Influence of 3D solar radiative transfer on a "mock-Walker" circulation

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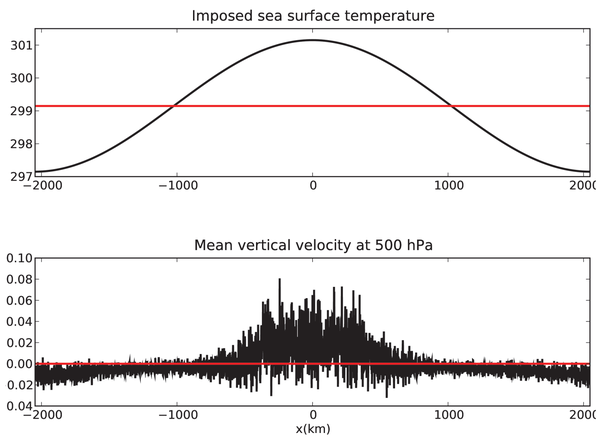
1. Introduction

Does 3D, rather than ICA, solar radiative transfer affect conclusions from studies using prescribed sea surface temperatures?

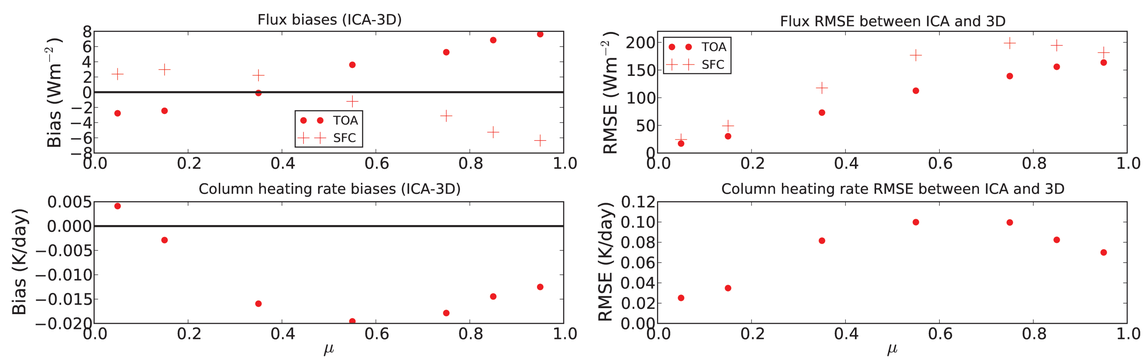
- SAM v6.5+solar Monte Carlo model
- 150 day integrations over prescribed SST variations
  - Mean SST = 299K
- 2D domain, 4096 km, dx=1 km, 64 vertical levels
- Diurnal cycle, nudging to suppress large-scale shear
- Diagnostics from simulations using 3D and ICA solar RT
- 3D vs ICA versus uniform SST increase of 2K
  - Place differences into context



- Warmer SSTs
  - Stronger ascent
  - Convective clouds
- Cooler SSTs
  - Weak descent
  - Largely cloud-free

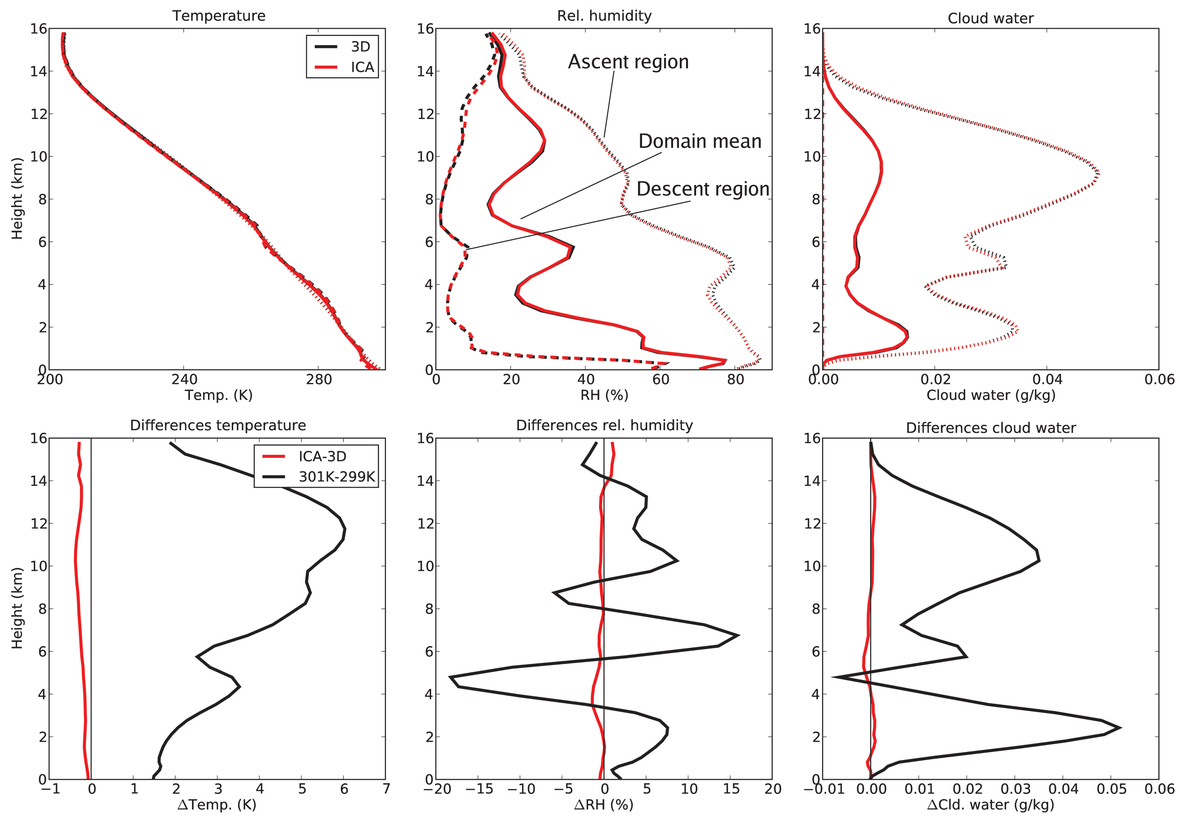
2. Magnitude of ICA-3D flux biases

- Offline 3D and ICA SW RT calculations for last 30 days
  - Instantaneous snapshot from each hour
  - Averages over central 2000 km of domain shown
  - Descent regions are cloud-free and bias is near zero
- Suggests underestimate of column solar heating in ICA



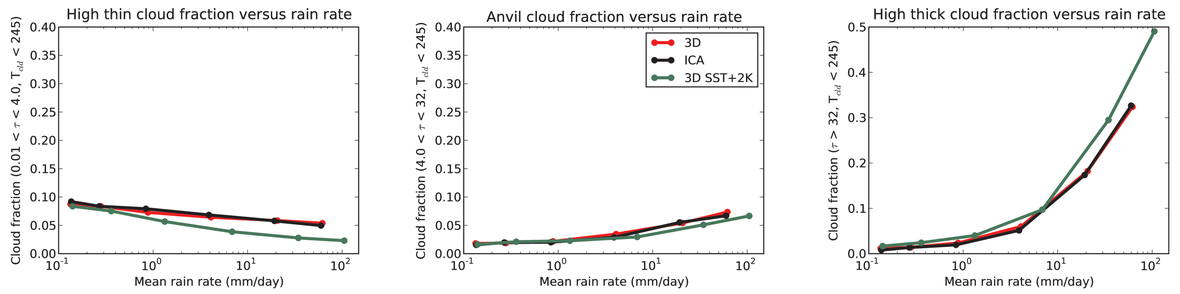
3. Mean state

- Mean over last 60 days of simulations
- Profiles in ascent and descent regions (Grabowski, 2000)
  - Ascent region (middle 500 km)
  - Descent region (500 km centered about domain edge)
  - Differences small (especially wrt other systematic changes)



4. Physical relationships

- High cloud fraction as function of rain rate (Lopez, 2008)
- Rain rate and cloud fraction from 128 km domain segments
  - Use output from last 60 days of simulation
- 3D and ICA rain rate percentiles (dots) very similar



5. Discussion

- Many diagnostics not sensitive to 3D solar radiative transfer
  - Use of ICA reasonable for this case study
- Issues with 2D CSRM dynamics and radiation
  - Suspect 3D CSRM results will be similar though
- Non-interactive surface may be mitigating effects
  - Simulations over simple land surface

References/Acknowledgements

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Lopez M.A., D. L. Hartmann, P. N. Blossey, R. Wood, C. S. Bretherton and K. L. Terence, 2008: A Test of the Simulation of Tropical Convective Cloudiness by a Cloud-Resolving Model. J. Climate, in press.

Grabowski, W.W., J.I. Yano, and M.W. Moncrieff, 2000: Cloud Resolving Modeling of Tropical Circulations Driven by Large-Scale SST Gradients. J. Atmos. Sci., 57, 2022–2040.