Fine-resolution global time slice simulations

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THIS TALK APPROVED FOR

Why include global-domain simulations in NARCCAP?

- Nice to have global-domain results
- Interesting to compare global time-slice results to nested model results

Advantages/disadvantages *vs.* nested model approach

Advantages:

- Nice to have global-domain results.
- Needed input data (SST + sea ice extents) are minimal, and universally available.
- Results are not subject to degradation by biases in lateral boundary conditions.

Disadvantages:

- Regional-scale results are not constrained by lateral boundary conditions.
- More demanding of CPU.
- Larger volume of output data.

What model did I use?

- Fine-resolution version of NCAR CAM3.1 global atmospheric model
- Finite Volume dynamical core
- 0.625 deg. (longitude) x 0.5 deg. (latitude) grid spacing
- *Ad hoc* retuning of parameterizations performed in collaboration with Hack *et al*. of NCAR

I performed two simulations

1. "Control" or "AMIP" simulation
   1. Covers 1979-2000
   2. driven by observed SSTs and sea ice extents
2. "Future" or "A2" simulation
   1. Covers 2041-2060
   2. Driven by

      $SST = SST_{obs} + SST_{ccsm}^{future} - SST_{ccsm}^{present}$.

      SST_{ccsm} from simulation of A2 emissions scenario performed with coarse-resolution version of CCSM
   3. This method of deriving SSTs provides first-order correction of biases in SSTs of CCSM model

What output did I save?

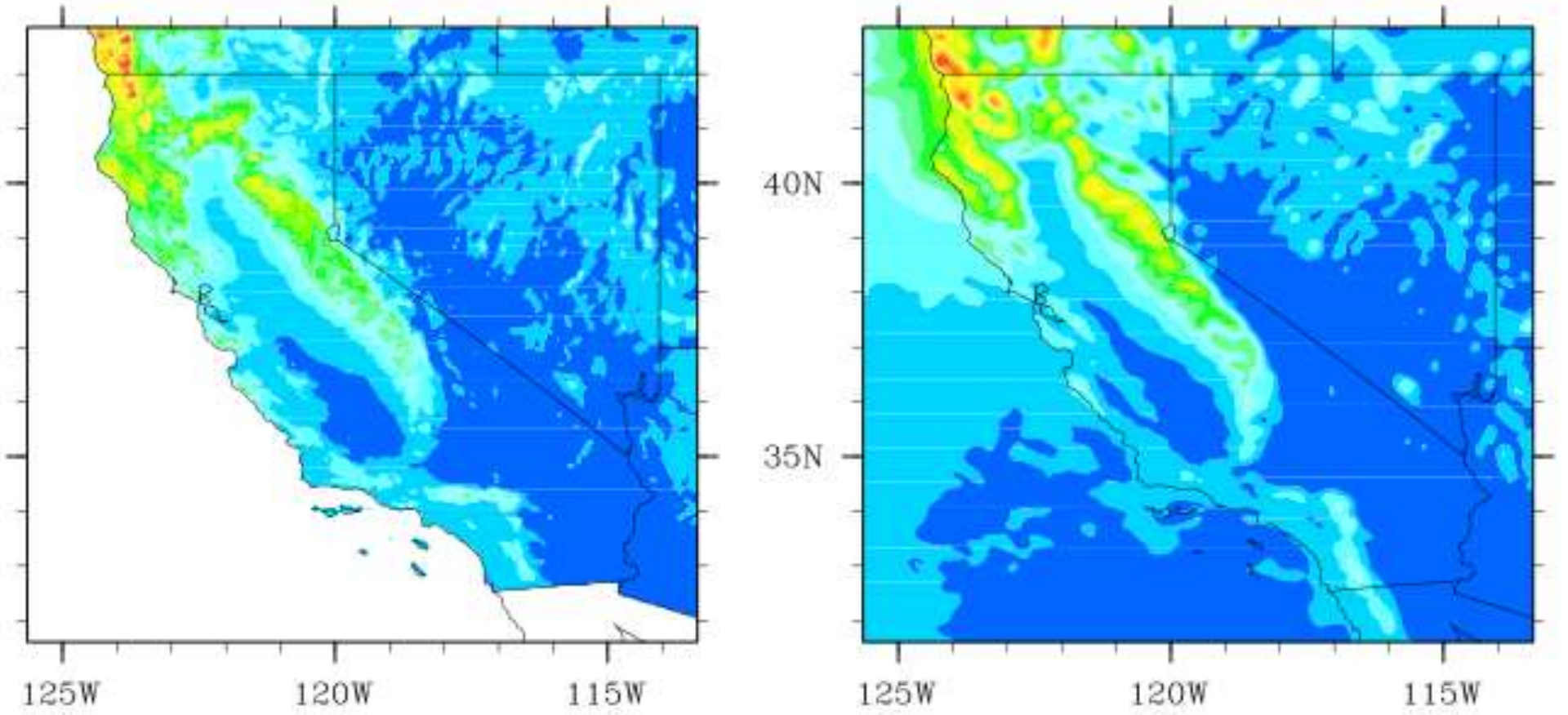
1. All quantities specified in NARCCAP protocol
2. Additional monthly-mean stuff
3. 3-hourly 3-d atmospheric fields needed to drive a nested atmospheric model. (This is 80% of the data volume).

- Raw data volume: 40 Tbyte
- After interpolation to specified pressure levels: 65 Tbyte.

Annual Mean Precipitation

"Observations"

Nested regional model at 9 km driven by global model at ~100 km

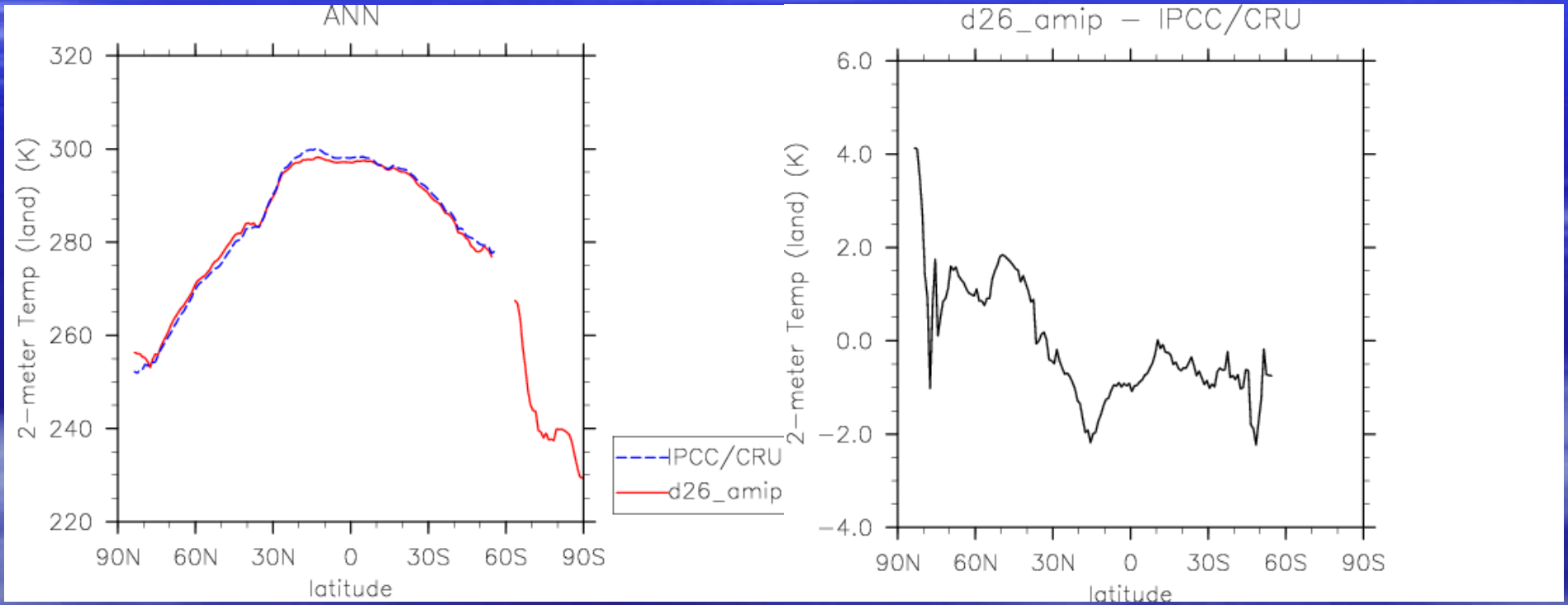


0 100 200 300 400 cm/yr

Status of simulations, etc.

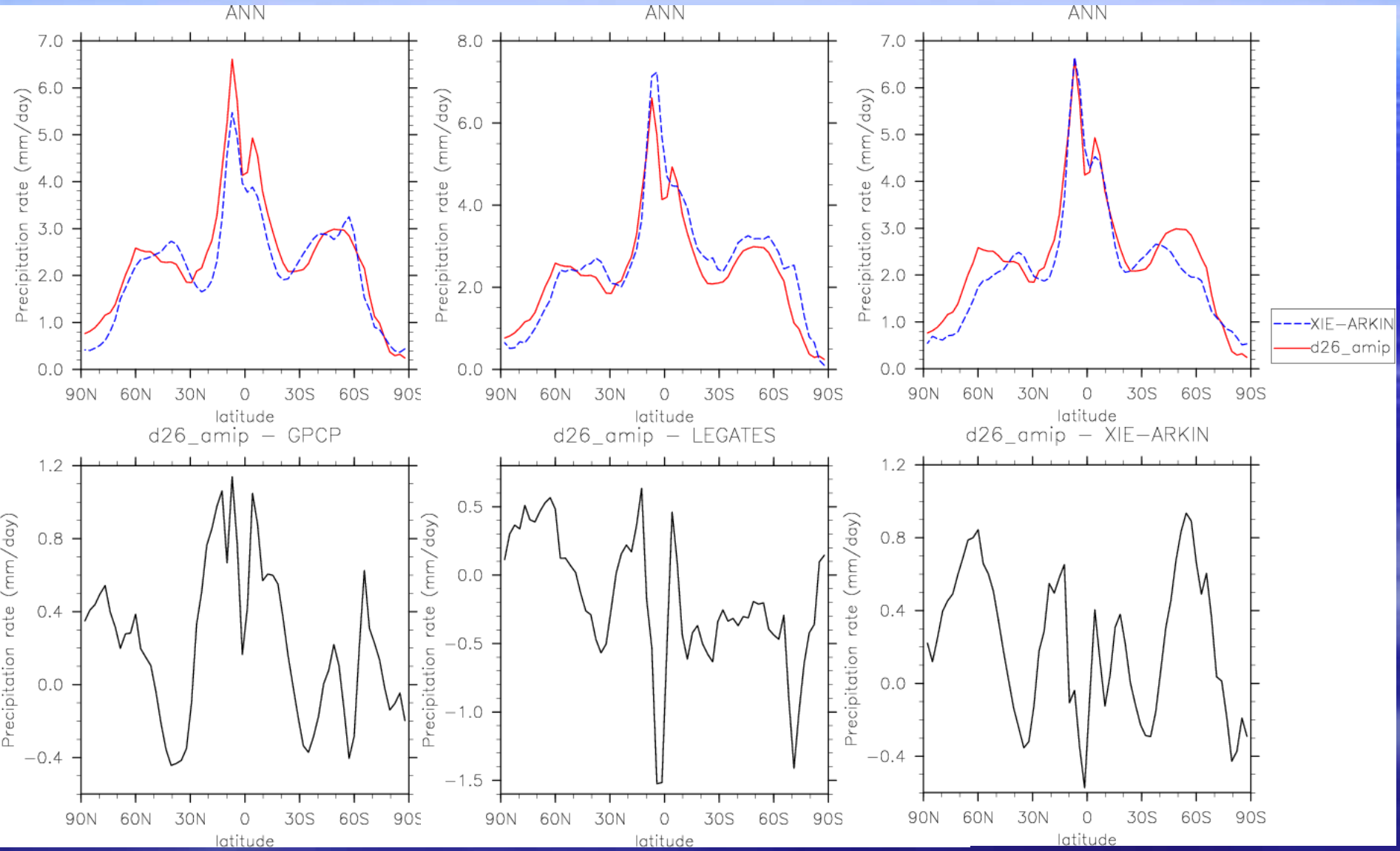
1. Simulations are complete.
2. Interpolation to specified atmospheric pressure levels is complete.
3. Conversion to CF-compliant format is not complete (although results are already in netcdf format)
4. AMIP results reside in NERSC archival storage
5. A2 results reside in NCAR mass storage
6. It's difficult to do anything with this much data!

AMIP simulation resembles planet earth



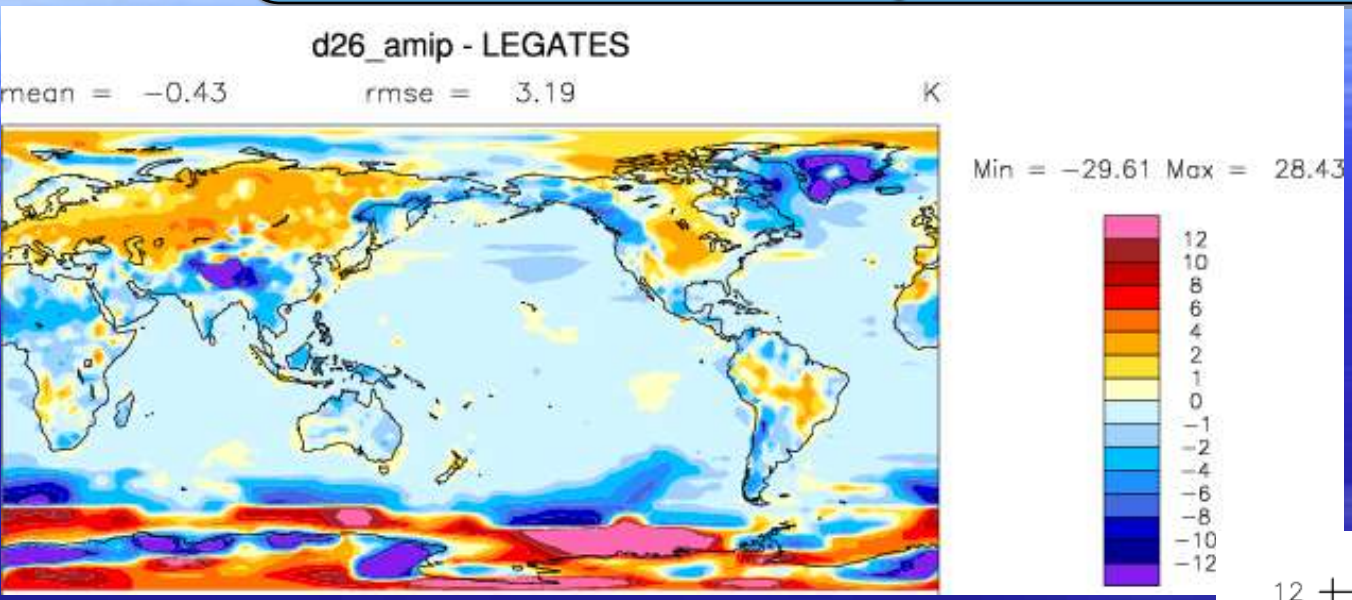
Reference height temperature over land

AMIP Precipitation…

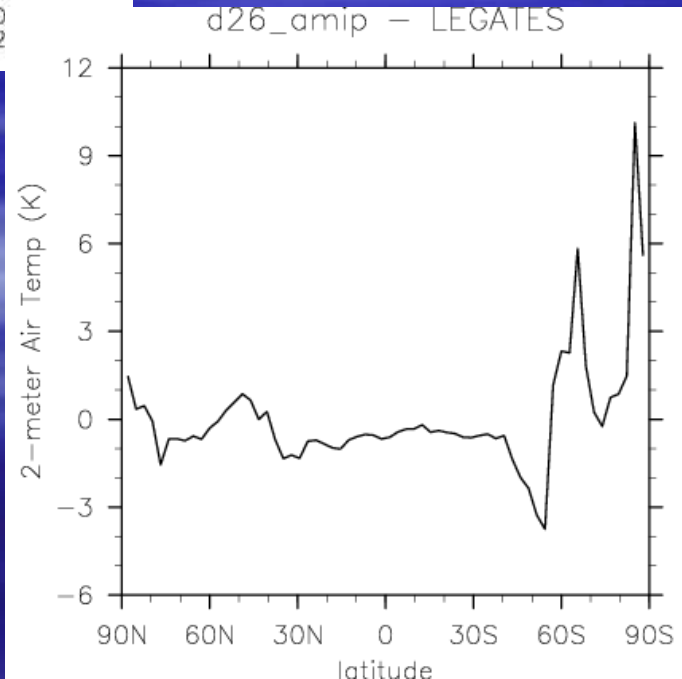


CAM *vs*: GPCP Legates & Wilmott Xie/Arkin

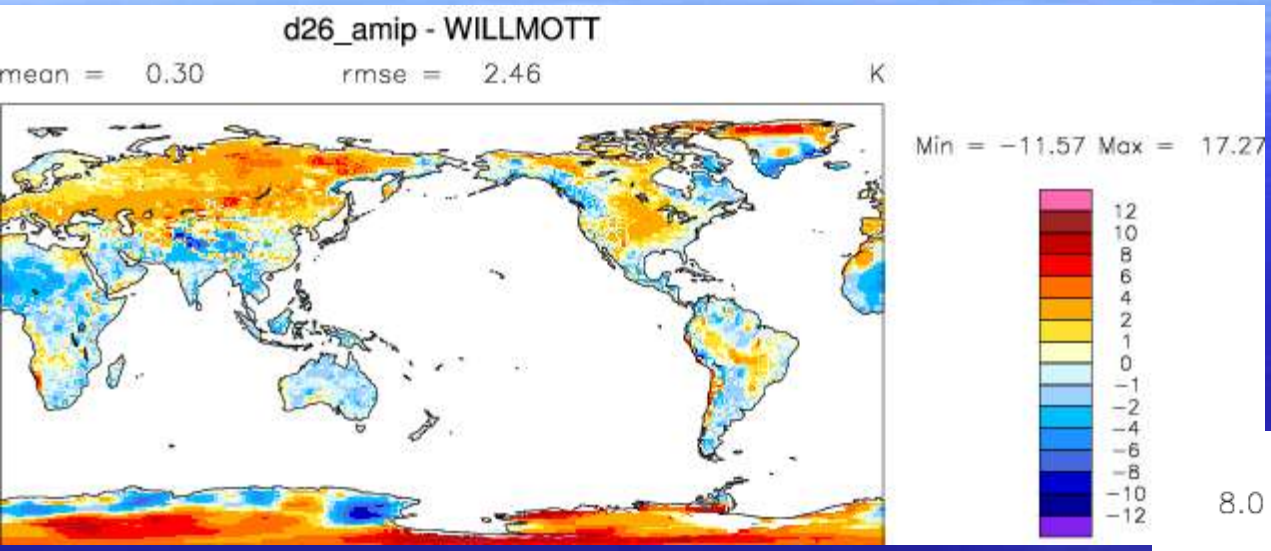
AMIP annual reference height temperature



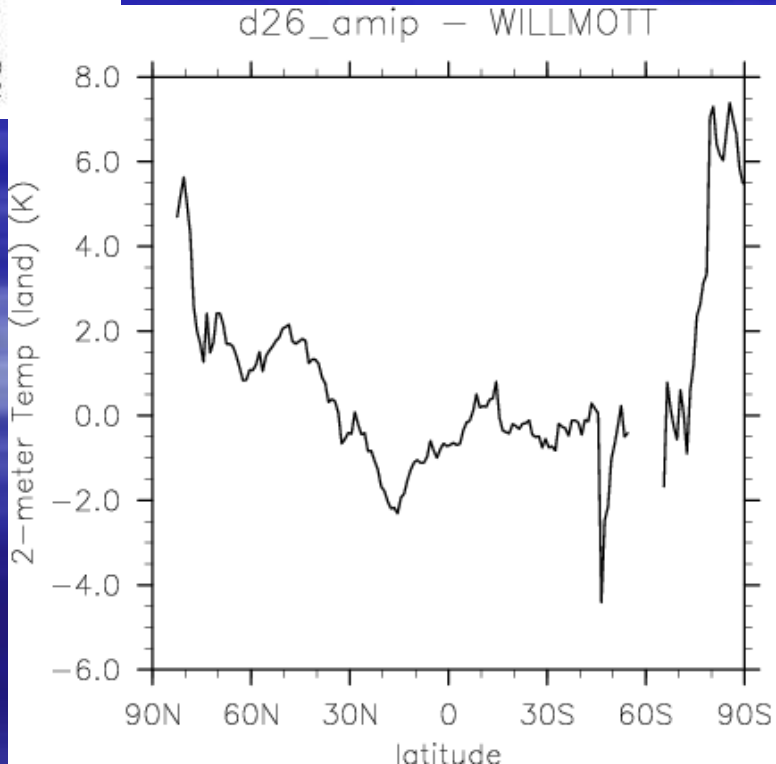
CAM *vs.* Legates & Wilmott (1920-1980)



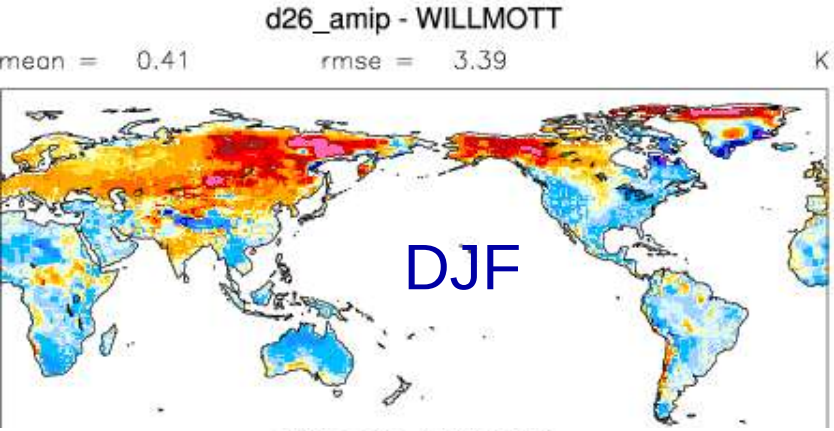
AMIP annual reference height temperature

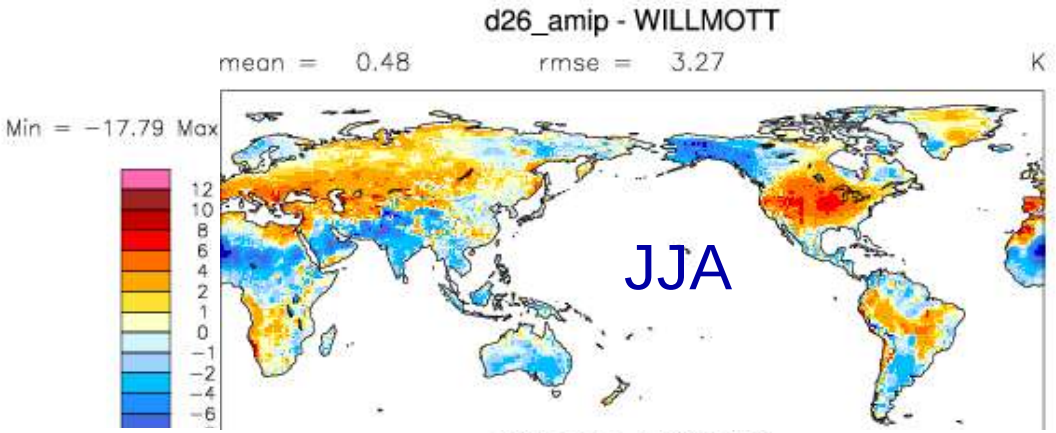


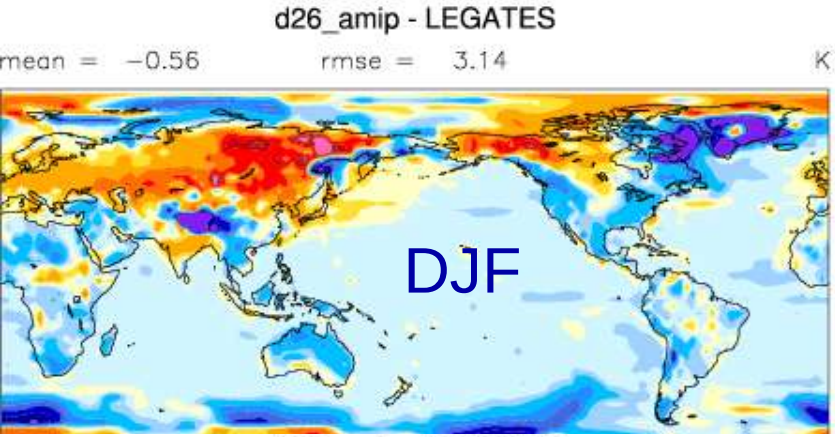
CAM *vs.* Wilmott & Matsura (1950-1999)

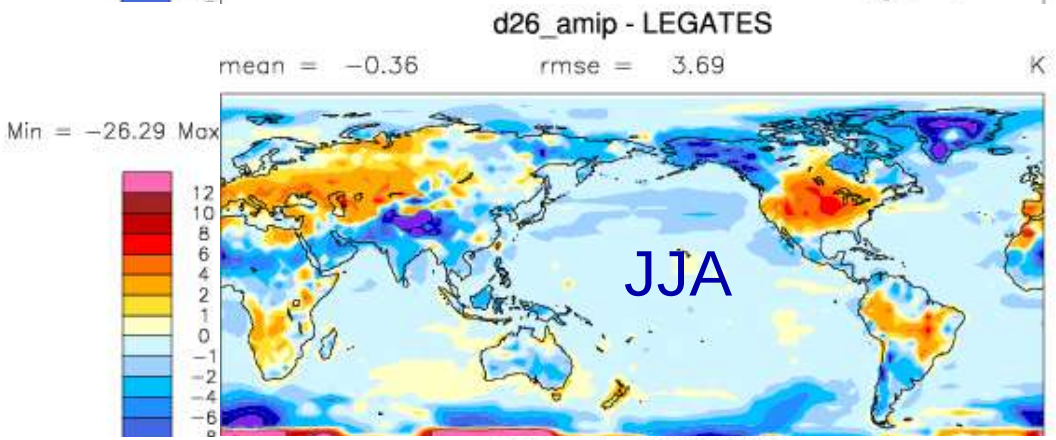


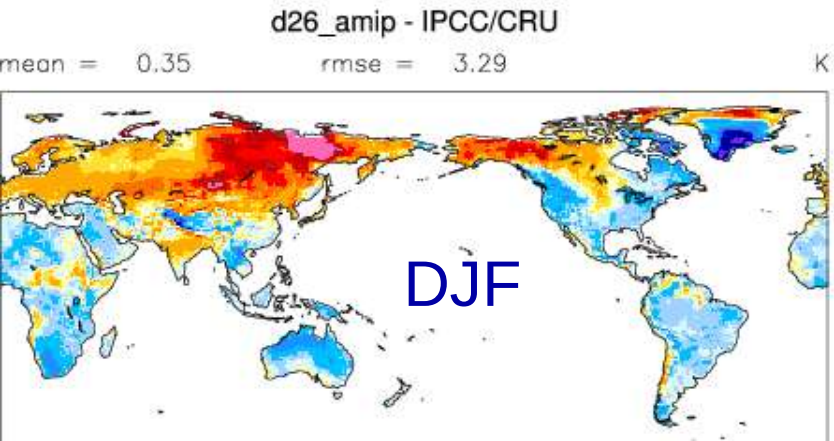
Reference height temperature biases

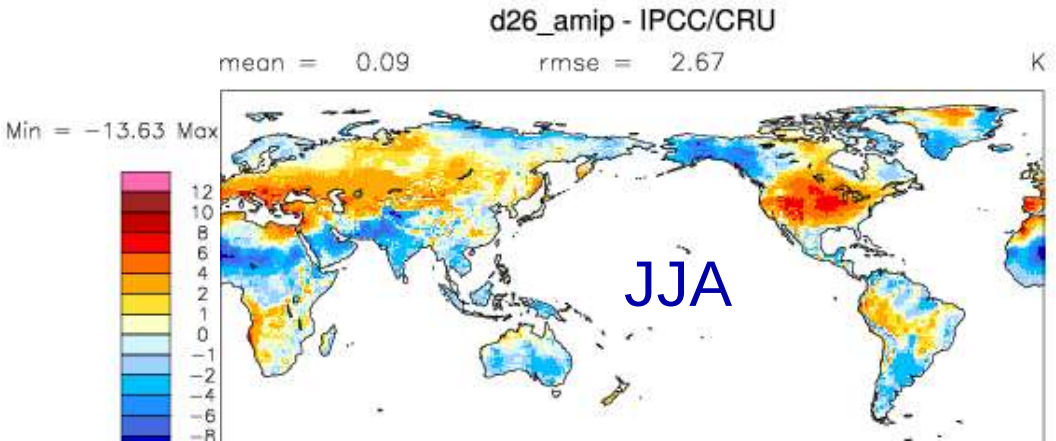




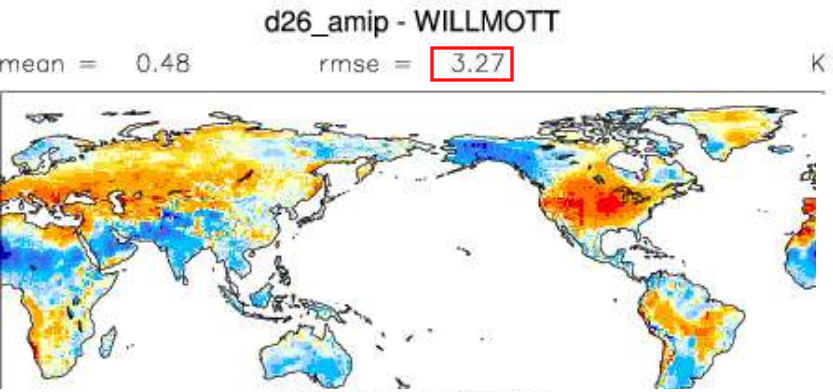


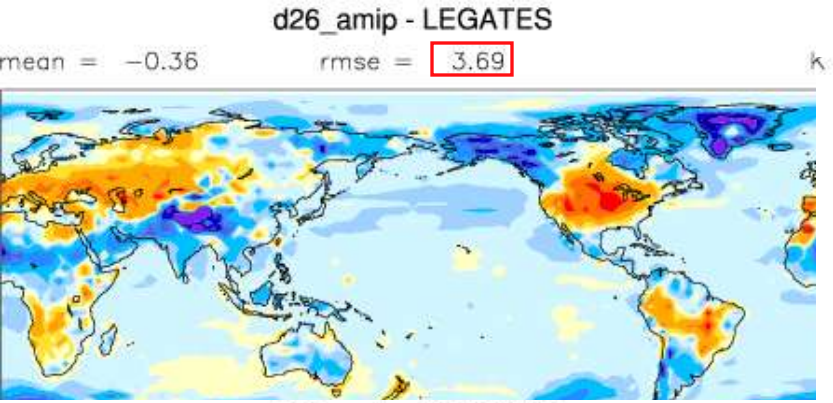


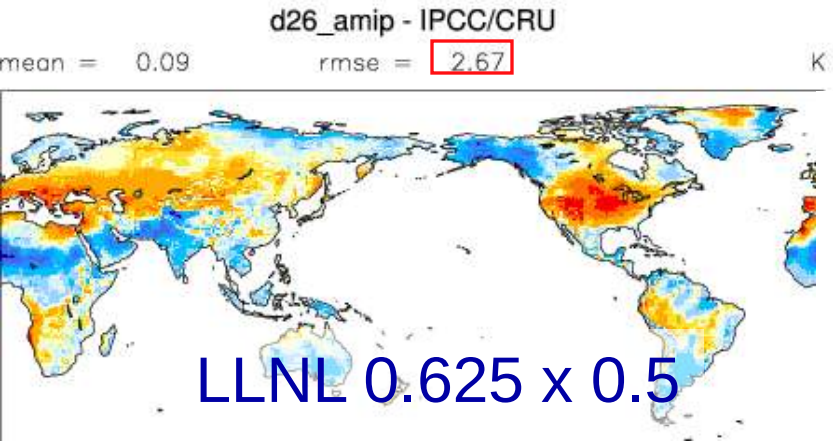




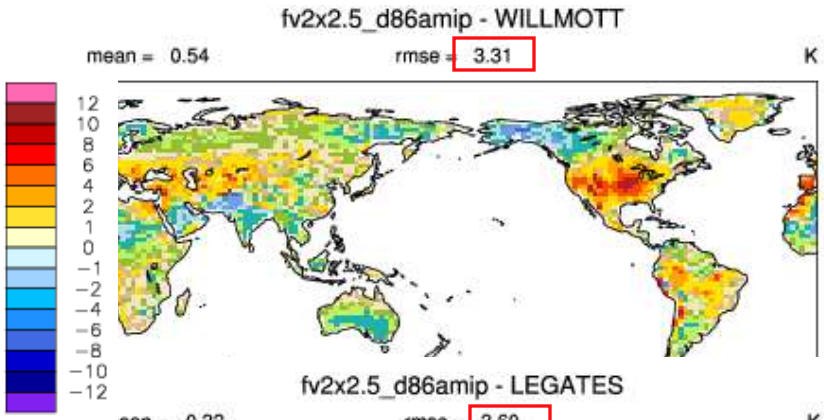
Biases in JJA temperatures are inherited from NCAR coarse-resolution model version

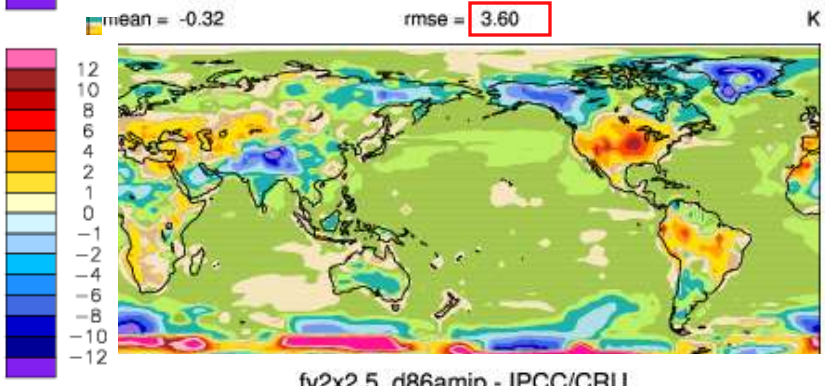


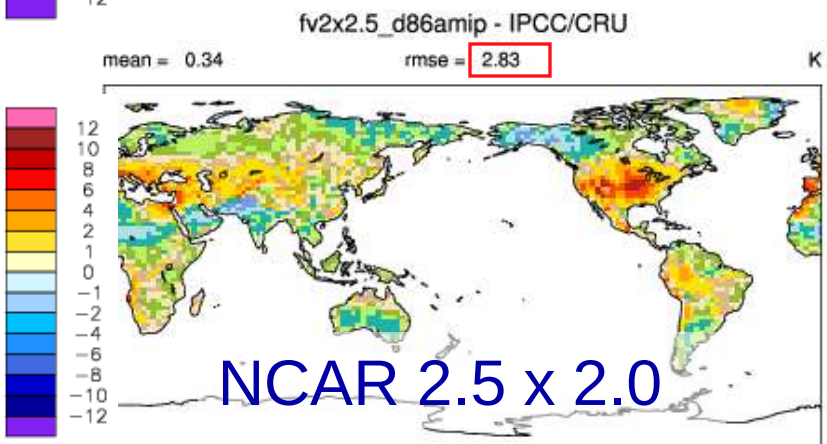




LLNL 0.625 x 0.5

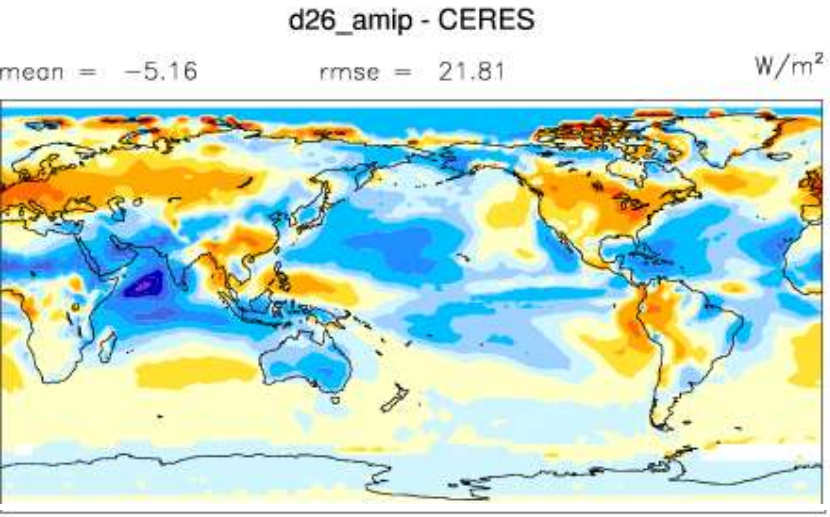


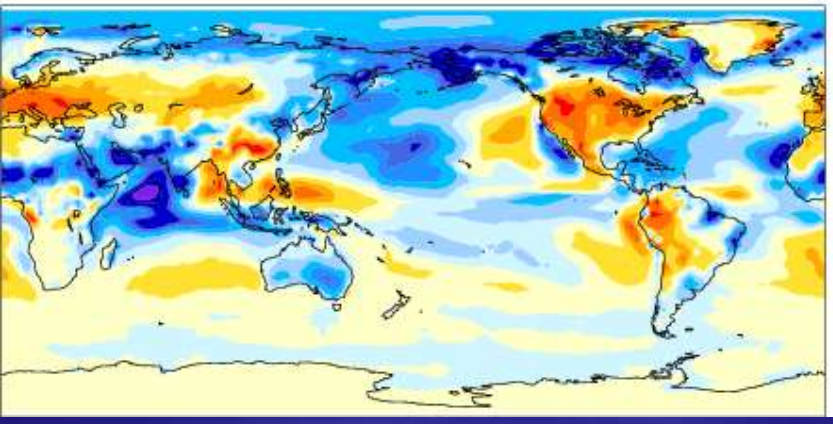




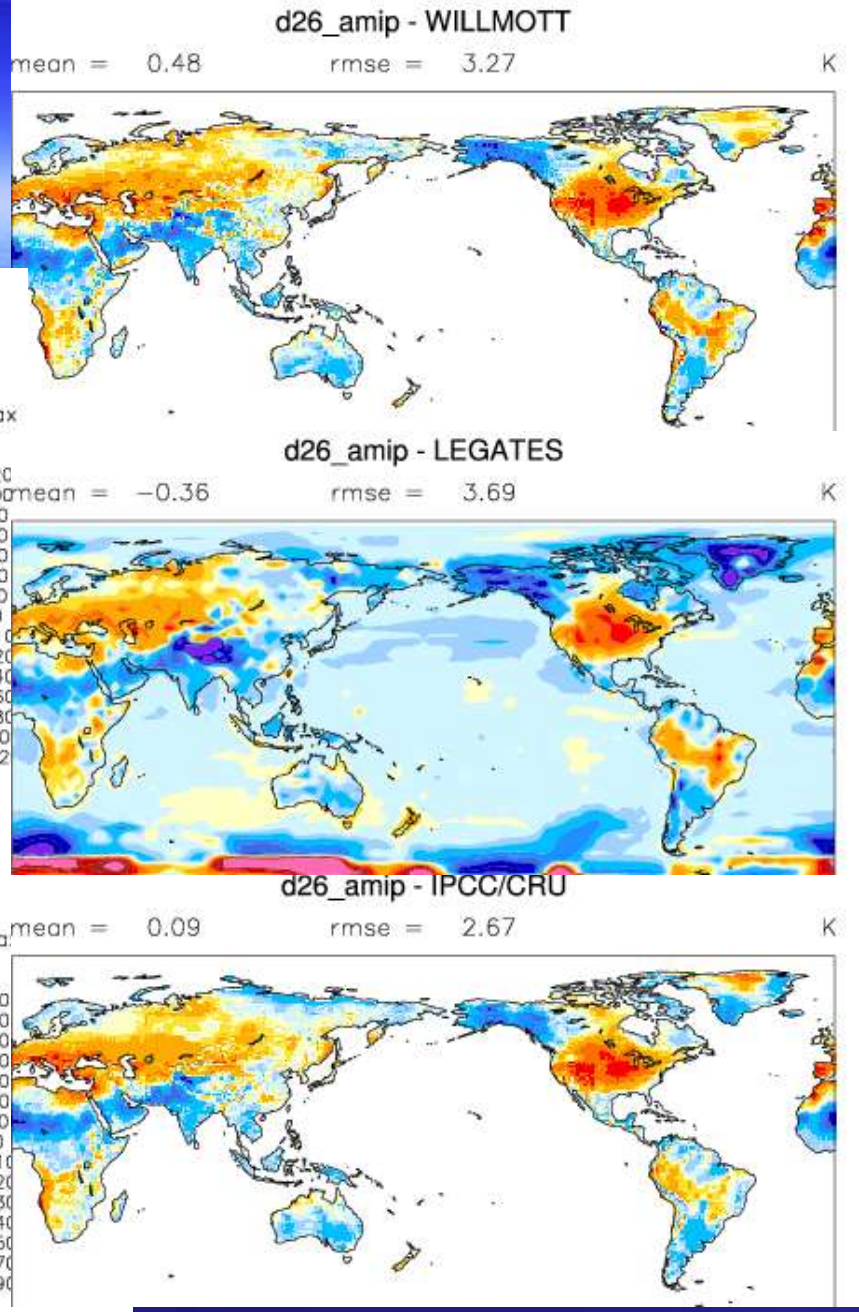
NCAR 2.5 x 2.0

Temperature biases seem to result from cloud errors



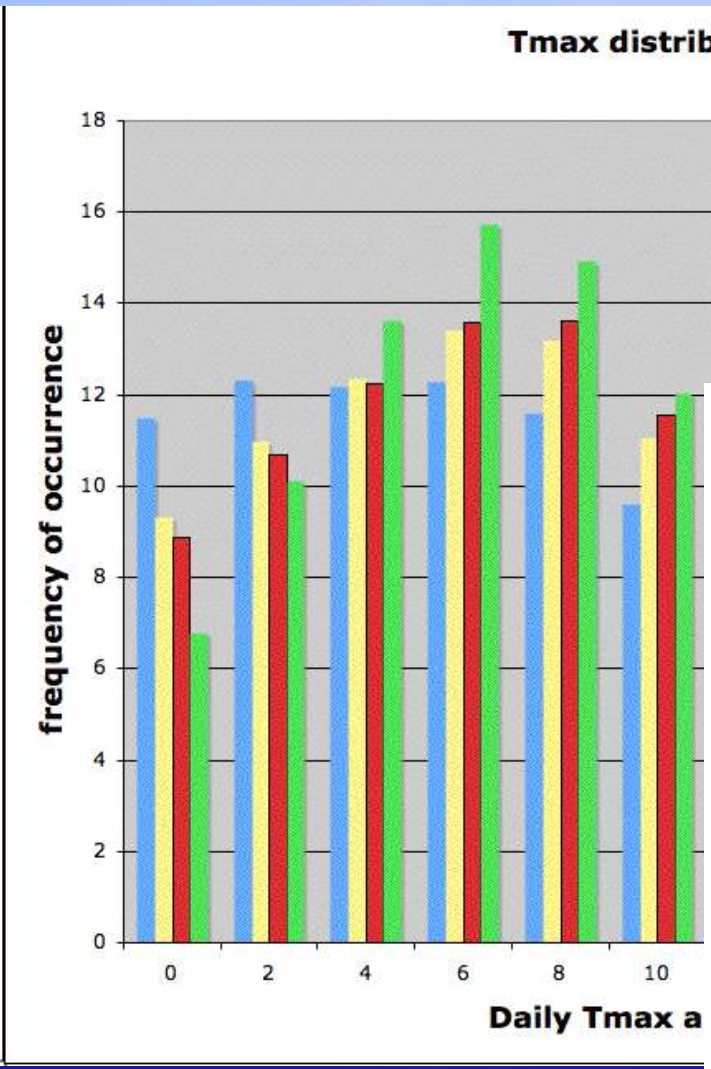


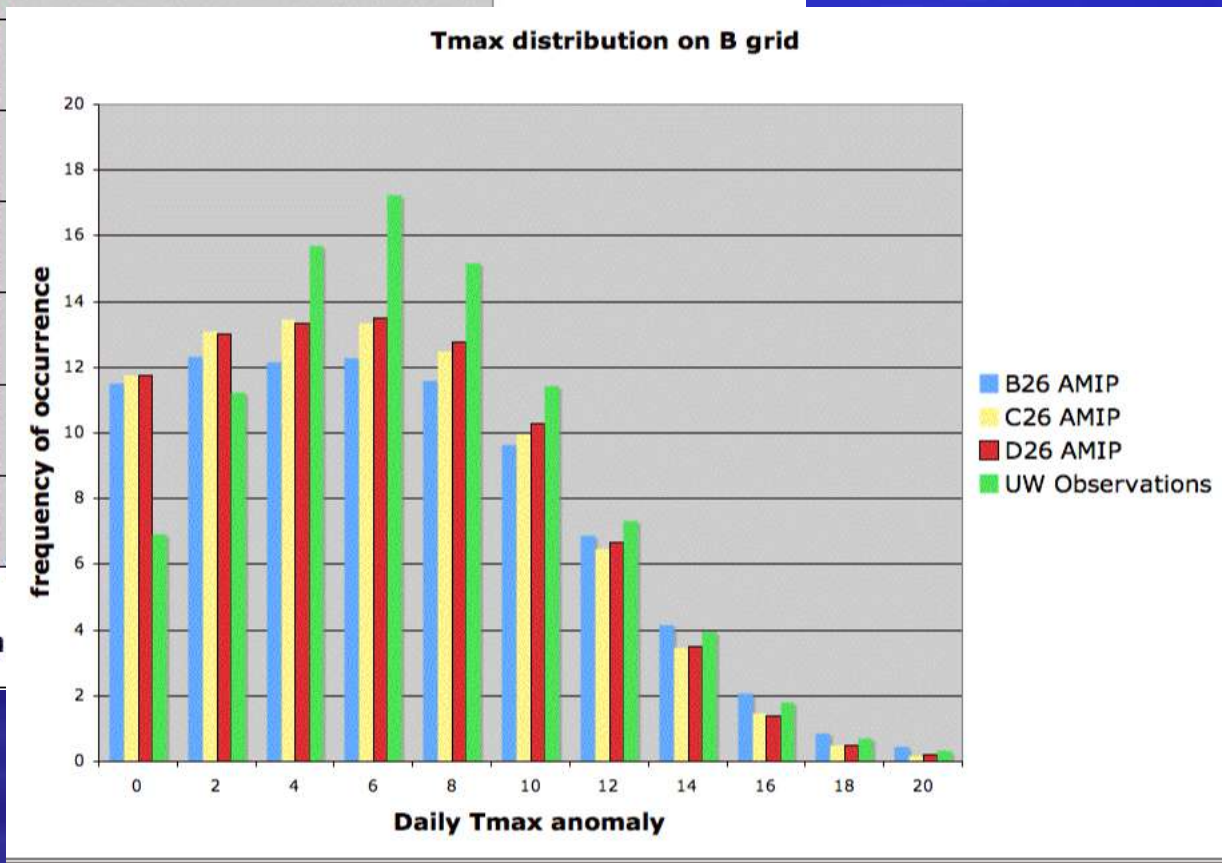
Errors in JJA short-wave cloud forcing



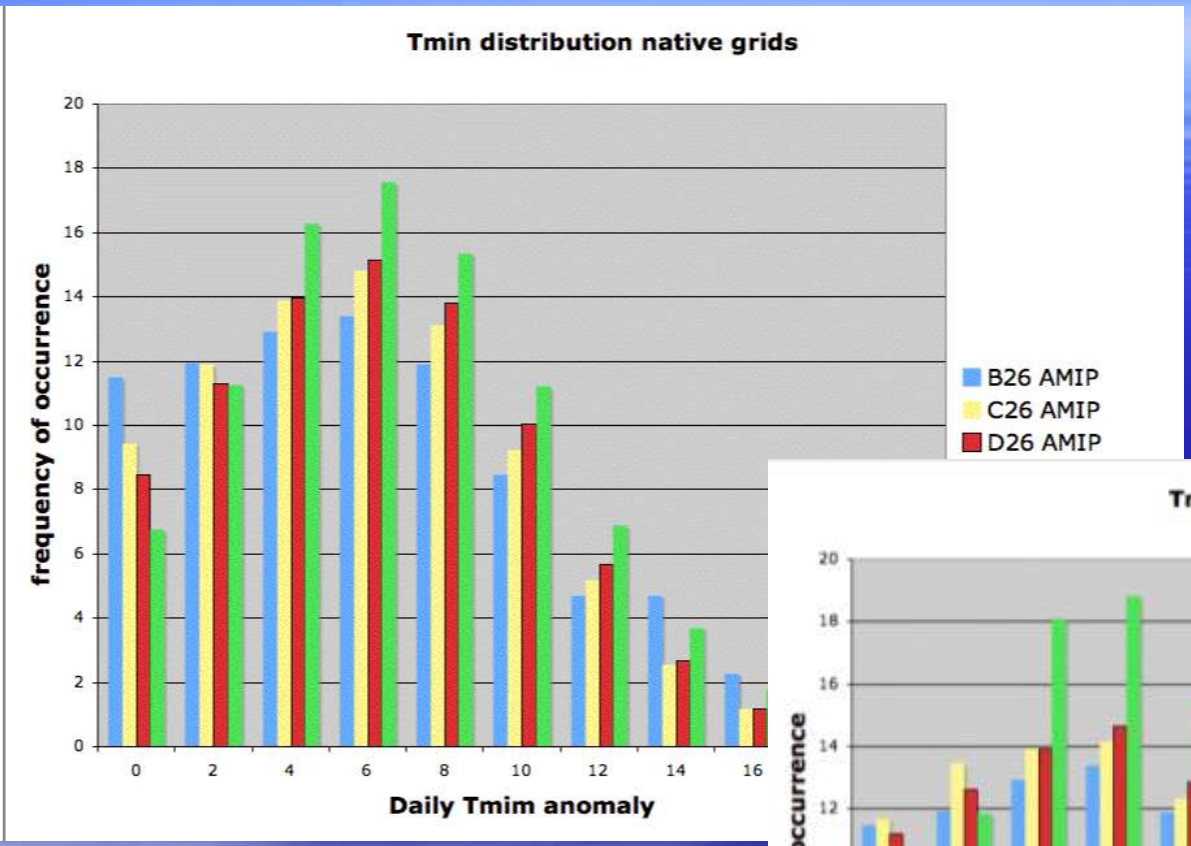
Errors in JJA T_{REFHT}

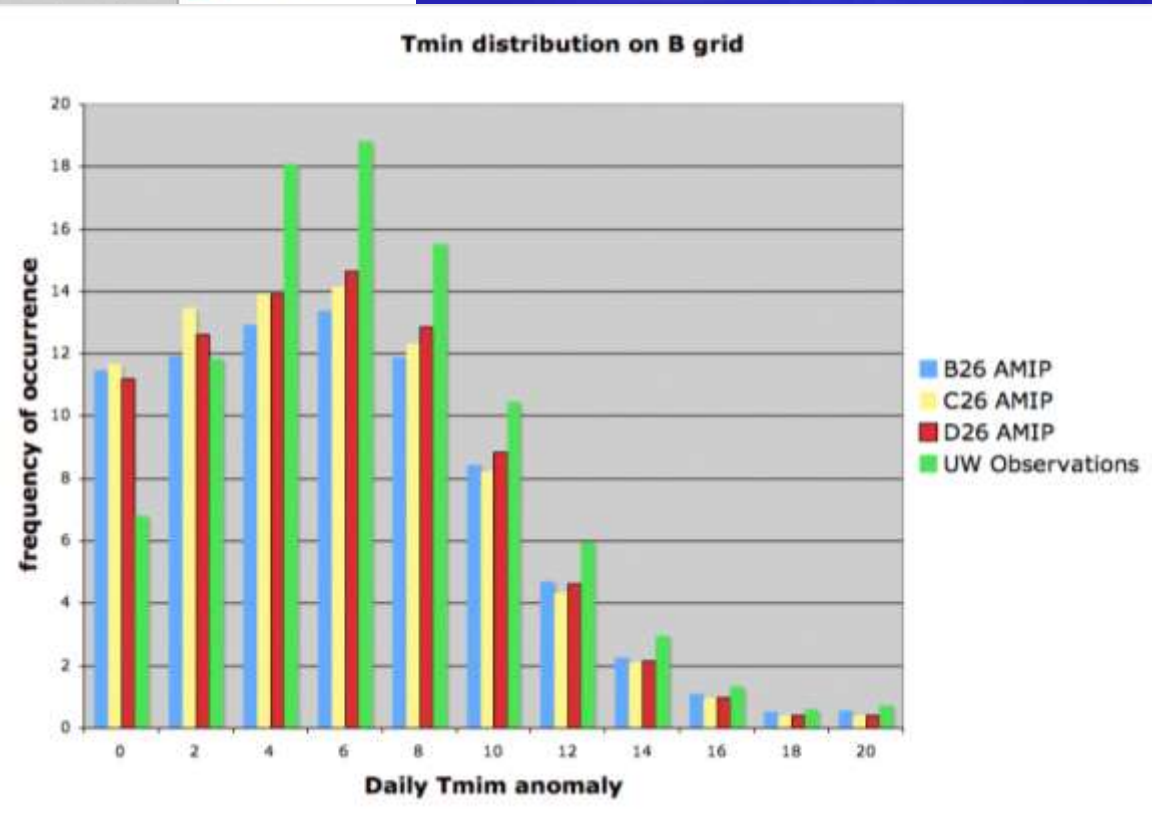
Anomalies in daily maximum near-surface temperatures



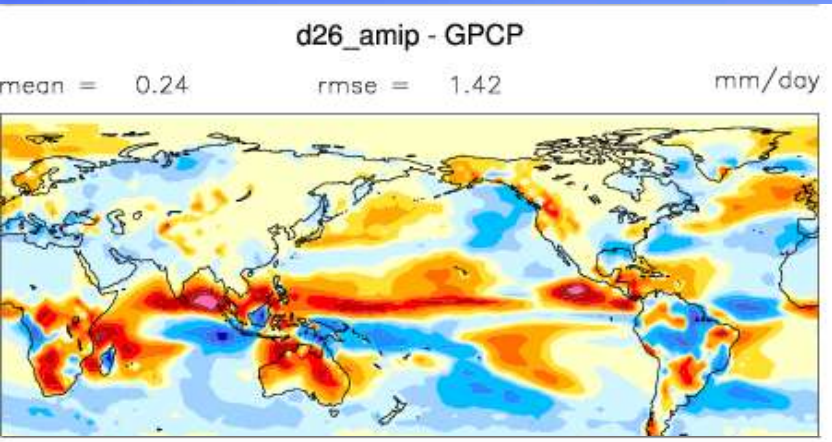


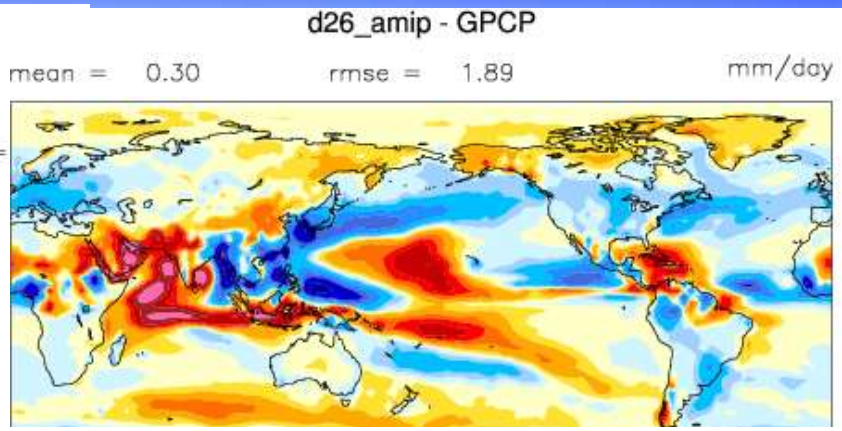
Anomalies in daily minimum near-surface temperatures

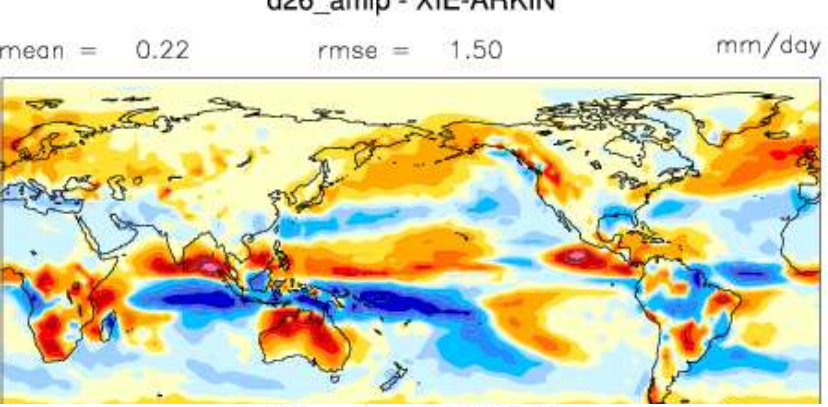


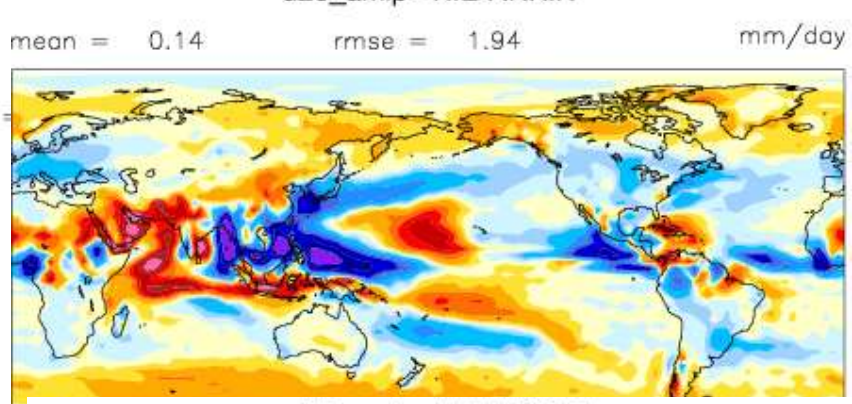


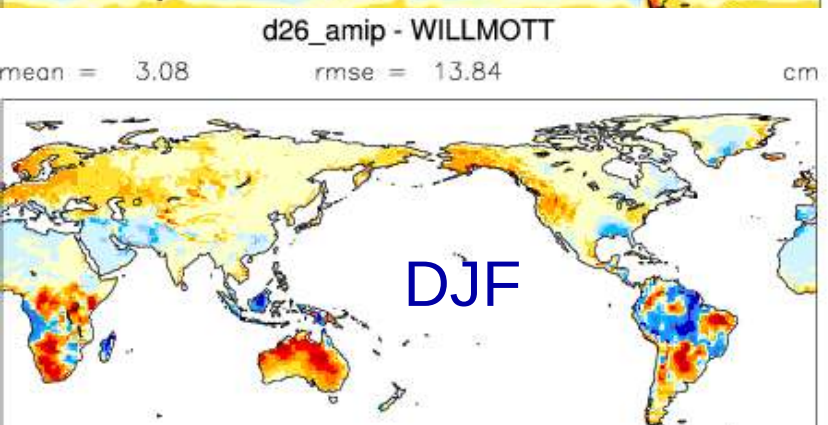
AMIP seasonal precipitation biases

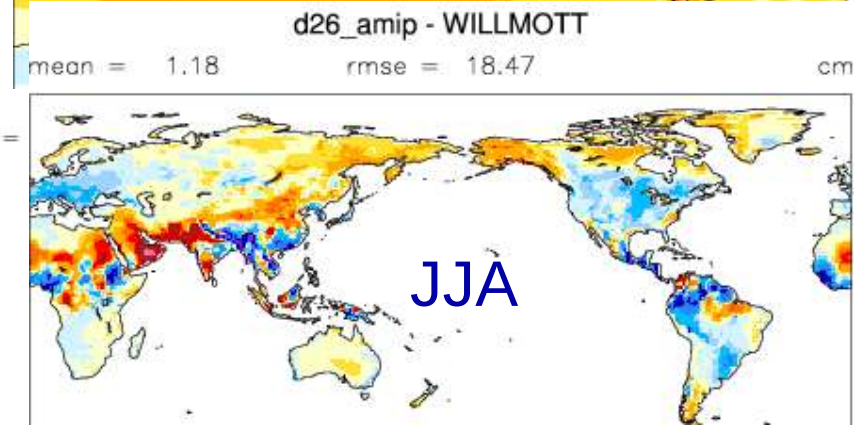


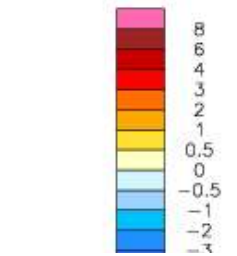


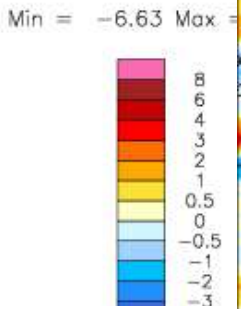


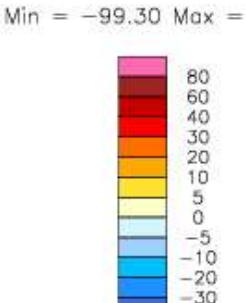




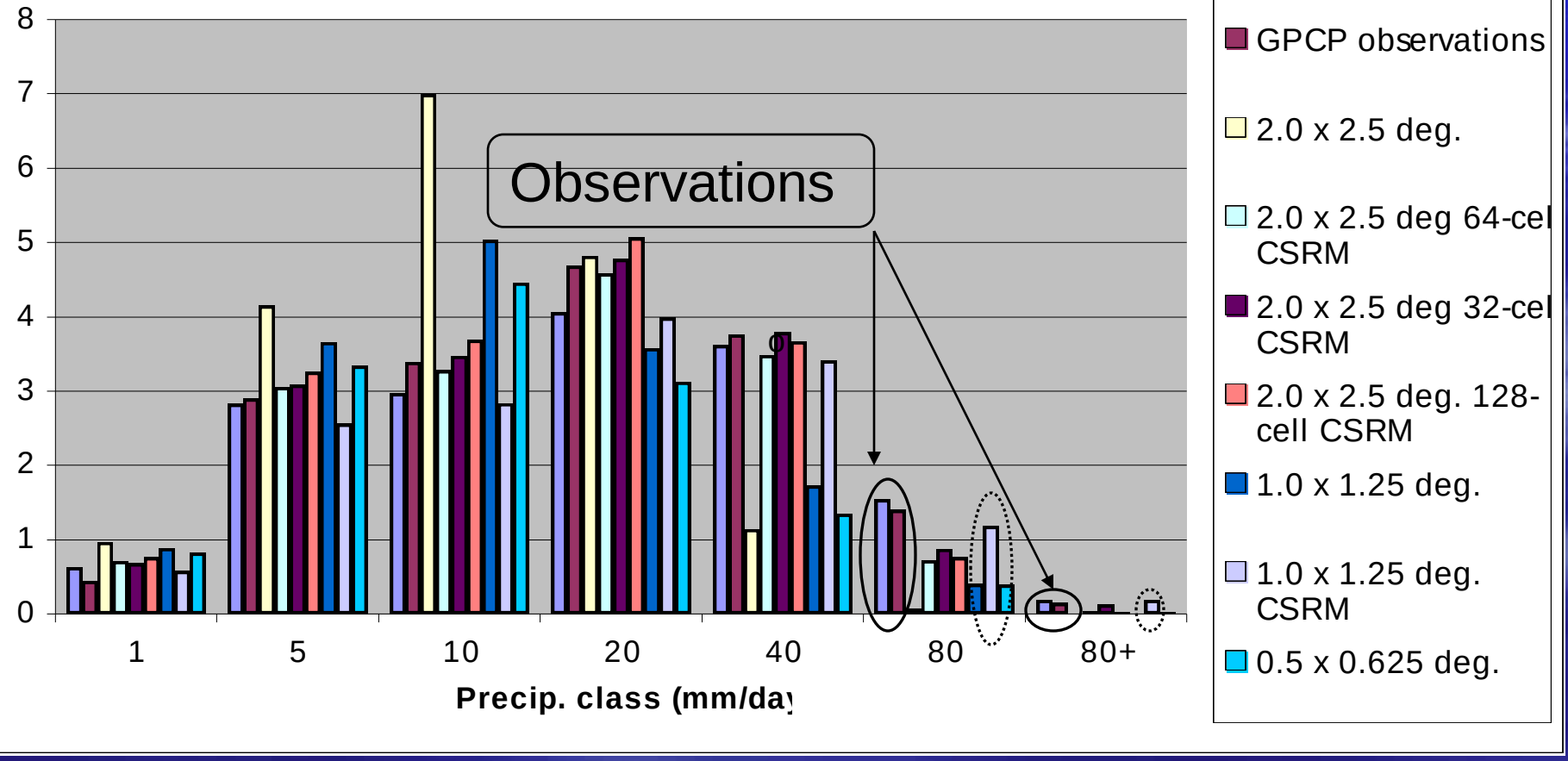






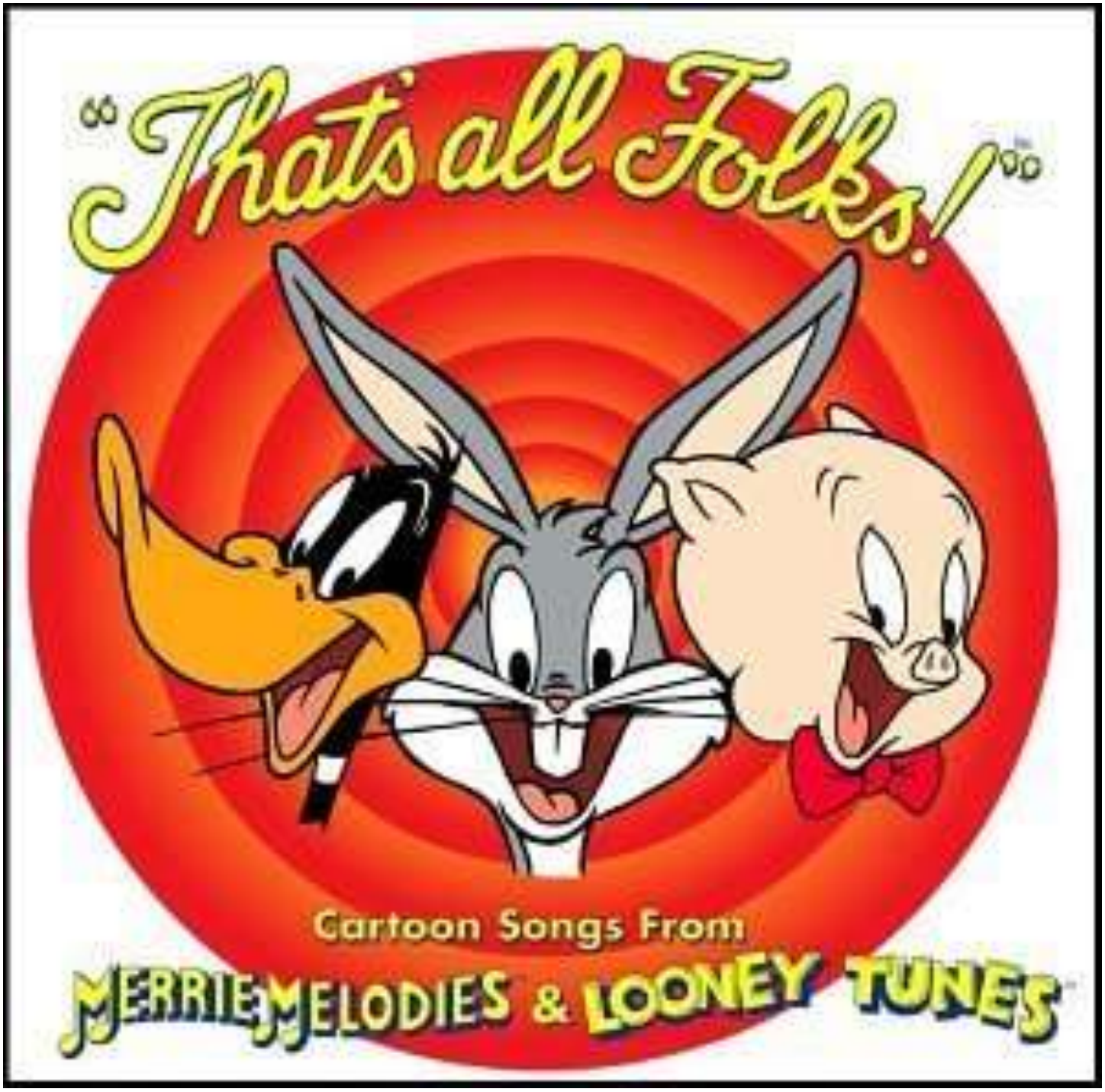


Daily precipitation amounts

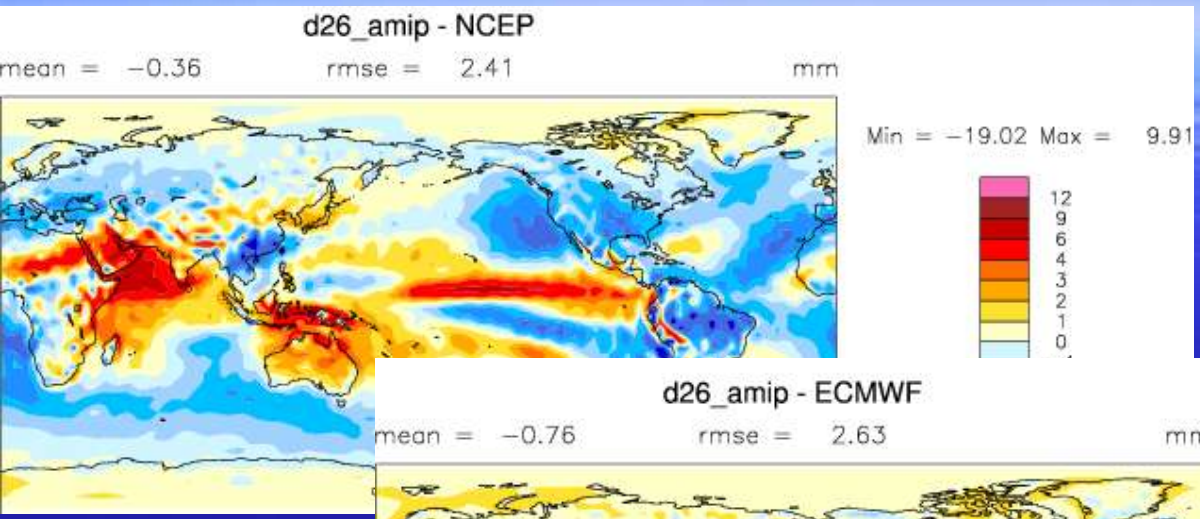


☐Summary: LLNL time-slice simulations

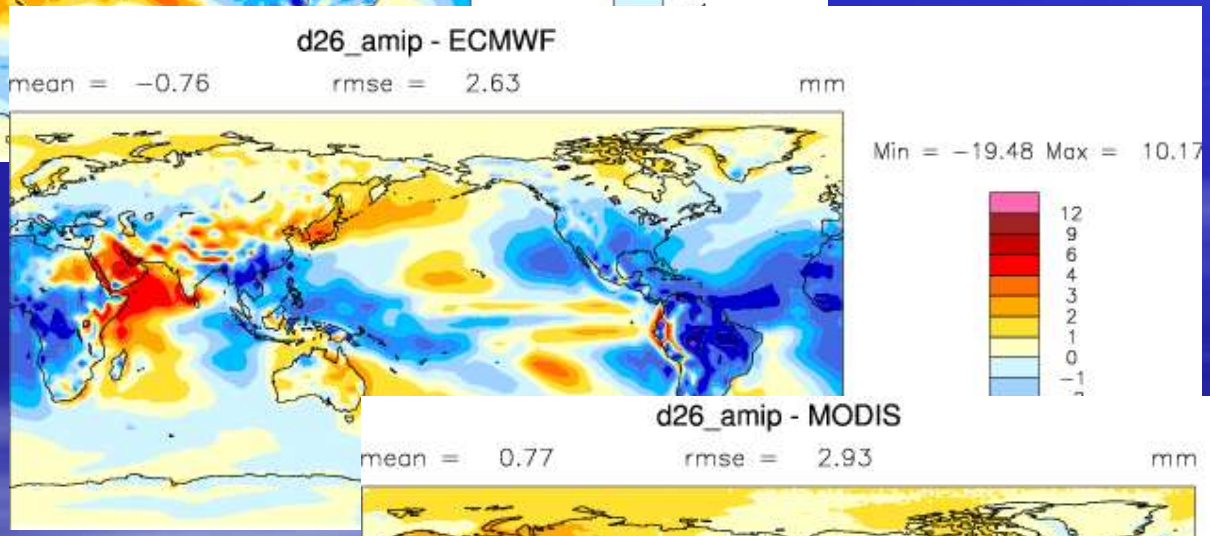
- Next time I'll be smarter about the difficulties of handling 60+ Tbyte of output.
- Results look like planet earth, but...
- …Near-surface temperatures have large biases in some regions, especially in summer.
    - These seem to be related to cloud errors and are inherited from the coarse-resolution model version.
- Daily temperatures and precipitation amounts are simulated better than in coarser-resolution versions of the same model.


"That's all Folks!"
Cartoon Songs From
MERRIE MELODIES & LOONEY TUNES

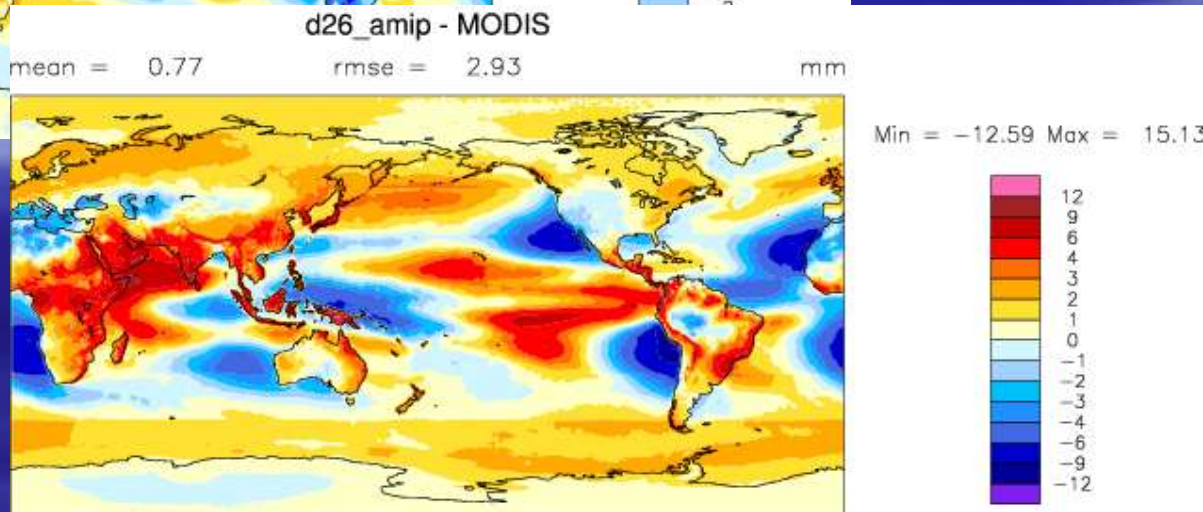
AMIP annual precipitable water



CAM minus NCEP



CAM minus ECMWF



CAM minus MODIS

50 km

300 km