Response of a CSRM to Varying Magnitudes of Shortwave Monte Carlo Radiative Transfer Noise

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1. Introduction

Examine effect of a 2D shortwave Monte Carlo noise on Cloud System Resolving Model (CSRM) configured like CSRMs used in Multiscale Modelling Framework (MMF).

Also examine effect of using 2D versus ICA shortwave radiative transfer calculations and effect of increase horizontal resolution.

Simulated TOGA/COARE between 19 Dec. 1992 and 8 Jan. 1993 and a radiative convective equilibrium case.

2. Experiment Setup

CSRM

System for Atmospheric Modelling version 6.5 (SAMv6.5)

2D with axis oriented west-east

24 vertical layers with gridspacing typical of CAM3/MMF

64 horizontal columns: $\Delta x = 4$ km, $\Delta t = 20$ s and $\Delta t_{rad} = 200$ s or
256 horizontal columns: $\Delta x = 1$ km, $\Delta t = 5$ s and $\Delta t_{rad} = 100$ s

10 member ensembles for each configuration

Shortwave Monte Carlo

Photons injected along CSRM axis
From east or west depending on solar azimuth angle

2D calculations used: 5.0×10^5(REF), 5.0×10^4 and 1.0×10^4 photons
ICA calculations used: 5.0×10^5 photons

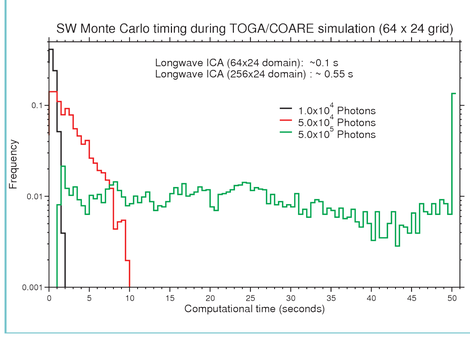
Longwave radiation

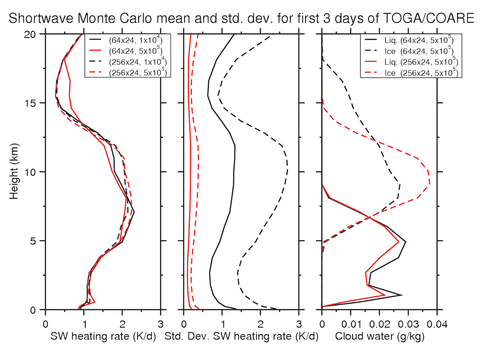
ICA calculations using LW radiative transfer solver described in Li, 2002

3. Monte Carlo Noise TOGA/COARE

Mean and mean standard deviation for daylit hours during first 3 days of one TOGA/COARE simulation

36 cloud scenes (sampled one per hour)

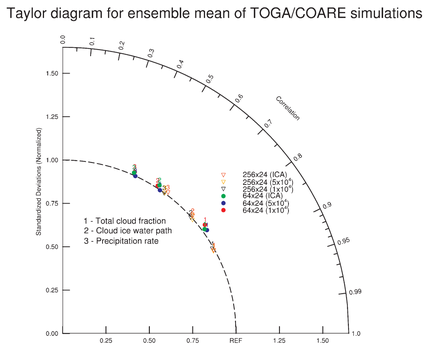




All Monte Carlo calcuations for one simulation (1 Ghz computer)

Similar timing results for 256x64 domains

4. Results (TOGA/COARE)



Some small biases as a function of height

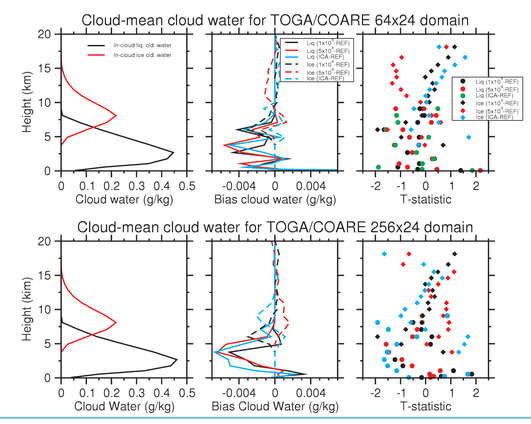
Biases not statistically significant

Ensemble mean results similar between 256x24 and 64x24 domains

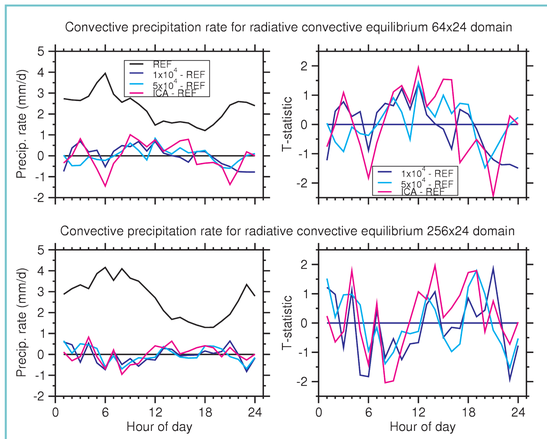
For surface and vertically integrated quantities impact of changing Monte Carlo noise is small

Decreasing gridspacing and increasing number of columns, increases correlation

No statistically significant differences for most variables



5. Results (RCE)



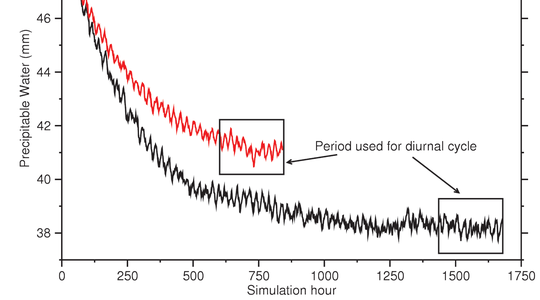
Diurnal cycle develops in most variables

Early morning maximum in convective precipitation

No significant differences caused by Monte Carlo noise or by ICA

Sensitive to domain configuration

64x24 domain drier than 256x24 domain



6. Discussion

Monte Carlo noise statistically insignificant (for the model configurations and simulations used here)

Domain-mean quantities similar for ICA or 2D shortwave Monte Carlo

Maybe feasible to test low photon shortwave Monte Carlo in MMF