Lauren Salberg

From: Andy Malone
Sent: Tuesday, June 11, 2024 2:35 PM
To: Jim Bennett; John Peterson; Robert Wagner; Russ Detwiler; Tom Watson; Trey Driscoll
Cc: Leonardo Urrego; Samantha Adams; Lauren Salberg; Eric W.H. Chiang
Subject: FW: FMP Calibration Results
Attachments: Figure 1. FMP-Estimated vs. CIMIS Precipitation.pdf; Figure 2. FMP-Estimated vs. Actual Pumping.pdf; Figure 3. OpenET vs. FMP ET.pdf

Good afternoon TAC members,

This email is an update on progress and preliminary results for Task 4 to Redetermine the Sustainable Yield by 2025 – *BVHM Recalibration.* We believe these are encouraging results that represent progress.

We have manually re-calibrated the Farm Process (FMP) and believe we have achieved an acceptable calibration and further improved the ability of the FMP to estimate groundwater pumping. A summary of the methods and results are presented below and in the attached figures.

We will discuss these results at the July 1, 2024 TAC meeting to receive your input and feedback. If you have immediate questions or feedback, please **Reply All** to this email so the entire TAC can benefit from the exchange.

FMP Calibration Methods

1. Adjusted parameters in the FMP, including:
    - **On-Farm Efficiency (OFE).** OFE values for irrigated crops in the FMP were adjusted within the acceptable ranges defined in the TM *Preparatory Work for Task 4 – Model Recalibration*, which relied on a literature review and interviews with farmers in Borrego Springs to identify reasonable irrigation efficiencies for the crops and irrigation methods employed in the Basin.
    - **Crop Coefficient (KC).** Monthly KC values for selected irrigated crops in the FMP (row crops, citrus, palms, potatoes) were adjusted to better match seasonal patterns in crop demands and values of KC recommended by the USGS based on crop stage (early, mid, or late).
    - **KC scaling factors.** Monthly KC scaling factors in the FMP were adjusted to better match monthly FMP-estimated pumping with monthly Actual pumping in WY 2021 and 2022.
    - **Transpiration Fraction of Consumptive Use (FTR).** FTR values for two crop types in the FMP (golf and potatoes) were increased to more closely match USGS-recommended values and to better match monthly FMP-estimated pumping with monthly Actual pumping in WY 2021 and 2022.
2. Ran the FMP from WY 1930 through WY 2022.
3. Reviewed calibration results by:
    a. Comparing FMP-estimated groundwater pumping to Actual pumping in WY 2021 and 2022. An 'acceptable' calibration result was defined as FMP-estimated pumping within +/-10% of Actual pumping.
    b. Comparing FMP-estimated evapotranspiration (ET) to OpenET models selected by the TAC as the most appropriate for Borrego Springs (geeSEBAL and eeMETRIC). No metric was established as an 'acceptable' calibration result. Instead, the OpenET models were used as a validation check on ET estimates made by the FMP.

FMP Calibration Results and Conclusions

As shown in the table below, the results of the Calibrated FMP show that the percent difference between FMP-estimated pumping and Actual pumping is **-1.7% (underestimated) in WY 2021 and 0.5% (overestimated) in WY 2022:**

WY	Actual Pumping (af)	FMP-Estimated Pumping (af)	Difference (af)	% Difference
	(a)	*(b)*	*(c) = (b) - (a)*	*(d) = (c)/ [[(a)+(b)]/2)*
2021	12,124	11,920	-204	-1.7%
2022	10,848	10,902	54	0.5%

The following OFE values were derived through the manual FMP calibration:

- Flood and furrow: 0.50
- Broadcast sprinkler: 0.70
- Micro-drip: 0:74

The attached figures further describe the results and conclusions of FMP calibration:

Figure 1. ***Precipitation vs. FMP-Estimated Evapotranspiration and Groundwater Pumping*** – This figure explains how the FMP estimates ET (by its individual components) and groundwater pumping on a monthly time step from 2020-2022. The figure shows: (i) monthly precipitation measured at the CIMIS station in Borrego Springs; (ii) monthly precipitation from the Basin Characterization Model (BCM) input to the FMP; (iii) monthly FMP-estimated ET terms for irrigated farms; and (iv) monthly FMP-estimated groundwater pumping. The main takeaways from Figure 1 are:

- Monthly precipitation in the BCM matches the monthly patterns of precipitation measured at the CIMIS station.
- During wet months, the FMP simulates that most of the precipitation is lost to evaporation, and the remainder is transpired by crop uptake which reduces the need for irrigation water.
- During dry months, the FMP simulates an increase in crop transpiration of irrigation water as groundwater pumping is the only source of water to meet crop demands.
- Monthly FMP-estimated groundwater pumping varies on a reasonable seasonal pattern in response to seasonal crop demands and precipitation.

Figure 2. ***Comparison of Monthly FMP-Estimated Pumping vs. Actual Pumping (WY 2021 and 2022)*** – This figure compares monthly FMP-estimated pumping from the Calibrated and Pre-calibrated FMP with Actual pumping for WY 2021 and 2022. FMP-estimated pumping from the Calibrated FMP is 2% lower than Actual pumping in WY 2021 and nearly the equal to Actual pumping in WY 2022. This represents an improvement in the calibration of the FMP and its ability to estimate groundwater pumping.

Figure 3. ***Comparison of Total Monthly ET from Farms in the FMP: FMP vs. OpenET Models*** – This figure compares the FMP estimates of ET to OpenET models (geeSEBAL and eeMETRIC) as a validation check. The figure includes four charts that compare ET estimated by the Calibrated FMP to: (A) ET estimated by the Pre-calibrated FMP; (B) ET estimated by eeMETRIC; (C) ET estimated by geeSEBAL; and (D) the mean and range of ET estimated by the geeSEBAL and eeMETRIC models. Inspection of these charts indicate that eeMETRIC and geeSEBAL generally underestimate ET compared to the Calibrated FMP, especially during the early period of 2016-2019. OpenET has acknowledged that its models (specifically geeSEBAL) underestimate ET in agricultural regions in very arid environments (such as Borrego Springs). Specially, the geeSEBAL model tends to yield lower ET estimates in desert and arid regions and the eeMETRIC model has uncertainty associated with atmospheric interference, particularly during cloudy conditions. These observations made by OpenET might explain why FMP-estimated ET are higher than the selected OpenET models. OpenET and the FMP estimates of ET match more closely during the more recent period of 2020-2022. The greatest exception occurred in March 2020 when the FMP estimated relatively high ET. Figure 1 showed that most of the FMP-estimated ET in March 2020 was due to evaporation of the high volumes of precipitation. In general, the FMP generates ET estimates that are similar in the seasonal pattern and magnitudes as OpenET.

Next steps

West Yost will review these results at the July 1, 2024 TAC meeting and will solicit TAC input and feedback. West Yost plans to proceed with the recalibration of the BVHM using the Calibrated FMP following the methodology described in the December 11, 2023 TAC memo titled: *Task 4 to Redetermine the Sustainable Yield by 2025 – Model Recalibration Methods*. A more fulsome discussion of the FMP calibration process will be documented in a technical memorandum that describes the entirety of Task 4 – *Model Recalibration*.

Please let us know if you have any comments or questions regarding the calibration of the FMP.

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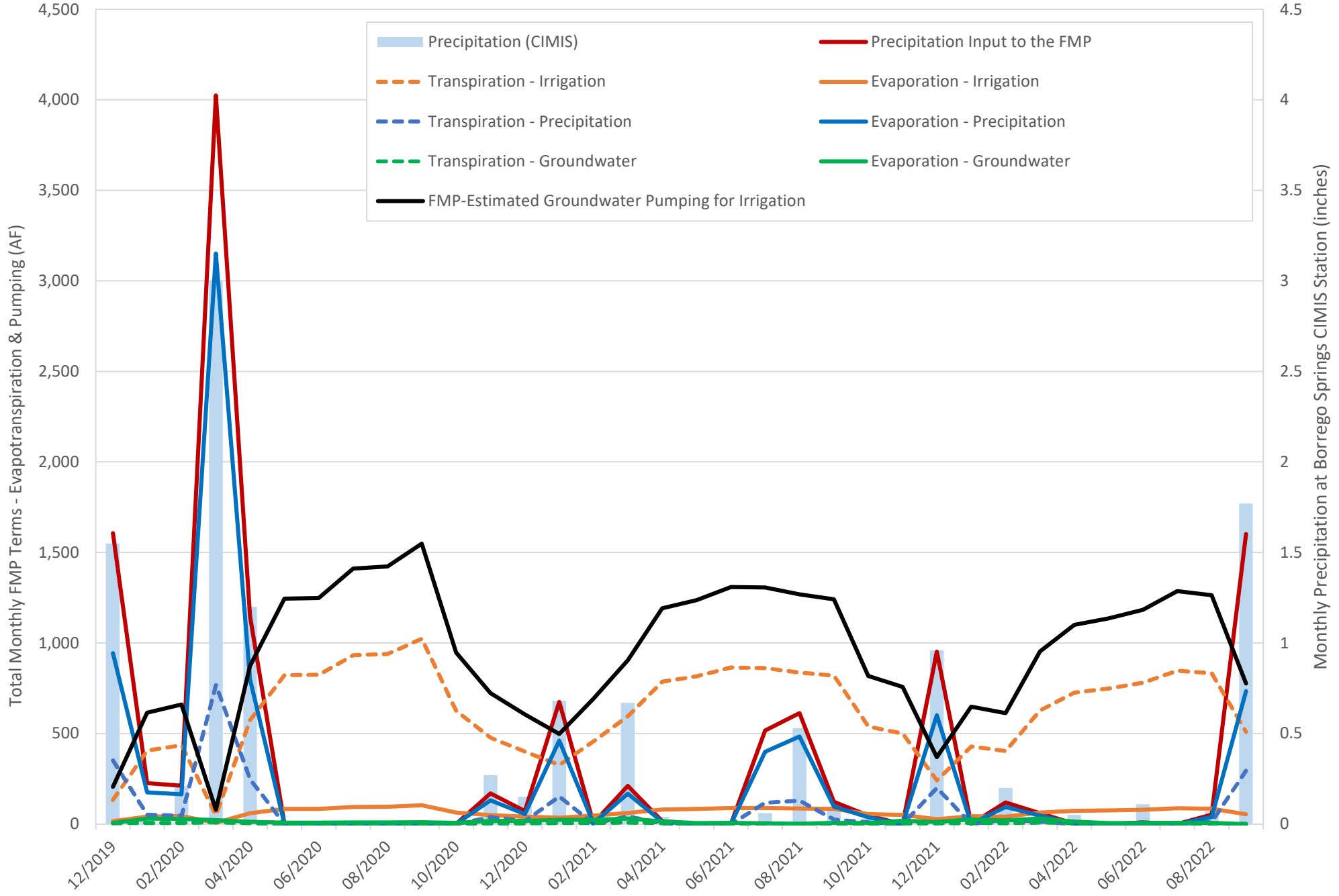
Figure 1. Precipitation vs. FMP-Estimated Evapotranspiration and Groundwater Pumping



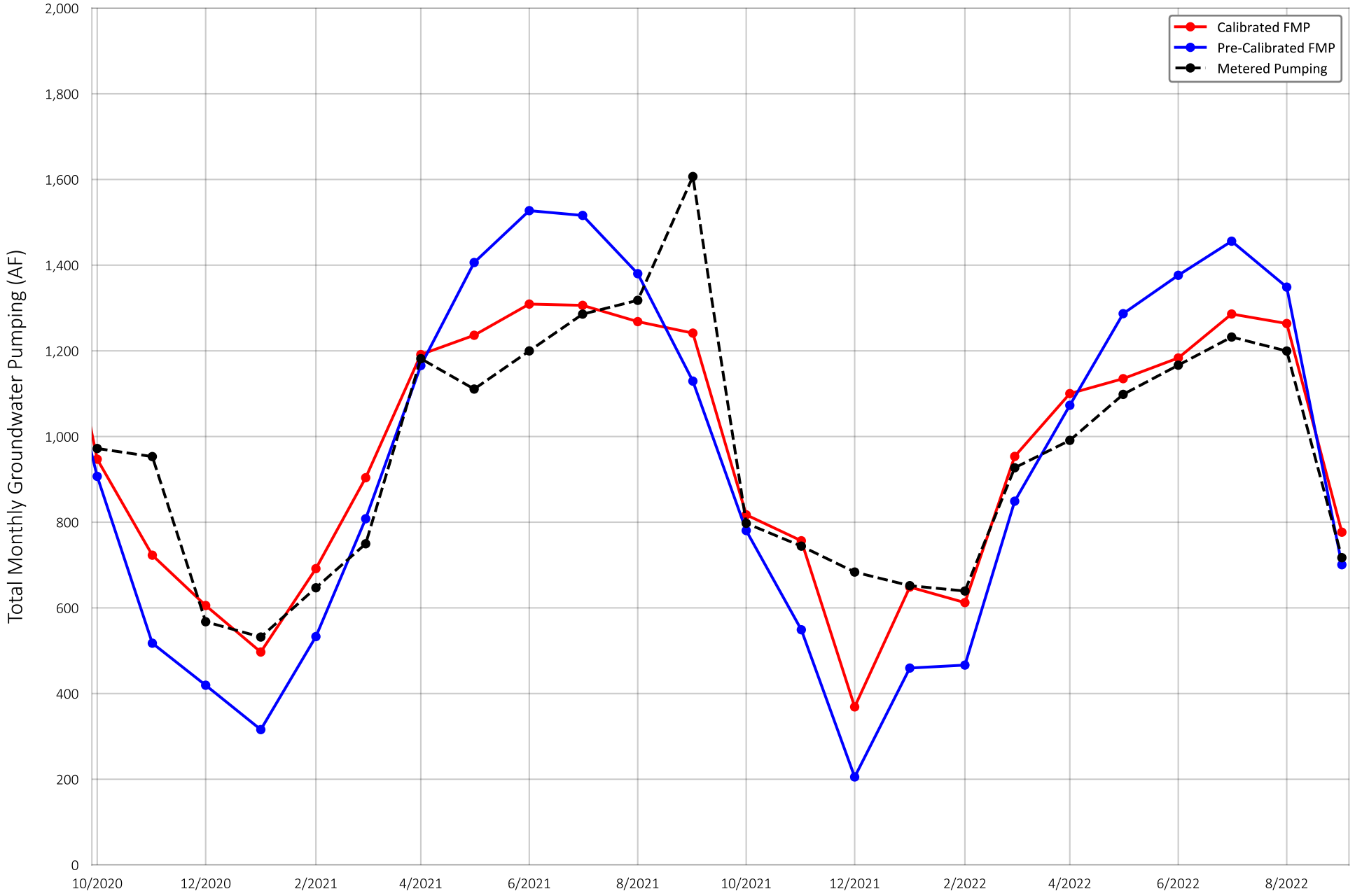


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Figure 2. Comparison of Monthly
FMP-Estimated Pumping vs. Actual Pumping
WY 2021 - 2022

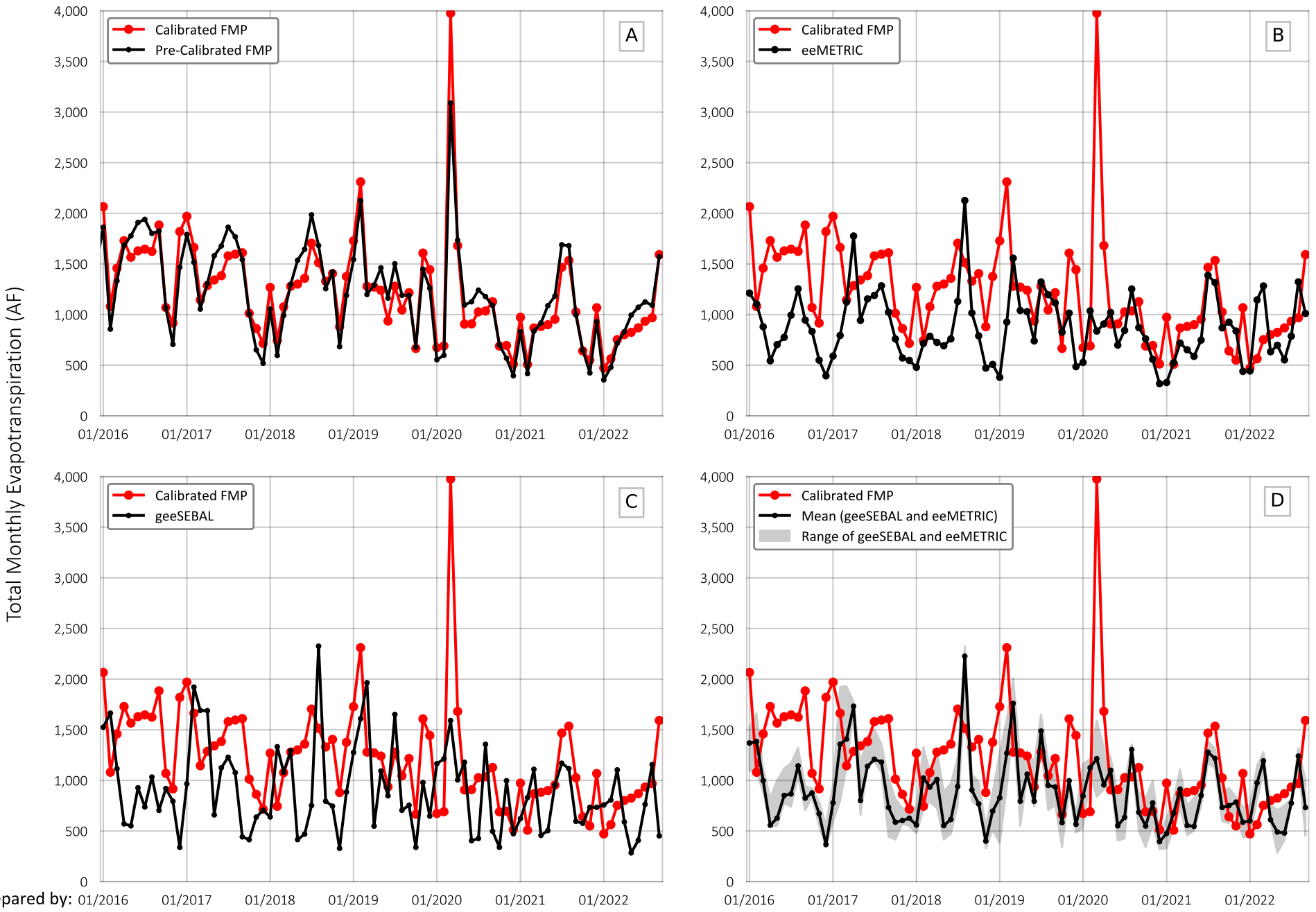

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Figure 3. Comparison of Total Monthly ET from Farms in the FMP:
FMP vs. OpenET Models