AMWG UPDATE

THE 26th ANNUAL CESM WORKSHOP

Julio Bacmeister, Christiane Jablonowski, Kevin Reed
AMWG Co-chairs

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Outline

- Development and timelines
- Vertical grid
- Physics reordering
- Topography
- Coupled results
- Survey on reducing software management burden

CAM development

"CAM7" for climate

- Vertical resolution/model top
  - L58 low top (45km) w/ simplified chemistry
  - L93 high top (85km)
- Physics
- Topography software
- Track development at: https://github.com/NCAR/amwg_dev

Other development

- Topography software (VR capability)
- Variable resolution
  - Tools for grid generation
  - Compsets
- Infrastructure
  - Cloud computing
  - Streamlined coupling/mediator infrastructure
- Simpler models

** Orange font indicates developments that facilitate and increase accessibility for community research using CAM

Physics development efforts

- Physics re-ordering (A. Herrington)
- ZM for high vertical resolution ("ZM2"; R. Neale *talk*)
- CLUBB-EDMF (J. Teixeira *talk)*
- CLUBB-prognostic momentum flux (C. Zarzycki *talk*)
- New topography processing (P. Lauritzen *poster*)
- **C**oupling of **L**and and **A**tmospheric **S**ubgrid **P**arameterizations (CLASP; N. Chaney, D. Lawrence, M. Fowler)
- **P**arameterization of **U**nified **M**icrophysics **A**cross **S**cales (PUMAS; A. Getttelman, H. Morrison, K. Thayer-Calder)
- Continued development of rigorous enthalpy/energy treatment in CAM to replace "fixer"(P. Lauritzen)

Short-term timeline

April -July 2022: First evaluation of coupled system (B1850) with SE-atmos dycore and L58 vertical grid

***April-October 2022**: Further development and evaluation of atmospheric physics and forcing*

Late 2022: Finalize configuration of CAM for CESM2.x , i.e, decide which atmospheric physics are included, specification of boundary forcing, e.g., radiatively active tracers for L58 and L92

Further CAM7 development

Coupled tuning of CESM2.x

- "CESM2.x" slated for release in mid 2023
- CESM2.x is intended to be a viable coupled version that incorporates MOM6 + L58/L93 atmosphere
- CESM2.x is ***NOT*** the next CMIP model
- Possible applications: high horz. resolution, regionally-refined studies

- ***Atmos physics in current evaluation:*** MG2, ZM2, re-ordering, updated topo, enthalpy "fixer" for MOM6
- By late 2022 hope to incorporate PUMAS and contributions from CPTs

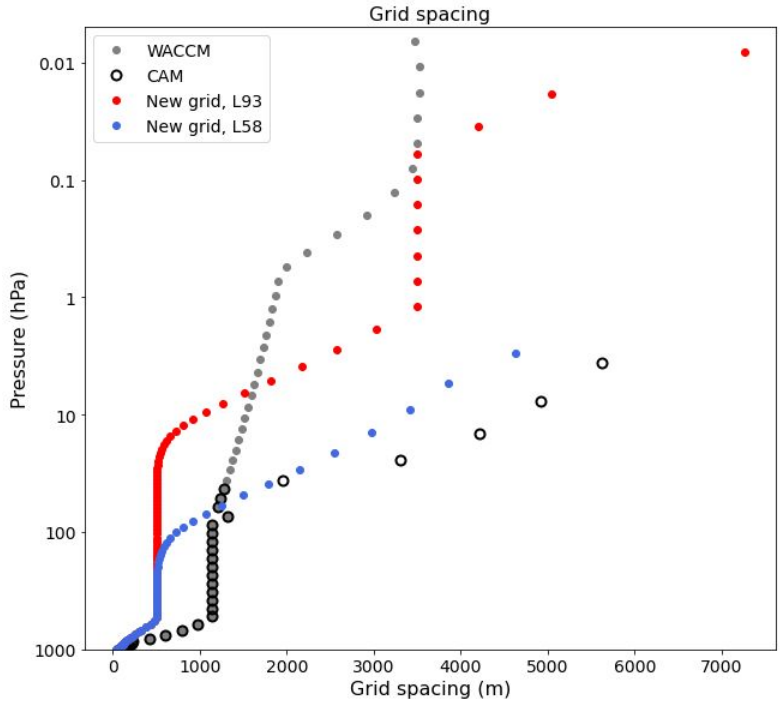
Vertical Resolution/Model Top

- Single L93 CMIP class model with top around 80km
  - Better resolved stratospheric dynamics including QBO
  - Full chemistry as option
- Cheaper L58 version with top around 40km
  - Optional simplified or no chemistry
- Increased PBL resolution for both

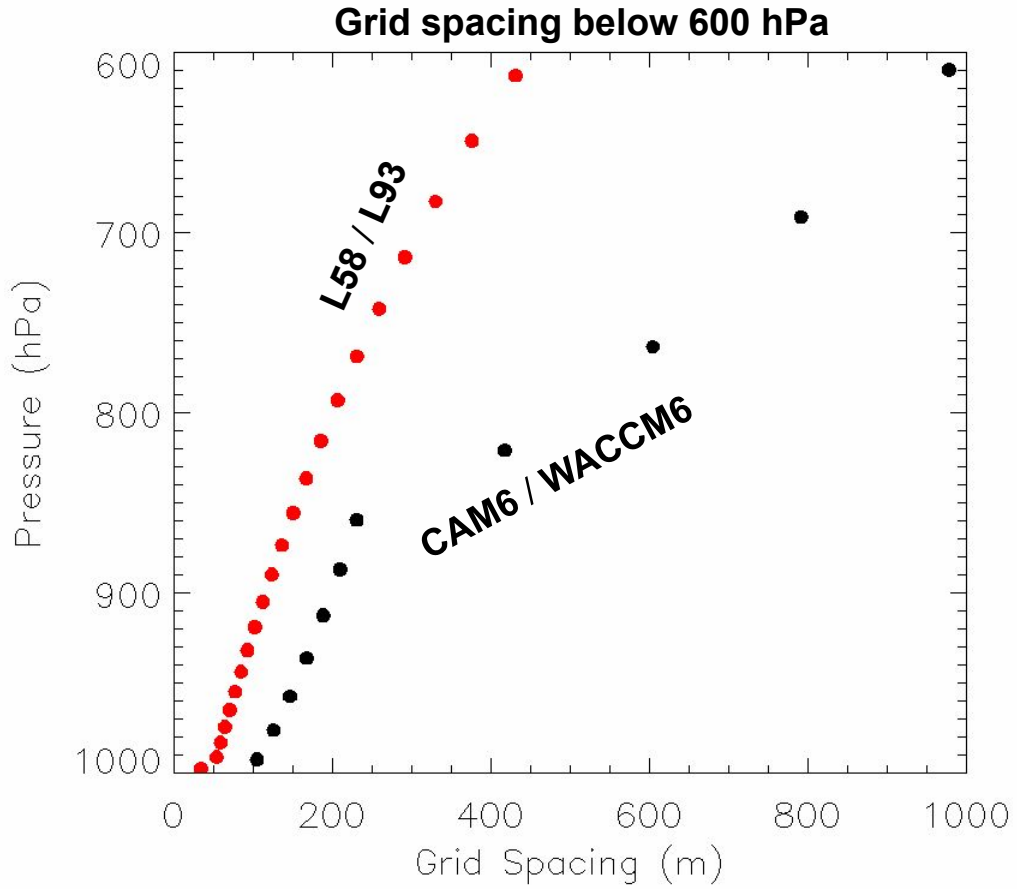
These vertical grids are now being used for all CAM development work. Coupled evaluations have begun.

Thanks to Isla Simpson and Brian Medeiros for leading the vertical grid selection process

Vertical Resolution/Model Top



- Free tropospheric/stratosphere resolution increased from DZ~1200m to DZ~500m.
- Two configurations L93 (top~85km) and L58 (top~45km). Identical vertical grid through mid stratosphere



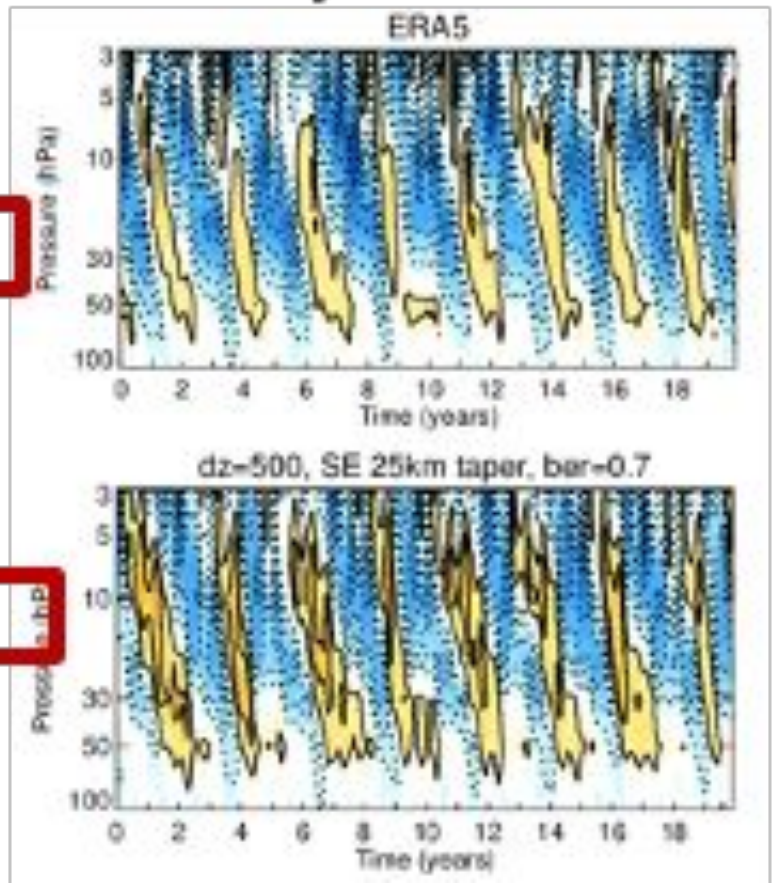
- Dramatically increased PBL/lower tropospheric resolution. New lowest model level height ~20m. Previously ~60m.
- New cloud base treatment needed for ZM (R. Neale)

Vertical Resolution/Model Top (L93)

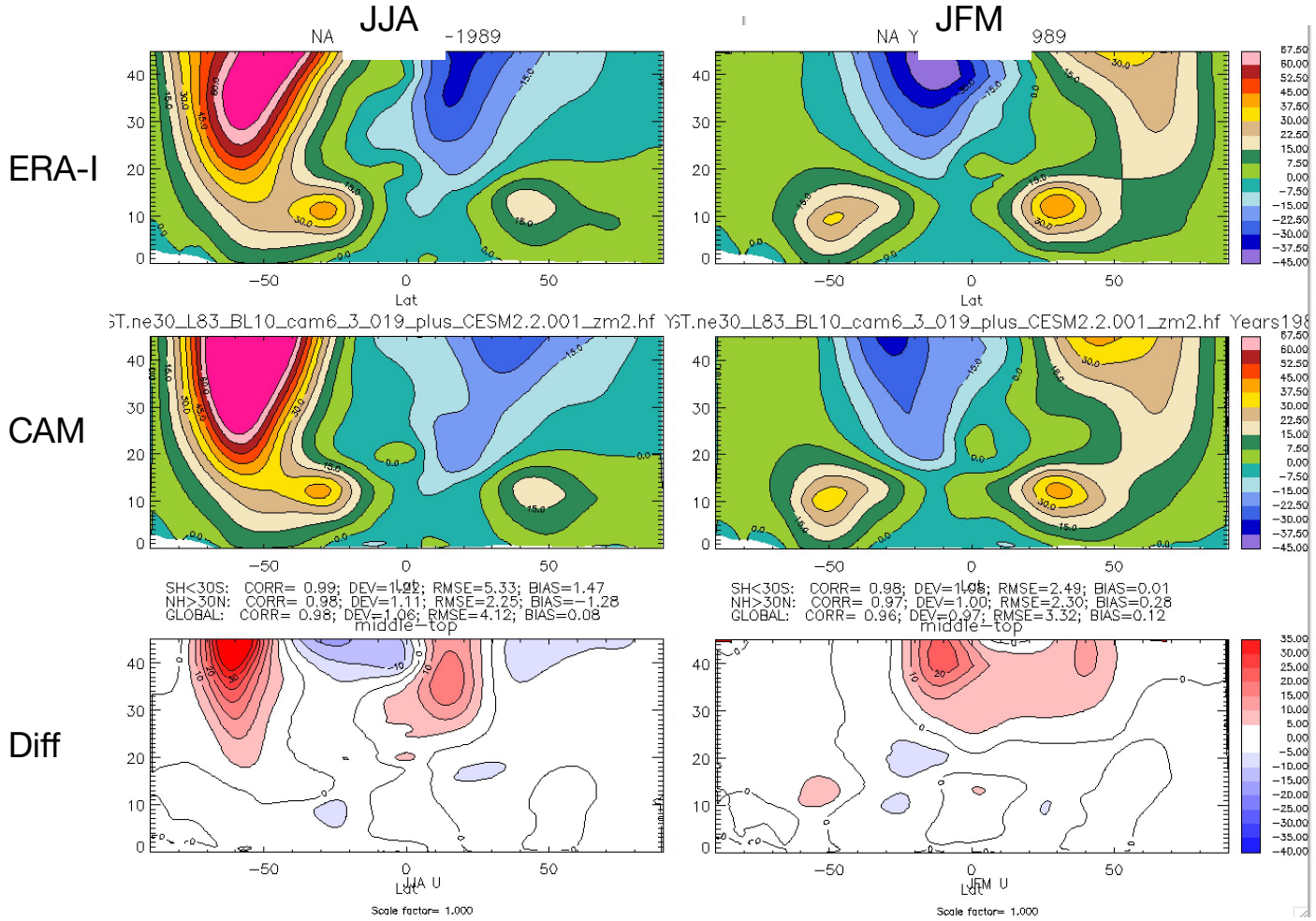
The QBO in the spectral-element dynamical core

OBS

Dz=500

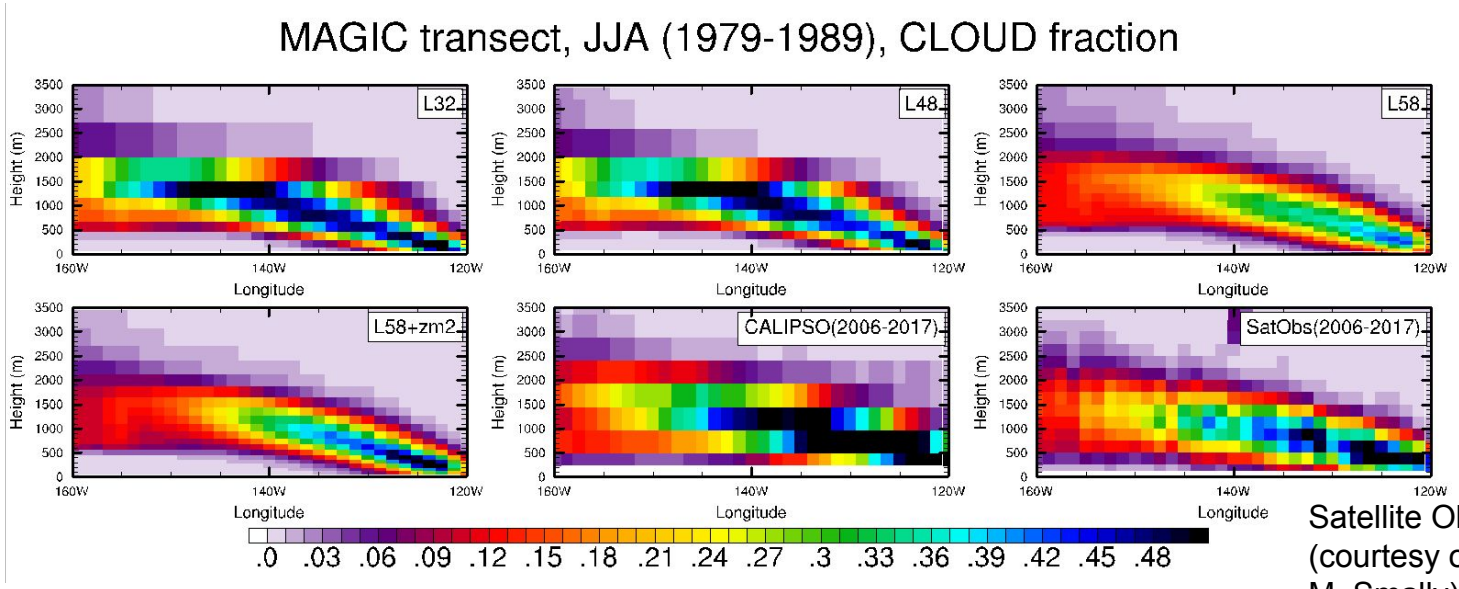


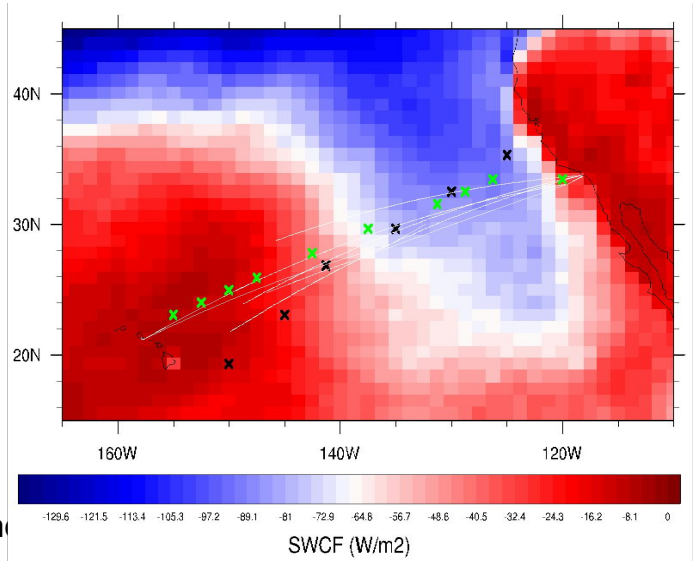
Zonally-averaged zonal wind 10-season averages



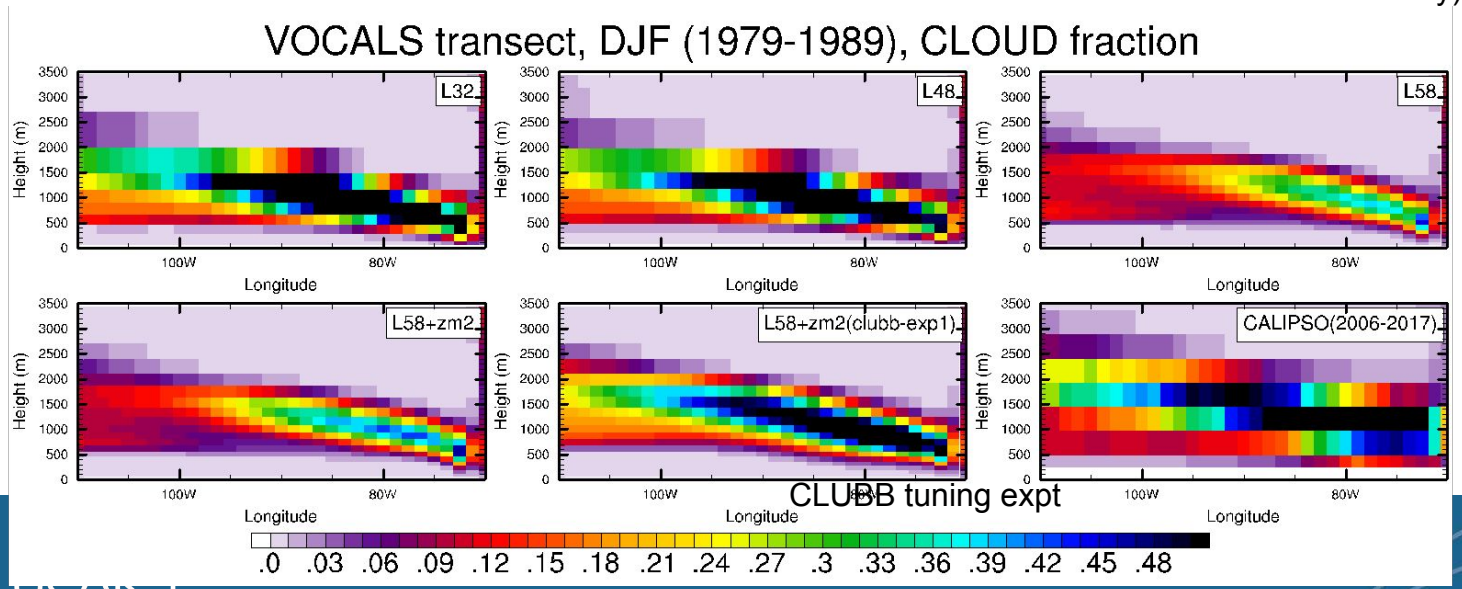
Vertical Resolution/Model Top

Plots from Adam Herrington

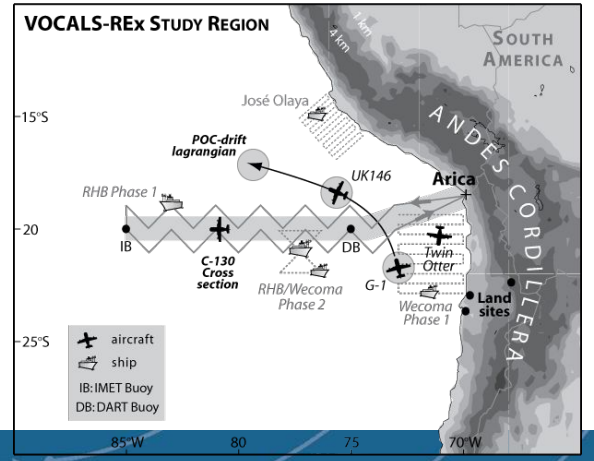




Satellite Observations (courtesy of B. Medeiros and M. Smally)



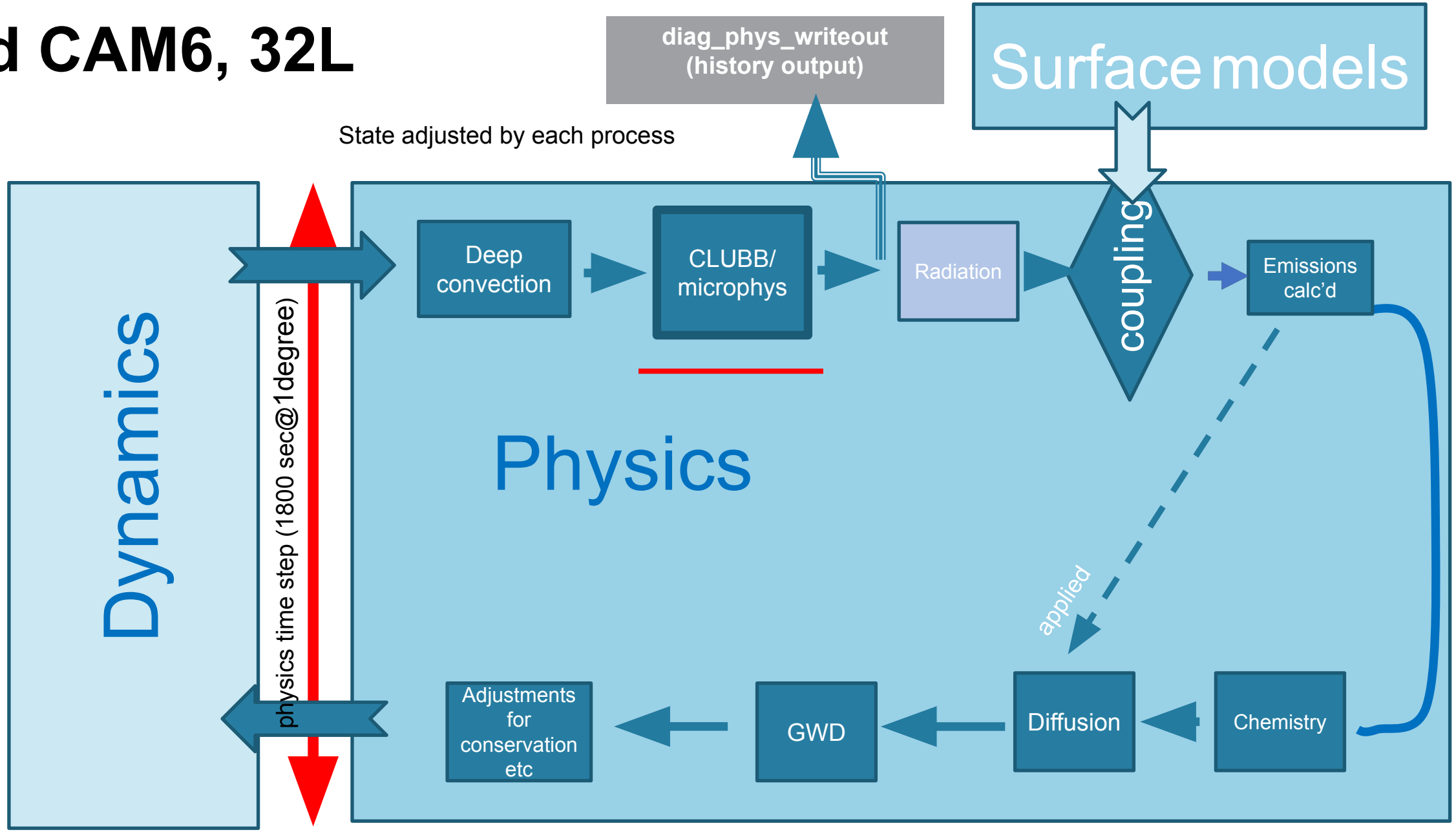
CLUBB tuning expt



Physics reordering

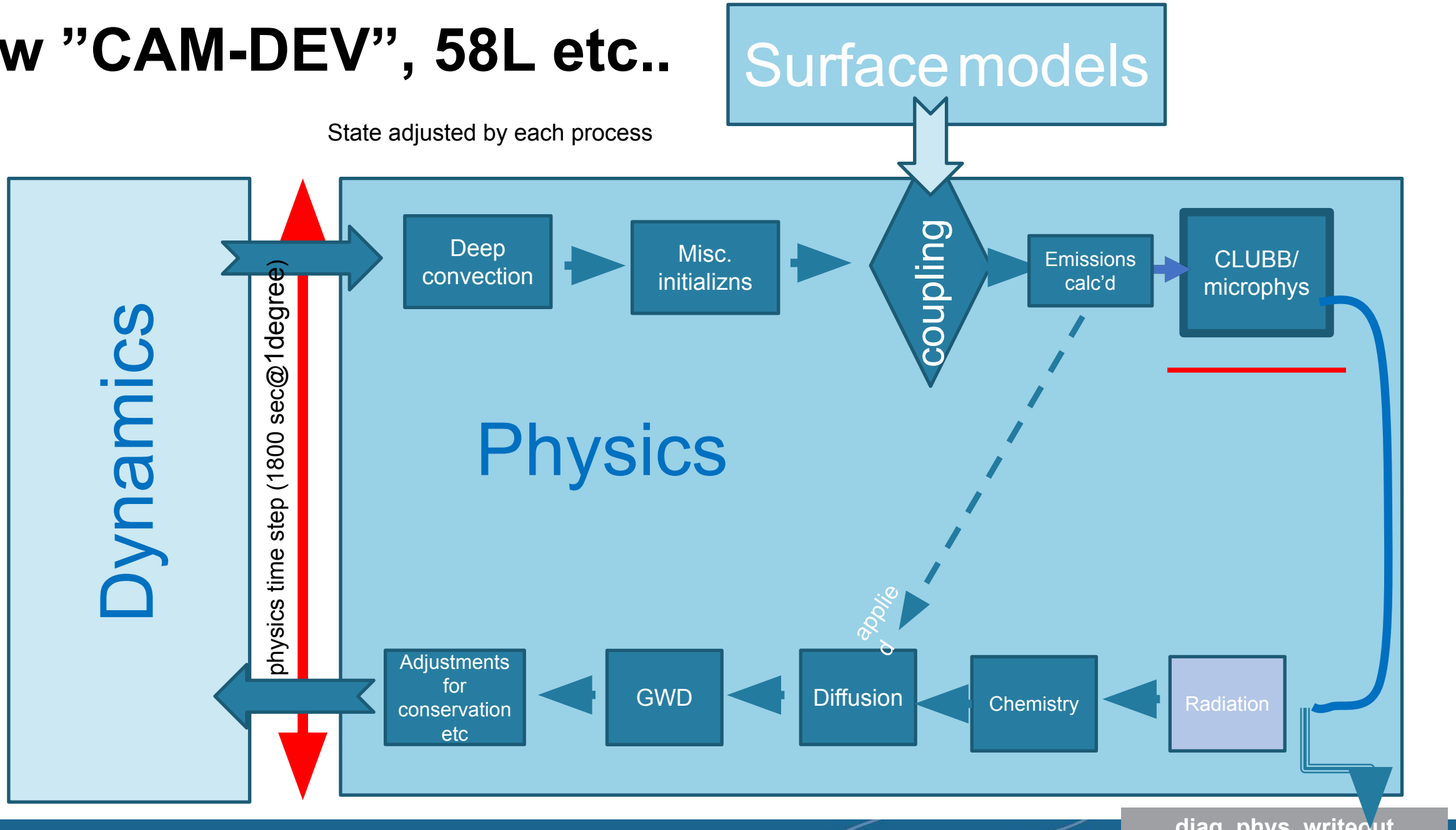
- Main difference: CLUBB moved after coupler
- Alleviates spurious high-frequency oscillations in surface layer (already present in L32 but more pronounced with increased PBL resolution)

Old CAM6, 32L



Adapted from Figure 7 of Wan et al. 2021 (GMD)

New ”CAM-DEV”, 58L etc..

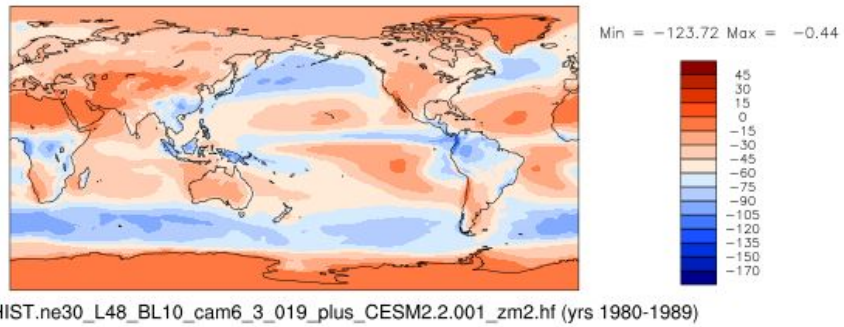


Adapted from Figure 7 of Wan et al. 2021 (GMD)

Impacts of re-ordering

f.e21 **Annual mean Shortwave Cloud Forcing**

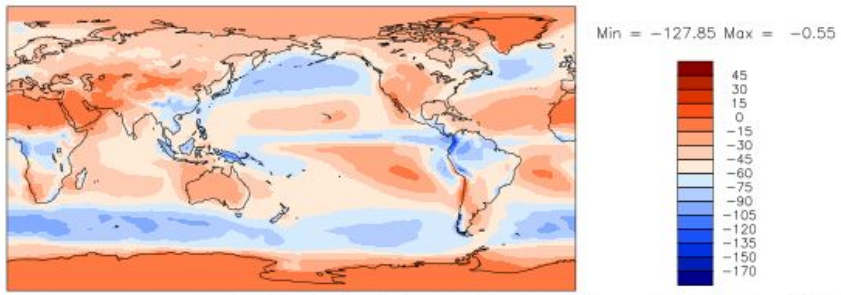
re-ordered physics



f.e21.FWscHIST.ne30_L48_BL10_cam6_3_019_plus_CESM2.2.001_zm2.hf (yrs 1980-1989)

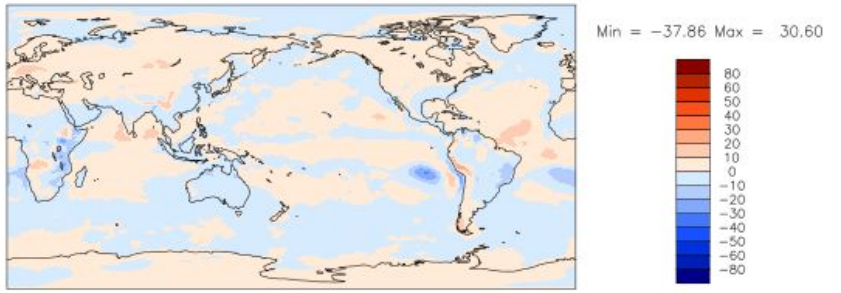
TOM SW cloud forcing mean= −46.96 W/m²

CAM6 physics order



_48_BL10_cam6_3_035.tphysac_zm2_reorder.001.hf2 - f.e21.FWscHIST.ne30_L48_BL10_cam6_3_019_plus_CESM2.2.001

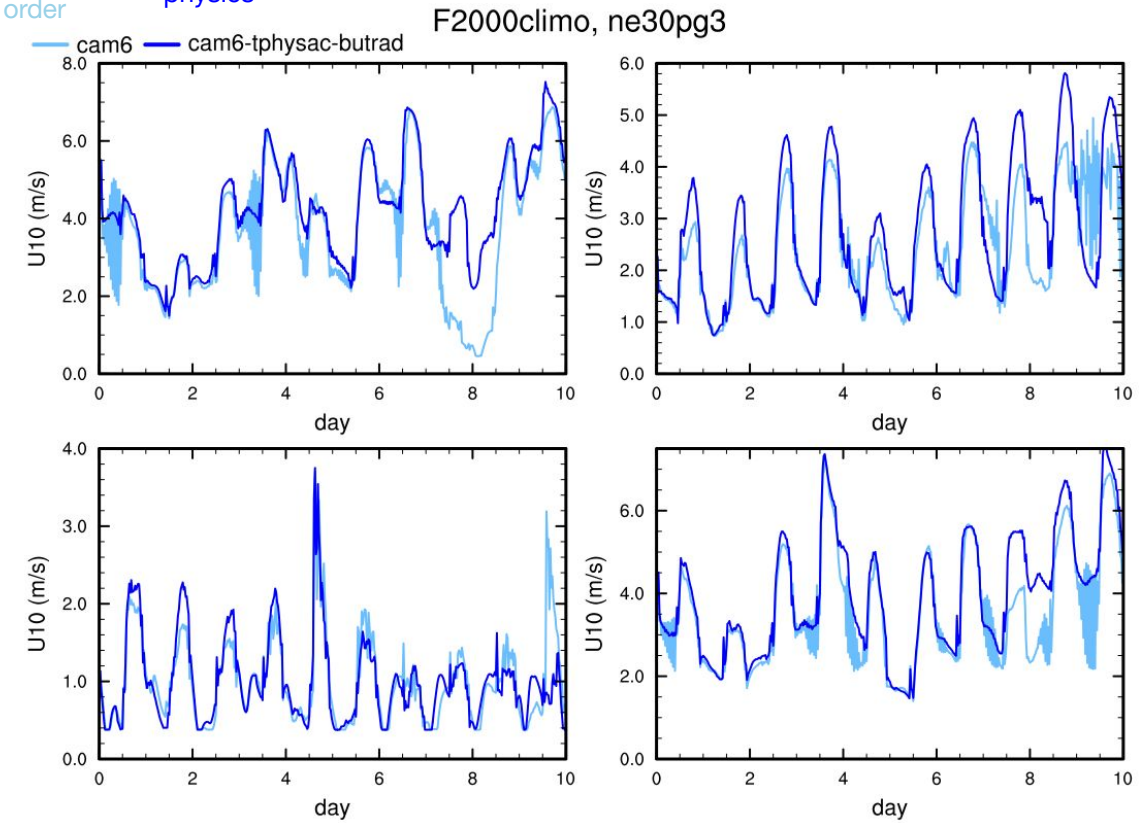
mean = 0.29 rmse = 4.39 W/m²



10-day timeseries (half-hourly) of 10 meter wind from 4 points in Amazon basin

CAM6 physics order

re-ordered physics

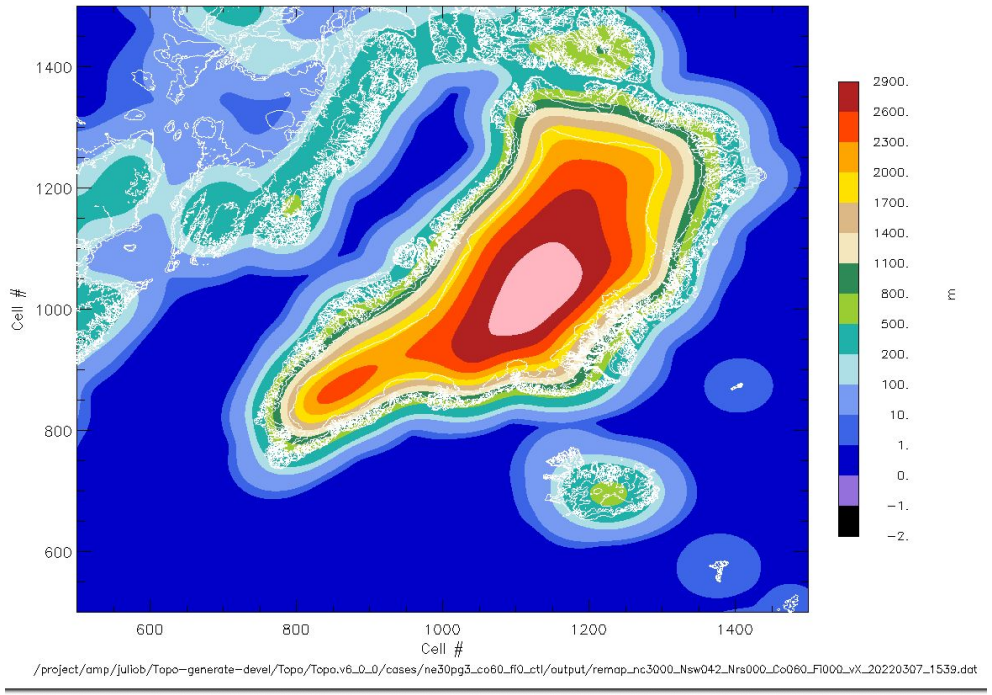


NCAR UCAR

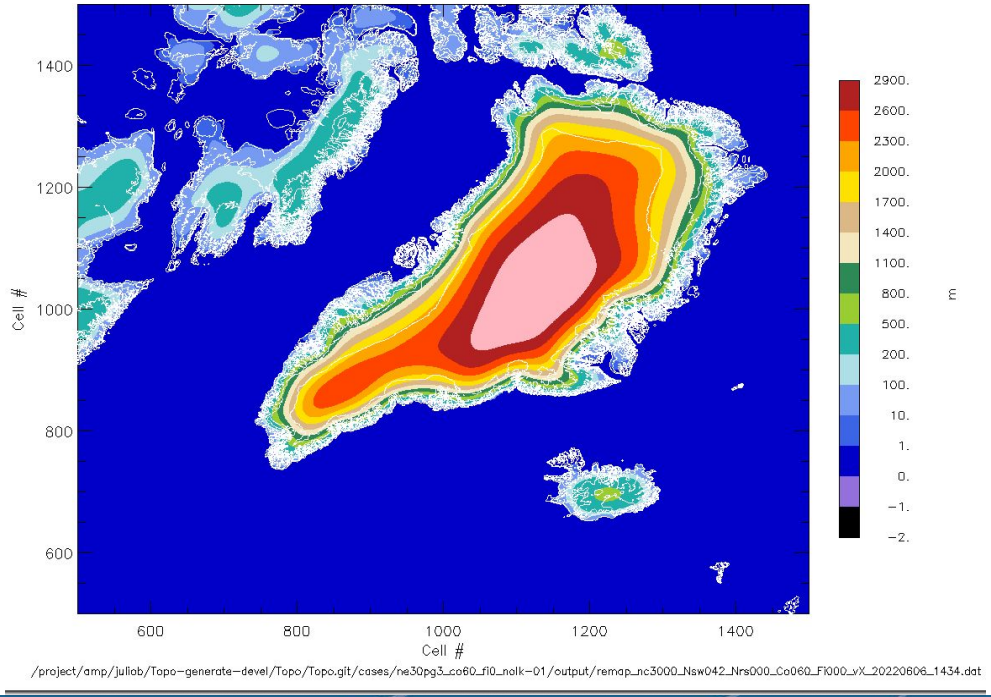
Updated topography software

- Bedmachine topography replaces GMTED in Greenland and Antarctica
- Streamlined workflow using command line options. Variable resolution capabilities added
- New iterative Laplacian smoother with “no-leak” option that preserves 0m height over ocean and global topography volume.
- Updated ridge-data
- Github repository: https://github.com/NCAR/Topo (see poster by Peter Lauritzen tomorrow)

Old smoothing. R~180km (for ~1 degree model)



“no-leak” smoothing/rescaling equivalent to R~180km



Coupled Evaluation has begun

- **Now-July:** B1850 (pre-industrial CTL) using L58+CAM_DEV (*reordered CAM6 physics+ZM2*)+MOM6+CICE6

- **Fall 2022:** Add L93 vertical grid. Incorporate contributions from CPTs. Incorporate PUMAS microphysics. *Additional configurations: 4xCO2? LGM?*

Survey on reducing software engineering workload:

- ~40 responses received. Thank you!
- Discussion during AMWG session tomorrow

Thanks