

# State of WACCM

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*Liaison: Mike Mills (NCAR)*

NCAR  
UCAR

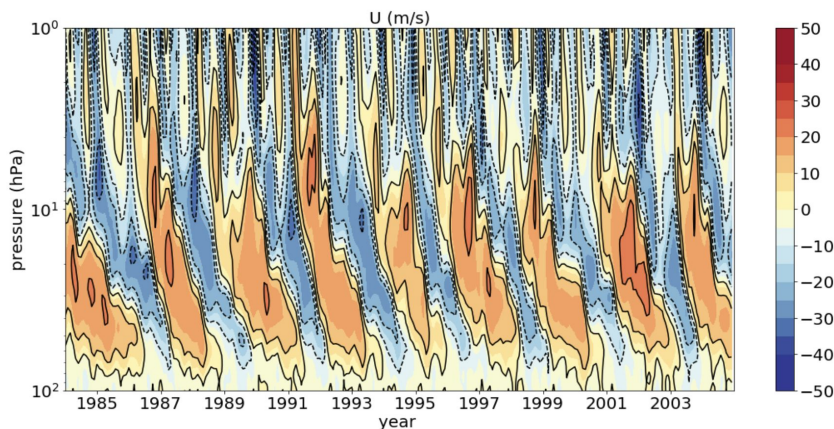
February 8, 2021

# Overview

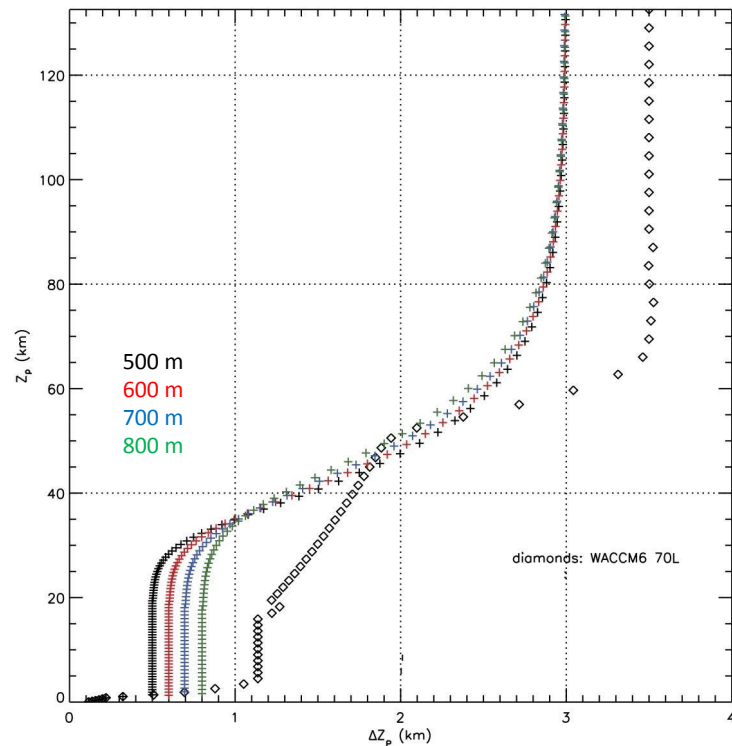
- Aligning WACCM with the new NCAR workhorse model
- Development of new best practices for WACCM
- WACCM chemical and subseasonal forecasts
- WACCM Last Millennium simulations
- WACCM-X developments
- Future directions and development

# Aligning WACCM with the new NCAR workhorse model

- Reformulate model configurations for consistency - more from Isla in this session
- Self-generating QBO in: ( $\sim 110L$ )/1 deg. spectral element,  $110L/2$  deg. finite volume dycores
- Scale-aware params - see morning session on Wednesday
- Issue: dry tape recorder bias at higher resolution

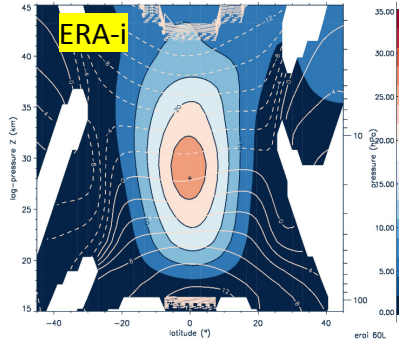


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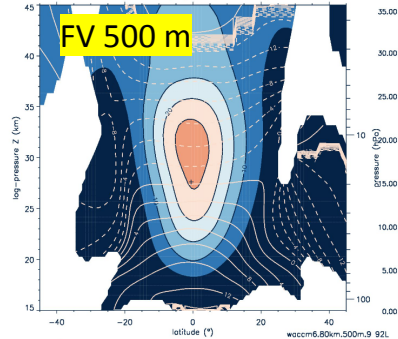


# Aligning WACCM with the new NCAR workhorse model

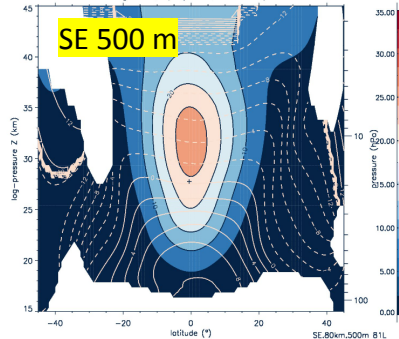
U ( $\text{m s}^{-1}$ ) Amp/Phi: (0.014–0.055) cpm; (18.1–72.2) mo; 1980–2010  
sig: 95%, bp: (0.0°, 18.8 hPa)



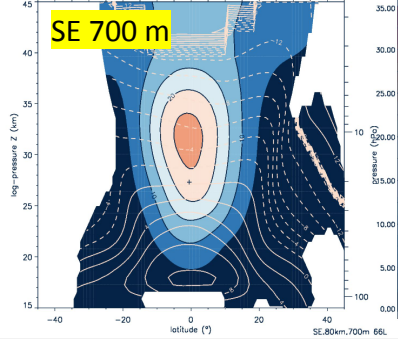
U ( $\text{m s}^{-1}$ ) Amp/Phi: (0.013–0.054) cpm; (18.5–80.0) mo; 1980–2010  
sig: 95%, bp: (-0.5°, 20.0 hPa)



U ( $\text{m s}^{-1}$ ) Amp/Phi: (0.013–0.057) cpm; (17.6–76.3) mo; 1979–1998  
sig: 95%, bp: (-0.5°, 19.6 hPa)



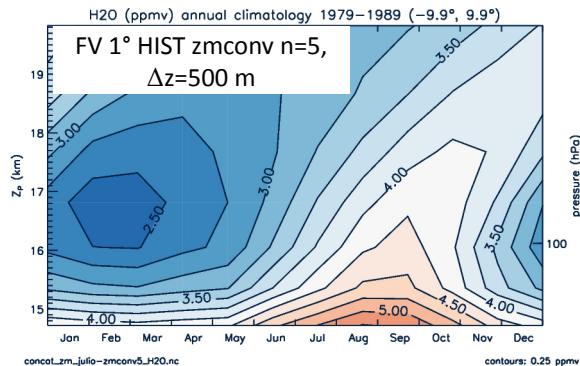
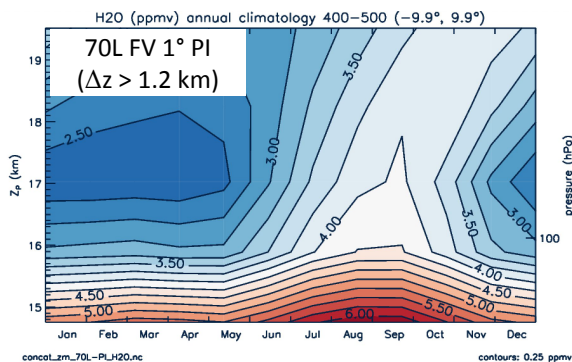
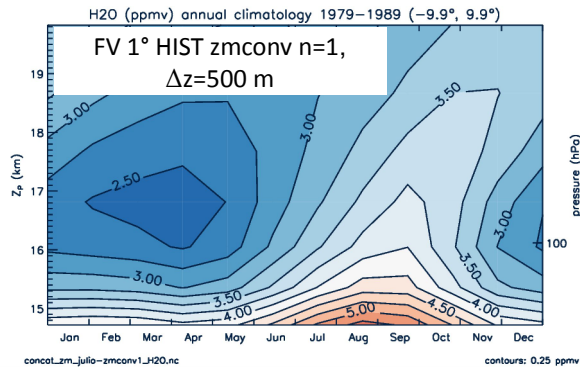
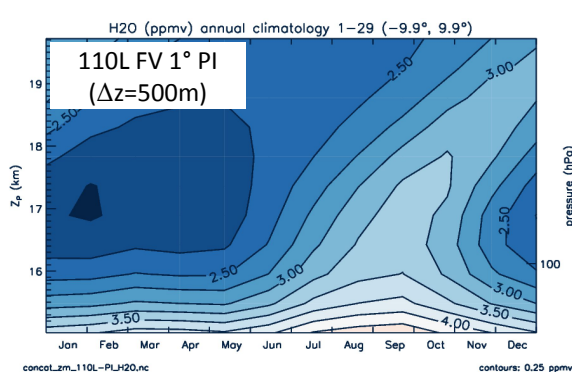
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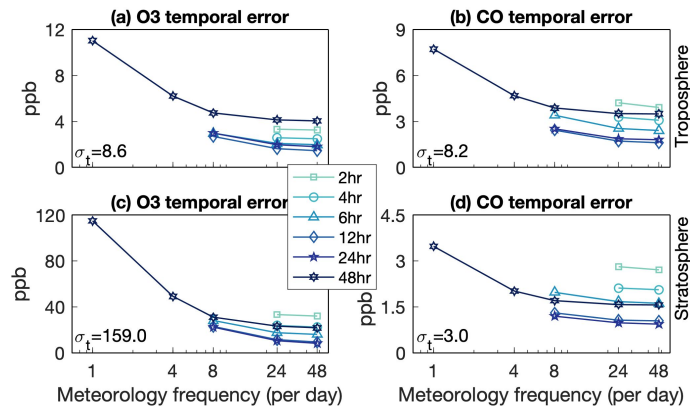
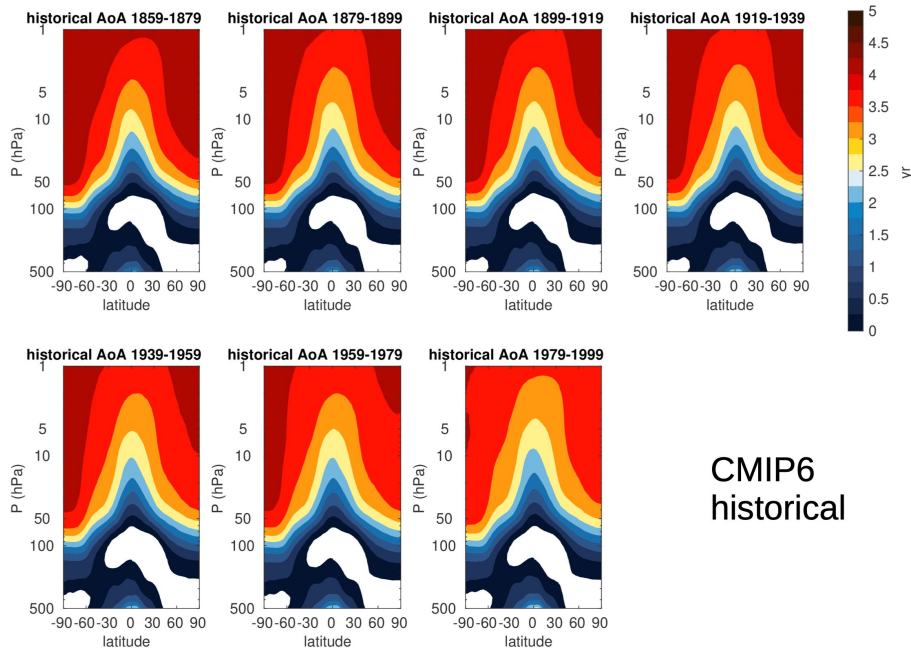
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# H<sub>2</sub>O tape recorder bias: a too-dry wet phase

- 110L runs are drier than 70L run (left panels)
- Increasing Zhang-McFarlane “attempts” moistens the wet phase (right panels)



# Best practices for WACCM6



- 12-24 hour nudging timescale at the highest meteorology frequency possible minimizes errors in clouds, tracers, and dynamics
- Age of air: negative in troposphere; sensitive to initialization, choice of reference level; potentially related to flux boundary condition; CMIP6 output impacted

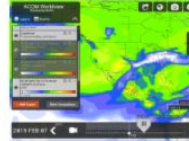


# ACOM WACCM Chemical Forecasts

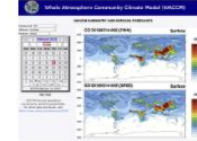
- *Daily* WACCM chemical forecasts (nudged to GEOS-5 meteorological forecasts)
- O<sub>3</sub>, NO<sub>x</sub>, region-specific CO, PM<sub>2.5</sub>
- Includes near-real-time fire and anthropogenic emissions
- Many viewing/downloading options
- 365-day archiving, with long-term archive under construction at NCAR RDA (ds313.6)
- Point of contact: Shawn Honomichl  
shawnh@ucar.edu

[WACCM Global Model](#)

WACCM IN WORLDVIEW



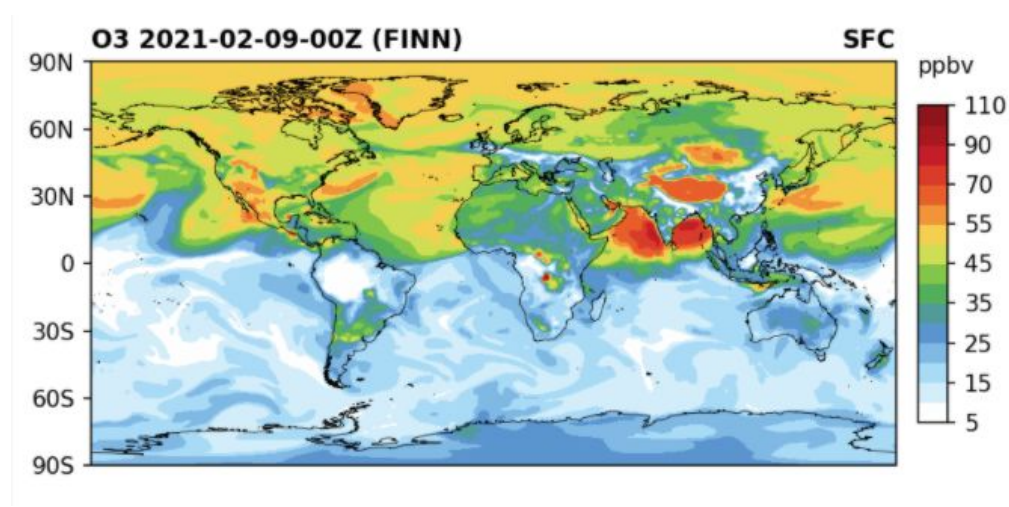
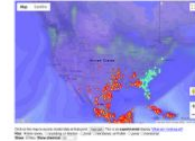
WACCM FORECAST MAPS



CUSTOM FORECAST PLOTS

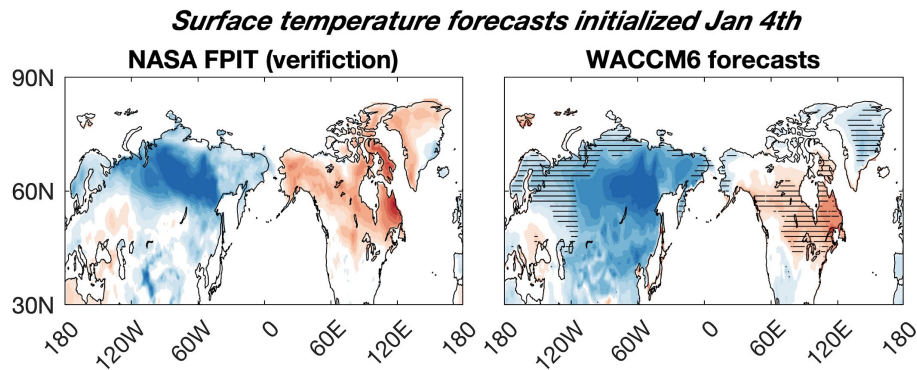
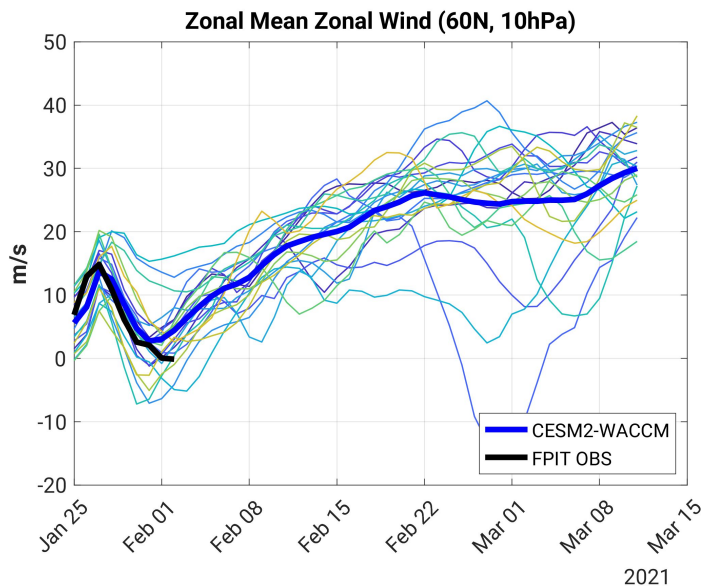


WACCM CHEMICAL MAP



<https://www2.acom.ucar.edu/acresp/forecasts-and-near-real-time-nrt-products>

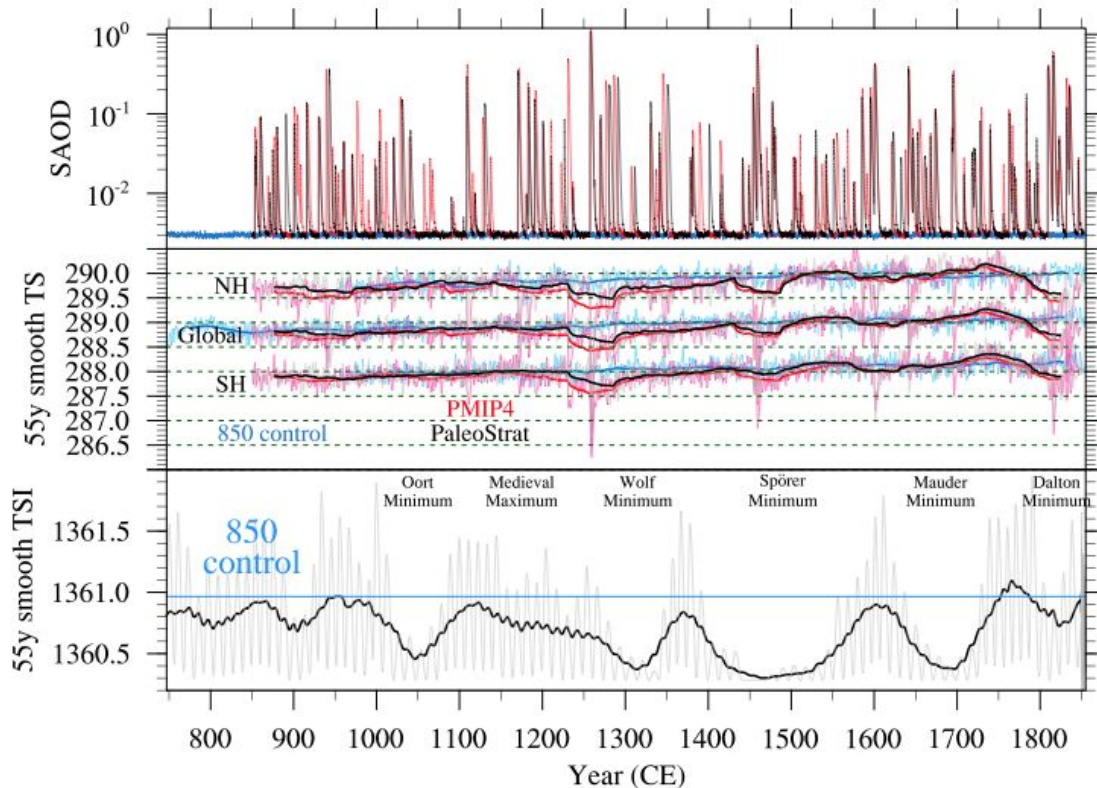
# CESM2-WACCM6 Subseasonal-to-Seasonal hindcasts/forecasts



- S2S hindcasts initialized weekly during Oct.-Mar. for 1999-2020
- Running in real-time since September 2020 with forecasts initialized every Monday
- Data are currently contributing to NOAA/CPC week 3-4 outlook, SubX
- More details in presentation during Wednesday AM session



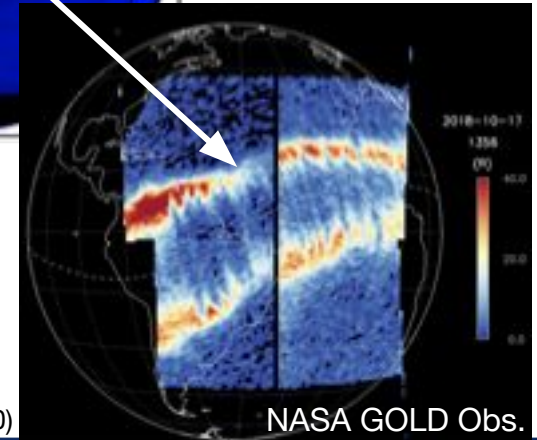
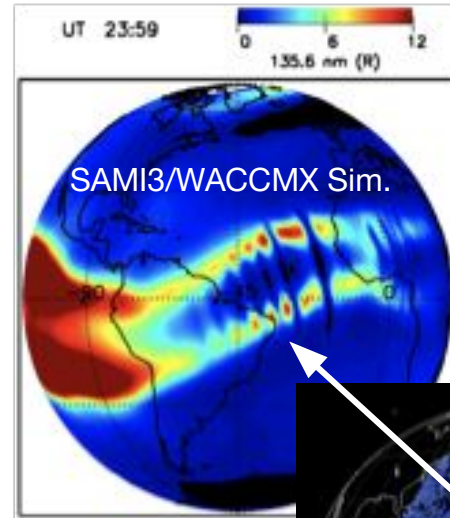
# Last Millennium Simulations



- Coupled climate simulations of years 850-1850CE
- WACCM6 with middle atmosphere chemistry at  $1.9^\circ$  lat x  $2.5^\circ$  lon
- **850 control**: constant solar, no eruptions
- **PMIP4**: used eVolv2k eruption database
- **PaleoStrat**: used VolcanEESM eruption database
- Small (0.3K) warming in 850 control over 1000 years
- Volcanic coolings are pronounced for years to decades
- Contact: Bette Otto-Bliesner, Esther Brady, Rolando Garcia, Mike Mills

# WACCM-X Developments

- High resolution FV WACCMX simulations coupled to NRL ionosphere model used to simulate equatorial irregularities
- WACCMX v6.2 (CESM2.2) supports CAM6 physics and 1 degree horizontal resolution
- Implemented generic regridding between geographic and geomagnetic grids
- Simulations using species dependent SE dynamical core and new regridding scheme (currently being evaluated)



(Huba and Liu, 2020)

# Future Directions and Development

- Fully implement the SE dynamical core in both WACCM and WACCM-X
- Begin experiments with regionally-refined domains
- Embrace GPU programming to make effective use of NWS-C3
- Strike a balance in whole atmosphere model development between increasing complexity and increasing *usefulness*



. . . In that Empire, the Art of Cartography reached such Perfection that the map of one Province alone took up the whole of a City, and the map of the empire, the whole of a Province. In time, those Unconscionable Maps did not satisfy and the Colleges of Cartographers set up a Map of the Empire which had the size of the Empire itself and coincided with it point by point. Less Addicted to the Study of Cartography, Succeeding Generations understood that this Widespread Map was Useless and not without Impiety they abandoned it to the Inclemencies of the Sun and of the Winters. In the deserts of the West some mangled Ruins of the Map lasted on, inhabited by Animals and Beggars; in the whole Country there are no other relics of the Disciplines of Geography.

Suarez Miranda: *Viajes de Varones Prudentes*,  
Book Four, Chapter XLV, Lérida, 1658.