An improvement of Simplified Atmospheric Correction: MODIS Visible Channel

Chang-Suk Lee* and Kyung-Soo Han**†

*Korea Environmental Technology Consulting Hotline
**Department of Geoinformatics engineering, Pukyong National University

Abstract: Atmospheric correction of satellite measurements is a major step to estimate accurate surface reflectance of solar spectrum channels. In this study, Simplified Method for the Atmospheric Correction (SMAC) radiative transfer model used to retrieve surface reflectance from MODIS (MODerate resolution Imaging Spectrometer) top of atmosphere (TOA) reflectance. It is fast and simple atmospheric correction method, so it uses for work site operation in various satellite. This study attempts a test of accuracy of SMAC through a sensitivity test to detected error sources and to improve accuracy of surface reflectance using SMAC. The results of SMAC as compared with MODIS surface reflectance (MOD09) was represented that low accuracy ($R^2 = 0.6196$, Root Means Square Error (RMSE) = 0.00031, bias = - 0.0859). Thus sensitivity analysis of input parameters and coefficients was conducted to searching error sources. Among the input parameters, Aerosol Optical Depth (AOD) is the most influence input parameter. In order to modify AOD term in SMAC code, Stepwise multiple regression was performed with testing and remove variable in three stages with independent variables of AOD at 550nm, solar zenith angle, viewing zenith angle. Surface reflectance estimation by using Newly proposed AOD term in the study showed that improve accuracy ($R^2 = 0.827$, RMSE = 0.00672, bias = - 0.000762).

Key Words: Surface Reflectance, Atmospheric Correction, Aerosol Optical Depth.

1. Introduction

Remotely sensed images observed by satellites are mostly contaminated by gases (i.e., $H_2O$, $O_3$, $O_2$ etc) and aerosol in atmosphere. Although many multi-spectral sensors designed to avoiding atmospheric effect using atmospheric windows, attenuation by atmosphere is indispensableness. Trace gases in atmosphere function reflectance, absorption, and scattering for solar illumination. Various problems arise during interpretation of remotely-sensed data due to ting atmospheric contamination (Rahman and Dedieu, 1994). In order to accurate estimating reflectance, atmospheric correction which remove atmospheric effects is one of the key steps to obtain surface reflectance from space borne optical instruments operating in the visible and near-infrared domain (Hagolle et al., 2008). It involves removing...
the effect of gaseous absorption as well as correcting for the effect of an atmospheric molecular and particulate scattering.

There are several methods to retrieving truly surface reflectance from satellite Top Of Atmospheric (TOA) reflectance. First, Dark Object Subtraction (DOS) method is based on assumption which exist darkest objects (i.e., dense forest, water, shadow) in a satellite image. Darkest objects have near zero-reflectance, such that the signal recorded by the sensor from those objects is solely a result for atmospheric effect, which must be removed (Chavez Jr., 1996). Second, Dense Dark Vegetation (DDV) use dark area to obtain surface reflectance. Dark area is dense forest and detected using red and blue bands. Second Simulation of the Satellite Signal in the Solar Spectrum 6S is the latest and most sophisticated code for atmospheric correction, requires some ancillary data such as water content, ozone content, and the aerosol optical depth of the atmosphere, as well as the terrain elevation (Kaoru, 2005). It was integrated to 2.5 nm within band width. These properties have high accuracy but required long computation time. Lasted, Simplified Method for the Atmospheric Correction (SMAC) is based on 6S code. SMAC previously yields many coefficients for specific satellite-based asted. The main advantage of SMAC is that it is several hundred times faster than more detailed radiative transfer codes like 6S and it does not require precalculated look up table (H. Rahman and G. Dedieu, 1994). SMAC employed for work-site operations in Meteo-France and EUMETSAT because of simple and fast implementation. It cautiously used because it is for work site atmospheric correction model. This study attempts a test of accuracy of SMAC through comparison of MODIS (MODerate resolution Imaging Spectroradiometer) surface reflectance (MOD09) and estimated surface reflectance form MODIS level-1b data using SMAC. A sensitivity test was conducted according to each input parameter for finding error sources. This study aims to detected error sources and to improve accuracy of surface reflectance using SMAC.

2. Data

The MOD02 product from Terra/MODIS were used for estimated surface reflectance and provided from Land 1 and Atmosphere Archive and Distribution system (LAADS) web site at http://ladsweb.Atscom.Atsa.gov/. MOD02 product is level-1b data which was calibrated radiances in spatial resolution 1km including the 250m and 500m resolution bands aggregated to seem to 1km resolution. Among the 36 bands of MODIS sensor, red band reflectance was used to estimate surface reflectance. Clear satellite imageries in day time were selected to retrieved surface reflectance around Korea peninsula.

The MOD09 GA product (MODIS surface reflectance) that were obtained from Land Process Distributed Active Archive Center (LP DAAS) used for validation. Several MODIS atmospheric products (MOD04: aerosols, MOD05: water vapor, MOD07: ozone, MOD35: cloud mask) were used to estimating surface reflectance and ancillary data (Digital Elevation Model, Atmospheric Pressure) as input parameters to the atmospheric correction (Vermote and Vermeulen, 1999). 6S radiative transfer code which can accurately simulate the atmospheric effects. MODIS surface reflectance was conducted by atmospheric correction based on the 6S code which is improved from 6S, developed by the Laboratoire d’ Optique Atmospherique several years ago (Vermote et al., 1997) as reference algorithm and to verify the MODIS atmospheric correction algorithm.

Several product of MODIS were used to