3.5

AN IMPROVED ADJACENCY EFFECT CALCULATION IN RADIATION TRANSFER MODELS

Haiyan Liu* and Volker Mohnen

ASRC, SUNY at Albany, Albany, NY

INTRODUCTION

Due to its spatial and temporal continuous coverage, satellite observations are very convenient and economic ways to monitor the earth system. Retrieval of the earth's surface reflectance from the satellite visible and infrared channels (0.4 -15 µm) requires atmospheric correction, which involves two steps: One is to remove the atmospheric intrinsic reflectance, another is to account for the adjacency effect that is the contribution from the adjacent surfaces. The current procedures handling the adjacency effect correction follow the principle of Tanre (Milovich et al., 1995; Ouaidrari and Vermote, 1999; Reinersman et al., 1995; Richter 1990; Tanre et al., 1981; Tanre et al., 1987; Zagolski et al., 1995).

With the great advances in measurement techniques, resolution of the measurement has been significantly increased. The spatial resolution of ASTER in the visible region approaches 15 m. A more accurate simulation of the interactions between the atmosphere and complex surfaces, may possibly provide a better retrieval of the surface reflectance.

In this work, a higher accuracy approximation for the adjacency effect is developed, with consideration of higher order scattering between surface and atmosphere. Then the magnitude of the possible improvement is estimated using the MODTRAN 4 radiative transfer model for the Summer-Spring standard atmosphere provided in MODTRAN 4. The result shows that this improvement may be important for complex surfaces in the presence of heavy atmospheric aerosol loading.

* *Corresponding author address*: Haiyan Liu, ASRC,
251 Fuller Road, Albany, NY 12203;
e-mail: hyliu@asrc.cestm.albany.edu

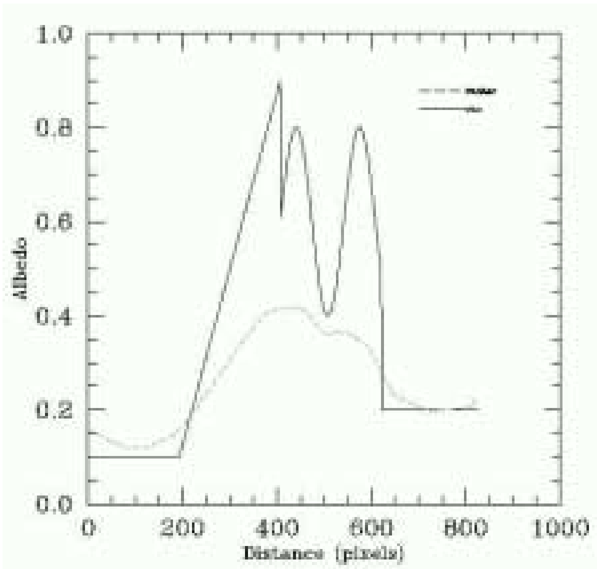
2. Preliminary Results

We start from the formulation of radiance transfer with full consideration of radiative interaction between a horizontally uniform atmosphere and the earth surface with heterogeneous reflectance. After ignoring the effect of BRDF (Bi-directional Radiation Distribution Function), we finally derive a formula, which has an additional term, A, comparing with that provided by Tanre 1981 in considering adjacency effect,

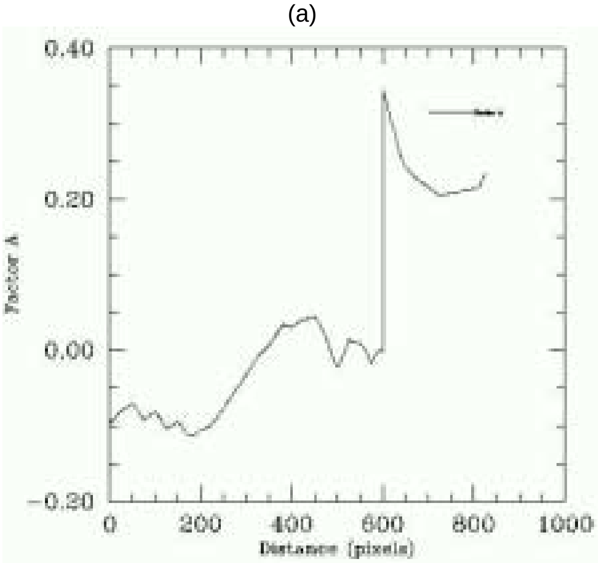
$$A = (\langle\rho\rangle - \langle\rho\langle\rho\rangle\rangle/\langle\rho\rangle) / (1 - S\langle\rho\rangle)$$

The above formula physically represents the high order multiple scattering interactions between all pixels. It takes into account the degree of surface heterogeneity and the scattering property of atmosphere above. The symbol <> is the convolution operator, determined by the environment function. ρ is the surface reflectance of Lambertian heterogeneous surface.

Figure 1 shows the relative importance of the additional term. For this case, a high aerosol loading is assumed (corresponding to a visibility of 9 km). The surface reflectance is not uniform, but changes from 0.1 in pixels 1-200, to 0.8 at pixels 200-600, then drops to 0.2 abruptly (Fig. 1(a)). In this case, the pixel size is 15m. Our new term is shown in Fig. 1(b). It is obvious that, when surface reflectance changes rapidly, the term is very large. The maximum value can reach 35% of total adjacency effect. Of course, it is easy to see that when a surface varies very slowly, the term is small, i.e. about 5%. In addition, the change in the factor A is more obvious with the change in surface reflectance than that of adjacent reflectance, which shows that the factor A is closely related to the surface reflectance heterogeneity. In this work, we have shown the important improvement in adjacency effect simulation for the case of a heavy atmospheric aerosol loading coupled with complex surface structures.



(a)



(b)

Figure 1. (a). The value of surface reflectance (solid line), adjacent reflectance (long dashed line) and (b). term A.

References

Milovich, J. A.,, L. A. Frulla and D. A. Gagaliardini, 1995: Environment contribution to the atmospheric correction for Landsat-MSS images, *Int. J. Remote Sensing*, **16**, 2515-2537.

Ouaidrari, H. and E. Vermote, 1999: Operational atmospheric correction of Landsat TM data, *Remote sens. Environ*., **70**,4-15.

Reinersman,

Richter, R., 1990: A fast atmospheric correction algorithm applied to Landsat TM images, *Int. J. Remote Sensing*, **11**, 159-166.

Tanre, D. and P. Y. Deschamps, 1981: Influence of the background contribution upon space measurements of ground reflectances. *Applied Optics*, **20**, 3676-3684.

Tanre, D., P. Y. Deschamps, P. Duhaut and M. Herman, 1987: Adjacency effect produced by the atmospheric scattering in thematic mapper data. *J. Geophys. Res.*, **92**, 12,000-12,003.

Zagolski, F. and J. P. Gastellu-Etchgorry, 1995: Atmospheric corrections of AVIRIS images with a procedure based on the inversion of the 5S model, *Int. J. Remote Sensing*, **16**, 3115-3146.