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Cover

Land surface hot-spot observed by MODIS over Central Africa

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The hot-spot is the term used to describe the increased directional reflectance that occurs over most land surfaces when the solar and view directions coincide. Under these viewing conditions, shadows cast on the surface are minimized, resulting in increased reflectance. This phenomenon has been observed in laboratory measurements (Sandmeier *et al.* 1998), airborne data (Vermote *et al.* 1997) and multi-angular satellite sensor data by systems such as POLDER (Hautecoeur and Leroy 1998).

Figure 1 and cover illustrates the hot-spot effect in MODIS land surface reflectance data (Vermote *et al.* 2002) sensed over dense forest in the Democratic Republic of Congo, 8:43 am GMT, 14 March 2001. MODIS has seven reflective bands for land studies, two 250 m bands and five 500 m bands. Figure 1 shows bands 0.645 μm (250 m), 0.555 μm (500 m) and 0.469 μm (500 m) as red, green and blue respectively to give a quasi-true colour representation. The 500 m 0.555 μm and 0.469 μm bands are sharpened to 250 m by multiplying them with the ratio of the 250 m and 500 m 0.645 μm data. An area of approximately 115 km $\times$ 160 km is shown with the top of the image sensed before the bottom of the image as MODIS passed from approximately north to south in a polar orbit inclined at approximately 98°. The solar and viewing geometry change between pixels. MODIS senses 10 km along track with each rotation of its scan mirror, sensing forty 250 m scanlines and twenty 500 m scanlines per scan (Wolfe *et al.* 1998). Hot-spots are evident in successive MODIS scans as the solar and view directions coincide and observed forest canopy shadows decrease.

Figure 2 shows a 20 km transect along a scan line through one of the central hot-spots. The 0.645 μm, 0.555 μm, and 0.469 μm land surface reflectance are plotted as a function of view zenith angle. The scattering angle, defined in equation (1), is also shown.

$$\cos(\Theta) = -\cos(\theta_s)\cos(\theta_v) - \cos(\phi_s - \phi_v)\sin(\theta_s)\sin(\theta_v) \quad (1)$$

The land surface reflectance maxima occur close to a scattering angle (Θ) of 180° where the sun zenith (θ_s) and view zenith (θ_v) angles coincide and the difference between the sun azimuth (ϕ_s) and view azimuth (ϕ_v) is small. The hot-spot affects all visible wavelengths with an increase of 20–40% reflectance, depending on the wavelength. Failure to account for these directional reflectance effects implies a

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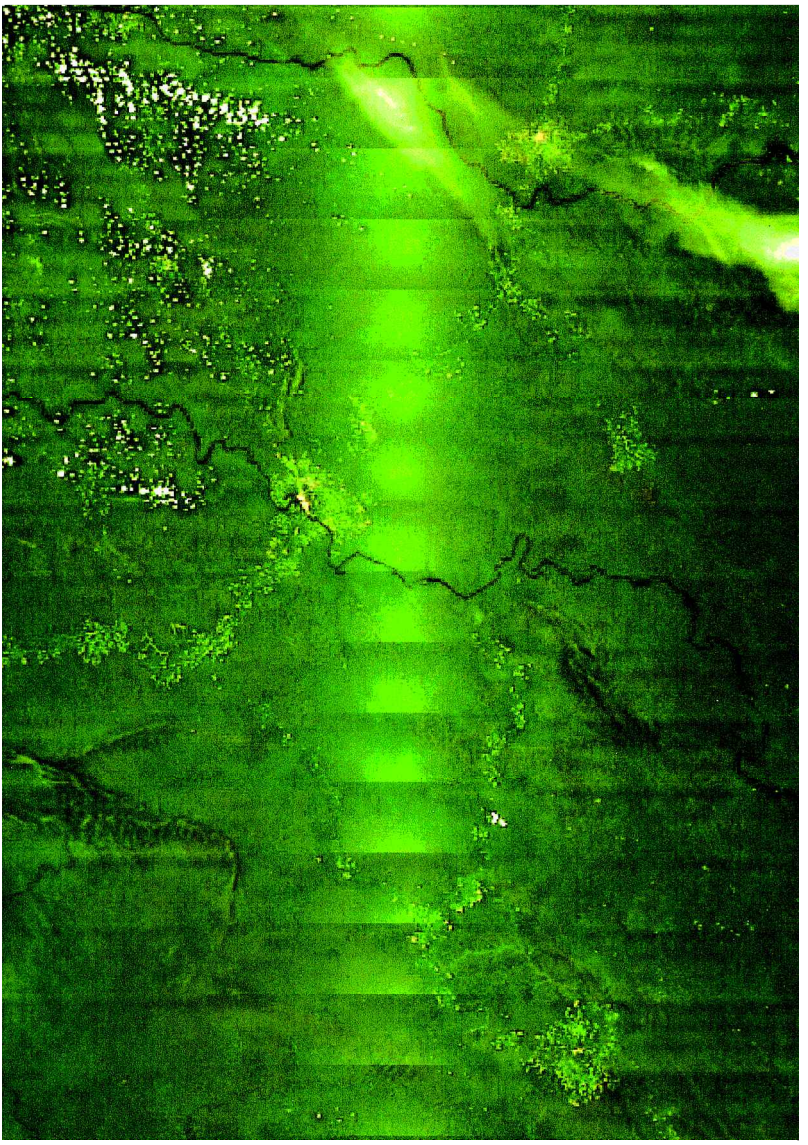

Figure 1. Hot-spot effect observed by MODIS over dense forest in the Democratic Republic of Congo. The MODIS 0.645 μm, 0.555 μm and 0.469 μm land surface reflectance are displayed as red, green and blue respectively to give a quasi-true colour representation. The bright circular regions falling along a vertical axis through the centre of the image show hot-spot effects in successive MODIS scans.

commensurate reduction in the capabilities of certain applications, for example, change detection (Roy *et al*. 2002), and fails to exploit the full range of information available in these data. The large number of daily global MODIS observations available at moderate spatial resolution encourage the development of inversion procedures (e.g. Lacaze and Roujean 2001) that retrieve physical parameters describing those land cover features that manifest themselves in the hot-spot amplitude and width.

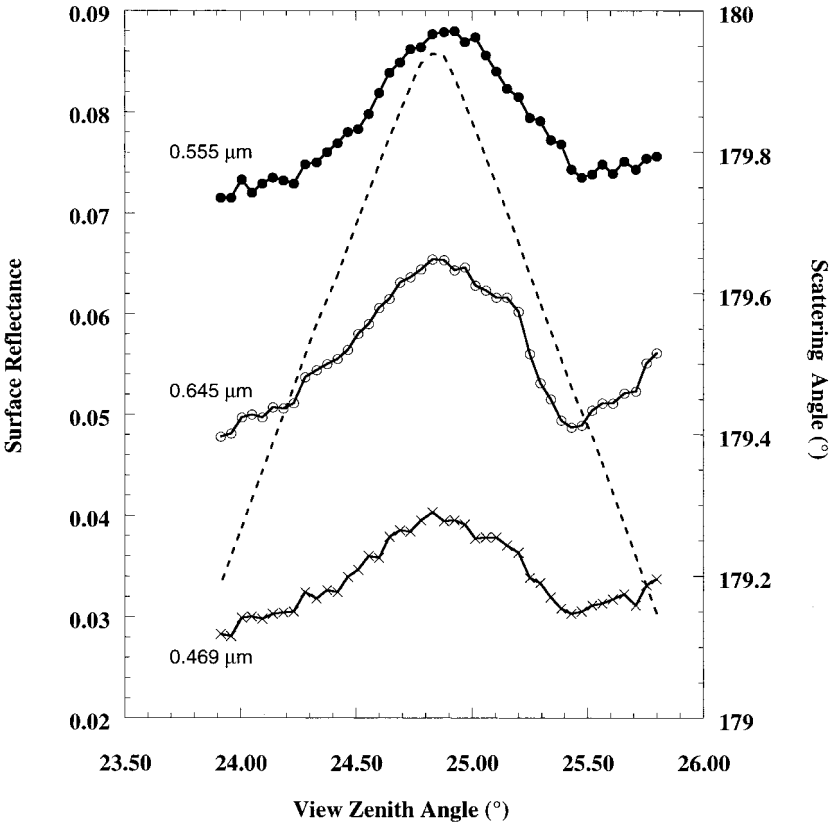

Figure 2. MODIS 0.645 μm (solid line, open circles), 0.555 μm (solid line, closed circles), 0.469 μm (solid line, crosses) land surface reflectance, and scattering angles (dashed line), for a 20 km transect along a scan line through one of the central hot-spots shown in figure 1. The maximum scattering angle occurs where the difference between the sun and view azimuth is 0.12° and the difference between the sun and view zenith is 0.04°.

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