

Aspects of the radiation scheme in the Harmonie NWP model

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Background: Harmonie 37h1



NWP SW radiation in general

1. Physical properties =>

2. Optical properties (τ , ssa & g) =>

3. SW fluxes.

NWP SW radiation in general

A. Parameterisation of cloud r_e

1. Physical properties =>

B. Optical parameterisation

2. Optical properties (τ , ssa & g) =>

C. Radiative transfer calculations

3. SW fluxes.

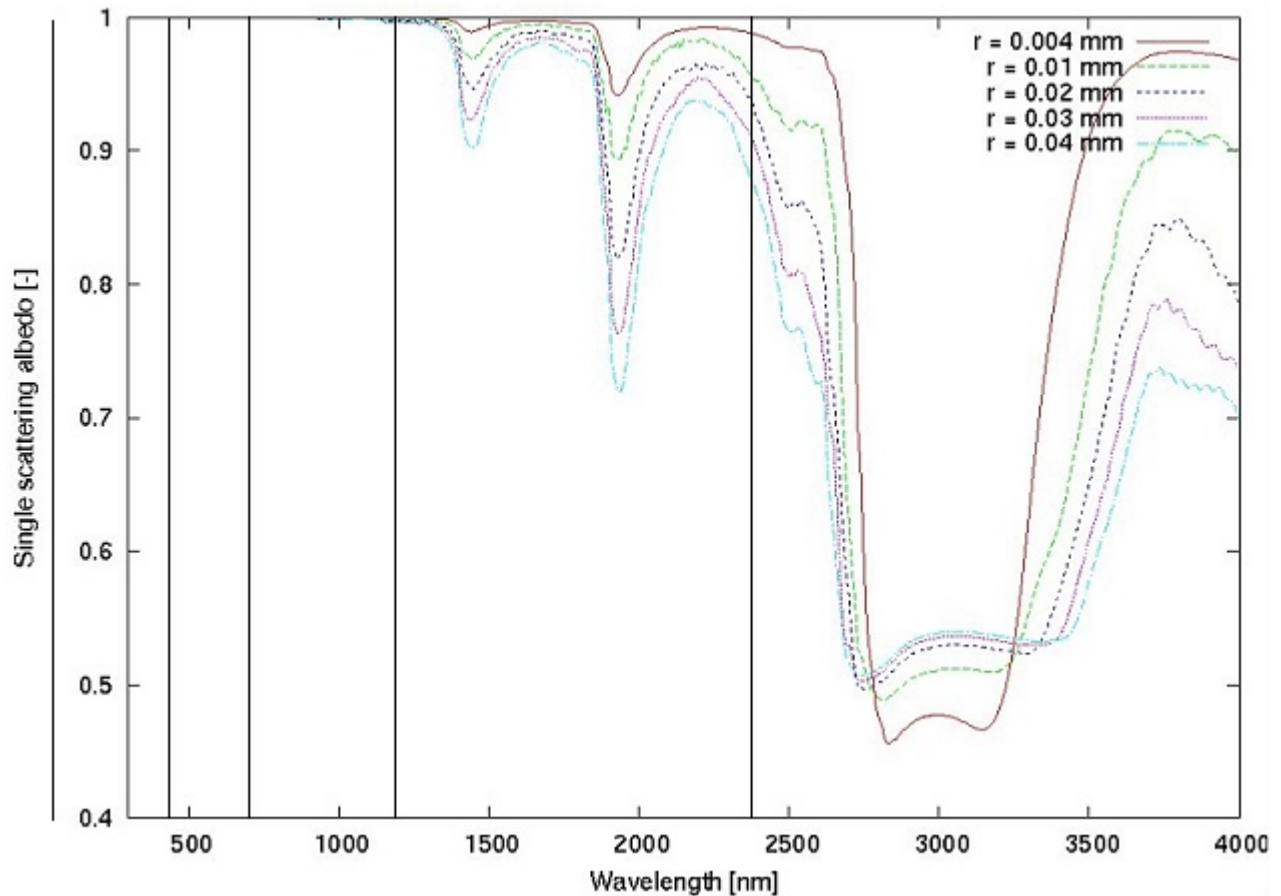
A. Harmonie cloud r_e parameterisation

- Setup file: `.../arp/phys_radi/suecrad.F90`
- Cloud liquid r_e default Martin et al. (1994)
 $\in [4\mu m; 16\mu m]$ - NRADLP = 2
- Cloud ice r_e default Ou & Liou. (1994) $\in [30\mu m; 60\mu m]$
- NRADIP = 2
- Sun & Rikus (1999, 2001) cloud ice r_e is better -
NRADIP = 3

B. Harmonie cloud optical properties

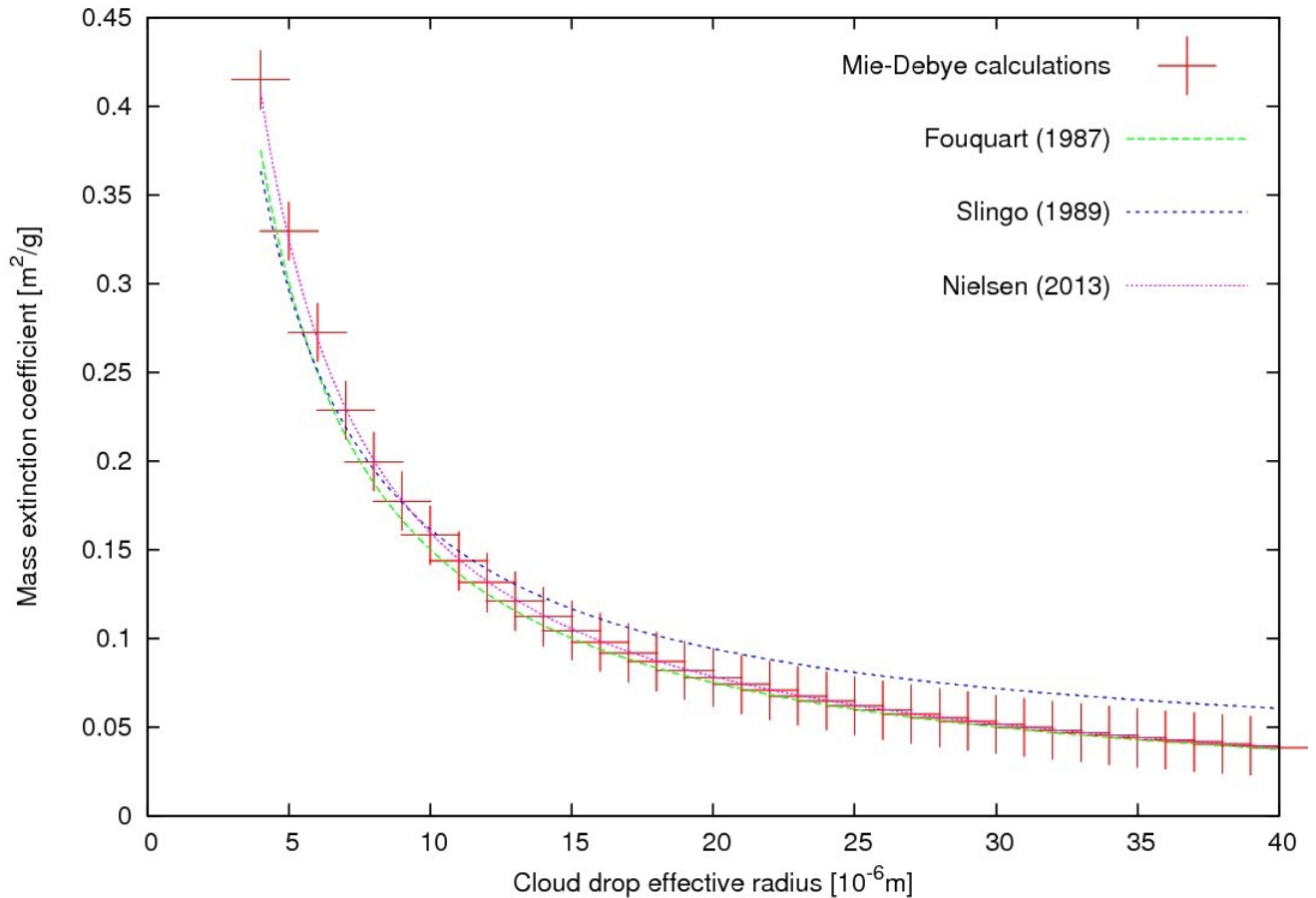
- Setup file: `.../arp/phys_radi/suecrad.F90`
- Cloud liquid OP default Fouquart (1987)
 τ multiplied with 0.7 “inhomogeneity factor”
`NLIQOPT = 0`
- Slingo (1989) cloud liquid OP is an alternative
`NLIQOPT = 1` or `2`
- Cloud ice OP default Ebert & Curry (1992)
`NICEOPT = 1`
- Fu (1996) cloud ice OP is better
`NICEOPT = 3`
- Choosing `NLIQOPT` and `NICEOPT` affects both SW and LW properties. These should be separated.

Mie test data: Cloud absorption



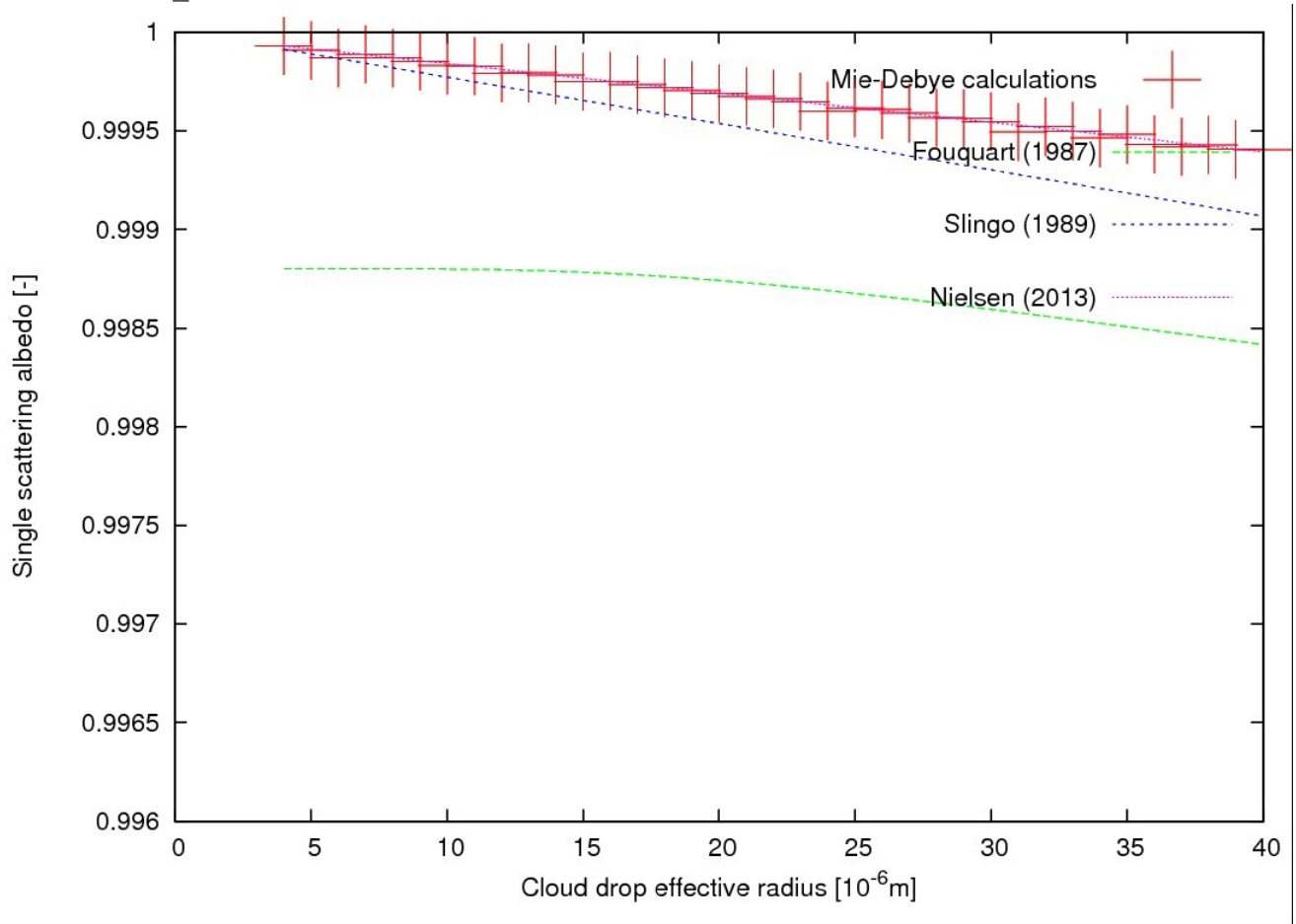
The lines show the 6 SW spectral bands in Harmonie.

Comparison of cloud OP schemes: τ



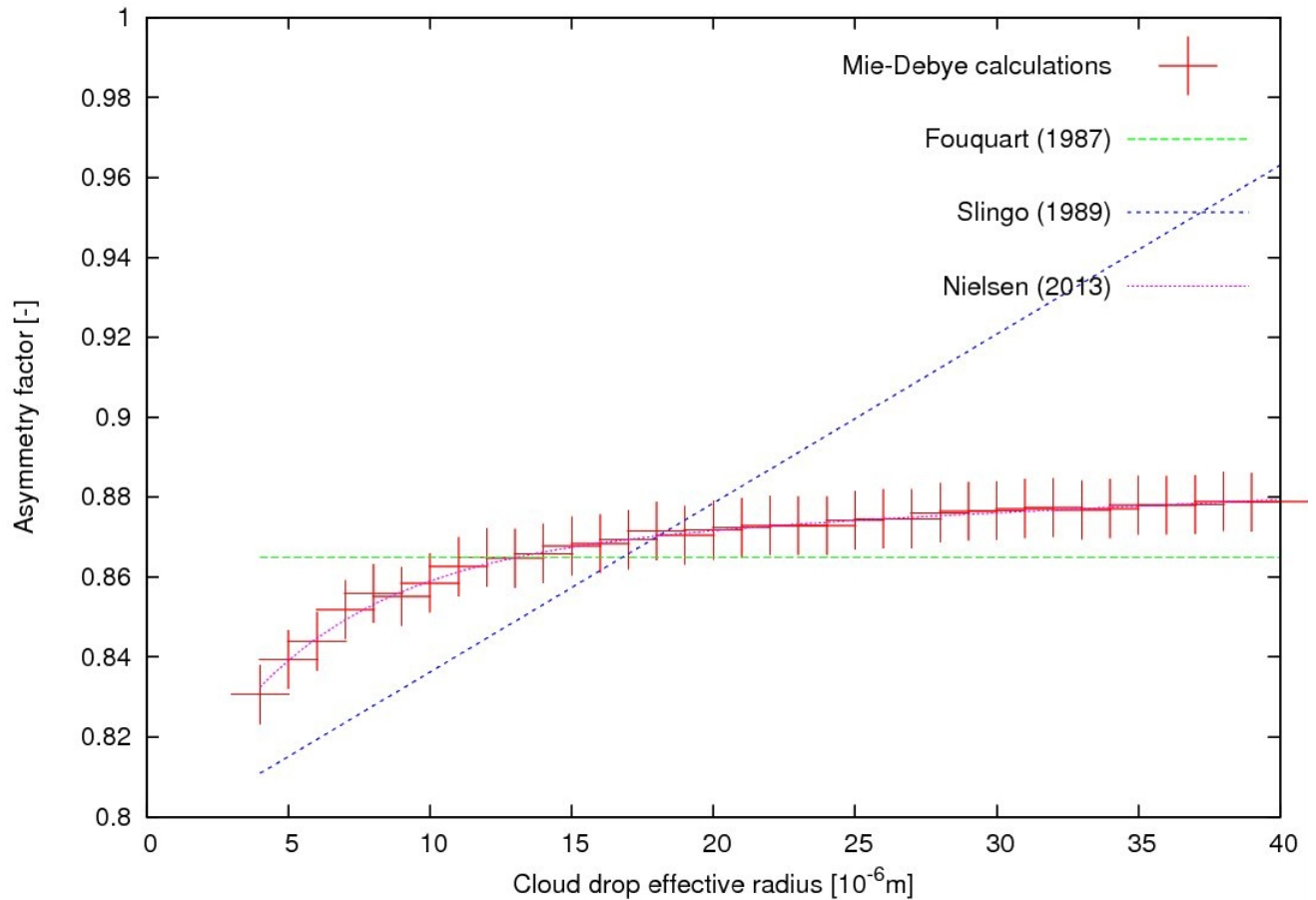
Results for spectral band 4: 690 nm - 1190 nm.

Comparison of cloud OP schemes: *ssa*



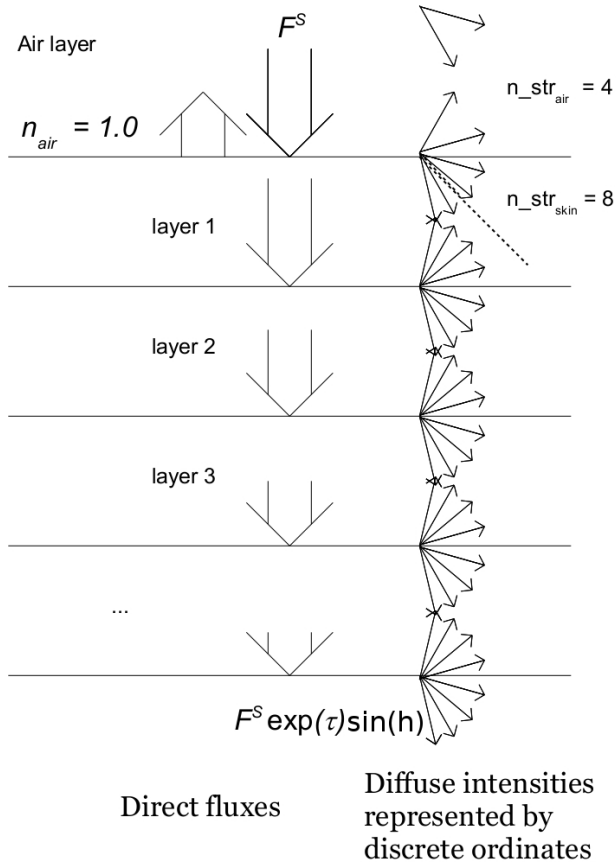
Results for spectral band 4: 690 nm - 1190 nm.

Comparison of cloud OP schemes: g



Results for spectral band 4: 690 nm - 1190 nm.

C. Radiative transfer models



- **Delta-2-stream (Schuster-Schwarzschild, Eddington).**

- **Multistream (DISORT).**

- **Doubling-adding.**

- **Monte Carlo (3D).**

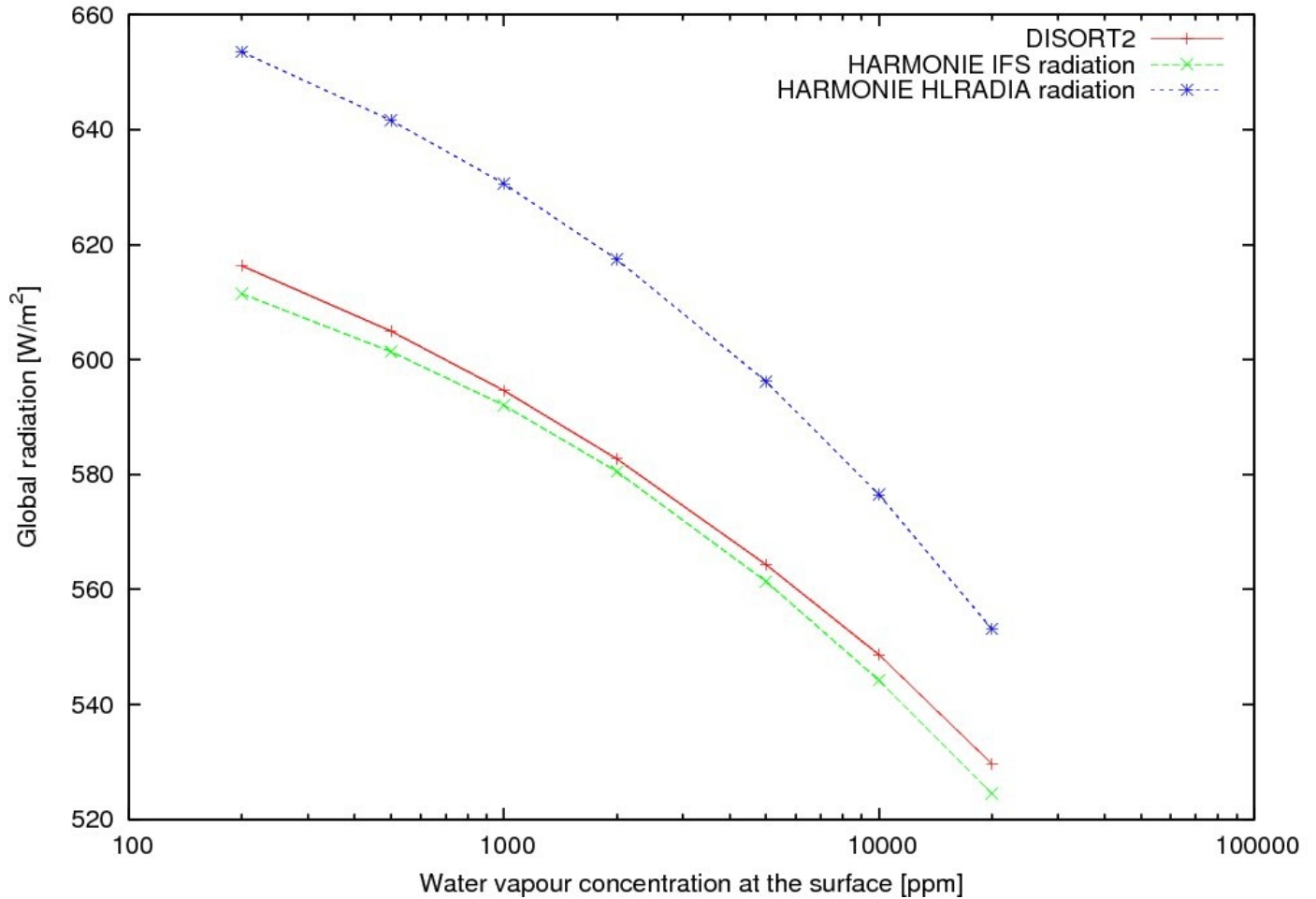
DISORT and Monte Carlo can be used in the libRadtran Gnu software package (www.libradtran.org).

SW radiation sensitivity experiment

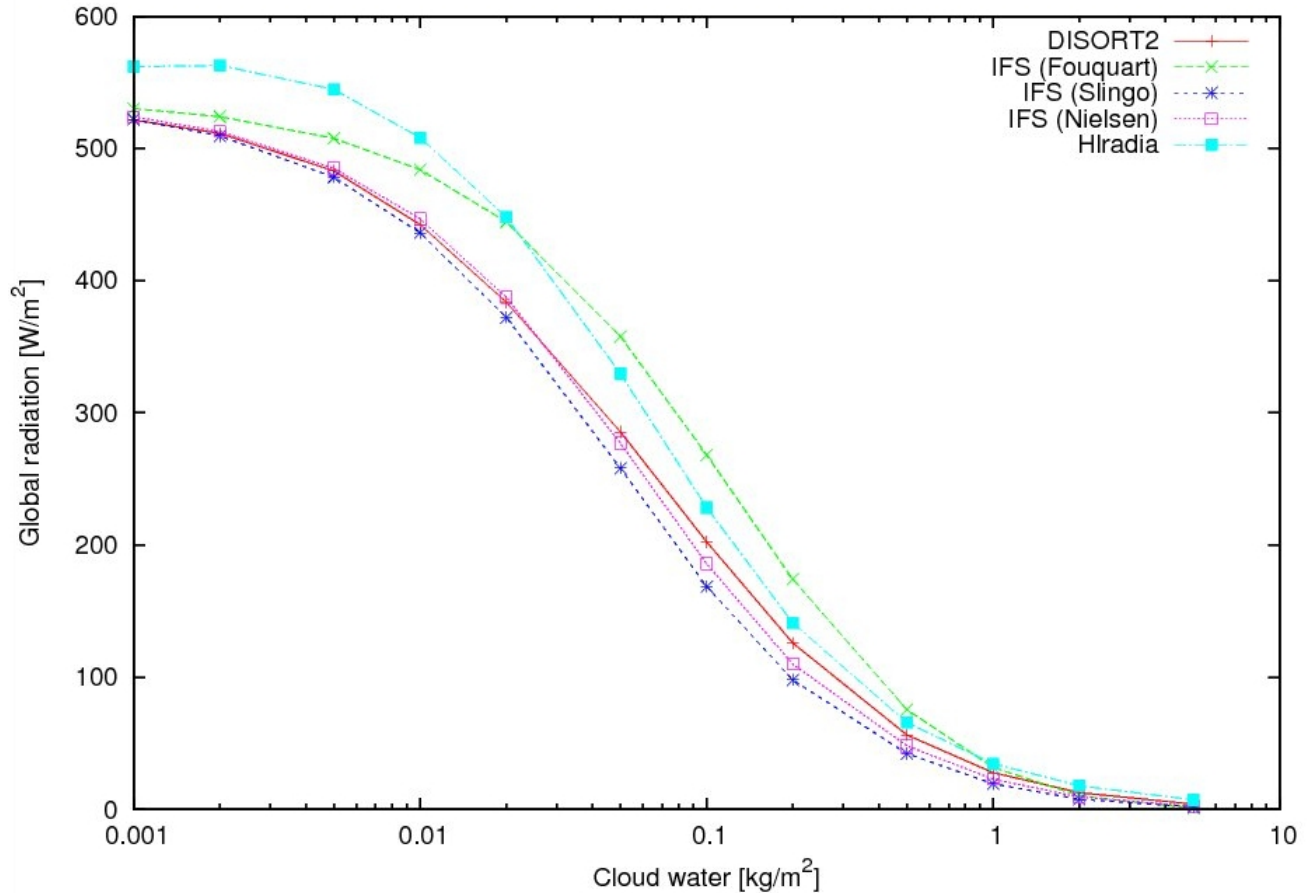
Setup:

- **DISORT 30-stream calculations**
- 2721 wavelengths (1 nm resolution)
- Run relative to standard atmosphere background
- **Experiments: H₂O, liquid clouds, ice cloud, albedo, ...**
- Harmonie MUSC used for testing
- Nielsen, Gleeson & Rontu (2013) publication in *Geoscientific Model Development*

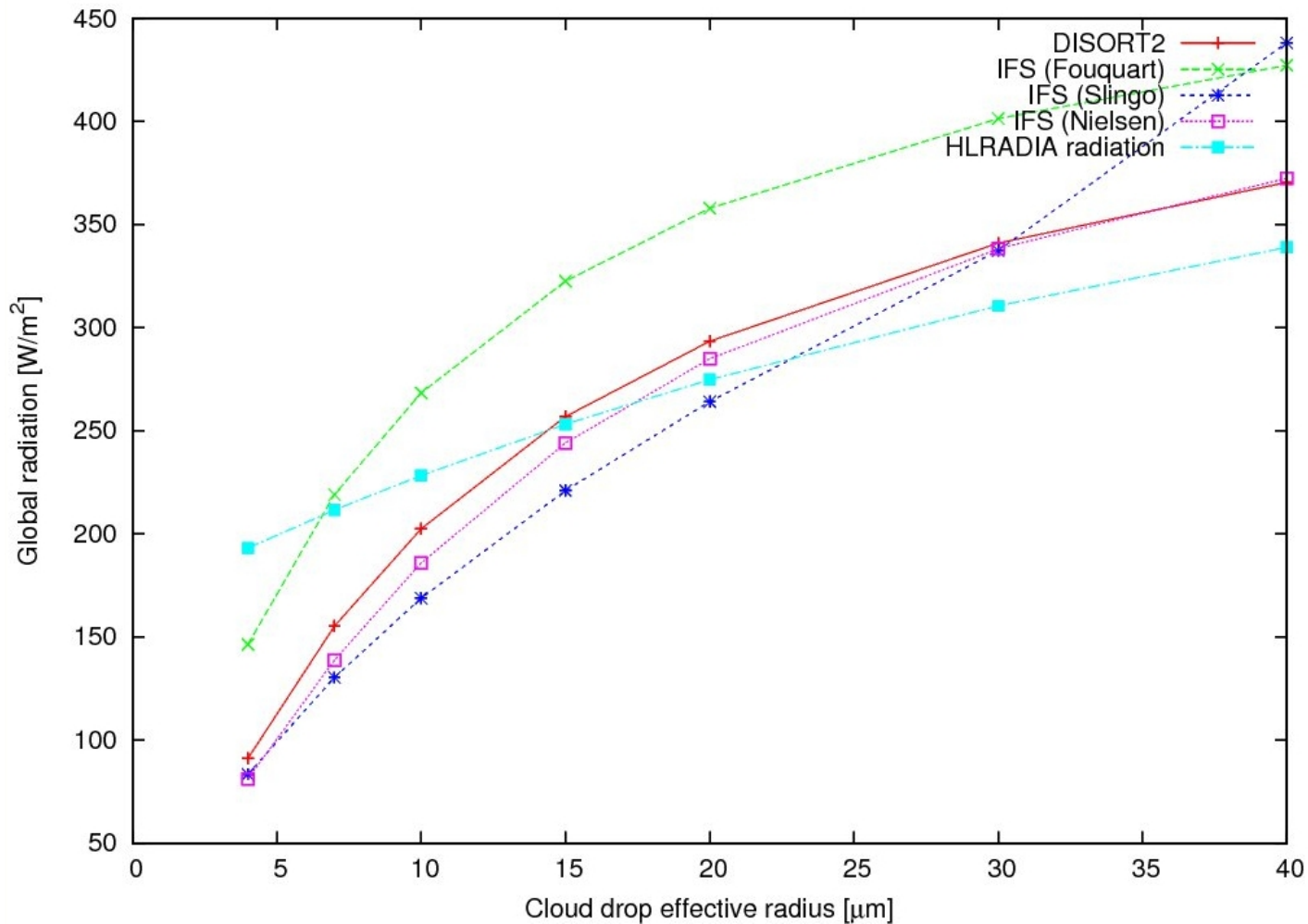
SW radiation sensitivity experiment



SW radiation sensitivity experiment



SW radiation sensitivity experiment



Concluding remarks

- “IFS radiation” means many things depending on version and namelist settings!
- The default Harmonie namelist settings need revision – for liquid clouds in particular!
- A new cloud optical property parameterisation has been made.

Future plans



- Key namelist settings => general Harmonie namelist.
- 2-stream cloud radiative implementation in hlradia.
- Aerosol implementation in hlradia.
- Sensitivity test are to be made for LW radiation.



Thank you!