

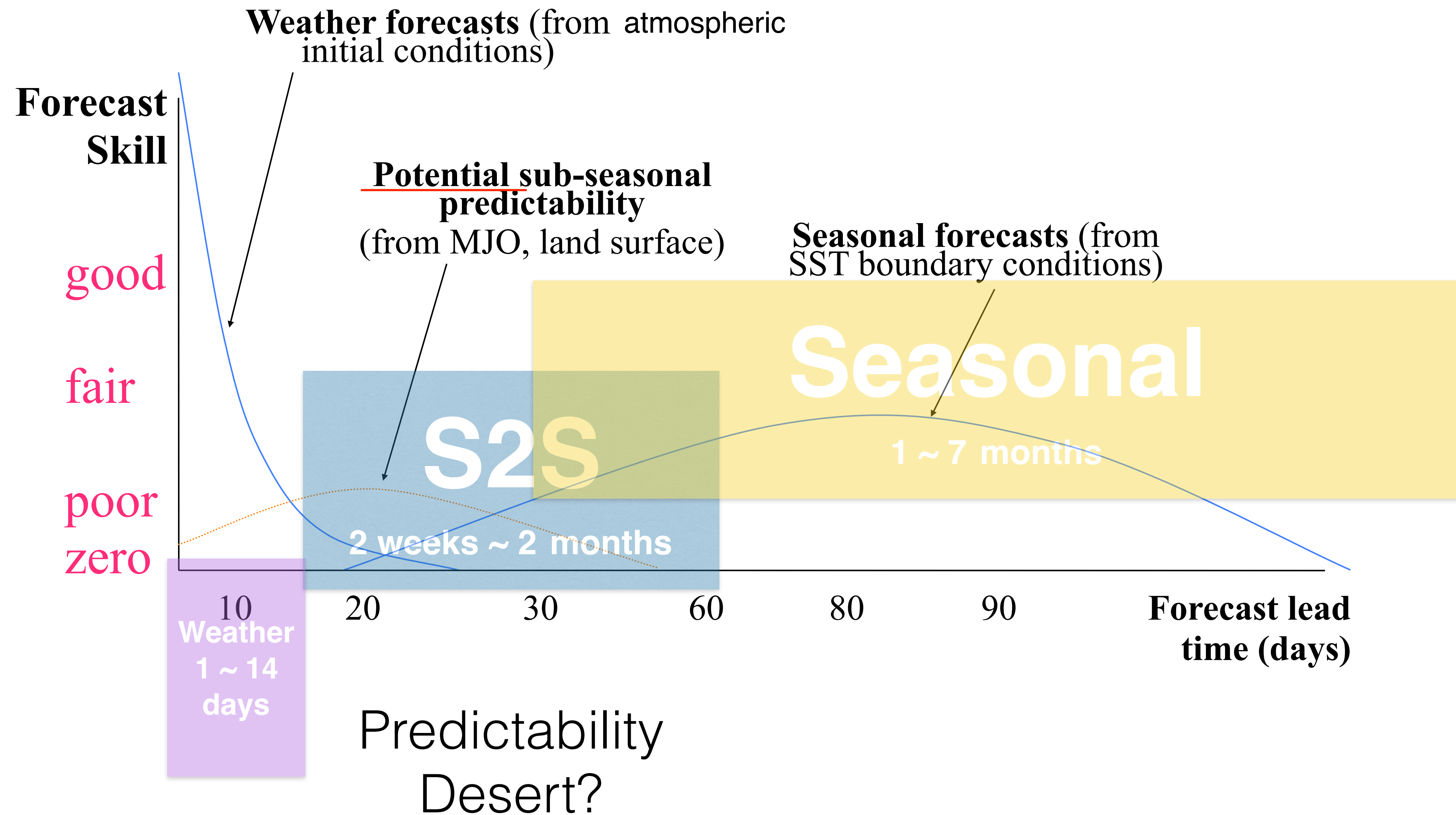
# Understanding sources of predictability at S2S Scale

Andrew W Robertson

# Outline

- S2S predictability:
  - Gray zone between weather vs climate predictability
- Phenomena/modes of variability on S2S scale (eg. MJO)
- Slowly varying atmospheric boundary conditions (Soil moisture, snow cover/snow pack, sea ice, SST, ...)

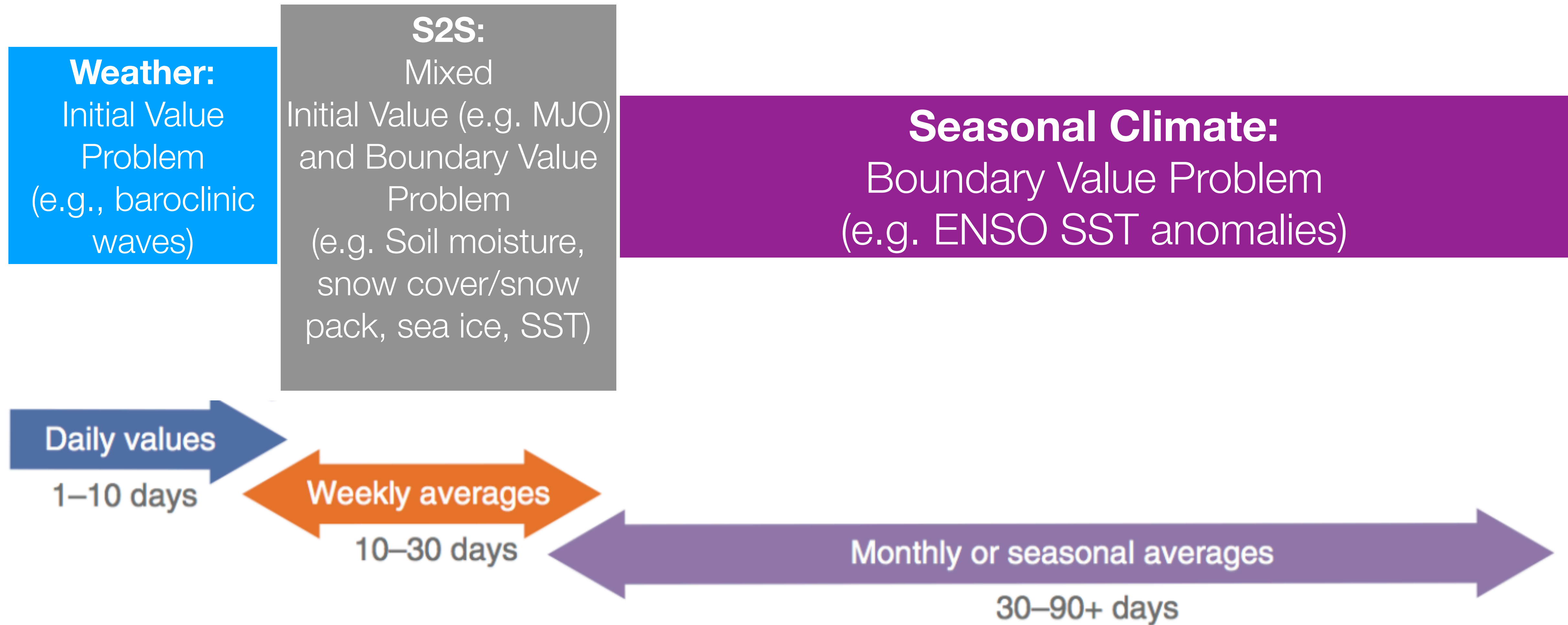
# Weather and Climate Forecast Ranges



from Tony Barnston, early 2000's



# Atmospheric Predictability



TIME AVERAGING!

Predictability of the Second Kind (Lorenz, 1975)



# How should the target periods be defined for sub-seasonal forecasts?

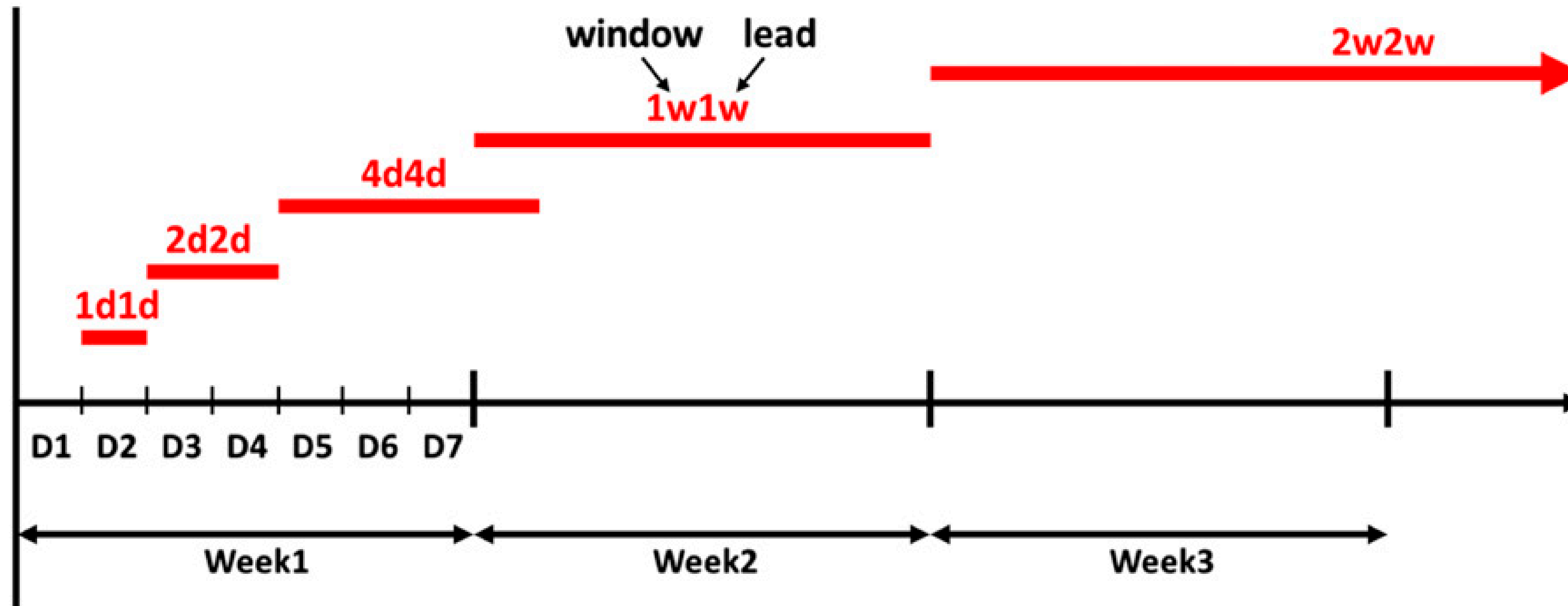
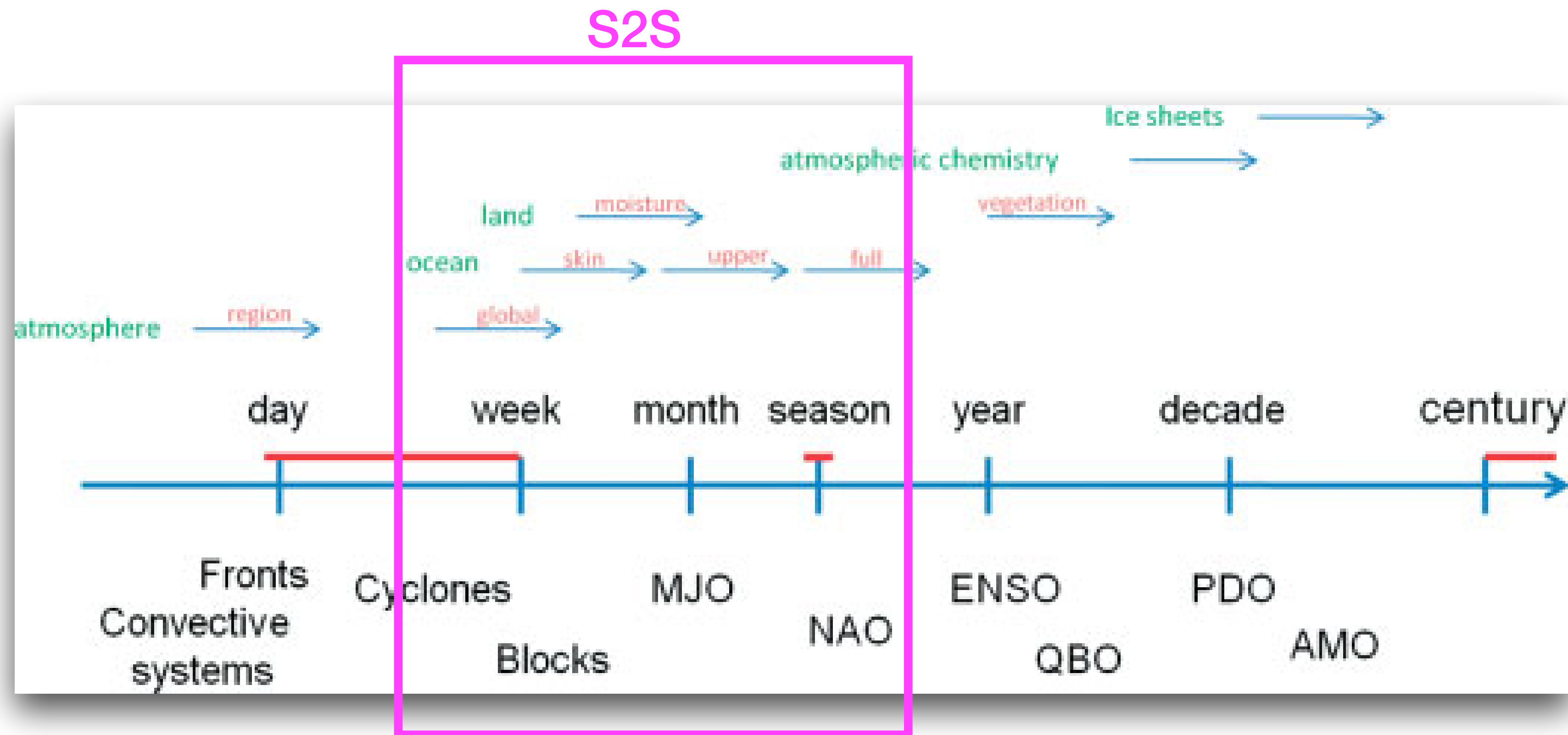


FIG. 1. Schematic of the time window and lead time definitions used in this analysis. The horizontal axis represents forecast time from the initial condition. The expression “1d1d” refers to an averaging window of 1 day at a lead time of 1 day. Similarly, “2d2d” represents an averaging window of 2 days at a lead time of 2 days, and so on. Note that 1d1d is what is usually called “day 2” in other papers, and 1w1w is what is usually called “week 2.”

Zhu et al (2014, MWR,  
DOI: 10.1175/MWR-  
D-13-00222.1)

# The Seamless Predictability concept



*“The phenomena in the Earth system that occur on all time-scales imply potential predictive power for the atmosphere on that time-scale.”*

Hoskins (2012, DOI:10.1002/qj.1991 )

# S2S Phase II Research Foci on Sources of Predictability

- **MJO prediction and Teleconnections:** incl. high impact weather in the tropics/subtropics
- **Land Initialization and Configuration:** observing system impact on land initialization/S2S forecasts; land/atmosphere processes in S2S models; land surface impacts on extremes
- **Ocean and Sea Ice Initialization and Configuration:** role of ocean-atmosphere coupling on S2S; sea ice process simulation, initialization, prediction; **S2S marine prediction** (eg storm surge, fisheries & coral bleaching)
- **Stratosphere:** role of vertical coupling, stratospheric systematic errors, and impact of quality of stratospheric initial conditions
- **Atmospheric Composition:** impact of prognostic aerosols on S2S forecasts; level of complexity needed; predictability of aerosols (e.g. dust) & potential forecast value for applications

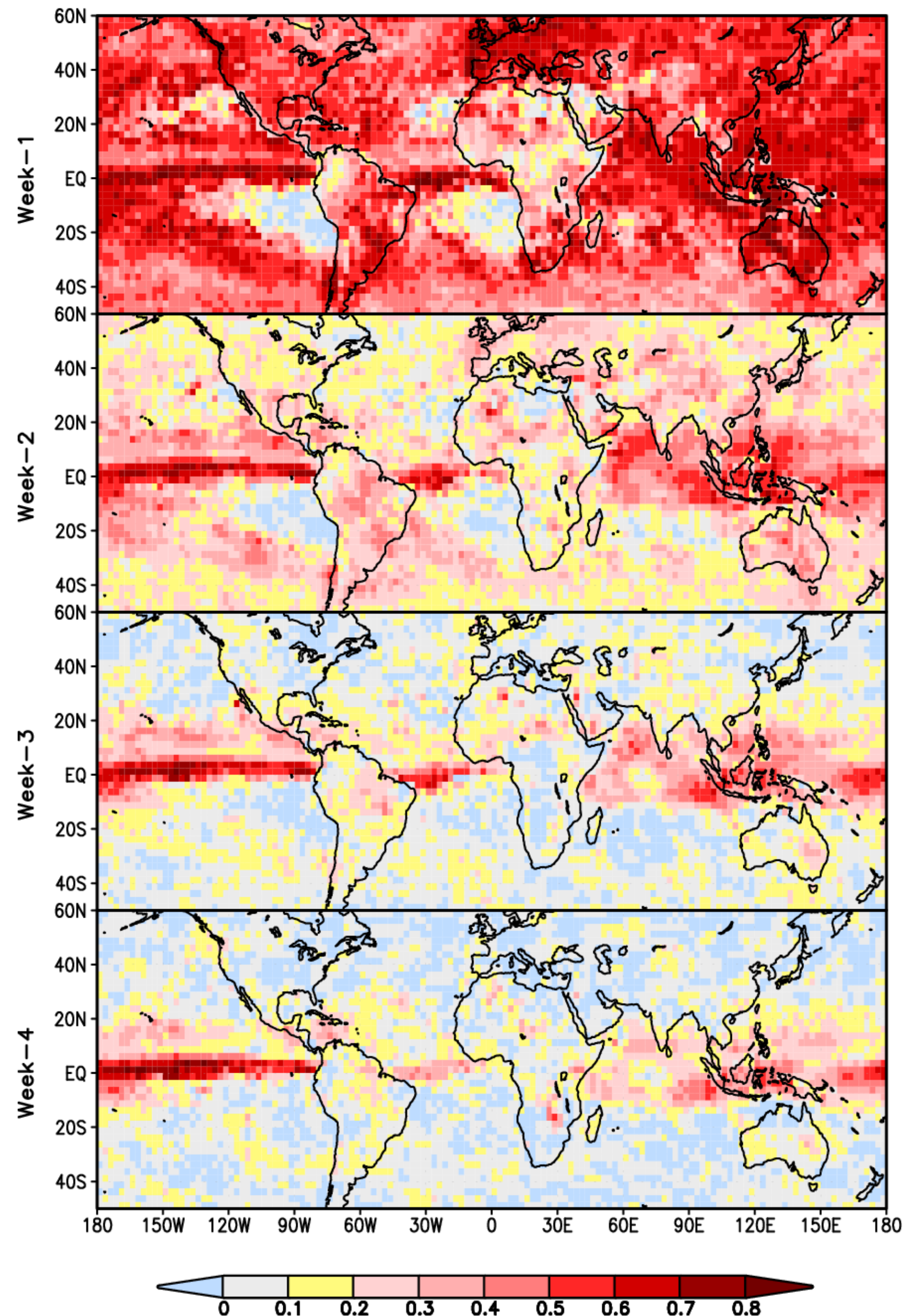


# ECMWF Sub-monthly forecast skill

Weekly average  
CMAP precipitation  
**Anomaly Correlation**

Jun–Aug  
1992–2008

Li and Robertson (2015)



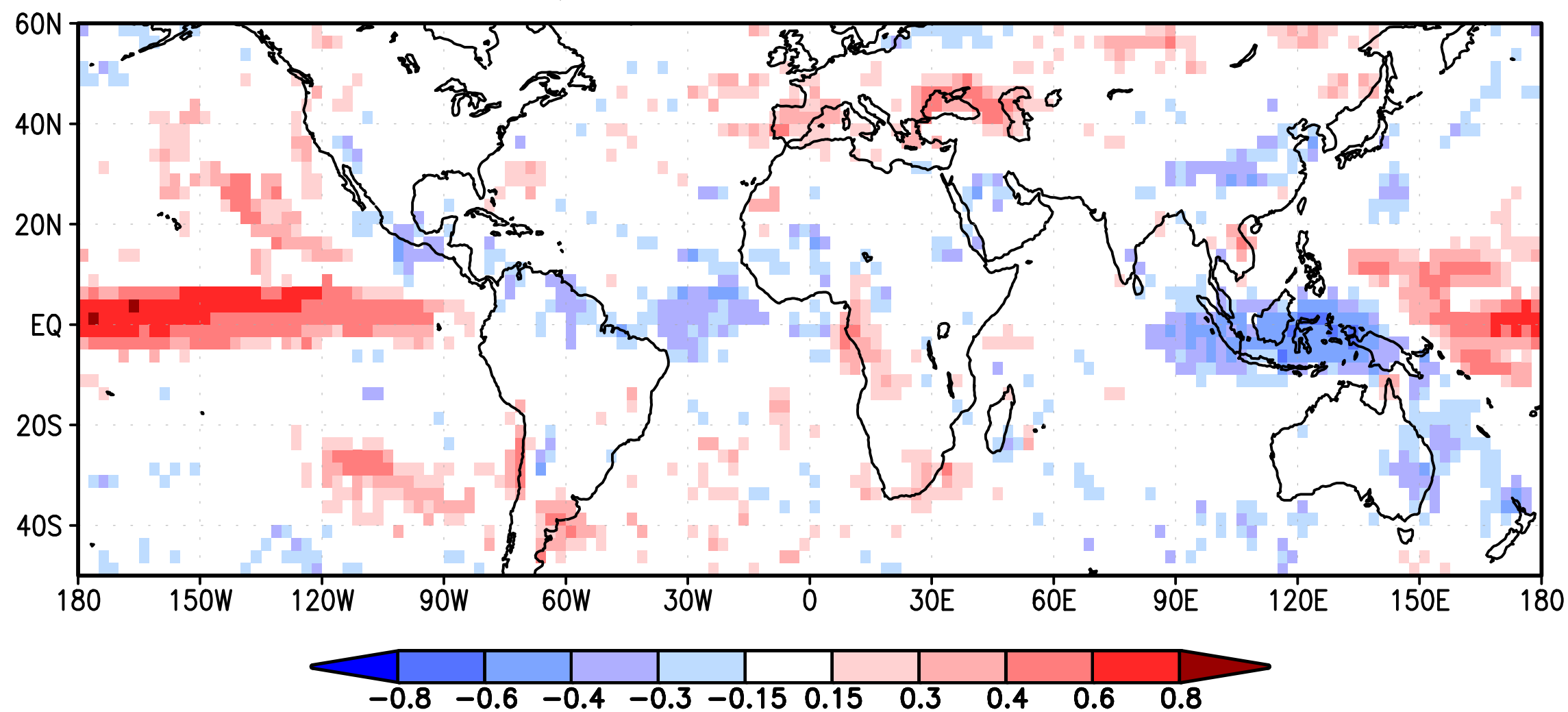
*Skill from  
Atmospheric  
Initial Conditions*

*Skill from  
MJO  
& Tropospheric  
Boundary Conditions*

# ENSO & MJO Precipitation Teleconnections

## Niño 3.4 Index

CMAP Precip vs ENSO: JJA 1992–2008

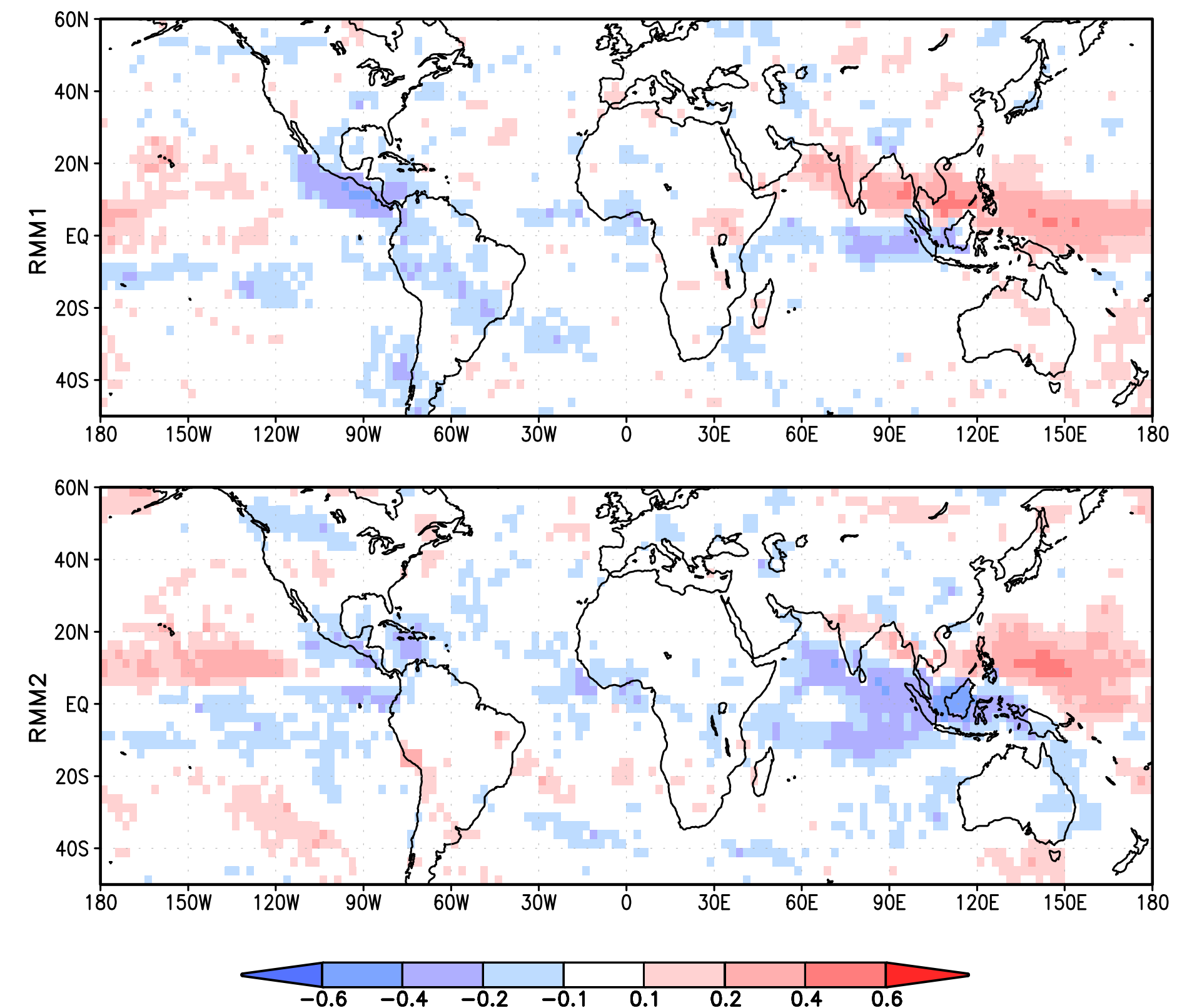


**Jun–Aug  
Anomaly correlation coefficient**

- Both MJO and ENSO play a role

## MJO RMM Indices

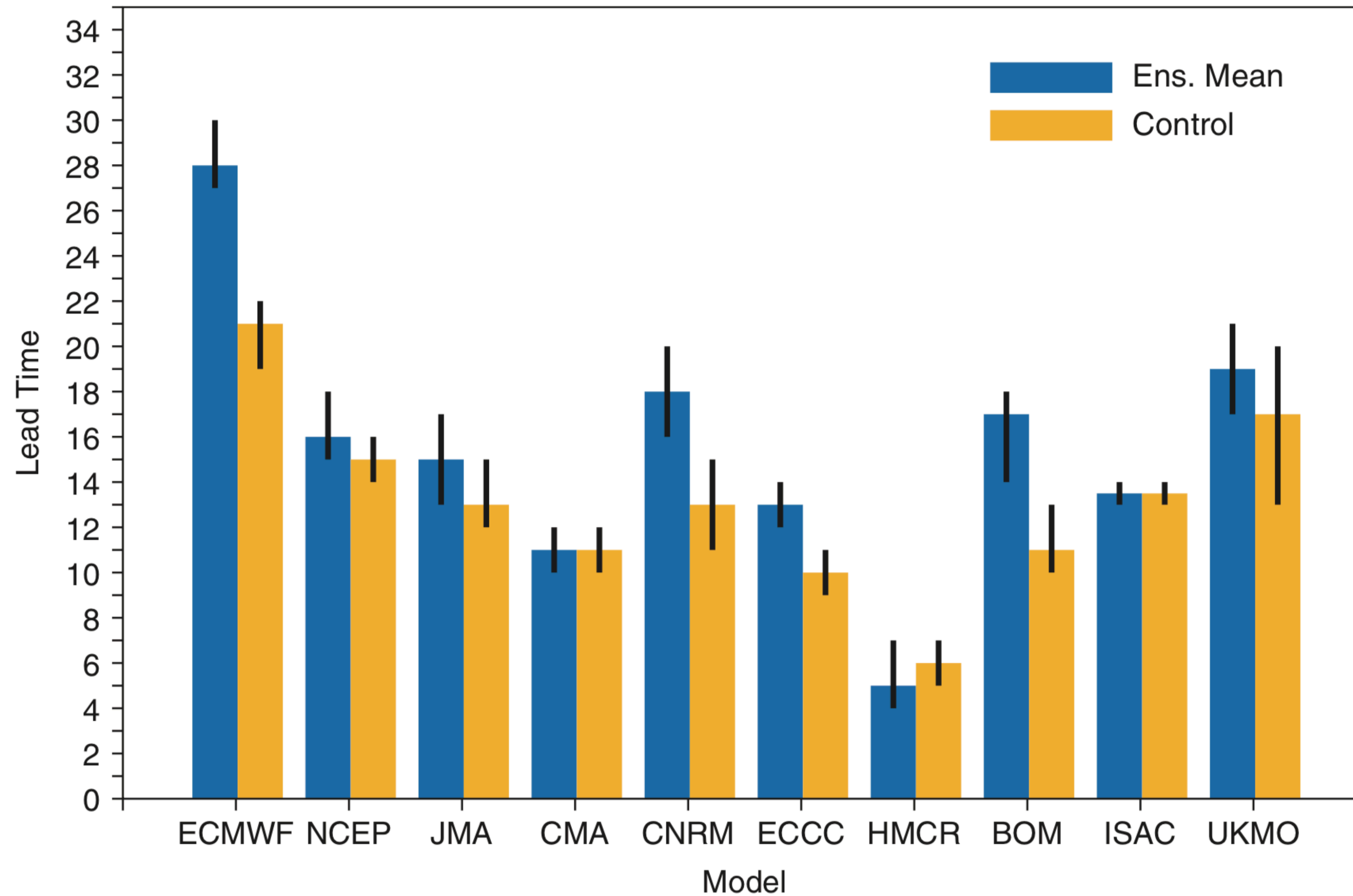
CMAP pentad precip vs RMM: Jun–Aug 1992–2008



Li and Robertson (2015)



# MJO Forecast Horizon now reaches up to 4 weeks ahead

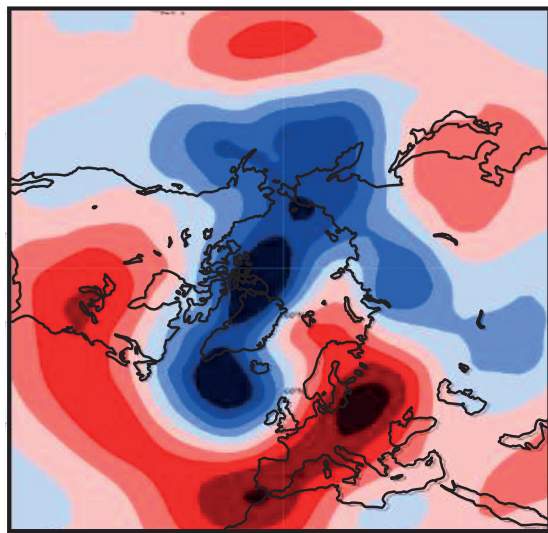


Vitart (2017, QJ)

**Figure 2.** Forecast lead time (in days) when the MJO bivariate correlation between the model ensemble means and control run reaches 0.6. The vertical black bars represent the 95% level of confidence computed from a 10 000 bootstrap re-sampling procedure. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)].

# MJO Teleconnections (S2S re-forecasts)

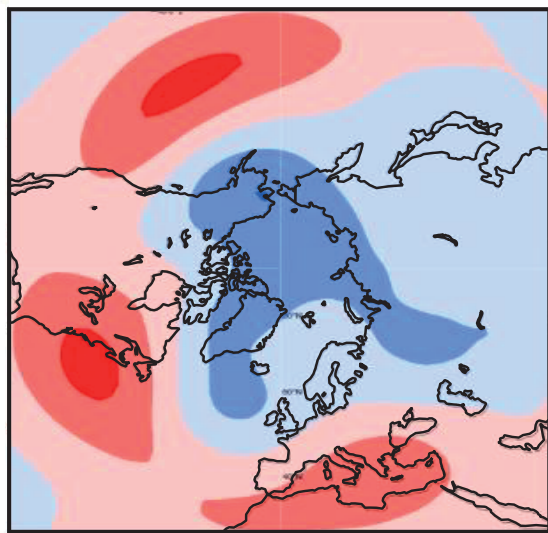
El 0.48



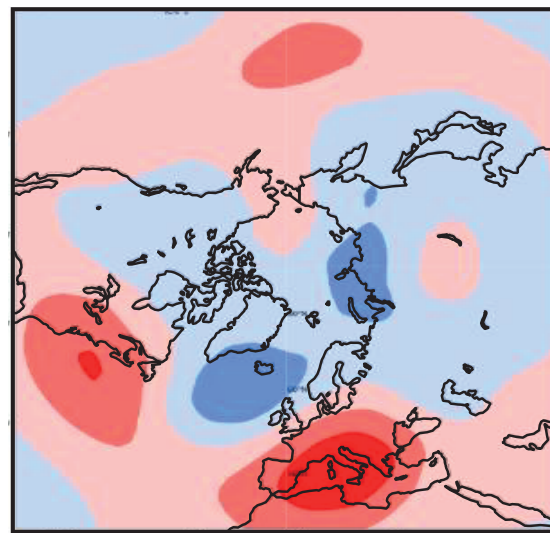
Z500 anomalies 10 days after an MJO in Phase 3

NAO Index: mean=0, std=1.02

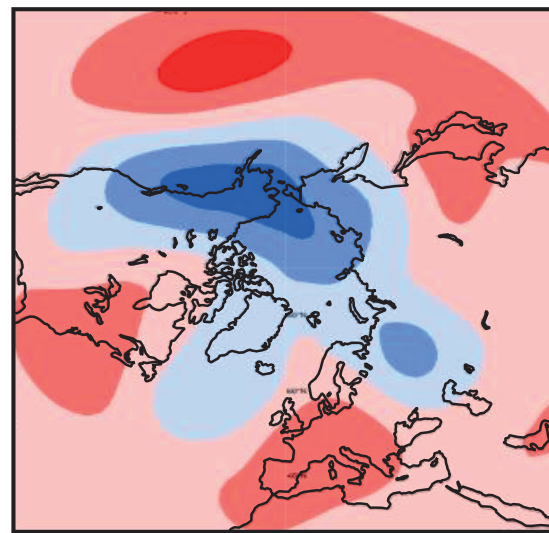
BoM 0.15



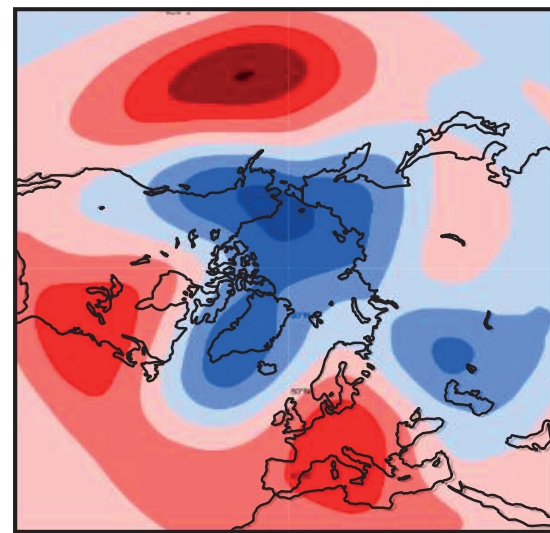
CMA 0.14



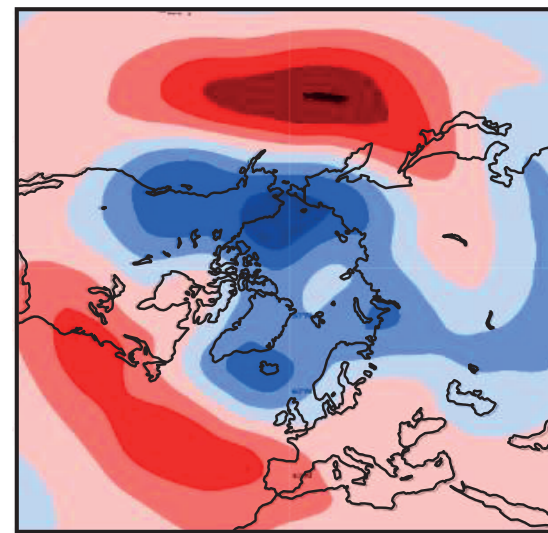
HMCR 0.13



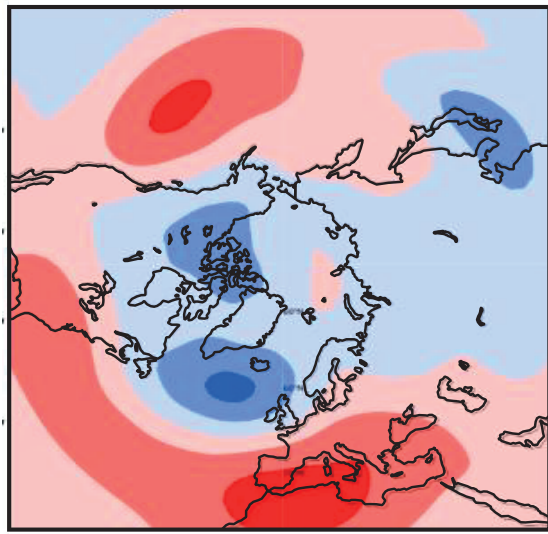
NCEP 0.32



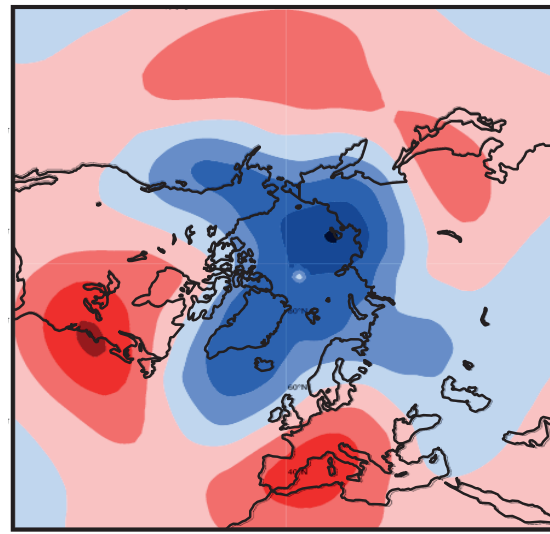
ISAC 0.25



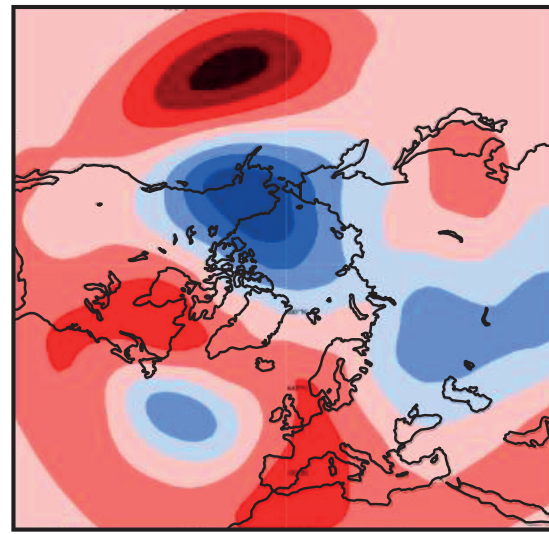
CNRM 0.15



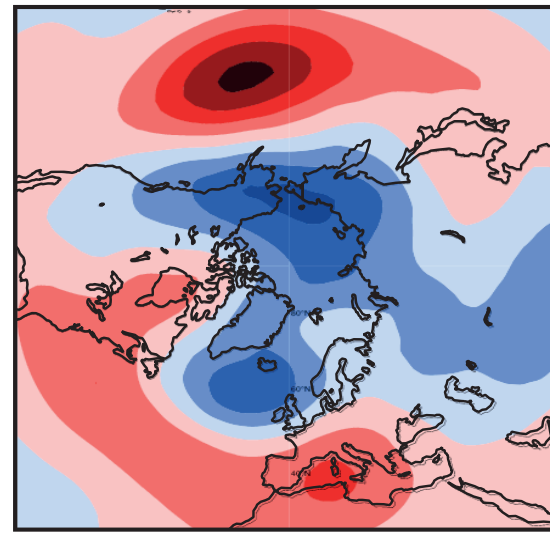
UKMO 0.29



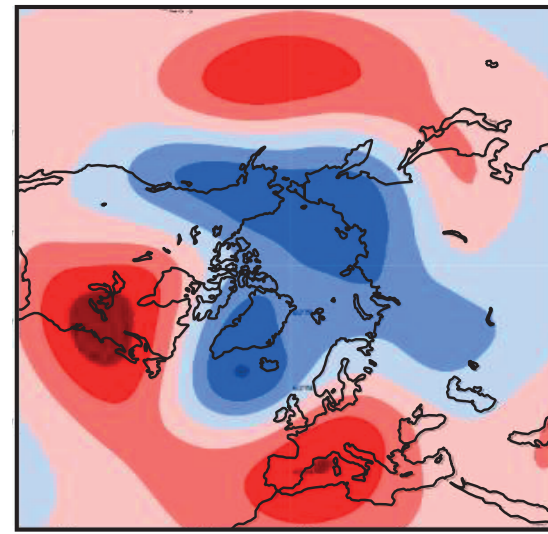
JMA 0.22



ECCC 0.21



ECMWF 0.31



<-40m

-40m - -30

-30m - -20

-20m - -10

-10m - 0

0 - 10

10 - 20

20 - 30

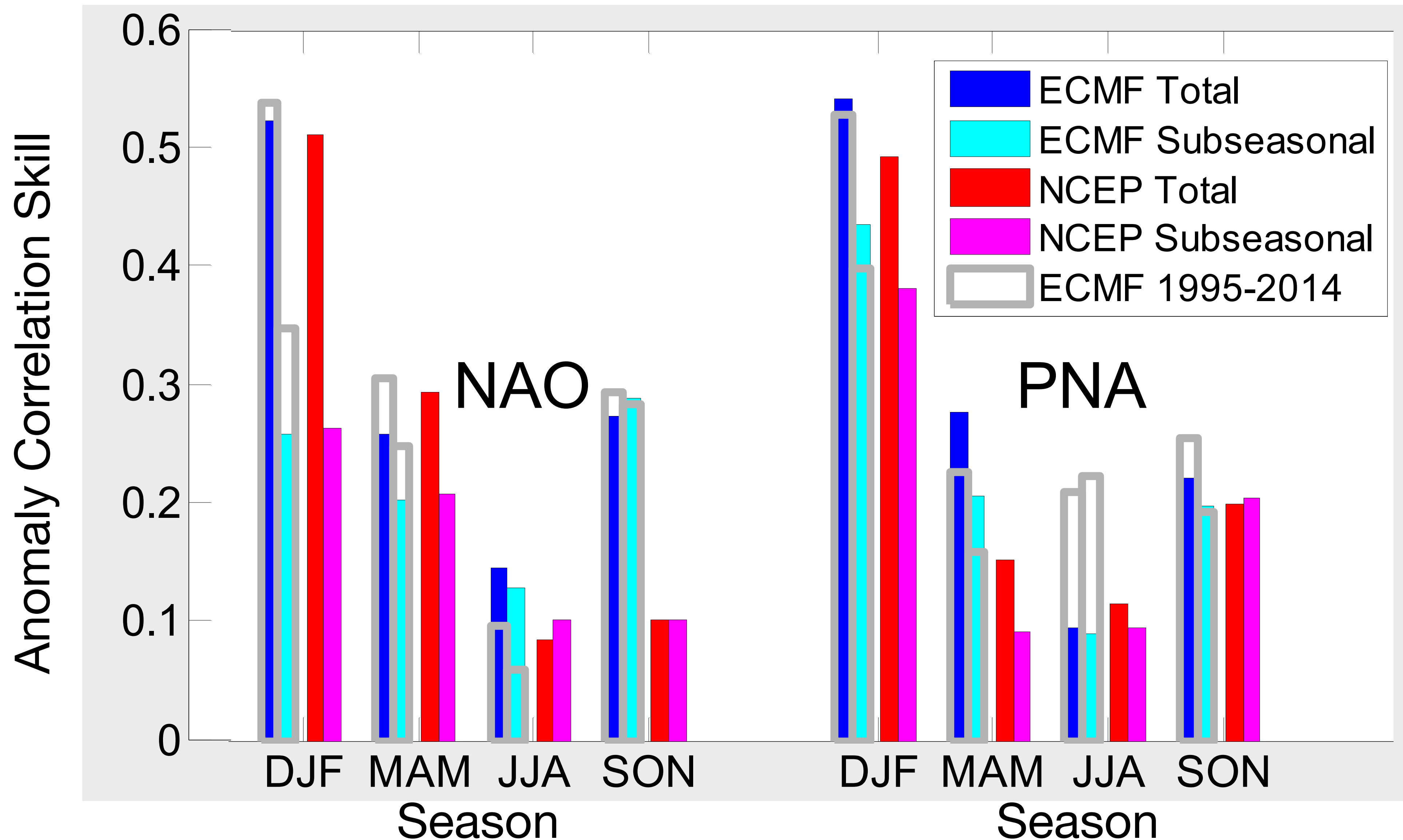
30 - 40

>40m

Vitart (2017, QJ)



# Week 3+4 Anomaly Correlation Skill of Teleconnection Indices



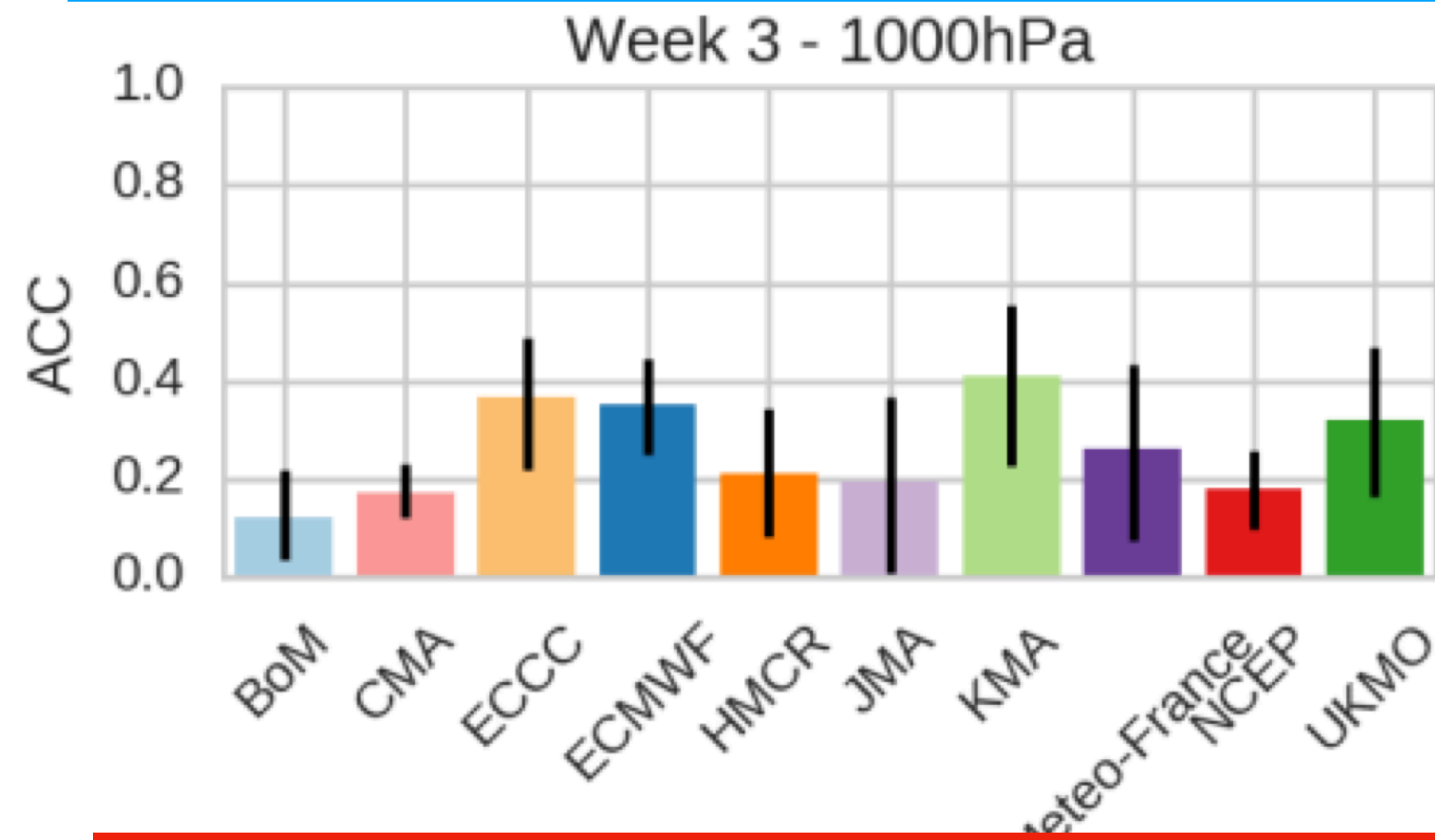
*Skill mostly in DJF; mostly subseasonal in PNA; interannual in NAO*

Wang and Robertson (2018)

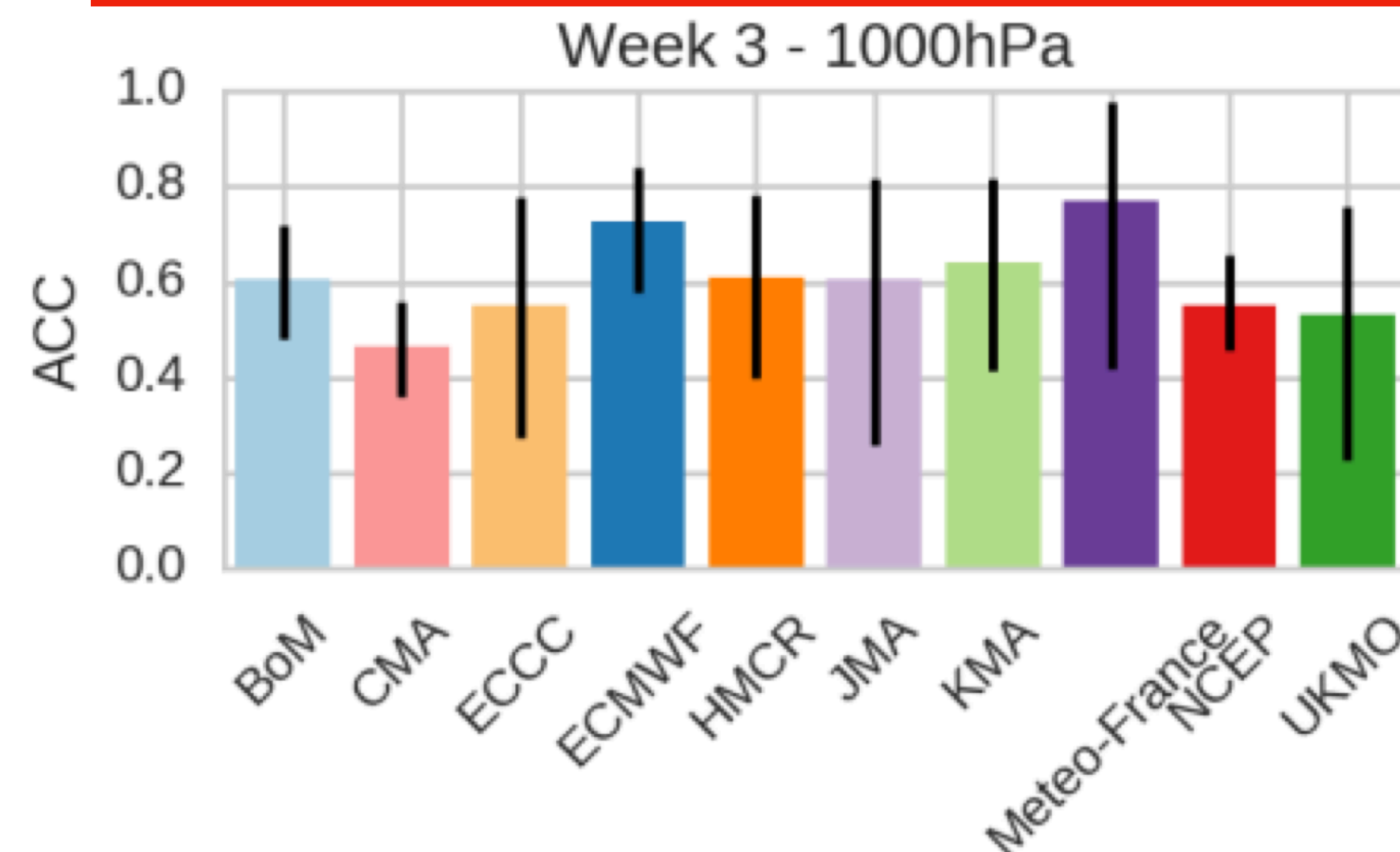


# Stratosphere

## Neutral Stratospheric Vortex



## Weak Stratospheric Vortex



Prediction skill of the 1000 hPa Northern Annular Mode for week 3 in the S2S models

For most models, skill is higher following weak vortex conditions. Similar results are found following strong vortex conditions.

SPARC-SNAP

# Summary

- Multiple sources of predictability on the 2 weeks to a season range
- Phenomena/modes of variability: Blocking, MJO, SSWs, NAO, ENSO, QBO, ...
- Slowly varying atmospheric boundary conditions: soil moisture, snow cover/snow pack, sea ice, SST, ...
- S2S Phase II will target Land, Ocean, Stratosphere, Aerosols