

SAIL – A Vegetation Canopy Reflectance Model

SAIL – *Scattering by Arbitrarily Inclined Leaves*

Uses radiative transfer theory to characterize the flow of energy through a canopy as three fluxes or streams:

- a downward flux of direct radiation
- a downward flux of diffuse radiation
- an upward flux of diffuse radiation

This model requires the reflectance and transmittance of component leaves to be known.

Main parameters of model

- Leaf Area Index (LAI) – the one sided area of leaves per unit ground area. It can take on values ranging from 0 – 16, however, agricultural crops are in the range of 5 – 6. In general, there is an inverse relationship between LAI and visible reflectance and a direct relationship with NIR reflectance.
- Soil reflectance (%) – Wavelength dependent and must be described for each band that is to be modeled.
- Diffuse skylight – With complete cloud cover this may be as high as 100%. However, on cloudless days, it can be less than 10%.
- Illumination and viewing angle (sun and sensor zenith and azimuth) – A vegetation canopy is a non-Lambertian surface and, therefore, dependent upon the angle at which it is illuminated and viewed.

Range (degrees)	Mid-Point (degrees)	Frequency of leaves at given angle (%)					
		Uniform	Spherical	Planophile	Erectophile	Plagiophile	Extremophile
0.0 – 9.9	5	11.11	1.52	22.00	0.22	0.88	21.34
10 – 19.9	15	11.11	4.51	20.68	1.54	5.67	16.55
20 – 29.9	25	11.11	7.37	18.22	4.01	13.00	9.22
30 – 39.9	35	11.11	10.00	14.89	7.33	19.45	2.77
40 – 49.9	45	11.11	12.33	11.11	11.11	22.00	0.22
50 – 59.9	55	11.11	14.28	7.33	14.89	19.45	2.77
60 – 69.9	65	11.11	15.80	4.01	18.22	13.00	9.22
70 – 79.9	75	11.11	16.84	1.54	20.68	5.67	16.55
80 – 81.9	81	2.22	3.45	0.11	4.34	0.43	4.02
82 – 83.9	83	2.22	3.46	0.07	4.38	0.26	4.18
84 – 85.9	85	2.22	3.48	0.03	4.41	0.14	4.31
86 – 87.9	87	2.22	3.49	0.01	4.43	0.05	4.39
88 – 90.0	89	2.22	3.49	0.00	4.44	0.01	4.44

The Problem

1. Use the SAIL model to investigate the relationship between LAI (0 – 6) and NDVI for a “dark” soil and a “light” soil and compare the results with SAVI. Prepare a report discussing your group’s findings. Use Red = 3% and NIR = 13% for the dark soil and Red = 25% and NIR = 40% for the light soil. Leave the viewing angles, leaf transmittance/reflectance, and diffuse skylight at their defaults.
2. Select 3 of the leaf angle distribution frequencies and determine the effect of view and sensor angle. Vary LAI between 0 and 6. Use default values for leaf transmittance/reflectance, soil reflectance, and diffuse skylight. Prepare a report discussing your group’s findings.