\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Skyrad.pack\_V5.0/sproc5: - 7/8 -

- Analysis Ver.5.0 -

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

1. History

----------

2006.04.20 Renewal Version 4.2 is fixed by M.Yamano

2024.01.17 Version 5.0 is fixed by M.Hashimoto

2. List of contents

-------------------

In the directory sproc5/ there are the following four files for

'sproc5' processing and this document 'ReadMe\_v5.doc'.

. sproc5.f : full source program file for analysis Ver.5.0.

. sproc.par : parameters/options file for 'sproc' processing.

. sproc5\_0.par: an example for 'sproc.par' for the level-0 analysis.

. sproc5\_1.par: an example for 'sproc.par' for the level-1 analysis.

3. Procedure for 'sproc5' processing

------------------------------------

3-1. Setting of 'sproc.par'

(1) The contents of 'sproc.par'

The contents of 'sproc.par' are as follows.

0 1 1 1 1 0 : IOUT IPAR IVOL IAUR IPHS IPF0(output option) - 1:create / 0:not

"ins.para.example" : instrument parameter file name

"METEO.DAT.default" : meteorological data(pressure & ozone) file name

C --- atmospheric model.

1 : NLN

1.0 : (CONCA(L),L=1,NLN)

1.0 : (CONCM(L),L=1,NLN)

C --- data information.

7 1 6 : NW(number of wavelengths) NO3(No.of O3 abs.) NWV(No.of WV abs.)

0.315E-4 0.400E-4 0.500E-4 0.675E-4 0.870E-4 0.940E-4 1.020E-4 : WL[cm]

0 1 2 1 1 0 1 : IANL

1.5 1.5 1.5 1.5 1.5 1.5 1.5 : CR

-0.005 -0.005 -0.005 -0.005 -0.005 -0.005 -0.005 : CI

0.1 0.1 0.1 0.1 0.1 0.1 0.1 : GA

C --- processing options.

1 1 1 20 0 0 : JTAU IDCR IDCI INVM IPLC IPHS

3.0 180.0 : ANGMN[deg] ANGMX[deg]

5 0.01 0.001 0.2 : LOOPMX EPSA EPSA1 EPSA2

20 0.01E-4 20.0E-4 : NSIZE RMIN[cm] RMAX[cm]

20 : NMODE/ RMODE[cm] / SSL

2.38E-06 3.36E-06 4.74E-06 6.70E-06 9.46E-06 1.34E-05 1.89E-05 2.67E-05

3.77E-05 5.32E-05 7.52E-05 1.06E-04 1.50E-04 2.12E-04 2.99E-04 4.23E-04

5.97E-04 8.43E-04 1.19E-03 1.68E-03

0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4

0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4

0.4 0.4 0.4 0.4

IOUT, IPAR, IVOL, IAUR, IPHS and IPF0 are flags for output options.

If it is positve, files corresponding to it are made.

If IOUT>0, full output files for analysis Ver.5.0(Out/\*.out) are made.

If IPAR>0, output files for analysis Ver.5.0(Par/\*.par) are made.

If IVOL>0, output files for analysis Ver.5.0(Vol/\*.vol) are made.

If IAUR>0, output files for analysis Ver.5.0(Aur/\*.aur) are made.

If IPHS>0, output files for analysis Ver.5.0(Phs/\*.phs) are made.

If IPF0>0, input data files for determination of F0(F0d/\*.w??) are made.

File names of observation conditions files, 'ins.para'(information

on instrument) and 'METEO.DAT'(meteorological conditions) are set.

Regarding 'atmospheric model':

The atmosphere is modeled of some atmospheric sublayers. NLN is

number of sublayers (NLN< 5). CONCA(L) and CONCM(L) are proportions

of the L-th layer's aerosol optical thickness and molecular to total

respectively.

\* NLN> 1 is not tested. So far NLN=1 is set.

Regarding 'data information':

Number of wavelengths(NW), wavelengths(WL[cm]) and numbers of order

for wavelengths having absorption by ozone(NO3) and by water vapor

(NWV) are set. IANL is a flag for use. If it is positive, data for

the wavelength corresponding to it are used for analysis.

CR and CI are initial values of retrieval for real and imaginary

parts of complex refractive index respectively. GA is the ground

albedo that is assumed in analysis. It should be changed, if the

surface of the measurement site is extraordinary.

\* Even if IANL>0, data for its wavelength are not used for analysis,

if it has absorption (corresponds to the wavelength of NO3 or NWV).

Regarding 'processing options':

JTAU is a flag for use of direct data. If JTAU=1, direct data(SA=0.0)

are used for analysis. If JTAU=0, only diffused data(SA>0.0) are used.

IDCR and IDCI are flags for retrieval options of real and imaginary

parts of complex refractive index respectively. If it is positive,

the part corresponding to it is retrieved. If it is zero, the part

is assumed to be the initial value of retrieval(CR or CI).

INVM gives type of kernel and INVM=20 is set for analysis Ver.4.2.

INVM=20 gives log-normal multi-modal kernel.

IPLC(control for polarization correction) and IPHS(control for phase

function) are not available (IPLC=IPHS=0).

ANGMN and ANGMX give minimum and maximum scattering angles for

analysis. Data corresponding to this angle range (and direct data,

if JTAU>0) are used for analysis.

Regarding iteration LOOPMX, EPSA, EPSA1 and EPSA2 are set. LOOPMX

is the maximum number of iteration. EPSA and EPSA1 are absolute

and relative criterions for convergence respectively. EPSA2 is a

criterion to give up convergence.

\*'Retrieval error' of the n-th loop(EROR(n)) is defined as the

RMSD of (AURC(i)-AUR(i))/AUR(i). Here AUR(i) and AURC(i) are

measured and retrieved sky radiance for the i-th scattering angle

respectively.

Results are got in the following three cases.

1. If EROR(n) .LE.EPSA --> converged(rank1).

2. ElseIf ABS(EROR(n)-EROR(n-1)).LE.EPSA1 --> converged(rank2).

3. ElseIf n.EQ.LOOPMX --> discontinued.

If n.GE.2 and EROR(n).GT.EPSA2, calculation discontinues. In this

case no results are got.

Regarding size distribution NSIZE, RMIN and RMAX are set. In case

of log-normal multi-modal kernel(INVM=20) NMODE, RMODE and SSL are

also set. NSIZE is number of discrete points of radius for volume

spectrum output. RMIN and RMAX are minimum and maximum radii for

size integration respectively. NMODE is number of modes of aerosol

size distribution and RMODE and SSL are mode radius and log-dispersion

of the respective modes. The size distribution of the m-th mode is

as follows. Here Cm is a constant.

dV/dlnr = Cm\*exp(-(ln(r/RMODE(m))/SSL(m))\*\*2/2)

The (total) size distribution is the summation of these NMODE size

distributions in case of INVM=20.

\* Regarding RMIN, RMAX and RMODE the next relation must be satisfied.

RMIN < RMODE(1) < RMODE(NMODE) < RMAX

(2) The level-1 and the level-0 analyses.

The level-1 analysis is a normal full analysis, that is, not only

optical thickness and size distribution, but also complex refractive

index are retrieved. For the level-1 analysis calibration constants

for the instrument(F0) are indispensable.

The level-0 anaysis is a rough estimate for optical thickness and size

distribution with assumed complex refractive index. For the level-0

analysis only forward scatterings of diffused sky radiance data are used.

Optical thickness got by the level-0 analysis and direct data are

used for determination of calibration constants(F0). Therefore input

data files for F0 determination(F0d/\*.w??) are made, if it is chosen

(IPF0>0).

'sproc5\_1.par' and 'sproc5\_0.par' are examples for 'sproc.par' for the

level-1 and the level-0 analses Ver.5.0. respectively.

3-2. Inputs

Input files for 'sproc5' processing are as follows.

DT5/\*.DT5: input data files for analysis Ver.5.0.

Tag/\*.tag: 'tag' files for respective input data files.

These files are made by 'dtform' processing in case of PREDE data.

In other cases they must be made from measurement data files by

yourself.

The formats of \*.DT5 and \*.tag files are given in ReadMe\_dtform.doc.

3-3. 'sproc5' processing

(1) Make output directories Par/, Vol/, Aur/ and Phs/ (or Out/)

Directories corresponding to positive flags IPAR, IVOL, IAUR and

IPHS (or IOUT) are made. If input data files for determination of

calibration constants(F0) for the instrument are made(if IPF0>0),

a directory F0d/ is also made.

mkdir Par Vol Aur Phs (or Out) [F0d]

(2) Make 'fname' file

'fname' is a list of data files that will be processed.

Data for 'fname' are given as file names with or without extension.

For example, the following A. and B. are equivalent. 'fname' for

'dtform' processing is also available, because the part of extension

is ignored.

A. B.

02012900 02012900.DT5

02013000 02013000.DT5

02013100 02013100.DT5

: :

\* 'fname' of type B. is made automatically by means of the following

procedure.

cd DT5

ls -1 \*.DT5 > ../fname

cd ../

(3) Run 'sproc5.e'

An executable file 'sproc5.e' for the source file 'sproc5.f' is

executed. 'ins.para' and 'METEO.DAT' files that are specified

in 'sproc.par' and a Mie-kernel file 'MIEKER' are necessary for

execution.

Sproc5.e

3-4. Outputs

Output files for 'sproc5' processing are as follows.

Par/\*.par : optical thickness, refractive index, single scattering

albedo (if IPAR>0)

Vol/\*.vol : volume spectrum (dV/dlnr[cm3/cm2]) (if IVOL>0)

Aur/\*.aur : measured and retrieved sky radiance (if IAUR>0)

Phs/\*.phs : phase function (if IPHS>0)

Out/\*.out : all results of \*.par, \*.vol, \*.aur and \*.phs (if IOUT>0)

F0d/\*.w?? : input data for determination of F0 (if IPF0>0)

sproc.tag : 'tag' file for all processed data

sproc5.log: processing log file

If data fail to be processed because of some error, an error message

is output to 'sproc5.log' file. 'sproc.tag' is a table of information

on analyzed data (conditions for measurement and analysis).

4. Formats of output files

--------------------------

4-1. Format of 'sproc.tag' file

An example for 'sproc.tag' file is as follows.

TNo yyyy mm dd Hour Long Lat Hs SA(max) SA r i error (LP)

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

2 2003 5 29 5.67 139.32 35.75 12.38 150.0 151.5 1 1 0.0409 ( 5)

3 2003 5 29 6.00 139.32 35.75 16.28 140.0 141.4 1 1 0.0494 ( 5) \*\*

: : : : : : : : : : : : : : :

This is a table of information on conditions for measurement and

analysis of analyzed data. There are serial number(TNo), year(yyyy),

month(mm), day(dd), time(Hour), longitude(Long), latitude(Lat), solar

height(Hs), maximum scattering angles for measurement(SA(max)) and

for use(SA), retrieval flags for complex refractive index(r and i),

retrieval error(error), number of iteration(LP) and convergence flag

(\*\_or \*\* or \_\_) in order from the left.

If retrieval flag for complex refractive index(r/i) is positive, output

value of the part corresponding to it(real/imaginary) is a retrieval.

If it is zero, that is not a retrieval, but a value assumed to be the

initial value of retrieval (CR or CI) in 'sproc.par'.

\* Besides the case of IDCR(or IDCI)=0 in 'sproc.par', when the retrieval

is not successful, the retrieval flag (r or i) is zero, that is, the

part is assumed to be the initial value.

Convergence flags [\* ], [\*\*] and [ ] mean convergence(rank1),

convergence(rank2) and no convergence respectively.

4-2. Format of Par/\*.par files

An example for Par/\*.par files is as follows.

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

0.4000 0.4639 0.4588 0.9690 1.4040 -0.00299

0.5000 0.3709 0.3726 0.9816 1.4164 -0.00169

0.6750 0.2502 0.2541 0.9836 1.4168 -0.00138

0.8700 0.1817 0.1823 0.9920 1.4147 -0.00063

1.0200 0.1513 0.1496 0.9969 1.4061 -0.00024

This is an output for one measurement. A header(the 1st record) is

a record of 'sproc.tag' file that corresponds to this result.

After header results are given. In order from the left

WL : wavelength in micron

OPT: (measured) optical thickness

TA : (retrieved) optical thickness

WA : single scattering albedo

Cr : real part of complex refractive index

Ci : imaginary part of complex refractive index

\* OPT is calculated from direct data and calibration constant F0.

WA is not retrieved directly, but calculated from other parameters.

4-3. Format of Vol/\*.vol files

An example for Vol/\*.vol files is as follows.

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

1.209E-06 2.684E-11

1.768E-06 2.017E-10

2.586E-06 1.170E-09

: :

7.734E-04 7.004E-07

1.131E-03 2.323E-07

1.654E-03 7.736E-08

This is an output for one measurement. A header(the 1st record) is

a record of 'sproc.tag' file that corresponds to this result.

After header results are given. In order from the left

Radius: radius in centimeter

Volume: volume spectrum dV/dlnr in cm3/cm2

4-4. Format of Aur/\*.aur files

An example for Aur/\*.aur files is as follows.

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

-9 81.5 0.0 0.0 5.417E-07 -1.000E+00

1 81.5 3.0 3.0 2.301E+00 2.375E+00

1 81.5 4.1 4.1 2.065E+00 2.117E+00

: : : : : :

1 81.5 144.6 140.8 7.369E-03 6.900E-03

1 81.5 156.6 151.1 8.132E-03 7.919E-03

1 81.5 173.4 161.8 8.587E-03 8.910E-03

This is an output for one measurement. A header(the 1st record) is

a record of 'sproc.tag' file that corresponds to this result.

After header results are given. In order from the left

fg : flag for availability

TH : zenith angle in degree

FI : (relative to solar) azimuth angle in degree

SA : scattering angle in degree

AUR : measured sky radiance

AURC: retrieved sky radiance

Regarding flag for availability:

fg = 1: available/ use for retrieval

-1: not available/ no use for retrieval (abnormal positive data)

0: no use for analysis (out of usable scattering angles)

-9: meaningless (direct data or negative data)

\* Measured direct data AUR(IW,1) are used for analysis as measured

optical thickness OPT(IW).

\* Results for the respective wavelengths are output sequentially.

4-5. Format of Phs/\*.phs files

An example for Phs/\*.phs files is as follows.

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

0.0 6.917E+00 5.477E+00 4.469E+00 3.862E+00 3.572E+00

0.2 6.775E+00 5.403E+00 4.435E+00 3.844E+00 3.561E+00

0.4 6.408E+00 5.203E+00 4.339E+00 3.793E+00 3.526E+00

: : : : : :

170.0 1.406E-02 1.672E-02 1.945E-02 2.214E-02 2.263E-02

175.0 1.432E-02 1.616E-02 1.820E-02 2.117E-02 2.187E-02

180.0 1.581E-02 1.851E-02 2.142E-02 2.500E-02 2.574E-02

This is an output for one measurement. A header(the 1st record) is

a record of 'sproc.tag' file that corresponds to this result.

After header results are given. In order from the left

THETA : scattering angle in degree

POBSN(IW=1,NW): normalized phase functions for the respective

wavelengths

4-6. Format of Out/\*.out files

An example for Out/\*.out files is as follows.

This is an output for one measurement. A header(the 1st record) is

a record of 'sproc.tag' file that corresponds to this result.

After header all results (contents of \*.par, \*.vol, \*.aur and \*.phs)

are given. Explanations for those are given in chapters 4-2.- 4-5. of

this document.

1 2003 5 29 5.33 139.32 35.75 8.55 160.0 161.8 1 1 0.0319 ( 4) \*\*

Refractive Indices

WL 0.4000 0.5000 0.6750 0.8700 1.0200

Cr 1.4040 1.4164 1.4168 1.4147 1.4061

Ci -0.00299 -0.00169 -0.00138 -0.00063 -0.00024

Radius Volume

1.209E-06 2.684E-11

1.768E-06 2.017E-10

2.586E-06 1.170E-09

: :

7.734E-04 7.004E-07

1.131E-03 2.323E-07

1.654E-03 7.736E-08

Cross sections

WL 0.4000 0.5000 0.6750 0.8700 1.0200

OPT 0.4639 0.3709 0.2502 0.1817 0.1513

TA 0.4588 0.3726 0.2541 0.1823 0.1496

WA 0.9690 0.9816 0.9836 0.9920 0.9969

fg TH FI SCA AUR AURC

-9 81.5 0.0 0.0 5.417E-07 -1.000E+00

1 81.5 3.0 3.0 2.301E+00 2.375E+00

1 81.5 4.1 4.1 2.065E+00 2.117E+00

: : : : : :

1 81.5 144.6 140.8 7.369E-03 6.900E-03

1 81.5 156.6 151.1 8.132E-03 7.919E-03

1 81.5 173.4 161.8 8.587E-03 8.910E-03

THETA POBSN(IW=1,NW)

0.0 6.917E+00 5.477E+00 4.469E+00 3.862E+00 3.572E+00

0.2 6.775E+00 5.403E+00 4.435E+00 3.844E+00 3.561E+00

0.4 6.408E+00 5.203E+00 4.339E+00 3.793E+00 3.526E+00

: : : : : :

170.0 1.406E-02 1.672E-02 1.945E-02 2.214E-02 2.263E-02

175.0 1.432E-02 1.616E-02 1.820E-02 2.117E-02 2.187E-02

180.0 1.581E-02 1.851E-02 2.142E-02 2.500E-02 2.574E-02

4-7. Format of F0d/\*.w?? files

An example for F0d/\*.w?? files is as follows.

5.000E-05 2 0 0 : WL(IW) IW IO3 IWV

Y M D HR M FOBS TAUR TAUO3 TAUE TAUS ERR

2003 5 29 5.334 6.7655 8.454E-06 0.1434 0.0090 4.028E-01 3.842E-01 2.263E-02

2003 5 29 5.667 4.6569 1.754E-05 0.1434 0.0090 5.019E-01 4.773E-01 3.316E-02

2003 5 29 6.001 3.5629 3.269E-05 0.1434 0.0090 5.230E-01 4.976E-01 3.796E-02

: : : : : : : : : : :

This is a table of daily optical data for the ??-th wavelength that

are used for determination of calibration constants(F0) by the Langley

or the Improved Langley methods.

Here WL(IW) is the wavelength and IW is its number of order. IO3 and

IWV are numbers of order for wavelengths having ozone and water vapor

absorptions respectively. After a title line in order from the left

Y M D: year(Y), month(M) and day(D)

HR : time in hour

M : airmass

FOBS : direct solar irradiance

TAUR : optical thickness of Rayleigh scattering

TAUO3 : optical thickness of ozone absorption

TAUE : optical thickness of aerosol extinction

TAUS : optical thickness of aerosol scattering

ERR : 'retrieval error'

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* End of ReadMe\_v4.doc \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*