

Stratocumulus Clouds in a Multiscale Modeling Framework

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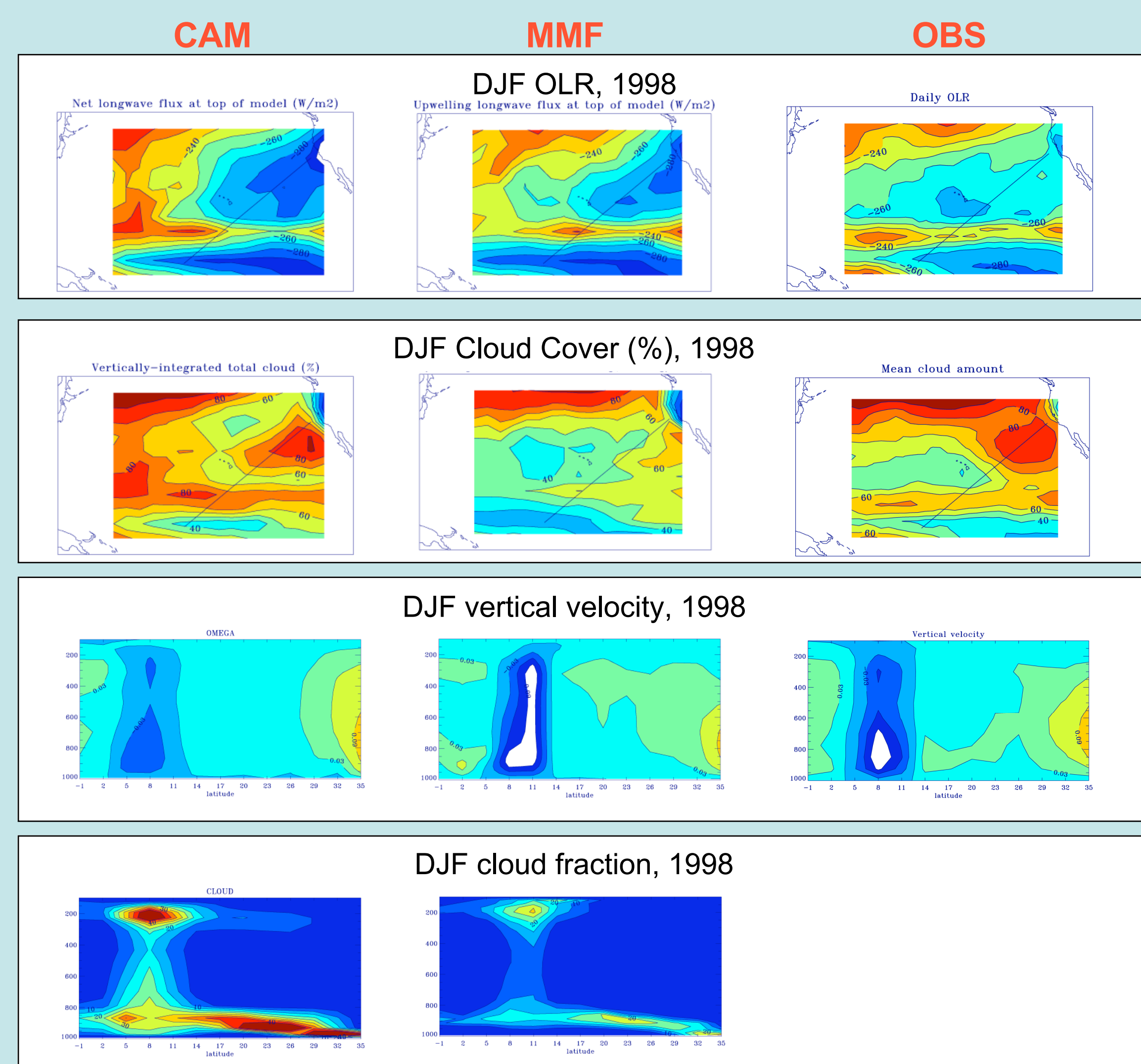
1. Introduction

The traditional cumulus parameterization in the Community Atmospheric Model (CAM3) was replaced with embedded 2D cloud resolving models (CRMs) in each GCM grid column, a “multiscale modeling framework” (MMF). Computational constraints limit CRM resolution to just 4-km in the x-direction, much coarser than typical CRM resolutions used to simulate stratocumulus clouds.

Can the MMF adequately simulate this important cloud type?

2. The Pacific Cross Section

Seasonal mean maps and cross sections along the GCSS Pacific Cross Section:



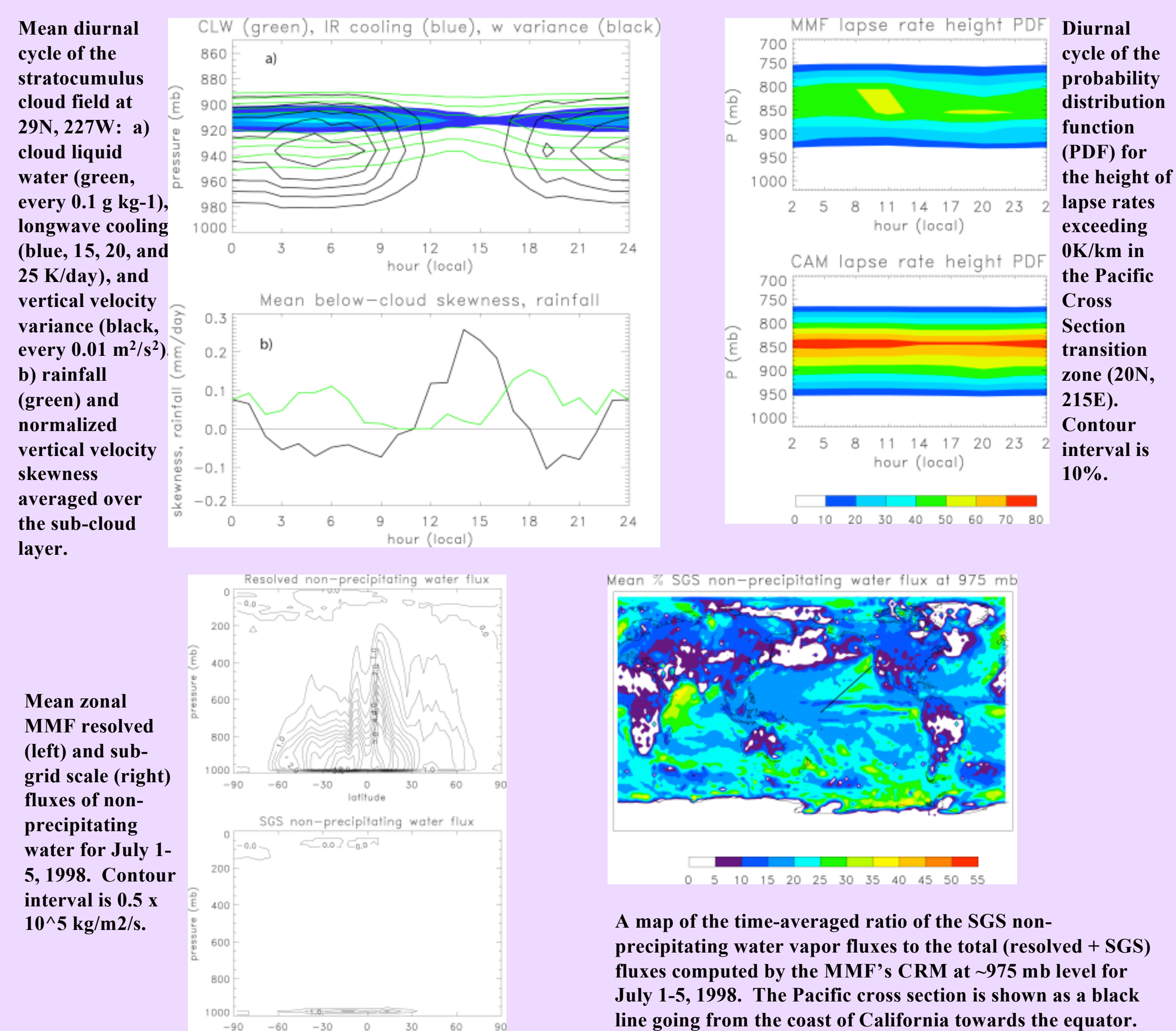
MMF cloud fractions are lower than those in CAM and those derived from observations, but other large-scale fields generally agree well with observations.

Summary: The cumulus parameterization in the CAM3 GCM has been replaced with an embedded CRM. The relatively coarse 4-km CRM grid resolution in the MMF produces physically realistic marine stratocumulus clouds with improved diurnal cycle over the traditional parameterization method, but low cloud fractions are too low in some areas.

3. High Resolution Analysis

“Looking inside the model...”

Hourly CRM-scale output was saved for a 5-day period (July 1-5, 1998) to examine the fine-scale structure of simulated stratus clouds.



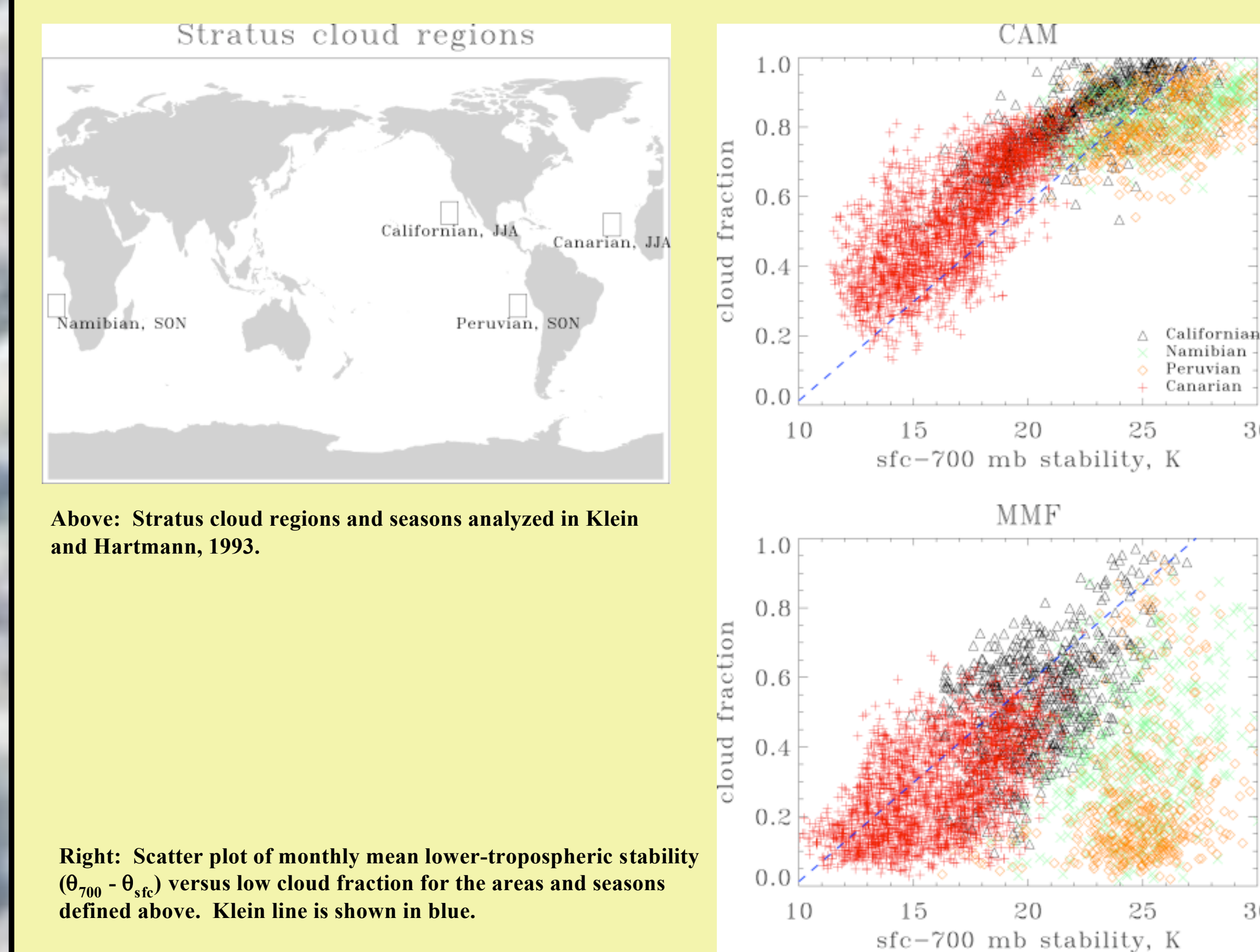
Simulated clouds:

- driven by radiative cooling
- have realistic vertical velocity skewness profiles.
- improved diurnal variability compared to the CAM.
- non-precipitating water fluxes handled by the CRM, and not the sub-gridscale parameterization.

4. Global marine stratocumulus

Do MMF-produced marine stratocumulus clouds exhibit the same sensitivity to lower tropospheric stability as seen in numerous observational studies?

Results from *two 14-year AMIP runs* let us compare model output to the “Klein Line” (Klein and Hartmann, 1993). CAM low cloud is parameterized using the Klein line. MMF low cloud is produced according to the embedded CRM dynamics and thermodynamics.



MMF stratus cloud sensitivity to lower tropospheric stability is good in the Northern Hemisphere, but less so in the descending regions of the Hadley cell in the Southern Hemisphere.

References

Klein, S. A. and D. L. Hartmann, 1993: The seasonal cycle of low stratiform clouds. *J. Climate*, **6**, 1587-1606.

Acknowledgements

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