

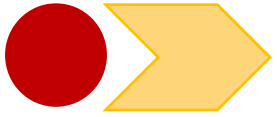
# Monitoring the onset/demise of the rainy seasons in the five water management districts of Florida

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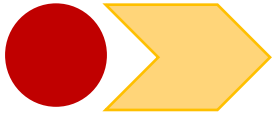


## Background

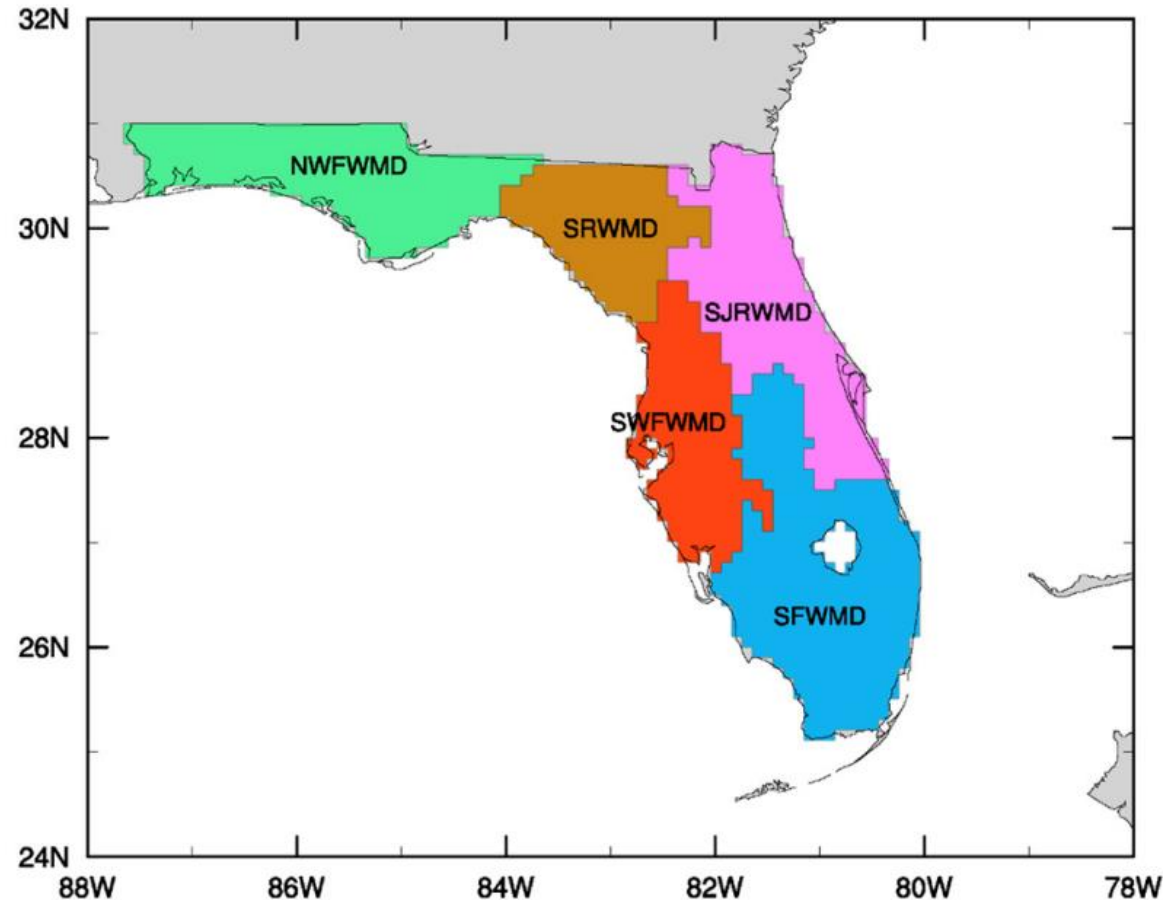
- We have shown in our earlier work (Misra et al 2017; 2020) that monitoring the onset of the rainy season has the added benefit of letting us anticipate the likelihood of the modulation of the length of the rainy season and in some instances the seasonal rainfall anomaly.
- In discussing the results for each of the Water Management Districts, we have included a correlation table of onset/demise date with seasonal length and seasonal rainfall anomaly.

The methodology and the significance of monitoring the onset/demise of the rainy season is explained in greater detail in the following references

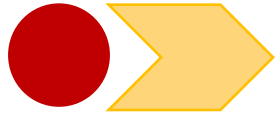
- Misra, V. and A. Bhardwaj, 2020: [Understanding the seasonal variation of Peninsular Florida](https://doi.org/10.1007/s00382-019-05091-73) Clim. Dyn., <https://doi.org/10.1007/s00382-019-05091-73>
- Misra,V., A. Bhardwaj, and A. Mishra, 2017: [Characterizing the rainy season of Peninsular Florida](https://doi.org/10.1007/s00382-017-4005-2) Clim. Dyn., [doi:10.1007/s00382-017-4005-2](https://doi.org/10.1007/s00382-017-4005-2).



# The Water Management Districts (WMD) of Florida

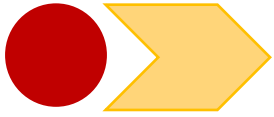


**Figure:** The domains of the five Water Management Districts (WMDs) of Florida: 1) South Florida (SFWMD), (2) Southwest Florida (SWFWMD), (3) St. Johns River (SJRWMD), (4) Suwannee River (SRWMD), (5) Northwest Florida (NFWMD).

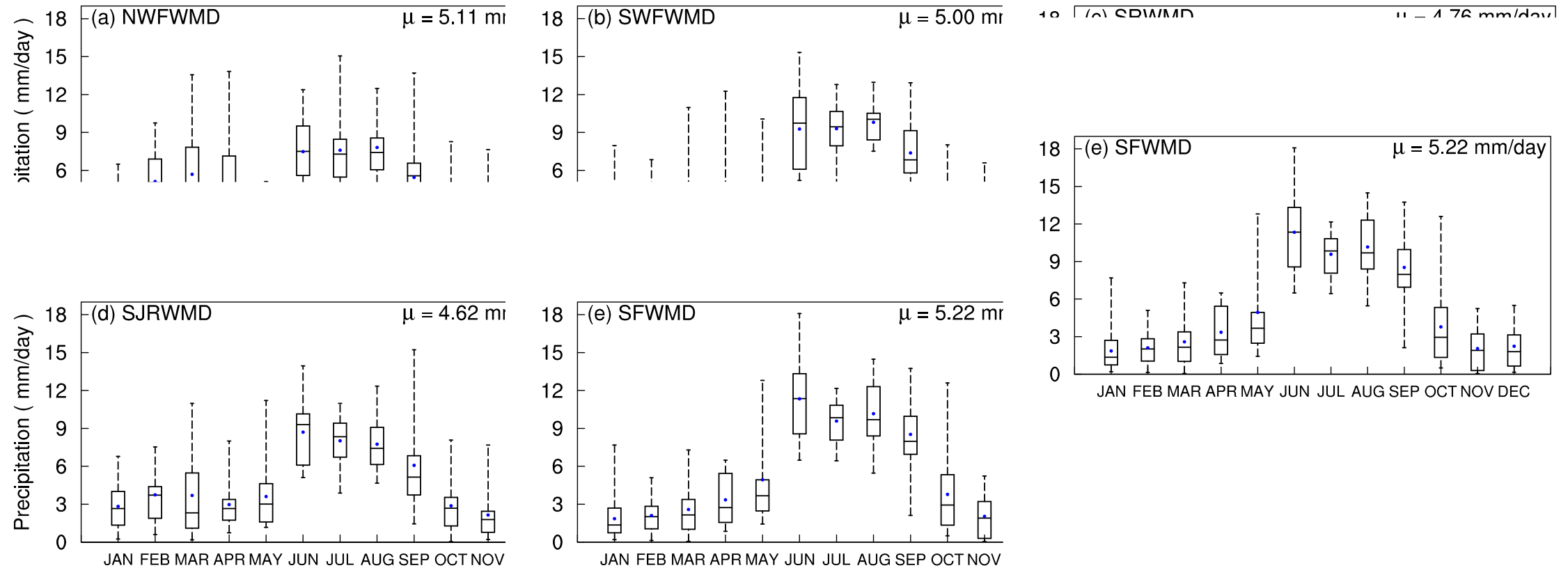


## Rainfall Dataset Used for Monitoring the Rainy Season

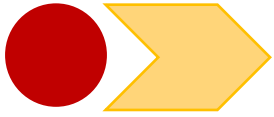
- The Integrated Multi-Satellite Retrievals for Global Precipitation Mission version 6 (IMERG) IMERG rainfall dataset comes from the Global Precipitation Measurement (GPM) mission launched in 2014 and developed jointly by NASA and the Japanese Aerospace Exploration Agency (JAXA).
- The IMERG data is available at  $0.1^\circ \times 0.1^\circ$  grid spacing at hourly interval from the year 2000 to the present.
- The IMERG dataset includes early, late, and final run products that have ~4 hour, 12 hour and 3.5 month latency.
- For this monitoring work we make use of the 12 hour latency product of IMERG.



# Monthly Mean Precipitation



**Figure:** The box and whisker plot of the monthly mean precipitation (mm/day) over (a) NFWWMD, (b) SWFWMD, (c) SRWMD, (d) SJRWMD, and (e) SFWMD. The corresponding annual mean climatology is indicated in the top right corner.

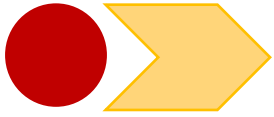


## Correlations of onset and demise dates of the rainy season with the seasonal length and seasonal rainfall anomalies

Region		Demise	Seasonal length	Seasonal rainfall
SFWMD	Onset	0.17	<b>-0.46</b>	<b>-0.41</b>
	Demise	1	<b>0.80</b>	<b>0.53</b>
SWFWMD	Onset	<b>-0.39</b>	<b>-0.79</b>	<b>-0.57</b>
	Demise	1	<b>0.87</b>	<b>0.64</b>
SJRWMD	Onset	0.11	<b>-0.45</b>	<b>-0.40</b>
	Demise	1	<b>0.84</b>	<b>0.47</b>
SRWMD	Onset	0.11	<b>-0.48</b>	<b>-0.24</b>
	Demise	1	<b>0.82</b>	<b>0.66</b>
NFWWMD	Onset	<b>0.38</b>	<b>-0.40</b>	<b>-0.50</b>
	Demise	1	<b>-0.69</b>	<b>0.34</b>

*The bold values of the correlation coefficient indicate that they are significant at 95% confidence interval according to t-test.*

- Over all the WMDs, early or later onset of the season is likely to be associated with longer or shorter and wetter or drier season, respectively.

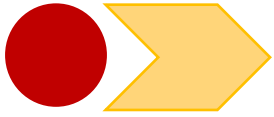


## Rainy Season Outlook

- We issued outlooks during 16 May, 21 May, May 25, May 28, June 1, June 4, June 8, June 11, June 15, July 16, Aug 16, Sep 16, Sep 22, and Sep 29
- The rainy season onset has occurred in all WMDs (by 15<sup>th</sup> June update)
- The onset in all WMDs are within climatological onset date +  $0.75 \times \sigma$ , where  $\sigma$  is standard deviation of the onset date.

Region	Onset date Climatology	Delay of 2021 rainy season onset relative to onset date climatology	0.75 X Standard deviation of onset date variability (in days)
SFWMD	23 May	6	7
SWFWMD	30 May	2	8
SJRWMD	29 May	3	8
SRFWMD	30 May	6	9
NWFWMD	11 Jun	4	13

- Since the onset date variations are within the normal range ( $\pm\sigma$ ), we anticipate a greater likelihood of **near normal rainy season** over all WMDs



# Cumulative Anomaly Curve up to September 28, 2021

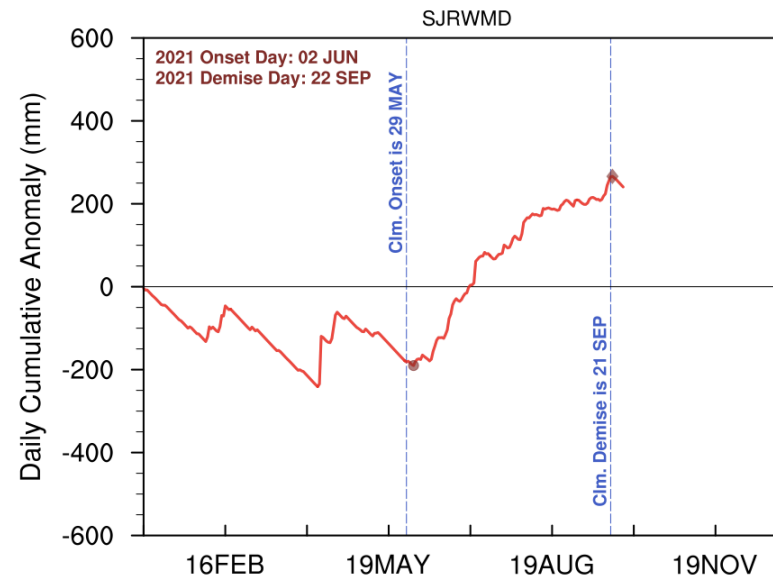
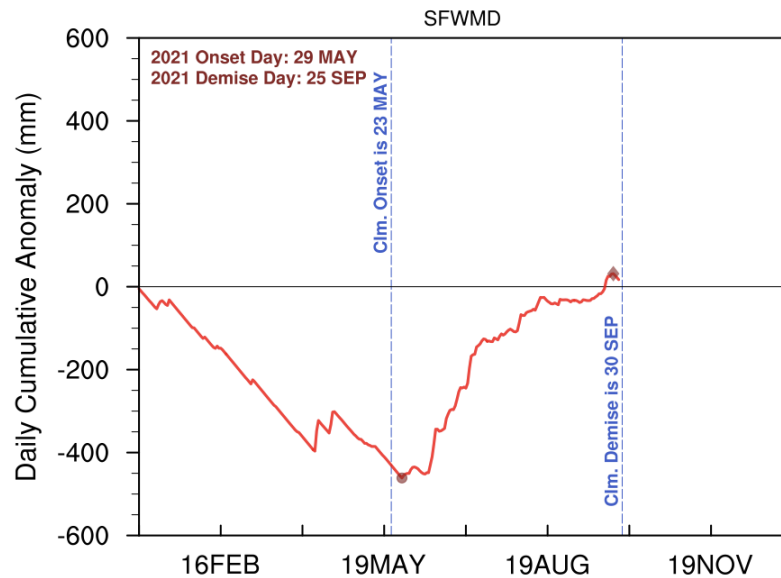
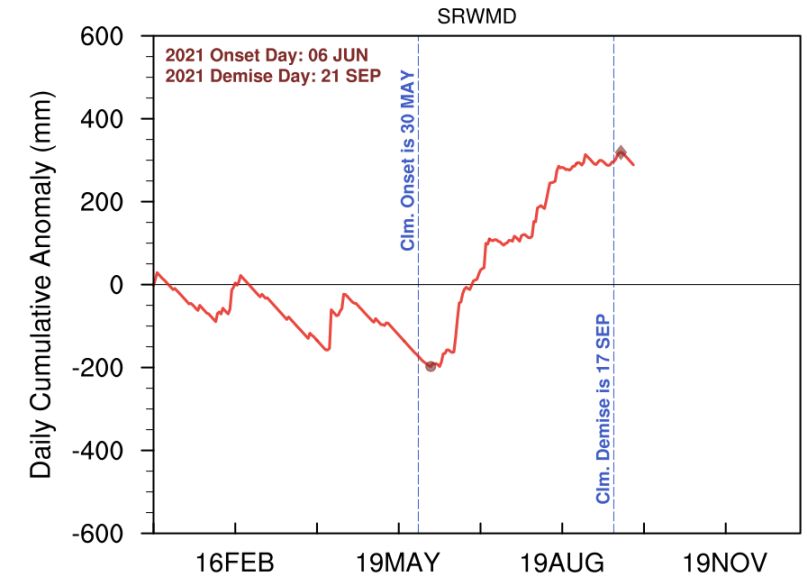
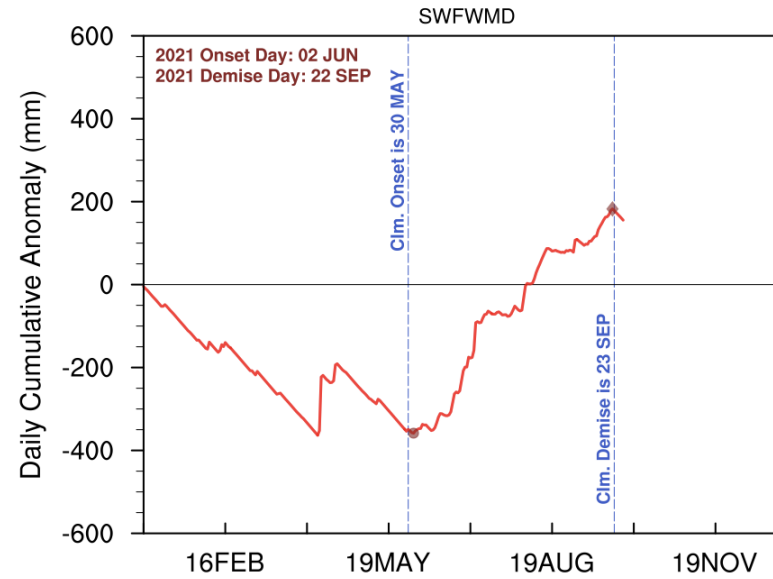
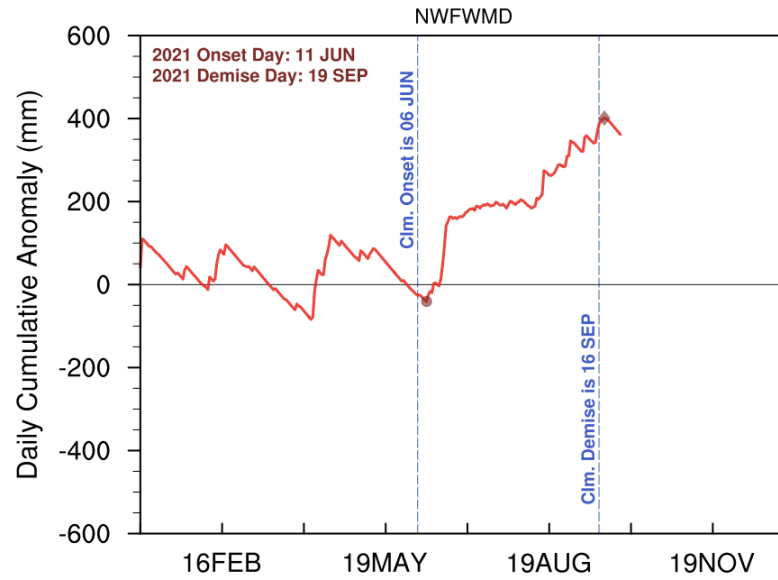
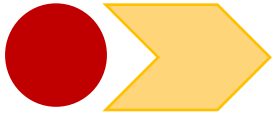


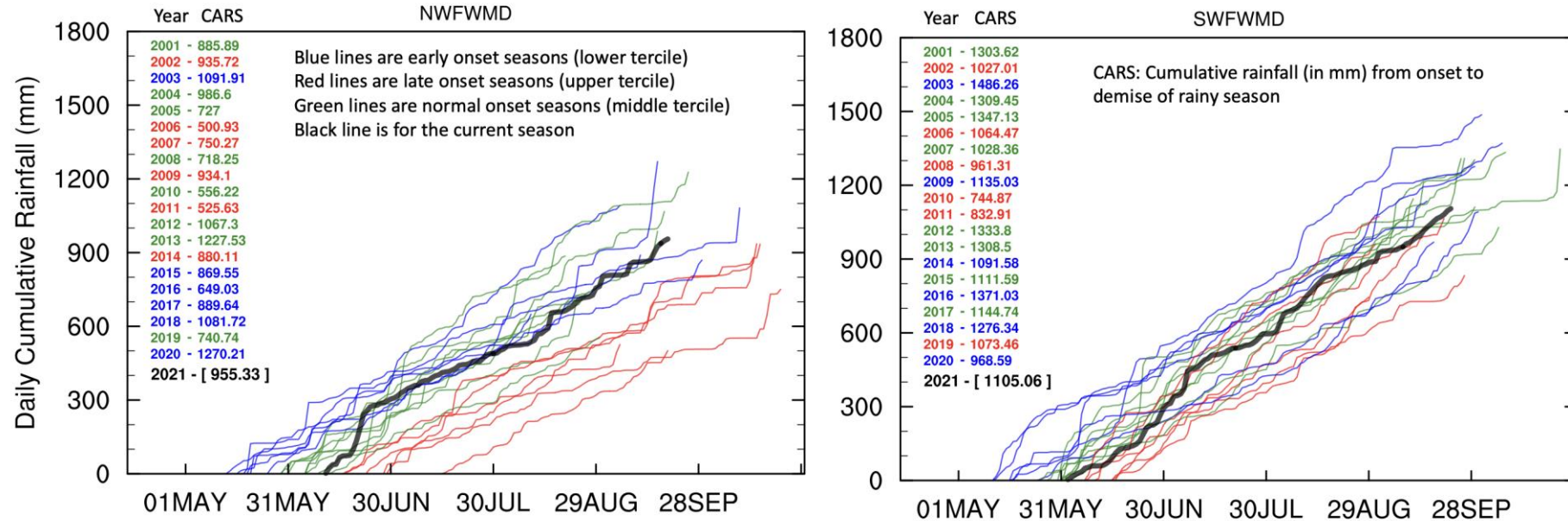
Table: Date of Onset (Julian Day), 2021

	NWFWMD	SWFWMD	SRWMD	SFWMD	SJRWMD
Threshold for lower tercile (onset occurring below this Julian day will be anomalous early onset season)	145	144	145	136	141
Threshold for upper tercile (onset occurring after this Julian day will be anomalous late onset season)	163	154	156	147	152
Onset date of 2021 season	162	153	157	149	153



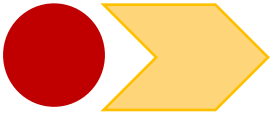


## Cumulative Rainfall From Day of Onset to the Day of Demise

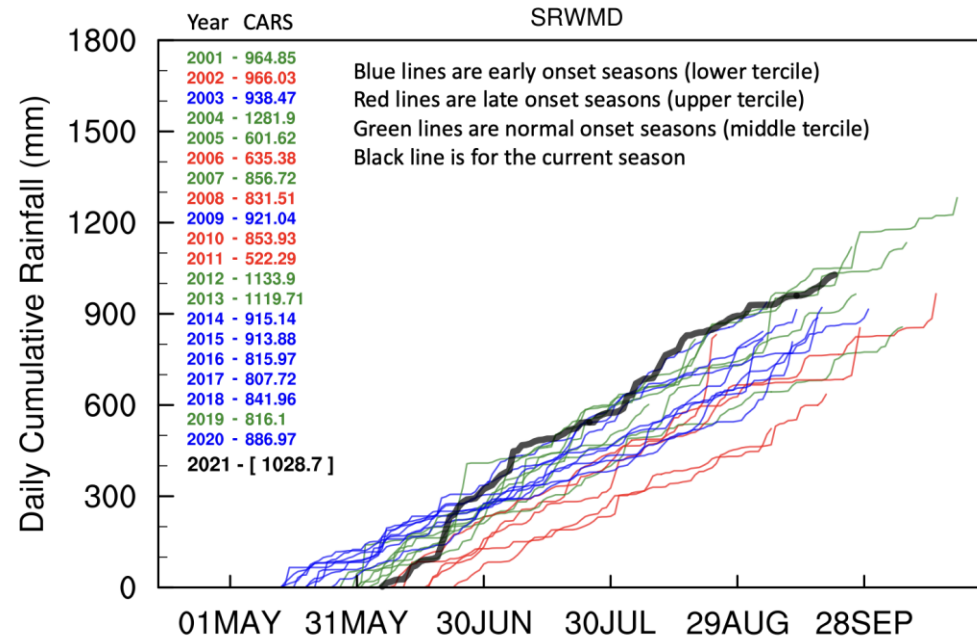


### Discussion

- Legend: total accumulation of rainfall (in mm) over the length of the season for early (blue), late (red), and normal (green) and for 2021.
- In NFWWMD and SWFWMD, the onset date for 2021 is embedded in the cluster of onset dates of the green lines (normal onset season). In both these WMDs the cumulative rainfall for 2021 also cluster around the green lines so far, which implies that the current season is tracking the normal season evolution.

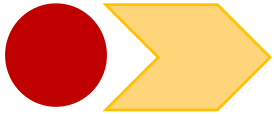


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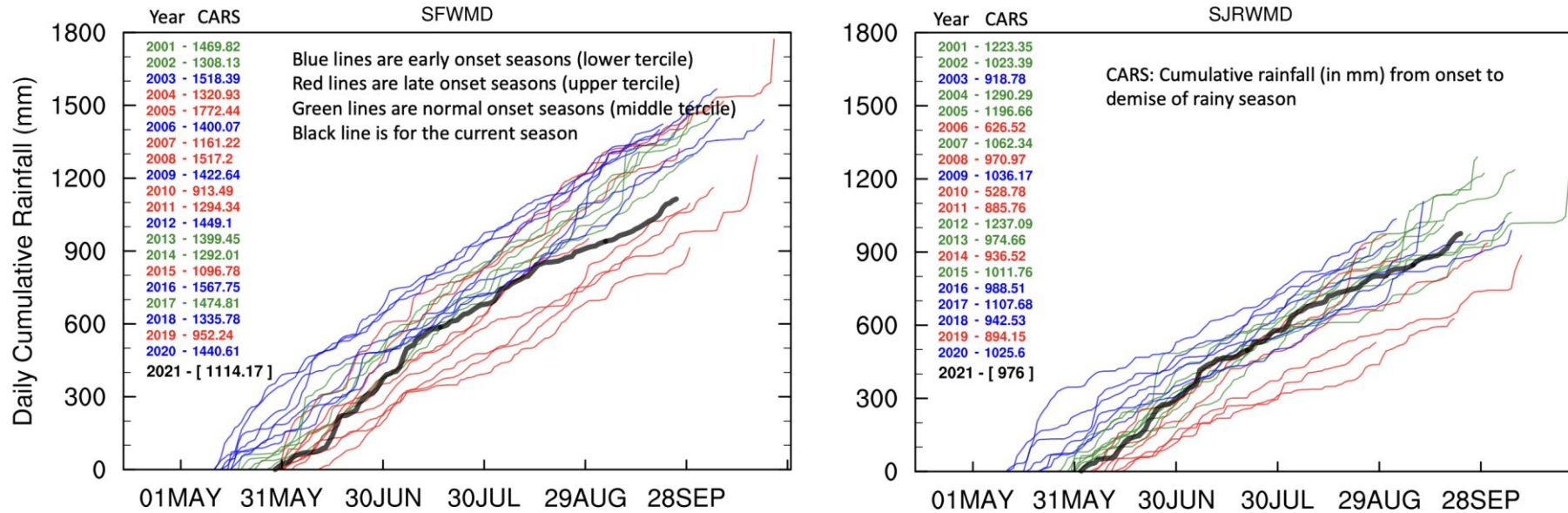


### Discussion

- Legend: total accumulation of rainfall (in mm) over the length of the season for early (blue), late (red), and normal (green) and for 2021.
- SRWMD is clearly tracking the cluster of blue lines since late June, suggesting a wet season for 2021 contrary to our earlier assessment. (It should be noted that the historical data for this WMD reveal that onset date anomalies of the rainy season does not seem to distinguish normal and wetter than normal rainy season as well as other WMDs).

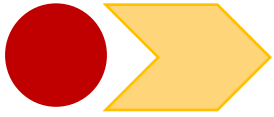


## Cumulative Rainfall From Day of Onset to the Day of Demise



### Discussion

- Legend: total accumulation of rainfall (in mm) over the length of the season for early (blue), late (red), and normal (green) and for 2021.
- In the remaining two WMDs (SFWMD, and SJRWMD), the rainfall is tracking along the margins of the green (normal) and red (drier than normal) seasons. In these two WMDs it may at best be a weak dry anomaly season.



## Inferences from the Final Update

- The demise of the wet season has been reached in all WMDs.

	SFWMD		SWFWMD		SJRWMD		SRWMD		NFWWMD	
	Climatology	2021 season	Climatology	2021 season	Climatology	2021 season	Climatology	2021 season	Climatology	2021 season
Onset date	May 23	<b>May 29</b>	May 30	Jun 2	May 29	<b>Jun 2</b>	May 30	<b>Jun 6</b>	Jun 6	Jun 11
Demise date	Sep 30	Sep 25	Sep 23	Sep 22	Sep 21	Sep 22	Sep 17	Sep 21	Sep 16	Sep 19
Length of the Season (days)	130	<b>119</b>	115	112	115	112	109	106	101	99
Seasonal rainfall (mm)	1,355	<b>1,114</b>	1,146	1,105	994	976	881	<b>1,029</b>	864.5	955

- The demise of the wet season in 2021 was near climatological demise date for all WMDs except for SFWMD which reached its demise date 5 days earlier than climatology.
- Wet season ended with **near normal** seasonal rainfall for NFWWMD, SWFWMD, and SJRWMD.
- SRWMD had a **wetter than normal** season.
- SFWMD, ended being a border line **drier than normal**, with the last 4 weeks being having the largest deficits of the season.



<https://doi.org/10.3389/fclim.2022.793959>



## Operational Monitoring of the Evolution of Rainy Season Over Florida

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# Thank you