Long-term Evaluation of Cloud Fraction Simulated by Seven SCMs Against the ARM Observation at the SGP Site

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1. Introduction

- Evaluation of the basic features (vertical profiles, mean cloud amounts and occurrences) of cloud fraction in 7 SCMs by comparison with ARM observations at the SGP site
- Statistical analyses with 3-year hourly data (Jan1999-Dec2001)
- Observation: CMBE ARSCL cloud fraction
- 7-SCM simulations driven by same surface and large-scale forcings plus a relaxation term, and run in FASTER SCM Testbed

2. Vertical Profiles of Cloud Fraction

- Vertical profiles of 3-year mean cloud fraction
- ECMWF SCMs and observation at high levels for three SCAMs.
- Differences of monthly mean convective cloud fraction in three SCAMs and monthly mean cloud fraction in observation (right panel).

3. Frequency Distribution of Cloud Fraction

- In the observation, it is a distinct U-shaped distribution of cloud occurrences, concentrating on CF<5% and CF>95% ranges.
- In 7 SCMs, cloud events occur much more frequently on moderately cloudy ranges at high levels or low levels.
- In ECMWF and GISS SCMs, the frequencies of cloudy events with CF>60% are much lower than the observation.

4. Partitioning of Cloud Fraction

- The contribution of non-stratiform-cloud-source events to the mean cloud fraction is mainly above 600-hPa in ECMWF and two GFDL SCMs and below 300-hPa in three SCAMs.
- The underestimation of low-level clouds in ECMWF and two GFDL SCMs and overestimation of high-level clouds in three SCAMs are mainly due to mean cloud fractional compensation between the overproduction of convective clouds and the underproduction of stratiform clouds.
- Larger critical RH in most SCMs than in the observation except for two GFDL SCMs at high levels.
- Critical RH for stratiform-cloud-source events are much larger than those for non-stratiform-cloud-source events in all SCMs, implying the lower sub-grid variability of humidity for stratiform-cloud-source events.

5. Summary

- Compared with observation, ECMWF SCM underestimates all-level clouds and GISS SCM underestimates clouds below 200 hPa.
- The two GFDL SCMs overestimate high-level cloud fraction but underestimate low-level cloud fraction.
- The three SCAMs overestimate high-level cloud fraction, but have low-level cloud fraction similar to the observation, due to the compensation between the overproduction of convective clouds and the underproduction of stratiform clouds.
- The frequency distribution of cloud fraction shows a large discrepancy between the observation and SCMs.
- The contribution of non-stratiform-cloud sources is mainly on the moderately cloudy range, at high levels for ECMWF and two GFDL SCMs and at low levels for three SCAMs.
- Further analysis will be focused on relationship between cloud fraction (stratus) and relative humidity in SCMs and observation.

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