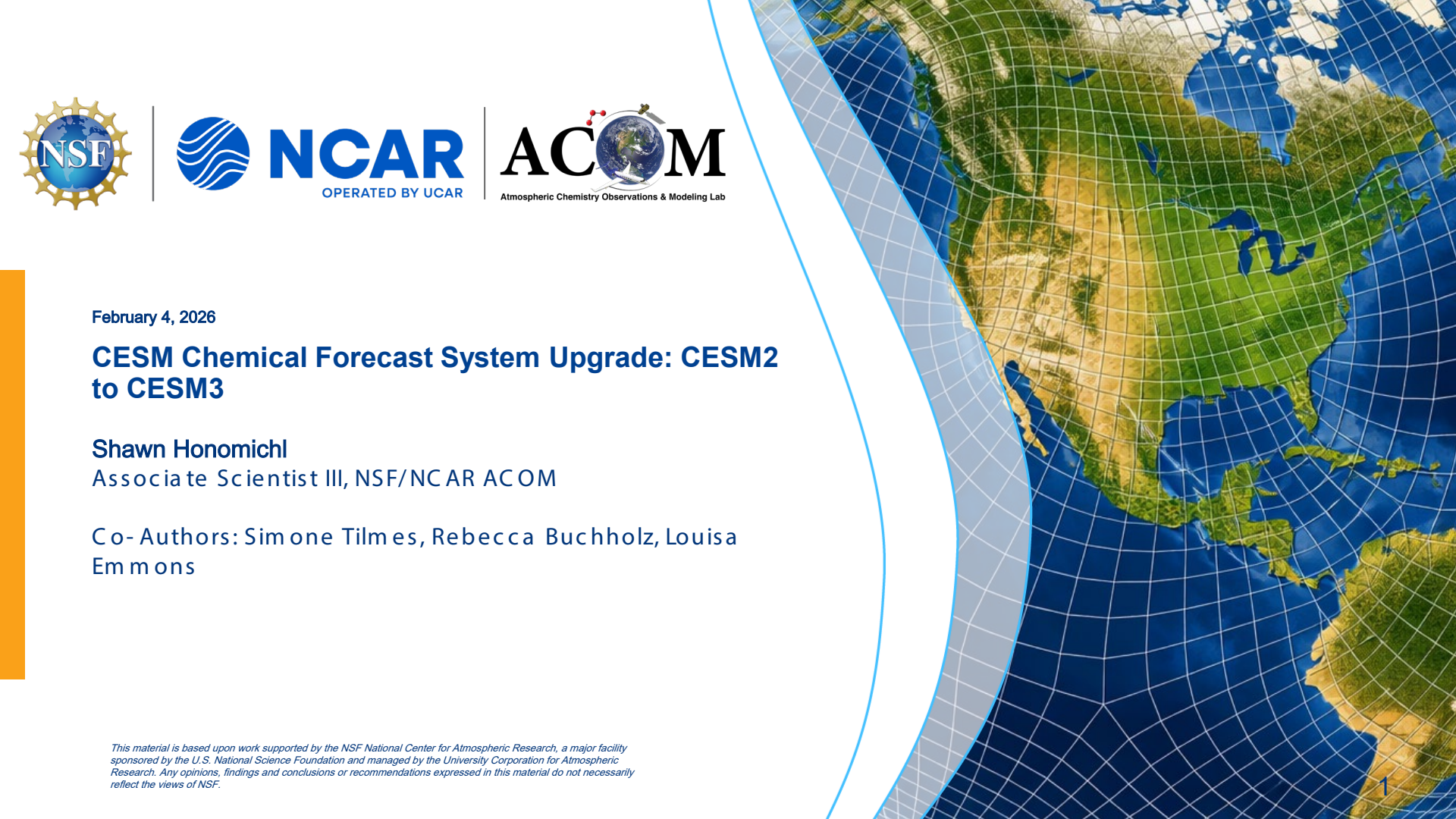

February 4, 2026

CESM Chemical Forecast System Upgrade: CESM2 to CESM3

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This material is based upon work supported by the NSF National Center for Atmospheric Research, a major facility sponsored by the U.S. National Science Foundation and managed by the University Corporation for Atmospheric Research. Any opinions, findings and conclusions or recommendations expressed in this material do not necessarily reflect the views of NSF.

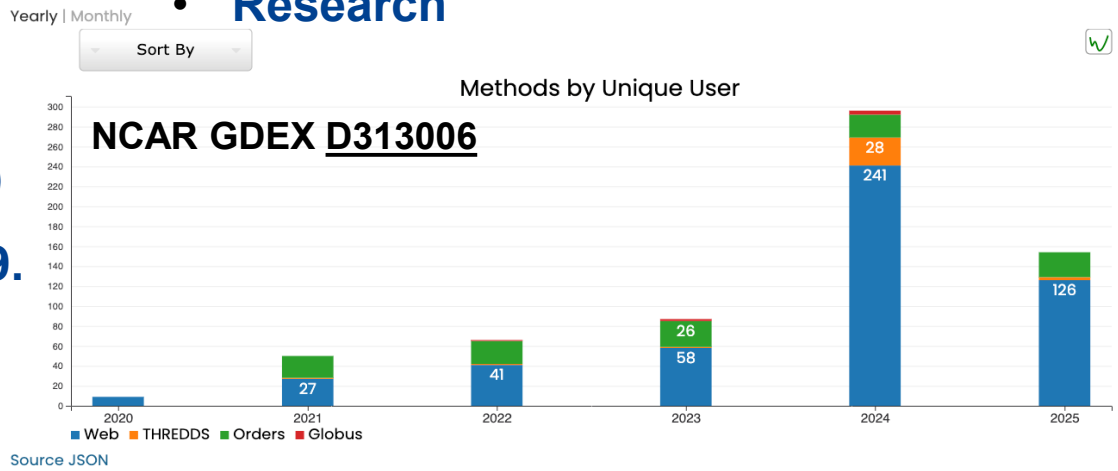
CESM Chemical Forecasts – Configuration

Original Fcst. Configuration

- CESM2.2 FV CAM6
- WACCM6 SD – TSMLT1
- 10 Day Forecasts
- 0.9x1.25x88L
- Nudged to GEOS-FP
- Run Once Per Day (T00Z)
- Running Daily Since 2019.
- CAMS V5 & FINNV1

Main Purpose/Use

- WRF-Chem Boundary Conditions
- External Users (i.e. Resource Watch)
- Field Campaign Flight Planning
- Research



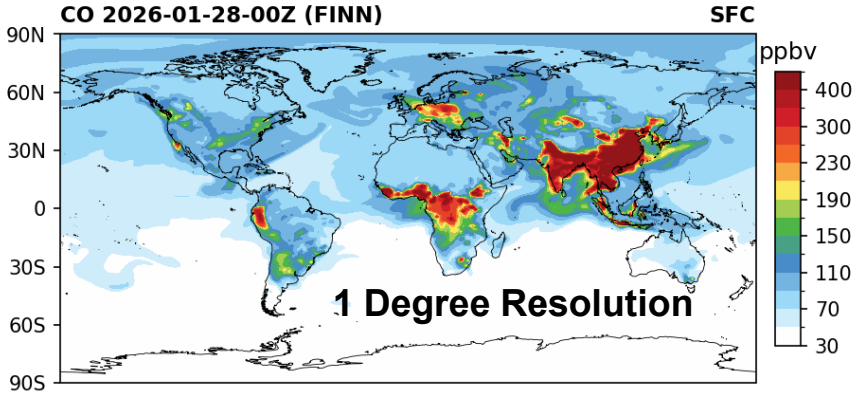
CESM Chemical Forecasts – Why the Switch?

Pros – Easy & Reliable

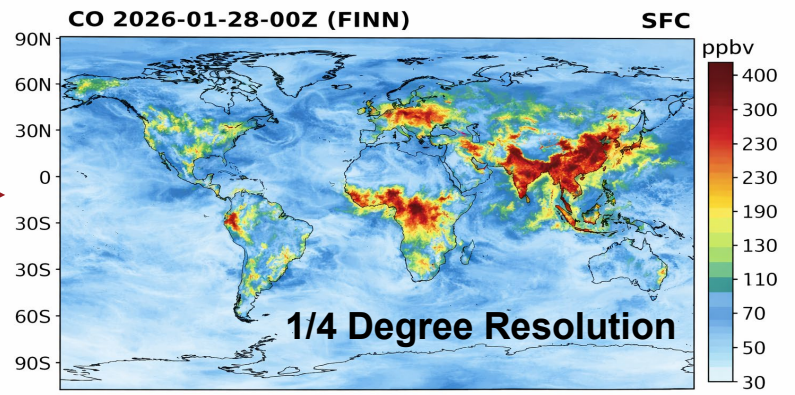
- Fast – 4 minutes per day
- Stable Build – Crashes Very Rare
- Output Easy to Work With

Cons - Outdated

- Resolution (Horiz. / Vert.)
- Chemistry
- CESM2



This is what we have now



This is what we want

CESM Chemical Forecasts –Next Gen Forecast

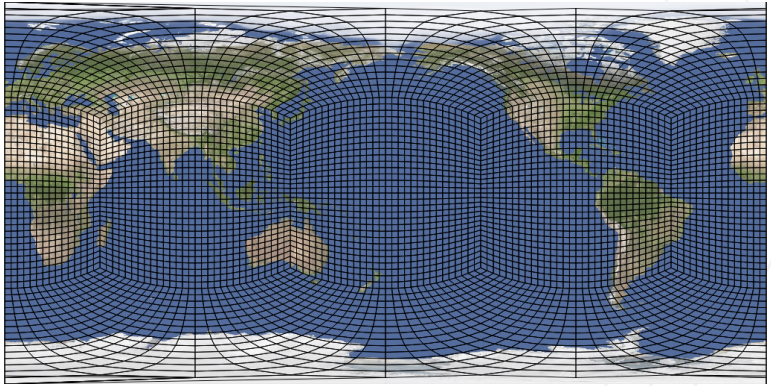
Two Configurations (rolled out in two phases)

Base Configuration

- CESM3 Spectral Element CAM7
- ne30 93L (i.e. 1 deg. horizontal res.)
- CAM-CHEM T1S
- CMIP7 Forcings
- FINN V2.5 – Biomass Burning
- 10 Day GEOS-FP Nudged Forecasts

High Res. Configuration

- Same as Base Configuration, but…
- ne120 93L (1/4 deg horizontal res.)
- Either 3 or 5 Day Forecasts.



CESM Chemical Forecasts – Old vs. New

Statistical Comparison

Old Forecast (CESM2 FV 0.9x1.25x88L WACCM)

- Model Cost: 26K pe-hrs/simulated year
- 1.04 Simulated Years Per Day
- 40 minutes to run a 10 day forecast
- Chemical Mech: TSMLT1

New Forecast (CESM3 SE ne30 93L)

- Model Cost: 22K pe-hrs/simulated year
- 1.1 Simulated Years Per Day
- <40 minutes for a 10 day forecast.
- Chemical Mech: T4S
- Final Forecast will be T1S – about 30% more expensive.

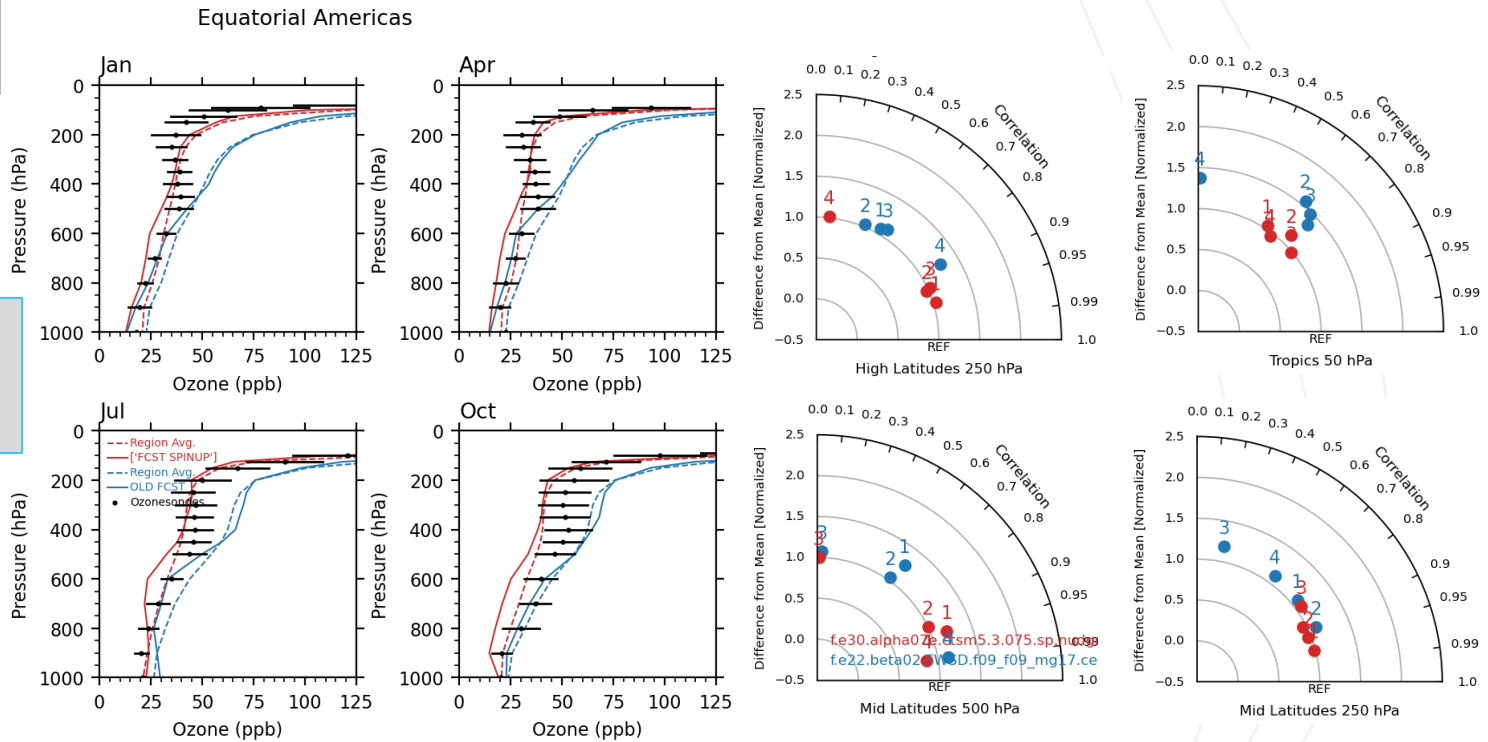
ne120 will cost more and take longer. Forecast length dictated by time and cost.

CESM Chemical Forecasts – Old vs. New

ADF (2020-2024)-Ozone

Red: New Forecast
Blue: Old Forecast

Old Forecast Ozone:
- **Too High**
- **Low Correlations**

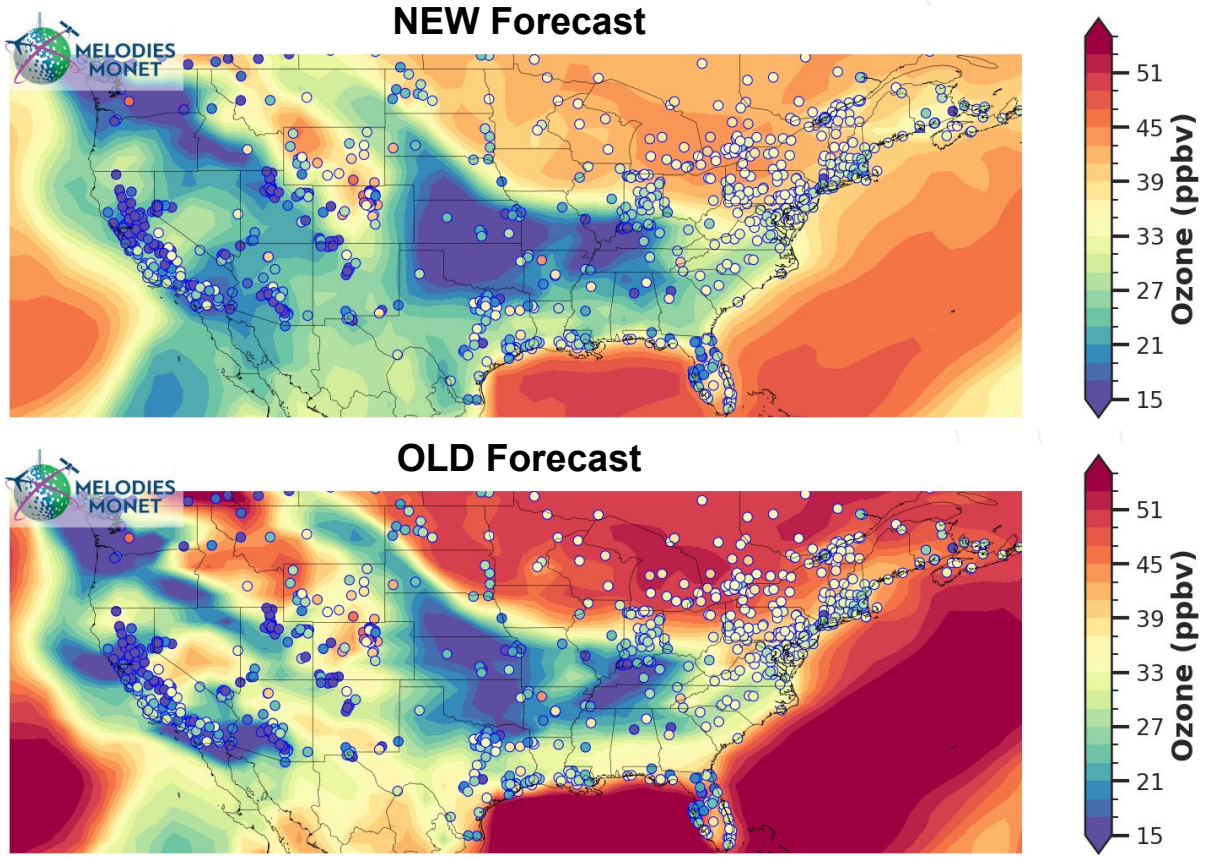


CESM Chemical Forecasts – AIRNOW

Observations Source: AirNOW

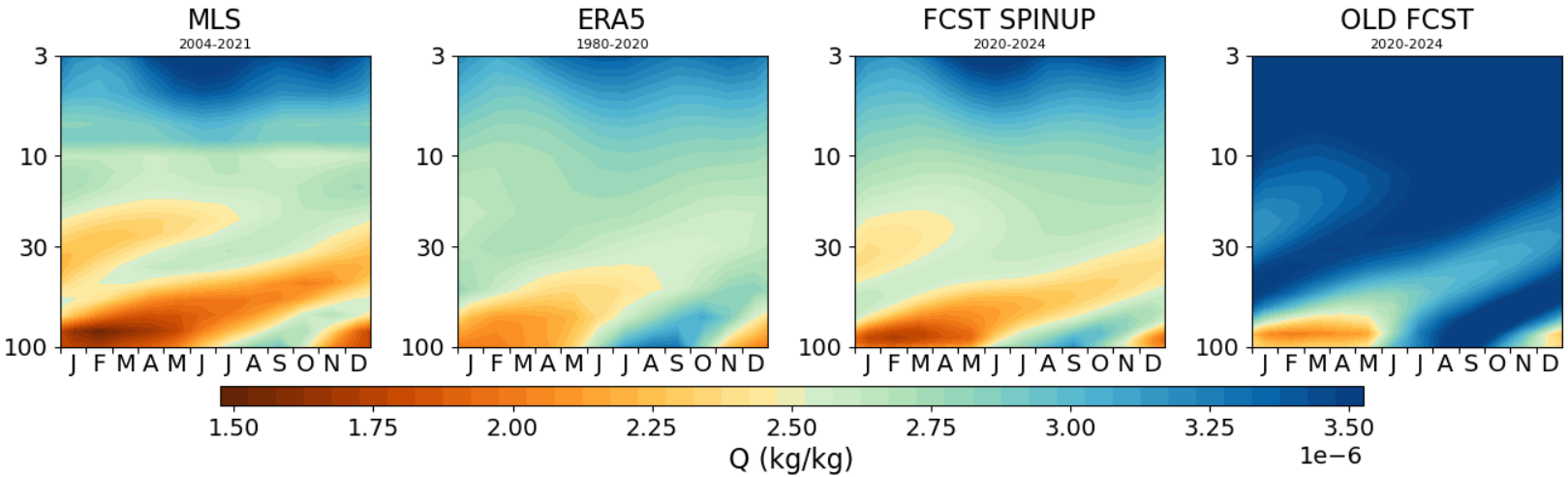
Single day: 2026-01-01

New Forecast: Surface Ozone in better agreement with observations



CESM Chemical Forecasts – Old vs. New

ADF Tape Recorder



Tape Recorder: Old Forecast too wet.

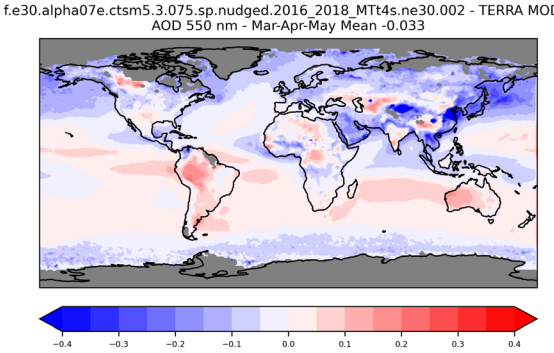
CESM Chemical Forecasts – Old vs. New

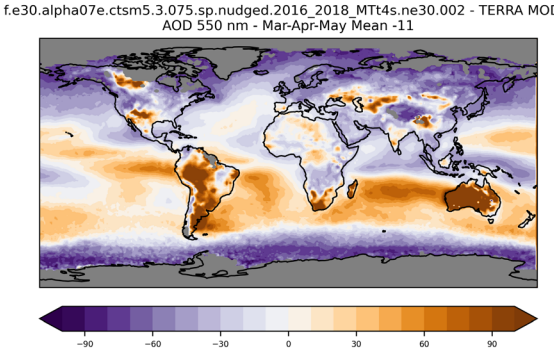
AOD Climatology Compared to MODIS

- Model – MODIS
- 550 nm AOD
- Mar-Apr-May Climatology

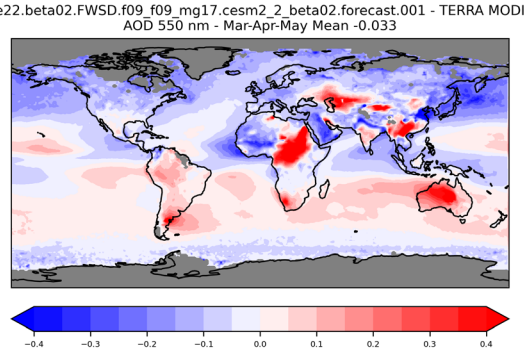
New Forecast: AOD Closer to Observations!

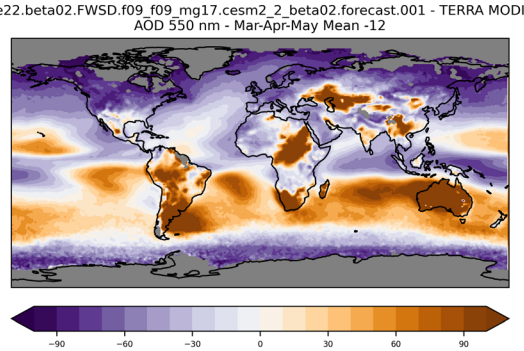
New Forecast





Old Forecast





CESM Chemical Forecasts – Additional Enhancements

Additional CESM3 Enhancements:

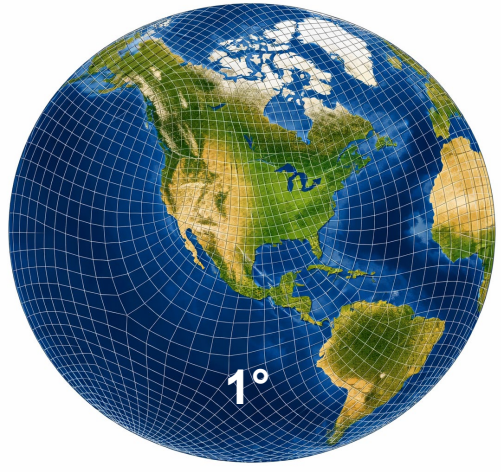
- Improved Dust Scheme (Leung 2023)
- Moving Mountain Gravity Wave Scheme
- MAM5
- All of the other unmentioned tuning / fixes associated with CESM3
- TUV?

Additional Forecast Enhancements:

- Code Updates
- Prescribed SSTs?
- ADF/CUPiD
- MELODIES (Model EvaLuation using Observations Diagnostics and Experiments Software)-MONET

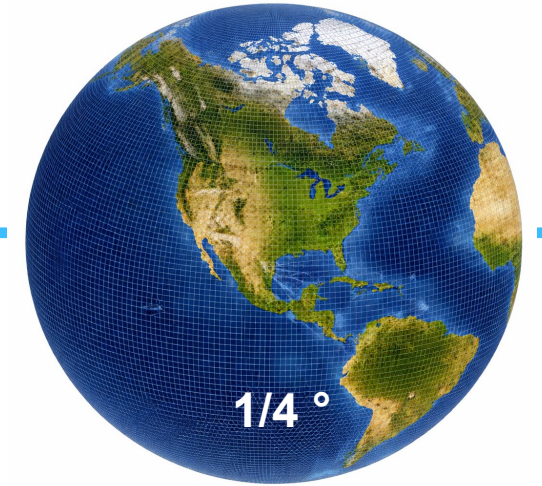
CESM Chemical Forecasts – Timeline

(Images generated by Chatgpt)



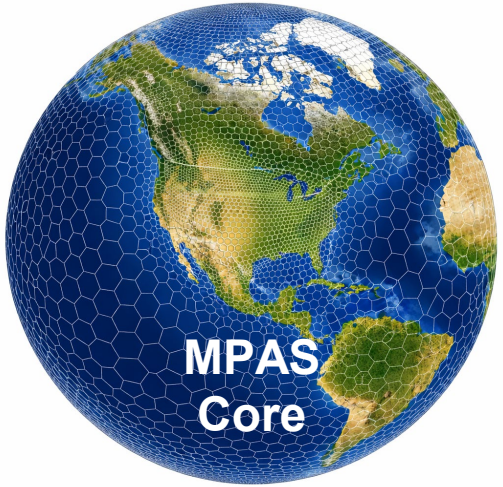
ne30

Soon After CESM3 Official Release – June 2026?



~6-12 Months After ne30

ne120



MUSICA V1

2-3 Years from Now?

CESM Chemical Forecasts – Resources

- **NCAR RDA/GDEX: https://gdex.ucar.edu/datasets/d313006/#**
- **NCAR ACOM Forecasts Page: https://www2.acom.ucar.edu/acresp/forecasts-and-near-real-time-nrt-products**
- **Rolling 1 Year Analysis Archive: https://www.acom.ucar.edu/waccm/DATA/**
- **Rolling 30 Day Forecast Archive: Available Upon Request (Glade).**
- **Coming Soon:**
  - **Full Forecast Description Page with the ACOM Forecast Page**
  - **GitHub Page with Forecast Code**

Thank You!

Questions?