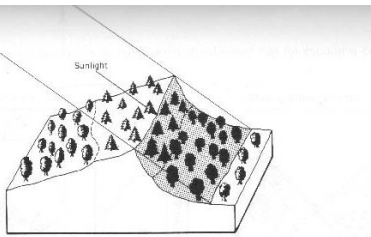


Topographic correction methods

Introduction

- For mountainous regions – topographic correction at least as important as atmospheric correction
- Topographic shading & shadowing modulates any remote sensing signal – affects inversion to land surface parameters
- Need high-resolution & accurate DEM data – not available globally – to do the correction



Land Cover/Illumination	Digital Number		
	Band A	Band B	Ratio (Band A/Band B)
Deciduous			
Sunlit	48	50	0.96
Shadow	18	19	0.95
Coniferous			
Sunlit	31	45	0.69
Shadow	11	16	0.69

Lillesand & Kiefer 2000

Figure 7.25 Reduction of scene illumination effects through spectral ratioing. (Adapted from [165].)

Introduction

- Mountain regions – ¼ of Earth's terrestrial surface
- Remote sensing over mountains – contaminated with topographic shading & shadowing
- Surface types same – brightness in sunlit areas & shaded areas are different
- Need to remove these topographic effects

Approach – high-resolution imagery

- Ratio algorithms
 - Illumination effects caused by topography are proportional at different bands
 - Ratio of 2 bands can eliminate topographic effects
 - But radiometric variations caused by topography are wavelength-dependent – differences at different bands are not simply increased or decreased by a constant
 - Ratio is a linear transformation of the original 2 bands, may not be desirable

Approach – high-resolution imagery

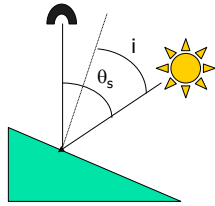
- Cosine correction algorithms
 - Simple and take advantage of DEM data
 - Most sophisticated – Dozier
 - IPW (image processing workbench)

Cosine correction method

- Consider difference of direct solar illumination
- Convert radiance observed over sloped terrain (L_T) to the equivalent value of the horizontal surface (L_H):

$$L_H = L_T[\cos(\theta_s)/\cos(i)]^k$$

θ_s – the solar zenith angle, i – the solar illumination angle, k – (Minnaert constant) a measure of the extent to which a surface is Lambertian (0–1) see Section 7.2



IPW method

- Based on Dozier & Frew 1981; Dozier 1989
- Total incoming shortwave irradiance to be sum of: direct solar radiation (F_I), diffuse solar radiation (F_D), and radiation reflected from neighboring pixels (F_T) – see Figure 7.3

IPW method

- Limitations of method
 - Assumes an isotropic sky radiance distribution – usually different from actual
 - Pixels with the same slope may receive different incoming solar radiation when they have different orientations (azimuth angles)
 - Results in errors for retrieving surface reflectance from RS imagery
 - Does not provide a solution to estimate incoming solar radiation that cannot be computed from climatologic conditions of atmosphere

Shadowing function algorithm

- Used for coarser-resolution data – AVHRR, MISR, MODIS
- Pixels will contain many slopes; poor quality of DEM data available; need to consider slope distribution
- Hapke (1984) developed a shadowing function (see Section 7.4)

Hapke (1984) shadowing function

- All relevant objects are large compared to wavelength of light – apply geometric optics
- Mean slope of rough surface is reasonably small
- Multiple scattering of light from one macroscopic surface facet to another is neglected
- Surface is made of facets tilted at a variety of angles with no preferred direction in the azimuth – describe by a Gaussian distribution in the zenith angle

Comparison of several models

- All models indicate that topography has a significant effect on scaled bidirectional reflectance at large solar zenith angles over rough surfaces
- Different models -> different predictions



DEM data

- USGS DEM data products
- NGA (NIMA)
- SPOT, ASTER
- Commercial sensors
- SAR interferometry, LightSAR
- ICESat
- LiDAR