NAME:

README

PURPOSE:

This file provides general information about the package,

written with the C and Fortran90 languages, which implements

the two-stream based radiation transfer model in

heterogeneous vegetation canopies. An extension of the model

for homogeneous canopies with preferred leaf normal distributions

is also included (in 2stream).

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REFERENCES:

B. Pinty, T. Lavergne, R.E. Dickinson, J-L. Widlowski, N. Gobron and M. M. Verstraete (2005).

Simplifying the Interaction of Land Surfaces with Radiation for Relating Remote Sensing Products

to Climate Models. Journal of Geophysical Research. in press.

IMPORTANT PRELIMINARY COMMENT:

The 2stream package is build around three main program units, respectively implemented in 2streams.c, Simple2stream.c and Simple2streamF.f90.

These program units use the same low-level equations (black background and black canopy terms) as described in [Pinty et al. 2005]. The implementations of these low-level routines are available in C and Fortran90 in sub-directories rad2s and rad2sf90, respectively.

However, these 3 models are not intended for the same use:

1) 2streams.c (which is compiled as 2stream) is designed to be a command-line tool whose user-interface thoroughly checks for mis-uses and whose output format can be configured.

It gives access to the radiative components as described in [Pinty et al. 2005]. Moreover, this program also implements the two-stream model for homogeneous canopies but with preferred leaf normal distributions (planophile, erectophile).

| This tool is intended as a) a demonstration/educational tool and b) a processing

| tool to be included in scripts.

2) Simple2stream.c (which is compiled as Simple2stream) and Simple2streamF.f90 (which is compiled

as Simple2streamF) are very similar except for the programming syntax. They are both designed

as minimalist models. Compared to 2streams.c, the same physics is embedded, except for the final

coupling equations. However, no user-interface is available, no checks are performed on the model

parameters and, finally, they do not give access to the intermediate calculation steps

(the radiative components). Both are build on loops over all input parameters to cover a large

range of conditions.

| These tools are written to help and guide users who would want to include the two-stream

| model in bigger codes (e.g. GCMs, biosphere models,...) in C or Fortran.

CONTENTS:

The 2stream package contains:

In the top-level directory:

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README

this file.

NEWS

documents changes made to the package.

INSTALL

contains instructions to build and install the executables

of the package.

EXAMPLES

A text file to present and comment some examples to

properly use the 2stream software.

makefile

input file to the make tool to build the 2stream package.

In the srcC/ sub-directory:

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2streams.c

contains the main program unit which activates

in turn the command line parser, the argument

checker, the radiative transfer 2s model and

eventually the output routines.

Simple2stream.c

contains an alternative main program unit which uses

a simpler and less user-friendly implementation of

the two-stream model.

It is simpler in the sense that it is not possible

to access the various radiative components but only

the total albedo, transmission and absorption. Moreover,

no user interface is used: input parameters are browsed

along successive loops to cover several conditions.

This main program unit is written for those users who want

to ingest the two-stream model in bigger codes (e.g. GCMs)

and need hence a simpler routine/interface.

interf.c [.h]

contains the routines in charge of parsing the

command line options, checking the arguments

given by the user as well as writting the model

results in a formatted string.

2streamsRTmodels.c [.h]

defines the generic 2s model as the sum of several

radiation components ([Pinty et al. 2005]) as well

as its specific implementations (scattering orders,

leaf normal distribution, etc...)

gamma.c [.h]

implements the various gamma coefficients as well as

the effective optical thickness to enter the 2s model.

common.h

defines some variables and macros used in several other

routines.

In the srcF/ sub-directory:

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Simple2streamF.f

contains an alternative main program unit much similar

to Simple2stream.c

In the rad2s/ subdirectory:

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Low-level radiation routines written in C.

Refer to the README file in directory rad2s.

In the rad2sf90/ subdirectory:

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Low-level radiation routines written in Fortran90.

Refer to the README file in directory rad2sf90.

INSTALLATION:

Please refer to the INSTALL file included in the distribution.

RUNNING THE PROGRAMS:

2stream:

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1) DEFAULT EXECUTION

A default execution of the 2stream is possible: just enters at

the shell's prompt the command:

[:prompt:] ./bin/2stream

The model will use default values for its arguments.

2) NORMAL EXECUTION:

The 2stream executable acts as a UNIX/Linux tool. In normal

configuration, 2stream takes its arguments from the command

line, checks they are valid, runs the 2s model and eventually

prints results on a single line (stdout). If an error occurs

during the processing or if the command line arguments cannot

be parsed, error and warning messages are issued on stderr.

EXIT\_SUCCESS is the return code of 2stream if, and only if,

the execution went fine and the results are nominal.

EXIT\_FAILURE is returned otherwise. These values usually

correspond to 0 and 1, respectively.

3) INPUTS and OUTPUTS:

Inputs and ouputs to 2stream are described in the USAGE file

which is created at compile time. The -h flag to the 2stream

executable also prints this information. This usage message

is re-produced at the end of this document (in the USING

section) for user's convenience.

Note, however, that this section does not act as a reference

and that the message displayed via the -h flag will usually

be more up-to-date.

Simple2stream and Simple2streamF:

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1) EXECUTION:

Both programs are written as loops on the model's input parameters

and hence take no parameters from the command line:

[:prompt:] ./bin/Simple2stream

[:prompt:] ./bin/Simple2streamF

2) OUTPUTS:

A little more than 2000 input parameters values are used and the

resulting fluxes (purely colllimated and isotropic sources) are

written on as many lines on stdout.

USING:

######################################################################################

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.