Mapping Woody Plant Cover using the Earth Observing System Multi-angle Imaging Spectro-Radiometer (MISR)

Mark Chopping[1], Lihong Su[1], John V. Martonchik[2], Albert Rango[3], Debra Peters[3] and Andrea Laliberte[3]

1. Earth & Environmental Studies, Montclair State University, Montclair, NJ 07043 2. NASA/JPL, Pasadena, CA 91109 3. USDA, ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM 88003

Goal: To provide improved maps of woody plant cover. Since the late C19th increases in woody plant abundance in grasslands have resulted in changes in C pools and cycling in the southwest United States (Figure 1). Woody plant cover could be provided by very high resolution imagery but moderate resolution Earth Observation is the only means to map changes over large areas inexpensively and on a regular basis. Here we show how data from MISR can be used to map woody plant cover in arid and semi-arid regions.

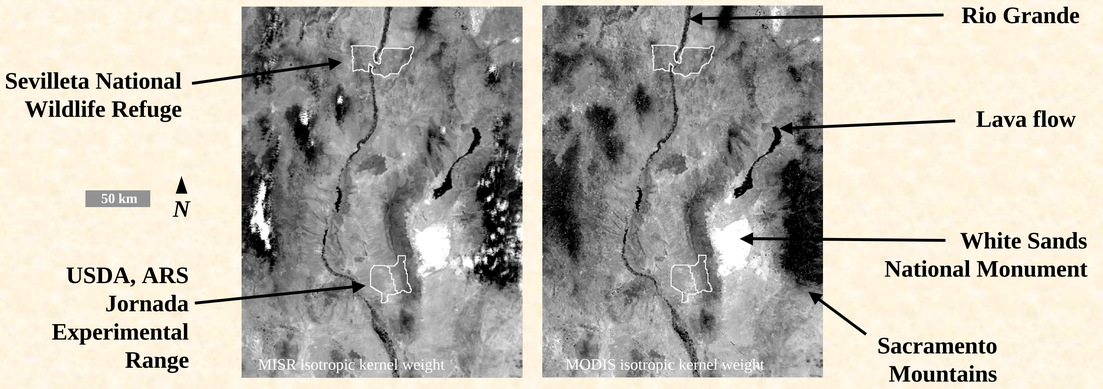

Figure 1. Locations of the Jornada and Sevilleta study areas

Method: A simple geometric-optical (GO) model, the Simple Geometric Model (SGM) was adjusted against MISR red band data (all 9 views) to retrieve fractional woody shrub cover. Shrub crown number density was fixed at 0.012 and mean radius was adjusted to fit the model. **Data:** MISR Level 1B2 Terrain Data from June 2002, atmospherically-corrected and mapped to a 250 m grid. **Obtaining the Background:** GO models cannot operate unless the large soil-understory contribution is adequately specified (Figure 2). The LiSparse-RossThin kernel-driven model was adjusted against the MISR red band data and the retrieved isotropic, geometric and volume scattering kernel weights were used together with the MISR An camera (nadir) green, blue, and NIR BRFs to estimate the background angular response in the MISR viewing plane *a priori*, via the Walthall model. Calibration of the relationship was effected using estimates of shrub cover obtained from IKONOS imagery in a transition zone in the Jornada Experimental Range.

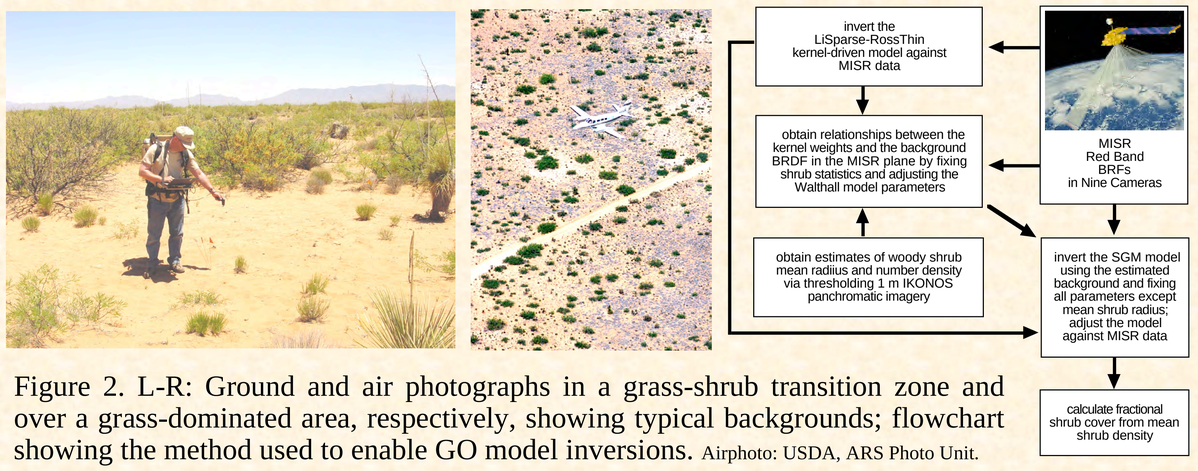

Figure 2. L-R: Ground and air photographs in a grass-shrub transition zone and over a grass-dominated area, respectively, showing typical backgrounds; flowchart showing the method used to enable GO model inversions. Airphoto: USDA, ARS Photo Unit.

Results: Retrieved woody plant cover at local (Figure 3 (a-c)) and larger scales shows a good relationship to that seen in IKONOS pan images, MODIS Vegetation Continuous Fields % Tree Cover, QuickBird-derived shrub maps, and orthophotography (Figure 4). MISR red band data in 9 view angles simulated using SGM and IKONOS-measured shrub crown statistics showed a good relationship to observed data (Figure 3 (d)).

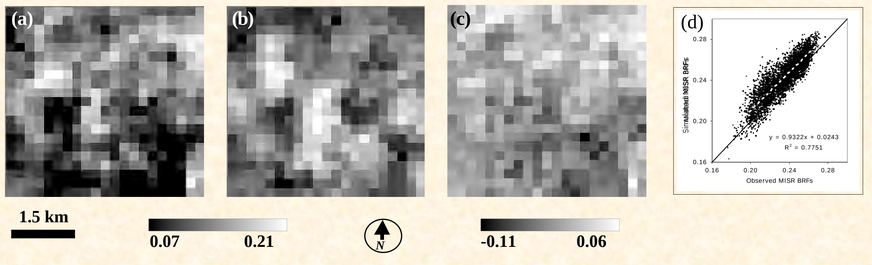

Figure 3. (a) Measured fractional woody cover from May 2001 IKONOS pan image (b) MISR/SGM fractional woody cover (black indicates failed inversions where cover is very low) (c) difference map (d) simulated MIRS red band BRFs in 9 looks vs. observed MISR data.

Retrieved woody plant cover for Pasture 12 in the Jornada showed a good albeit biased relationship with (n=90) estimates from segmentation of a QuickBird image (Figure 5 (a)) that was improved by using 1 x Ross rather than *kC* x Ross (Figure 6).

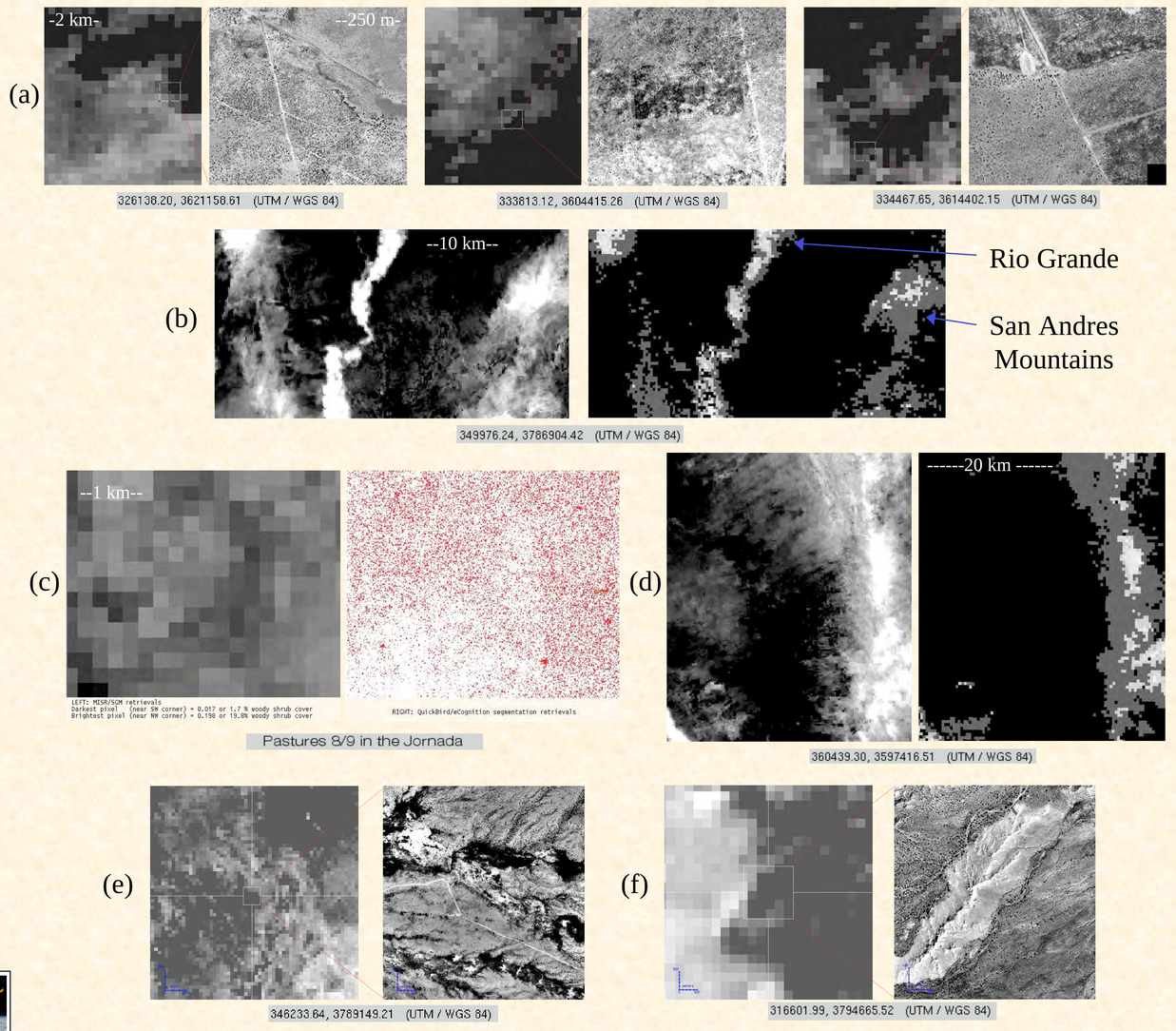

Figure 4. Retrieved woody plant cover maps (left side of each pair) vs: (a) IKONOS pan images (b) MODIS Vegetation Continuous Fields (VCF) % Tree Cover for the Sevilleta (c) QuickBird-derived shrub cover map for pastures 8/9 in the Jornada, red=shrub, white=background (d) MODIS VCF % Tree Cover for the Jornada (e) and (f) orthophotographs in the Sevilleta.

Figure 5. (a) QuickBird shrub map for pasture 12 in the Jornada, red=shrub, white=background (b) shrub cover aggregated to 250 m (c) retrieved using MISR via inversion of the SGM GO model.

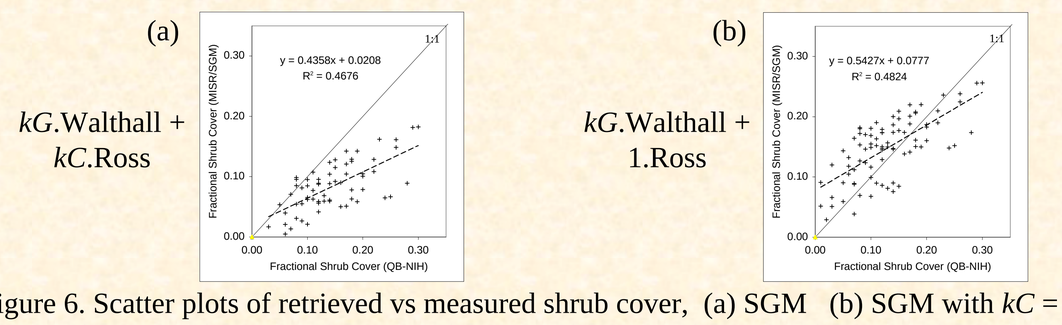

Figure 6. Scatter plots of retrieved vs measured shrub cover, (a) SGM (b) SGM with *kC* = 1

Conclusions: Multi-angle data from MISR are sensitive to canopy structure and can be exploited to provide maps of woody plant cover over large areas using GO models. Kernel-driven models can provide a means of separating the contributions from the soil-understory background and the overstory. See: http://csam.montclair.edu/~chopping/woody/

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