

Daily maps of the Bi-directional Reflectance Distribution Function (BRDF) over the Siberian region based on the MODIS data²

Ivan Shmakov, Anatoly Lagutin

2010-07-09

The problem

There're a range of effects that influence the land surface reflectances as "seen" by a spacecraft-based sensor, including, but not limited to:

- poor geolocation;
- atmospheric changes;
- (illumination, view) geometry changes.

The MODIS instrument onboard the Terra satellite was the first space-based spectroradiometer which allowed these issues to be addressed. Namely:

- the geolocation's accuracy is verified to be within 50 m (typically), just 20 % of the MODIS finest resolution (250 m);
- the careful choice of the MODIS' 36 bands have for the first time allowed for accurate atmospheric correction by means of physically-sound retrieval of the key atmospheric variables;
- the availability of the data on the near-daily basis allows for the time series to be accumulated within a 16-day interval and the Bi-directional Reflectance Distribution Function (BRDF)

The half-empirical model used:

$$\begin{aligned} R_s(\Lambda, \theta, \vartheta, \varphi) &= \sum_{k=1}^{n=3} f_k(\Lambda) K_k(\theta, \vartheta, \varphi) = \\ &= f_1(\Lambda) K_{\text{iso}} + f_2(\Lambda) K_{\text{tt}}(\theta, \vartheta, \varphi) + f_3(\Lambda) K_{\text{geo}}(\theta, \vartheta, \varphi), \end{aligned} \quad (1)$$

Minimizing the least-squares error function:

$$e_{\Lambda}^2 = \frac{1}{d} \sum_{l=1}^m \frac{(\rho_s(\Lambda, \theta_l, \vartheta_l, \varphi_l) - R_s(\Lambda, \theta_l, \vartheta_l, \varphi_l))^2}{w_{\Lambda, l}}, \quad (2)$$

the coefficients $f_k(\Lambda)$ could be determined.

The processing

process	real	user, s	system, s	ratio, %
destriping	6 : 43.45	292.54	35.05	81
MODIS/Terra (10 day + 1 night)				
MOD09...	4 : 35 : 02.	11666.89	183.98	71
MODPT...	7 : 35.57	402.27	6.40	89
	7 : 44.20	415.13	6.17	90
MODMGGAD	0 : 10.22	7.11	1.00	79
	0 : 11.01	7.76	1.19	81
MOD09GST	0 : 13.41	4.25	0.67	36
	0 : 11.01	5.46	3.74	83
MOD09GHK	1 : 12.24	50.45	5.34	77
	1 : 20.91	53.07	5.88	72
MOD09GQK	3 : 14.21	86.78	8.92	49
	2 : 01.82	91.87	10.64	84
MODIS/Aqua (10 day + 3 night)				
MYD09...	4 : 47 : 03.	13258.66	196.25	78