A first look at the high vertical resolution runs with track 5

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Vertical Distributions

- Track 1, and many previous CAM and CCM models use 26 layers
- Track 5 standard (30 layers), bottom layer still 100m thick, four new layers above it
- Track 5 – LLNL (ECMWF 80 layer configuration)
- Track 5 – Moderate resolution increase
  - Divide each layer of 30L config into 2 layers
  - Add a 30m thick layer at surface
  - Smooth it
  - = 61 layers
Layer Distributions

The diagram shows the distribution of layer thickness as a function of height above the surface in kilometers. The x-axis represents layer thickness, while the y-axis shows the height above the surface. The layers are labeled as 30 layer, 61 layer, 80 layer, and 30 layer, indicating the thickness and distribution of each layer.
Layer Distributions

![Graph showing layer distributions with height above surface (m) on the y-axis and layer thickness on the x-axis. The graph includes layers 30, 61, 80, and 26, each represented by different markers and colors.](image-url)
Track 5 “Tags”

- LLNL – camdev21_cam3_6_26
- PNNL – camdev43_cam3_6_61
  - + Sungsu’s mods to deal with mountain torques
  - + Sungsu’s mods to reduce sensitivity of shallow convection to vertical resolution
Vertical Resolution Study

- Good news is most things hold together quite well without major changes
  - No catastrophic increase in low cloudiness as Dave Williamson found in CAM3.1

- Increased vertical resolution produces
  - Reduced marine stratocumulus clouds (bad)
  - Smooth vertical and drier tropical moisture profiles (good)
  - Much colder surface temperatures over Greenland and Antarctica in winter (bad?)
Improved Tropical Humidity

Excess moisture near the melting layer is due to the Zhang-McFarlane deep convection detrainining too much.
In winter, there is a large (~10K) decrease in surface temperatures over Greenland and Antarctica.
Stratocumulus – July, DYCOMS-II
30N, 120W

Example Obs, drizzling cloud, van Zanten, 2005

Model 5 yr climatology
61 layer PBLH = 370m
30 layer PBLH = 440m

Cloud Fraction
Grid Box Averaged $q_l$
Poor mans in-cloud $q_l$
Issues, Next Steps

- Excessive stratiform rain over Himalayas
- Surprises in cloud fraction behavior near surface
- Strong feedbacks with convective precipitation near Panama
- Cold biases over winter polar land masses
- Marine Stratocumulus biases (and perhaps Arctic clouds)
  - Hypothesis: CAM microphysics and boundary processes were tuned for thick layers. These layers are thicker than most boundary layer cloud decks. Reducing layer thickness means cloud decks can be produced with layer thicknesses that are closer to the real world (e.g. thinner).
  - If the physical parameterizations were tuned to produce reasonable cloud forcings with standard thick layers then the condensate mixing ratios must be low.
  - Equivalent condensate mixing ratios will produce clouds that are optically too thin with more realistic layer thicknesses.

- Explore these features with SCAM, CAPT, field data
EXTRA SLIDES
Improved Tropical Humidity

ANN

AMIP1.9x2.5L30 (yrs 2005-2007)

Precipitable water mean = 34.82 mm

Min = 3.39 Max = 56.03

AMIP1.9x2.5L80 (yrs 2005-2007)

Precipitable water mean = 34.26 mm

Min = 3.24 Max = 55.93

AMIP1.9x2.5L30 - AMIP1.9x2.5L80

Mean = 0.56 rmse = 1.88 mm

Min = -1.57 Max = 7.23

AMIP1.9x2.5L80 - NVAP

Mean = 1.23 rmse = 3.05 mm

Min = -12.82 Max = 9.29

AMIP1.9x2.5L30 - NVAP

Mean = 1.77 rmse = 3.34 mm

Min = -12.15 Max = 8.90
There may be issues in how the stable boundary layer mixing responds to increased vertical resolution.
Clear-sky Longwave is improved
Vertical Resolution Study
Vertical Resolution Study

- CAM Track V model (camdev21_cam3_6_26) at @ 2.0° resolution is integrated with observed SSTs (AMIP mode) for 3 years at two resolutions, L30 and L80.

- 80 Levels match those of the current operational 91L ECMWF model up to the L30 CAM top at ~3 mb.

- This roughly doubles to triples tropospheric vertical resolution:
  - 14 levels in L80 vs. 7 in L30 beneath 850 hPa
  - 27 levels in L80 vs. 8 in L30 above 100 hPa