3D Shortwave Radiative Transfer in the Multiscale Modelling Framework

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1. Introduction

Within the Multiscale Modelling Framework (MMF) radiative transfer calculations are performed every 15-minutes which may be too infrequent.

Before implementing a 2D shortwave Monte Carlo into the MMF we use a Cloud System Resolving Model (CSRM) to test the impact of different methods of invoking the radiative transfer.

Use a time period from TOGA/COARE (19 Dec. 1992 and 8 Jan. 1993).

2. Experiment Setup

CSRM

System for Atmospheric Modelling version 6.6.5 (SAMv6.6.5)

- 2D with axis oriented west-east
- 24 vertical layers with gridspacing typical of MMF
- 256 horizontal columns: $\Delta x = 1$ km, $\Delta t = 2.5$ s
- 5 member ensembles for each experiment

Longwave radiation

- ICA calculations using LW radiative transfer solver

Shortwave Monte Carlo

Photons injected along CSRM axis,
- Direction (east or west) function of time of day

Experiments

- Changing number of photons, Δt_{rad} and approximations
- Except for ICA, all experiments use 3D SW radiative transfer

- In the SCALE experiment, cloud opt. props. are delta-scaled
- Reduces time for SW Monte Carlo by 50-60%
- As N_{photon} decreases total SW RT time driven by optical properties

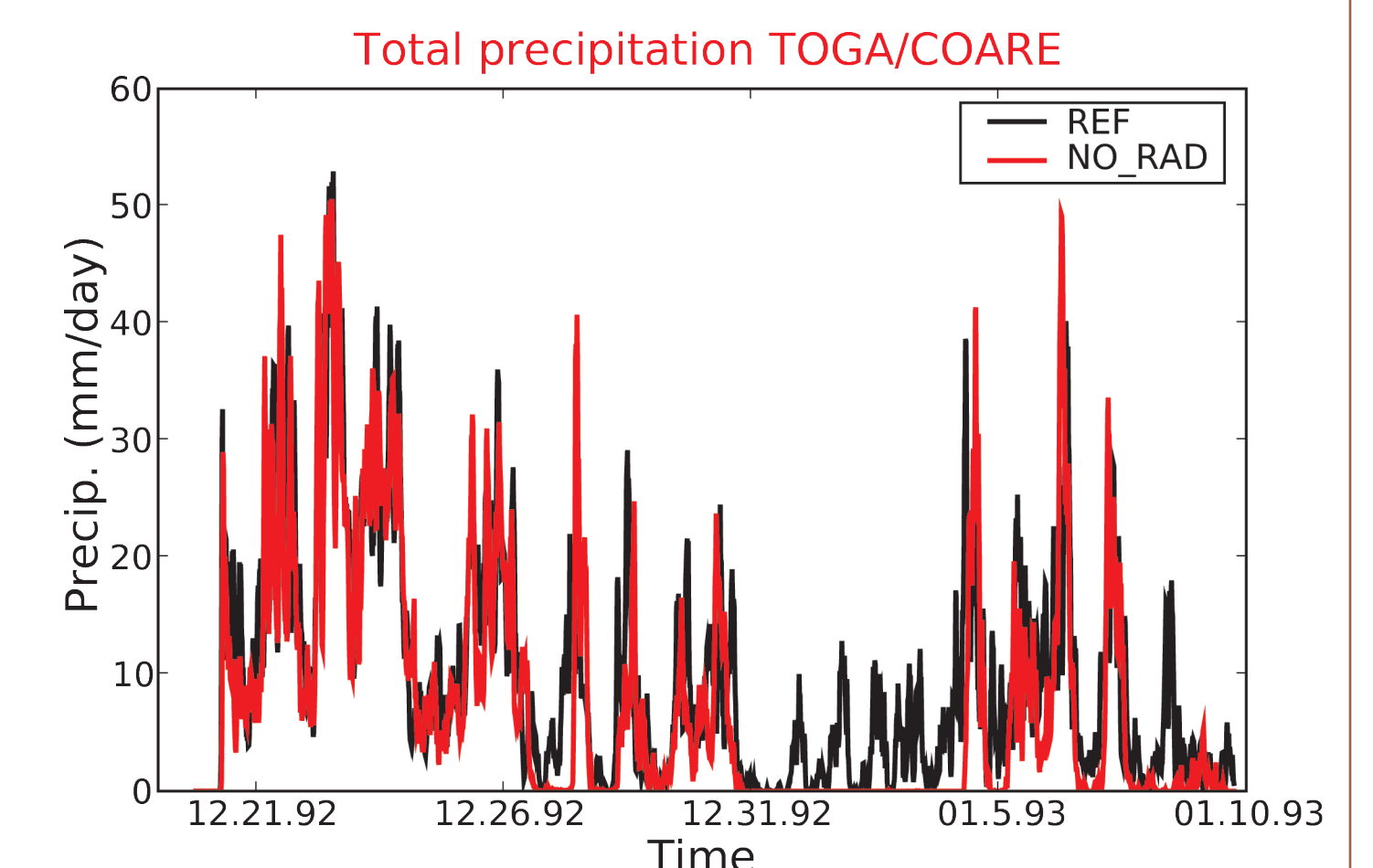| Expt.	REF	SCALE	ICA	MMF_1E6	MMF_1E5	3_MIN	5_MIN
T_{rad}	50 s	50 s	50 s	15 min	15 min	3 min	5 min
N_{photon}	1E6	1E6	1E6	1E6	1E5	2E4	3.3E4

Radiative transfer computational time
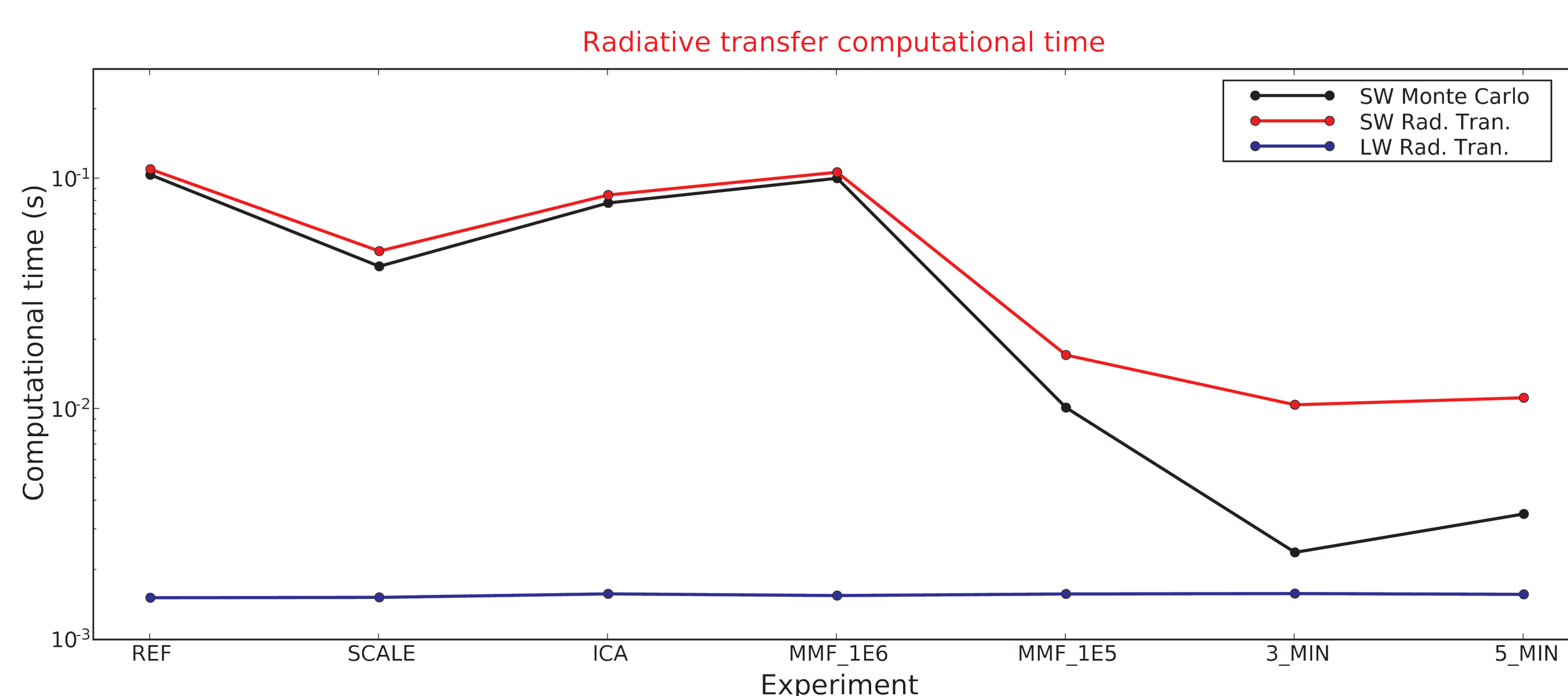
3. Results

Although simulated 21 days focus on 4 days (1-4 Jan. 1992)

- NO_RAD - no interactive radiation
- More convective events with rad.

Total precipitation TOGA/COARE

Below are boxplots of 4 variables

- Difference from REF for each exp. and ensemble member used to generate boxplots
- Generally very small mean differences relative to REF and similar distributions of differences
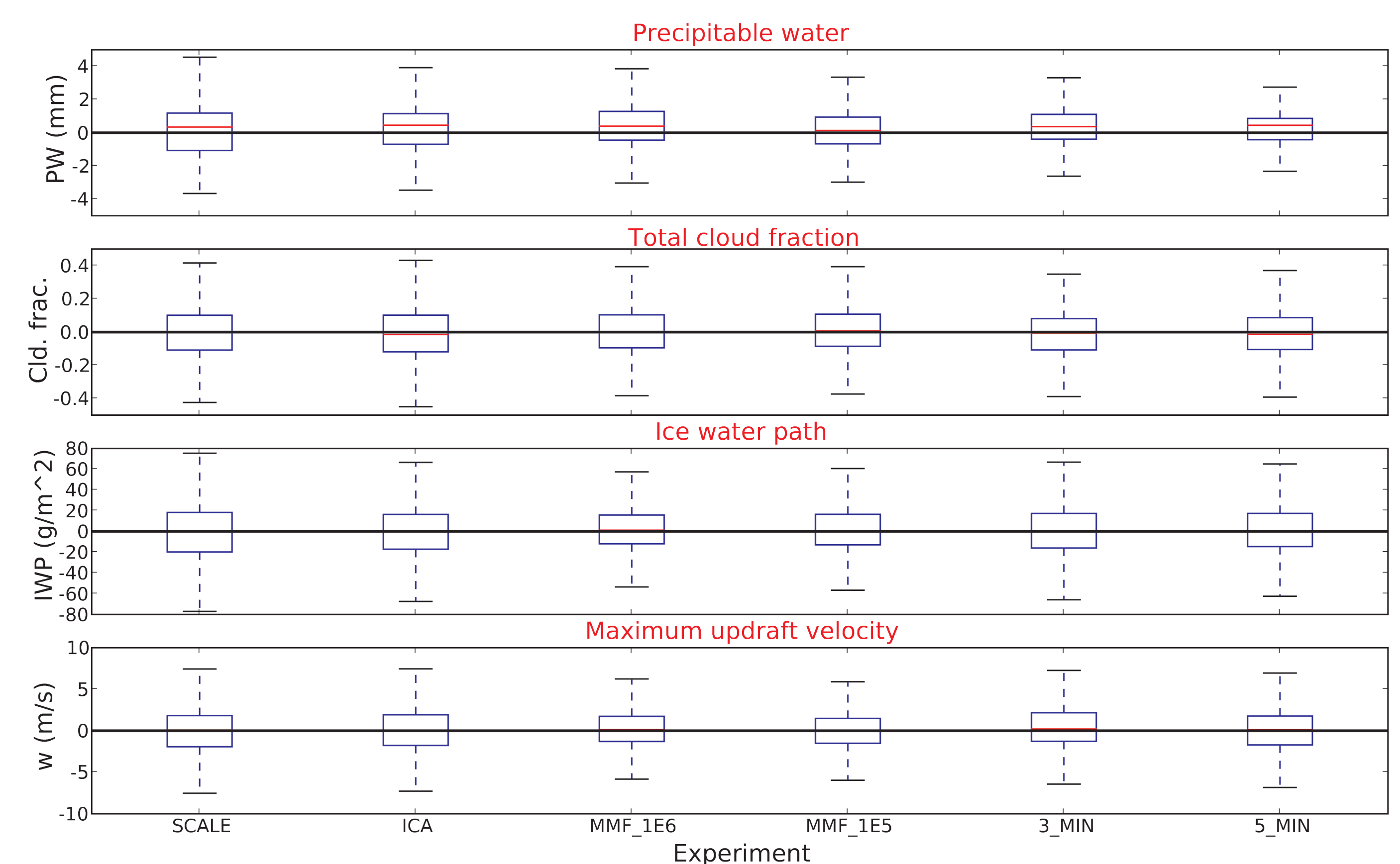
Similar results for vertical profiles
- Very small, statistically insignificant, differences for many variables
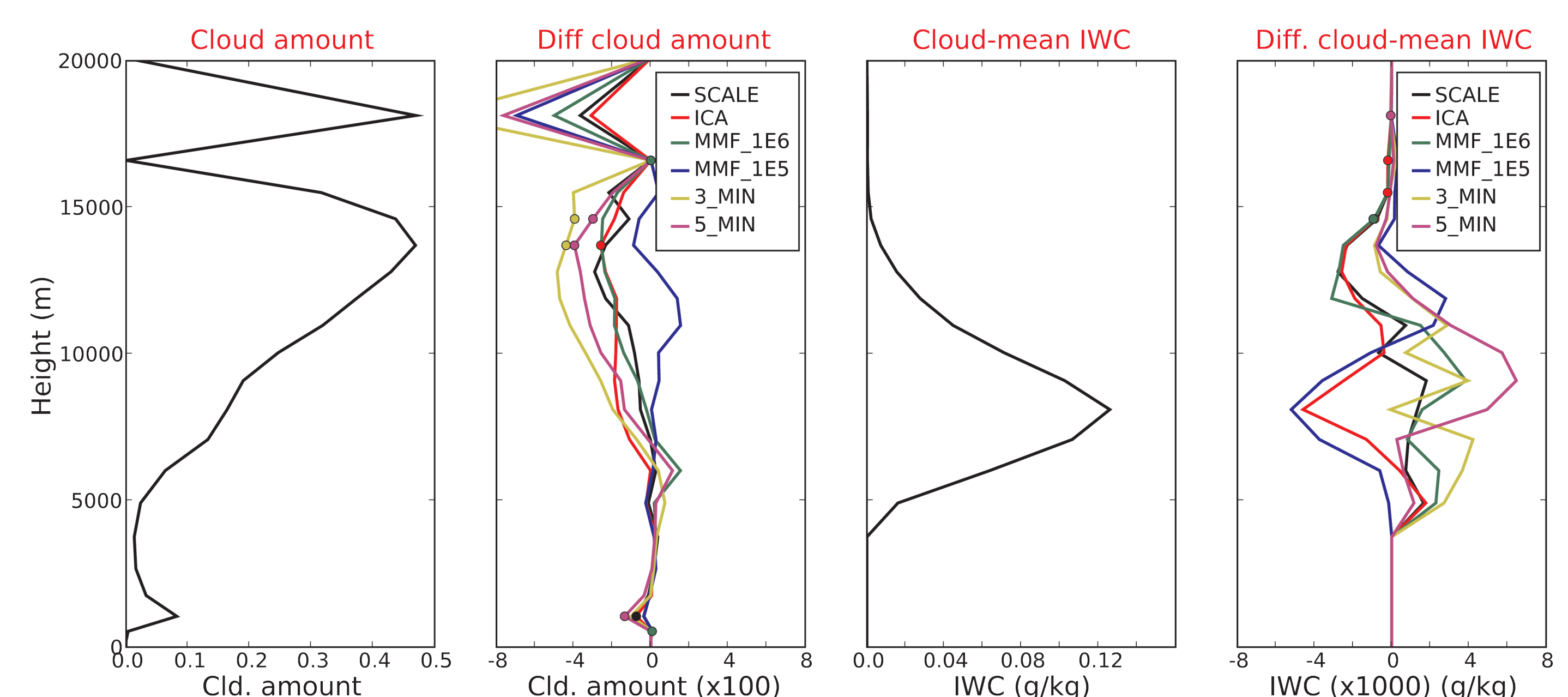
4. Discussion

Does not seem very sensitive to the details of how radiation scheme is called. Results will be re-tested using other cases and using the MMF.

Using the MMF will allow radiation to affect large-scale avoiding perscribed large-scale forcing.