What has changed relative to the last update?
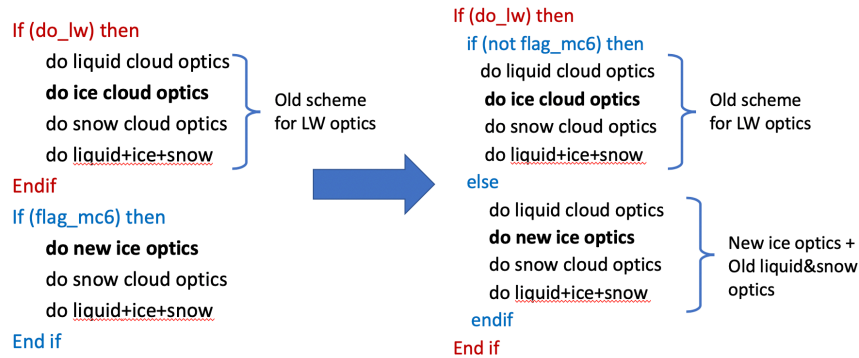Xianwen Jing
June 10, 2020

1. Major changes:
   a. **Structure change**
   In $E3SM_ROOT/components/cam/src/physics/rrtmg/radiation.F90, the computation of longwave optics has been changed as the following picture:

   b. **Bug fixed**
   In $E3SM_ROOT/components/cam/src/physics/rrtmg/radiation.F90, the following bug was found in the computation of ssa and xmomc. To fix this, jcol and jlev is now replaced with i and k, respectively.
   In addition, ssa and g calculation are put in the same 'I & j' loops.

   c. **Variable name and dimension changes**
   The variables with 'xmomc' in the names (in various codes, such as radiation.F90, cloud_rad_props.F90, radlw.F90, mcica_subcol_gen_lw.f90, rrtmg_lw_rad.f90, and rrtmg_lw_rtrnmc.f90) are replaced with ones with ones with 'asm' in the names, to

represent the physical meaning. Also, the dimension of these variables used to be (0:1, nbndlw, pcols, pver), now they are changed to (nbndlw, pcols, pver) since the first dimension is unnecessary and confusing.

d. **Regarding BFB**: To solve the non-BFB problem. we used to modify the restart_physics.F90 to write variables into CAM restart files. BUT, we found another way is to write variables into CLM restart file. We are using the latter approach now. These are achieved by the modifications in lnd_import_export.F90 and atm_import_export.F90 (the calculation of ts_atm and srf_emis_spec are changed).

e. **Add namelist variables** flag_mc6, flag_rtr2, flag_scat, and flag_emis in radiation. F90.

2. Minor changes:

a. In radlw.F90, Subroutine rad_rrtmg_lw: delete 'intent(out)' property of ful, fsul, fdl, and fsdl.

b. In rrtmg_state.F90: add intent(in) property to ts_lw

c. In atm_run_mct.F90: 1) use nlwbands from module radconstants to replace the number '16'; 2) emissivity for water/desert/snow/ice/grass are now read from input file, rather than given in the code; 3) Since emissivity file is different for RRTMG and RRTMGP, the 'filename' is set to be an fixed file name, and the real file is linked (' ln -s') to the run directory to have this fixed file name during the build process; 4) For the treatment of emissivity, all single precision variables are changed to double precision in these subroutines/functions: atm_run_mct, read_surface_emis, get_Ts_from_LW_emis, gaulegf, and planck. The emissivity data (water/desert/snow/ice/grass emissivities and lat/lon) are temporarily read into single precision variables and then immediately converted to double precision ones; 5) the variable 'count' is renamed 'cnt' to avoid confusion with the intrinsic 'count' function.

d. In atm_import_export.F90 and atm_comp_mct.F90, : use 'use radconstants, only: nlwbands', to replace 'use parrrtm, only: nbndlw'. This is because parrrtm is not an available module in RRTMGP.

e. In seq_flds_mod.F90, clm_cpl_indices.F90, lnd2atmType.F90, and lnd_import_export.F90: add integer parameter nlwbands=16 to increase the readability of the code.