Combination equation models with Sentinel-2 data and comparison with thermal-based energy balance for operational water management.

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Accurate field-scale evapotranspiration (ET) estimation is crucial for sustainable water management in Mediterranean climates [1]. While the OpenET [2] system provides 30-meter data based primarily on Landsat imagery through an ensemble of six models (five of which are based on land surface temperature, LST), the integration of high-temporal frequency observations from Sentinel-2 (10~20 m) offers a strategic opportunity to improve the robustness of estimates. This study evaluates the integration of the Sentinel-2-based Shuttleworth-Wallace (SW-S2) [3,4] model within the OpenET framework. The aim is to exploit the higher spatial and temporal resolution of Sentinel-2 and the capabilities of the dual-source SW-S2 model, increasing the number of available observations while benefiting from the stability of an ensemble approach. The SW-S2 model was validated and compared with six native OpenET models (ALEXI/DisALEXI, METRIC, SEBAL, PTJPL, SIMS, and SSEBop) and the multi-model Ensemble on irrigated crops in California. In this context, a new integrated ensemble, called $Ensemble_{SW}$, was generated by incorporating SW-S2 alongside the existing models, using the Median Absolute Deviation (MAD) approach to mitigate individual uncertainties [1]. The results demonstrate that the inclusion of SW-S2 improves the accuracy of the entire ensemble, particularly on Sentinel-2 sensor overpass days. The approach achieved Kling-Gupta Efficiency (KGE) values above 0.84, with low average errors (MAE and RMSE ~1 mm/day). The integration of the SW-S2 model demonstrates that the synergistic use of different satellite constellations (Landsat and Sentinel-2) and the combination of thermal and optical approaches can provide more reliable ET estimates, offering concrete support to irrigation decisions and water accounting in complex agricultural contexts.

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[2] OpenET. https://etdata.org/

[3] D'Urso, G., Bolognesi, S. F., Kustas, W. P., Knipper, K. R., Anderson, M. C., Alsina, M. M., ... & Belfiore, O. R. (2021). Determining evapotranspiration by using combination equation models with sentinel-2 data and comparison with thermal-based energy balance in a California irrigated vineyard. Remote Sensing, 13(18), 3720.

[4] Bhattarai, N., D'Urso, G., Kustas, W. P., Bambach-Ortiz, N., Anderson, M., McElrone, A. J., ... & Belfiore, O. R. (2022). Influence of modeling domain and meteorological forcing data on daily evapotranspiration estimates from a Shuttleworth–Wallace model using Sentinel-2 surface reflectance data. Irrigation Science, 40(4), 497-513.