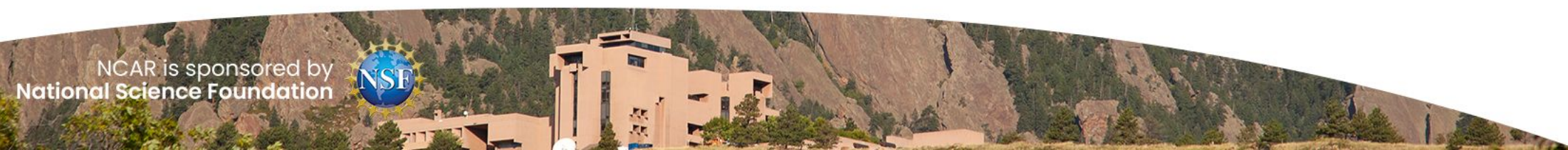# Subseasonal-to-seasonal (S2S) hindcasts with CESM2 & CESM2(WACCM)

Jadwiga (Yaga) H. Richter

Jim Edwards, Sasha Glanville,
Lantao Sun, Who Kim, Hyemi Kim, Julie Caron, Steve Yeager
Gokhan Danabasoglu, Nick Pedatella

January 27, 2021

S2S hindcasts

I. **CESM2:** designed specifically for community use
& framework for research/experimentation

II. **CESM2-WACCM**: designed to test whether a 'whole atmosphere' model improved surface prediction skill; NOAA-sponsored; Real-time forecasts going to CPC/NOAA

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CESM2 & CESM2-WACCM

CESM2

- 1° horizontal resolution
- Top at ~40 km; 32 levels
- Only orographic GW parameterization
- No interactive chemistry
- Cost: 3,500 core-hrs/year
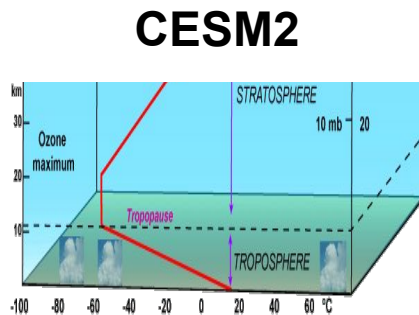
CESM2-WACCM

- 1° horizontal resolution
- Top at 140 km; 70 levels
- Interactive non-orographic parameterizations (Convection + Fronts)
- Fully interactive tropospheric and stratospheric chemistry
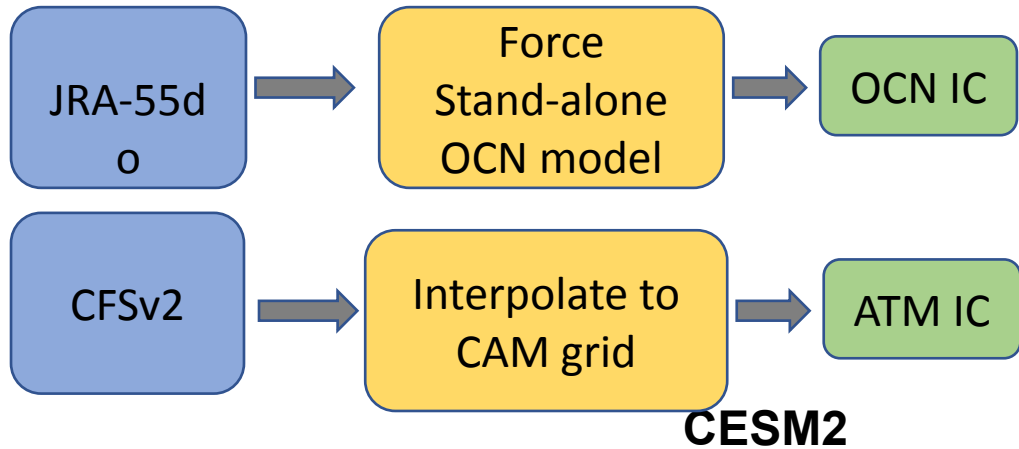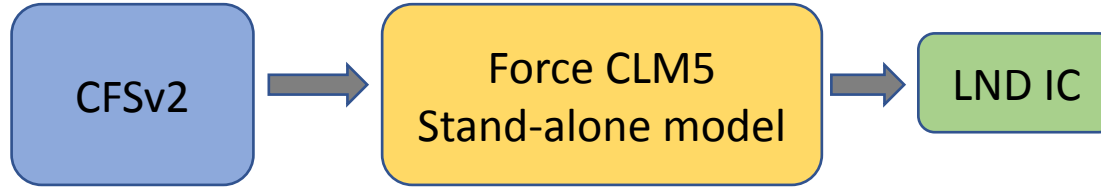- Cost: 25,000 core-hrs/year
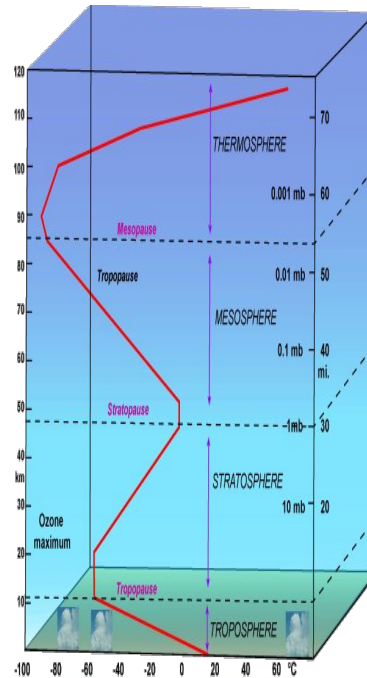
CESM2

Available Hindcasts/Forecasts
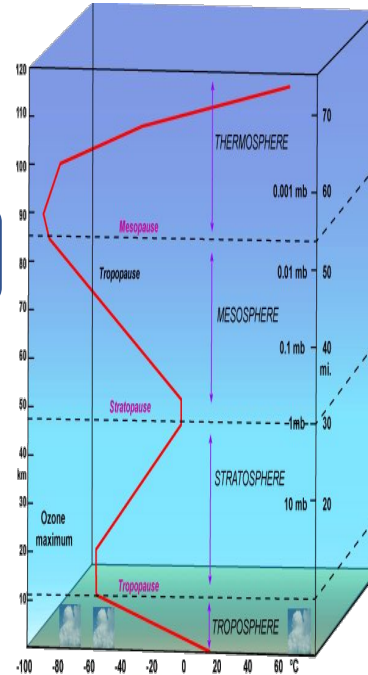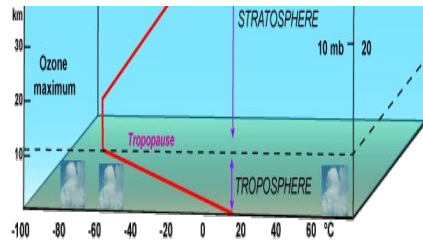
Follow SubX Protocol (Pegion et al. 2019, BAMS)

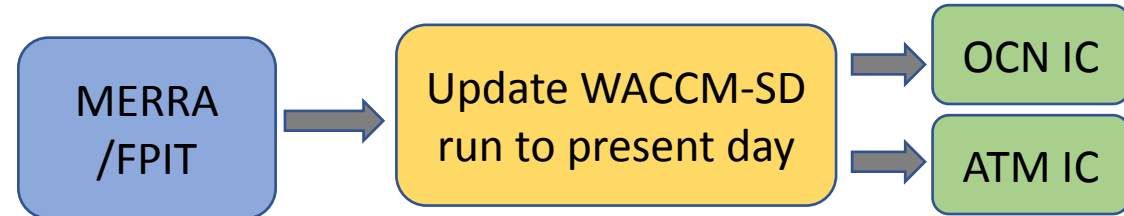|	CESM2	CESM2-WACCM
Reforecast Period	1999 – 2019; (2020 will be coming soon)	1999 – Mar 2020; Start dates between Oct – Mar only
# Ens Mems Reforecasts	11	5
Near-real time:	Coming soon	Started Sep 2020
# Ens Mems real-time	N/A	**21**
Initialization day	Monday	Monday

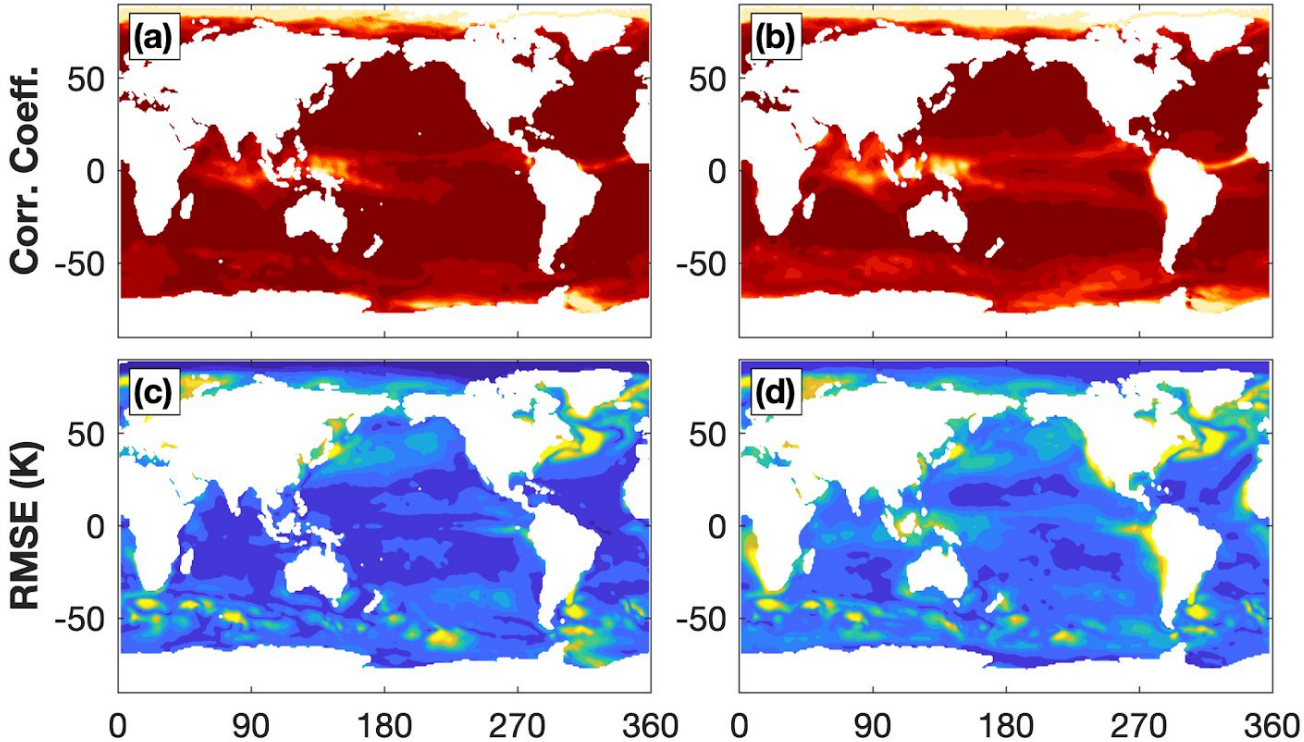# LAND Initialization: Same for CESM2 and CESM2-WACCM

CFSv2 → Force CLM5 Stand-alone model → LND IC

JRA-55do → Force Stand-alone OCN model → OCN IC

CFSv2 → Interpolate to CAM grid → ATM IC

CESM2

CESM2-WACCM

MERRA/FPIT → Update WACCM-SD run to present day → OCN IC / ATM IC

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Effects of Ocean Initialization

(CESM2)

(CESM2-WACCM)

JRA55do

WACCM-SD

Corr. Coeff.

(a)

(b)

Correlation relative to HadISSTs

RMSE (K)

(c)

(d)

Bigger issues with WACCM in Tropics

ENSO Index (K)

(e)

HadISST
JRA55do
WACCM-SD

Richter et al. 2021 (in prep)

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6

Ts Skill

2m Temperature ACC for global land (DJF)

2m Temperature ACC for North America land (DJF)
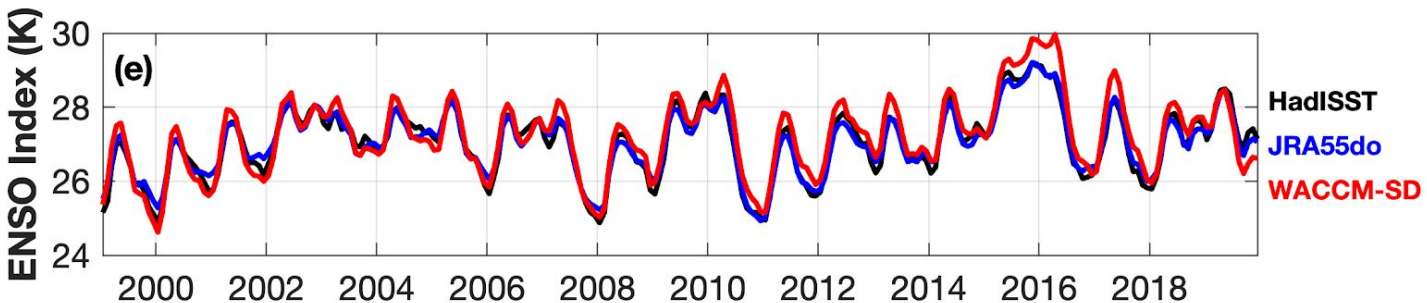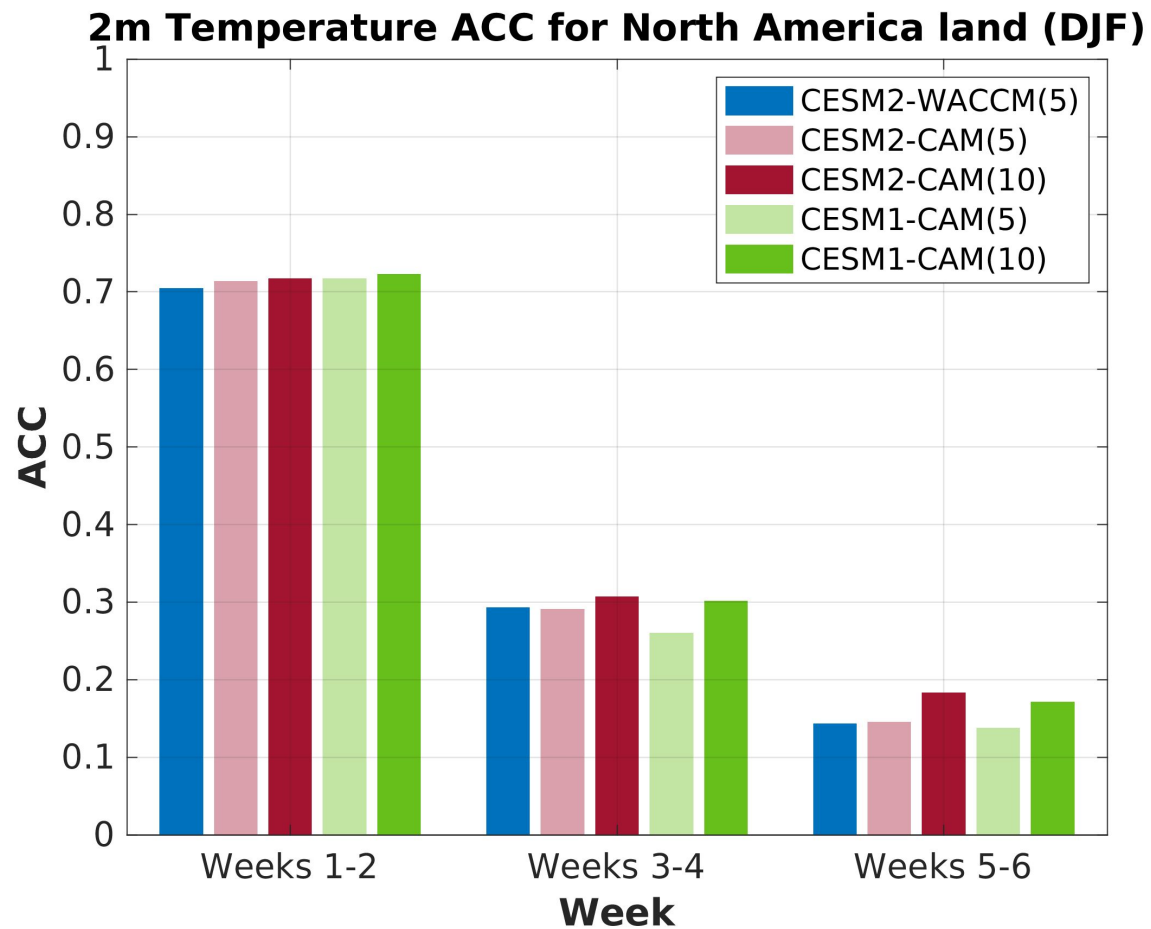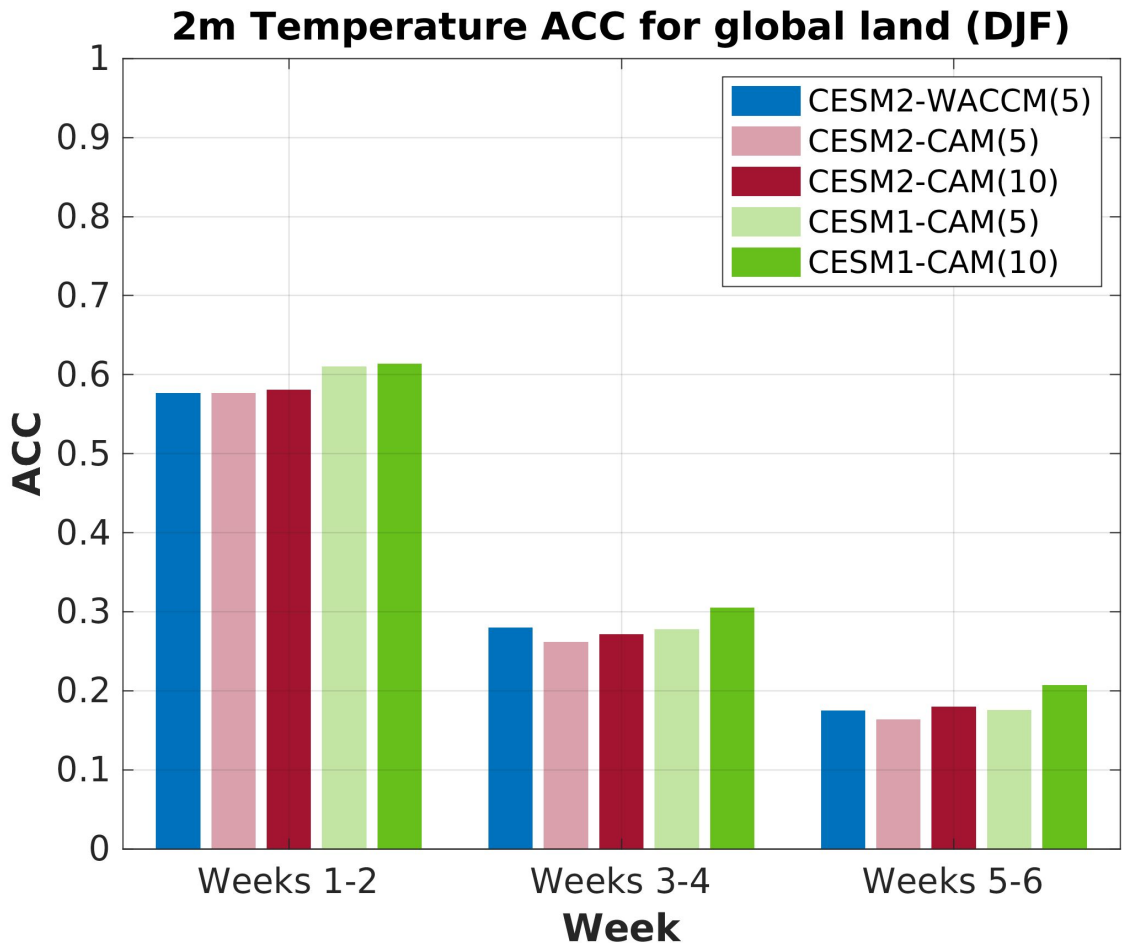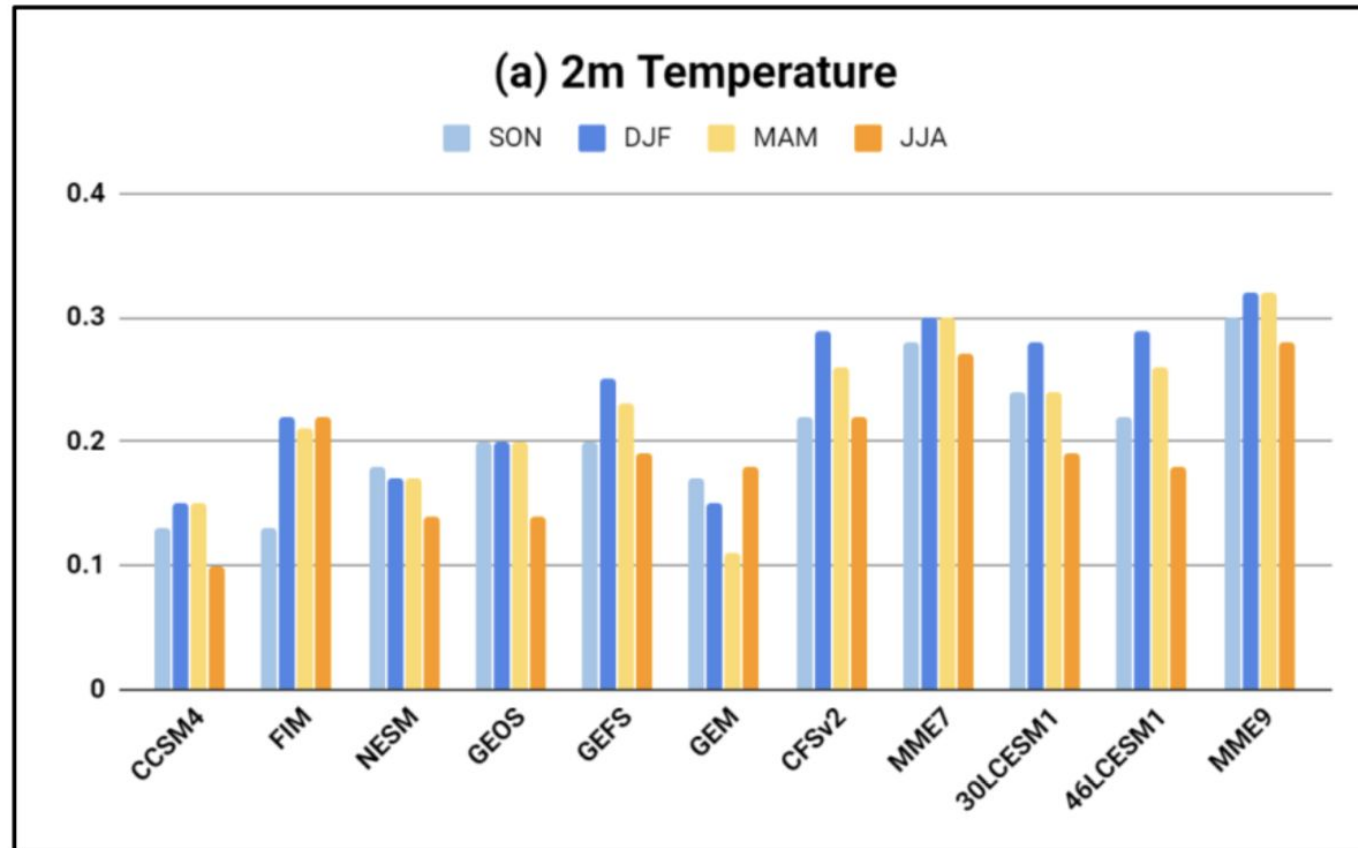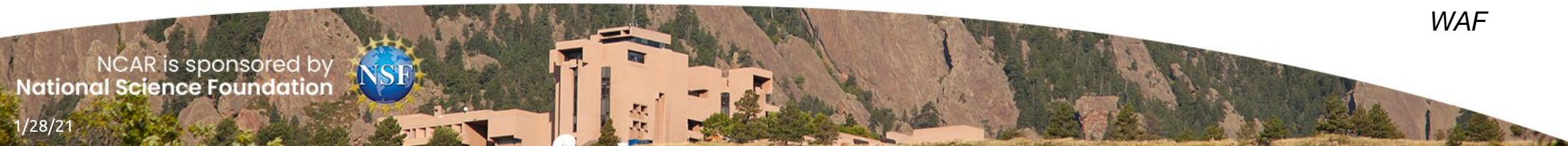
Richter et al. 2021 (in prep)

CESM1 Skill compared to SubX

(a) 2m Temperature

Richter et al. (2020), WAF

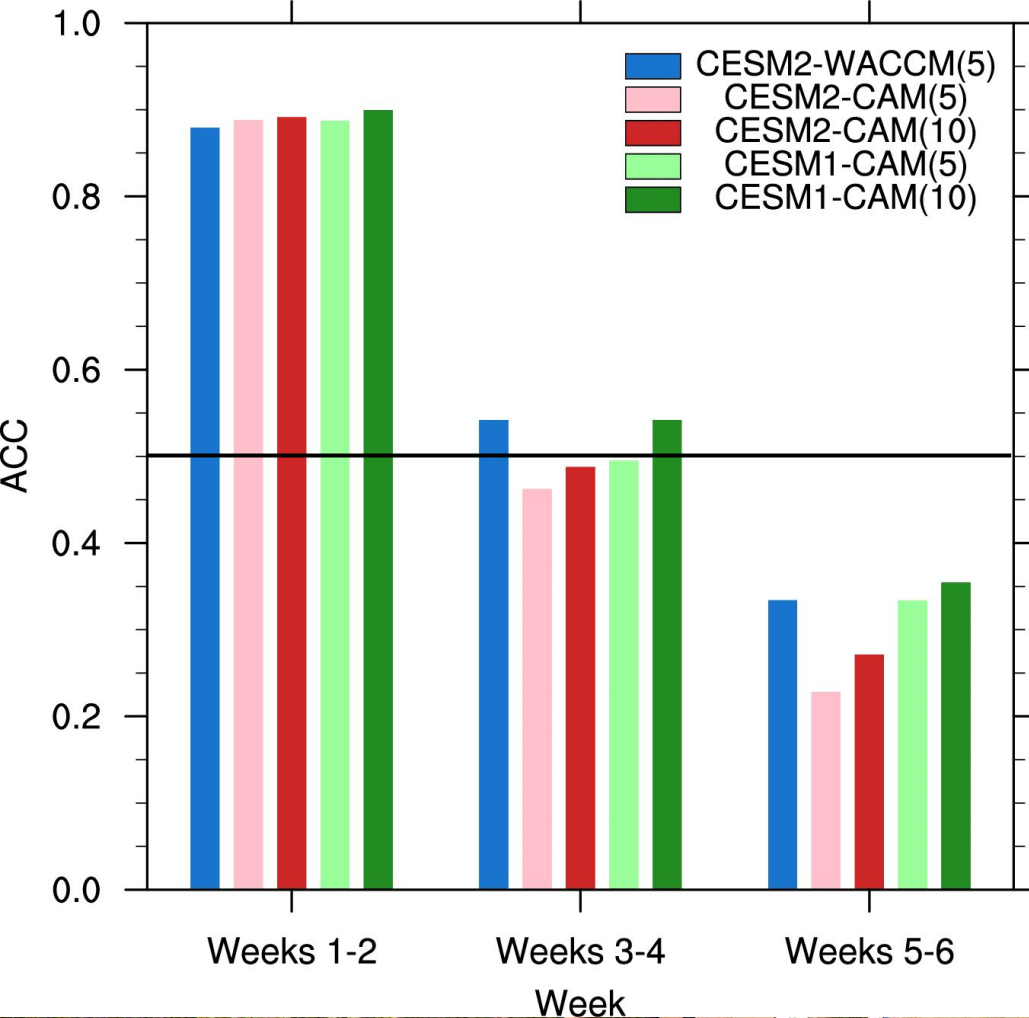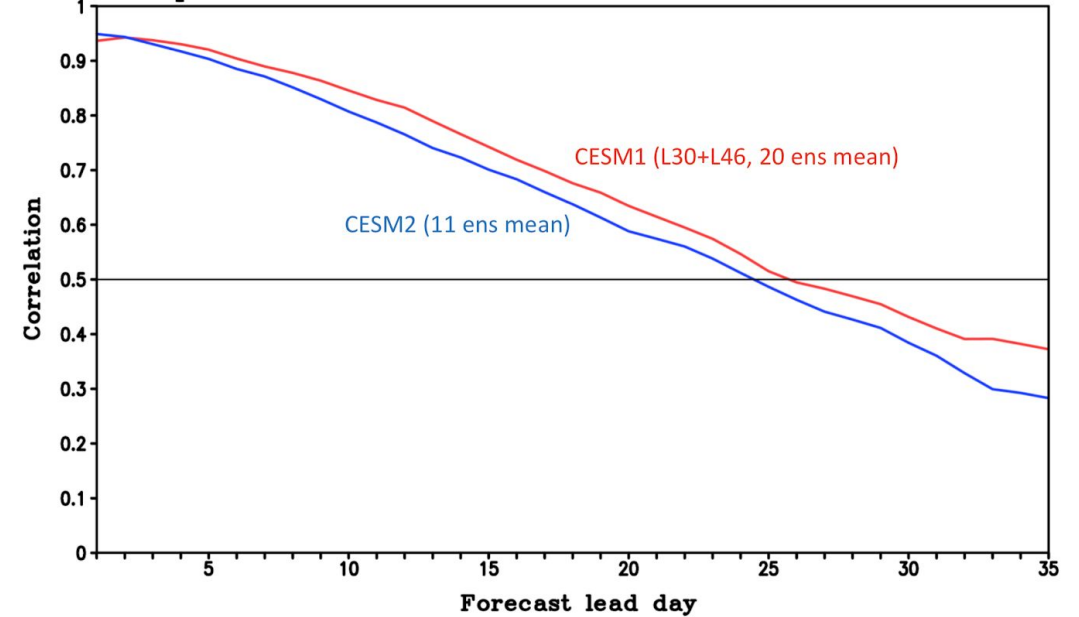# Surface Temperature ACC for DJF

MJO and NAO

NAO ACC in DJF

Legend:
- CESM2-WACCM(5)
- CESM2-CAM(5)
- CESM2-CAM(10)
- CESM1-CAM(5)
- CESM1-CAM(10)
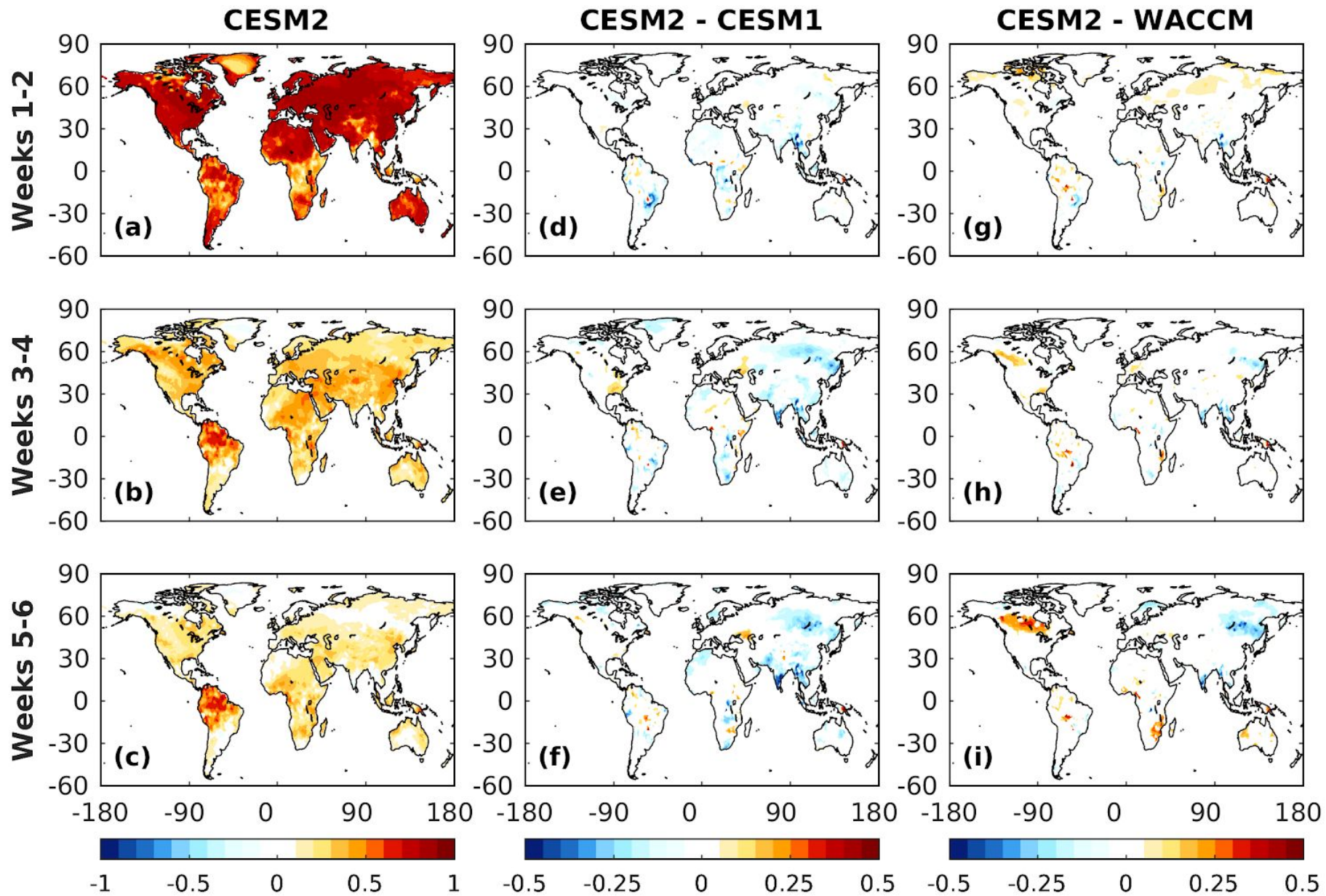
Figure from L. Sun; Richter et al. 2021 (in prep)

MJO prediction skill

CESM1 (L30+L46, 20 ens mean)
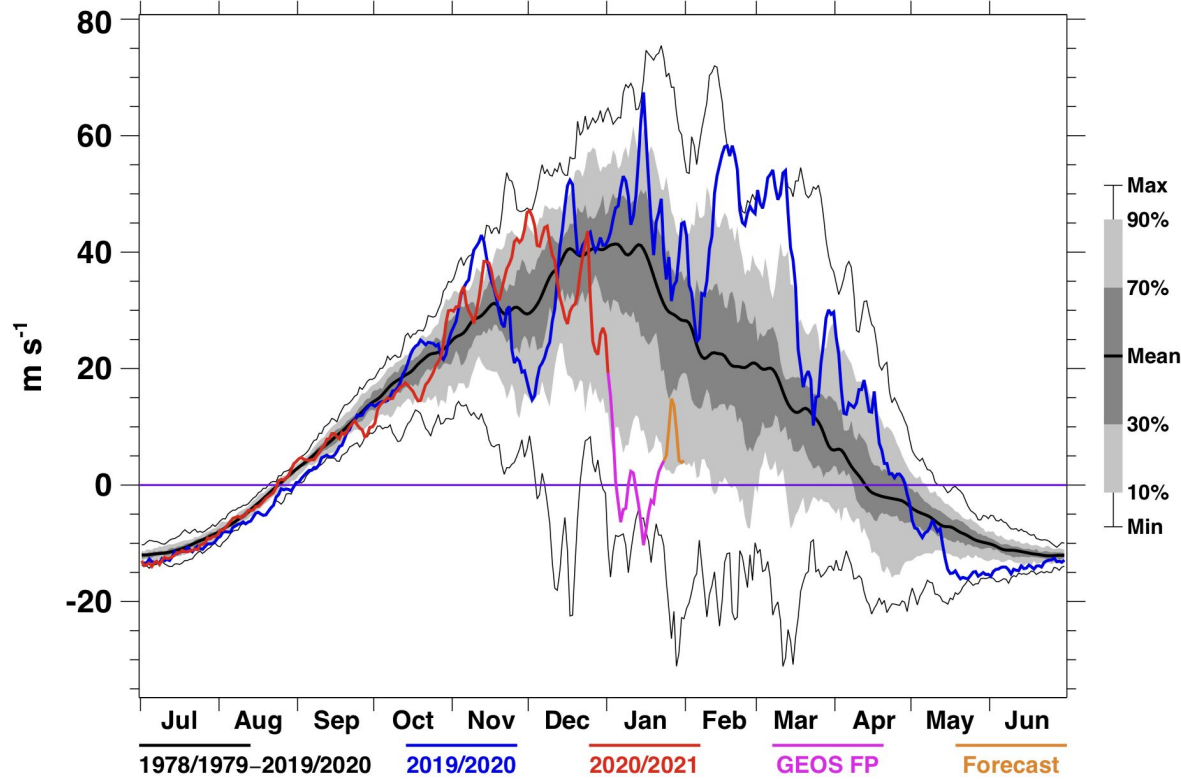
CESM2 (11 ens mean)

1999-2015, NDJFM only, all days

Figure from H. Kim; Richter et al. 2021 (in prep)

Recent SSW: Jan 5, 2021

**60°N Zonal Mean Zonal Wind
10 hPa   MERRA2**

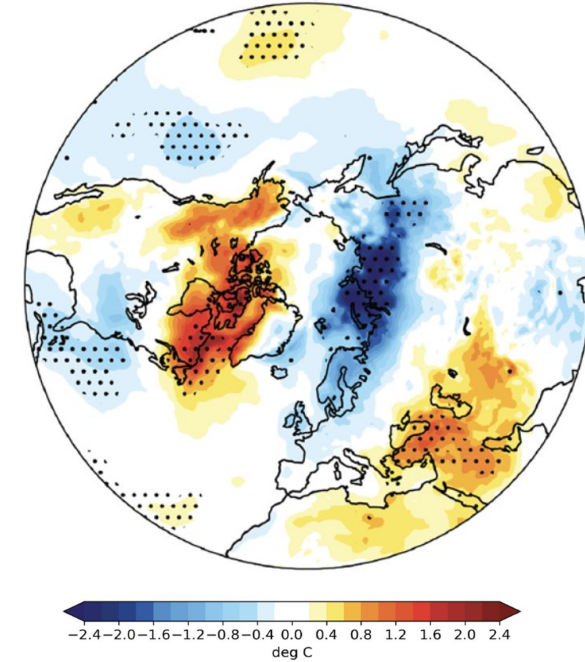1978/1979−2019/2020   2019/2020   2020/2021   GEOS FP   Forecast

P. Newman (NASA), E. Nash (SSAI), S. Pawson (NASA)   2021-01-23T14:15:36Z

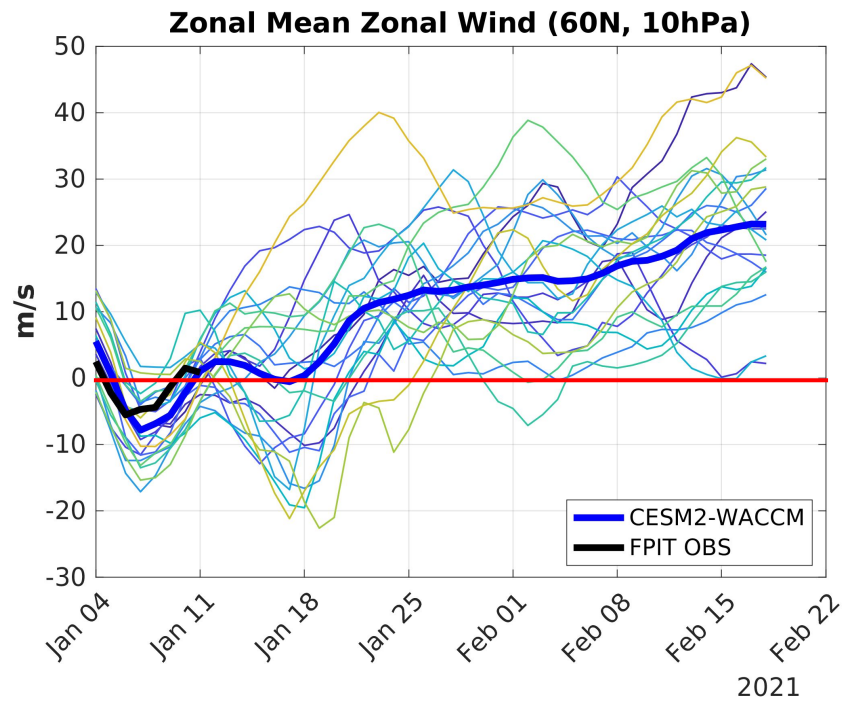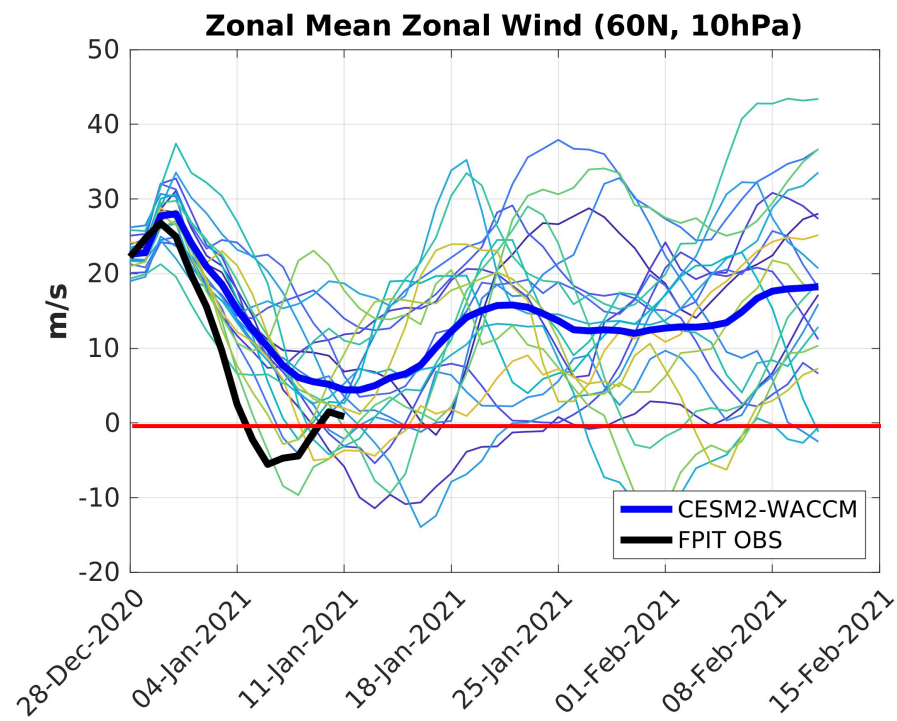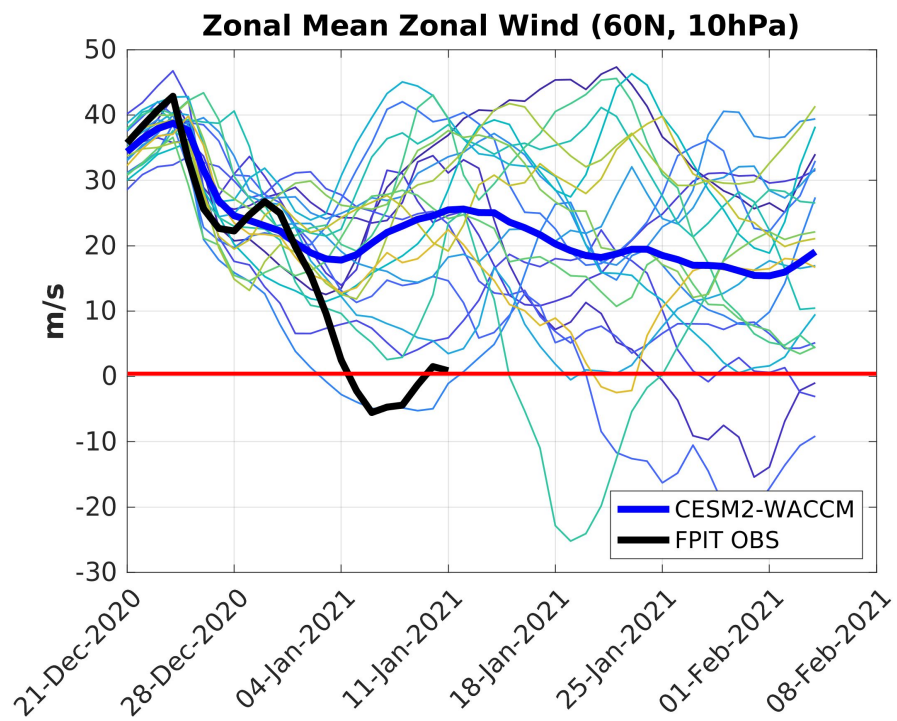Surface T anomalies 1 month after SSW

(a) Mean Surface Temperature Anomaly

Butler et al. 2020

CESM2-WACCM forecasts

SubX Week3-4 Forecast: Jan 23 – Feb 05

GEFS Anom

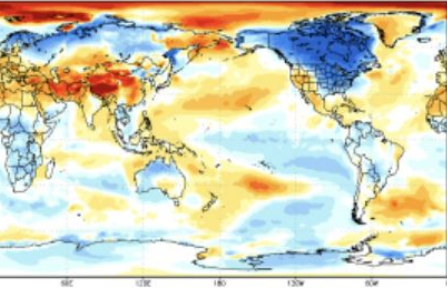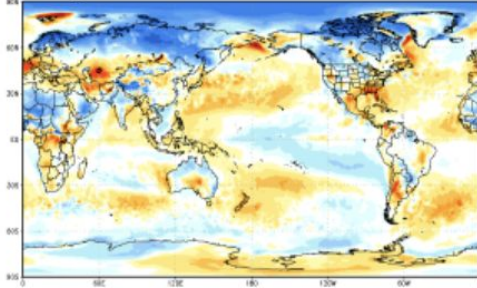**ECCC Anom**

WACCM6 Anom

CFSv2 Anom

IC: Jan 01-07

RSMAS_CCSM4 Anom

FIM Anom

NESM Anom

GEOS Anom

NCAR is sponsored by
National Science Foundation
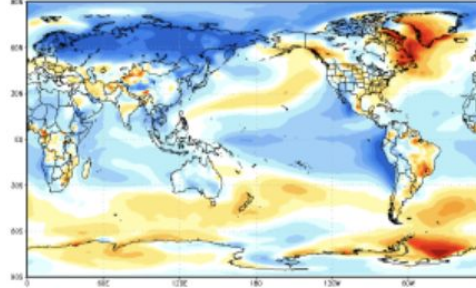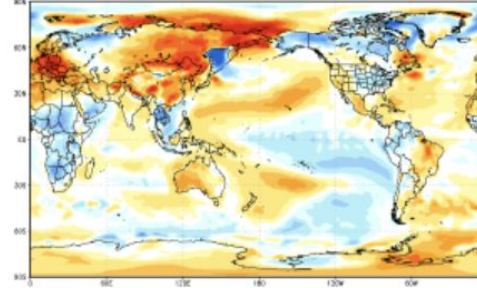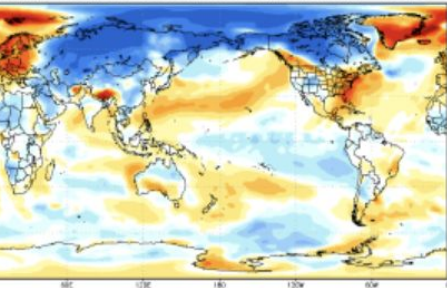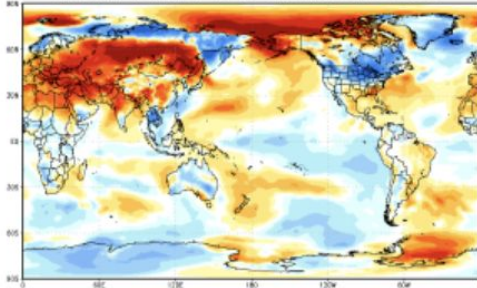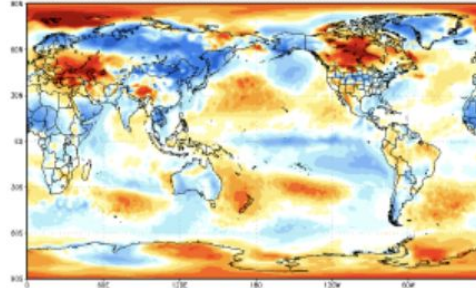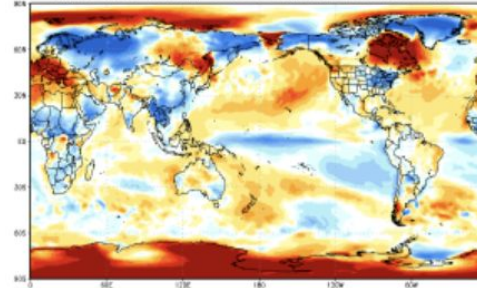
Output

- **EXTENSIVE!**
- Follows SubX Protocol
- + 3D fields of Omega, Q, RELHUM, T, U, UQ, V, VQ, Z3
- Lots of extra land and sea-ice output

- Currently available on campaign storage on casper, but will be put up on the Climate Data Gateway
- Data Policy: same as for SMYLE

Would like to coordinate analysis

CESM2:

- TCs: Hui Li (NCAR)

- Sea-Ice (Marika Holland and PCWG)

- Danica Lomardozzi (Land – but little time; help needed!)

CESM2-WACCM:

- 2021 SSW: Nick Davis, Yaga Richter

- MLT: Nick Pedatella

- Email: jrichter@ucar.edu

New Upcoming S2S Experiments

Understanding Sources:

- Ocean ICs shifted by 1 year (existing; J. Richter)
- Climatological atmosphere :(lead J. Richter)
- Climatological land (lead: J. Caron)
- Climatological ocean (lead?)

- **Stochastic physics** (J. Berner/NOAA supported)
- **Tests with Data Assimilation** (Dan Amrhein)

- **S2S Case Studies**: focused on extreme events (lead? Which cases?)
- **S2S Case Studies with new vertical grid**