Sungkyunkwan University
Environment and Remote Sensing Lab.

EUROPEAN GEOSCIENCE UNION (EGU)
Virtual conference, 23-27th May 2022

AN APPLICATION OF EVAPOTRANSPIRATION PARTITIONING FOR MONITORING DROUGHT FROM SENTINEL-2 DATA

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Introduction

- Agricultural and meteorological droughts are manifest as the deficits in actual evapotranspiration (ET) and a surplus in atmospheric evaporative demand ET_0 (sometimes referred to as potential ET). Therefore, the accurate estimations and reliable information regarding to ET might enhance the drought monitoring and provide better agricultural management policies (Jasechko et al., 2013).
- However, ET estimations and its components remain many challenges.
- With the rapid development of remote sensing platforms, the remote sensing-based models are able to cover a large and regional scale, but they remain higher uncertainties due to the low spatial resolution, complexities in processing, requirements of many input data.
- Currently, the optical Sentinel-2 is a newly launched product with the Multi Spectral Instruments that might provide 10, 20, and 60-m spatial resolution, which potentially supports to design and improve ET models with superior performance. To overcome these mentioned disadvantages of ET models, the main objectives of this study are to propose an optical trapezoidal method (OPTREF) using only optical Sentinel-2 dataset to improve the accuracy of ET estimation; and to project the enhanced ET partitioning as feasible method for further monitoring the agricultural drought.

Study area

In this study, to assess the performance of the proposed OPTREF method, an area (ranging from 38.006 – 38.479°N and 120.891 – 121.793°W) located in California's Central Valley region was subset and utilized as the study area. The study region are mainly covered by cropland, grassland, and savanna. The study area overlaps with the selected S2 scene and covers 8 eddy covariance sites, which are shown in Fig. 1.

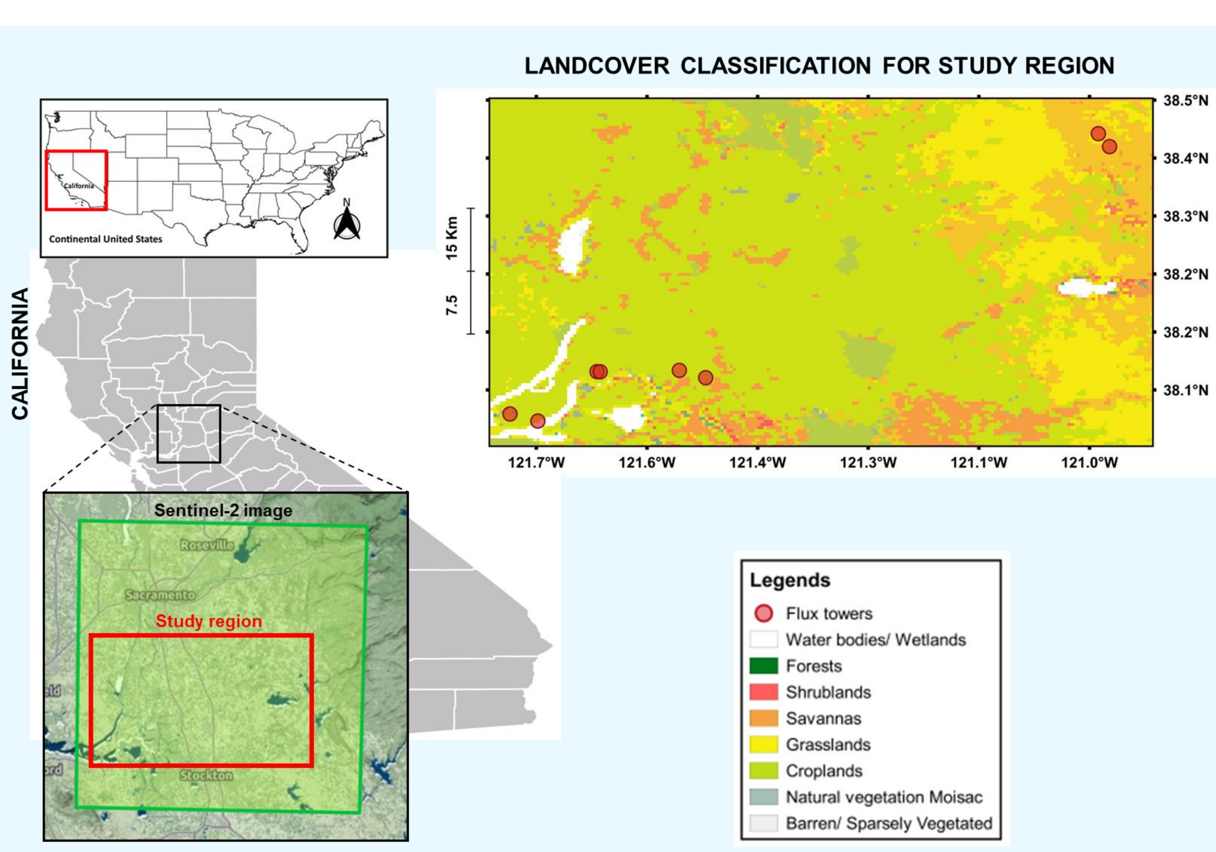

Figure 1 Land cover classification map of study region and geographical locations of the 8 flux towers selected for this study.

Dataset and Methodology

- In this study, a total of 98 high spatial resolution S2MSL1C images covering study area from 2018 to 2020 were acquired in this research. These acquired images were selected based on the criteria that cloud cover under 20%.
- To obtain *NDVI* and *STR*, the TOA data was processed and converted to the reflectance of the BOA data using Sentinel SNAP toolbox and Sen2Cor algorithms. Pixels containing clouds are removed using a synthesis of available cloud masks in the S2 products (Sadeghi et al., 2017; Babaeian et al., 2018) with supports of the snappy SNAP toolbox.
- The OPTREF method developed for partitioning *ET* and tracking drought events using only optical Sentinel-2 product can be performed based on there following equations:

$$W = \frac{SM - SM_D}{SM_W - SM_D} = \frac{STR - STR_D}{STR_W - STR_D} \quad (1)$$

And, evaporative drought index (EDI):

$$EDI = 1 - \frac{ET}{ET_{Potential}} \quad (2)$$

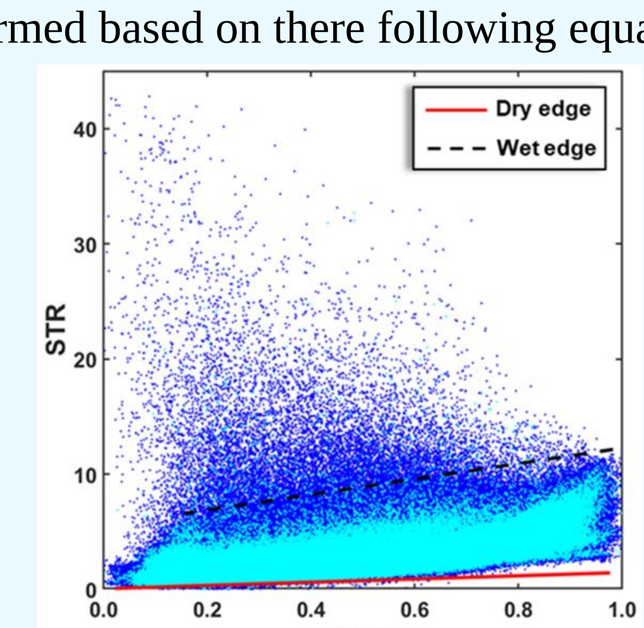

Figure 2: Pixel distribution within STR-NDVI spaces for all images in during study period (2018-2020).

Results and Discussion

Table 1: Comparison of T/ET estimated by the proposed model and previous publications for three main vegetation types of study region.

Land cover types	This study	Schlesinger and Jasechko (2014)	Yimam et al. (2015)	Ma et al. (2020)	Nguyen et al. (2021)
Cropland	0.37-0.75	-	0.41-0.70	-	0.35-0.60
Grassland	0.30-0.82	0.38-0.81	-	0.15-0.70	0.17-0.71
Savanna	0.39-0.77	0.36-0.72	-	0.40-0.90	0.37-0.67

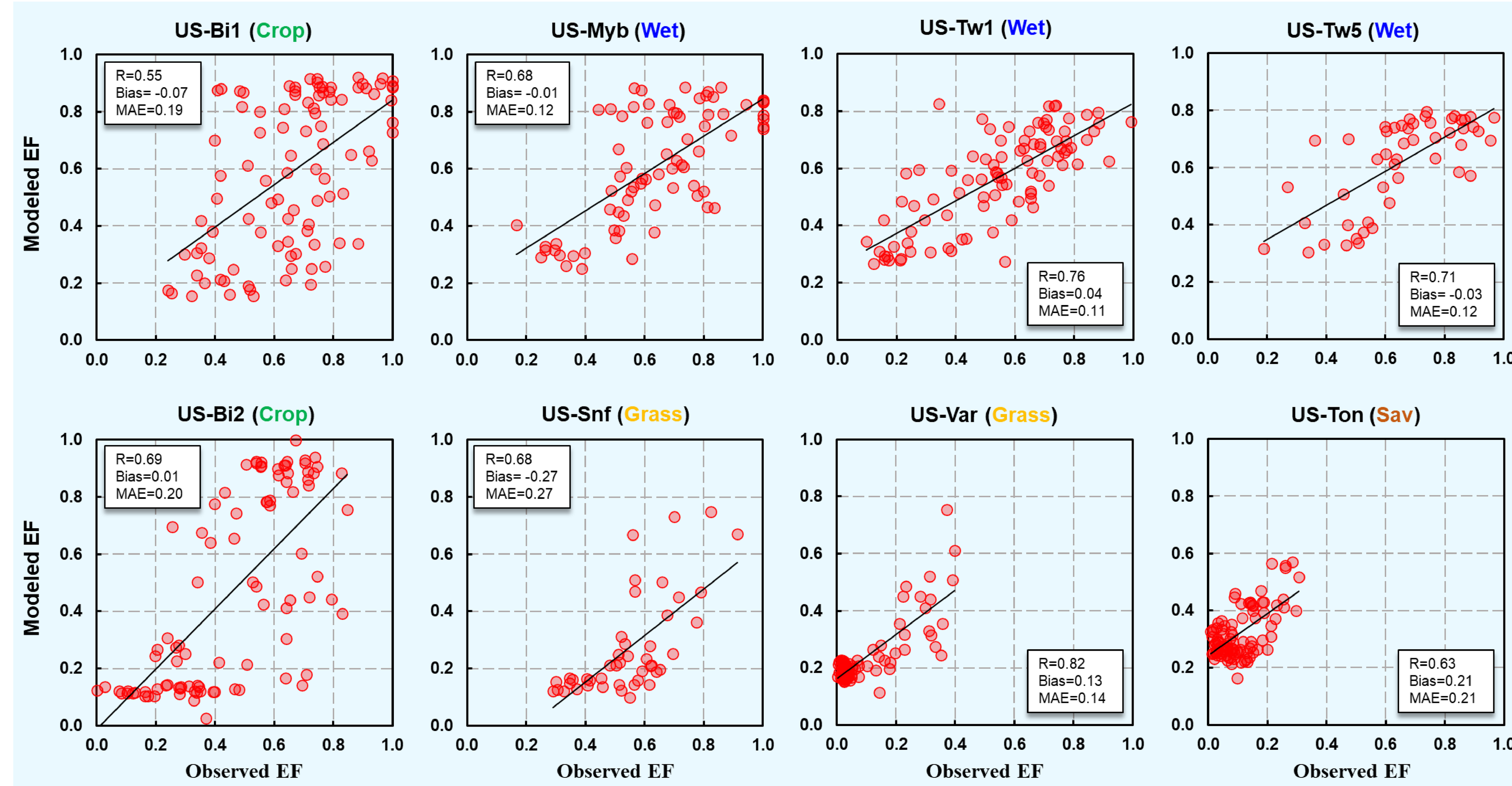

Figure 3 Temporal validation of *EF* from the OPTREF model against observed *EF* at 8 flux towers.

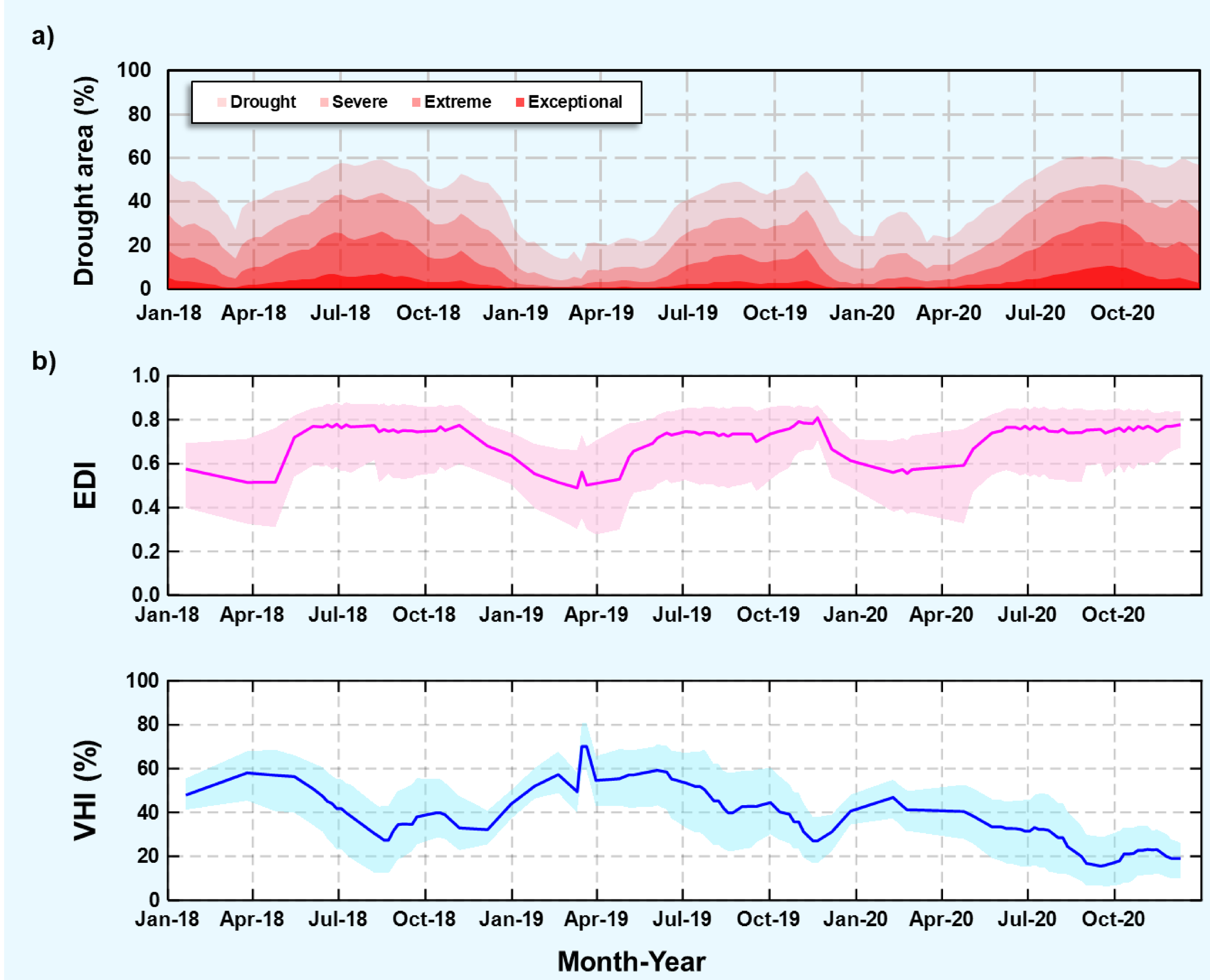

Figure 4 Temporal variation of the *EDI* and *VHI* indexes during study period: a) Drought area percentages for four drought categories in whole California retrieved from NOAA; and b) Changes in spatial median, 25th, and 75th quantiles of *EDI* and *VHI* over study period.

Conclusion

- The OPTREF model succeed to capture both spatial and temporal variation of EF, and further compute T/ET, which provides an insight into hydrological cycle. Also, it has potential promising to track agricultural drought events using only optical remote sensing dataset and to improve the sustainable management of agriculture.
- The OPTREF model is able to resolve three main disadvantages of the traditional VIs-LST space method such as lack of contribution of interception evaporation, the limited application to satellite with high spatiotemporal resolution but without thermal band (i.e, Sentinel-2), and inferiority in capturing spatial variability.

Acknowledgement

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2022R1A2C2010266). This research was supported by a grant (2021-MOIS37-002) of "Intelligent Technology Development Program on Disaster Response and Emergency Management" funded by Ministry of Interior and Safety (MOIS, Korea). This research was supported by the BK21 FOUR (Fostering Outstanding Universities for Research) funded by the Ministry of Education (MOE, Korea) and National Research Foundation of Korea (NRF).The author would like to thank the European Space Agency (ESA) for freely providing Sentinel-2 data and the AmeriFlux Networks for providing ground-based datasets.

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