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On the potential of constellr imagery for evapotranspiration and water stress monitoring: land surface energy balance experiments

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ABSTRACT

High spatio-temporal remote sensing data from sensors observing in the visible-near infrared (VNIR) and thermal infrared (TIR) spectrums allow enhanced monitoring of surface energy and water exchanges. Terrestrial TIR acquisitions, for example, enable evapotranspiration (ET) estimation and detection of water stress at finer scales for effective irrigation water management or for improving the monitoring of forest fire risks. Several missions, such as TRISHNA and LSTM, are planned for the next future with the aims to improve revisit time in comparison to current Landsat constellation. TRISHNA is an Indo/French thermal Infrared mission that will be launched in 2027 by ISRO and CNES. LSTM is an ESA mission, which is currently developed in the frame of the COPERNICUS European program. Commercial missions, such as the HIVE constellation by constellr, are also undergoing.

Here, we present preliminary results on evapotranspiration analyses using data from the new constellr SkyBee microsatellites over a cropland and grassland in southern France. constellr operates the HiVE (High-precision Versatile Ecosphere) constellation (with two SkyBee satellites currently in orbit since 2025), providing global VNIR and TIR data products at high spatial resolution (e.g. *LSTprecision* at 30 m and *LSTzoom* at 10 m) every 1.5-3 days. Variables required for contextual and point-based ET modelling were calculated from the *LSTprecision* product, including: i) NDVI, ii) EVI, iii) surface broadband albedo, which was here fitted from the narrow VNIR bands while taking the Landsat-based albedo as the response/reference. These and Land Surface Temperature (LST) were then assessed against those from Landsat8/9 OLI/TIRS. ET was herein calculated using the ensemble-based EVASPA algorithm (Gallego-Elvira et al., 2013), which will be used together with the STIC model (Mallick et al., 2014) to provide TRISHNA's ET products. Work is also ongoing to test the data on point-based source models such as STIC and SPARSE/SPARSE4 (Boulet et al., 2015; Mwangi et al., 2022). The LST and vegetation indices from the two platforms showed similar spatial distribution, though some disparity mainly arose due to the varying water/cloud masks. These differences manifested in EVASPA's contextual T-VI and SSEBI evaporative fraction (EF) spaces and thus in the calculated EFs and ETs, especially at the cropland. Further differences in the simulated contextual edges and thus EF are also introduced by the uncertainties in the fitted broadband albedos. Overall, the similarity of the sets of estimates based on data from the two satellites shows that new sensors with high spatial and temporal resolution like constellr's HiVE have great potential especially for local water use applications. Synergistically, constellr, which provides more bands in the VNIR spectrum (particularly red-edge bands) but none in SWIR, can be used together with other high resolution sensors (like Landsat OLI, ECOSTRESS ...) for more holistic vegetation monitoring.