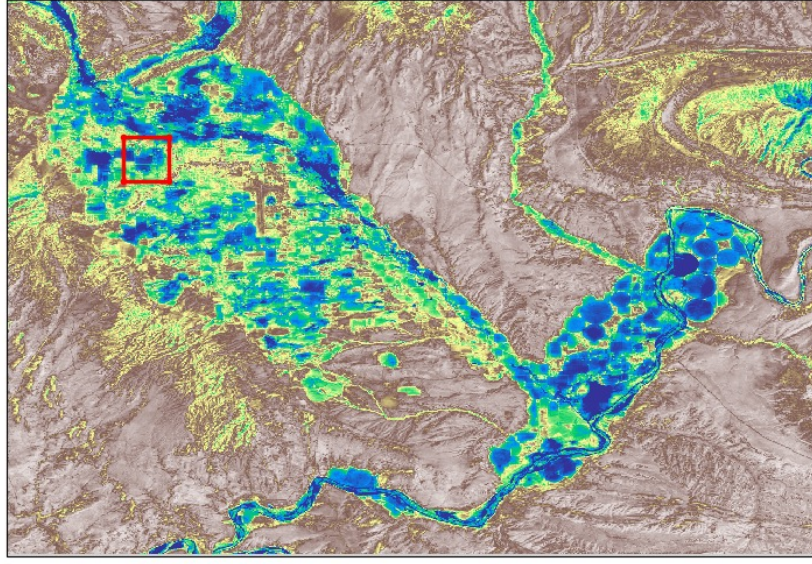
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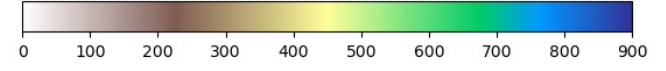
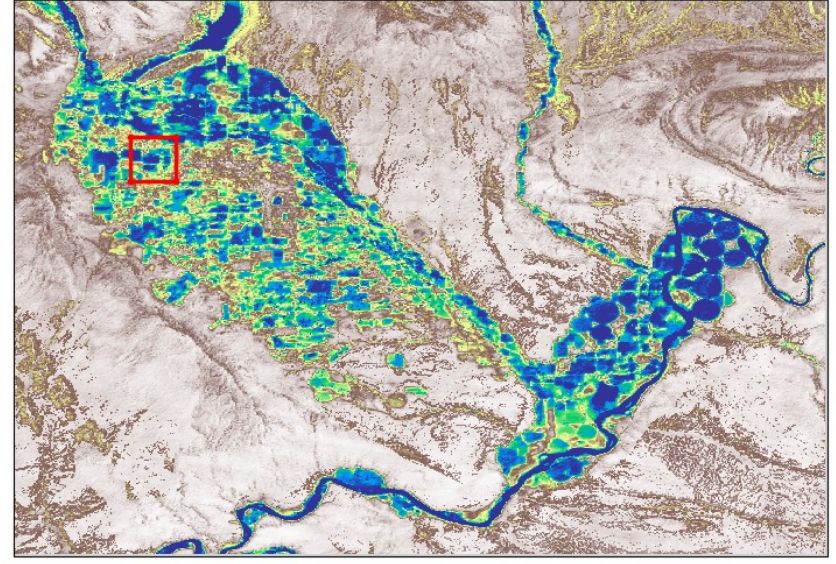
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DisALEXI

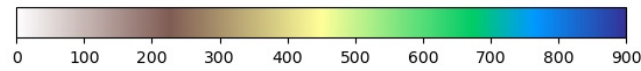
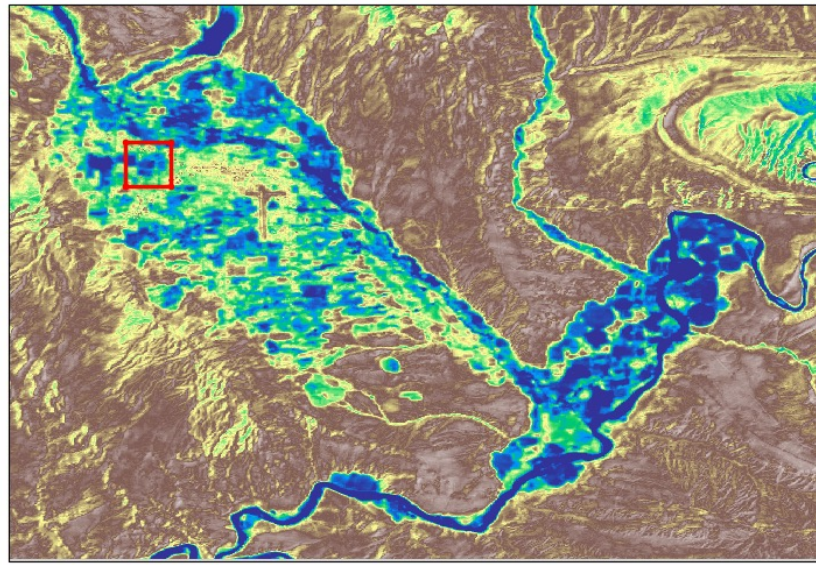


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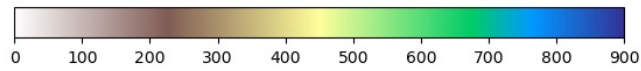
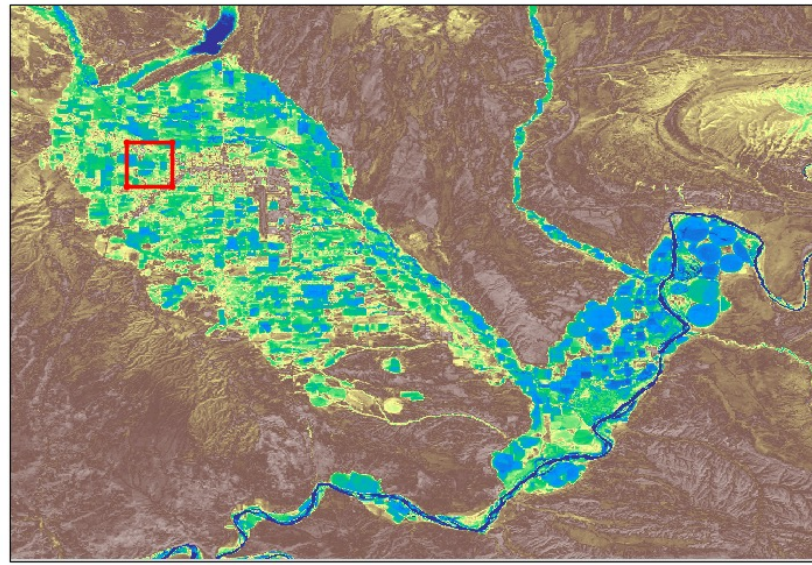


Vernal, UT

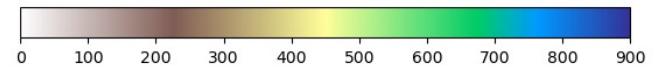
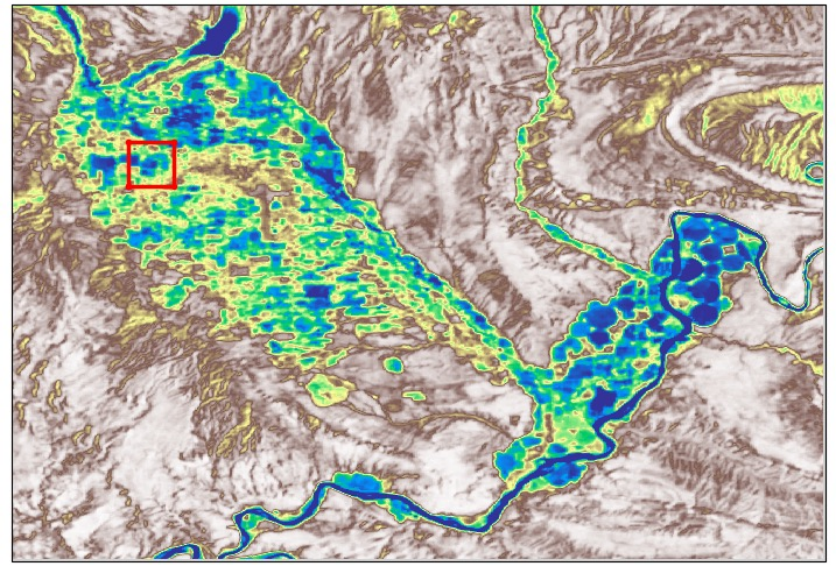
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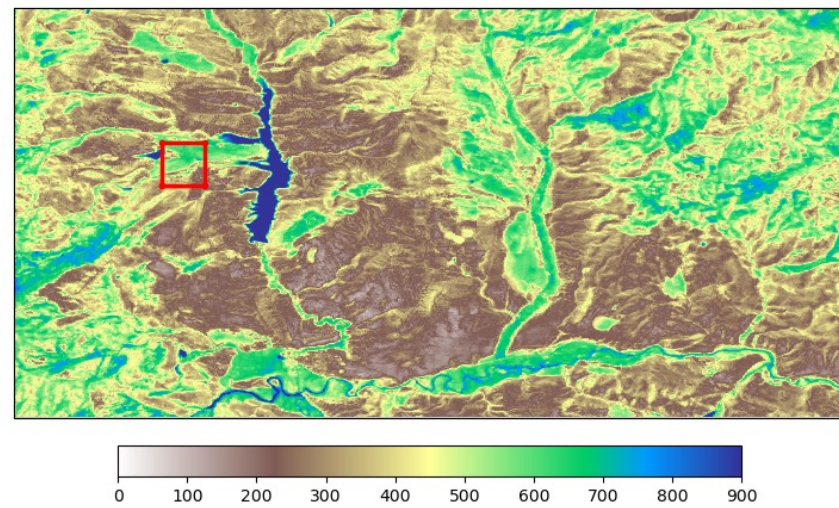
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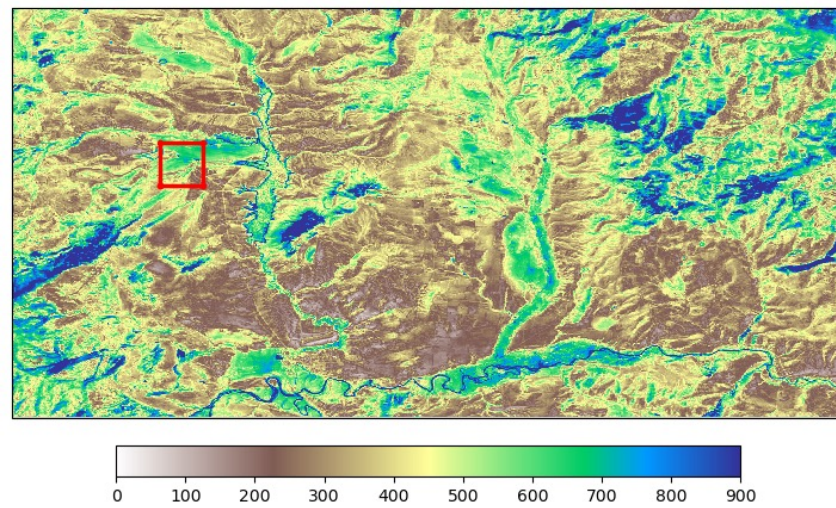
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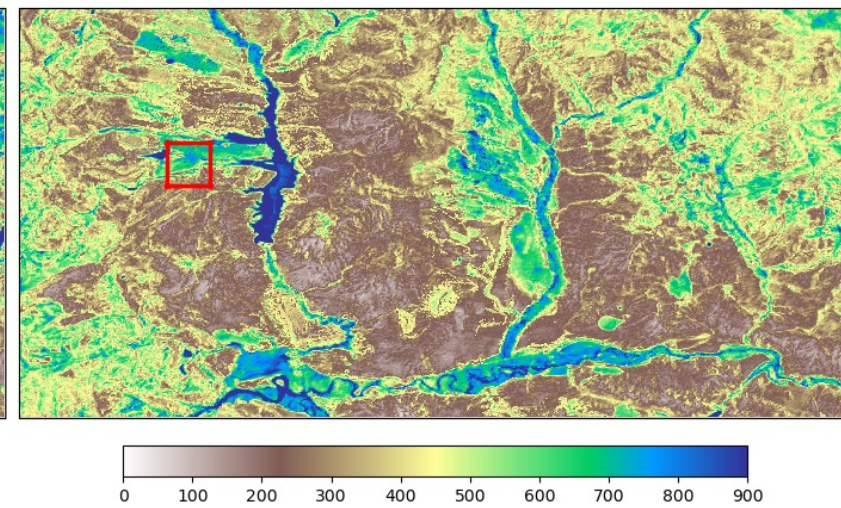
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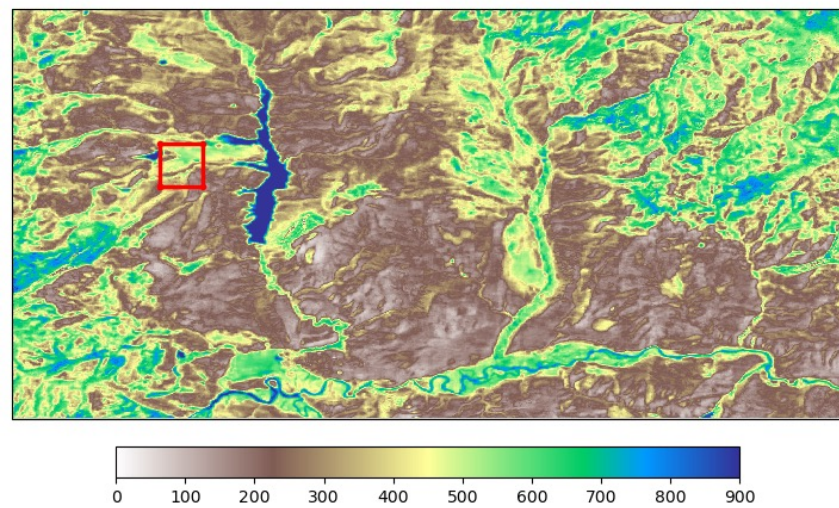
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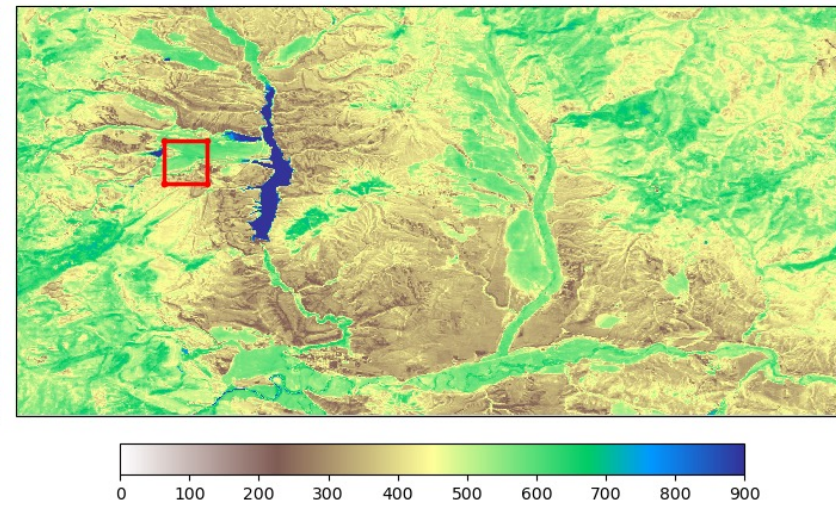
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GEE-SEBAL



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