The diurnal cycle of cloudiness in the standard and MMF CAM

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MMF Background

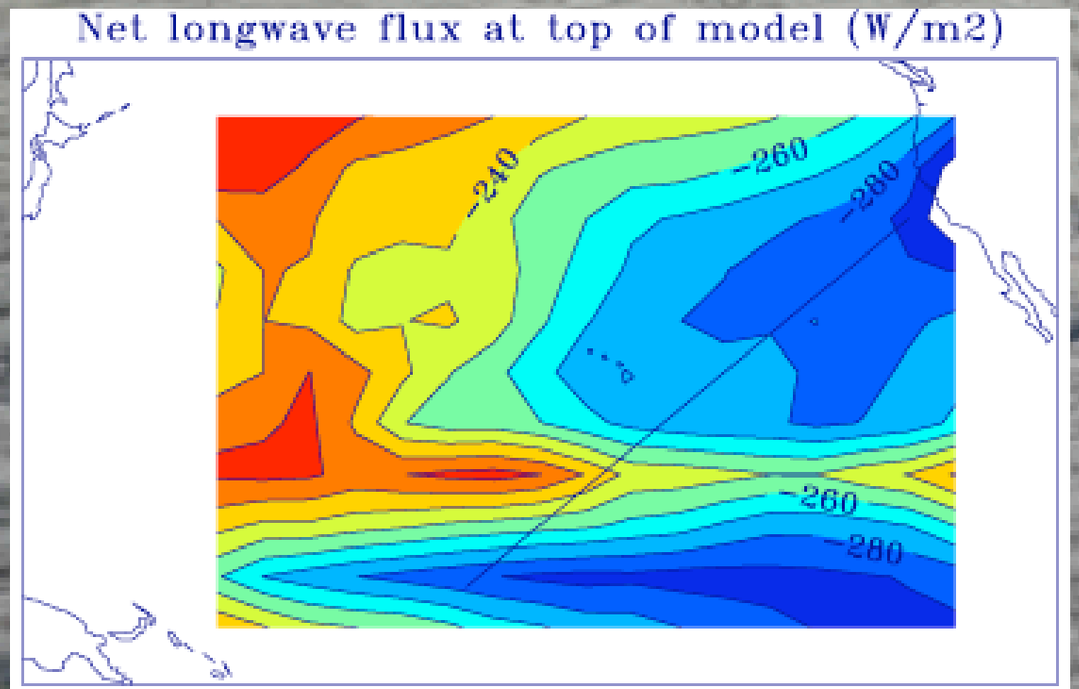
- CAM3 is run with cloud-resolving model (SAM) in place of cumulus parameterization.
  - 2D CRM simulation with 32 4-km horizontal grid spacing.
    - vertical levels in SAM same as those used in CAM3.
  - Radiative calculations performed on SAM grid. Surface fluxes computed on CAM3 grid.

Motivation

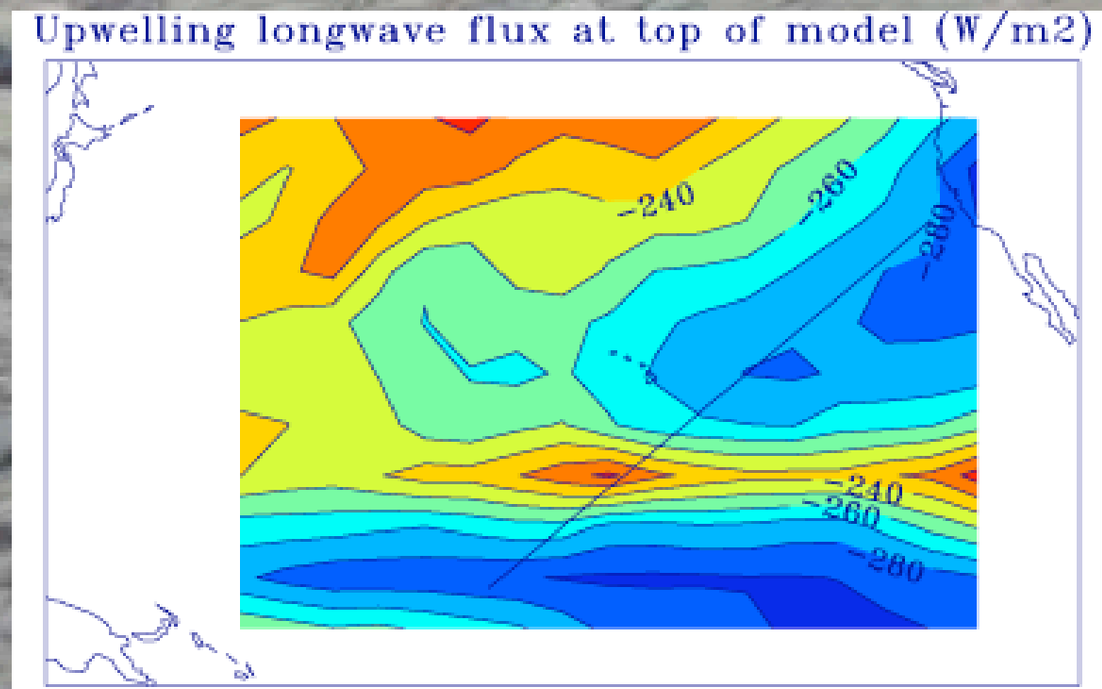
- In the AMIP runs, SAM has been configured primarily for deep convection (4 km grid spacing) and "speed" (32 grid columns).
- Can we realistically expect to simulate marine stratocumulus with such a setup?

Basic comparisons - OLR 1998

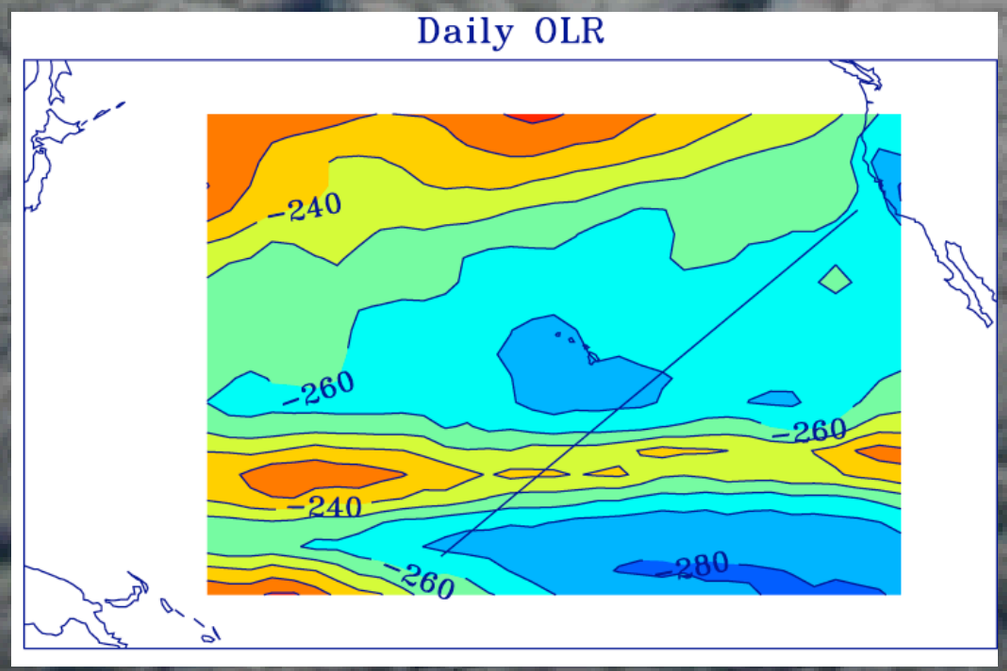
CAM3



MMF

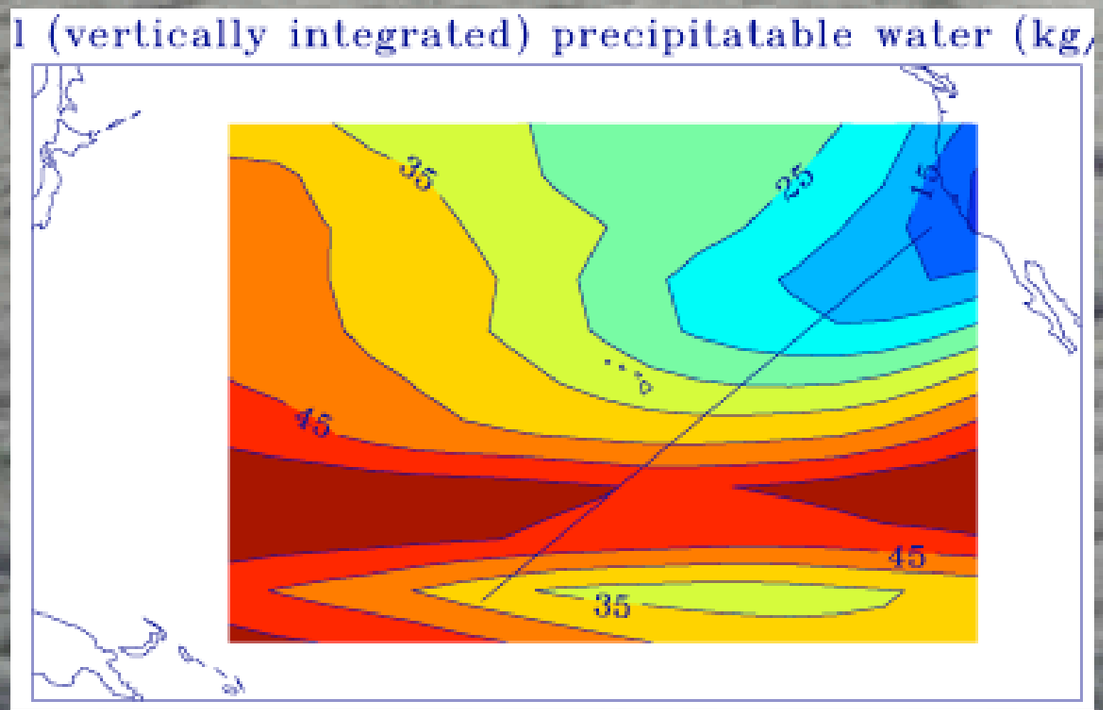


NOAA

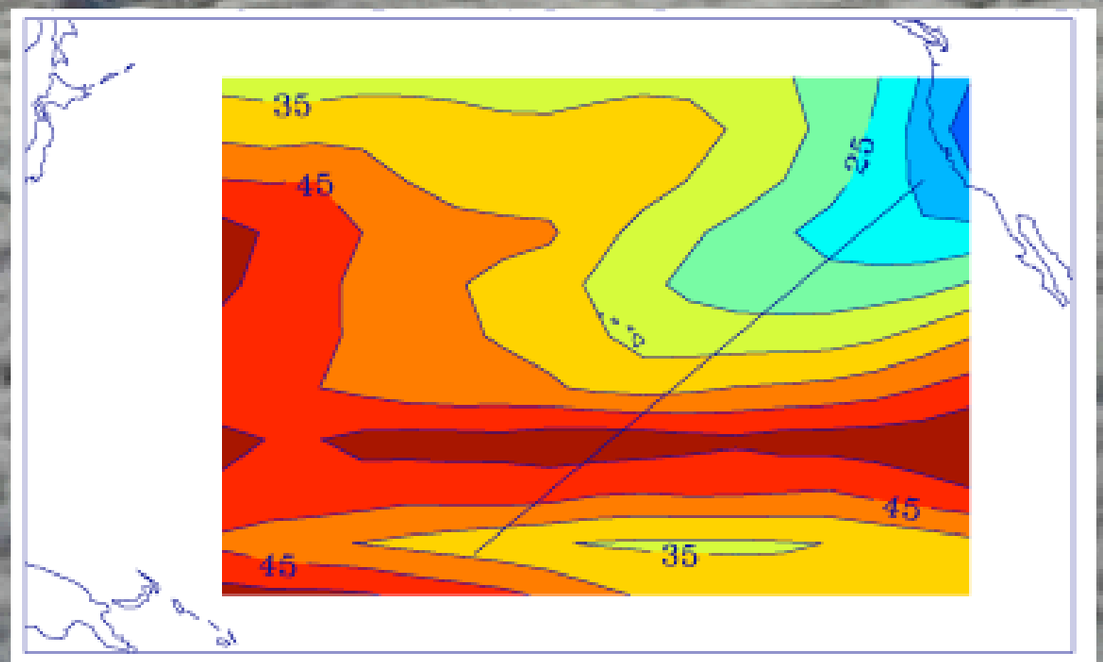


Precipitable Water (mm) - 1998

CAM3



MMF



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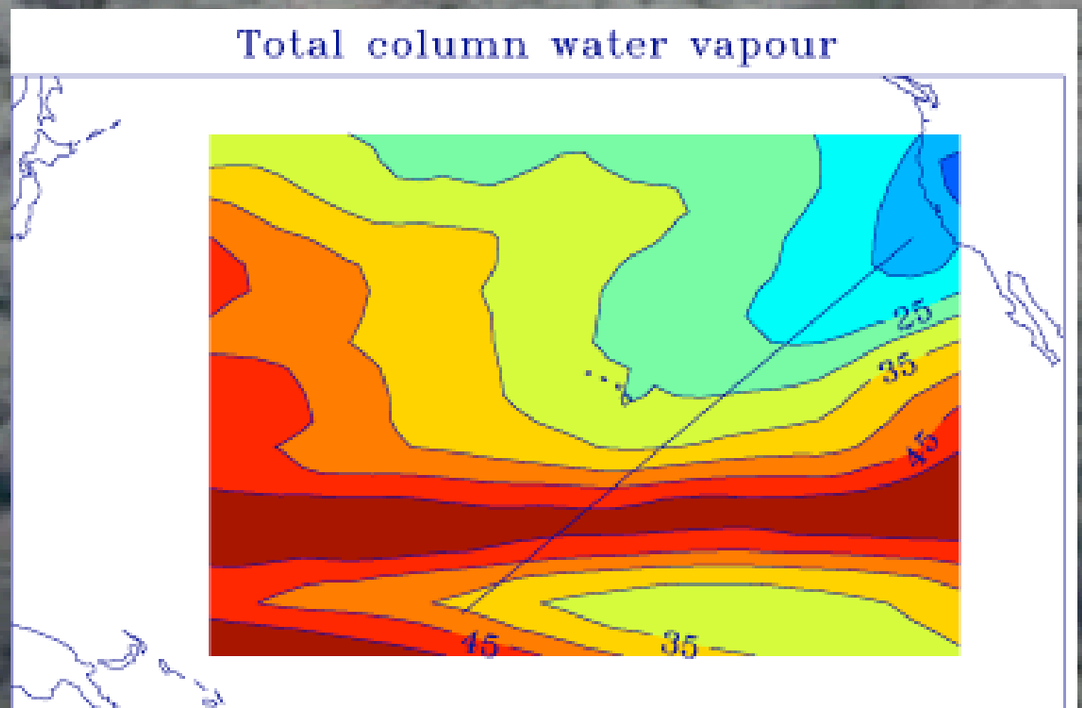
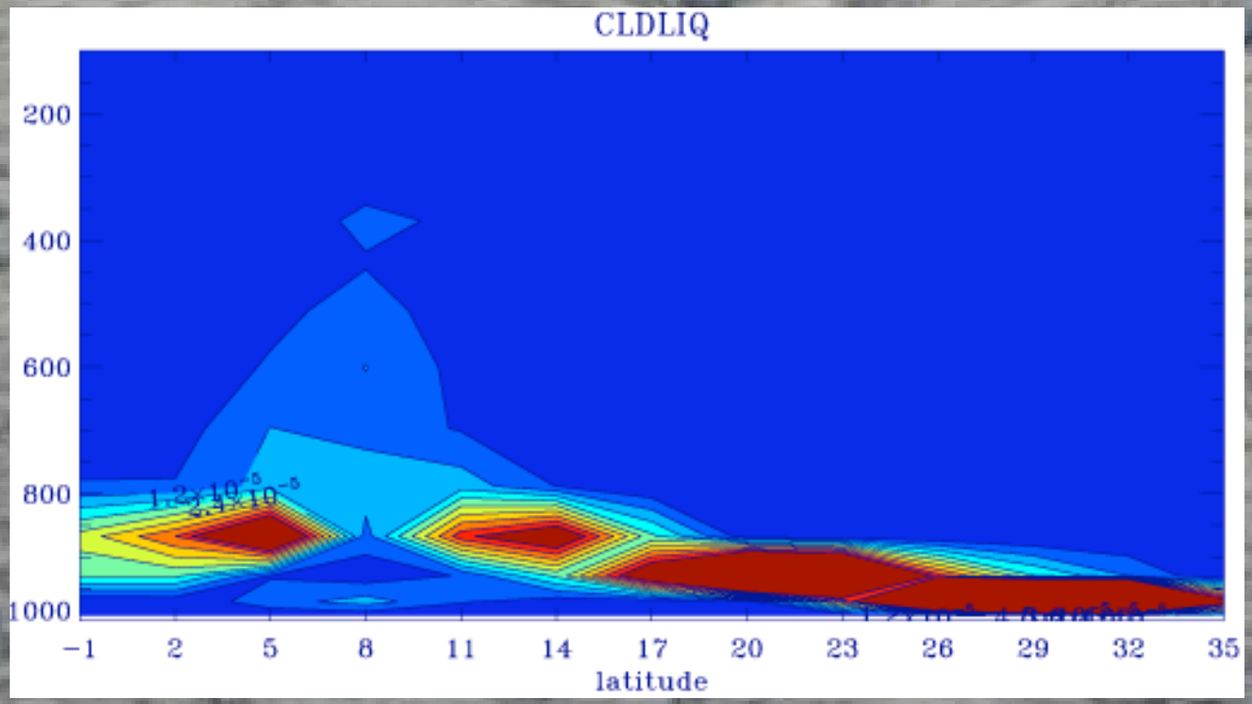
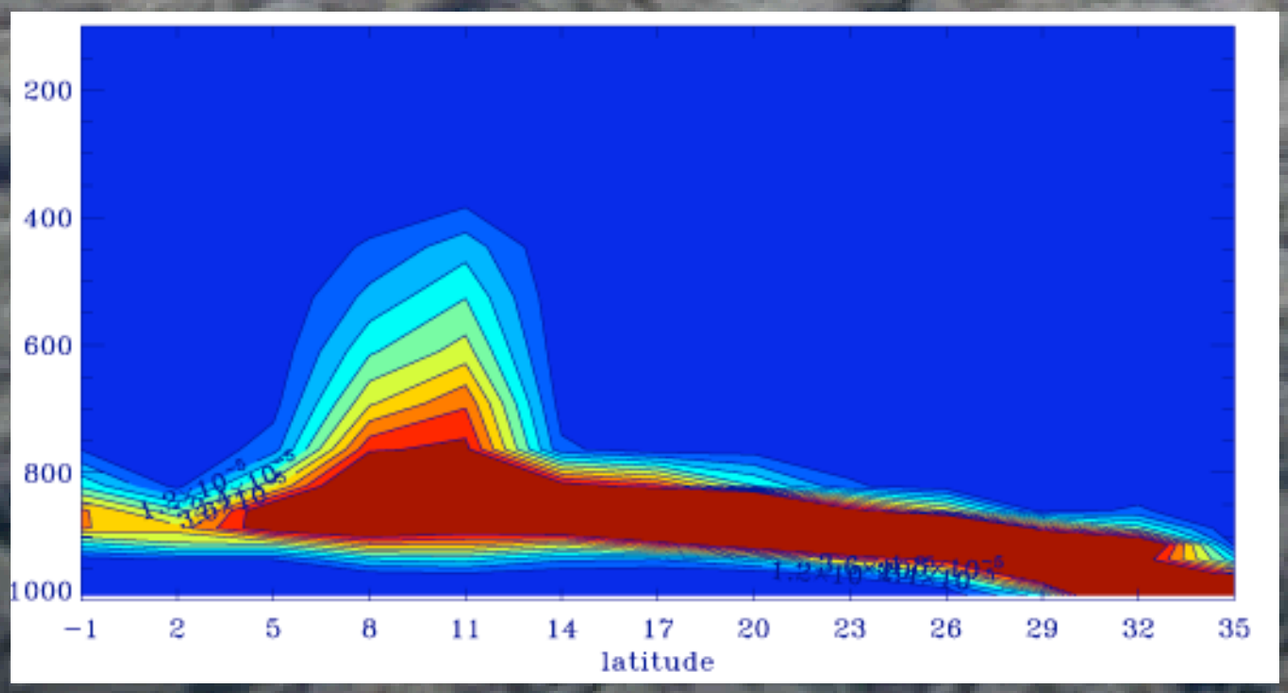


Cloud Water (kg/kg) - 1998

CAM3

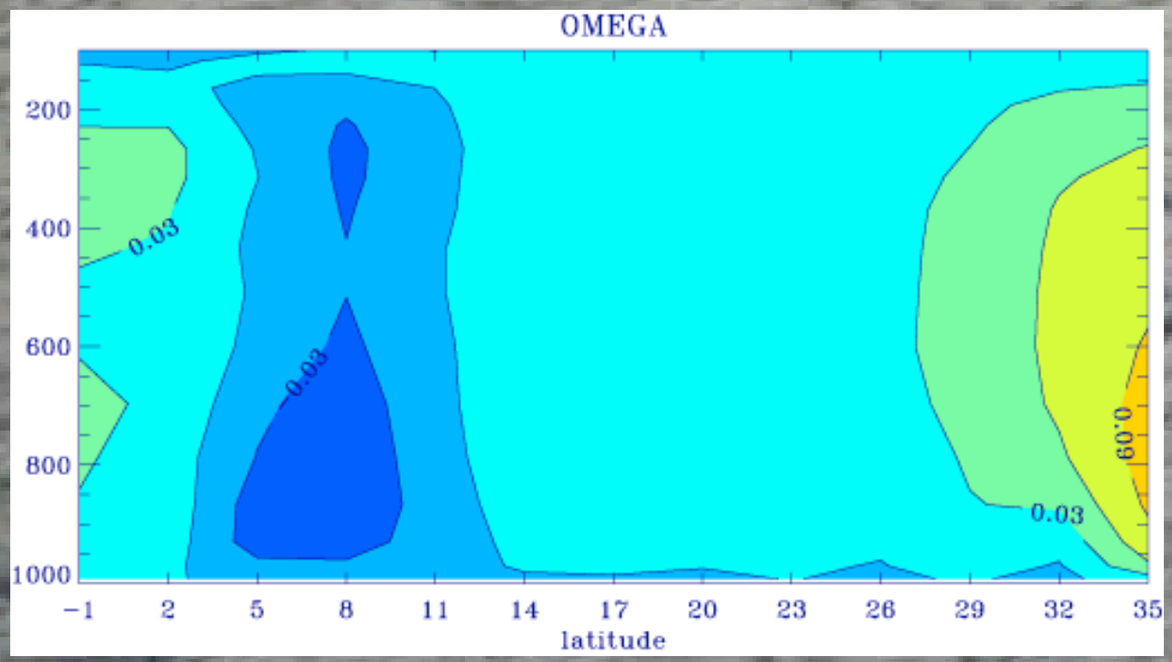


MMF

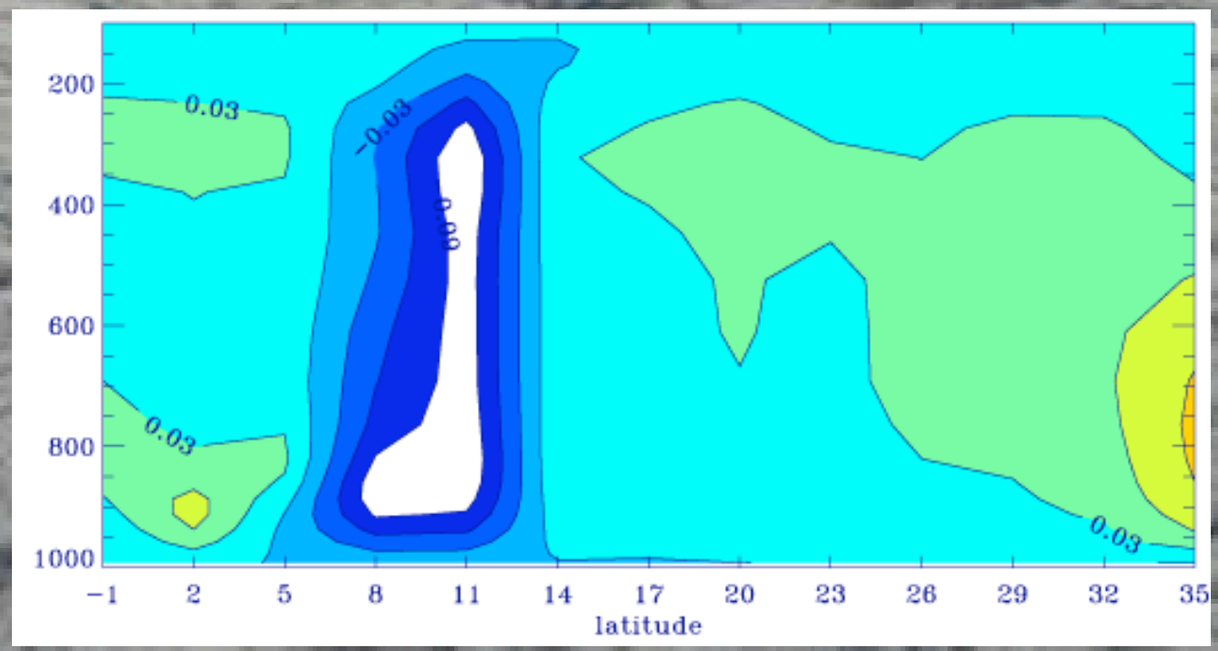


Vertical Motion (Pa/s) - 1998

CAM3



MMF



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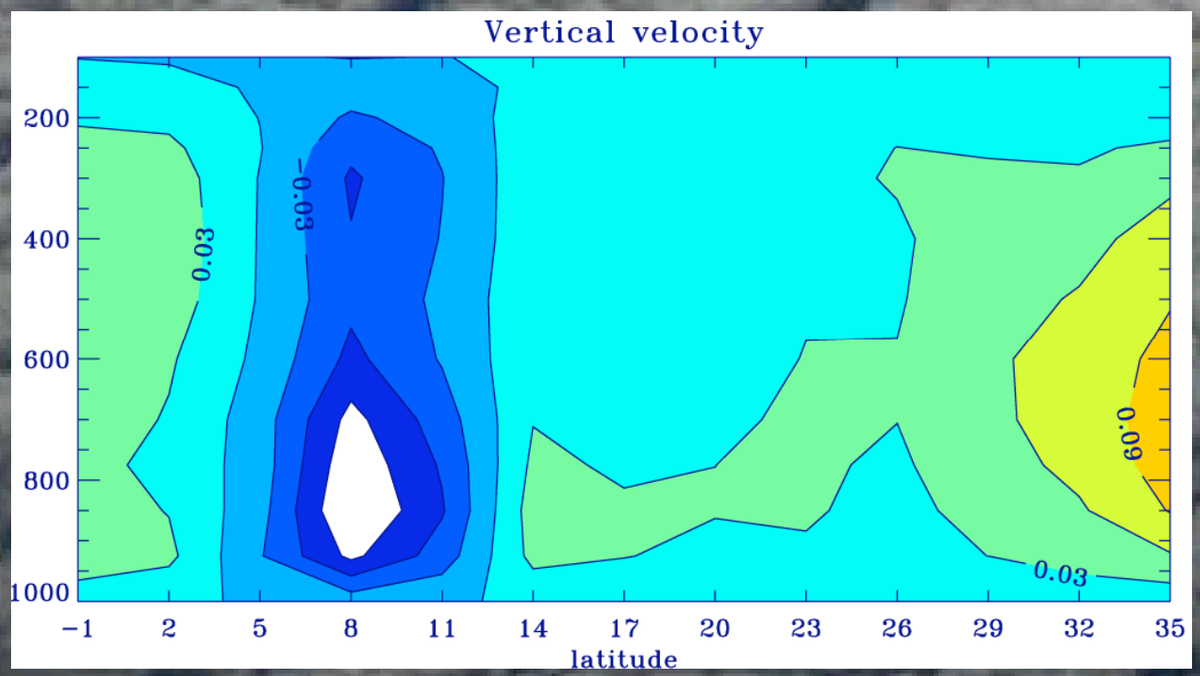


How do the two simulations produce marine Sc clouds?

- Standard CAM
  - cloud is assumed to be located in the model layer below the strongest stability jump between 750 mb and the surface. If no two layers present a stability in excess of -0.125 K/mb, no cloud is diagnosed (after Klein and Hartmann, 1995).
- MMF CAM
  - SAM is simply given surface and momentum fluxes, and left to its own devices.

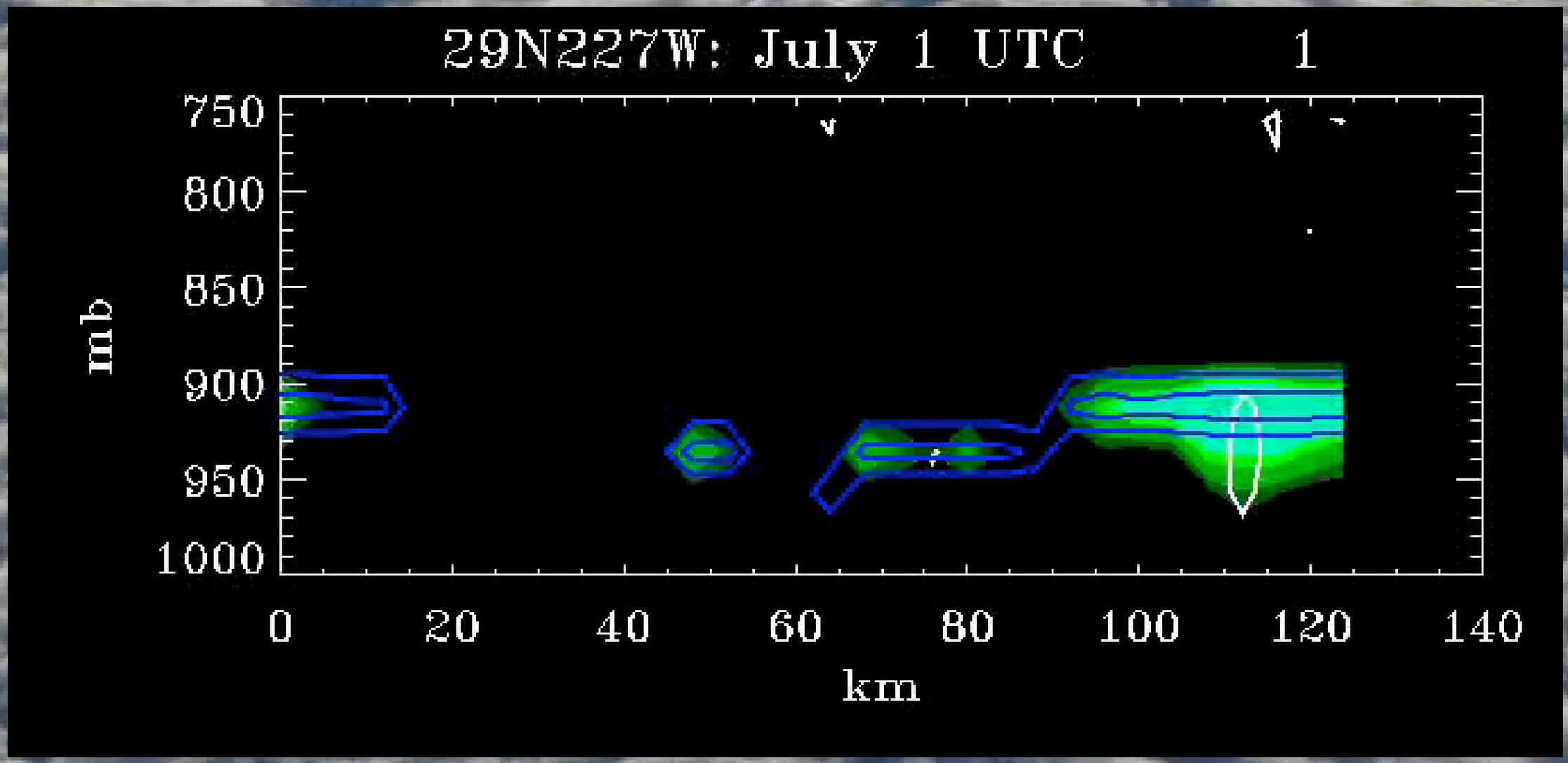
More questions about the MMF

- Does the MMF really produce stratocumulus clouds?
- Do the MMF stratus clouds behave as they do in nature?
- Does the MMF produce a transition zone between Sc and Cu clouds?

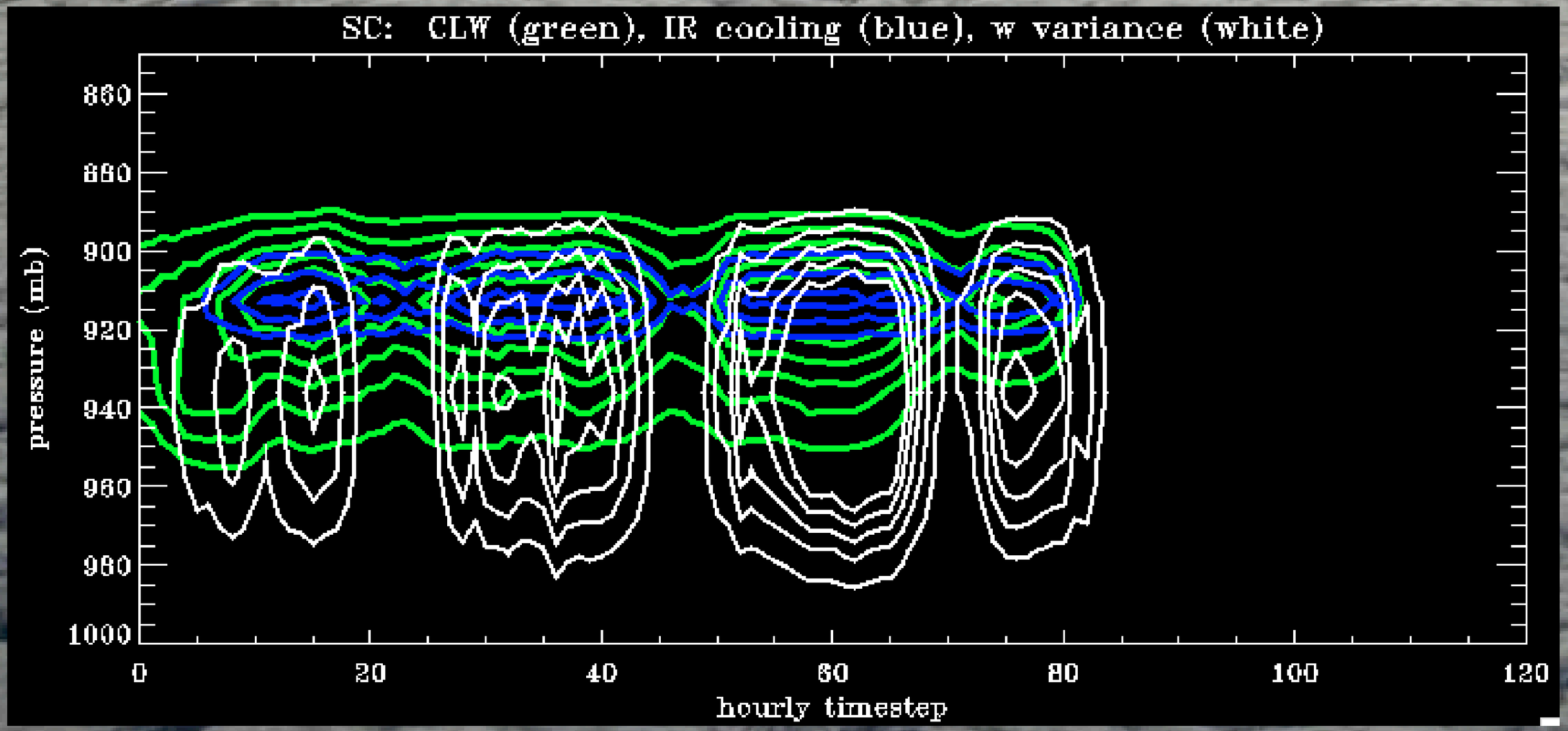
MMF fine-scale analysis

- Randomly selected a 5-day period to save hourly full-resolution SAM output
  - July 1-5, 1998
  - Saved SAM output at 32 columns x 4-km resolution x 28 vertical levels (coincident with CAM3 vertical levels).
- Examine marine Sc clouds, Sc-Cu transition clouds, and deep convective clouds along cross-section.

29N: hourly SAM output

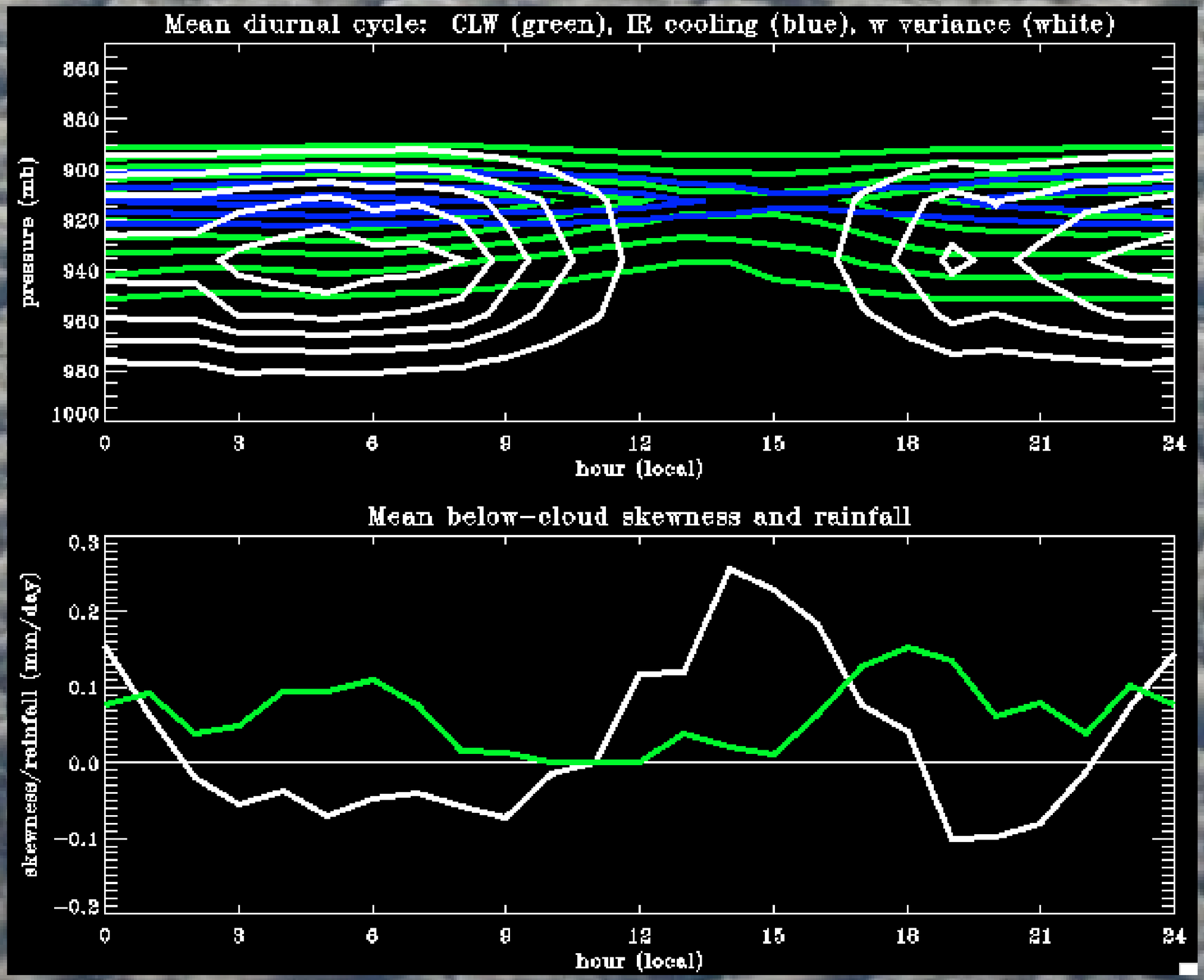


29N: an area-averaged perspective

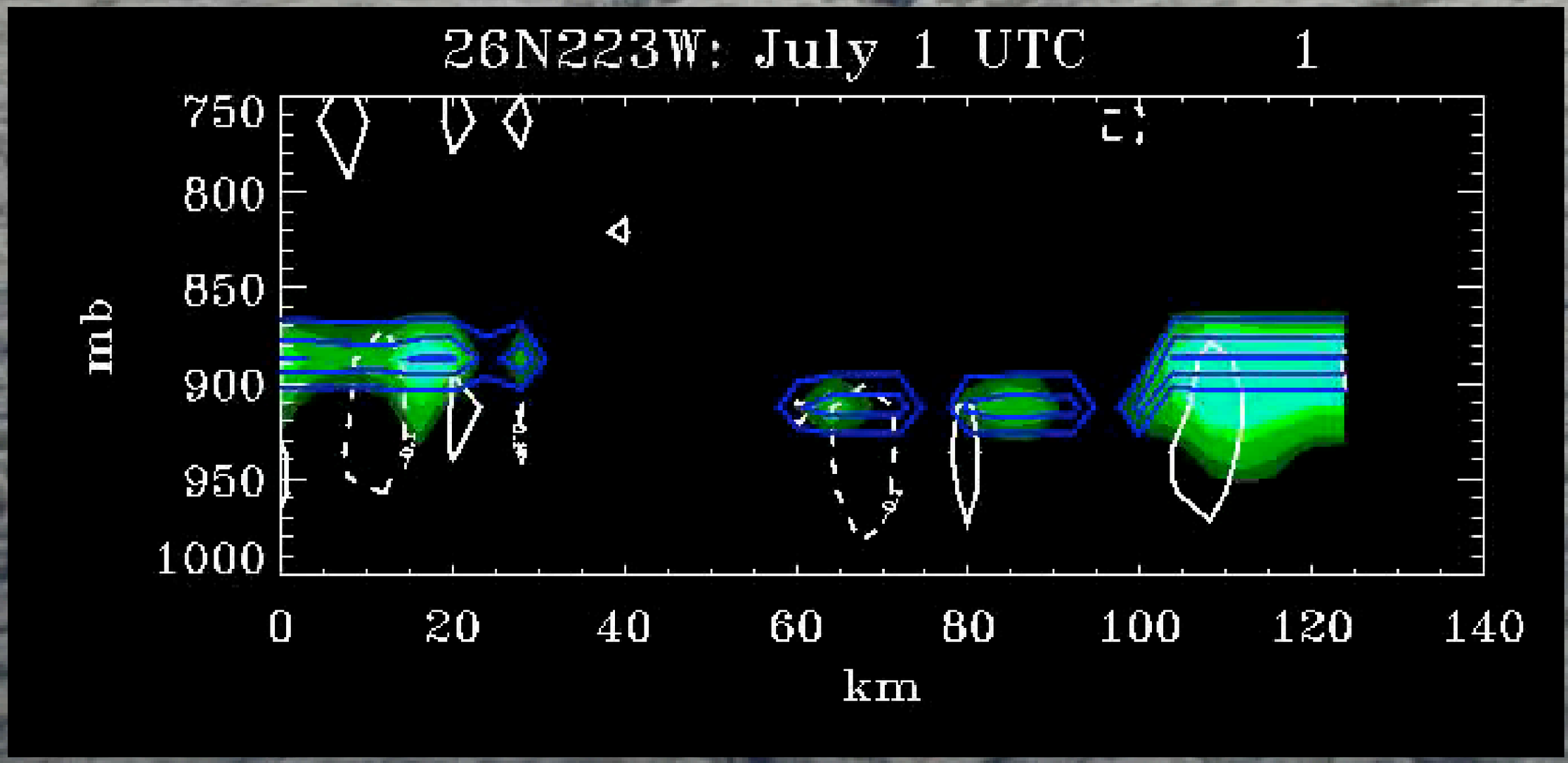


- IR cooling coincident with maximum cloud water
- w variance coincident with IR cooling
- all three vary diurnally

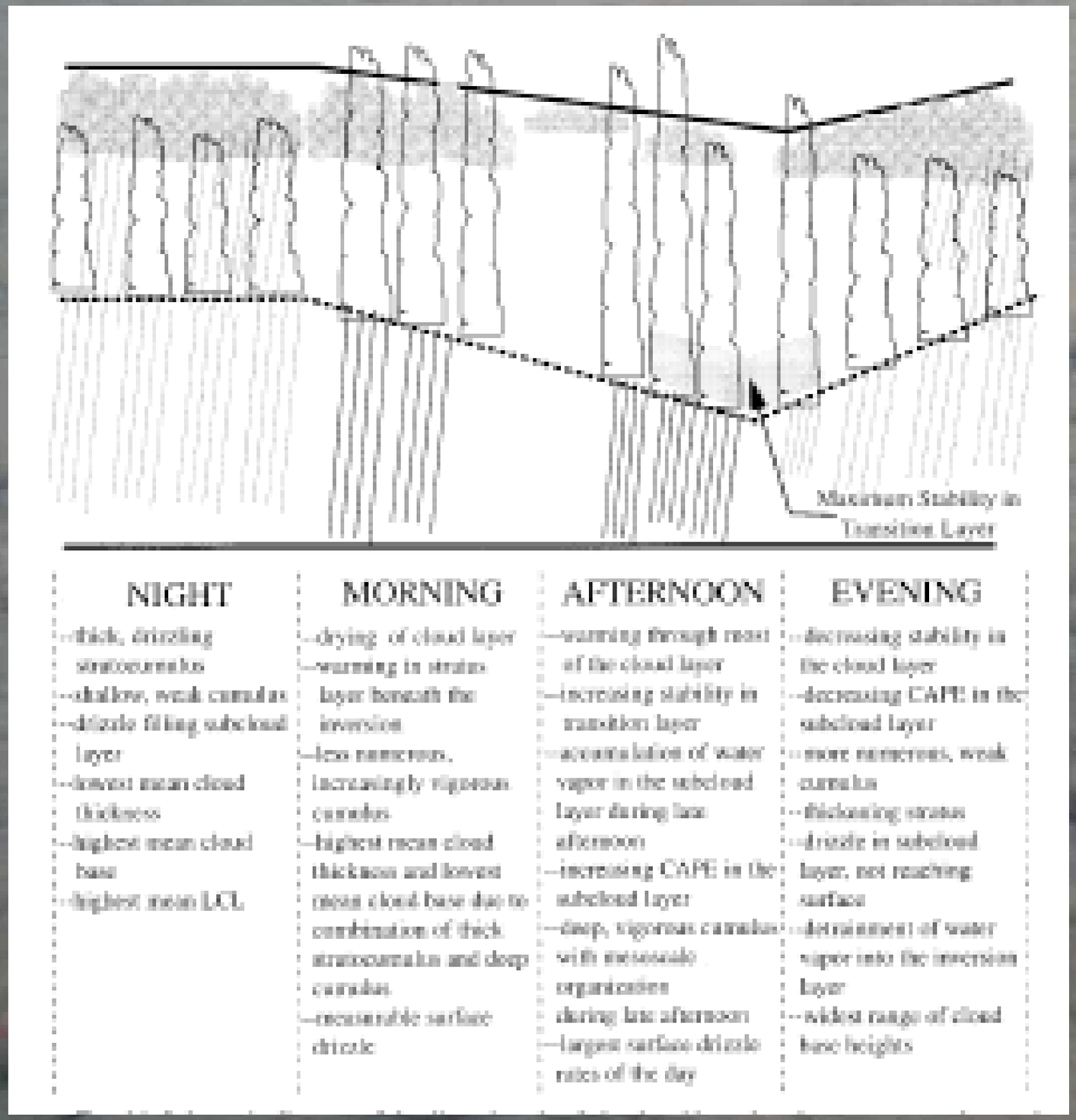
29N: what drives sub-cloud turbulence?



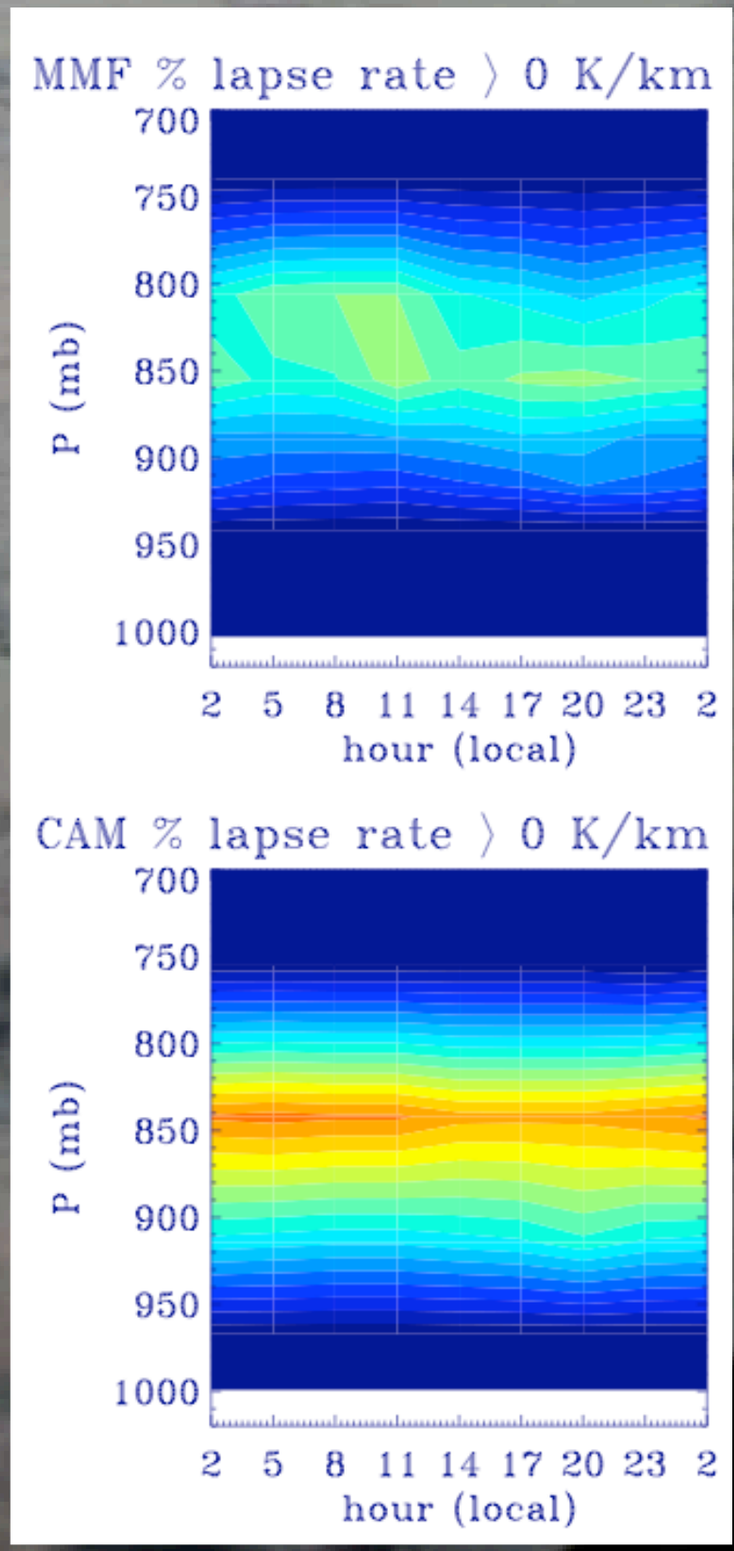
26N (transition zone) animation



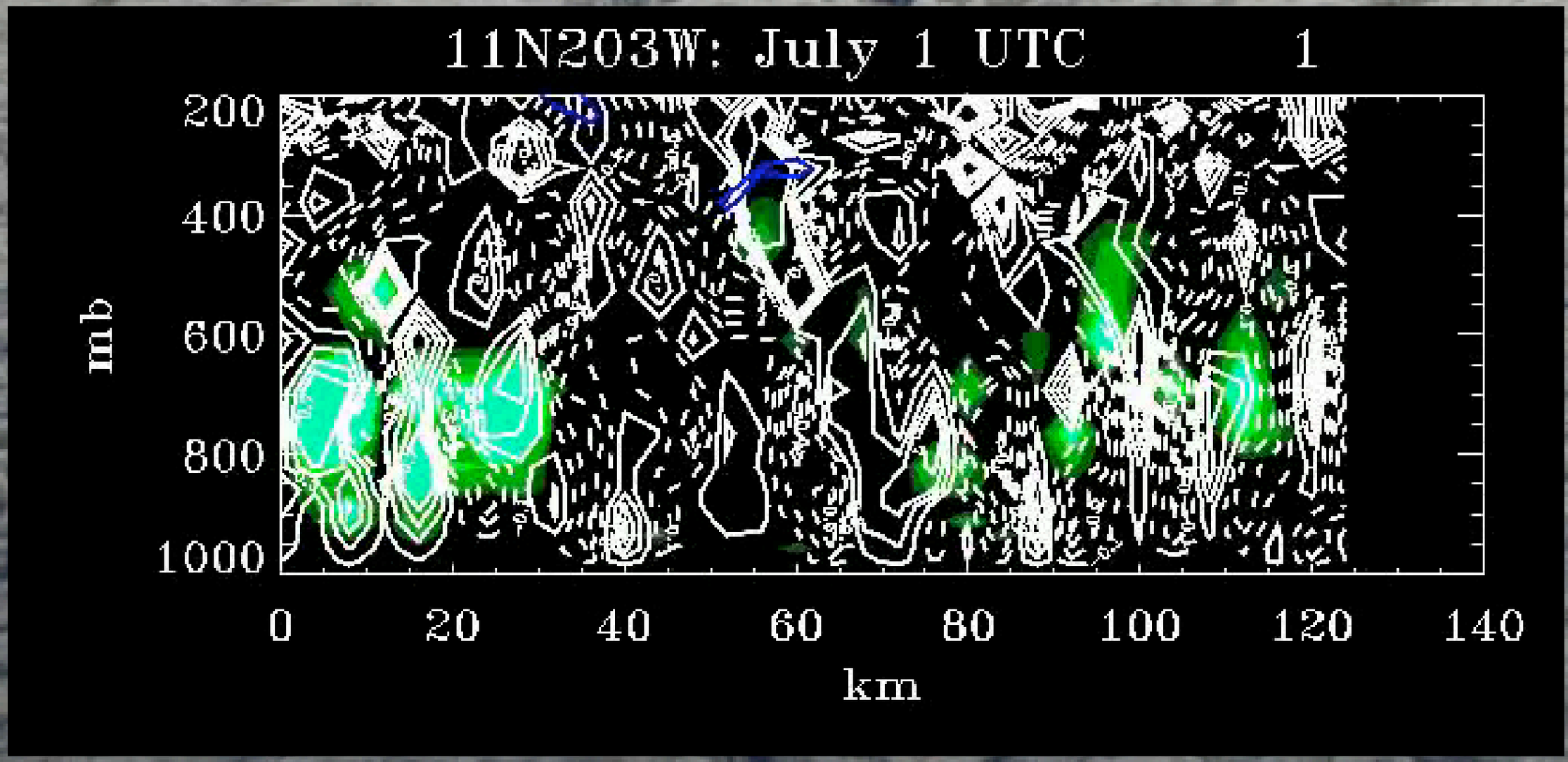
26N (transition zone): mean diurnal cycle



from Miller et al, 1998



ITCZ: Deep convection animation



Summary

- The good news
  - MMF appears to produce reasonable marine Sc clouds and cloud behavior despite relatively coarse resolution.
  - Transition zone PBL height variability is properly simulated.
- The bad news
  - MMF shifts ITCZ convection too far north compared to observations.