MMFhr

Do high resolution MMF simulations give better boundary layer cloud?

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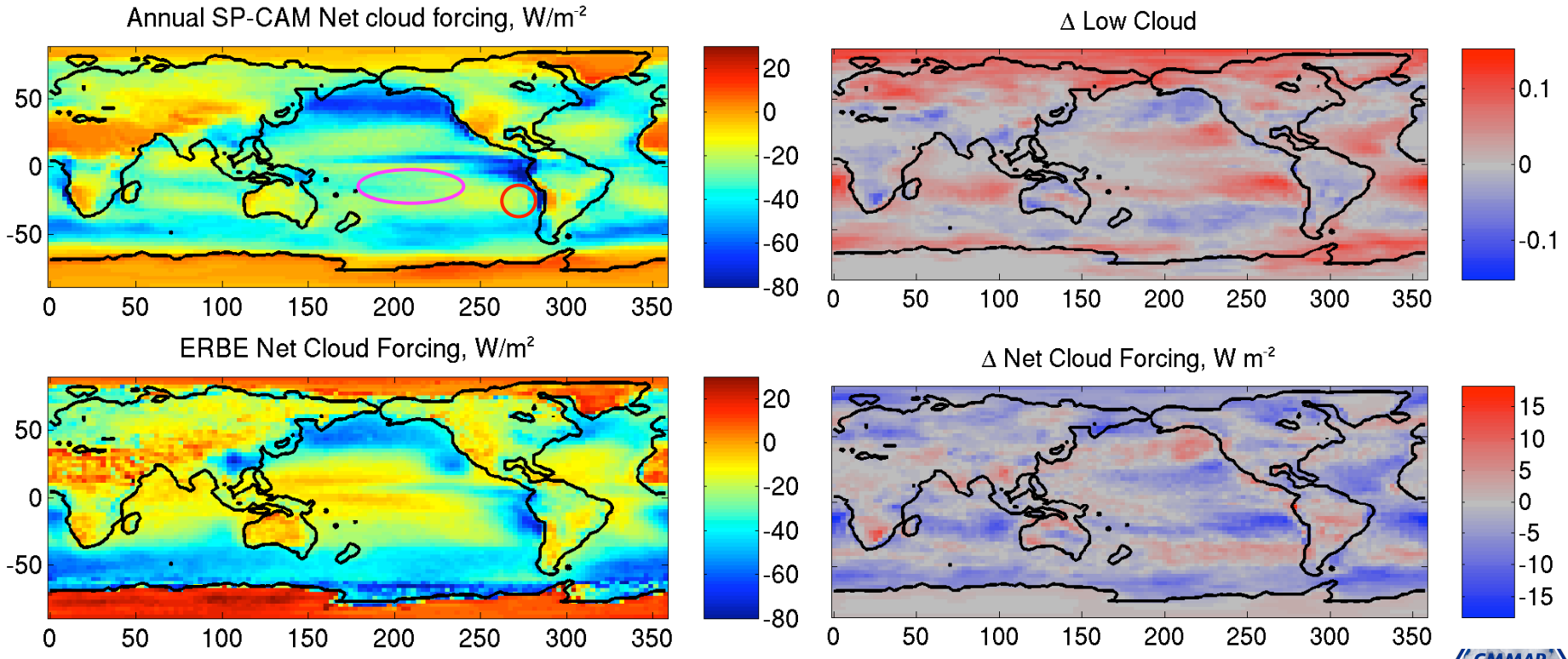
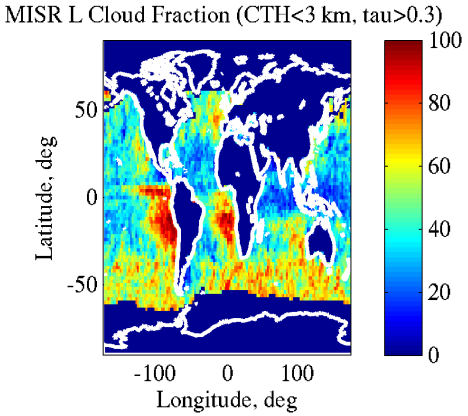
SP-CAM cloud climatology

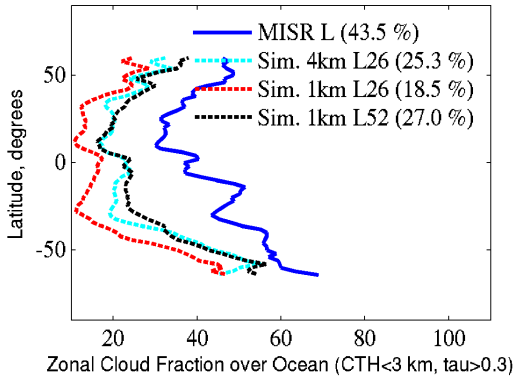
SP-CAM MMF: 30 levels, Δx = 4 km

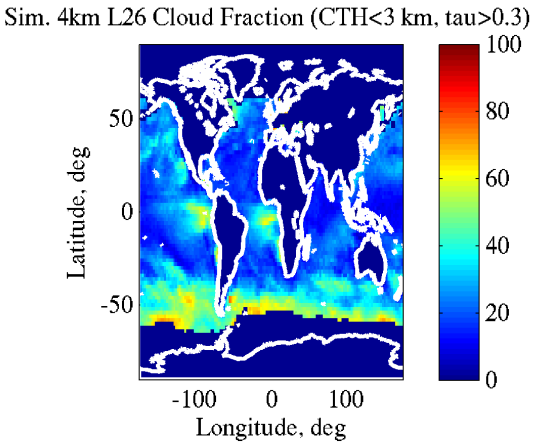
- Under-resolves boundary-layer Cu & Sc
- Climatological bright trade Cu/dim Sc bias
- Strong increase in low cloud for a 2K SST increase

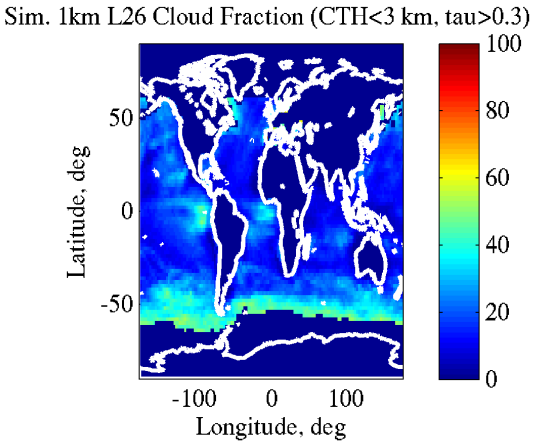


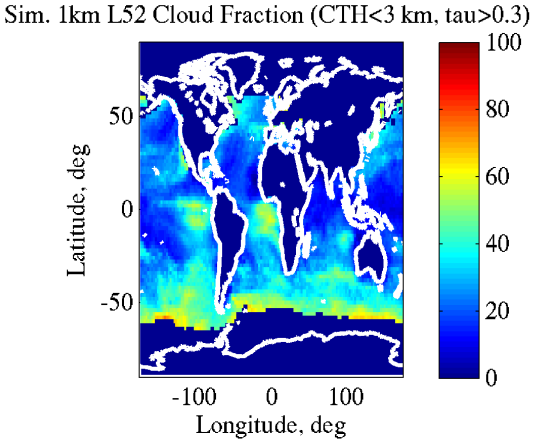
Sensitivity of low cloud amount to CRM resolution









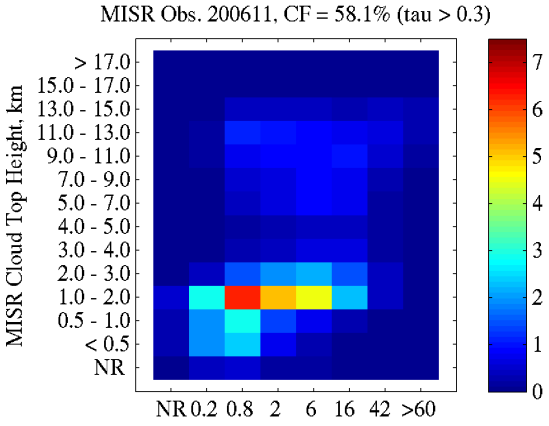


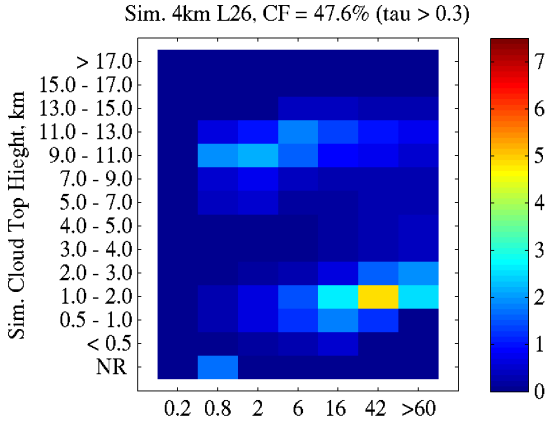
Control
- 4 km horizontal
- 64 columns
- 26 vertical layers

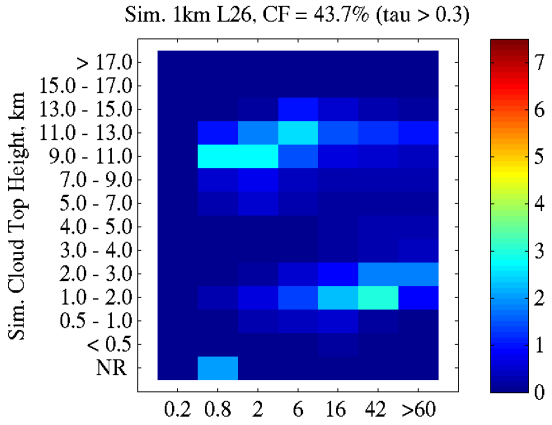
- Test A
  - 1 km horizontal
  - 64 & 128 columns
  - 26 vertical layers

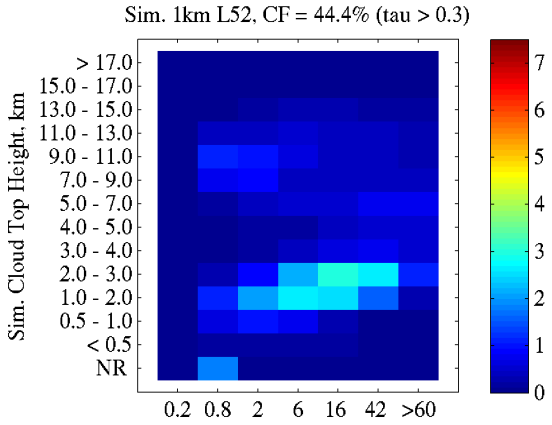
- Test B
  - 1 km horizontal
  - 64 columns
  - 52 vertical layers

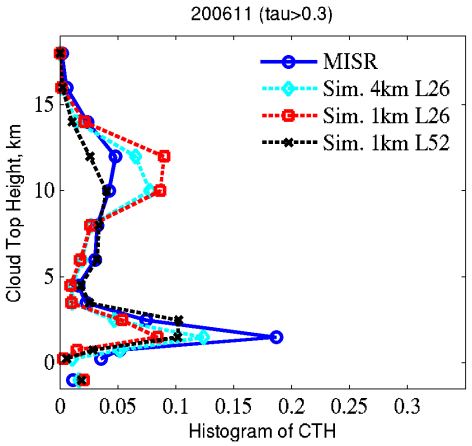
Hawaiian Trade Cumulus

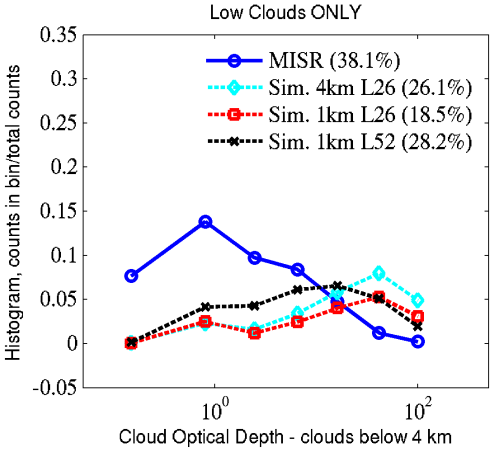










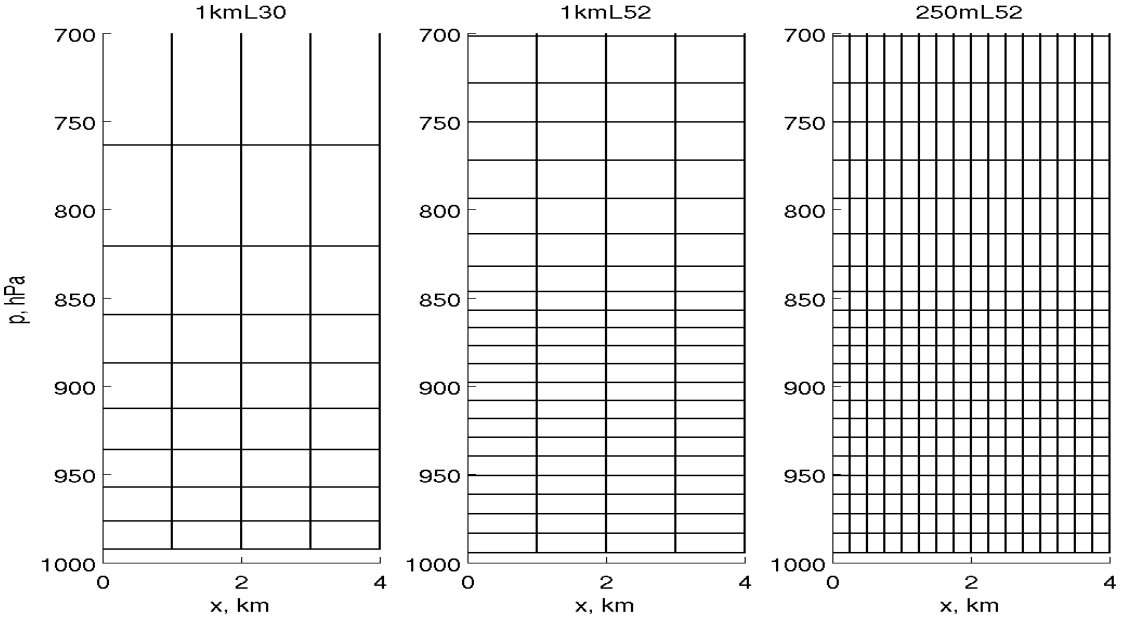


Could further resolution improvement help?

- For trade Cu, LES suggests Δx, Δz = 250,100 m adequate
- For Sc, sharp inversion requires Δz << 5 m or kluges in SAM.

$\Rightarrow$ Goal: Better trade Cu in MMF

Expt	N_x	T [d]
1kmL30	64	9
1kmL52	64	9
250mL52	128	2

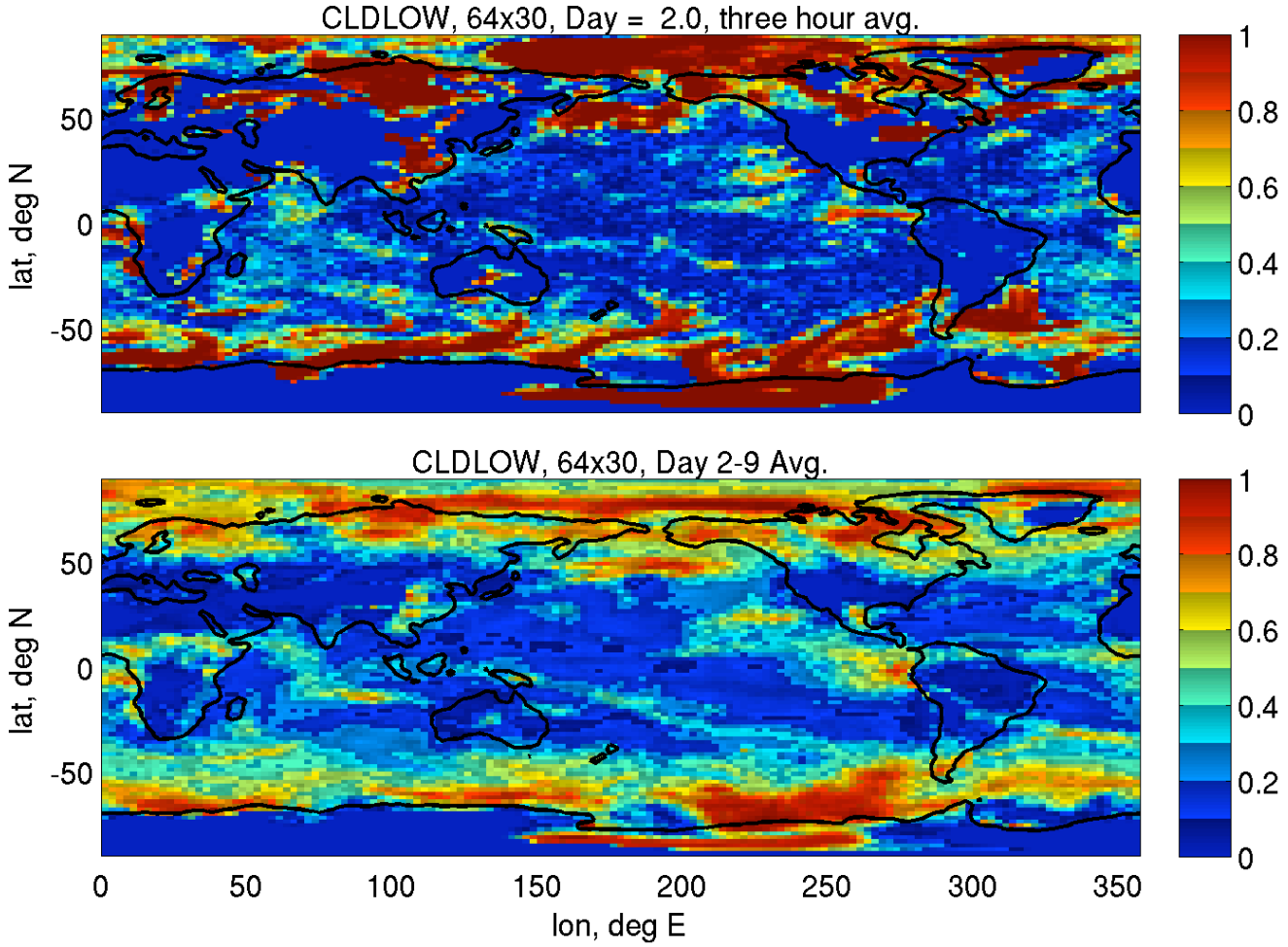


Pilot runs show

- Month-long L52 runs at 250 m resolutions are feasible.
- Main bottleneck is writing restart files .

Analysis strategy

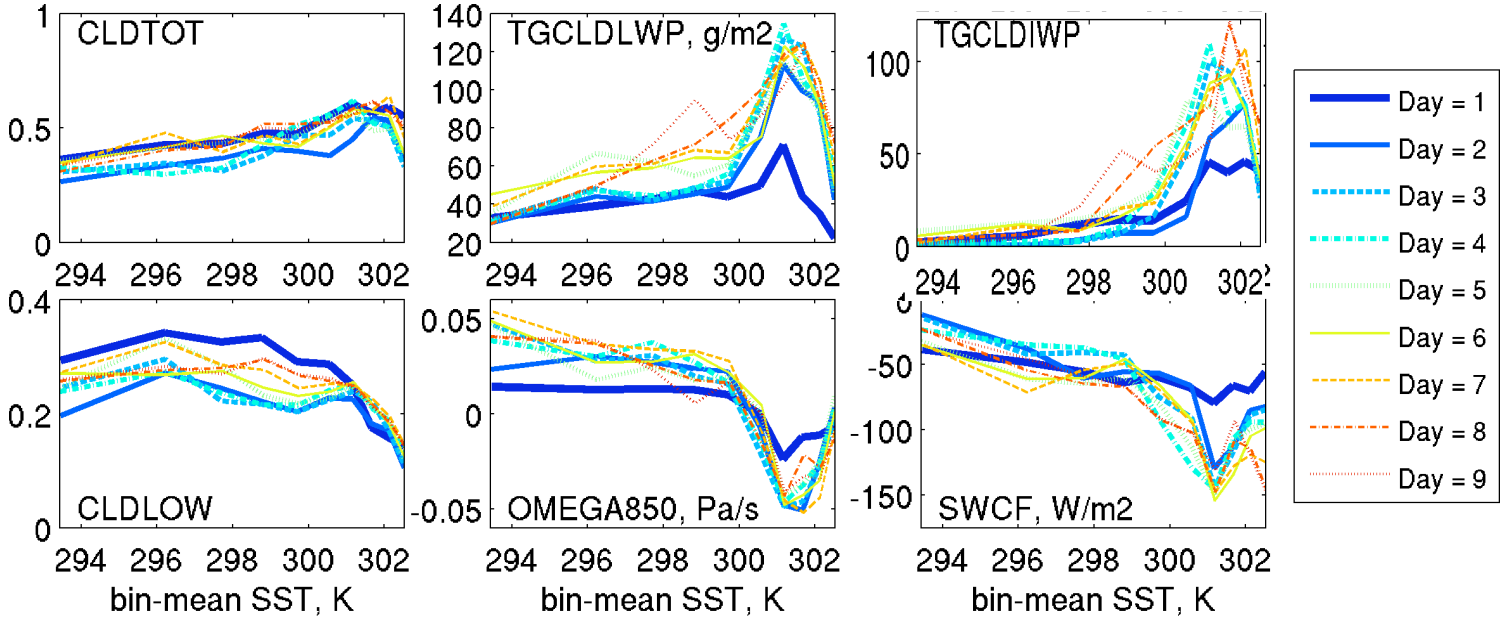
Low cloud field is noisy and synoptically modulated



so:

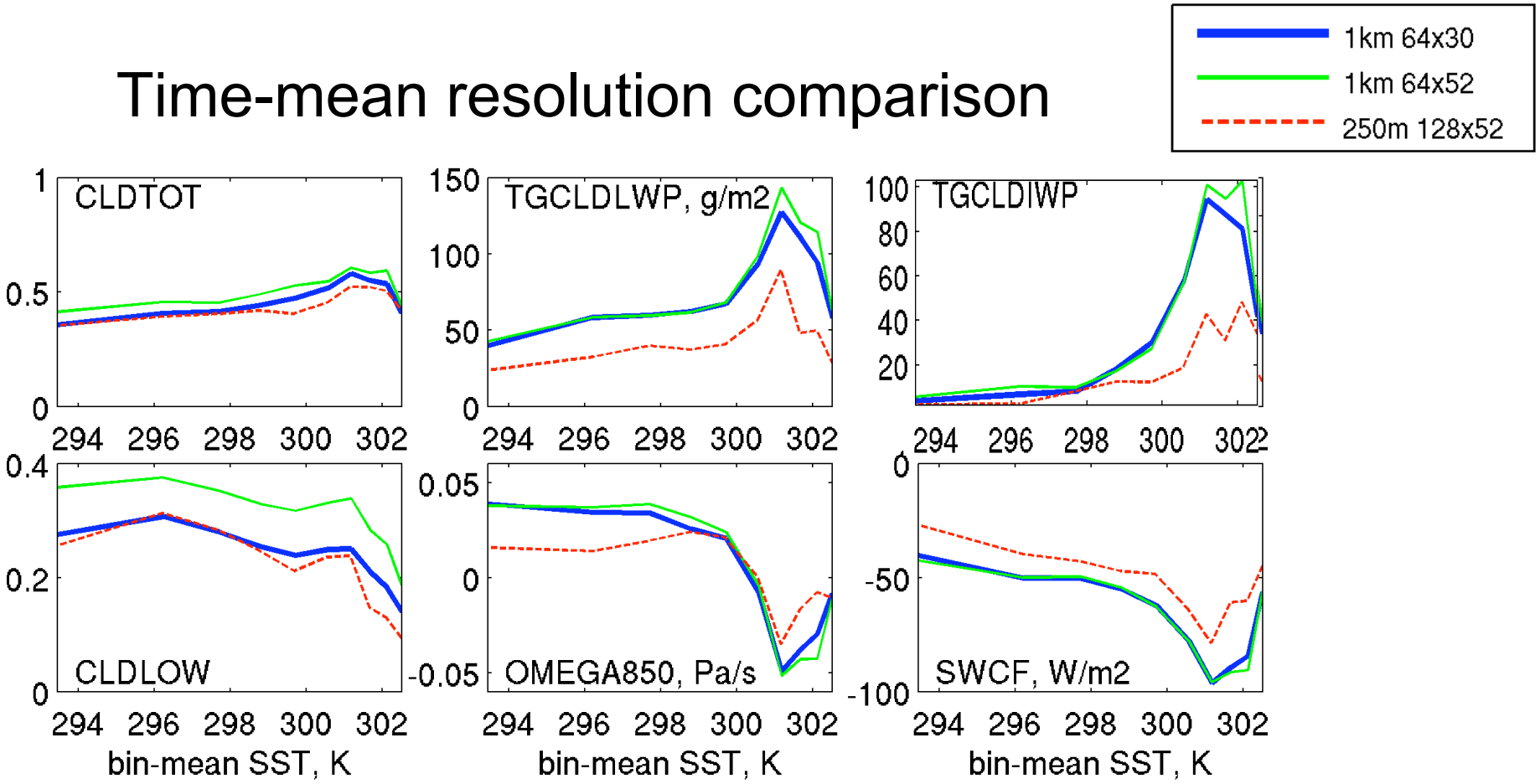
- Average over deciles of SST in 30S-30N.
- Plot daily averages to look for spinup.

SST 1kmL30 decile-sorted daily averages



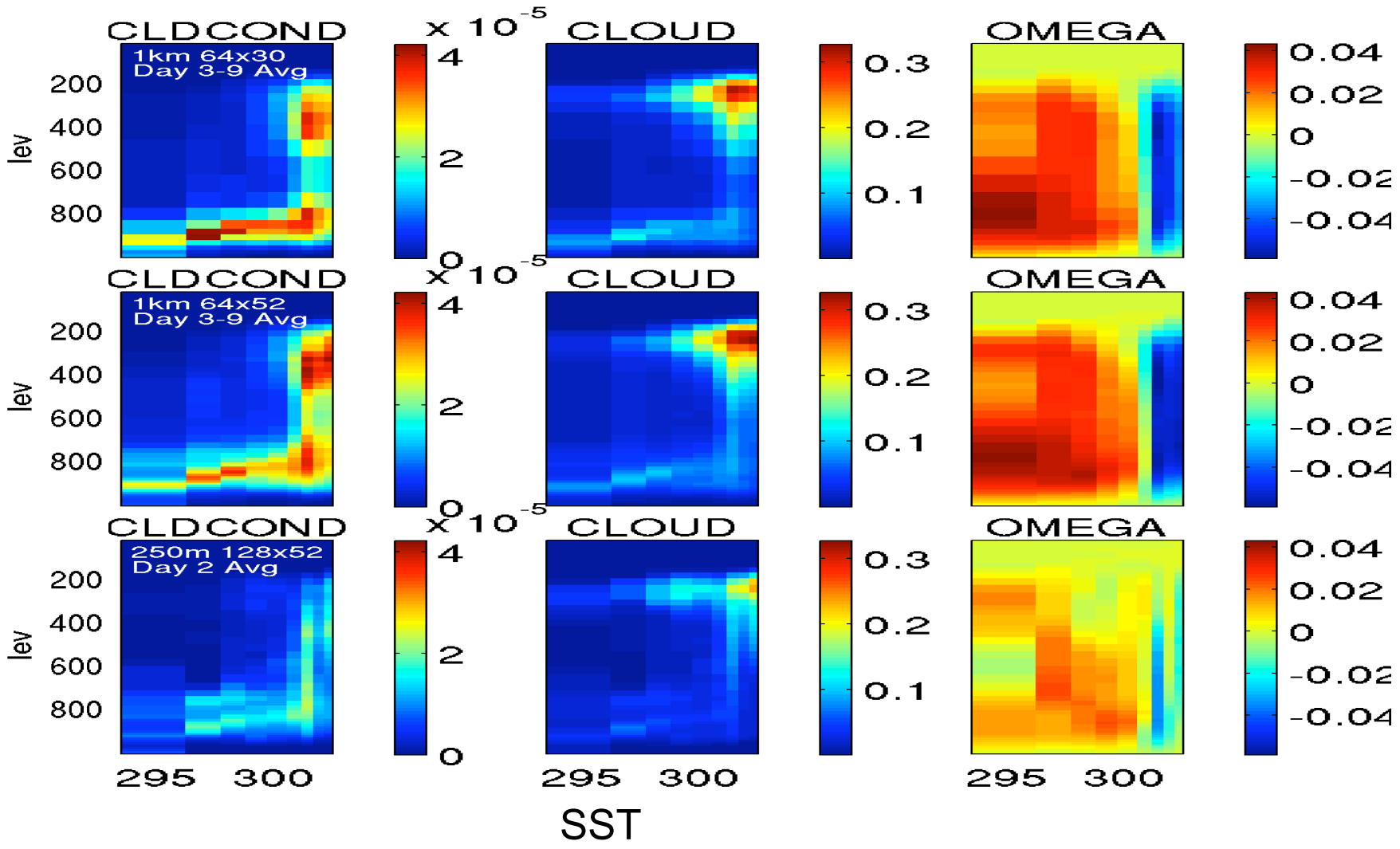
- Cloud statistics spin up rapidly.

Time-mean resolution comparison



- Caveat: 250m run is not fully spun up (only day 2 shown)
- Smaller Δz increases low cloud cover
- Smaller Δx decreases low cloud cover, LWP, |SWCF| in all regimes consistent with narrower, better-resolved shallow cumuli.
- No runs exhibit a clear stratocumulus low cloud max at low SST.

SST-binned vertical structure comparisons



- 1 km runs have max cloud just above LCL;
- 250 m run omega not spun up? day 2 has a second condensate peak at inversion base in subsidence regions.

Conclusions

- MMFhr pilot experiments confirm sensitivity of simulated low cloud and CRF to CRM resolution.

  Caveat: Need to run 250m simulation more than 2 days!
- Vertical structure of cloud and condensate seems more realistic at higher vertical/horizontal resolution.
- No Sc decks at any feasible MMFhr resolution with current numerics/physics.