

# Introduction of using RRTMGP with MC6 ice scattering optics

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- How to run RRTMGP

1. Build the libraries
  - a. `$ cd build`
  - b. set environment variables (FC, FCFLAGS) in Makefile.conf.
  - c. `$ make`
2. Build and run example executables
  - a. `$ cd ../examples/all-sky-XJ`
  - b. Set environment variables (RRTMGP\_ROOT, RRTMGP\_BUILD, NCHOME, and NFHOME) in Makefile.libs
  - c. `$ make` (this will generate an executable 'rrtmgp\_allsky')
  - d. `$ python run-rfmip-examples.py` (this will run the executable and generate outputfile 'rrtmgp\_allsky.nc')
  - e. `$ python compare-to-reference.py` (this compares the output with the reference file in ./ref/)

- Output variables

1. **Flux profiles** ( $n_{lev} \times n_{col}$ ): lw\_flux\_dn, lw\_flux\_up, sw\_flux\_dn, sw\_flux\_up
2. **Optics profiles** ( $n_{bnd} \times n_{lay} \times n_{col}$ ): lw\_tau, lw\_ssa, lw\_g, sw\_tau, sw\_ssa, sw\_g
3. **Vertically accumulated optics** ( $n_{bnd} \times n_{col}$ ): lw\_tau\_tot, lw\_ssa\_tot, lw\_g\_tot, sw\_tau\_tot, sw\_ssa\_tot, sw\_g\_tot
4. **Cloud profiles** ( $n_{lay} \times n_{col}$ ): lwp, iwp, rel, rei

- MC6 longwave ice scattering related codes

1. **`$ROOT/examples/all-sky-XJ/mo_ice_optics_mc6.F90`:**  
*Switch on/off MC6 ice optics:* `flag_mc6 = .true./.false.`  
*Switch on/off MC6 ice scattering:* `flag_scat = .true./.false.`  
*Compute MC6 ice optics according to cloud input:* subroutine `compute_all_from_mc6()`
2. **`$ROOT/examples/all-sky-XJ/mo_mc6_table.F90`:**  
*The table of MC6 ice optics:* subroutine `mc6_table_init()`
3. **`$ROOT/extensions/cloud_optics/mo_cloud_optics.F90`:**  
*Call* `compute_all_from_mc6()`

4. **\$ROOT/examples/all-sky-XJ/mo\_garand\_atmos\_io.F90:**

*Write out cloud optics and microphysical properties:* subroutine `write_lw_optics`, `write_sw_optics`, `write_clouds`

- Cloud layer setup in `rrtmgp_allsky.F90`

Clouds are represented by **lwp**, **iwp**, **rel**, and **rei** in `rrtmgp_allsky.F90`.

Current setups (May 26, 2020):

1. Ice clouds only (i.e., **lwp** and **rel** = 0.0)
2. Ice cloud layer locate at layers where pressure is between 100-500 hPa and temperature is < 263 K.
3. Ice water path (i.e., **iwp**) equals 10.0 g/m<sup>2</sup> in each single layer.
4. Ice effective radius (i.e., **rei**) ranges linearly from 11.3 To 180  $\mu m$ , from the first to the last column.

The outputs with the above cloud setups are saved in files [\\$ROOT/examples/all-sky-XJ/ref/rrtmgp-allsky-std-ice-ref-XJ.nc](#), [rrtmgp-allsky-mc6-ice-ref-XJ.nc](#), and [rrtmgp-allsky-mc6-noscat-ice-ref-XJ.nc](#) for RRTMGP standard, MC6 scattering, and MC6 absorption (without scattering) ice optics, respectively.