S2S Prediction with CESM and Estimates of Error Growth

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NCAR

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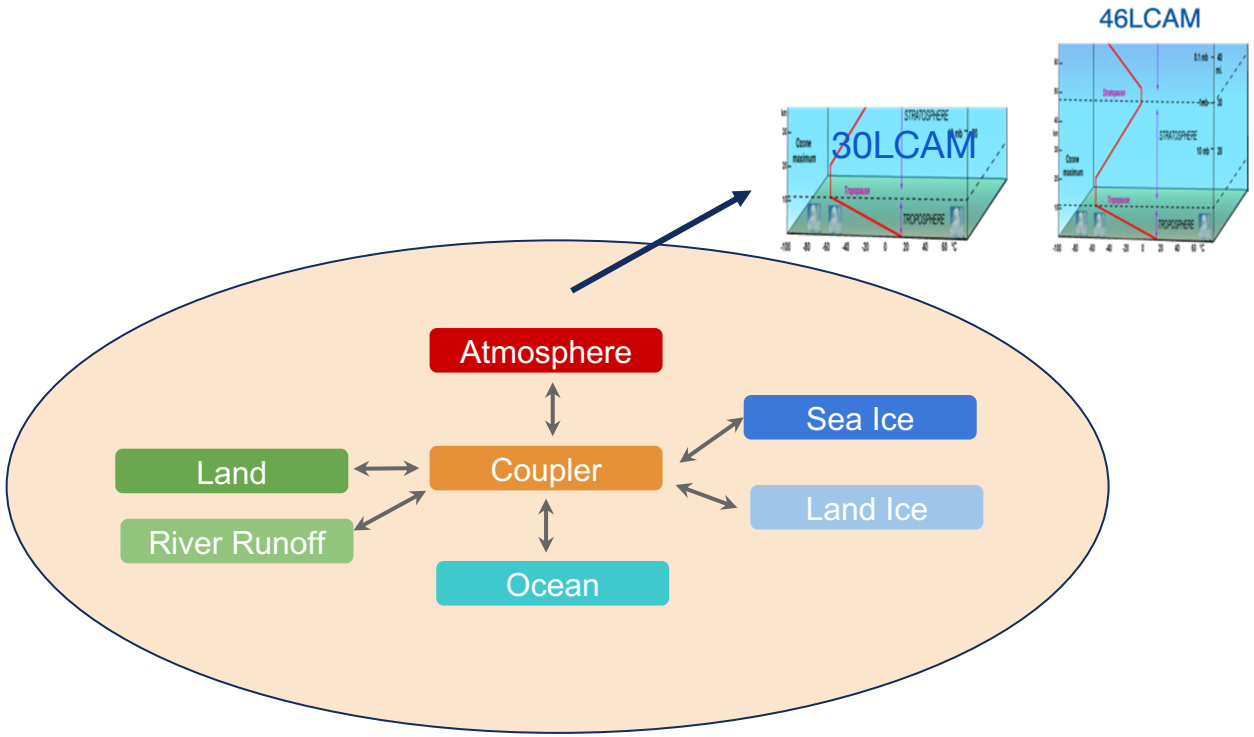
Introduction

- S2S efforts at NCAR started with a NOAA funded proposal:
  J. Perlwitz (NOAA/ESRL) and J. Richter (NCAR)

- Initial main goal: to investigate role of stratosphere on NAO predictability

- Learnt several lessons in the process & now leading to a community S2S research framework

S2S with CESM1: Hindcast Set-up

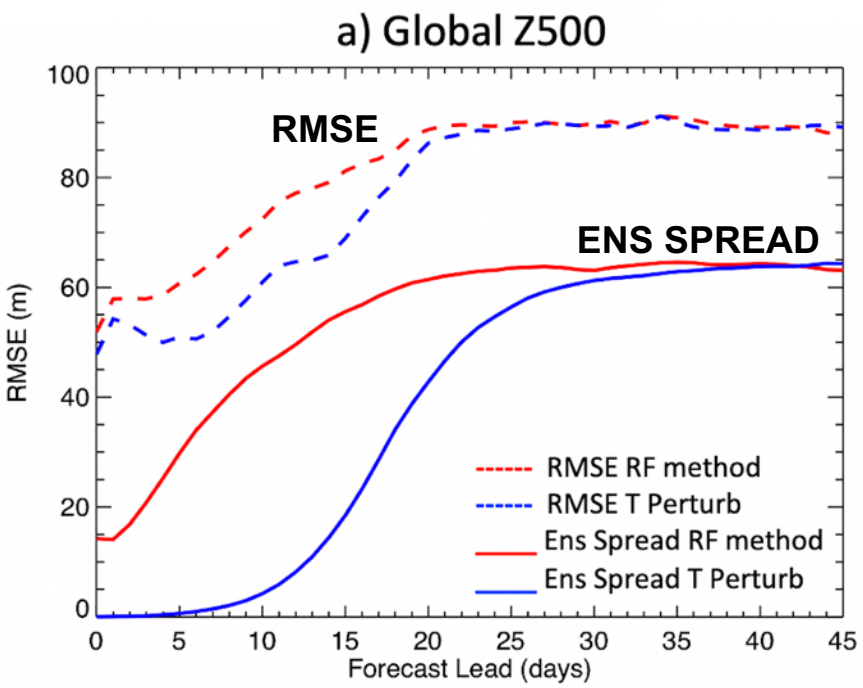


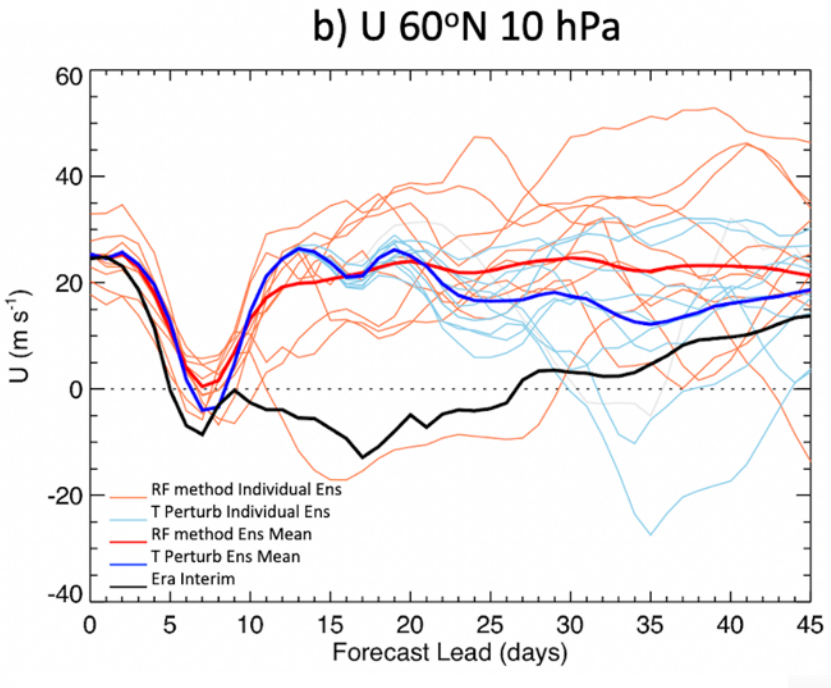
	Subseasonal (45 day runs)
	Hindcasts following SubX protocol 1999 - 2015 10 ens with default 30L model 10 ens with 46L model
INITIALIZATION ATMOS	**ERAI** **Ensembles: Random Field Perturbation Method**
LAND	**CRU-NCEP**
OCEAN	**JRA-55 Forced Ocean Hindcasts**

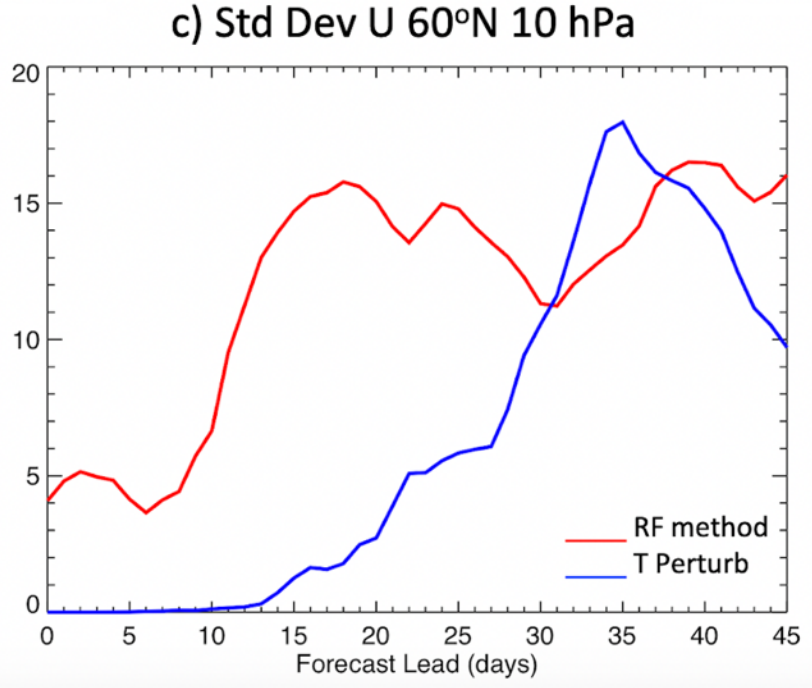
DATA AVAILABLE IN THE IRI LIBRARY WITH SUBX MODELS

https://iridl.ldeo.columbia.edu/SOURCES/.Models/.SubX/

Spread

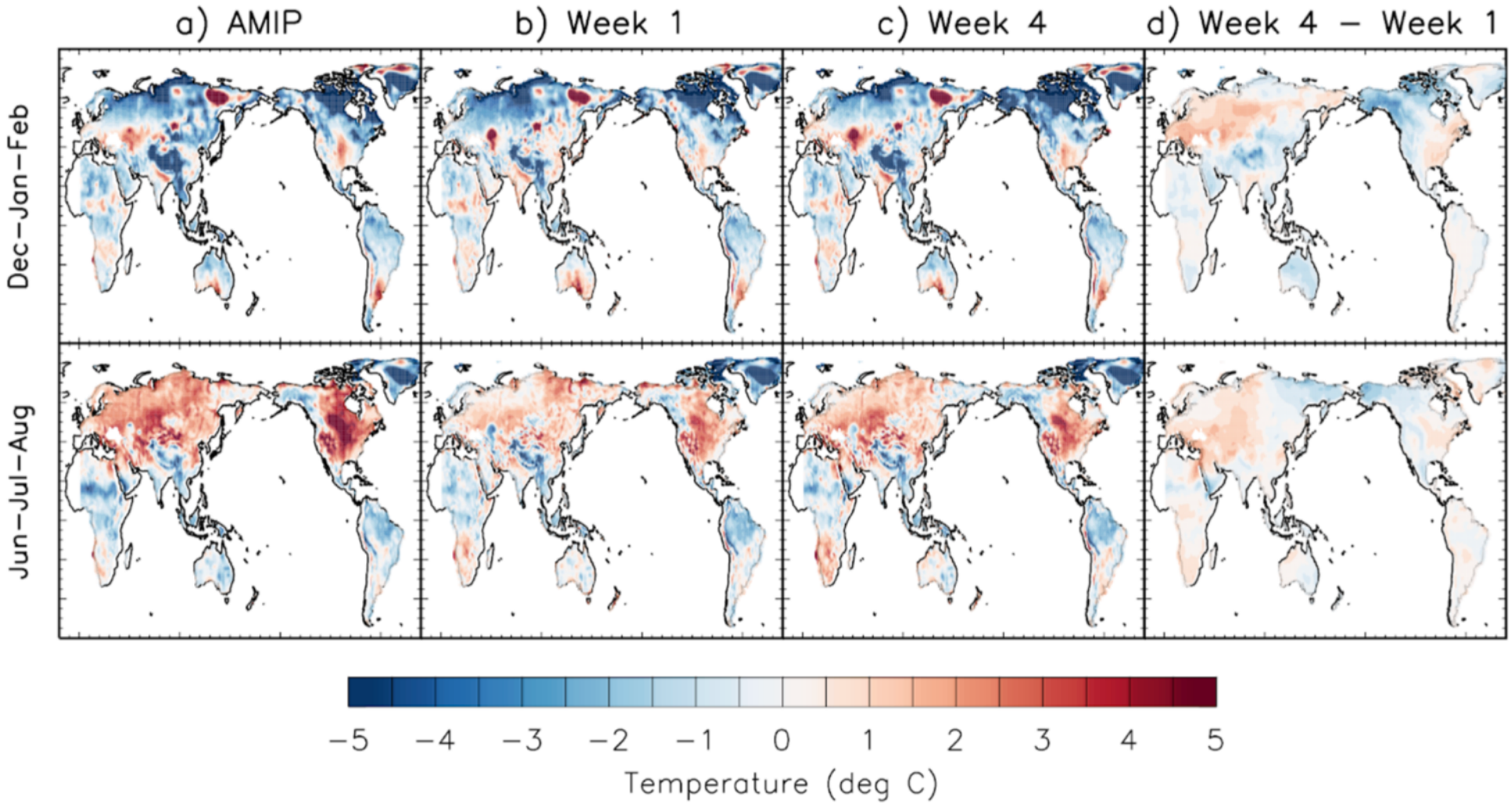






Richter et al. (2020), WAF Accepted

Error Growth



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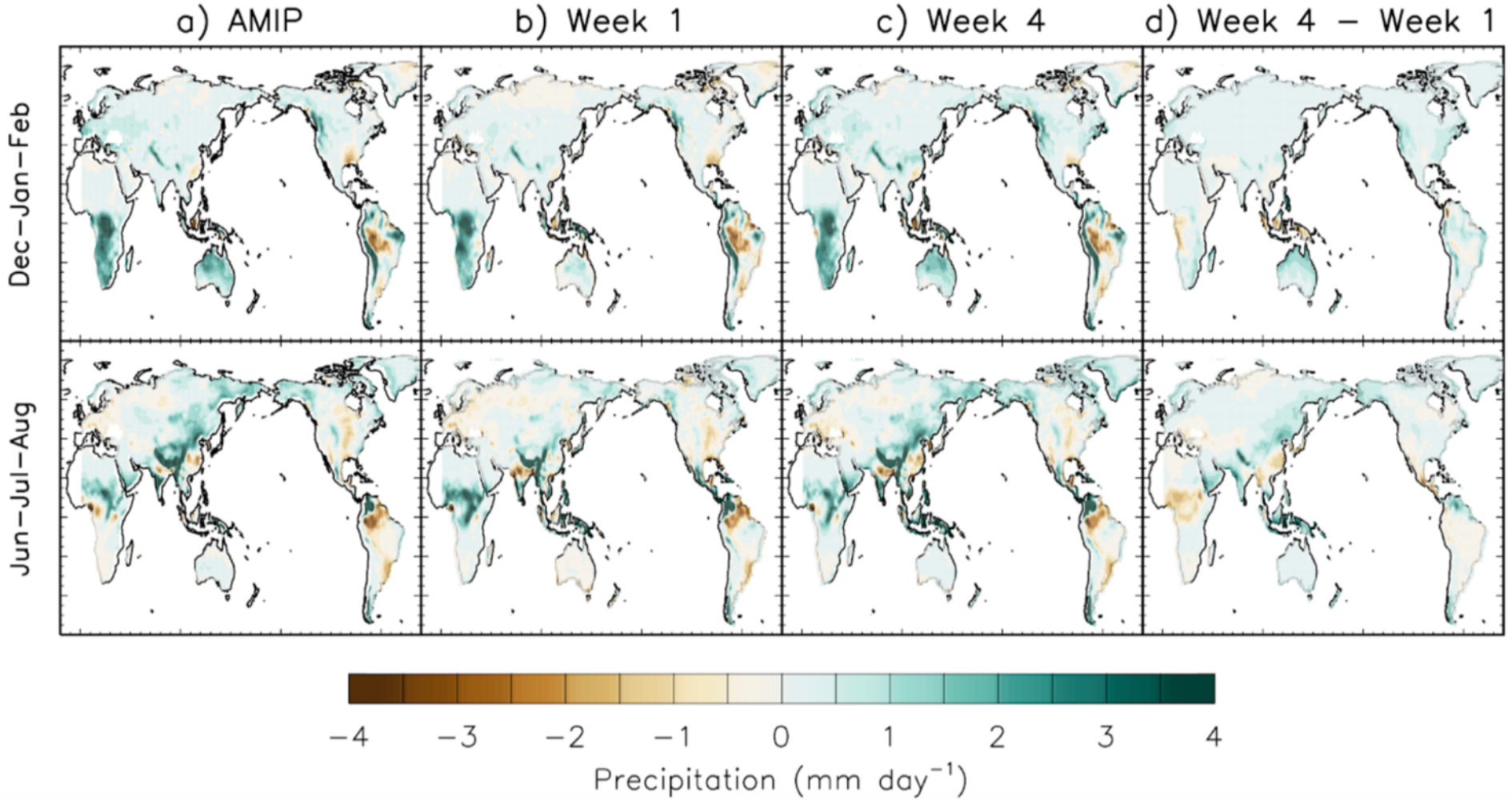
Richter et al. (2020), WAF Accepted

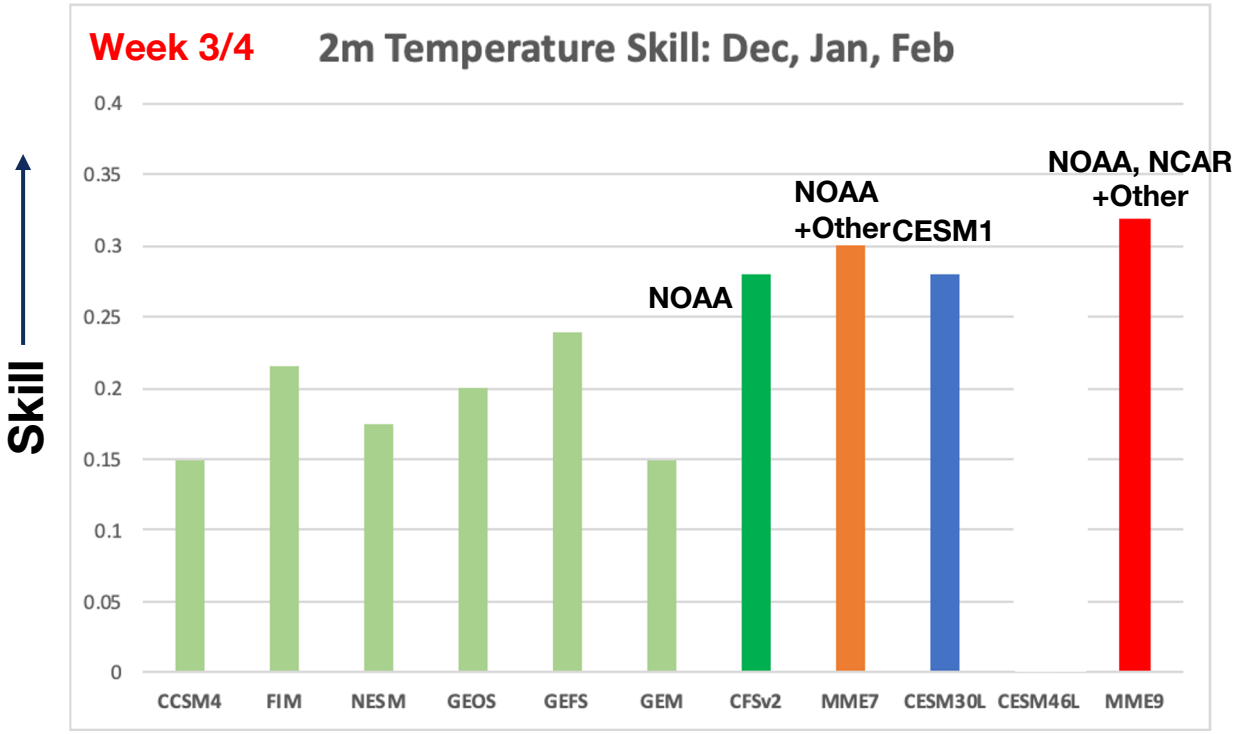
Error Growth

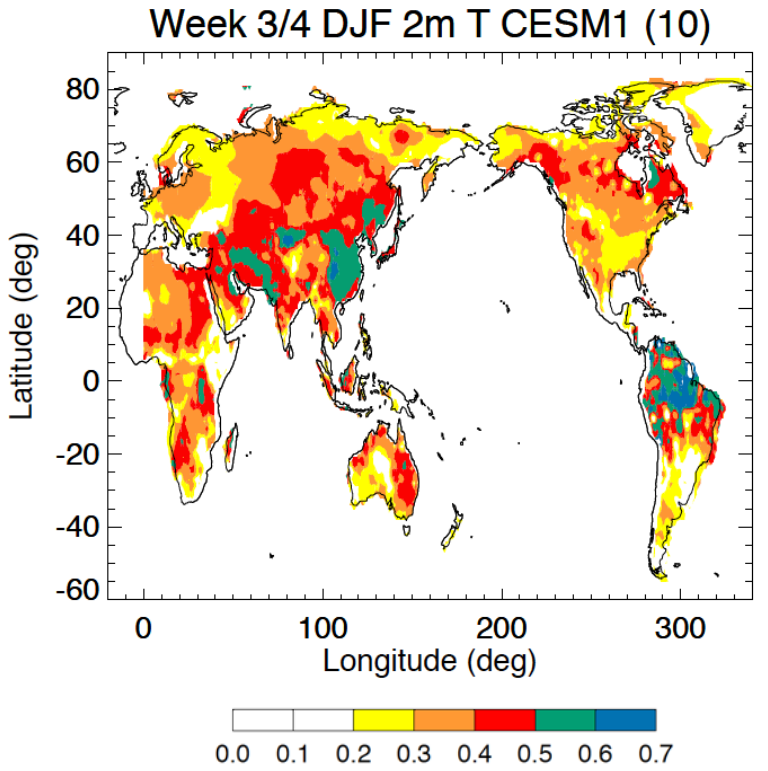


Precipitation

Richter et al. (2020), WAF Accepted

I. CESM1 S2S SKILL

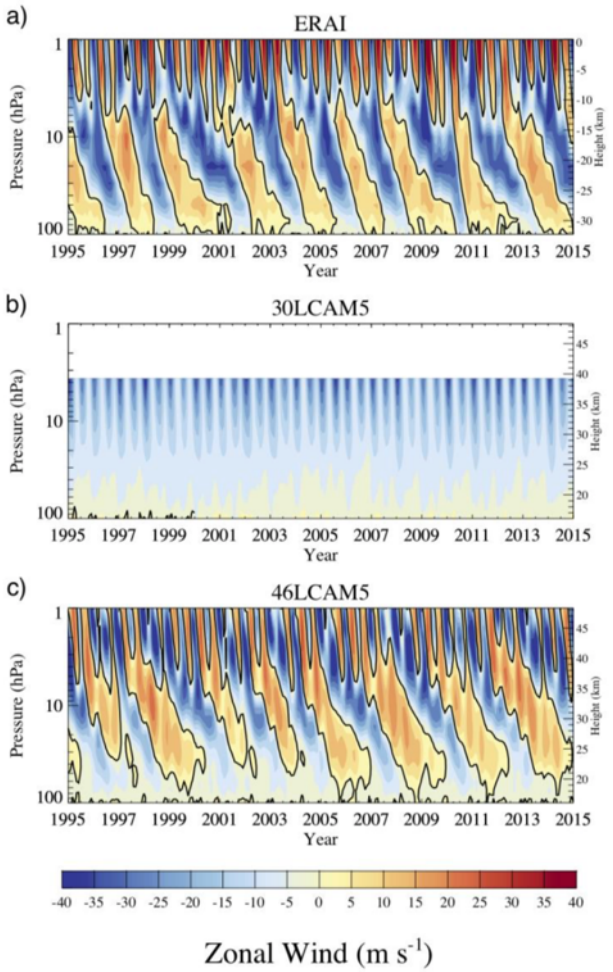


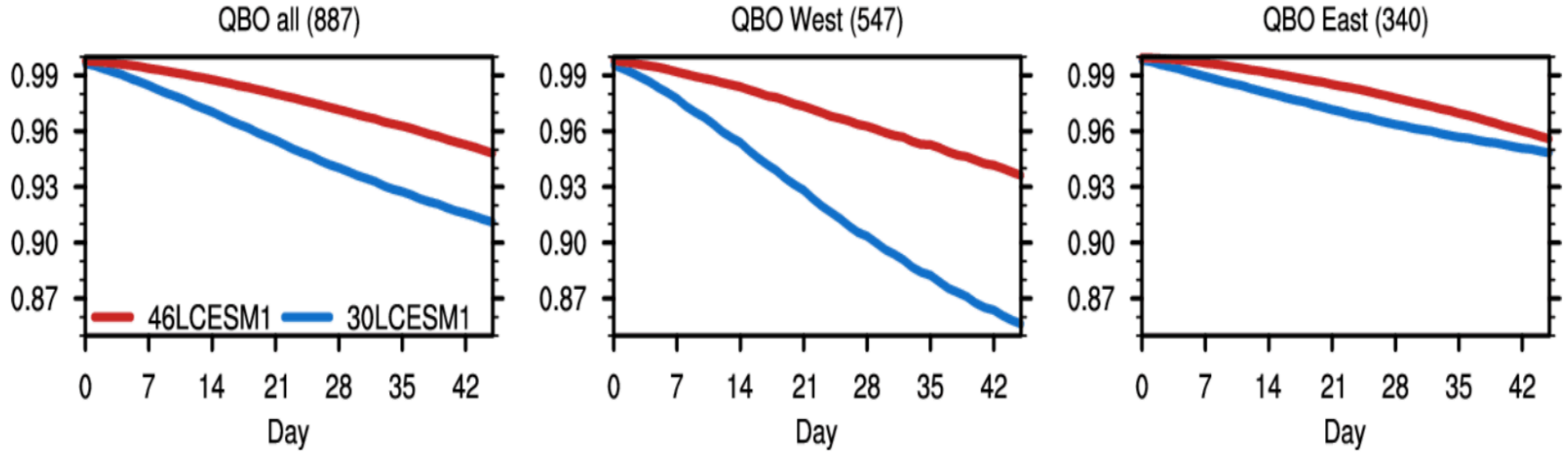


- CESM1 has 2m Temperature and precipitation skill comparable to NOAA's operational model
- CESM1 has better skill than most other US models participating in SubX

Richter et al. (2020), WAF Accepted

Better stratospheric model -> better stratospheric predictability

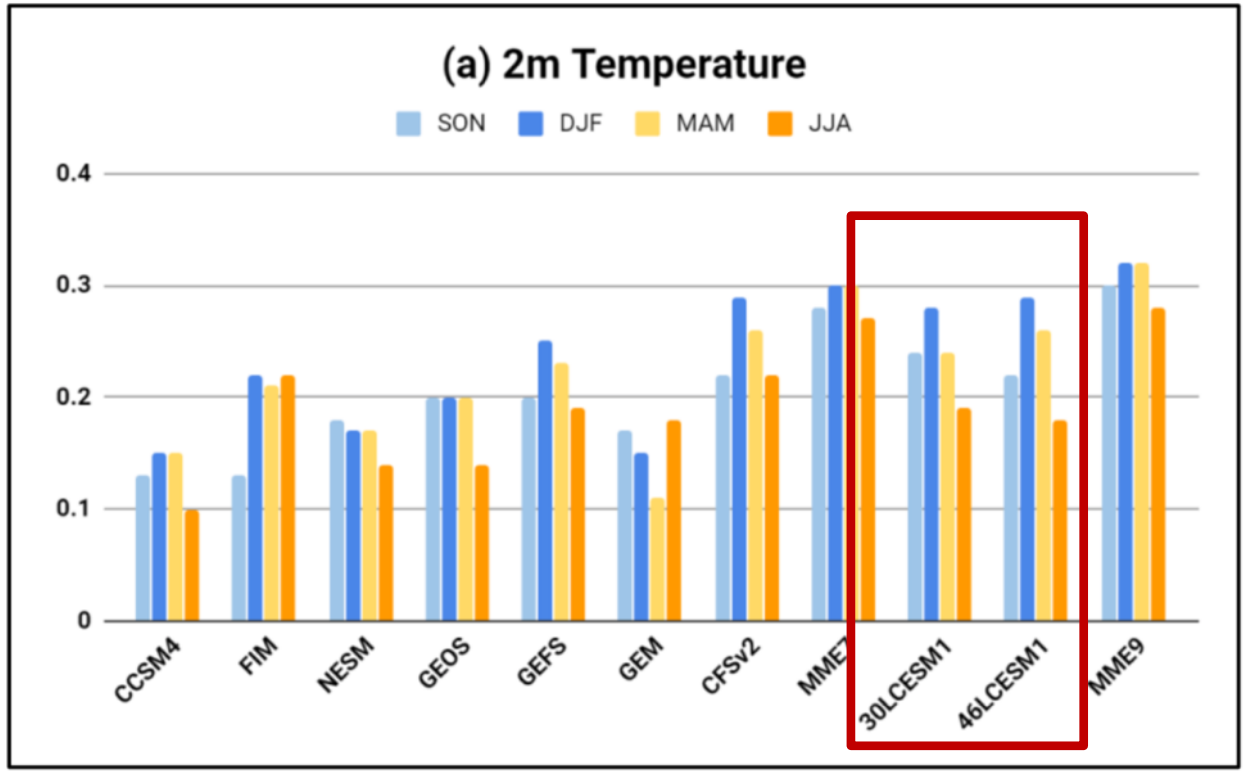


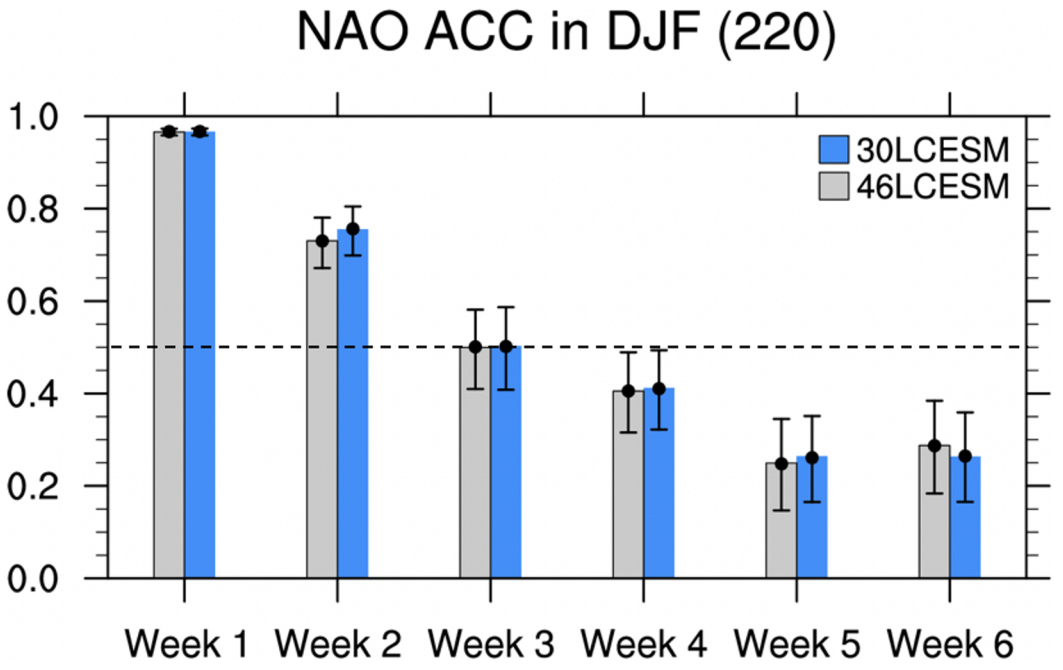


Predictability of the QBO much better in 46L vs 30L CESM1

Richter et al. (2020), in revision

Better stratospheric model -> surface skill unchanged

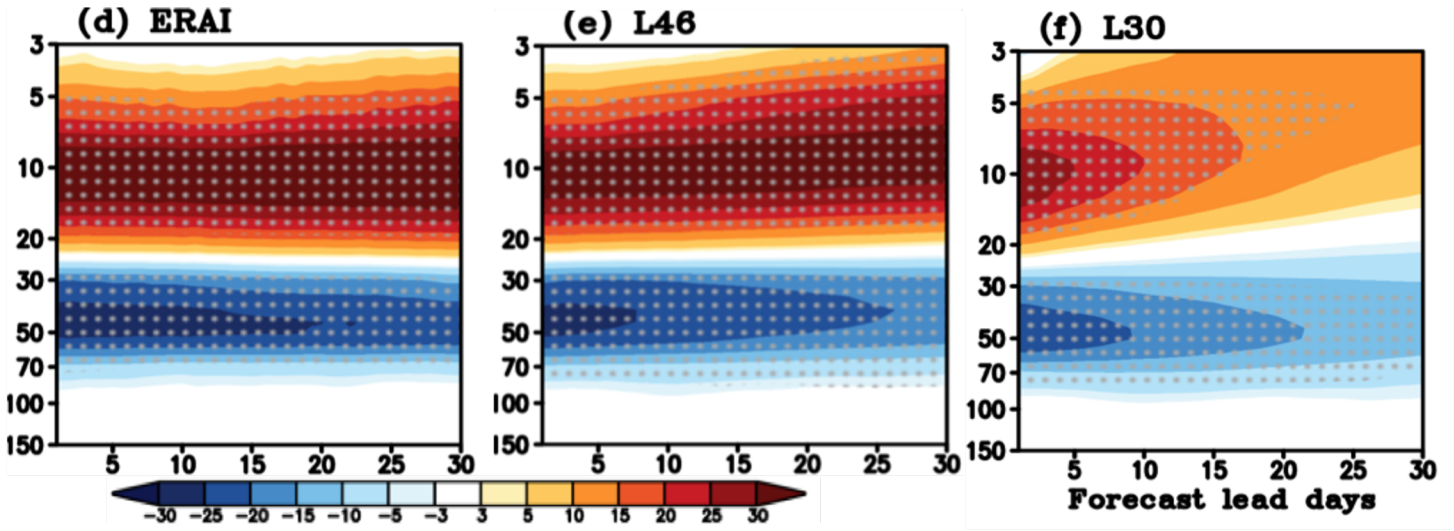




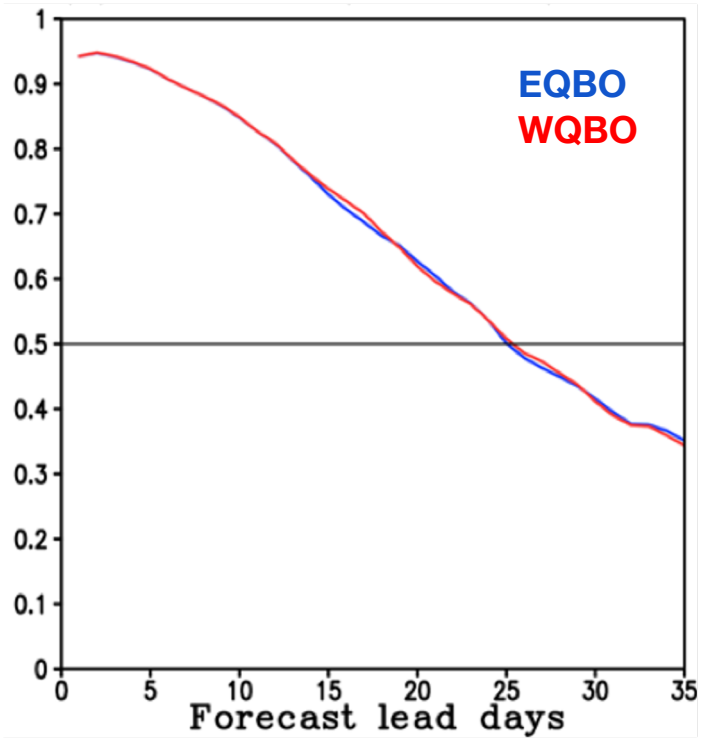
Richter et al. (2020), in revision

Better stratospheric model -> surface skill unchanged

[U]:
10S to 10N



MJO Predictability



46LCESM1 and 30LCESM1 hindcasts can be combined into a 20-member ensemble for most purposes…

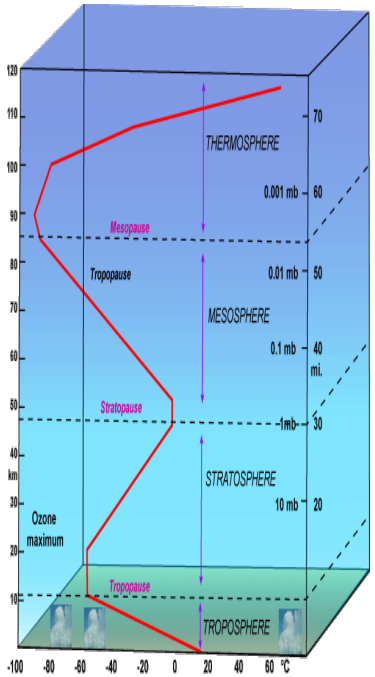
L46-CESM1:
→ better QBO, identical MJO

Kim, Richter, Zane (2019)

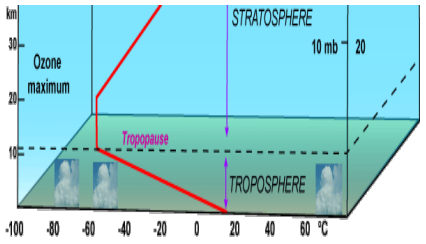
CESM2

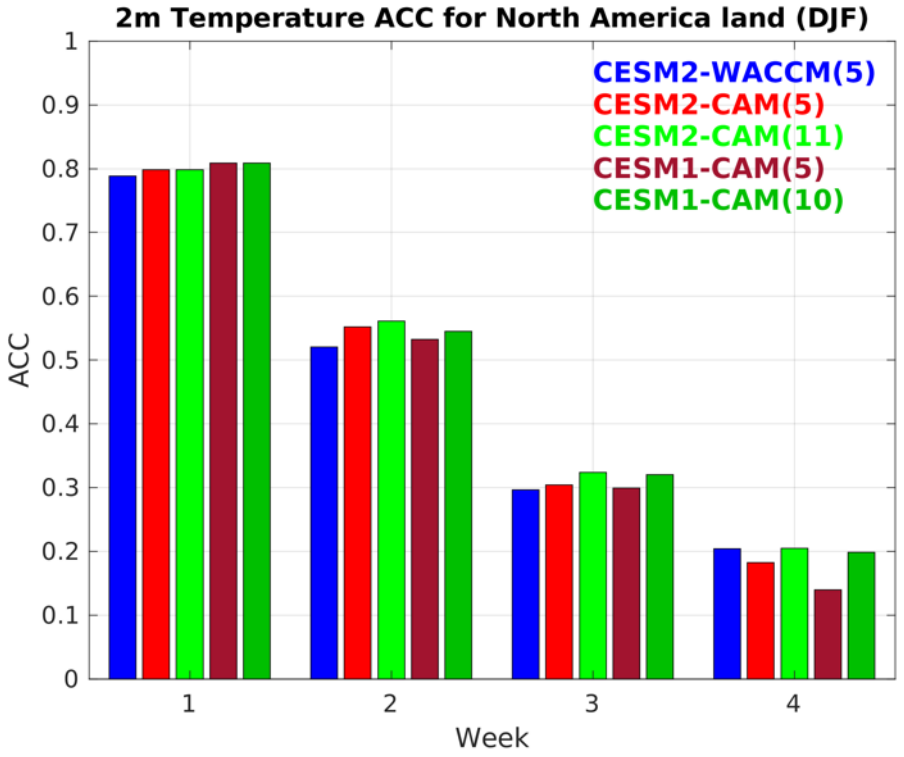
Running in near real-time

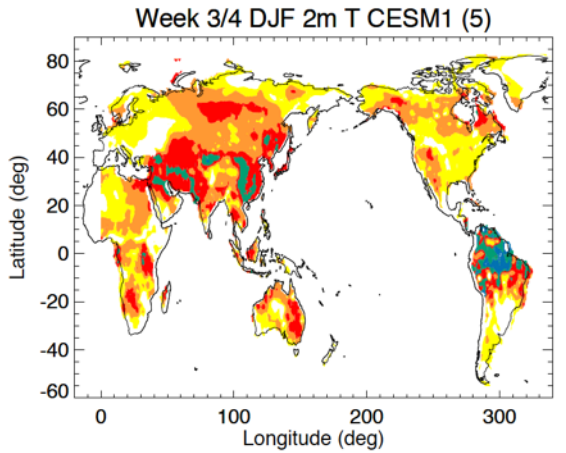
CESM2-WACCM

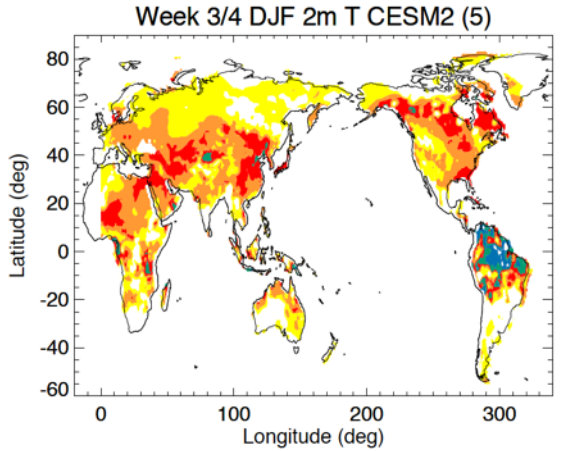


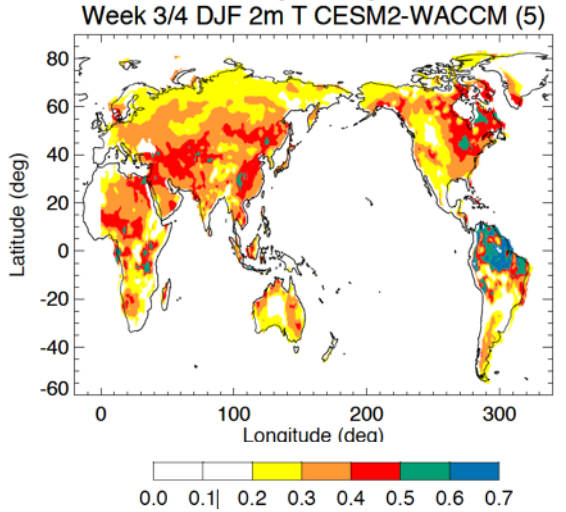
CESM2



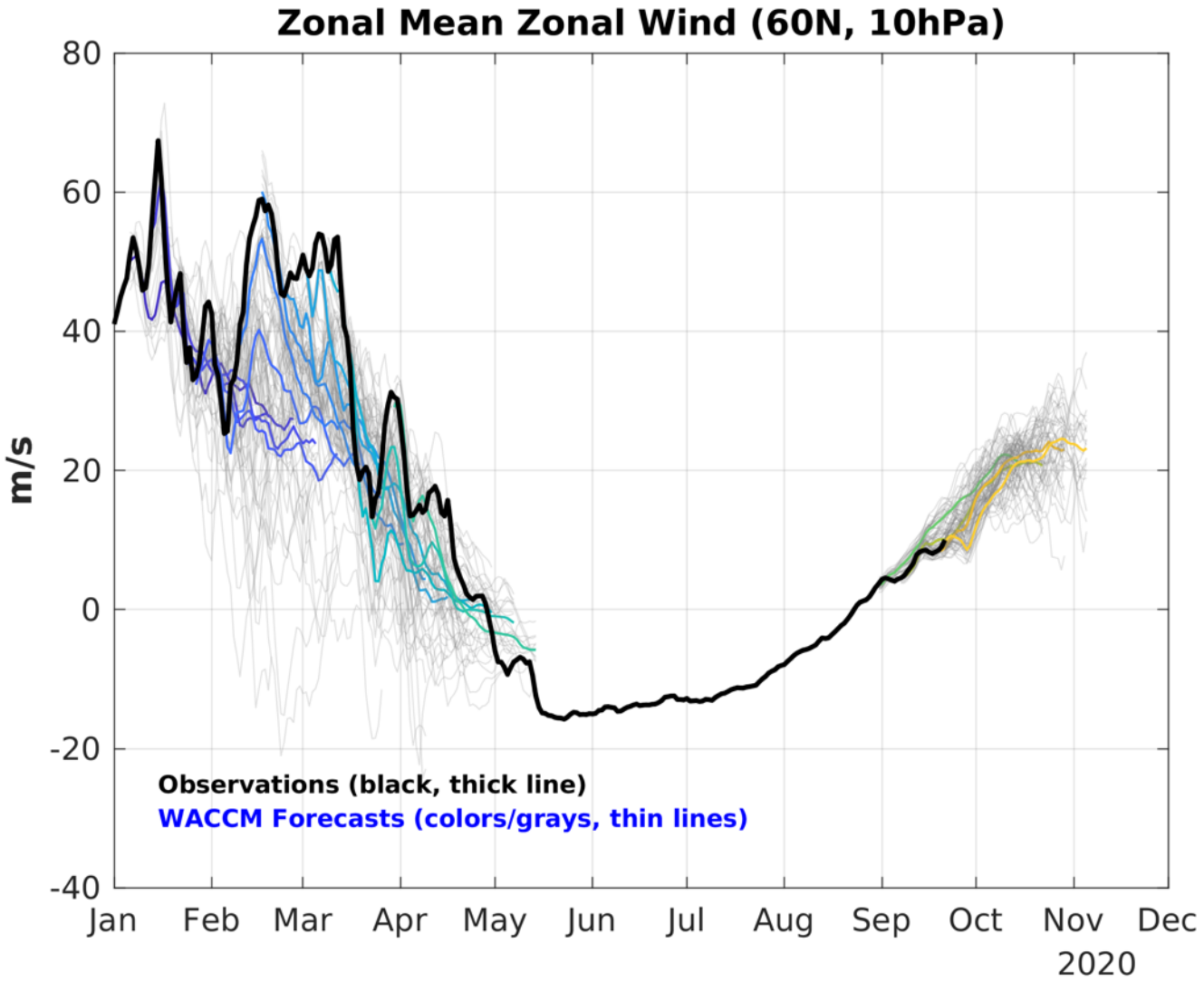


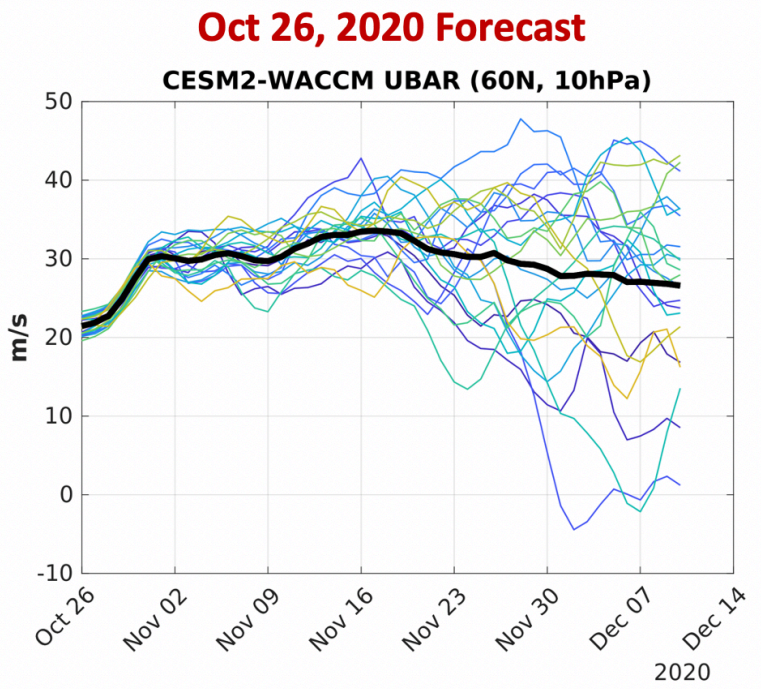






SSW Watch with WACCM





Summary

- We've demonstrated the utility of CESM1 as a tool for S2S research
- CESM1 has overall really good subseasonal skill
- Better representation of the stratosphere does not increase overall predictability -> Increased ensemble size is more beneficial
- Currently running CESM2-WACCM in near-realtime, and have completed S2S hindcasts
- Looking to engage broader community via the ESPWG

Error growth in S2S system

Julio Bacmeister and Yaga Richter

WGNE-35 November 5, 2020

Recap of CESM2/t-AMIP Initial results presented last year

- Precipitation approaches model climate quickly - within 2 days
  - Significant spin-up hinders interpretation
- Dynamical variables PS, U take longer

Next steps promised last year:

- Will run 10-15 day CAPT forecasts
- Physics “swaps”, e.g., UW PBL for CLUBB etc.

Obstacles to CAPT/t_AMIP studies

- Lack of personnel. Focus on CMIP6
- CAPT framework has gotten “stale” during CAM development
  - “Present day” forcing data for land, aerosols etc sometimes not continued past 2014
  - Not well integrated into climate model development

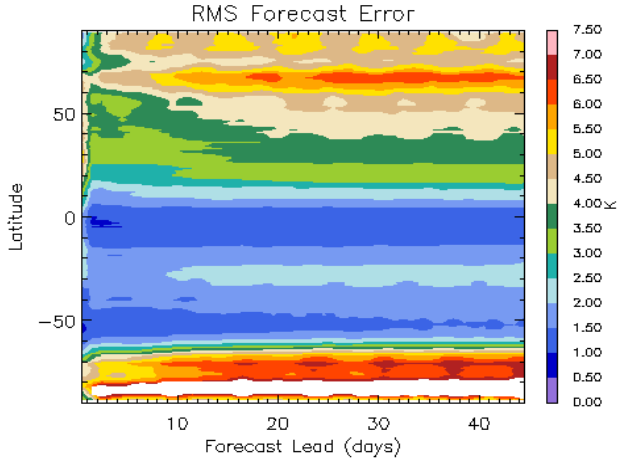
Looking at extended (5+ day) error growth

- “Workflow” issues remain. Instead of CAPT used S2S suite (Yaga Richter will discuss in a few minutes).
- 10-member forecast ensemble initialized every 7 days. CESM1. Coupled ocean. Land spun up with obs forcing.
- Extensive suite performed for subX – error growth examined for 2009-2010

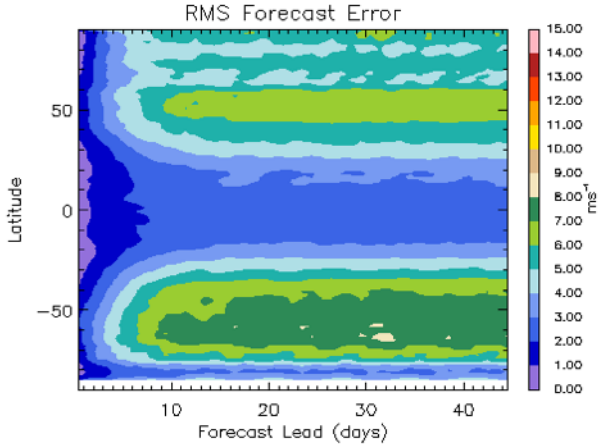
Zonal mean RMS forecast error (average over 52 forecast ensembles, 10-members each)

Simple definition: RMS[$\langle S_{cesm}(x,y,t_{val}) \rangle - S_{erai}(x,y,t_{val})$]

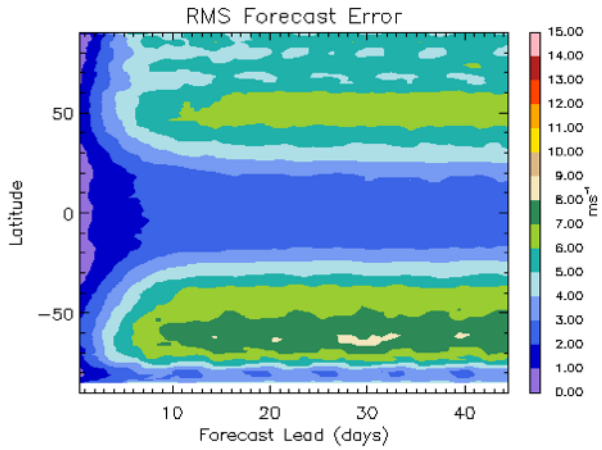
2m Tas (2009)



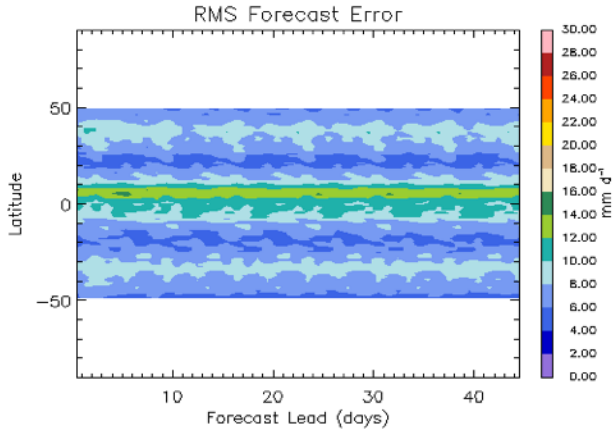
U 850 hPa (2009)



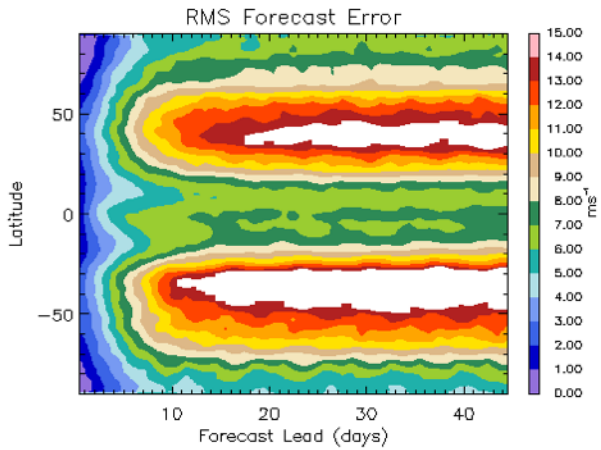
U 850 hPa (2010)



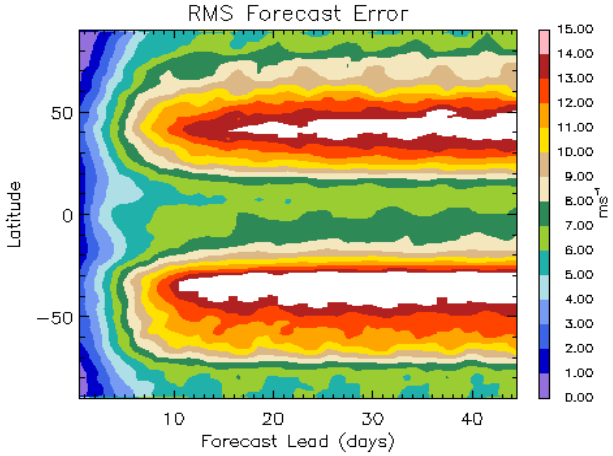
Precip. (2009)



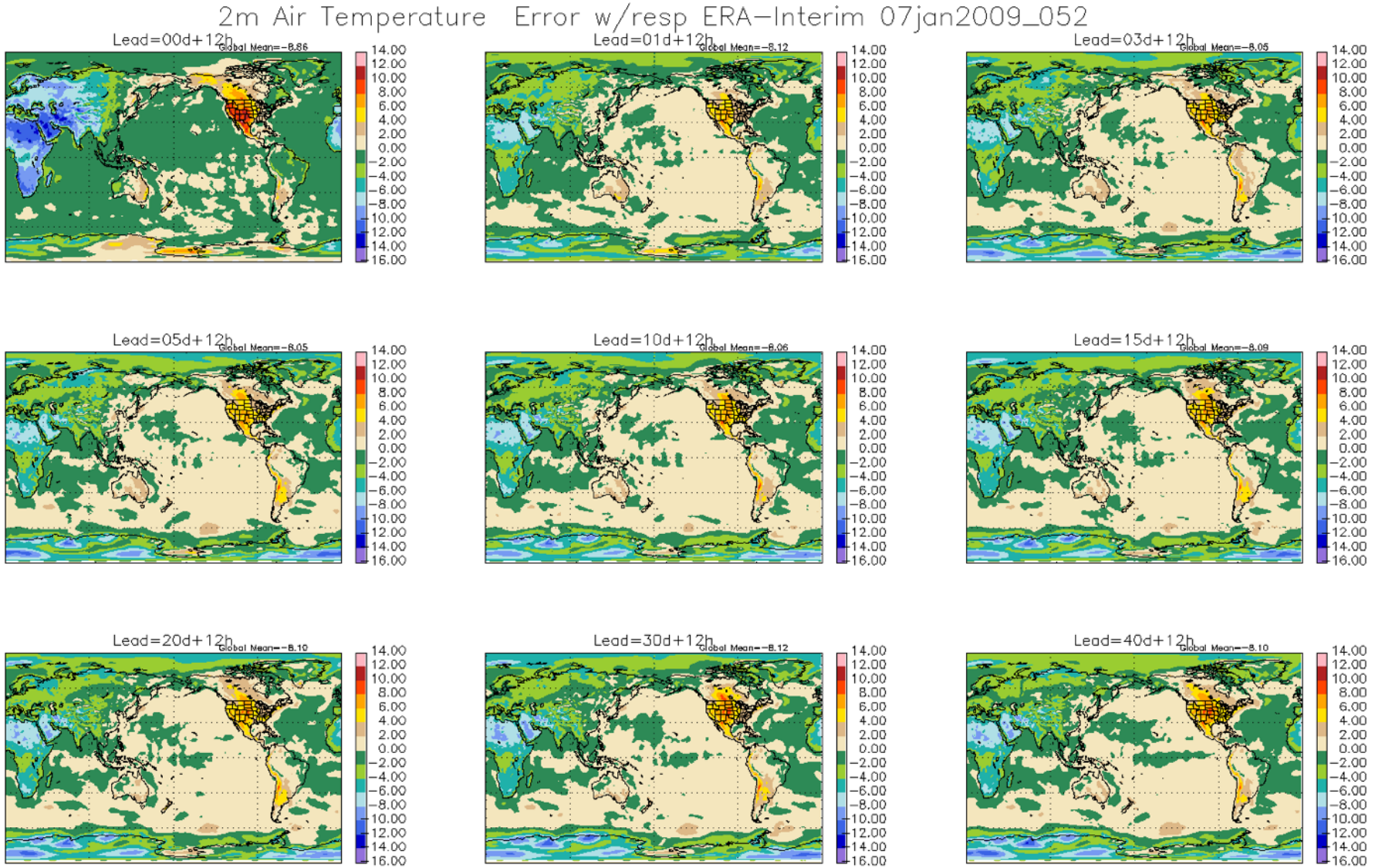
U 200 hPa (2009)

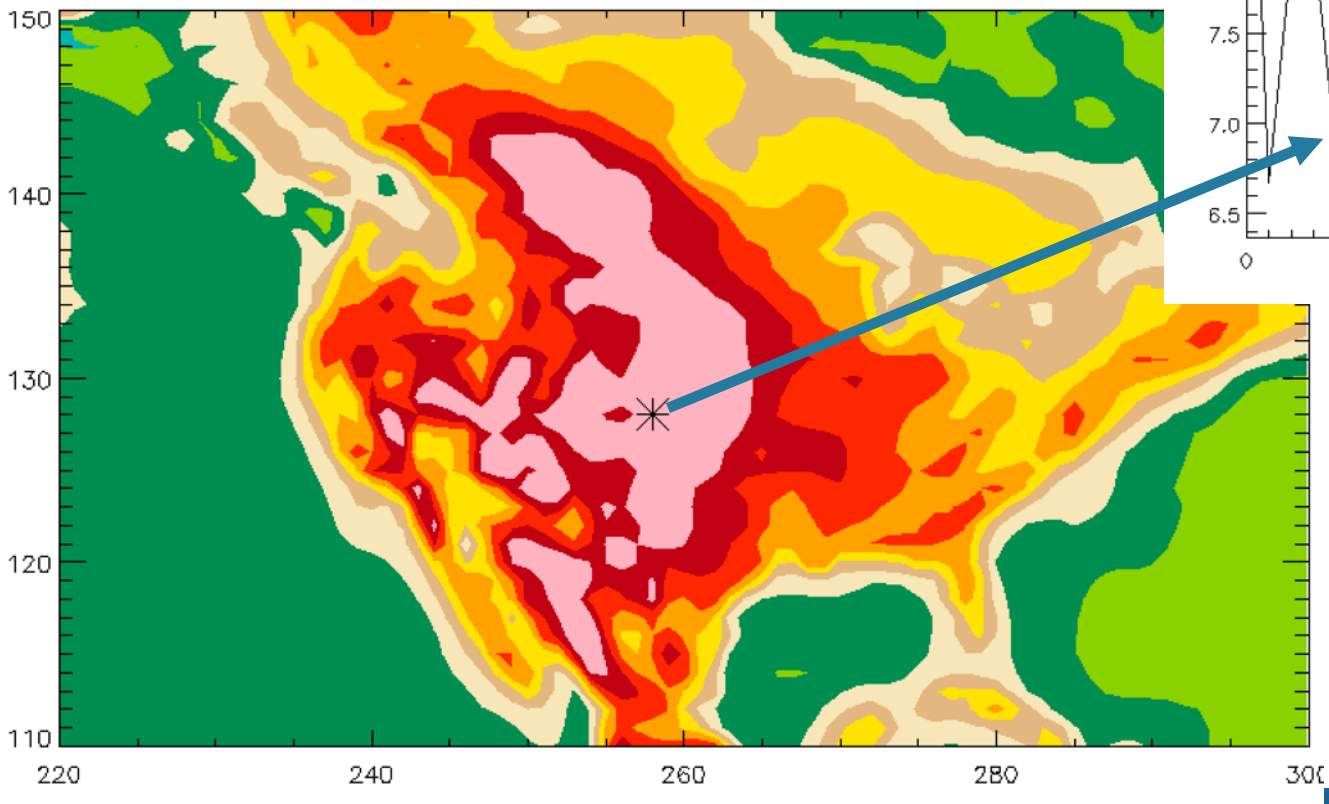


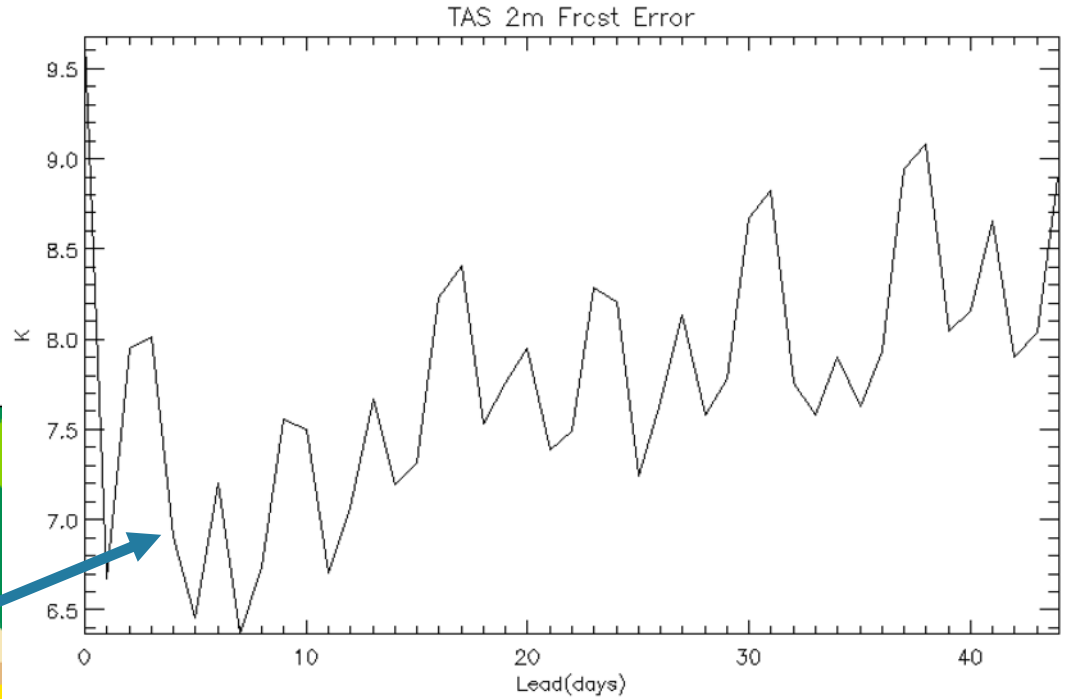
U 200 hPa (2010)



Simple definition:
error = $<S_{cesm}(x,y,t_{val})> - S_{erai}(x,y,t_{val})]$




150
140
130
120
110
220
240
260
280
300


TAS 2m Frcst Error
9.5
9.0
8.5
8.0
7.5
7.0
6.5
K
0
10
20
30
40
Lead(days)

Error growth summary

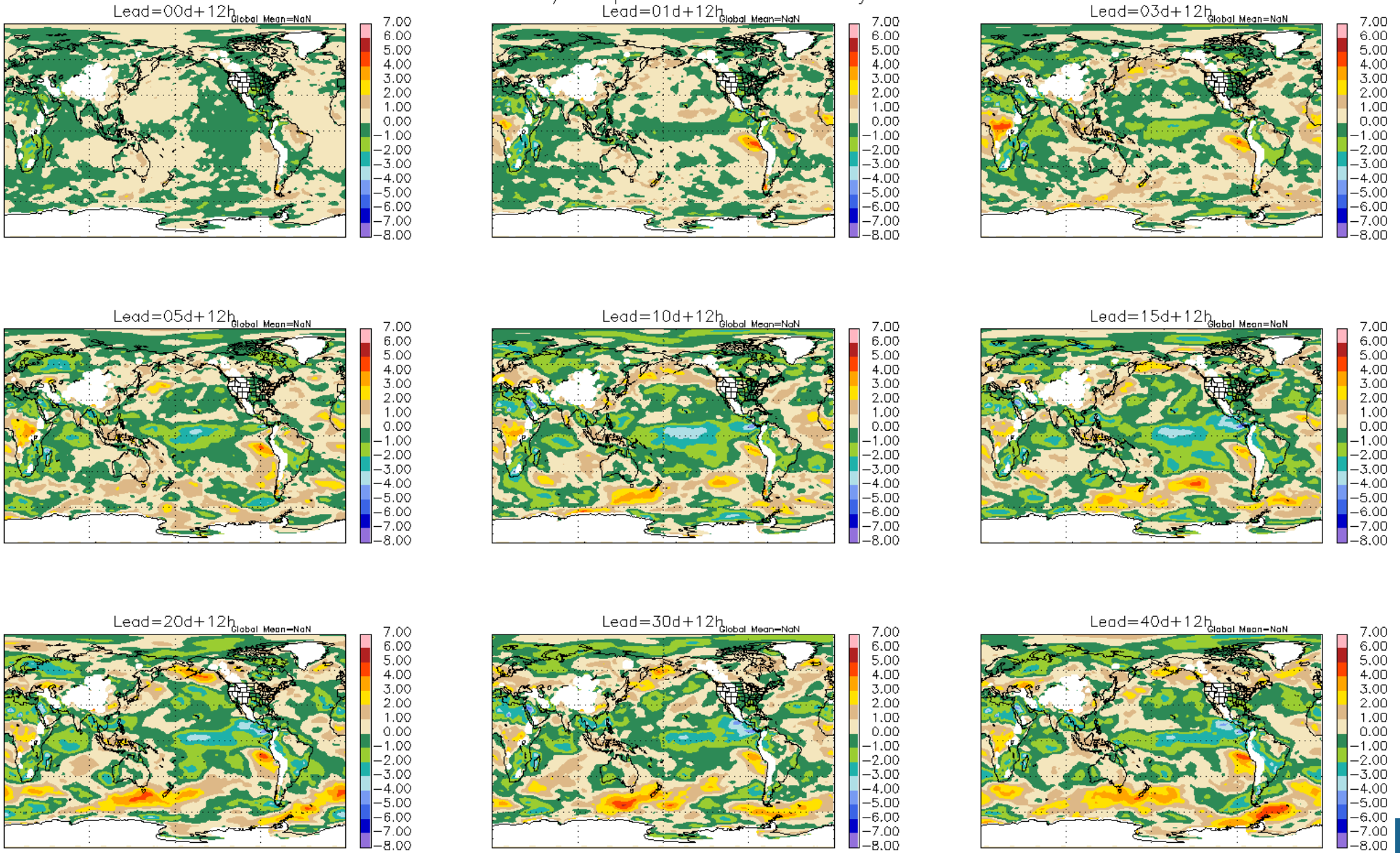
- Most errors saturate within around 10 days
- Some exceptions – notably US high-plains T2m

Future Work

- US high-plains focus study
- How much can we learn from “quick and dirty” analyses of bias and error compared to more stringent S2S-anomaly based analyses

Extra Slides

850hPa U Error w/resp ERA-Interim 07jan2009_052



Precipitation Forecast 07jan2009_052