Climatic and seasonal variation in ET_r to ET_o ratios calculated using ASCE Standardized Penman-Monteith model across the contiguous U.S.

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Why do we need to explore this?

- The crop coefficient (k_c) values for alfalfa or grass reference surfaces cannot be used interchangeably with ET_o or ET_r to estimate actual crop water use. It's specific to regions and weather networks reporting either of them.
- The ASCE Standardized Penman-Monteith model uses a correction factor (k_r) (ET_r/ ET_o ratio) to account for differences in plant properties and environmental factors. Understanding this ratio and its variation is important for standardization.
- One method proposed by Allen et al. (1998) in FAO56 Irrigation and Drainage Paper estimates k_r values based on climate variables.

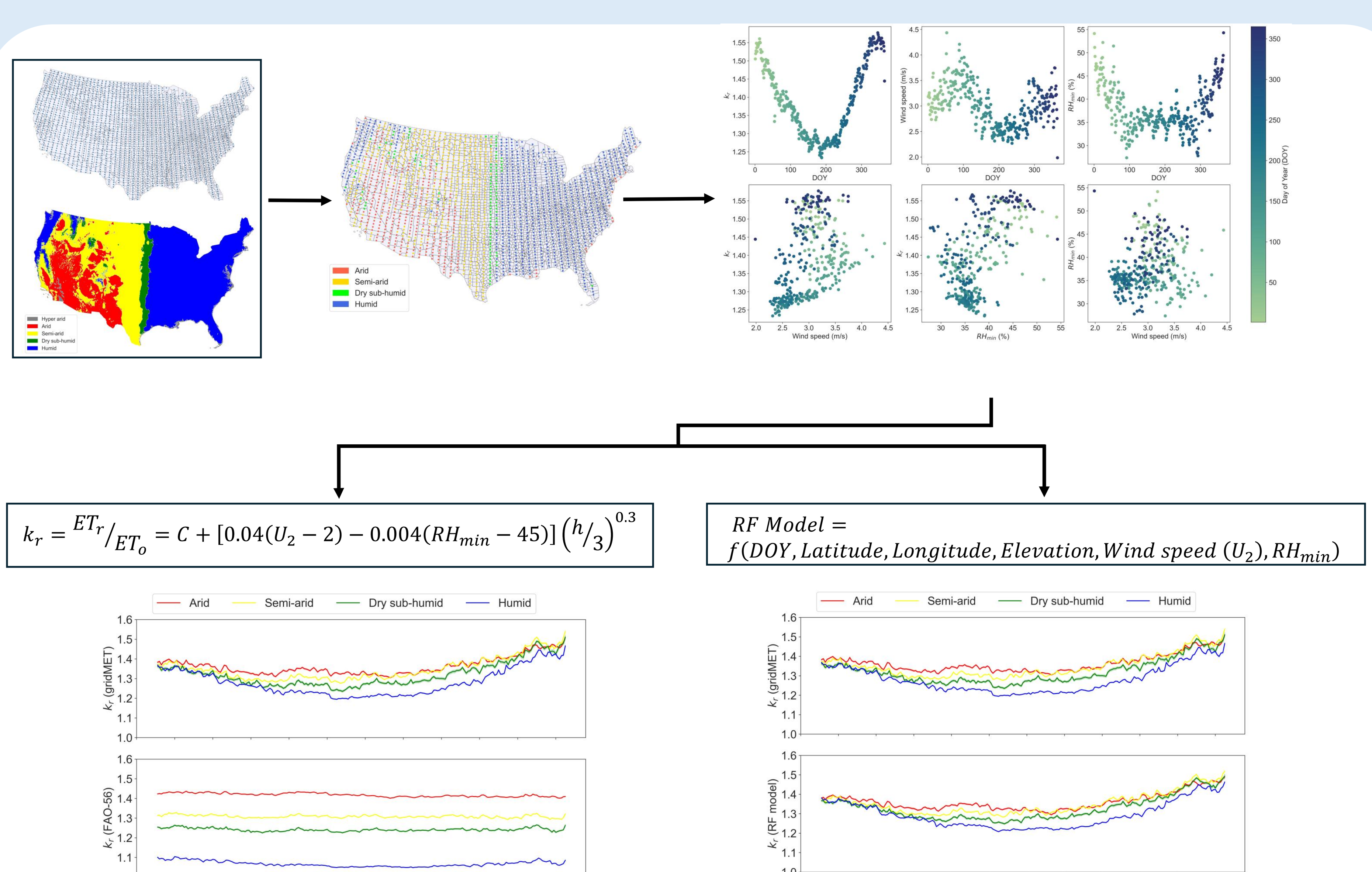
Is the FAO56 equation adequate for predicting daily variations in k_r across different climate conditions?
Is it possible to develop a more effective method for predicting daily k_r?

How did we achieve this?

- A grid of 1830 point locations was created across the contiguous United States (CONUS), and the points were categorized into four groups based on climatic conditions.
- Wind speed, RH_{min}, and k_r for all points were collected from gridMET for over 40 years. Elevation data at points was obtained from STRM.
- The Kr values were computed based on climate conditions using the equation recommended in FAO56.
- A random forest (RF) model with 150 estimators was trained using six features. Day of Year (DOY) was used for seasonality, while latitude, longitude, and elevation were utilized to capture spatiality in the model.
- A total of 13.68 million samples were used to train and test the model with an 80:20 split, and 3.9 million samples were used for model validation.
- RMSE and R^2 were utilized to assess the performance of both methods.

What did we find?

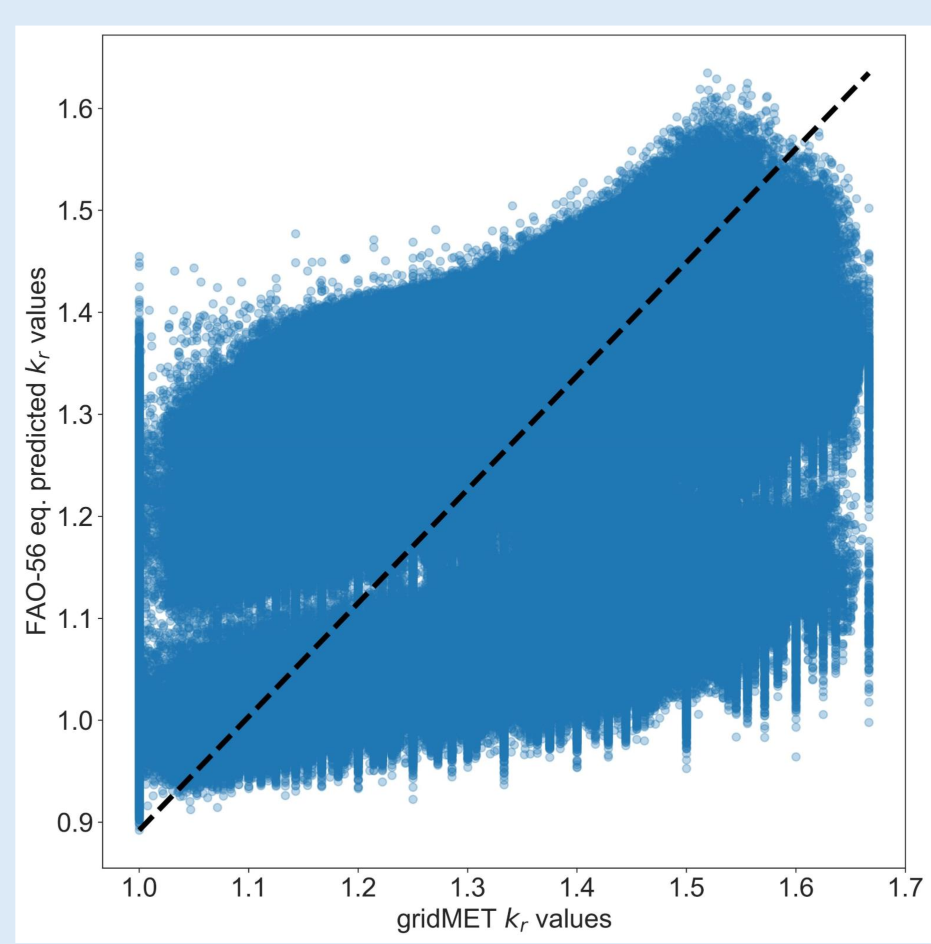
- RMSE and R^2 for RF model testing were 0.03 and 0.91, respectively.
- The RMSE and R^2 values for the FAO56 equation were 0.17 and -1.1, respectively, and for the RF model were 0.04 and 0.88.
- RF model feature importance was calculated using the permutation method. RH_{min} had the highest importance, followed by DOY, while longitude had the least impact on model predictions.



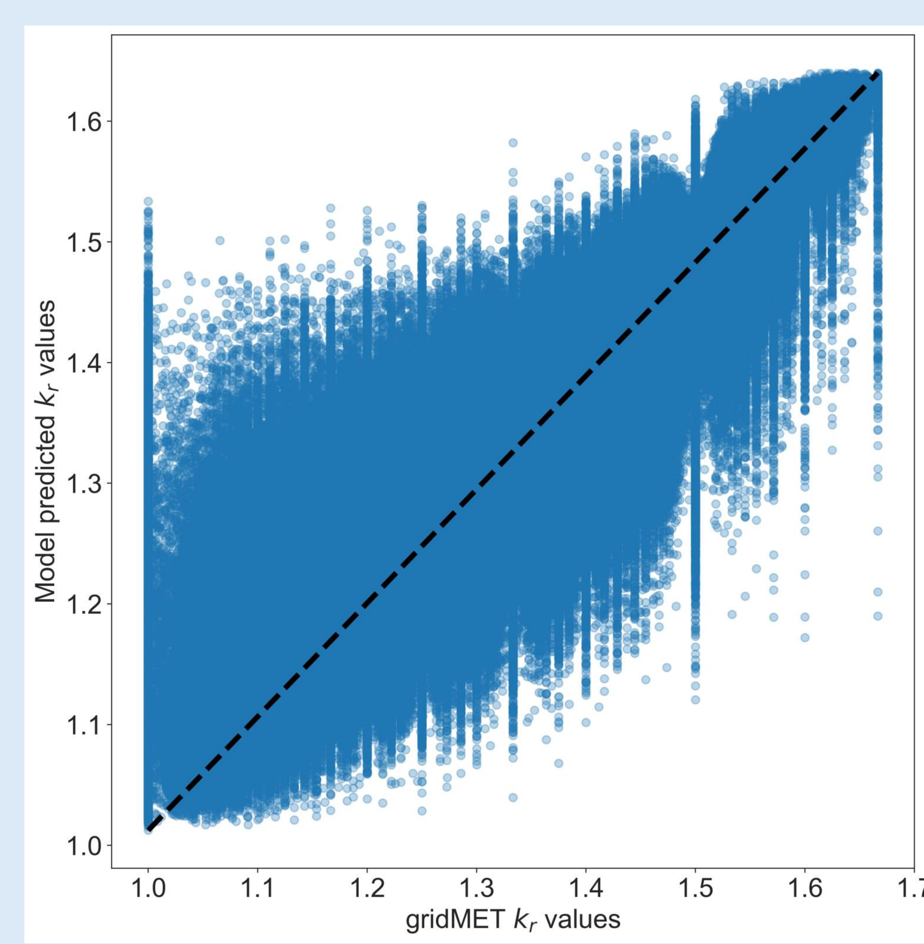
Comparison of daily seasonal k_r values estimated with FAO56 eq. and gridMET for different climatic zones

Comparison of daily seasonal k_r values estimated with RF model and gridMET for different climatic zones

The machine learning model predicts a better daily value of the correction factor with the incorporation of features to capture spatiotemporal variations compared to the FAO56 proposed equation



Daily k_r values predicted with FAO56 against gridMET k_r values on validation dataset with of R2 -1.1 and did not perform well



Daily k_r values predicted with RF model against gridMET k_r values on validation dataset with of R2 - 0.88 and perform reasonably well due to incorporation of additional temporal and spatial features

References

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