Description of Phase 2 (Case 4 & 5) experiments

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Synopsis:

- All remote sensing experiments are strictly monochromatic.
- All remote sensing output is upwelling radiances at pixel scale.
- Periodic boundary conditions
- Output directions (experiment set 3) are MISR angles.
- Optional output of extinction, single scattering albedo, and phase functions for case 3 to check optical property calculations. Note: radiative transfer is performed with given optical properties.
- Optional output of photon path length moments (mean, sdev, skew) for nadir radiances.

For each experiment set, run:

- two accuracies: high (as much as computationally feasible), low (10 times less computer time)
- two cloud fields
- two solar zenith angles (0 and 60 degrees)
- two solar wavelengths (0.67 and 2.2 um) + 11 um thermal radiation (optional)

Experiment sets:

1) no atmosphere, Mie phase function re=10 um, Lambertian surface, bidirectional reflectances at mu=1.

2) Rayleigh + molecular absorption + aerosol (fixed optical properties, vertically varying extinction) + Mie phase function re=10, Lambertian surface: albedo=0.20 (for solar wavelengths), 0.0 (for thermal). Bidirectional reflectances at 0, 60.0 degrees zenith angle and 0, 90, 180 viewing azimuths (4 directions).

All cloud, aerosol, and molecular optical properties needed for the radiative transfer are provided for all cases. Physical properties cloud LWC and effective radius, aerosol size distribution and index of refraction) are also provided for those who wish to check their single scattering methods.

Input data

Case 4 input data: cu.tar
Case5 input data: stcu.tar

Details about the input files (including format)

Cloud property files (1st row of table)
These are properties at layer centers. The order of the columns is as follows:

IX	IY	IZ	LWC (gm-3)	Reff (um)	ext067 (/km)	omega067	ext213 (/km)	omega213	ext11 (/km)	omega11

The first three columns are grid indexes, the fourth is liquid water content, the fifth is effective radius. The remaining columns are volume extinction coefficient and single scattering albedo for 0.67, 2.13, and 11 um.

The midpoints (zm) of the verical layers (in km) are given by:
zm=1.02+(IZ-1)*0.04, IZ=1,36 Cu cloud field (case 4)
zm=0.4125+(IZ-1)*0.025, IZ=1,16 Sc cloud field (case 5)

Horizontal grid size (in both X and Y directions) is 0.0667 km for the Cu cloud field and 0.055 km for the Sc cloud field.

Cloud Mie files (2nd row of table)
The Mie files are tables of extinction, single scattering albedo, and phase functions represented with Legendre polynomial coefficients for LWC=1 g/m^3 for several effective radii (increment of 0.5 um). Use `plotmietab.f` to read (subroutine `READ_MIE_TABLE`) and reconstruct the phase functions. It is left up to the participant to decide how to use these phase functions for obtaining cloud droplet phase functions for each gridpoint of the 3-d field (for experiments where reff varies with location).

Aerosol Mie files (3rd row of table)
These are similar to their cloud counterparts. The aerosol size distribution is a single mode lognormal size distribution with re=0.130 um sigma=0.70. The index of refraction is independent of wavelength with value m=(1.45,-0.01).

Atmospheric extinction coefficient files (4th row of table)
The aerosol and water vapor profiles below 5 km are from ARM Southern Great Plains site Raman lidar data on 10/6/99 at 1450UTC. Aerosol extinction profile scaled using single mode lognormal size distribution and Mie theory fit to CIMEL optical depths. McClatchey midlatitude summer atmosphere used above 5 km. Profiles of molecular absorption at 0.67, 2.13, 11.0 um, molecular scattering at 0.67 um, and aerosol extinction at 0.67 and 2.13 um. These profiles should be combined with the cloud optical property profiles for experiments where atmospheric effects are accounted for; exact implementation is left to the participant. There is only one actual profile, but two files because the levels are chosen to match the two cloud cases. The order of the columns is as follows:

height (km)	temp (K)	molecular absorption 0.67 2.13 11.0	Rayleigh 0.67	Aerosol 0.67 2.13

Atmospheric optical depth files (5th row of table)
Equivalent information to the extinction profiles, but integrated to layer optical depths for models that assume uniform optical properties in a grid cell. The order of the columns is as follows:

bottom (km)	top (km)	temp (K)	molecular absorption 0.67 2.13 11.0	Rayleigh 0.67	Aerosol 0.67 2.13

Atmospheric sounding files (6th row of table)
The water vapor profile below 5 km is from ARM Southern Great Plains site Raman lidar data on 10/6/99 at 1450UTC. McClatchey midlatitude summer atmosphere used above 5 km. The order of the columns is as follows:

Height (km)	Pres (mb)	Temp (K)	AirDensity (g/m^3)	H2Odensity (g/m^3)	O3density (g/m^3)

Source code files (7th row of table)
Both Fortran source codes `plotmietab.f` and `rpv_reflection.f` are taken from Frank Evans' SHDOM distribution package. Th first routine reads in the cloud and aersol Mie table files and reconstructs the phase function from the Legendre coefficients. The second routine give surface BRDF reflection according to Rahman, Pinty, Verstraete (RPV), 1993, J. Geophys. Res., 98, 20791-20801. For surface BRDF calculations, however, you are encouraged to write your own code based on the above paper. The values of the RPV model parameters are given in the experiment descriptions below.

DETAILED BREAKDOWN TO EXPERIMENTS

For **each** cloud field (case), perform the following experiments:

First set

Experiment 1: no atmosphere, wavelength=0.67 um, SZA=0 deg., Mie phase function with re=10 um throughout the cloud field, Lambertian surface albedo= 0.2 (used for all solar experiments of this set, i.e. independent of wavelength). Output is only bidirectional nadir reflectance at 30 km.
Experiment 2: As Experiment 1, SZA=60 deg., azimuth=0 deg.
Experiment 3: As Experiment 1, wavelength=2.13 um
Experiment 4: As Experiment 2, wavelength=2.13 um
Experiment 5: **Optional.** No atmosphere, wavelength=11 um, Mie phase function with re=10 um throughout the cloud field, black surface, surface temperature = T(0 km) from atmospheric sounding profile file. Output is only nadir emittance at 30 km.

Second set

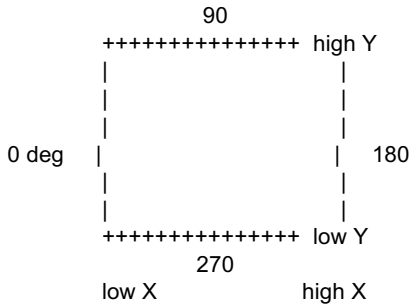
Experiment 6: Rayleigh + molecular absorption + aerosol (fixed optical properties, vertically varying extinction) , Mie phase function with re=10 um throughout the cloud field, wavelength=0.67 um, SZA=0 deg., Lambertian surface with albedo=0.2 (used for all solar experiments of this set, i.e. independent of wavelength). Outputs are bidirectional reflectances at 0, 60.0 degrees zenith angle and 0, 90, 180 viewing azimuths (4 directions).
Experiment 7: As Experiment 6, SZA=60 deg., azimuth=0 deg.
Experiment 8: As Experiment 6, wavelength=2.13 um
Experiment 9: As Experiment 7, wavelength=2.13 um
Experiment 10: **Optional.** molecular absorption , wavelength=11 um, black surface, surface temperature = T(0 km) from atmospheric sounding profile file. Outputs are directional emittances at 0, 60.0 degrees zenith angle and 0, 90, 180 viewing azimuths (4 directions).

Third set (optional)

Experiment 11: Rayleigh + molecular absorption + aerosol (fixed optical properties, vertically varying extinction), wavelength=0.67 um, SZA=0 deg., Mie phase function with re depending on LWC (and thus a function of position). Parameterized vegetation BRDF surface from RPV model with parameters (using the name convention in rpv_reflection.f): RHO0=0.076, k=0.648, THETA= -0.290 (corresponding to plowed field and used in all solar experiments). Outputs are bidirectional reflectances at 0, 26.1, 45.6, 60.0, 70.5 degrees zenith angle (MISR angles) and 0, 90, 180 viewing azimuths.
Experiment 12: As Experiment 11, SZA=60 deg., azimuth= 0 deg
Experiment 13: As Experiment 11, wavelength=2.13 um
Experiment 14: As Experiment 12, wavelength=2.13 um
Experiment 15: Molecular absorption , wavelength=11 um, Mie phase function with re depending on LWC (and thus a function of position), black surface, surface temperature = T(0 km) from atmospheric sounding profile file. Outputs are directional emittances at 0, 26.1, 45.6, 60.0, 70.5 degrees zenith angle and 0, 90, 180 viewing azimuths.

Bidirectional reflectances are defined as pi*radiance/[mu0*F(30 km)] for incident solar flux F(30 km)=1, where pi=3.1415927 and mu0=cosine(Solar Zenith Angle).
Directional emittances are defined as radiance/B(Ts) where Ts=T(0 km) is the surface temperature and B is the Planck intensity function at 11 um.

Note on azimuth convention:



The above sketch shows our azimuth convention. For example, a sun azimuth of 0 degrees means that the sun's rays are directed from 0 deg. ("West") towards 180 deg. ("East"). Similarly, a view azimuth of, say, 90 deg. indicates that a sensor is located at 90 deg. ("North"), viewing towards 270 deg. ("South"), thus collecting radiation streaming from 270 deg. ("South") to 90 deg. ("North").

OUTPUT FILE FORMAT AND NAME CONVENTION

Name convention for output files follows the rules of Phase I. Create a separate file for each experiment and output field. Use the following name convention:

`I3RC_RQ_case_accu_RS_exp#.inst[n]`

where:

"`RQ`" is the radiative quantity contained in the file. `RQ` takes the following values:

	RQ index
Iu (bidirectional nadir reflectance)	iq=1
I1_0, I1_90, I1_180 (bidirectional reflectance at 26.1 deg. view, 0, 90, 180 deg. azimuth)	iq= 2, 3, 4
I2_0, I2_90, I2_180 (bidirectional reflectance at 45.6 deg. view, 0, 90, 180 deg. azimuth)	iq= 5, 6, 7
I3_0, I3_90, I3_180 (bidirectional reflectance at 60.0 deg. view, 0, 90, 180 deg. azimuth)	iq= 8, 9, 10
I4_0, I4_90, I4_180 (bidirectional reflectance at 70.5 deg. view, 0, 90, 180 deg. azimuth)	iq= 11, 12, 13

"`case`" is the cloud field case. For phase II the cloud field cases have been assigned the following numbers:

`case=4` LES Cu cloud
`case=5` LES Sc cloud

"`accu`"=`H` (for high accuracy runs) `or L` (low accuracy runs).

"`RS`" stands for "Remote Sensing"

"`exp#`" is the experiment number as listed above. Valid numbers are 1-15.

"`inst`" is the four-letter code that has been assigned to each institution participating in the experiment.

"`[n]`" is an index number following the institution whenever there are more than one participant or codes from the same institution. There is no number for institutions with one participant and one code.

Examples

1) The nadir reflectance field of Remote Sensing experiment 3, low accuracy, LES Cu cloud case submitted by a participant affiliated with institution MESC should have the following filename:

```
I3RC_Iu_4_L_RS_3.MESC
```

2) The bidirectional reflectance field at 60 deg. zenith view, 90 deg. azimuth, of Remote Sensing experiment 2, high accuracy, LES cloud Sc case submitted by the 2nd participant of institution UMBC should be put in the following file:

```
I3RC_I3_90_5_H_RS_2.UMBC2
```

Output format should be like the one produced by the following sample Fortran code:

```
      parameter (nx=100, ny=100)
c     rq is the radiative quantity of interest
      real rq(nx,ny)
      open (11, file='I3RC_Iu_4_RS_15.KIAE', status='unknown')
      do ix=1,nx
        do iy=1,ny
           write (11, '(f8.5)') rq(ix,iy)
        enddo
      enddo
      close(11)
```