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

- Phil Rasch (PNNL)
- Sungsu Park (NCAR)
- Steve Klein, Jim Boyle (LLNL)
- Chris Bretherton (UW)

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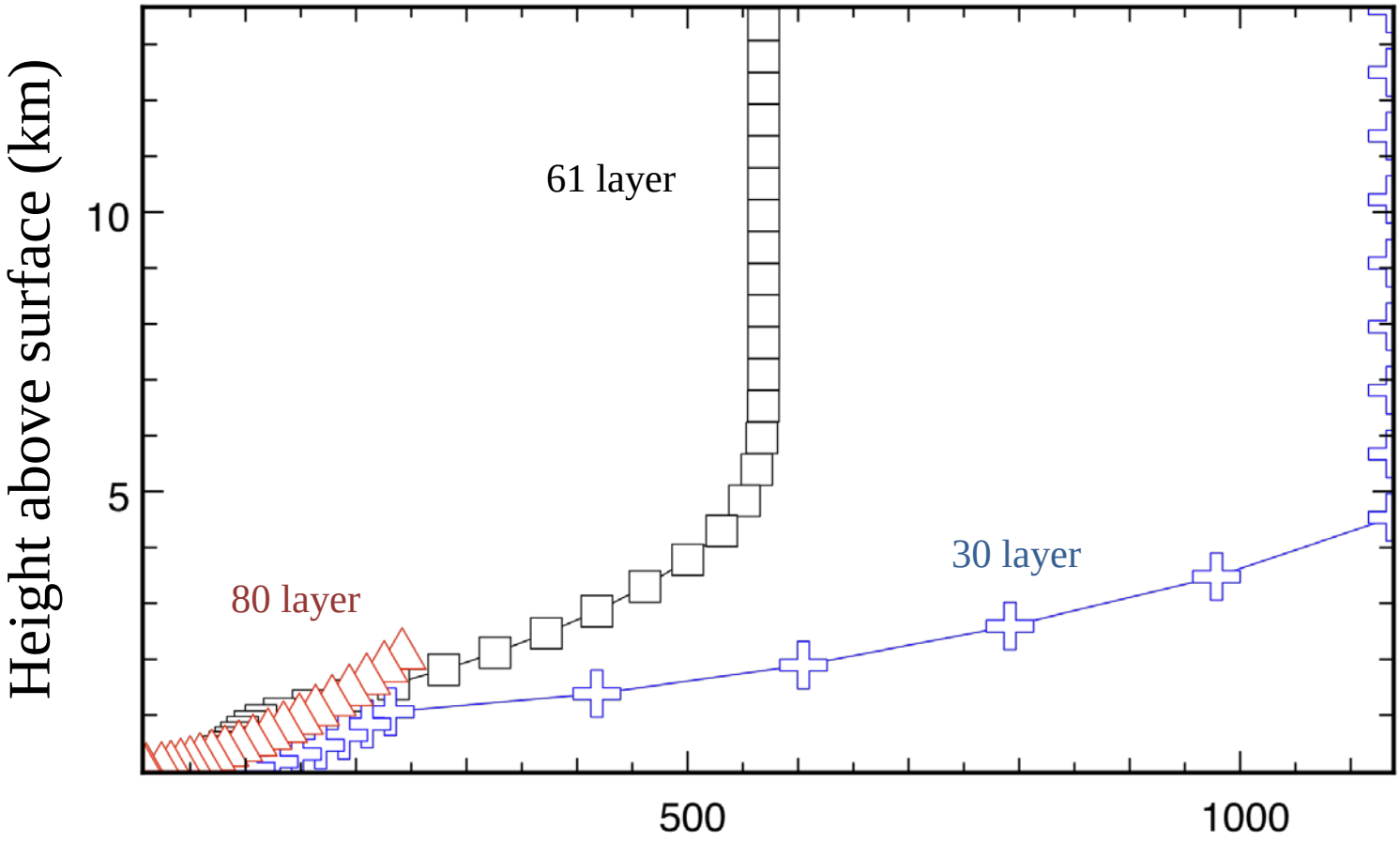
Vertical Distributions

- 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



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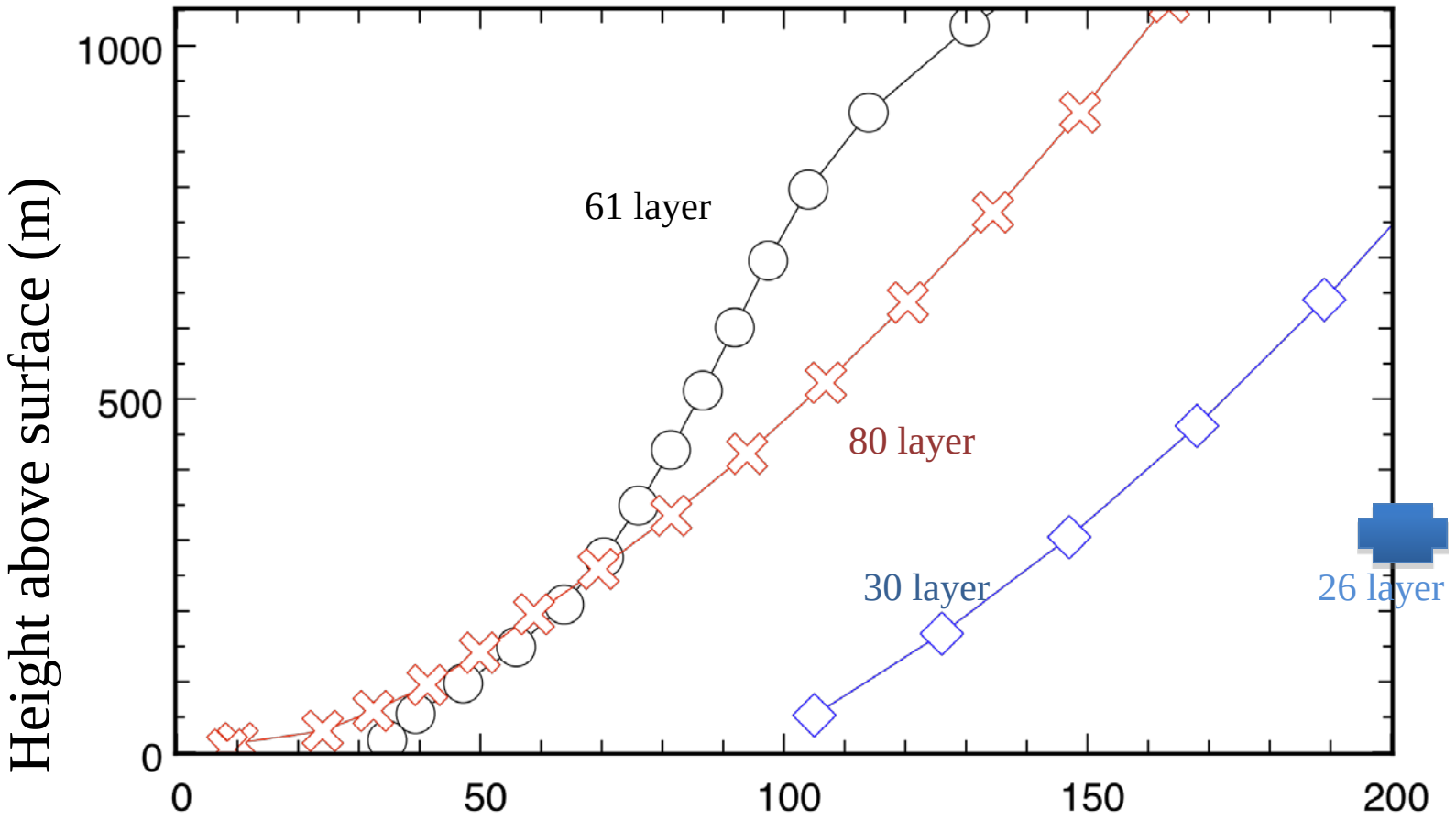
Layer Distributions



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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

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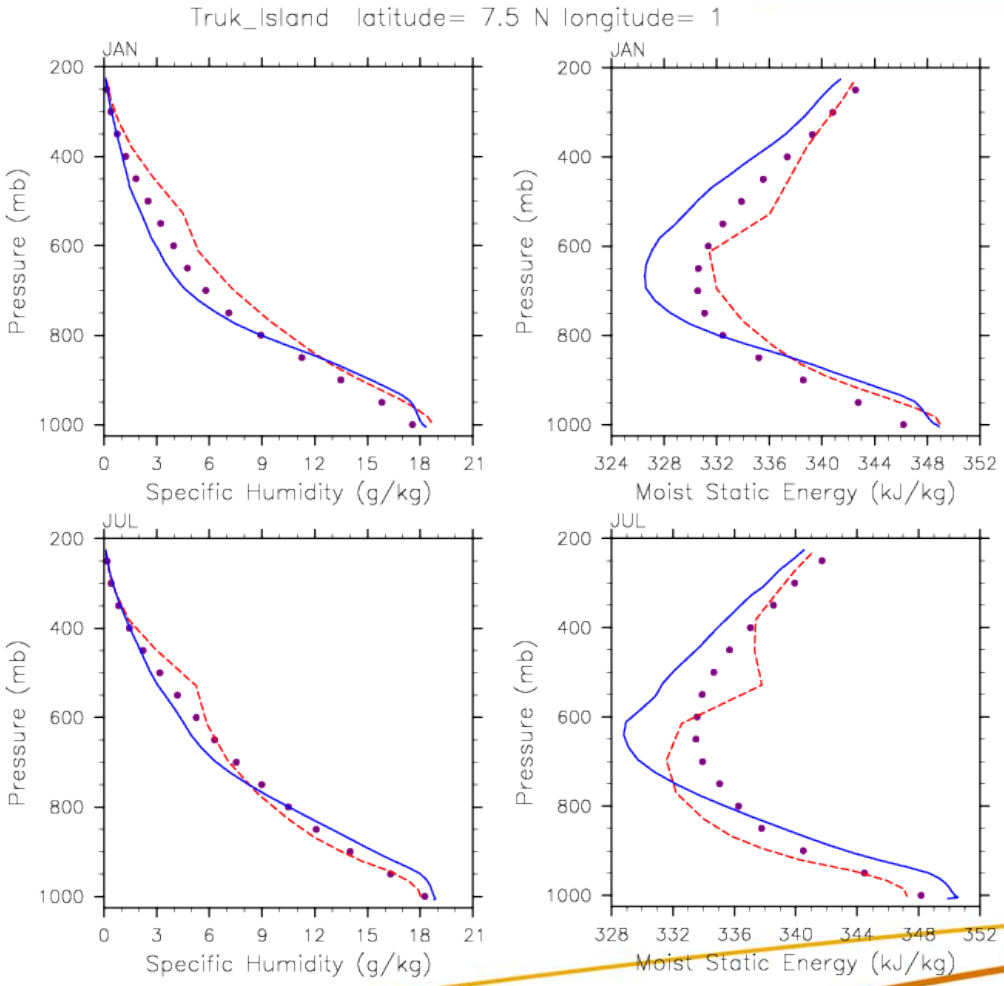
Vertical Resolution Study

- 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



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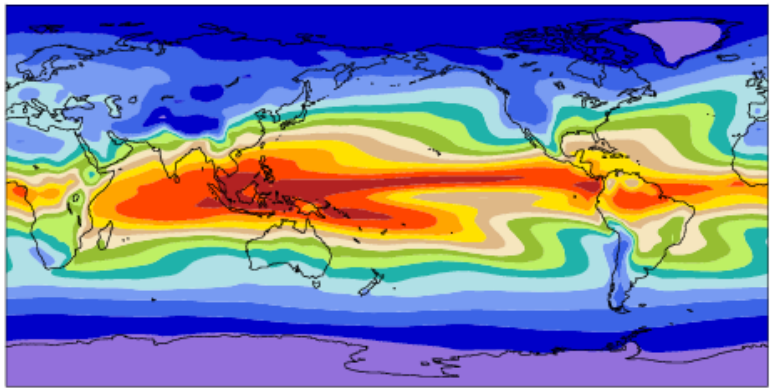
pjr_u152_30L3a (yrs 0-1)

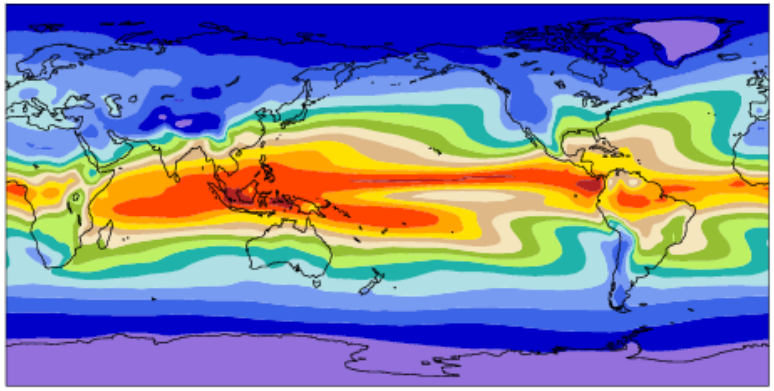
Precipitable water mean= 25.58 mm



Min =

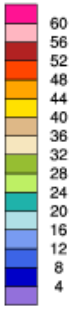
pjr_u152_61L3a (yrs 0-1)

Precipitable water mean= 24.98 mm



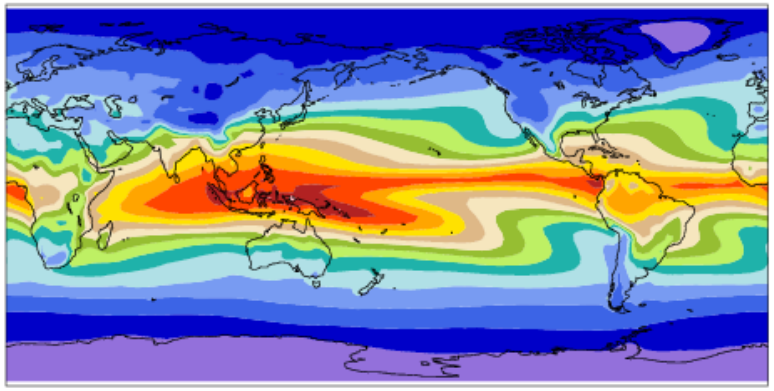
ANN

Min = 0.22 Max = 55.68



NVAP

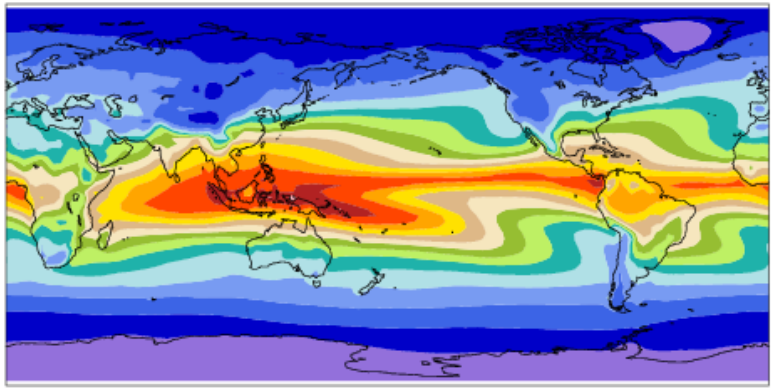
Precipitable water mean= 24.60 mm



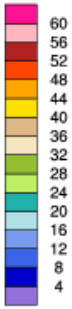
Min =

NVAP

Precipitable water mean= 24.60 mm

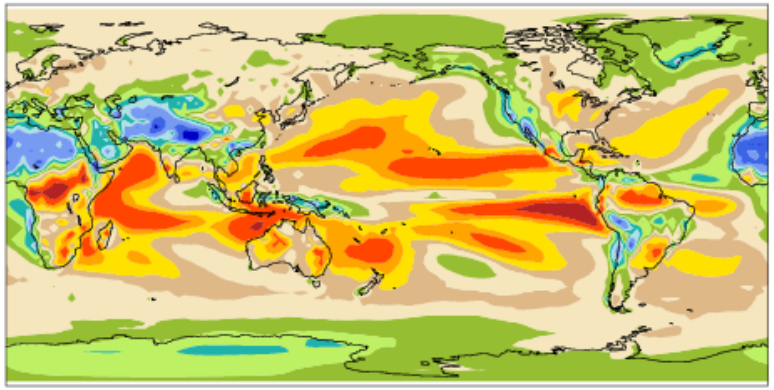


Min = 0.88 Max = 58.29



pjr_u152_30L3a - NVAP

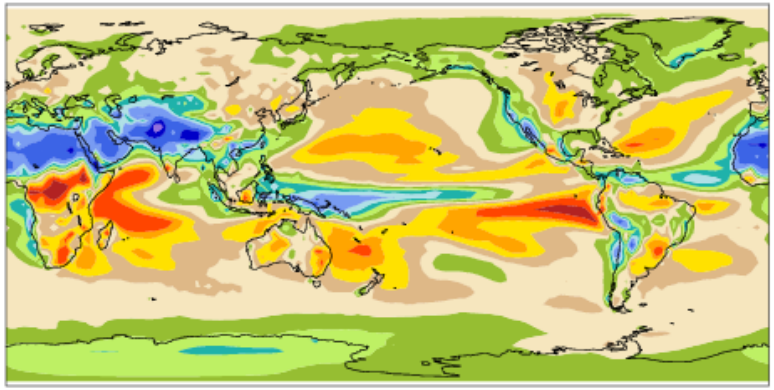
mean = 0.98 rmse = 2.45 mm



Min =

pjr_u152_61L3a - NVAP

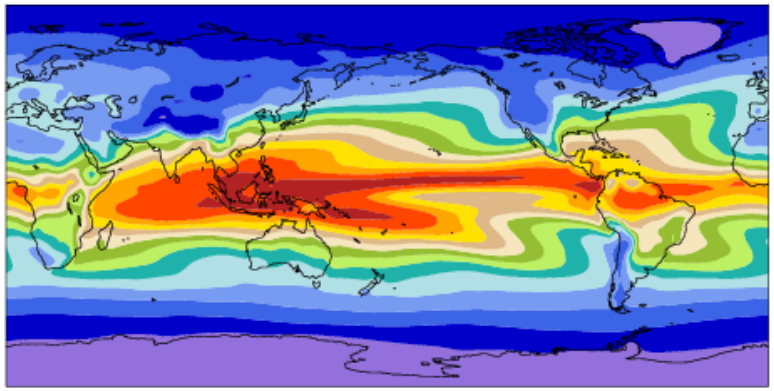
mean = 0.38 rmse = 2.37 mm



Min = -14.34 Max = 8.25

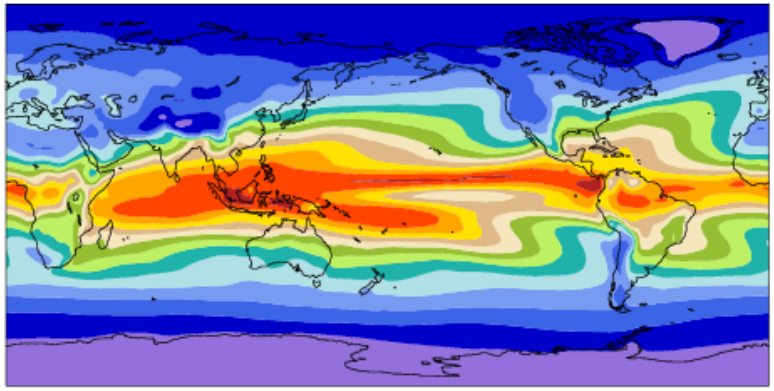
pjr_u152_30L3a (yrs 0-1)

Precipitable water mean= 25.58 mm



pjr_u152_61L3a (yrs 0-1)

Precipitable water mean= 24.98 mm



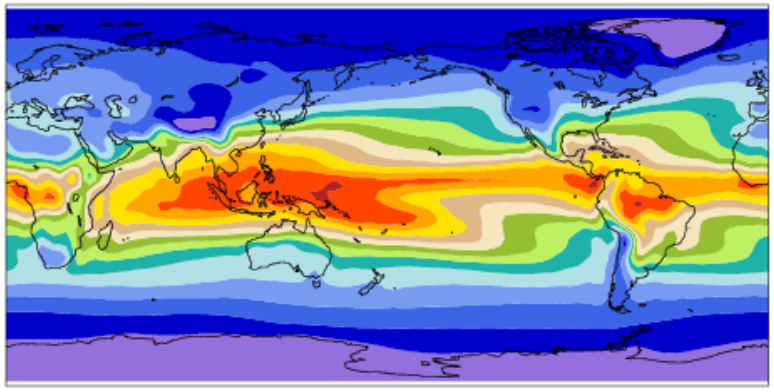
ANN

Min = 0.22 Max = 55.68

60 56 52 48 44 40 36 32 28 24 20 16 12 8 4

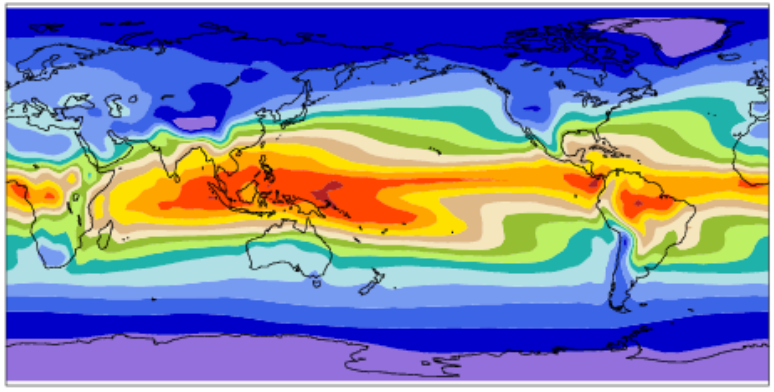
ECMWF

Precipitable water mean= 24.33 mm



ECMWF

Precipitable water mean= 24.33 mm

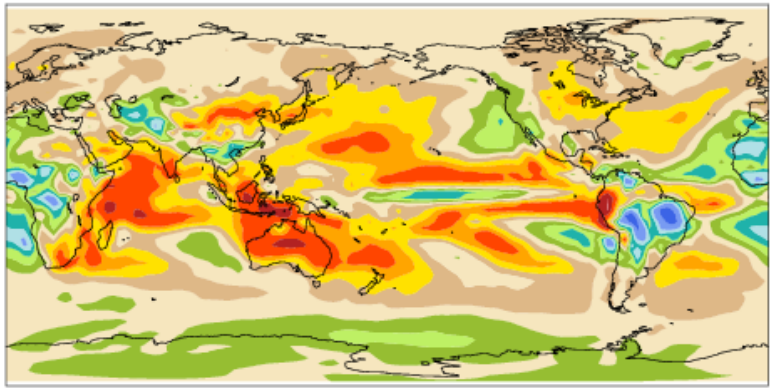


Min = -0.56 Max = 53.40

60 56 52 48 44 40 36 32 28 24 20 16 12 8 4

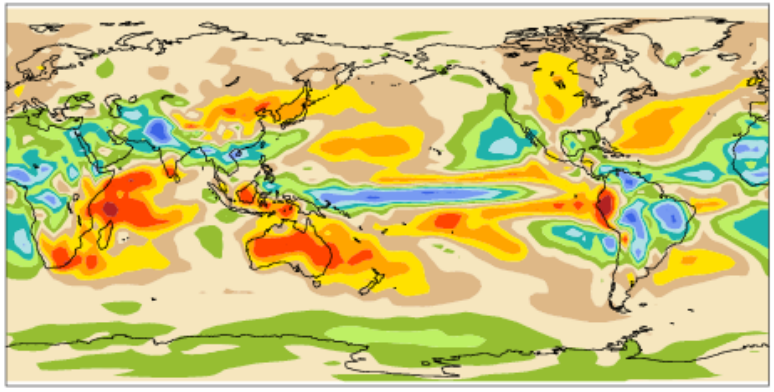
pjr_u152_30L3a - ECMWF

mean = 1.25 rmse = 2.32 mm



pjr_u152_61L3a - ECMWF

mean = 0.65 rmse = 2.10 mm



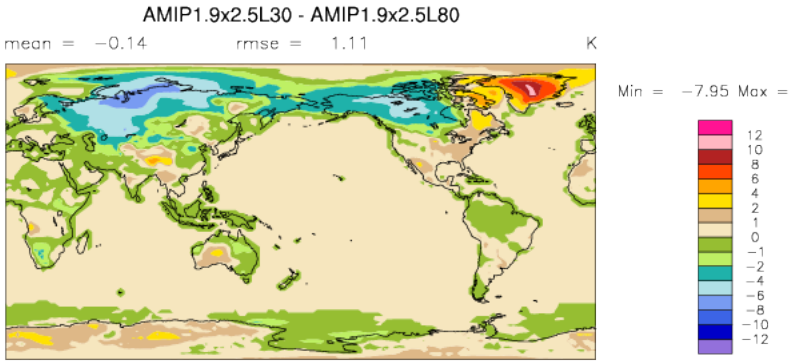
Min = -8.46 Max = 8.69

12 9 6 4 3 2 1 0 -1 -2 -3 -4 -6 -9 -12

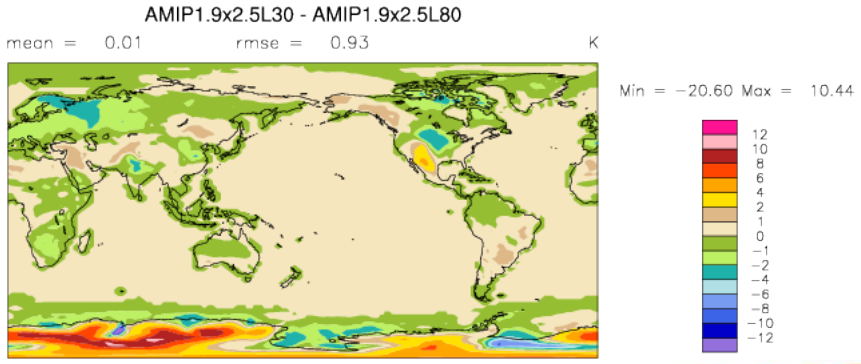
Ice Sheet Surface Temperatures

- In winter, there is a large (~10K) decrease in surface temperatures over Greenland and Antarctica

DJF



JJA



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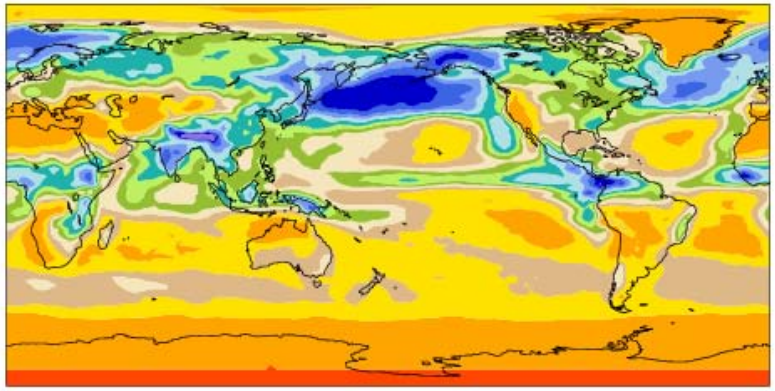
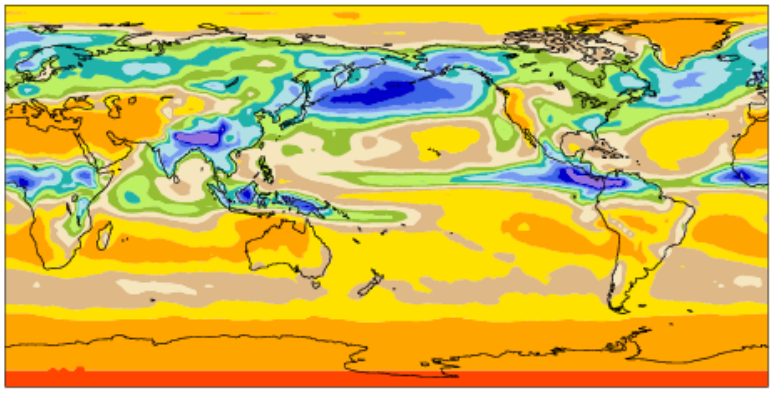
pjr_u152_30L3a (yrs 0-1)

TOA SW cloud forcing mean= -49.09 W/m^2



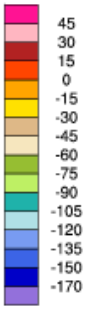
pjr_u152_61L3a (yrs 0-1)

TOA SW cloud forcing mean= -46.79 W/m^2



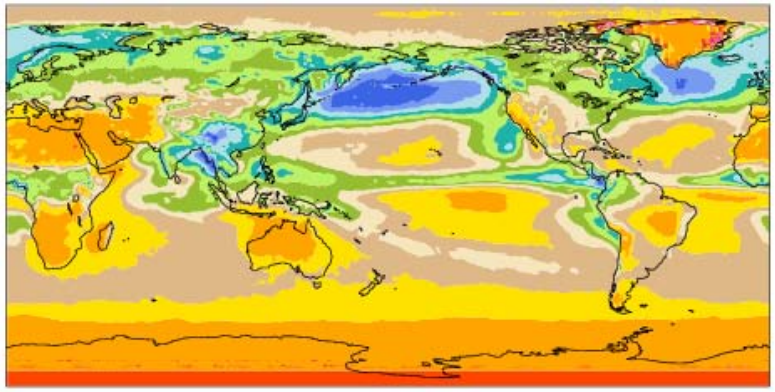
JJA

Min = -256.61 Max = 0.00



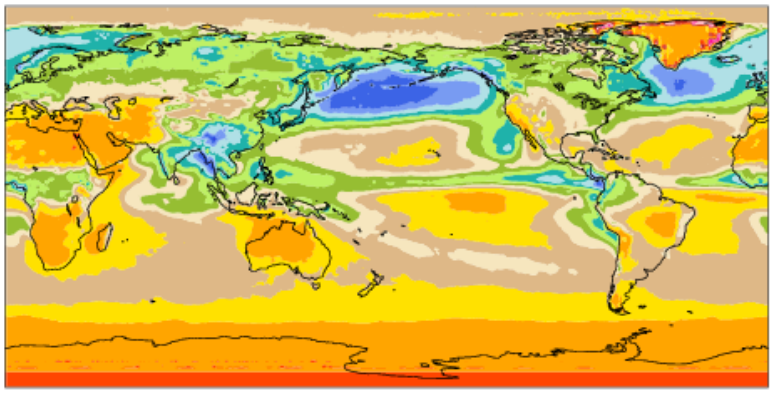
CERES2

TOA SW cloud forcing mean= -45.03 W/m^2

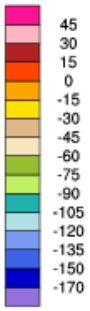


CERES2

TOA SW cloud forcing mean= -45.03 W/m^2

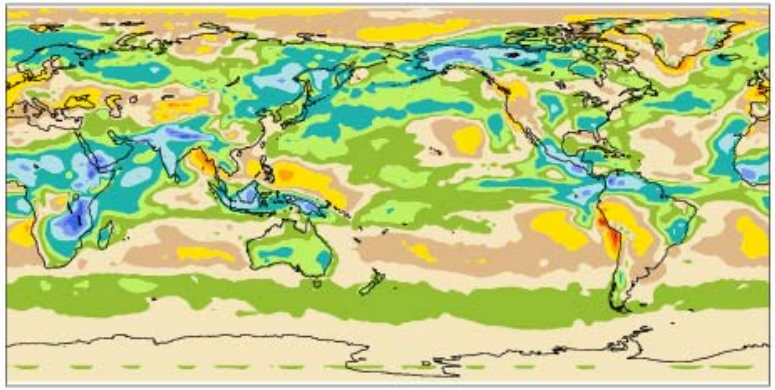


Min = -156.06 Max = 94.38



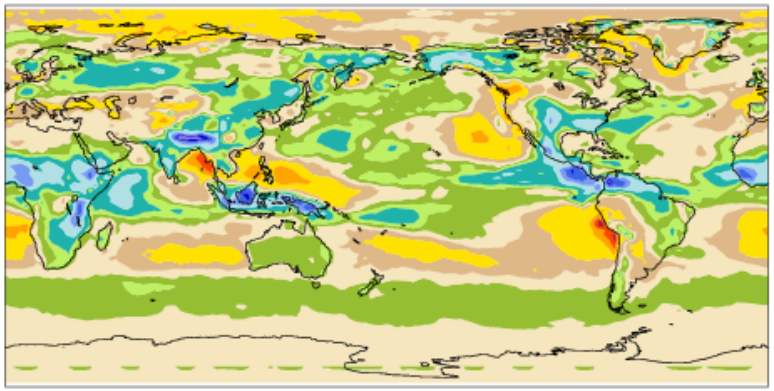
pjr_u152_30L3a - CERES2

mean = -4.06 rmse = 19.75 W/m^2

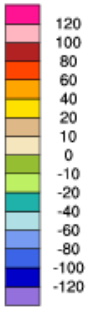


pjr_u152_61L3a - CERES2

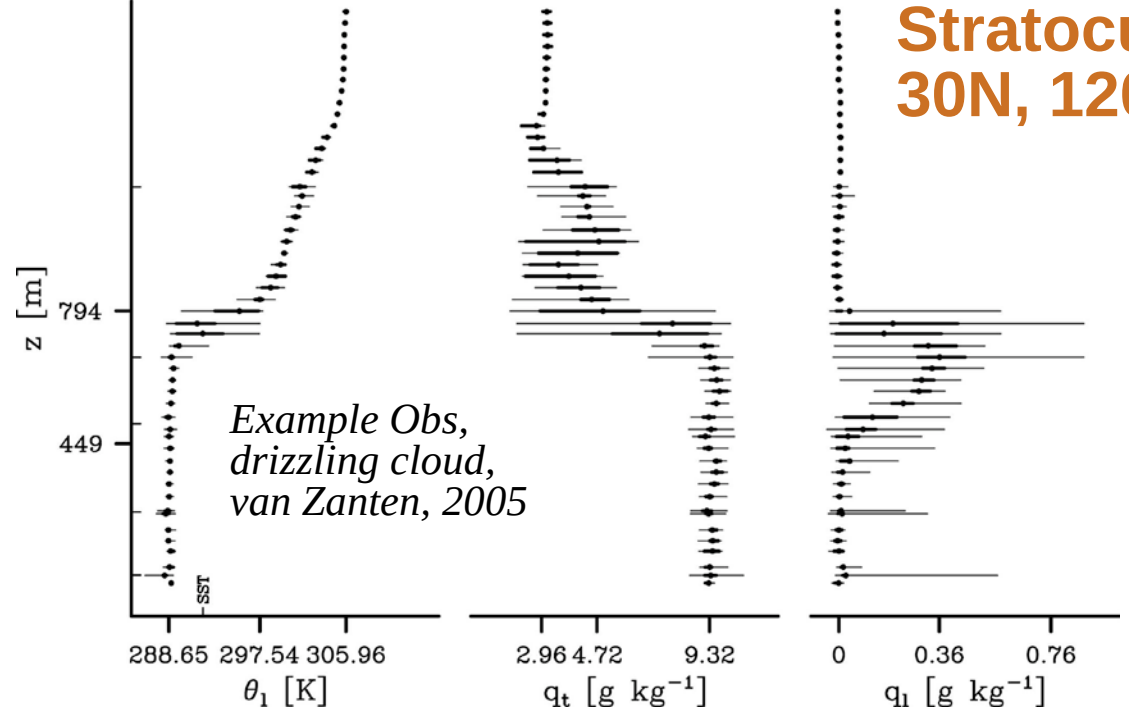
mean = -1.76 rmse = 20.73 W/m^2



Min = -141.65 Max = 97.85



Stratocumulus – July, DYCOMS-II 30N, 120W

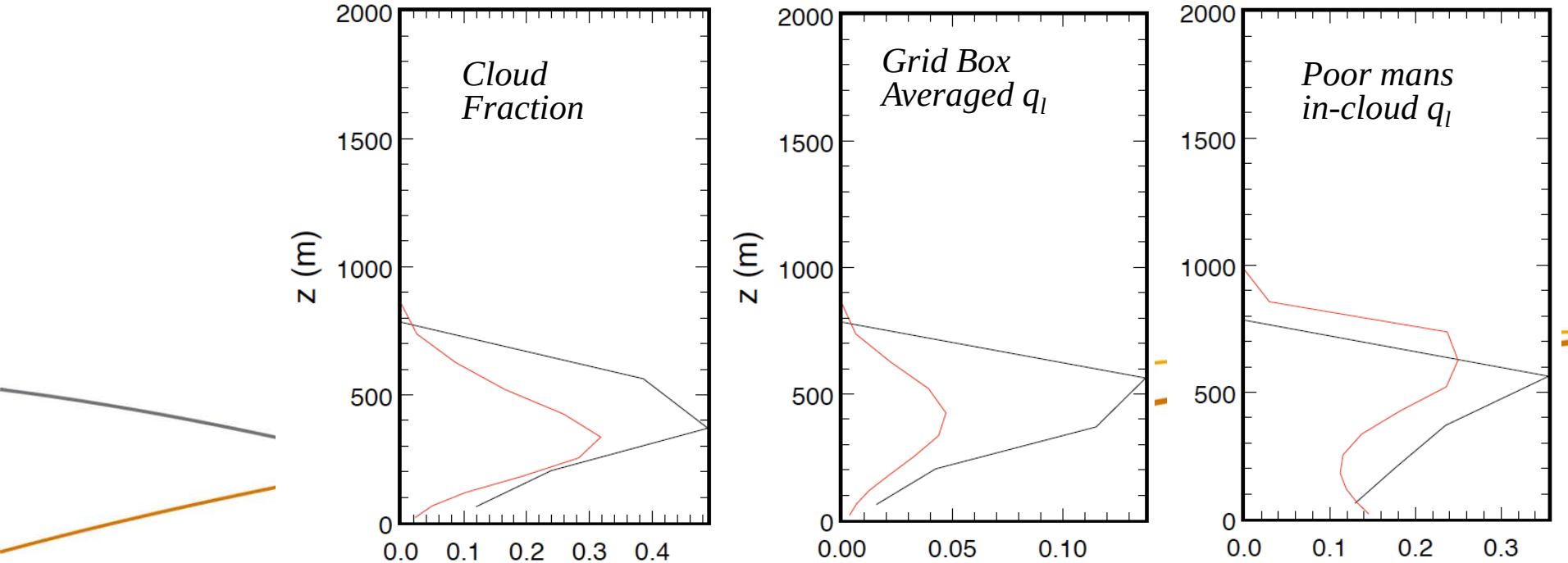


Example Obs, drizzling cloud, van Zanten, 2005

Model 5 yr climatology

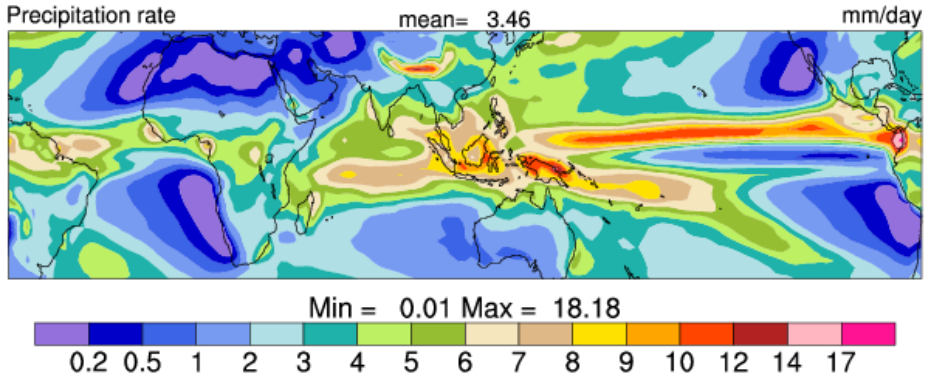
61 layer PBLH = 370m

30 layer PBLH = 440m

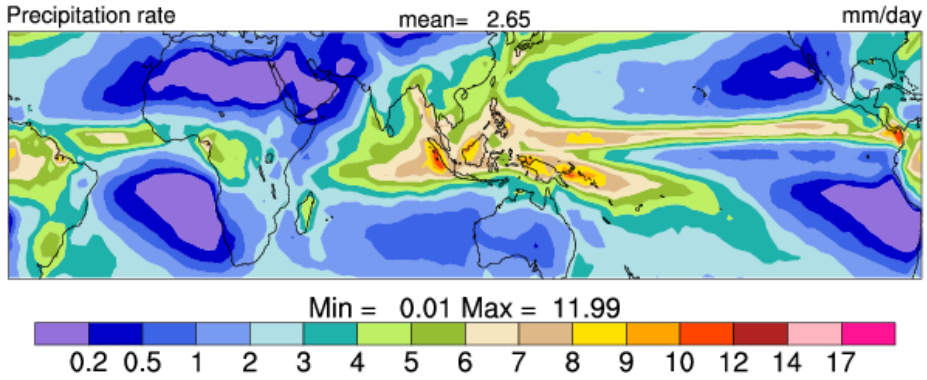


ANN

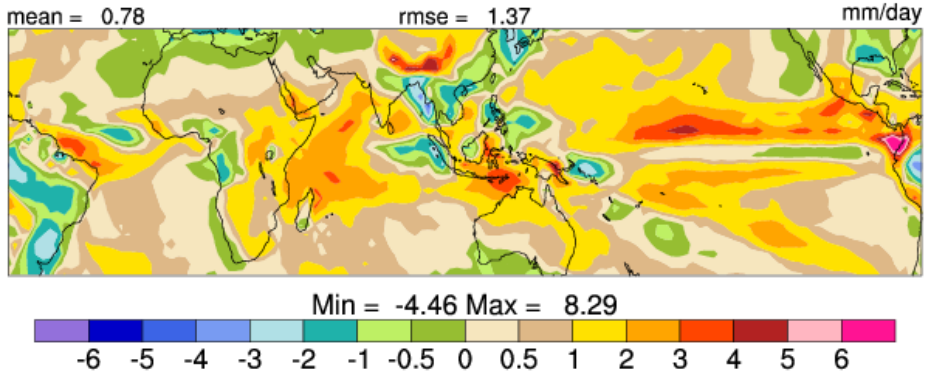
pjr_u152_30L3a (yrs 0-1)



TRMM

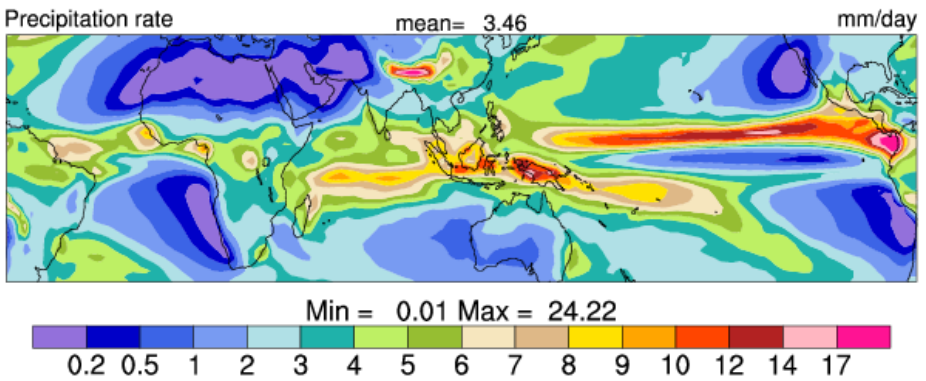


pjr_u152_30L3a - TRMM

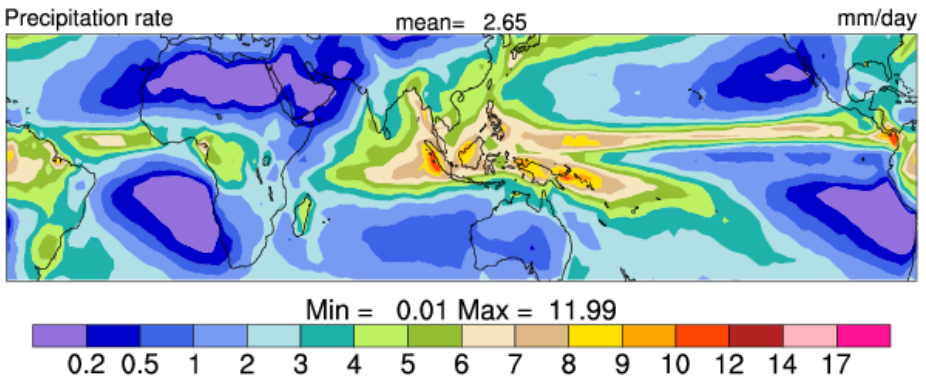


ANN

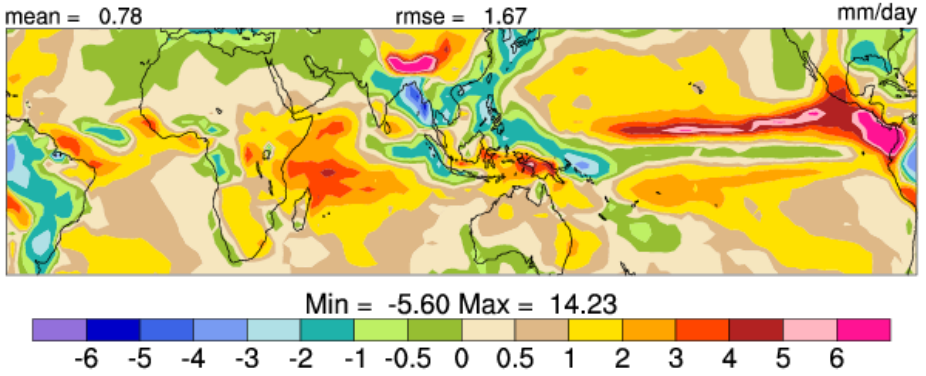
pjr_u152_61L3a (yrs 0-1)



TRMM



pjr_u152_61L3a - TRMM

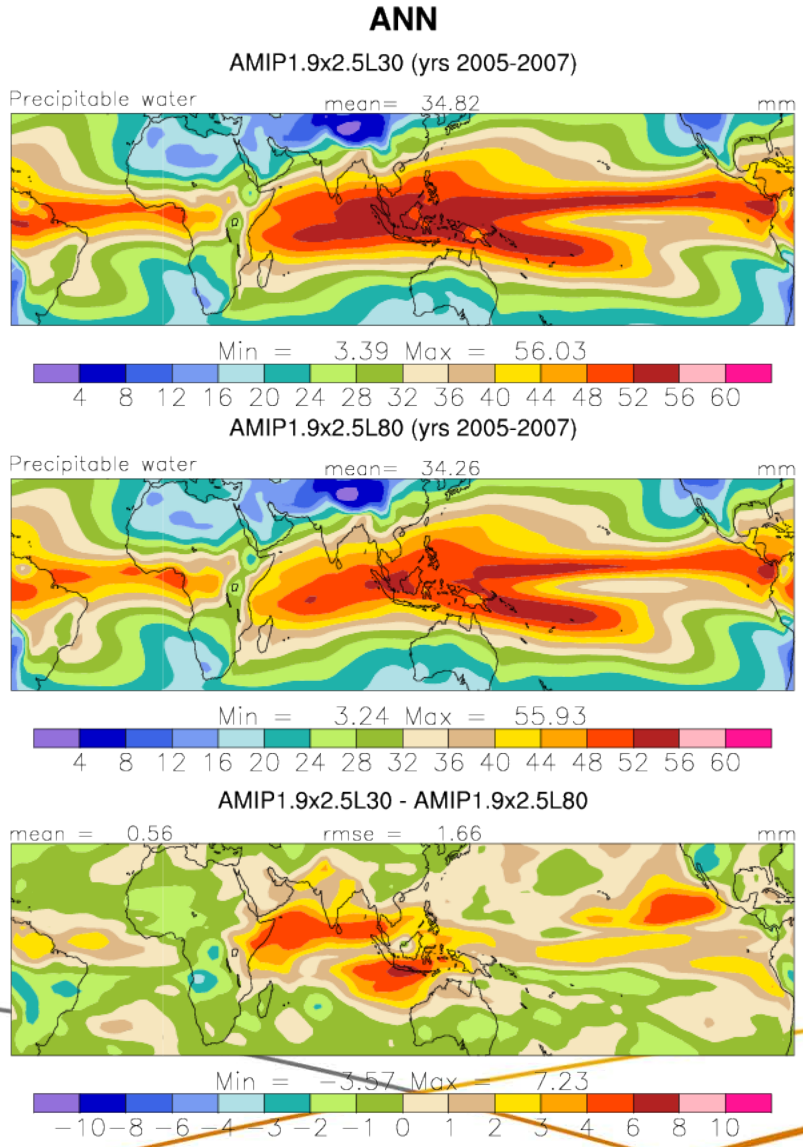


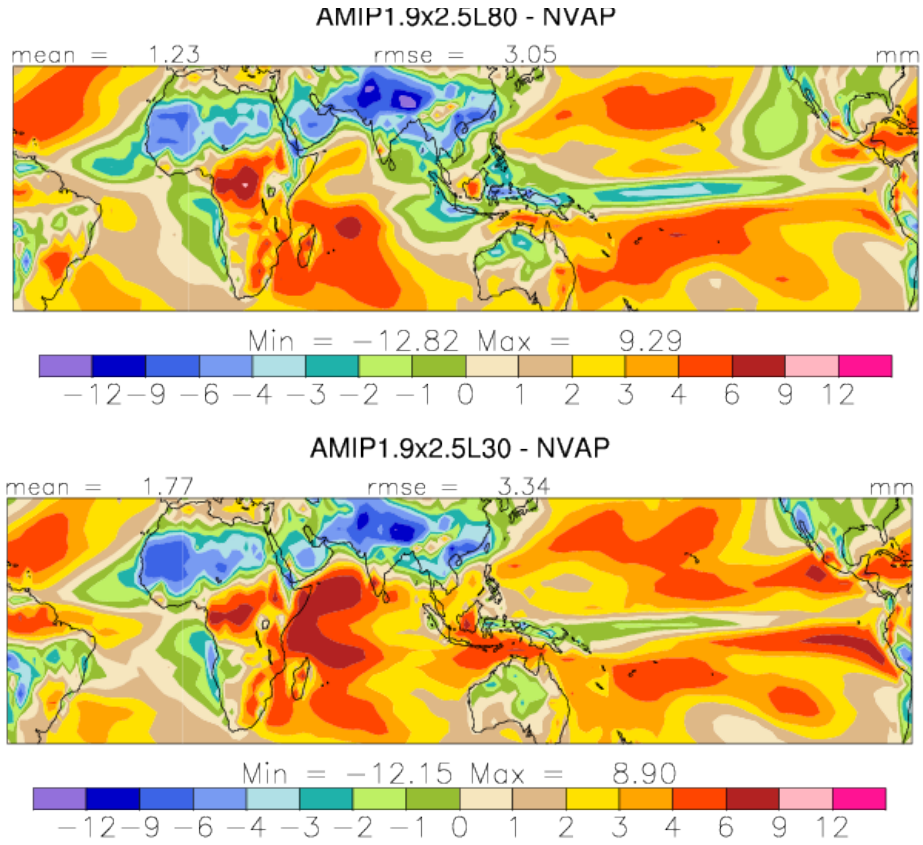
Issues, Next Steps

- 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





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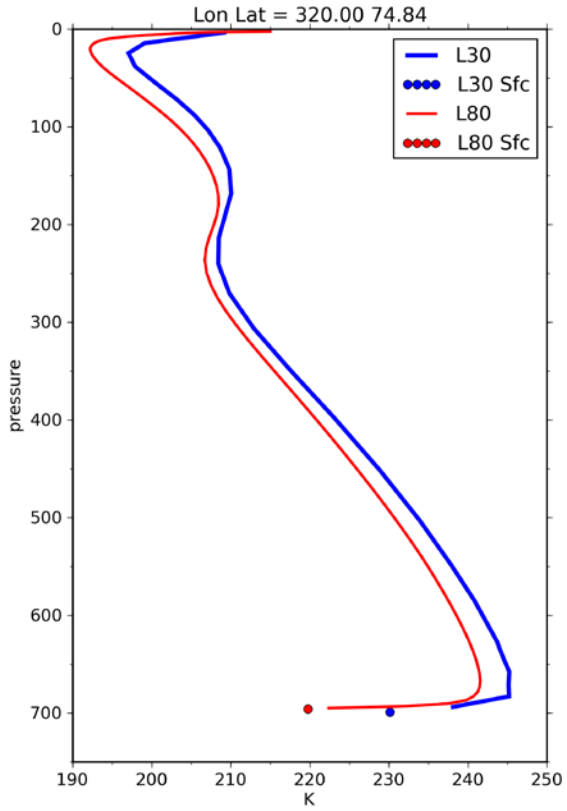
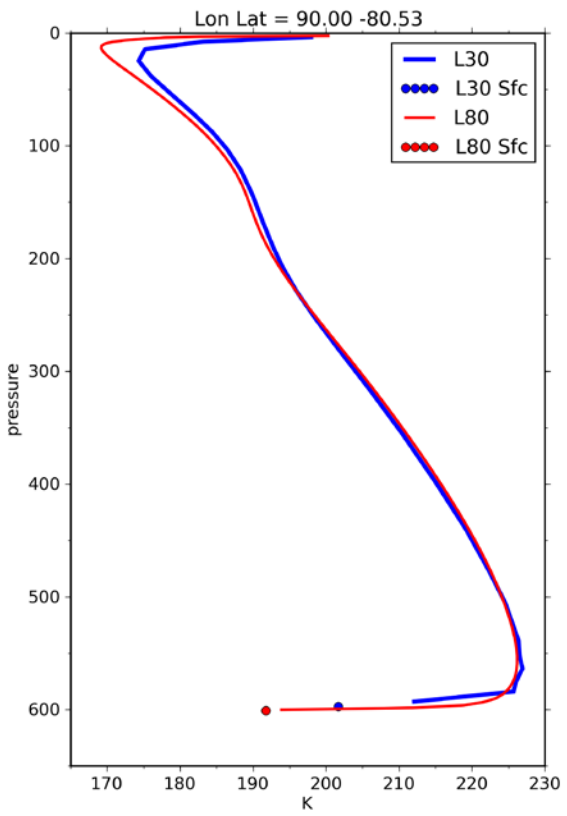
Ice Sheet Surface Temperatures





- There may be issues in how the stable boundary layer mixing responds to increased vertical resolution

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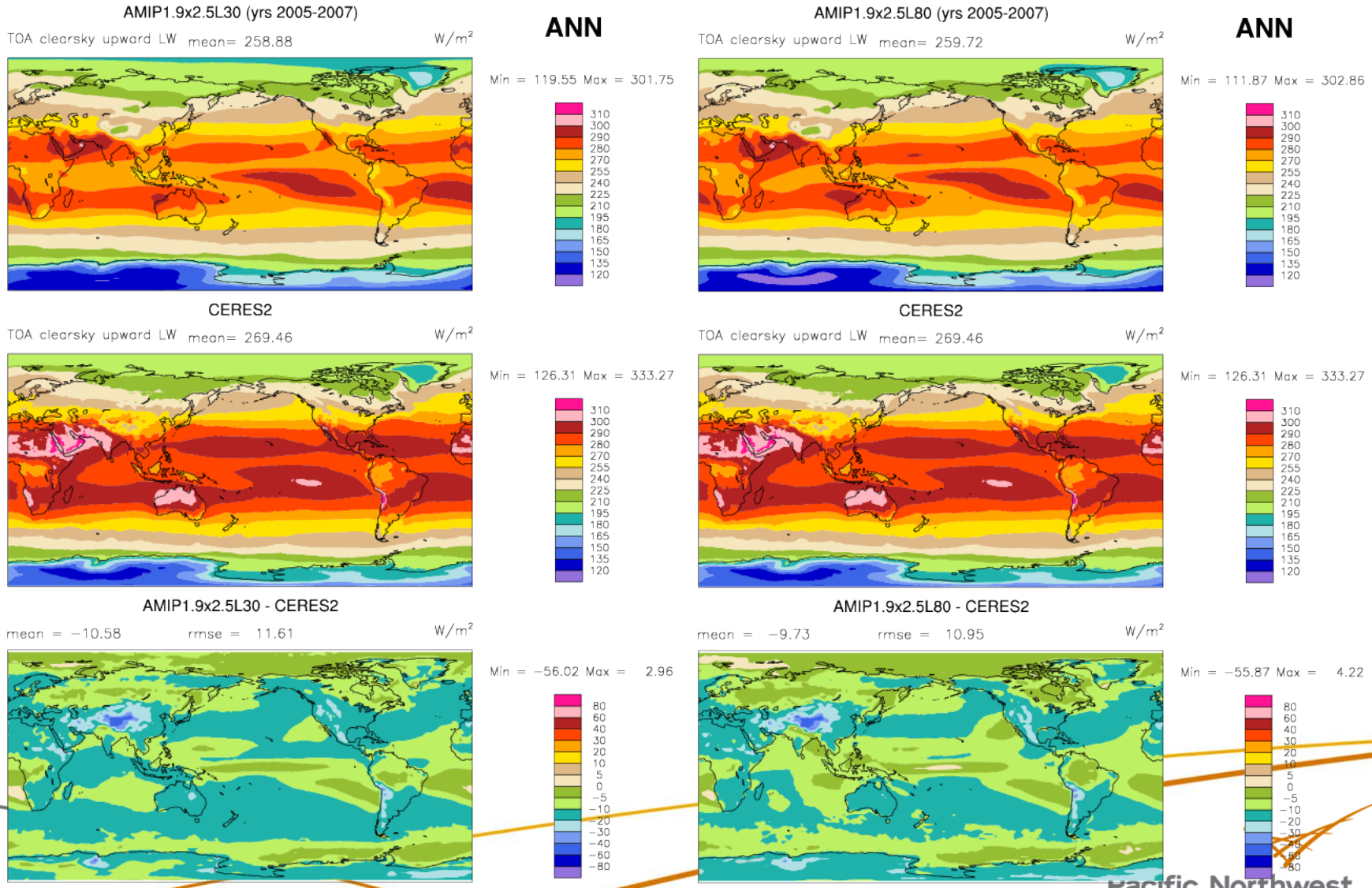
Clear-sky Longwave is improved



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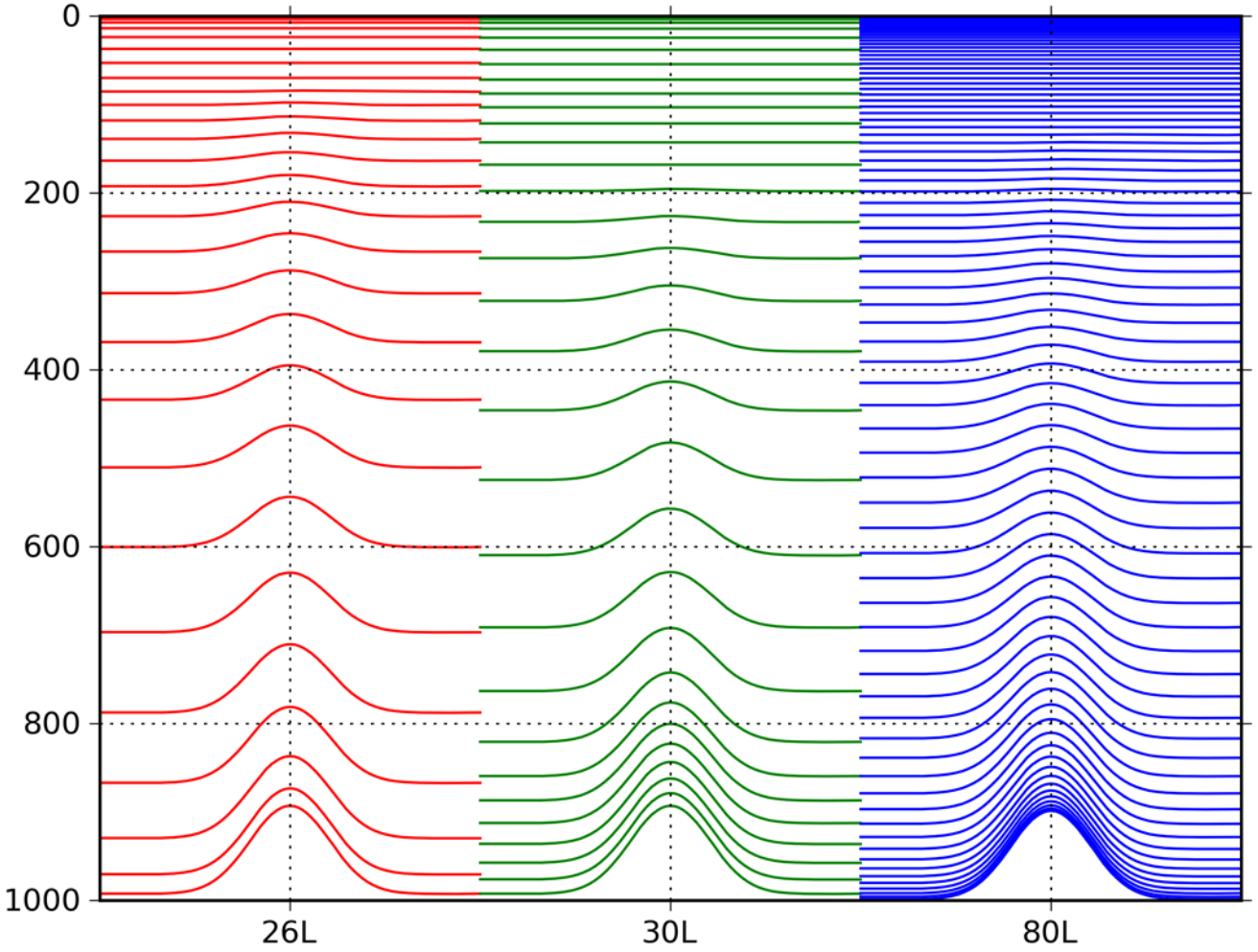
Vertical Resolution Study



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

CAPT
CCPP-ARM Parameterization Testbed

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