Intercomparison of Long-term SCM Simulations of Clouds at the ARM SGP Site

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1. ASD/BNL 2. NOAA/GFDL 3. NASA GISS 4. KNMI

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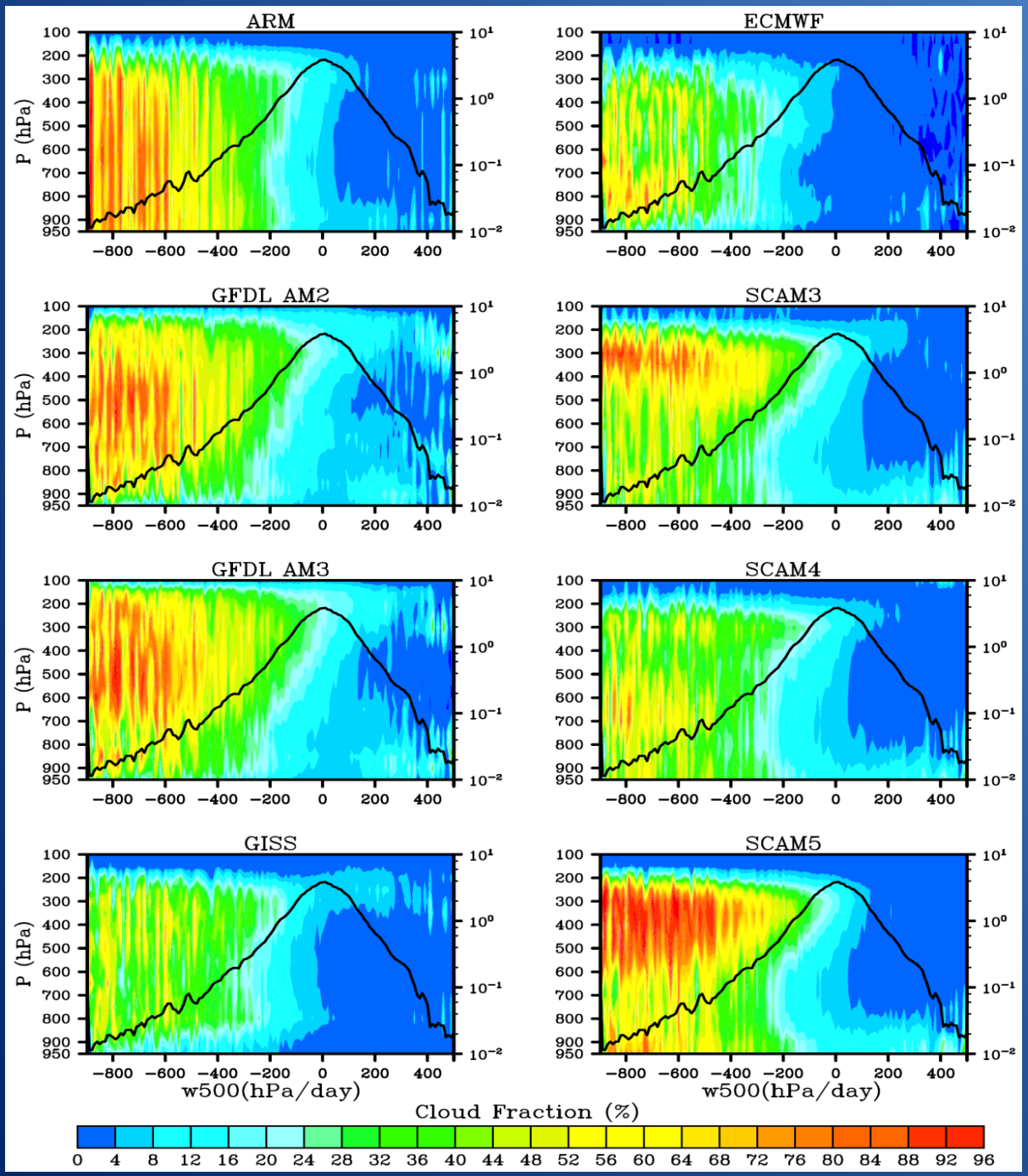
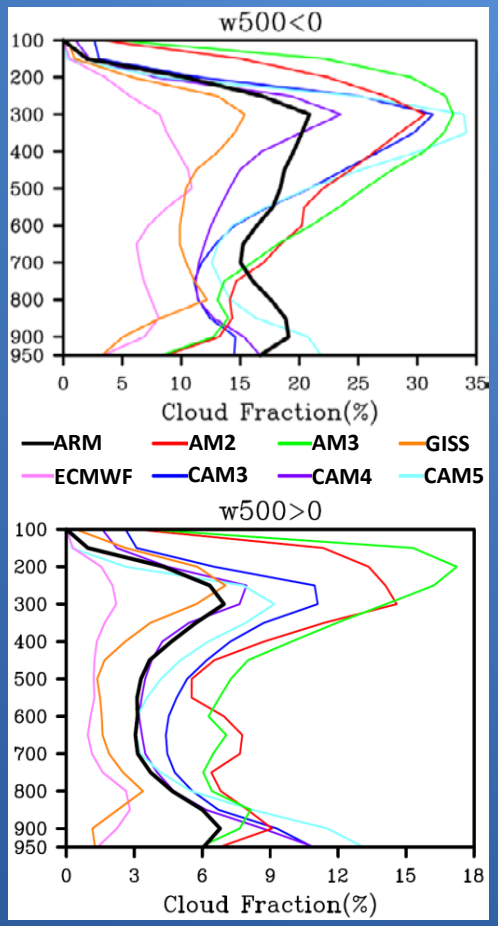
Introduction

- ✓ Statistical analysis with 3-year hourly data: Jan1999-Dec2001
- ✓ ARM observations: ARSCL cloud fraction and ABRFC precipitation
- ✓ 7 SCMs outputs, forced by same large-scale continuous forcing (Xie et al 2004)
- ✓ To bin data according to 500hPa omega and precipitation

Table 1. Main parameterization schemes of 7 AGCMs

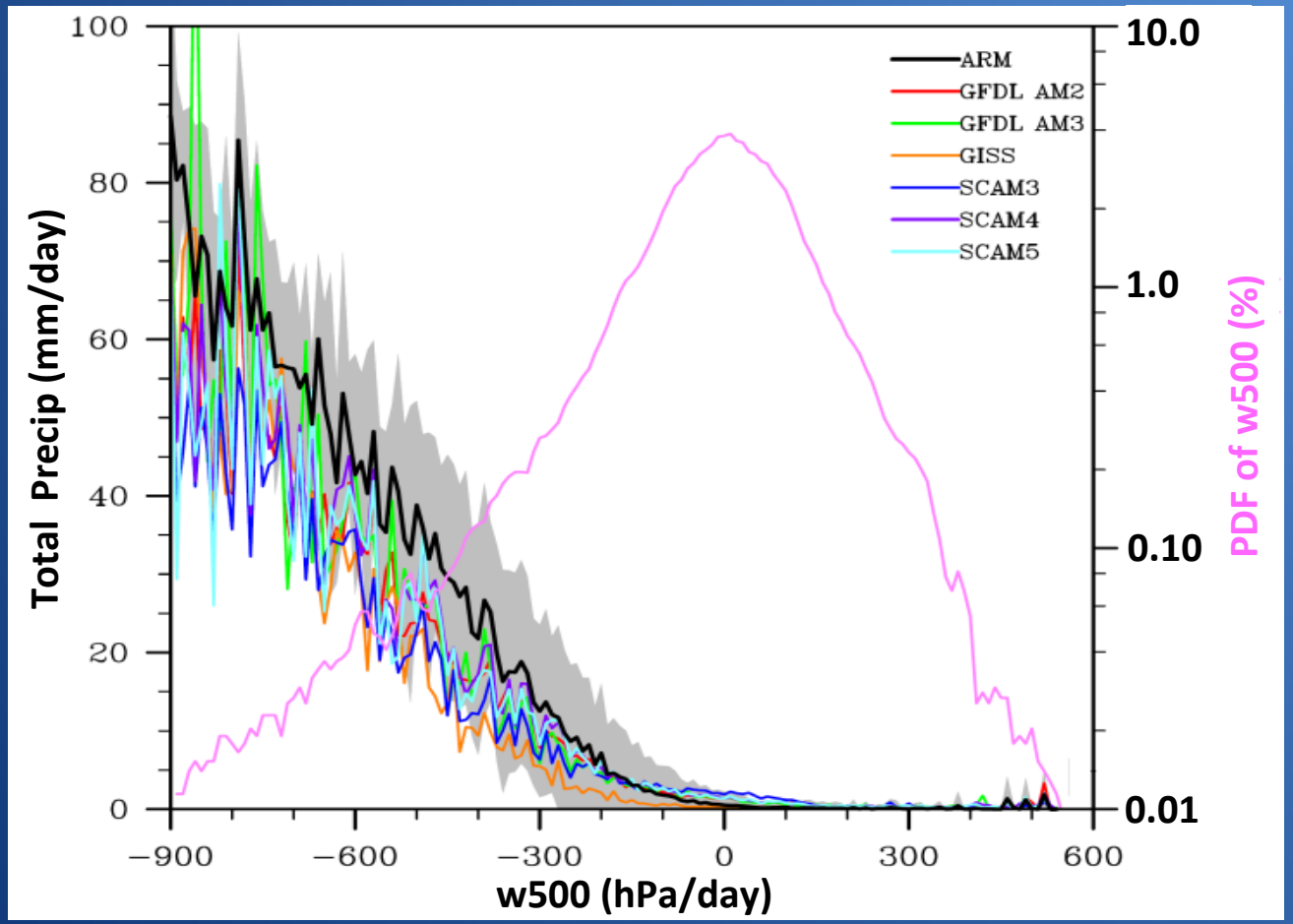
Models	Convection Scheme	Microphysical Scheme	Cloud Fraction	Resolution
GFDL AM2	Relaxed AS scheme Moorthi and Suarez 1992	One-moment Rotstayn 1997	Prognostic Tiedtke 1993	L24, 30mn
GFDL AM3	Cumulus conv. scheme Donner et al. 2001	Two-moment Salzmann et al. 2010	Prognostic Tiedtke 1993	L24, 30mn
GISS ModelE	Bulk mass flux scheme Yao and Del Genio 1995	One-moment Del Geino et al. 1996	Diagnostic Del Genio et al. 1996	L40, 30mn
ECMWF/KNMI	Bulk mass flux scheme Tiedtke 1989	One-moment Tiedtke 1993	Prognostic Tiedtke 1993	L91, 5mn
NCAR CAM3	Simplified AS scheme Zhang and McFarlane 1995	One-moment Rasch and Kristjansson 1998	Diagnostic Slingo 1987	L26, 20mn
NCAR CAM4	Simplified AS scheme Modified ZM, Neale et al. 2008	One-moment Rasch and Kristjansson 1998	Diagnostic Slingo 1987	L26, 20mn
NCAR CAM5	Simplified AS scheme Modified ZM, Neale et al. 2008	Two-moment Morrison and Gettelman 2008	Diagnostic Park/Gettelman et al. 2010	L30, 20mn



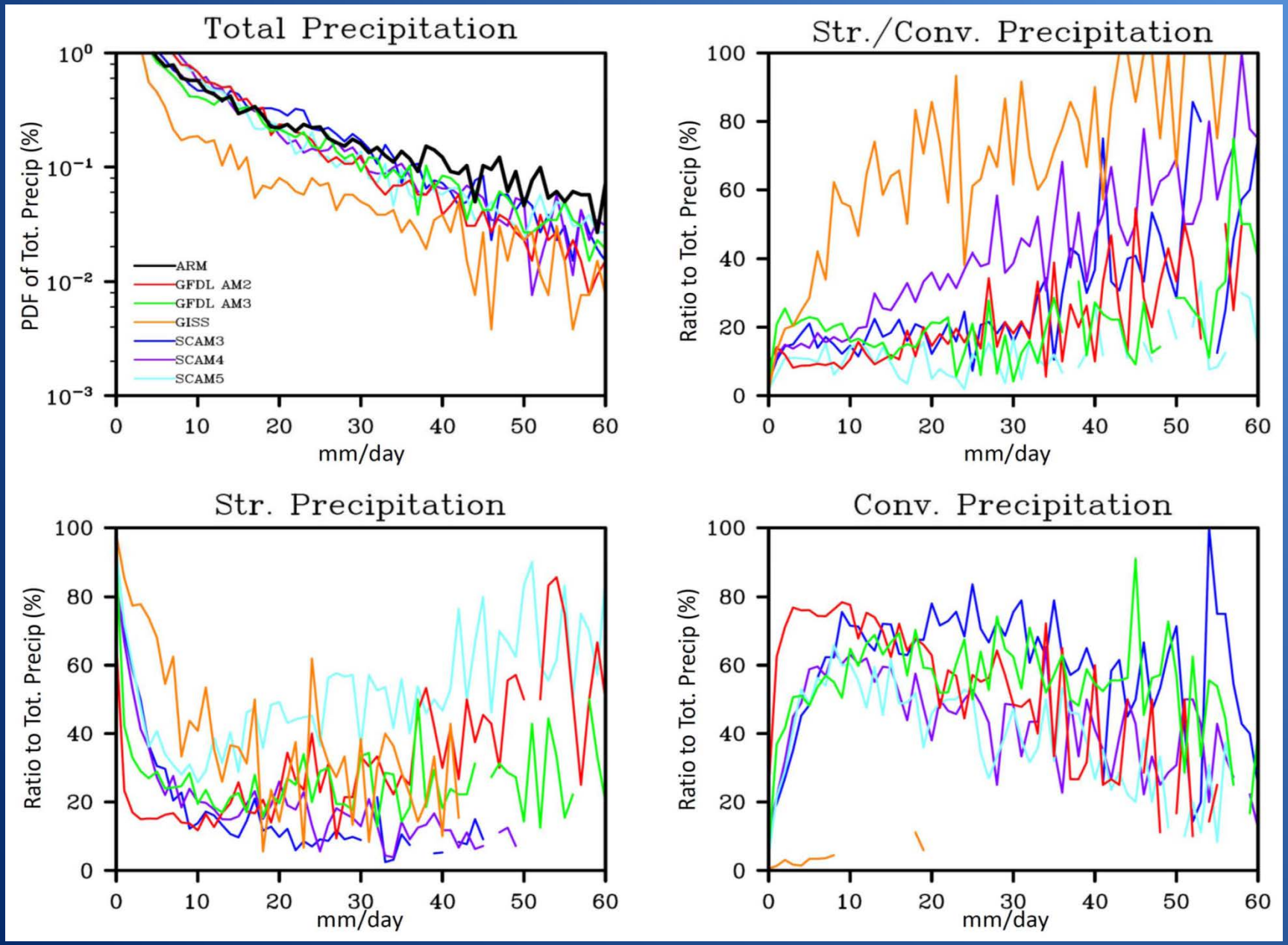


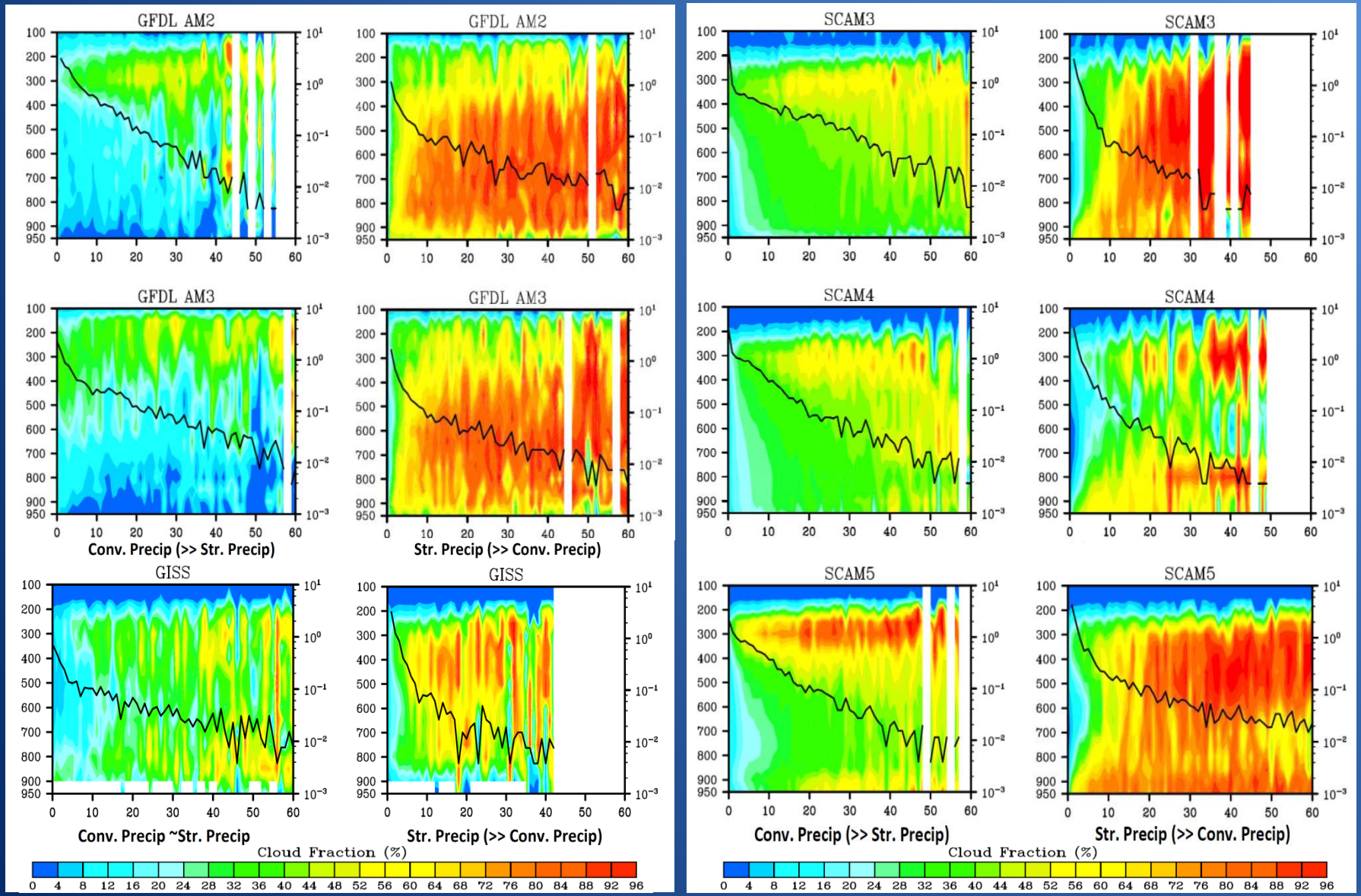
Cloud Fraction binned by 500hPa **Omega**

Total Precipitation binned by **500hPa Omega**



- Most precipitation occurs during strong ascending events
- Models underestimate obs. precipitation
- The underestimation is not significantly large
- Precipitation in models is well constrained by large-scale forcing


Total Precipitation
PDF of Tot. Precip (%)
mm/day
ARM
GFDL AM2
GFDL AM3
GISS
SCAM3
SCAM4
SCAM5
Str./Conv. Precipitation
Ratio to Tot. Precip (%)
mm/day
Str. Precipitation
Ratio to Tot. Precip (%)
mm/day
Conv. Precipitation
Ratio to Tot. Precip (%)
mm/day



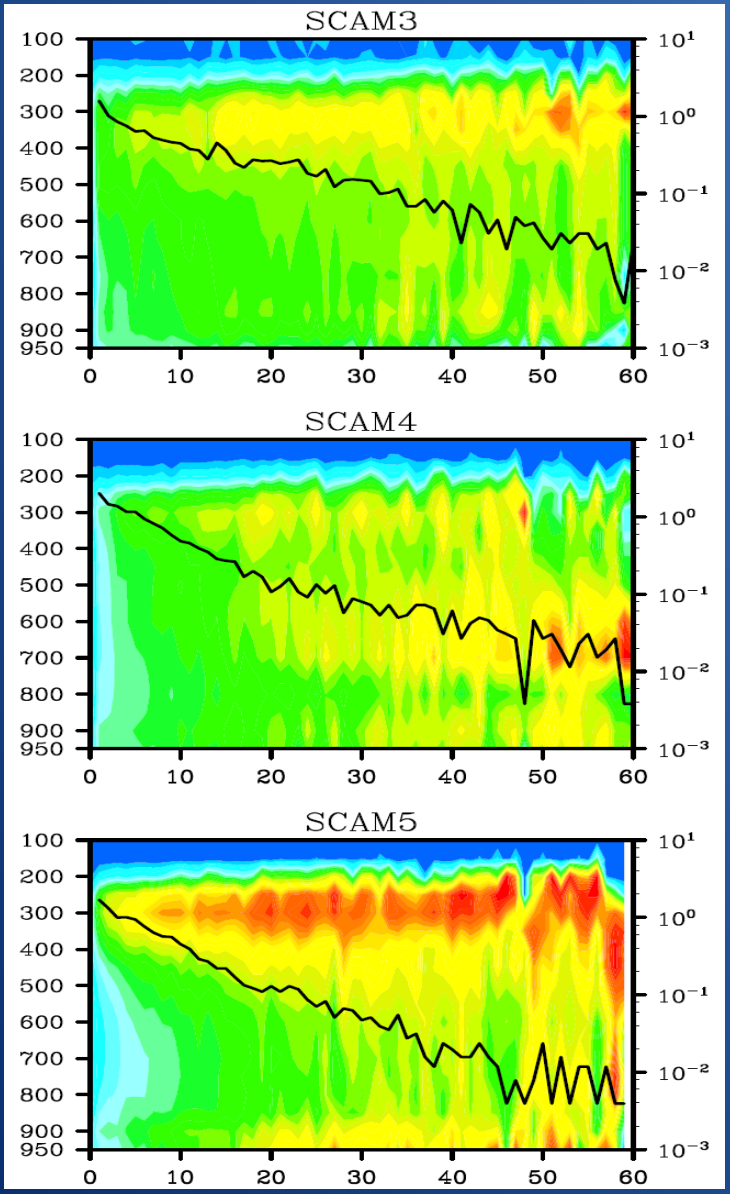
Cloud Fraction binned by

Conv.-dominated**, Strat.**-dominated **and Conv./Strat.**-dominated **Precipitation**

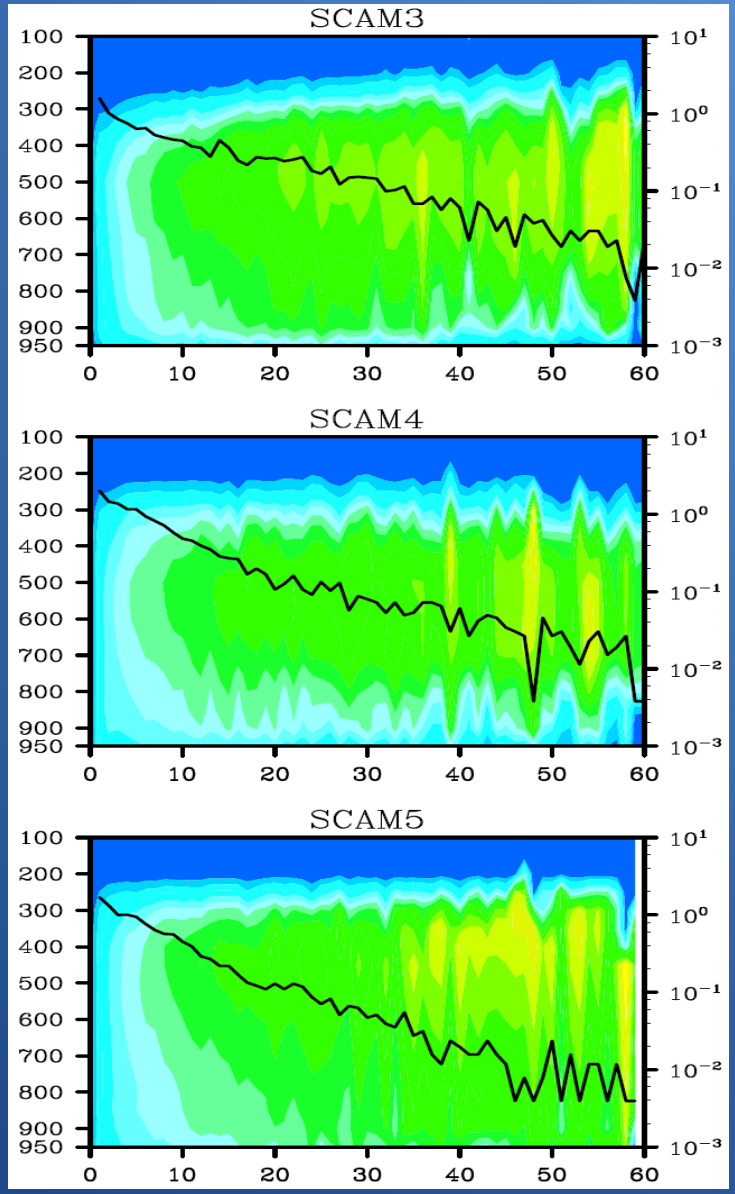
Summary

- Large differences in cloud fraction distributions:
  - ✓ Most models overestimate cloud amounts in descending regimes
  - ✓ Both GFDL AMs overestimate top cloud amounts
  - ✓ Models with higher resolutions tend to produce fewer cloud amounts (GISS and ECMWF)
  - ✓ From CAM3 to CAM5, the middle level cloud amounts are improved
- Small underestimation of total precipitation, well constrained by large-scale forcing.
- Partitioning of total precipitation is quite different among 6 models.
- Vertical cloud fraction distributions are top-heavy for convection-dominated events, but more homogeneous for stratiform-dominated events.

Cloud Fraction binned by **Convective Precipitation**



All Clouds



Convective Clouds Only