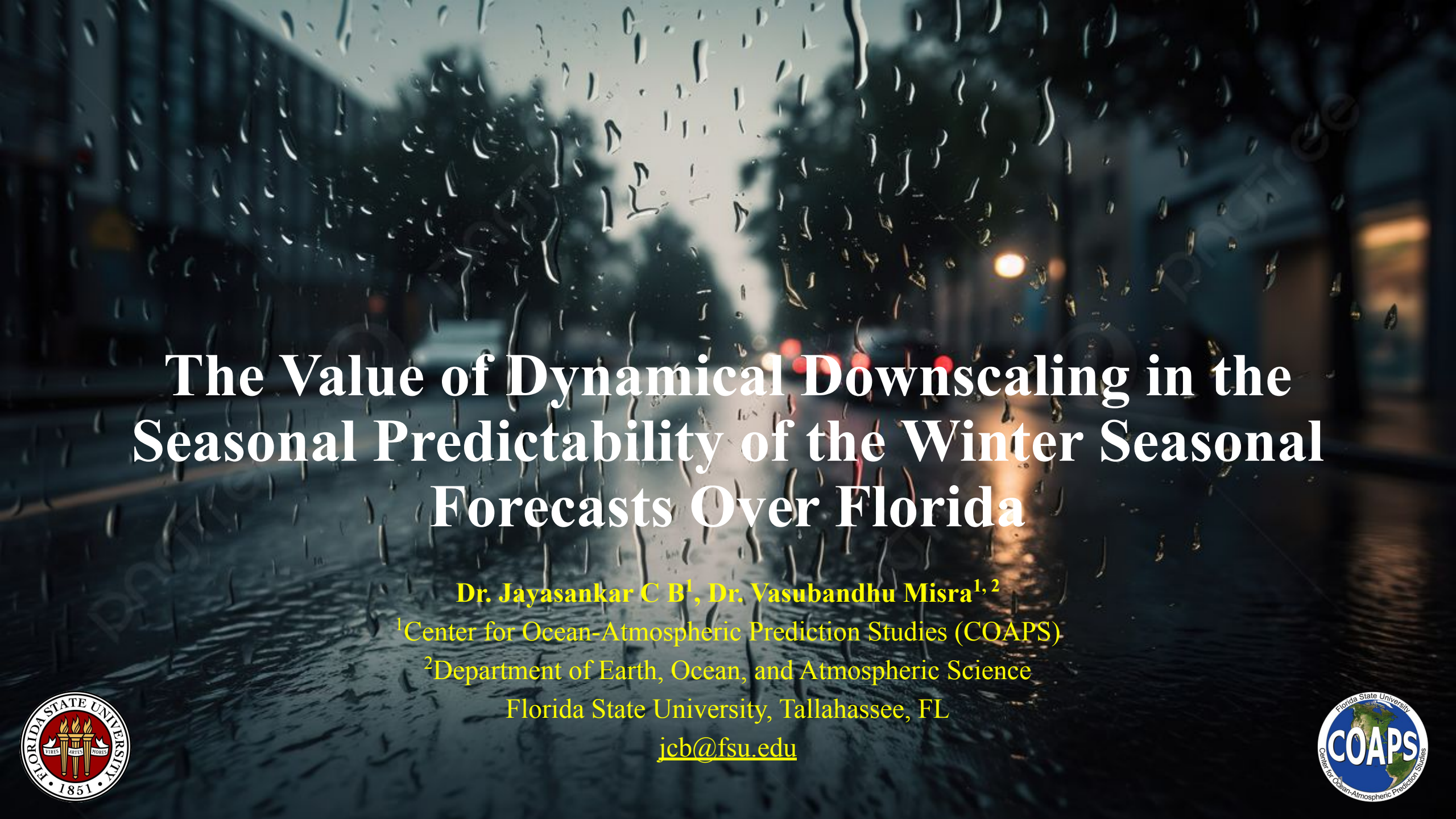

The Value of Dynamical Downscaling in the Seasonal Predictability of the Winter Seasonal Forecasts Over Florida

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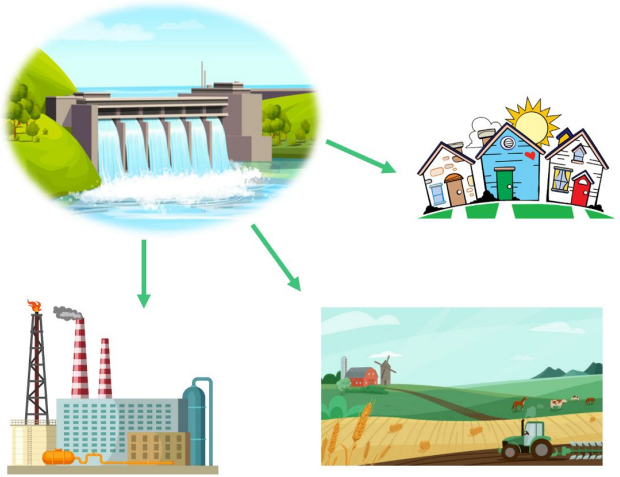
INTRODUCTION

- **Florida's Spring Season**:
  - The driest season in the state, characterized by reduced precipitation and increased water scarcity

- **Importance of Water Allocation**:
  - Critical for various sectors including agriculture, industry, and residential use, particularly in regions prone to water scarcity like Florida.

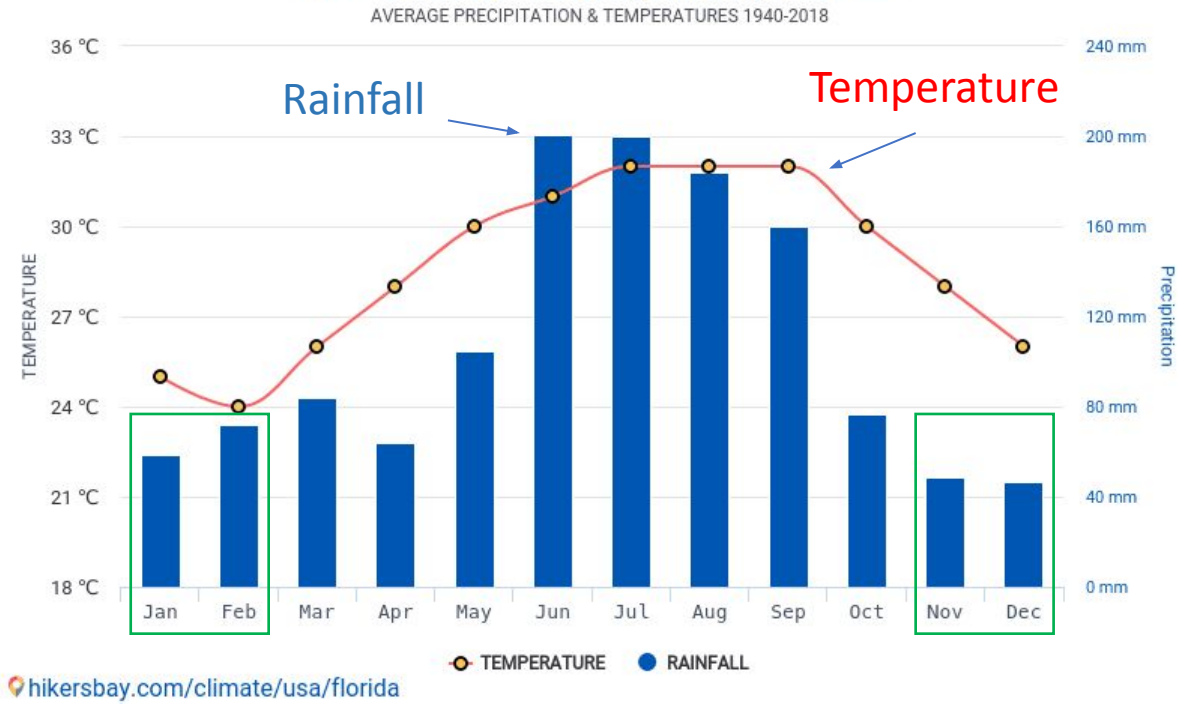


INTRODUCTION

- **Planning Based on Winter Demand**:
  - Water managers rely on historical data of water demand during the winter season to inform their planning and allocation strategies for the subsequent spring season.

- **Significance of Winter Planning**:
  - Effective planning is essential for ensuring adequate water resources are allocated to meet the anticipated demand
  - It helps to mitigate potential shortages or overages

INTRODUCTION

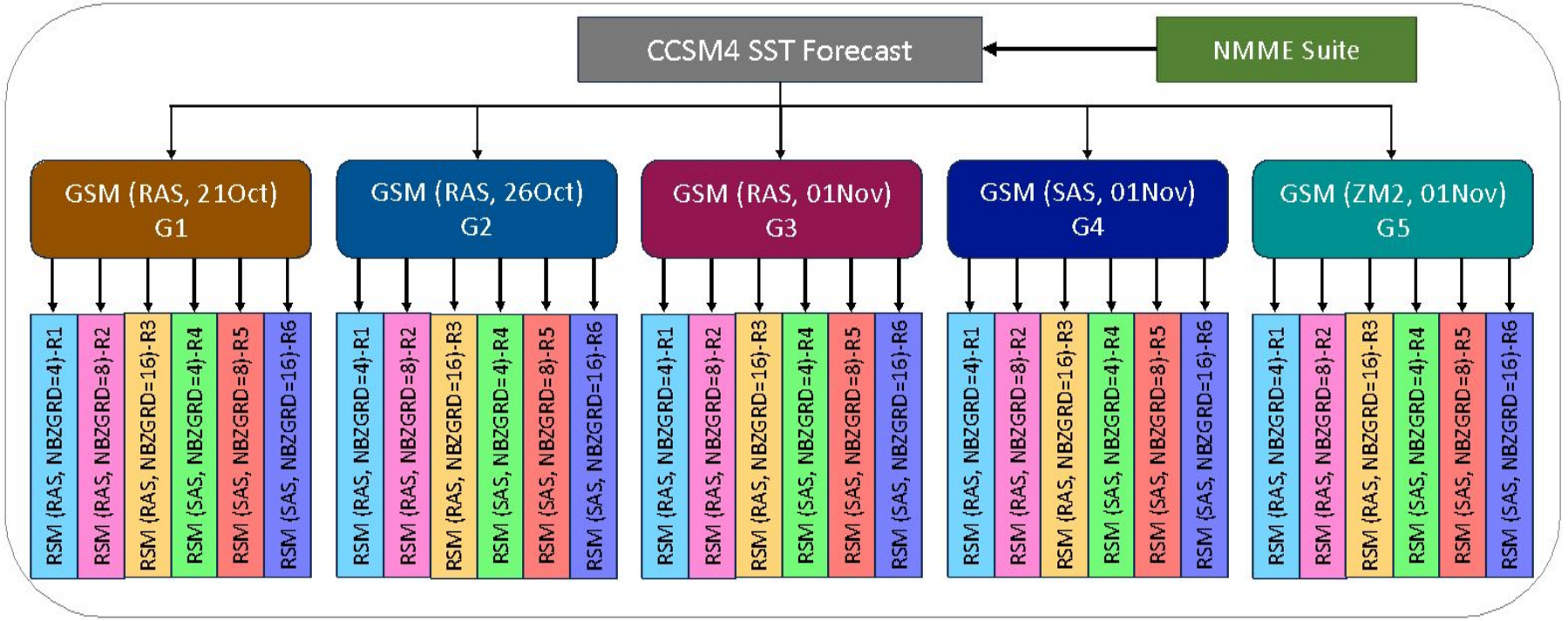


Winter (November - February) rainfall is around 18 % of total annual rainfall

What we do?

- Develop “customized” winter seasonal forecasts for Florida; **CLIFF**: experimental seasonal **CLI**mate **F**orecasts for **F**lorida
- Communicate the CLIFF forecast with the water managers and Water Management District officials

Model Framework for Experimental Winter Forecast



- Three different ICs
- Three different Parameterizations

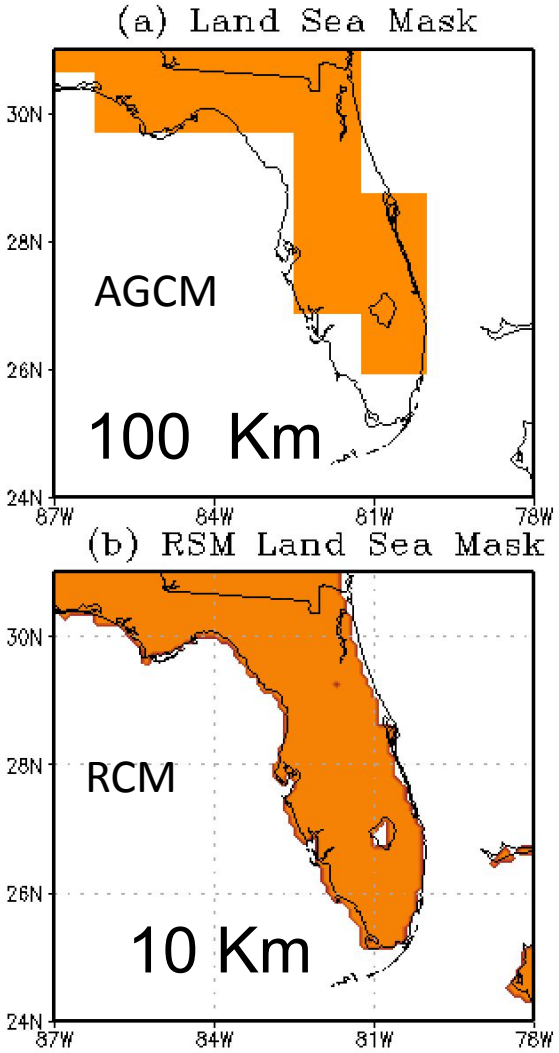
- Three different widths of the sponge zone
- Two different Parameterizations

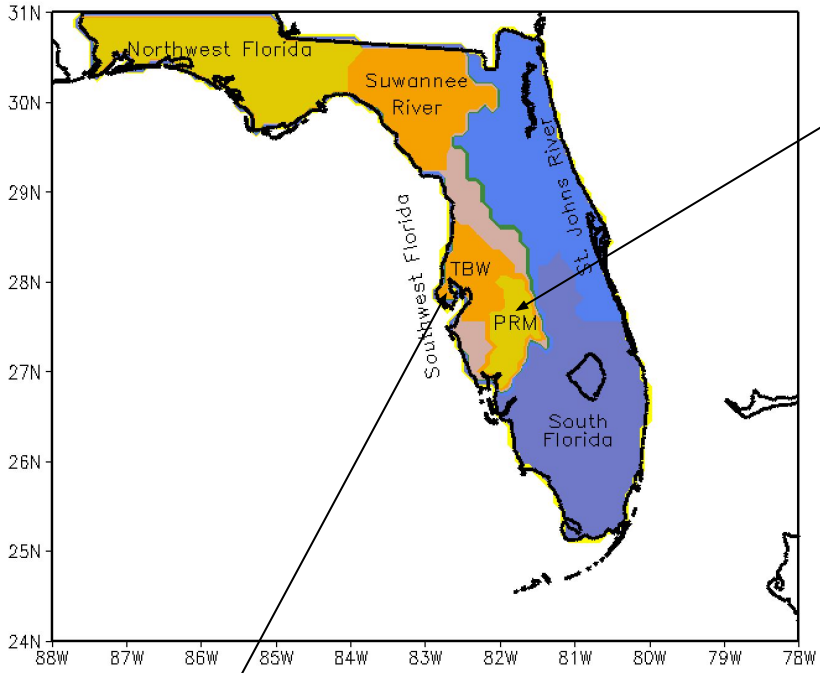
5 - Global Models X 6 - Regional Models → **30 ensemble member regional seasonal climate forecasts at a 10-km grid spacing over Florida**

Model Description

Physical Parameterization	AGCM	RSM
Deep convection	1) RAS: Moorthi and Suarez (1992) 2) SAS: Hond and Pan (1998) 3) ZM: Zhang and McFarlane (1995)	1) RAS: Moorthi and Suarez (1992) 2) SAS: Hond and Pan (1998)
Shallow convection	Tiedtke (1983)	Tiedtke (1983)
Cloud Scheme	Slingo (1987)	Zhao and Carr (1997)
Boundary layer	Hong and Pan (1996)	Hong and Pan (1996)
Land Model	Ek et al. (2003)	Ek et al. (2003)
Gravity wave drag	Alpert et al. (1988)	Alpert et al. (1988)
Longwave radiation	Chou and Lee (1996)	Chou and Lee (1996)
Shortwave radiation	Chou and Suarez (1994)	Chou and Suarez (1994)

METHODOLOGY





47 grid points

73 grid points

Five Water Management Districts (WMDs) of Florida:

1) South Florida (SFWMD)
2) Southwest Florida (SWFWMD)
3) St. Johns River (SJRWMD)
4) Suwannee River (SRWMD)
5) Northwest Florida (NWFWMD)

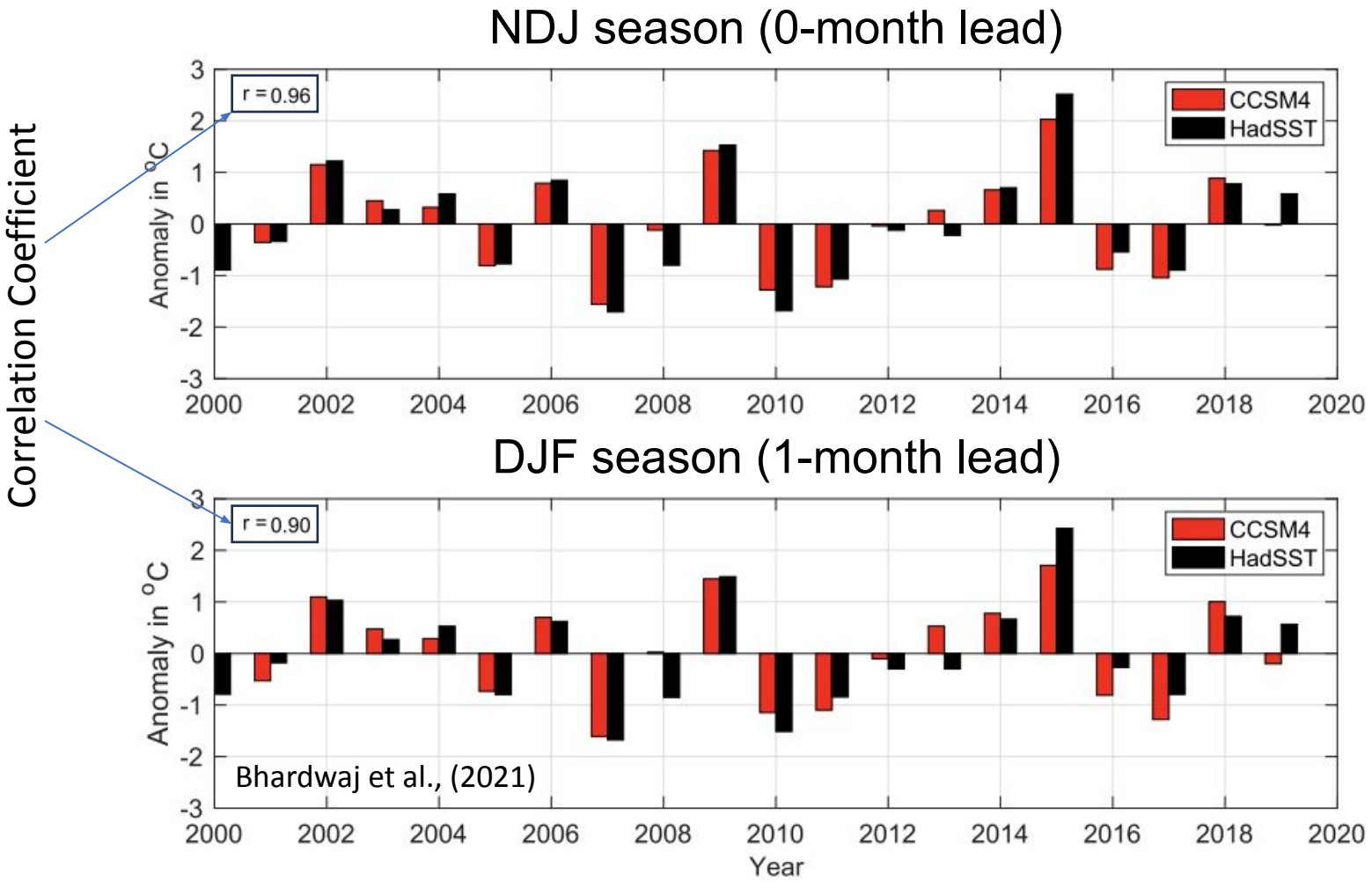
Two Water Suppliers Within SWFWMD

6) Peace River Water Supply (PRM)
7) Tampa Bay Water Supply (TBW)

- High-resolution models, such as CLIFF, represent realistic regional characteristics of Florida
- Such models are essential for providing reasonable seasonal forecasts tailored to local-scale needs

VERIFICATION

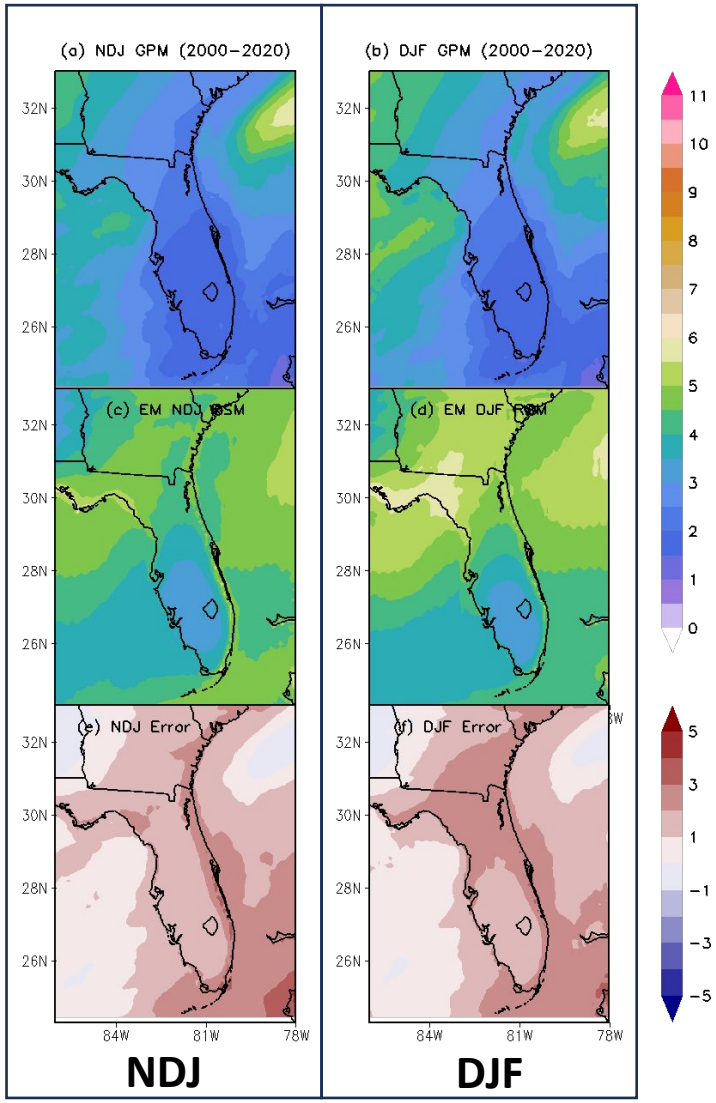
Seasonal forecast anomalies of SST over the Niño 3.4 region from CLIFF vs. HadSST
(both at zero-month lead NDJ and at one-month lead DJF)



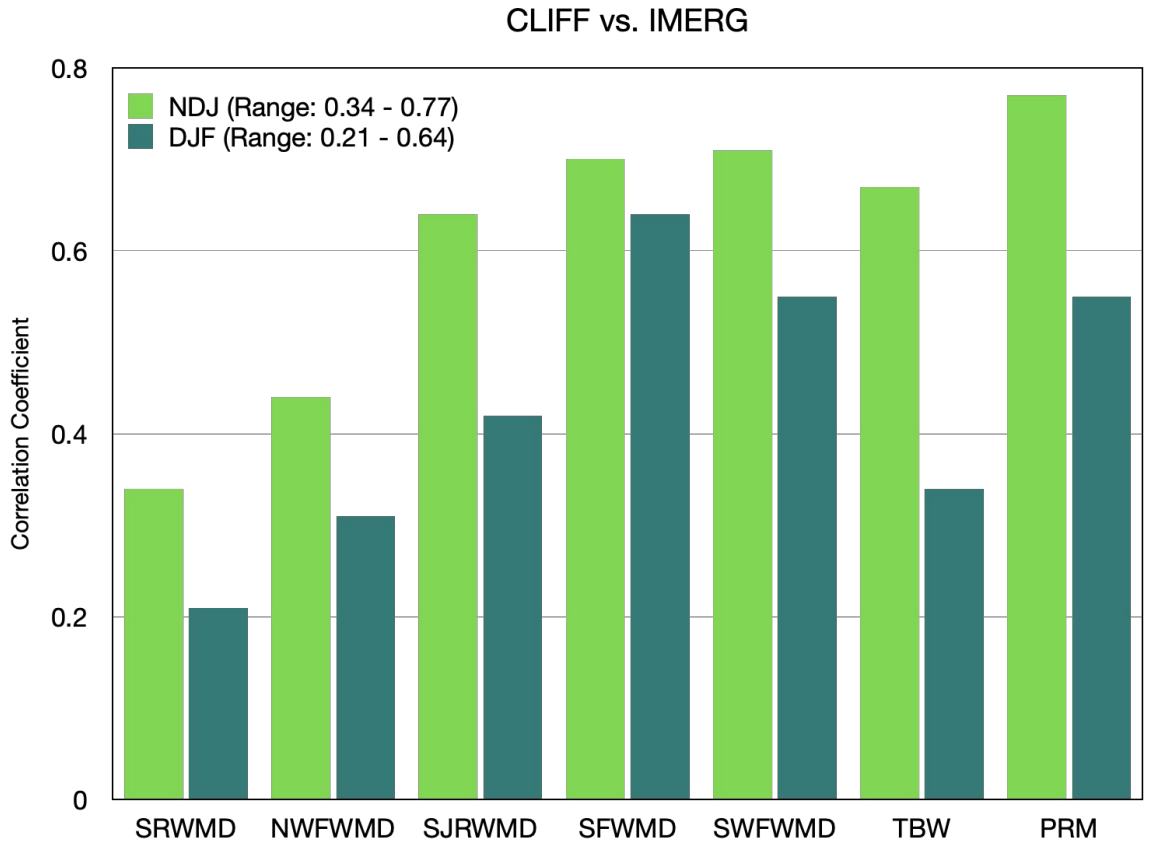
- The forecasted Niño-3.4 SST anomalies exhibit exceptionally high fidelity, indicating CLIFF's proficiency, particularly in remote ENSO forcing

VERIFICATION

Reforecast Verification: Seasonal Precipitation

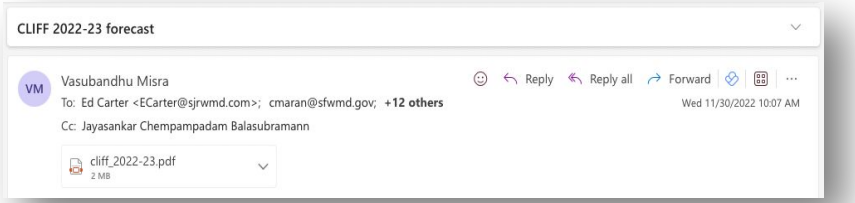


CLIFF has wet bias!

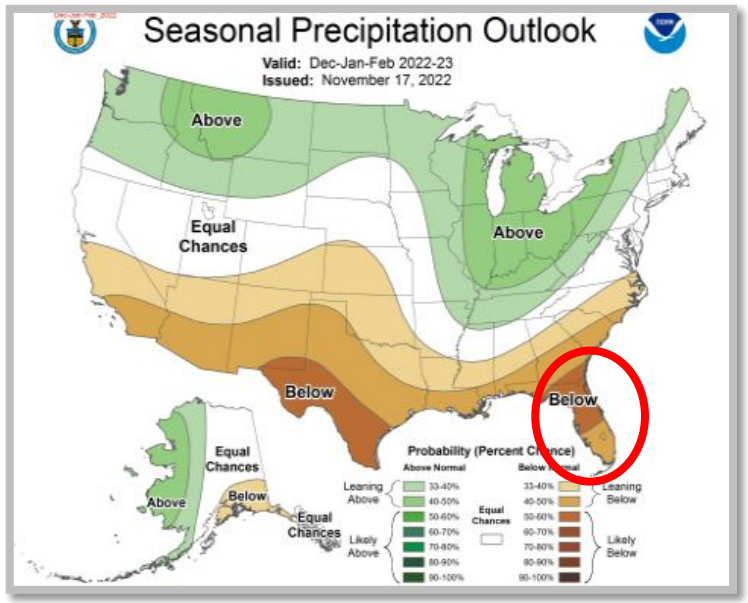


Real-time 2022-23 winter Forecast

- We issued three real-time seasonal predictions for the period 2020-2021, 2021-2022, and **2022-2023**, and all of which produced promising results

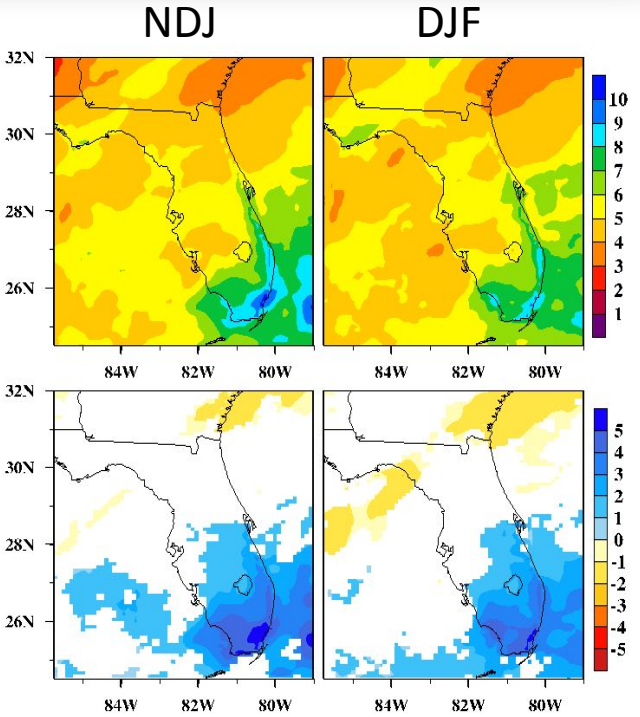


Climate Prediction Center Outlook



Source: https://www.cpc.ncep.noaa.gov/

- CPC calls for below-normal rainfall over Florida
- CLIFF suggests above normal over south Florida and near normal forecast for rainfall across other regions
- The first half of the winter season will likely be slightly wetter than the second half



RESULTS

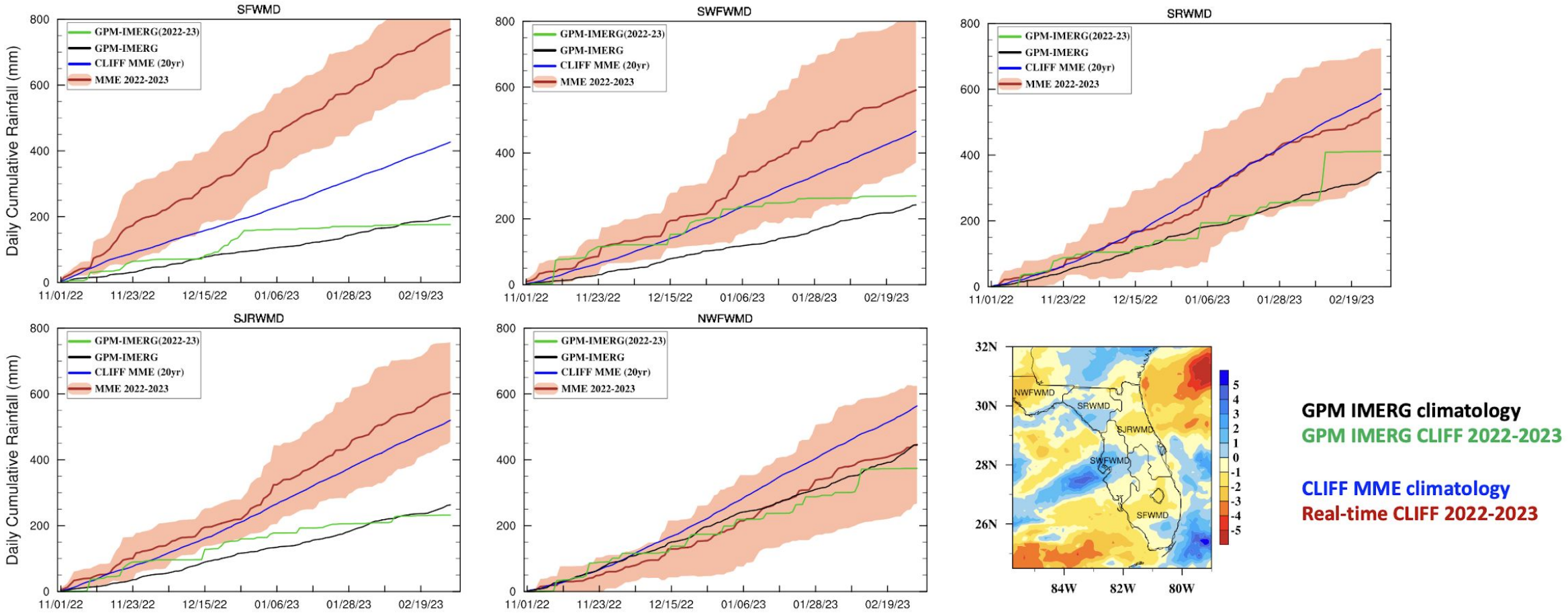


Figure: The cumulative rainfall (in mm) over a) SFWMD, b) SWFWMD, c) SRWMD, d) SJRWMD, and d) NWFWMD from 1 November 2022 to 28 February 2023 of the following year for the ensemble mean (red line) and the individual ensemble members (shaded) of CLIFF. The solid blue line is the corresponding model climatological cumulative rainfall for the season, and the black line is the observed climatology. The solid green line is observation for 2022-2023. The spatial map is Nov-Feb rainfall anomaly for this 2022-2023.

- Despite its wet bias, CLIFF demonstrated reliability in forecasting winter seasonal precipitation anomalies over Florida

RESULTS

- Winter seasonal rainfall anomalies in Florida have a strong influence on ENSO teleconnections

Year	CPC Website		
	SON	OND	NDJ
2001	-0.3	-0.3	-0.3
2002	1.2	1.3	1.1
2003	0.3	0.4	0.4
2004	0.7	0.7	0.7
2005	-0.3	-0.6	-0.8
2006	0.8	0.9	0.9
2007	-1.3	-1.5	-1.6
2008	-0.4	-0.6	-0.7
2009	1	1.4	1.6
2010	-1.6	-1.6	-1.6
2011	-1	-1.1	-1
2012	0.3	0.1	-0.2
2013	-0.2	-0.2	-0.3
2014	0.5	0.6	0.7
2015	2.4	2.6	2.6
2016	-0.7	-0.7	-0.6
2017	-0.7	-0.8	-1
2018	0.8	0.9	0.8
2019	0.3	0.5	0.5
2020	-1.2	-1.3	-1.2
2021	-0.8	-1	-1
2022	-1	-0.9	-0.8

Year	CPC	Forecast for WMDs based on CLIFF MME						
		PRM	TMP	NFWMD	SWFWMD	SFWMD	SRWMD	SJRWMD
2001	BN	NN	BN	NN	BN	NN	BN	BN
2002	AN	AN	AN	AN	AN	NN	AN	AN
2003	BN	NN	NN	NN	NN	NN	NN	NN
2004	NN	NN	NN	NN	NN	NN	NN	NN
2005	NN	BN	BN	BN	BN	BN	BN	BN
2006	AN	NN	NN	BN	NN	NN	NN	NN
2007	BN	BN	BN	BN	BN	NN	BN	BN
2008	NN	BN	NN	AN	NN	BN	AN	NN
2009	AN	AN	AN	AN	AN	AN	AN	AN
2010	BN	NN	NN	BN	NN	NN	NN	NN
2011	BN	NN	NN	NN	BN	BN	BN	BN
2012	NN	NN	NN	NN	NN	BN	NN	NN
2013	BN	NN	NN	NN	NN	NN	NN	NN
2014	AN	NN	NN	NN	NN	NN	NN	NN
2015	AN	AN	AN	AN	AN	AN	AN	AN
2016	BN	BN	BN	NN	NN	BN	NN	BN
2017	BN	BN	BN	BN	BN	BN	BN	BN
2018	AN	AN	AN	AN	AN	AN	AN	AN
2019	NN	NN	NN	NN	NN	NN	NN	NN
2020	BN	AN	AN	AN	AN	AN	AN	AN
2021	BN	BN	BN	BN	BN	AN	BN	NN
2022	BN	AN	AN	NN	AN	AN	NN	AN

- PRM -> 14 / 22
- TMP -> 12 / 22
- NWFWMD -> 9 / 22
- SWFWMD -> 12 / 22
- SFWMD -> 12 / 22
- SRWMD -> 14 / 22
- SJRWMD -> 12 / 22

NN - Normal **AN** - Above Normal **BN** - Below Normal

*Years, when CLIFF verifies with CPC Seasonal prediction outlook, are marked in bold

RESULTS

El Niño Years

Year	CPC Website		
	SON	OND	NDJ
2002	1.2	1.3	1.1
2004	0.7	0.7	0.7
2006	0.8	0.9	0.9
2009	1	1.4	1.6
2014	0.5	0.6	0.7
2015	2.4	2.6	2.6
2018	0.8	0.9	0.8

Year	CPC	Forecast for WMDs based on CLIFF MME						
		PRM	TMP	NFWMD	SWFWMD	SFWMD	SRWMD	SJRWMD
2002	AN	AN	AN	AN	AN	NN	AN	AN
2004	NN	NN	NN	NN	NN	NN	NN	NN
2006	AN	NN	NN	BN	NN	NN	NN	NN
2009	AN	AN	AN	AN	AN	AN	AN	AN
2014	AN	NN	NN	NN	NN	NN	NN	NN
2015	AN	AN	AN	AN	AN	AN	AN	AN
2018	AN	AN	AN	AN	AN	AN	AN	AN

NN - Normal

AN - Above Normal

BN - Below Normal

- CLIFF accurately predicts homogenous seasonal rainfall anomalies during El Niño years

La Niña Years

Year	CPC Website		
	SON	OND	NDJ
2005	-0.3	-0.6	-0.8
2007	-1.3	-1.5	-1.6
2008	-0.4	-0.6	-0.7
2010	-1.6	-1.6	-1.6
2011	-1	-1.1	-1
2016	-0.7	-0.7	-0.6
2017	-0.7	-0.8	-1
2020	-1.2	-1.3	-1.2
2021	-0.8	-1	-1

Year	CPC	Forecast for WMDs based on CLIFF MME						
		PRM	TMP	NFWMD	SWFWMD	SFWMD	SRWMD	SJRWMD
2005	NN	BN	BN	BN	BN	BN	BN	BN
2007	BN	BN	BN	BN	BN	NN	BN	BN
2008	NN	BN	NN	AN	NN	BN	AN	NN
2010	BN	NN	NN	BN	NN	NN	NN	NN
2011	BN	NN	NN	NN	BN	BN	BN	BN
2016	BN	BN	BN	NN	NN	BN	NN	BN
2017	BN	BN	BN	BN	BN	BN	BN	BN
2020	BN	AN	AN	AN	AN	AN	AN	AN
2021	BN	BN	BN	BN	BN	AN	BN	NN

- Many cold (La Niña) years and ENSO neutral years, the seasonal rainfall anomalies are more heterogeneous

Concluding Remarks

- The winter seasonal forecast from CLIFF at the WMD level is encouraging
- Customized seasonal forecasts like CLIFF show a clear advantage over CPC outlook
- El Niño years show consistent and pronounced ENSO teleconnections in Florida's winter rainfall anomalies, CLIFF's verification underscores the greater variability observed during La Niña and ENSO neutral years
- CLIFF's spatial resolution and 30-member ensemble spread to resolve internal variations contribute to its skill

Thank You

Questions?

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Real-time 2021-22 winter Forecast

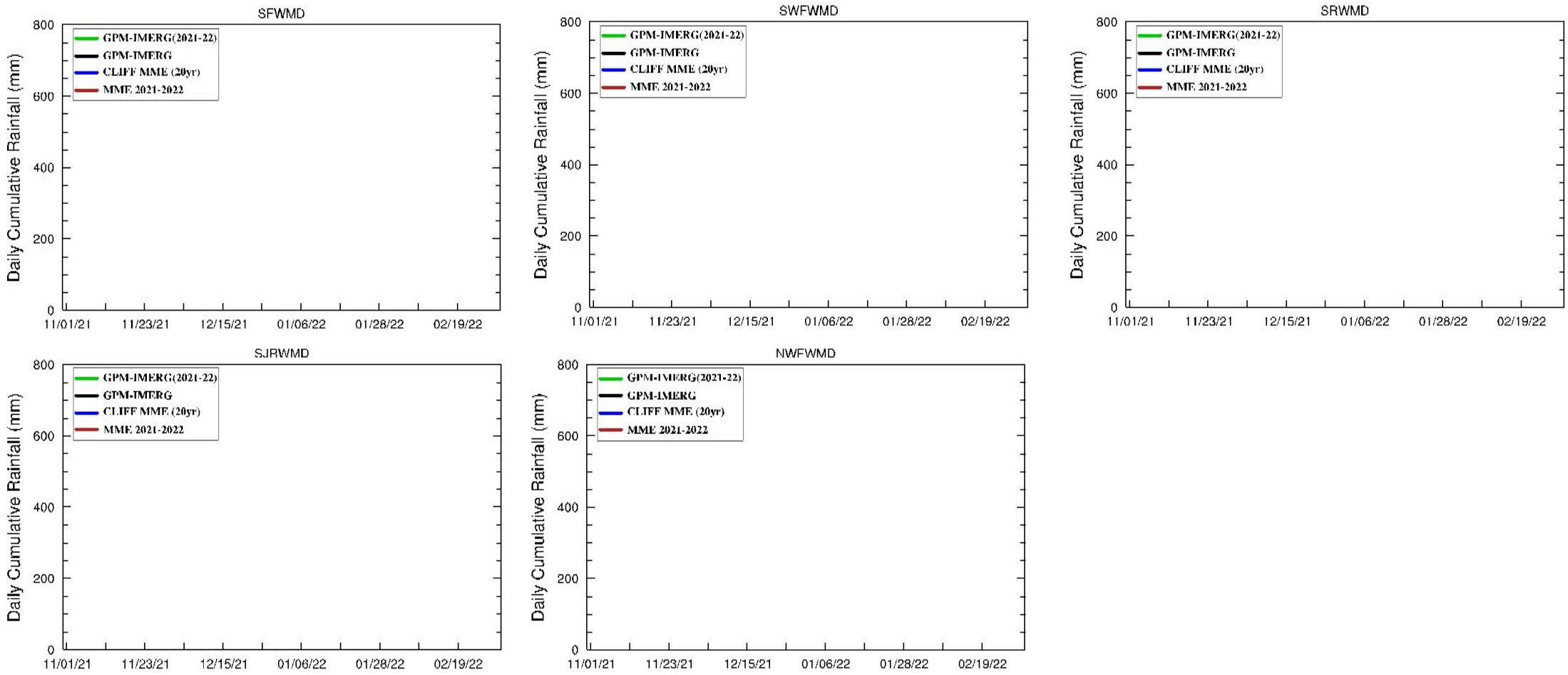

Figure: The cumulative rainfall (in mm) over a) SFWMD, b) SWFWMD, c) SRWMD, d) SJRWMD, and d) NWFWMD from 1 November 2021 to 28 February 2022 of the following year for the ensemble mean (red line) and the individual ensemble members (shaded) of CLIFF. The solid blue line is the corresponding model climatological cumulative rainfall for the season, and the black line is the observed climatology. The solid green line is the GPM observation for the 2021-2022.

ADDITIONAL RESULTS

Year	CPC Website		
	SON	OND	NDJ
2001	-0.3	-0.3	-0.3
2002	1.2	1.3	1.1
2003	0.3	0.4	0.4
2004	0.7	0.7	0.7
2005	-0.3	-0.6	-0.8
2006	0.8	0.9	0.9
2007	-1.3	-1.5	-1.6
2008	-0.4	-0.6	-0.7
2009	1	1.4	1.6
2010	-1.6	-1.6	-1.6
2011	-1	-1.1	-1
2012	0.3	0.1	-0.2
2013	-0.2	-0.2	-0.3
2014	0.5	0.6	0.7
2015	2.4	2.6	2.6
2016	-0.7	-0.7	-0.6
2017	-0.7	-0.8	-1
2018	0.8	0.9	0.8
2019	0.3	0.5	0.5
2020	-1.2	-1.3	-1.2
2021	-0.8	-1	-1
2022	-1	-0.9	-0.8

Year	CCSM4 SST (NMME)		
	SON	OND	NDJ
2001	1.26	0.61	-0.23
2002	1.56	1.49	1.27
2003	-1.37	-0.44	0.57
2004	0.14	0.25	0.45
2005	-1.53	-1.18	-0.68
2006	0.34	0.66	0.9
2007	-0.94	-1.12	-1.44
2008	-0.24	-0.1	-0.01
2009	1.8	1.69	1.54
2010	0.02	-0.62	-1.17
2011	-0.42	-0.76	-1.1
2012	-0.27	-0.09	0.09
2013	0.13	0.18	0.37
2014	-0.25	0.24	0.77
2015	1.46	1.88	2.14
2016	-0.76	-0.74	-0.77
2017	-0.18	-0.5	-0.91
2018	0.01	0.46	1
2019	0.29	0.26	0.11
2020	0.13	-0.84	-1.92
2021	-1.17	-1.31	-1.37