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Integrating Landsat-8, Sentinel-2, and nano-satellite data for deriving atmospherically corrected vegetation indices at enhanced spatio-temporal resolution

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Flocks of nano-satellites are emerging as an economic resource for overcoming spatio-temporal constraints of conventional single-sensor satellite missions. Planet Labs operates an expanding constellation of currently more than 40 CubeSats (30x10x10 cm3), which will facilitate daily capture of broadband RGB and near-infrared (NIR) imagery for every location on earth at a 3-5 m ground sampling distance. However, data acquired by these miniaturized satellites lack rigorous radiometric corrections and radiance conversions and should be used in synergy with high quality imagery required by conventional large satellites such as Landsat-8 (L8) and Sentinel-2 (S2) in order to realize the full potential of this game changing observational resource. This study integrates L8, S2 and Planet data acquired over sites in Saudi Arabia and the state of California for deriving cross-sensor consistent and atmospherically corrected Vegetation Indices (VI) that may serve as important metrics for vegetation growth, health, and productivity. An automated framework, based on 6S and satellite retrieved atmospheric state and aerosol inputs, is first applied to L8 and S2 at-sensor radiances for the production of atmospherically corrected VIs. Scale-consistent Planet RGB and NIR imagery is then related to the corrected VI data using a selective, scene-specific, and computationally fast machine learning approach. The developed technique uses the closest pair of Planet and L8/S2 scenes in the training of the predictive VI models and accounts for changes in cover conditions over the acquisition timespan. Application of the models to full resolution Planet imagery results in cross-sensor consistent VI estimates at the scale and time of the nano-satellite acquisition. The utility of the approach for reproducing spatial features in L8 and S2 based indices based on Planet imagery is evaluated. The technique is generic, computationally efficient, and extendable and serves well for implementation within a cloud computing framework for processing over larger domains and time intervals.