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| **Extension of GEDI canopy structure with radar and optical imagery for quantifying disturbance effects in an African savanna** |
| The savanna of South Africa’s Kruger National Park and surrounding landscapes are subject to a multitude of disturbance pressures such as from megafauna and timber and fuelwood harvesting. Airborne lidar and its fusion with satellite imaging has proven effective in quantifying woody vegetation structure and the effects of disturbances in small locales of this region. However, the limited spatial coverage of airborne lidar precludes its use for calibrating models that apply to the diversity of vegetation types across the Greater Kruger region. Spaceborne waveform lidar from the Global Ecosystem Dynamics Instrument (GEDI) provides an alternative for measurements of canopy structure that can be extended wall-to-wall through fusion with other remote sensing datasets. We compared methods for annual mapping GEDI’s relative height 98th percentile (RH98), foliage height diversity (FHD), plant area index (PAI), and canopy cover (COV) from 2007 to 2023 using different combinations of PALSAR-1/2 backscatter coefficients, Landsat, and phenology metrics derived from Harmonized Landsat Sentinel-2. In initial models, joint Landsat and PALSAR predictors yield slightly higher accuracies (e.g., RH98 RMSE = 4.6%, R2 = 0.46) than either Landsat (RH98 RMSE = 4.8%, R2 = 0.43) or PALSAR (RH98 RMSE = 5.3%, R2 = 0.3) alone. The temporal transferability of these different models and resulting maps were evaluated against withheld years of GEDI data using temporal cross-validation with small area estimation to test their suitability for use in years outside the range of GEDI data collection. The highest performing model was then used in model-based estimators to quantify changes in canopy structure for areas experiencing recent land management and land use changes such as timber harvesting in communal lands and elephant impacts following fence removal for private nature reserves. |