We show how moderate resolution data from the Multiscale Imaging SpectroRadiometer (MISR) on the NASA Earth Observing System Terra satellite can be interpreted through a simple geometric-optical model (SGM) to retrieve forest crown cover, mean canopy height, and biomass. These are important parameters in western forests that are increasingly vulnerable to wildfire with earlier melting of the snow pack. MISR Level 1B2 Terrain radiance data from overpasses in May and June 2002 over SE Arizona and S New Mexico were atmospherically corrected using MISR aerosol data and the bidirectional reflectance factors (BRF) were mapped to a 250 m grid. The background angular response in the MISR viewing plane was estimated prior to model inversion using the isotropic, geometric, and volume scattering weights of a LiSparse-RossThin kernel driven model, plus nadir camera blue, green and near-infrared reflectance factors. Calibration of these relationships was effected using woody plant cover estimates obtained from IKonos 1 m panchromatic imagery in the USDA, ARS Jornada Experimental Range. The SGM was adjusted against red band data in all nine MISR views (view zenith angles <= 70.5°) using the Praxis algorithm.

![Figure 1. The method used to perform SGM inversions.](image)

Fractional crown cover is calculated by adjusting retrieved crown radius (r) with fixed tree number density (λ) -- exploiting sensitivity to brightness. Canopy height is calculated by adjusting retrieved b/r with fixed h/b, where b is vertical crown radius and h is crown center height above the reference plane -- exploiting sensitivity to BRF shape (Figure 2). The starting point for the inversions was r = 0.25 and b/r = 0.2, with the fixed parameters set to 0.012 (λ), 2.0 (b/h), 0.09 (leaf reflectance) and 2.08 (crown leaf area index). When results from three adjacent overpasses were tested against data extracted from US Forest Service maps of biomass (estimated from crown x height, forest cover, and canopy height), coefficients of determination were 0.76, 0.58 and 0.53 after filtering for error on model fitting and cloud/cloud-shadow contamination (N=547; all significant at the 99% level). The RMSE of the estimates was 2.8 m for canopy height, 35.6 Mg ha\(^{-1}\) (15.9 tons / acre) for biomass, and 0.17 for fractional cover (dimensionless). Correlations are a monotonic function of RMSE on model fitting. Figure 3 shows the retrieved distributions against the US Forest Service data for the Inter-mountain West. Figure 4 shows the effects of imposing RMSE thresholds on the results.

![Figure 2. The effects of changing (a) fractional crown cover with fixed λ = 5, and maintaining canopy height at 3.0 m (b) crown shape (b/r), maintaining h/b fixed at a typical value of 2.0.](image)

The results from nine Terra overpasses were merged using min(RMSE) as the selection criterion to produce almost cloud-free cover, mean height, and biomass maps. Figures 5-8 show the results in maps that also include values for woody shrubs in desert grasslands. The technique also provides a map of understory density, estimated via the background brightness (not shown).

We have shown that MISR data can be interpreted through a hybrid geometric-optical model to provide maps of canopy crown cover, height, and biomass over large areas with good accuracy. To our knowledge, these results are a unique application of moderate resolution EO data.