Two-stream model for heterogeneous vegetation canopy. Version 2.4

Reference: "Symplifying the Interaction of Land Surfaces with Radiation for Relating Remote Sensing Products

to Climate Models", Pinty et al. (2005), Journal of Geophysical Research (JGR), in press.

All flags can appear in no specified order on the command line.

**GENERAL FLAGS**

-h Displays this message and exits

-v Displays the software's version number and exits

-o format\_string. Use format\_string to select the radiative quantities to be displayed as output. This is not compatible with the -A flag.

-A Display the whole set of resulting radiative quantities. This is not compatible with the -o flag.

-O (capital o) Display a line composed of the columns' tags and index.

For both -o and -A, refer to section OUTPUT FORMAT.

**TWO-STREAM MODEL**

The first three models are intended to calculate the radiative fluxes in heterogeneous vegetation canopies by using effective variable values:

--full

Selects the generic model in [Pinty et al. 2005] with all orders of scattering activated.

--dble

Selects a model with only the first and second orders of vegetation scattering activated.

--sgle

Selects a model with only the first order of vegetation scattering activated (single scattering).

To choose a model is optional. The default is to use the full model.

The following three models are intended to calculate the radiative fluxes in homogeneous vegetation canopies but with different leaf normal distributions (LND):

--spher Models a homogeneous canopy with a spherical LND.

--plano Models a homogeneous canopy with a planophile LND (mostly horizontal leaves).

--erecto Models a homogeneous canopy with an erectophile LND (mostly vertical leaves).

**ILLUMINATION**

The model calculates the radiative fluxes in two illumination geometry, namely collimated source and isotropic source. The fraction of diffuse to total downward flux f\_diff can be specified. A weighting is applied between the outputs in the two illumination conditions to yields the resulting fluxes:

Flux(tot) = (1 - f\_diff)\*Flux(collimated) + f\_diff\*Flux(isotropic)

-s illu :

Describe the illumination geometry. If illu is a numerical value, it is the zenith angle of the collimated source. Unit is degrees and it must be in ]-90,90[. However, if illu is the keyword "iso" (quotes removed), it indicates that the source is purely diffuse (f\_diff is implied to 1.0)

-F f\_diff :

set the fraction of diffuse to total downward flux. If no -F flag is used, the illumination is either purely collimated or purely isotropic, depending on the -s flag. f\_diff is a numerical value that must be in ]0,1[. The -F flag can only be used if -s is present and is given a numerical value.

**VEGETATION AND BACKGROUND DESCRIPTION PARAMETERS**

-l lai :

Set the True Leaf Area Index of the canopy <LAI>. Must be > 0. The Structure factors zeta and zeta\* multiply <LAI> to yield the effective value of LAI.

-z zeta : Structure factor zeta. Must be > 0.

-z\* zeta\_star : Mean Structure factor zeta\_star. Must be > 0.

If both are unset, the canopy is homogeneous: zeta=zeta\_star=1. If only one is set, both zeta and zeta\_star are set to the given value.

-g rg : Set the background reflectance. Must be in [0,1]. If the flag is omitted, the background reflectance defaults to 0 (black background model).

The effective value for the leaf Reflectance and Transmittance can be set using 2 (and no more than 2) of:

-r rl : Set the effective leaf Reflectance. Must be in [0,1[

-t tl : Set the effective leaf Transmittance. Must be in [0,1[.

-w wl : Set the effective leaf single scattering albedo. wl=rl+tl. Must be in [0,1[.

-d dl : Set the effective leaf forward-scattering efficiency. dl = rl/tl. Must be > 0.

OUTPUT FORMAT (issued on stdout only if the model completes the calculations).

The results are all displayed on one line. The first 8 columns are a remainder of the input parameters to the program, in the following order.

(1) sun : Sun zenith angle in degrees. (if the illumination is purely diffuse: a non-value)

(2) fdiff : fraction of diffuse downward radiation.

(3) <lai> : True Lai of the canopy.

(4) zeta : Structure factor of the canopy for this Sun angle.

(5) zeta\* : Mean Structure factor of the canopy.

(6) rbgd : Background reflectance.

(7) rleaf : Leaf reflectance (effective value).

(8) tleaf : Leaf transmittance (effective value).

The results of the calculations are then displayed on the same line. Some (and their relative order) of these values can be choosen via the -o format\_string sequence. format\_string is a list of space (or comma) separated tokens, all of which composed of the % (percent) character immediatly followed by a multi-character identifier (e.g. %Ttot). These tokens are now listed. If no -o flag is specified, the output is the same

as if the sequence -o "%Alb,%Abs,%Tran" had been specified.

Alternatively, the -A flag makes all the following radiative fluxes to be displayed, in this order:

( 9) %Alb Total Albedo.

(10) %Abs Total Absorption by the vegetation canopy.

(11) %Tran Total Transmission to the background level.

(12) %Alb\_t1 Albedo accounting for the Black Background component.

(13) %Alb\_t2 Albedo accounting for the Black Canopy component.

(14) %Alb\_t3 Albedo accounting for the coupled canopy-background term.

(15) %Abs\_t1 Absorption by the vegetation for the Black Background component.

(16) %Abs\_t3 Absorption by the vegetation for the coupled canopy-background term.

(17) %Tran\_t1 Transmission to the background level for the Black Background conponent.

It only accounts for the radiation collided by the vegetation.

(18) %Tran\_t2 Transmission to the background level for the Black Canopy conponent. This is the direct transmission through the layer.

(19) %Tran\_t3 Transmission to the background level for the coupled canopy-background term.

(20) %Rbgd1 Albedo accounting for the radiation having hit only once the background (whether collided or not by the vegetation, whether upward or downward).

NOTE

Except for -z and -z\*, only the first letter of the flag is parsed

so that -t -tl -trans -tta are all equivalent.