

EFFECTS OF PIXEL MISREGISTRATION, DEFORMATION, AND SUBSAMPLING ON CROSS-CALIBRATION OF VEGETATION INDEX DATA RECORDS

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ABSTRACT:

The development of a long-term, seamless vegetation index (VI) data record requires data assemblage from multiple sensors and their cross-calibration. The latter could be performed by directly comparing data from an overlapping period of observations on a per-pixel or per-window (e.g., 5-by-5 window) basis. Due to differences in orbital, scanning, pixel sub-sampling, and geolocation accuracy characteristics of sensors, however, pairs of observations to be cross-compared can result in different areal coverage (different footprint sizes/scales at slightly different locations). In this study, we characterized the effects of these footprint deformation, sub-sampling, and misregistration on cross-sensor VI comparisons. The objectives were to establish error bounds in cross-calibration results due to these effects and to develop recommendation for reducing the impacts of pixel deformation and misregistration on cross-calibration. Orbital, scanning, sub-sampling, and geolocation error characteristics of three satellite sensors, Terra Moderate Resolution Imaging Spectroradiometer (MODIS), NOAA-14 Advanced Very High Resolution Radiometer (AVHRR), and SPOT-4 VEGETATION, were modeled and footprints of these three sensors were predicted for a 16-day compositing period (June 1998 and June 2002) over agricultural fields in Bondville, IL, USA and a tall grass prairie in Konza, KS, USA. Atmospherically-corrected Landsat Enhanced Thematic Mapper (ETM) images acquired within the compositing period were obtained for the two areas and spatially aggregated to simulate normalized difference vegetation index (NDVI) and enhanced vegetation index (EVI) values for the modeled observation/footprint conditions. The results showed that differences in pixel aerial coverage due to pixel deformation and mis-registration brought about large differences in index values among the three sensors. Root mean square errors (RMSE) of the NDVI and EVI values varied from day to day, reaching 0.06 RMSE for the NDVI and 0.05 RMSE for the EVI. After examining a series of spatial averaging with various window sizes, we found that taking 7-by-7 averages of neighboring pixels would effectively reduce RMSE by 80%. These error bounds and number of pixels to be averaged are expected to vary depending on surface heterogeneity and, thus, we plan to apply the same procedures to other areas for obtaining general recommendation.