Progress on an ARM/GCSS/SPARC TWP-ICE Monsoon Case Study

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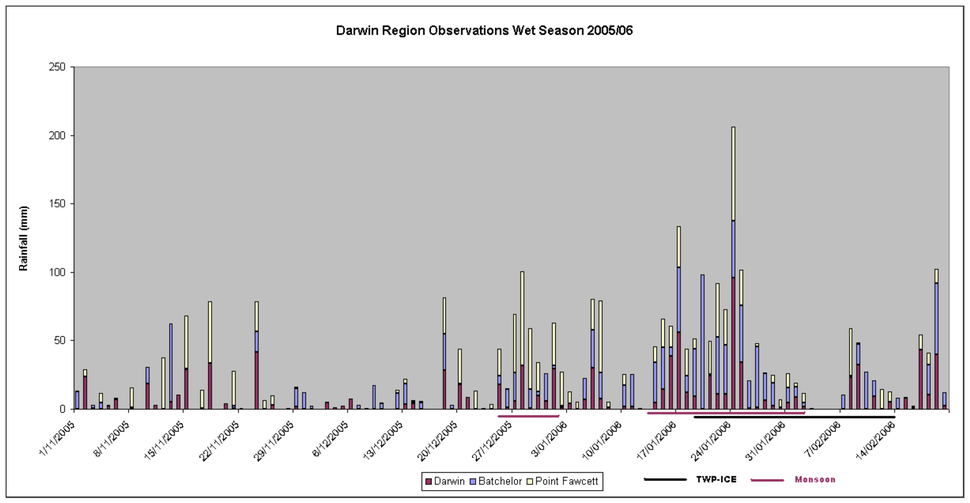
Introduction



Source: Lori Chappel, Australian BOM

The Tropical Warm Pool–International Cloud Experiment (TWP-ICE) assembled aircraft and ground instruments at the DOE-ARM long-term site in Darwin, Australia during the 2005/2006 monsoon, and the early part of the campaign encountered active monsoon conditions (left). The goal of this work is to help develop a model intercomparison case study that can be carried out jointly by three organizations: the ARM cloud modeling working group, the GEWEX Cloud System Study (GCSS) deep convective clouds group, and the Stratospheric Processes and Their Role in Climate (SPARC) group.

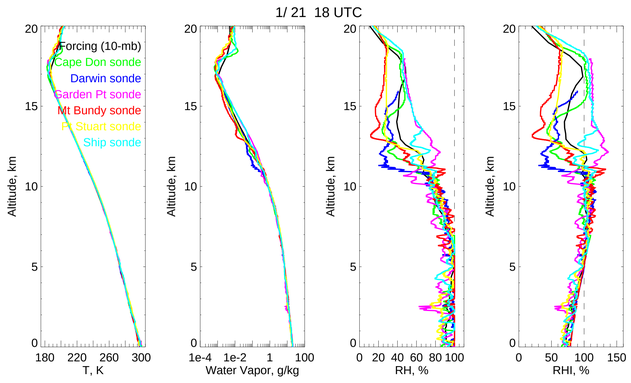
Case description

- idealized maritime convection (specified SST)
- large-scale forcing data from variational analysis
- compare results with in situ, ground-based, and satellite data
- 18–24 January (6 days), may extend to 2 February (15 days)

Model description

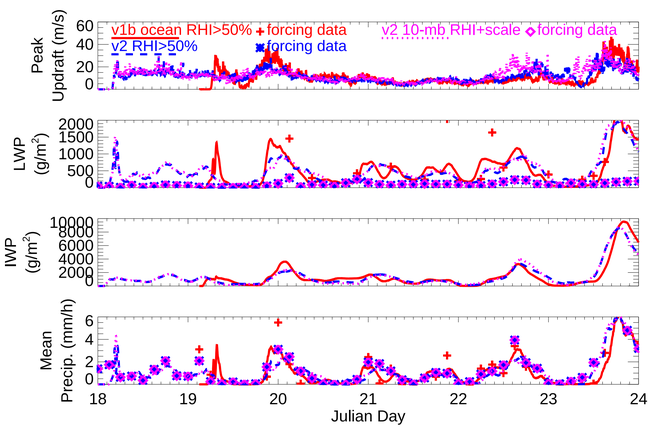
- large-eddy simulation
- periodic lateral boundary conditions, sponge layer aloft
- bulk microphysics with q_c, q_r, q_{if}, q_{id}
- 192-km *x* 192-km *x* 24-km domain
- 1-km horizontal resolution
- 100-m to 250-m resolution below 18.5 km

Large-scale forcing issues: vertical resolution, tropopause drying

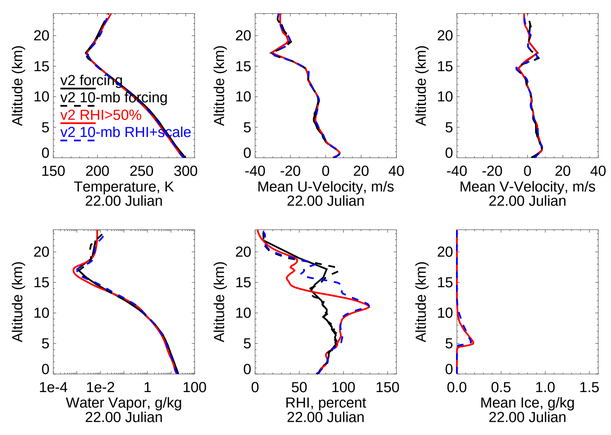


Source: Tim Hume sondes, Shaocheng Xie forcings

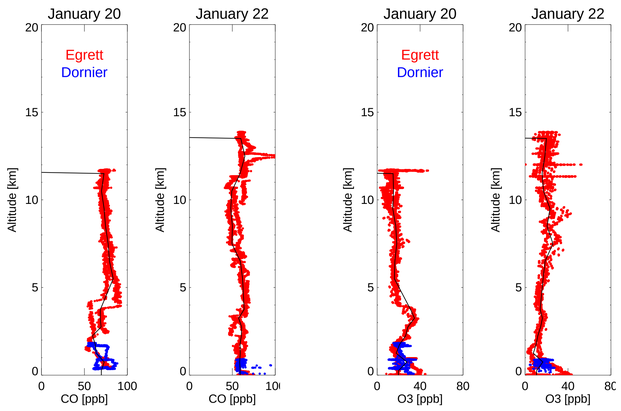
To reflect small-scale structure in tropopause RHI (left), the forcing data set resolution was increased from 25-mb to 10-mb (courtesy Shaocheng Xie). Because forcing (at either resolution) produced drying near the tropopause inconsistent with measurements, a procedure was developed to bring predictions into line with atmospheric conditions. While surface variables are well simulated with either data set (near right), upper level RHI is better resolved with increased resolution (far right).



Source: GISS simulations, Shaocheng Xie forcings

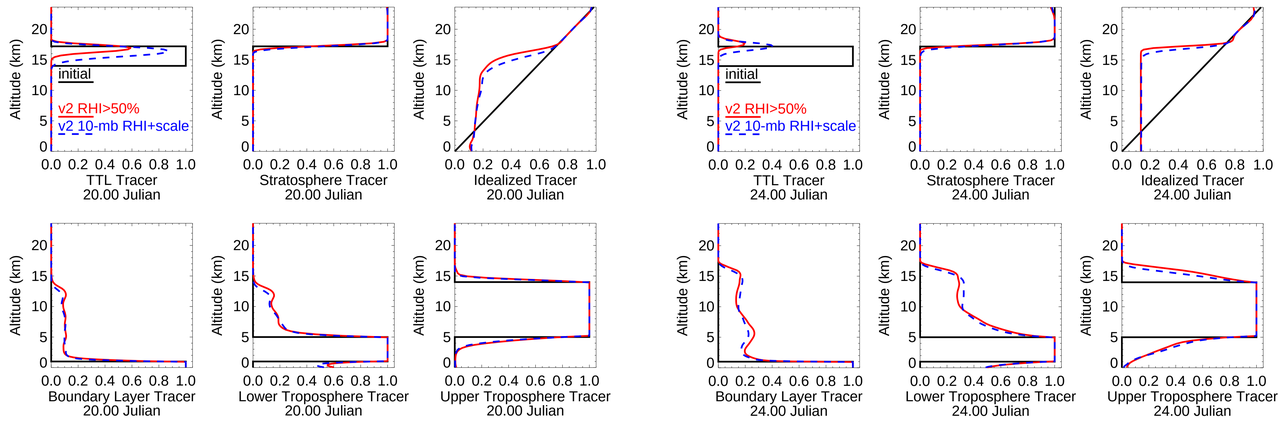


Deep convection tracers: complex reality, idealized simulation



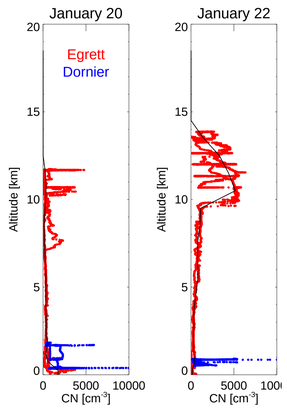
Source: Ally Lewis, ACTIVE archive

Owing to complexity in measured tracers (left) and poorly-constrained boundary conditions, the case study is likely to include only idealized tracers (right). Current candidates (to be chosen by the SPARC team) include tracers that are simply initialized and advected (TTL, stratospheric, and linear gradients shown at right, top rows), or tracers that are held at uniform initial values and decayed with a half life of 6 hours (boundary layer, lower troposphere, and mid-troposphere exampled at right, bottom rows).



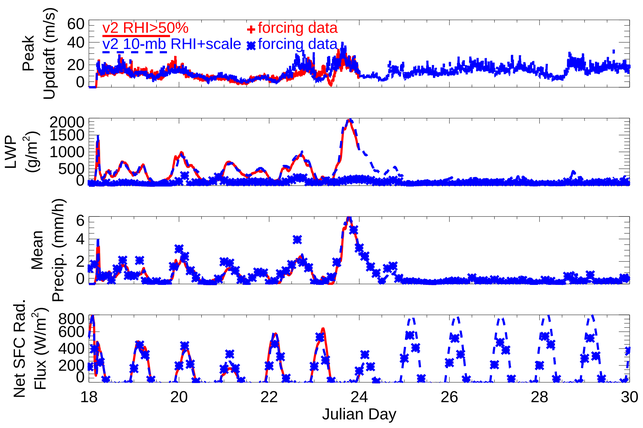
Source: GISS simulations

Future work: aerosols, case study description



Source: Martin Gallagher, ACTIVE archive

Aerosol data (e.g., left) will be analyzed for the final case description. The case study duration may be extended to include the latter half of the observed monsoon period, characterized by shallower convection and less precipitation, but signifiant reductions in surface radiative fluxes and continuous cloud formation (right). A preliminary case study description, with GISS and UK Met Office results, will be presented at the Pan-GCSS meeting in June 2008. Additional comparisons with ARM data will be included (e.g., ARSCL cloud boundaries, surface heat fluxes, and radar observations).



Source: GISS simulations

Summary

- forcings implemented at 10-mb resolution
- idealized tracers under consideration
- preliminary case description due June 2008
- contacts: Ann Fridlind, Jon Petch, Christian Jakob

Acknowledgments

- DOE ARM Program
- DOE ARM Climate Research Facility archive
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- TWP-ICE science team
- ACTIVE science team