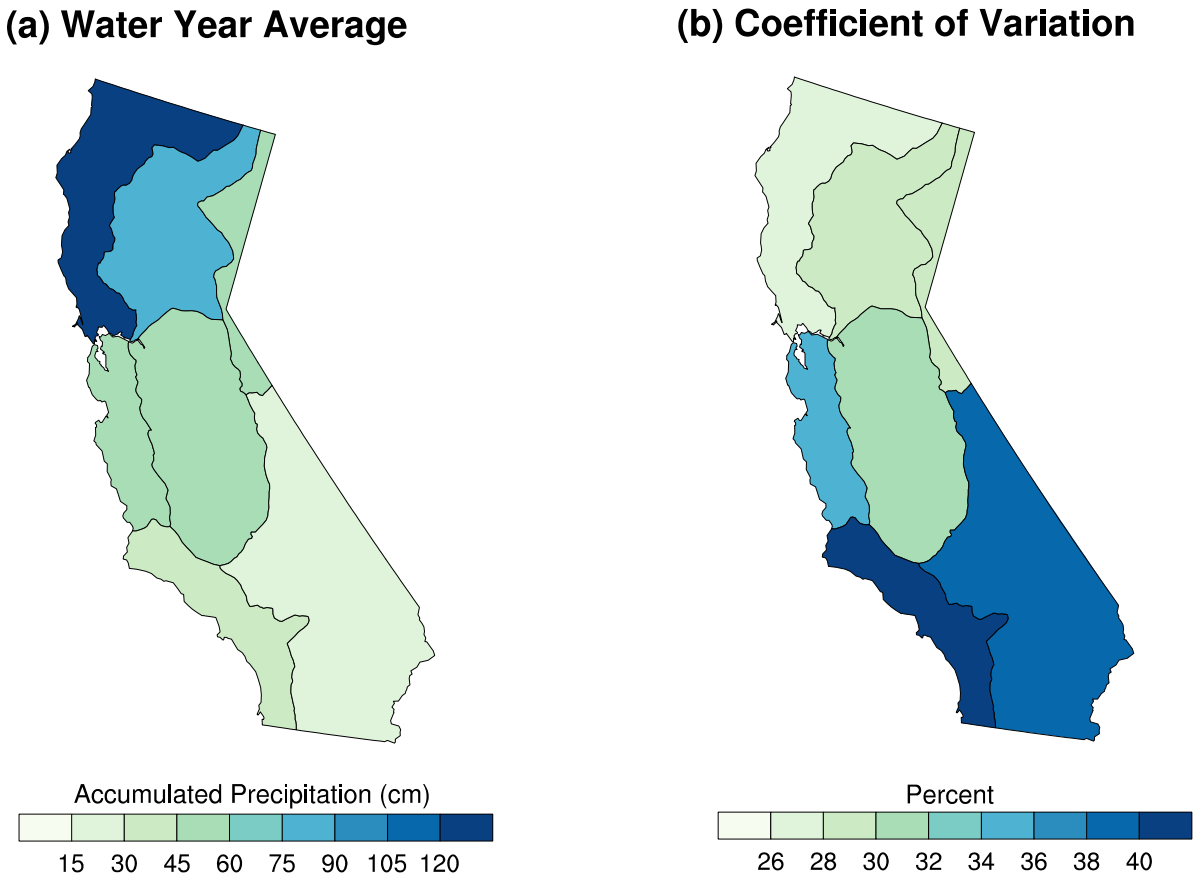
What Determines the Amount of Precipitation During Wet and Dry Years Over California?

Andy Hoell

NOAA/Earth System Research Laboratory Physical Sciences Division

California is Home to a Large Annual Rainfall Spread



NCEI Climate Division Data 1901-2014

California is Home to a Large Annual Rainfall Spread

“California is shown here to experience unusually large variations in annual precipitation and streamflow totals relative to the rest of the US, variations which mostly reflect the unusually small average number of wet days per year needed to accumulate most of its annual precipitation totals (ranging from 5 to 15 days in California). Thus whether just a few large storms arrive or fail to arrive in California can be the difference between a banner year and a drought.”

Dettinger et al., 2011: Atmospheric Rivers, Floods and the Water Resources of California

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How does one quantify a large storm?

When do these large storms occur?

Are wet/dry years predictable?

What Determines the Amount of Precipitation During Wet and Dry Years Over California?

- A change in the occurrences of light and/or heavy precipitation days?

  Both, with a stronger preference toward heavy

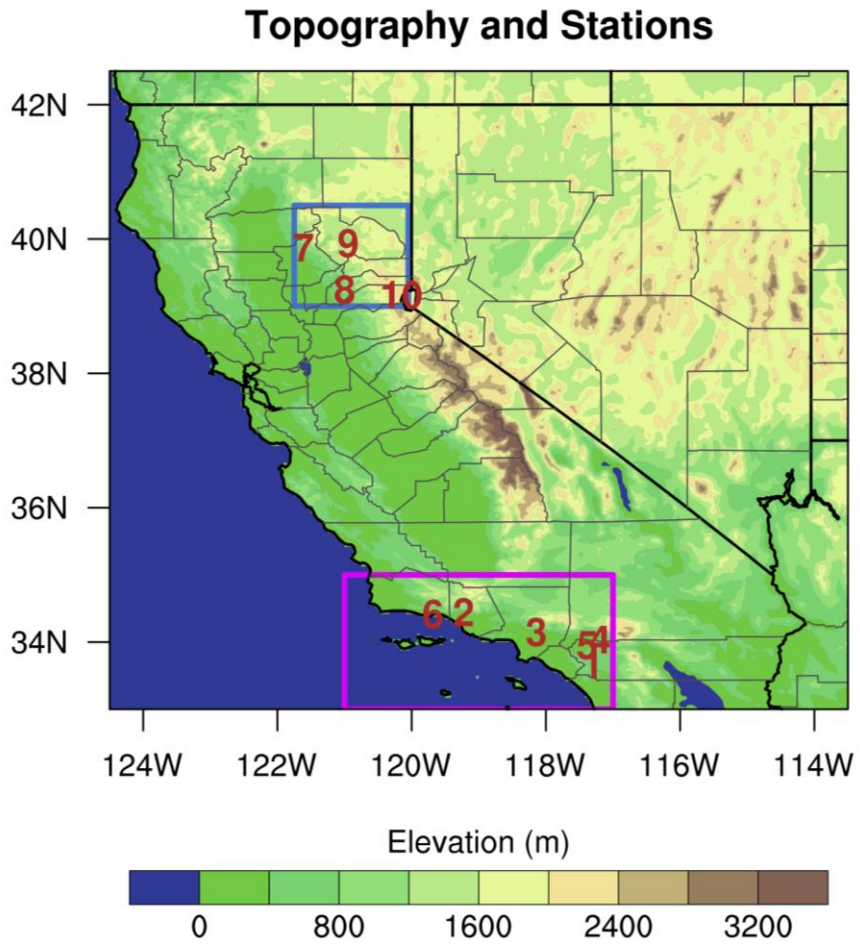
- Changes in precipitation days and intensity during certain months?

  November-March for heaviest precipitation days

- Can knowledge of ENSO be used to predict these wet and dry years?

  El Niño increases the odds of wet years

U.S. Climate Reference Network Stations and Area for Atmospheric Model Simulations

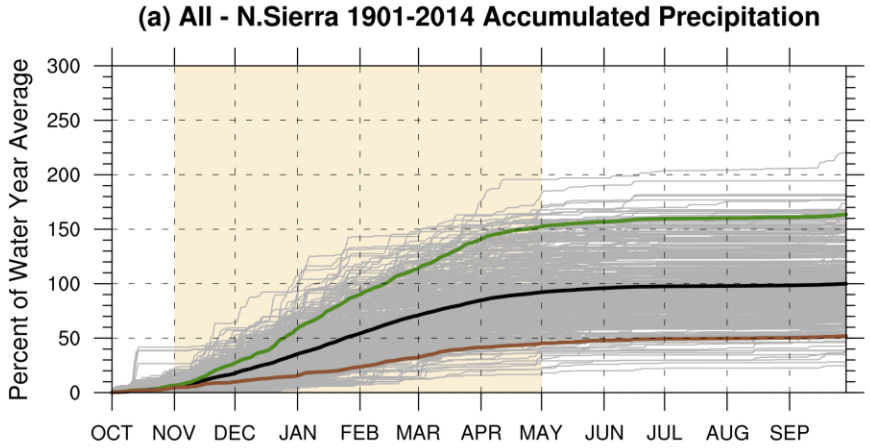


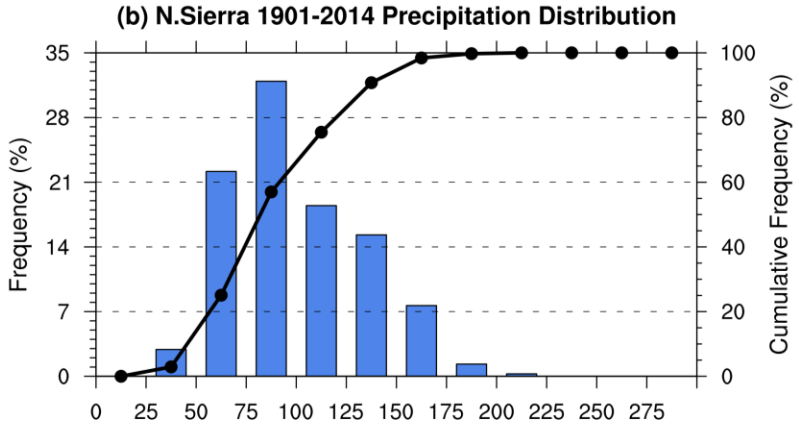
	Number	Identifier	Location
SoCal	1	USC00042805	Elsinore
	2	USC00046399	Ojai
	3	USC00046719	Pasadena
	4	USC00047306	Redlands
	5	USC00047470	Riverside
	6	USC00047902	Santa Barbara
N.Sierra	7	USC00042402	De Sabla
	8	USC00046136	Nevada City
	9	USC00047195	Quincy
	10	USC00048758	Tahoe City

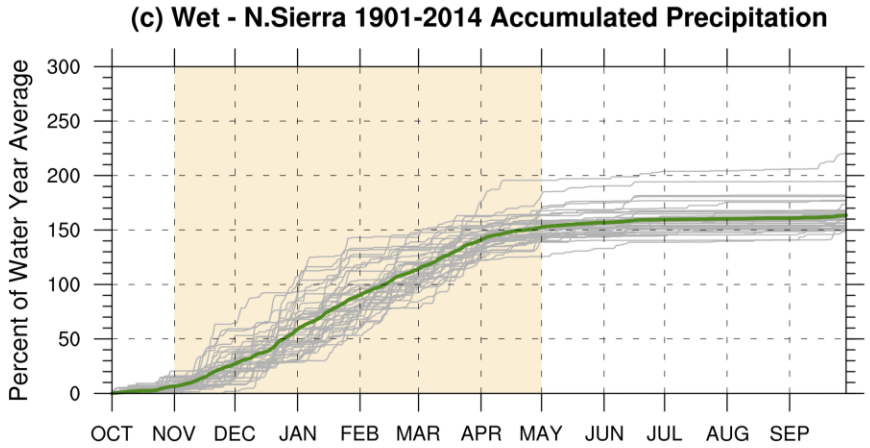
Methodology to Identify Wet and Dry Years

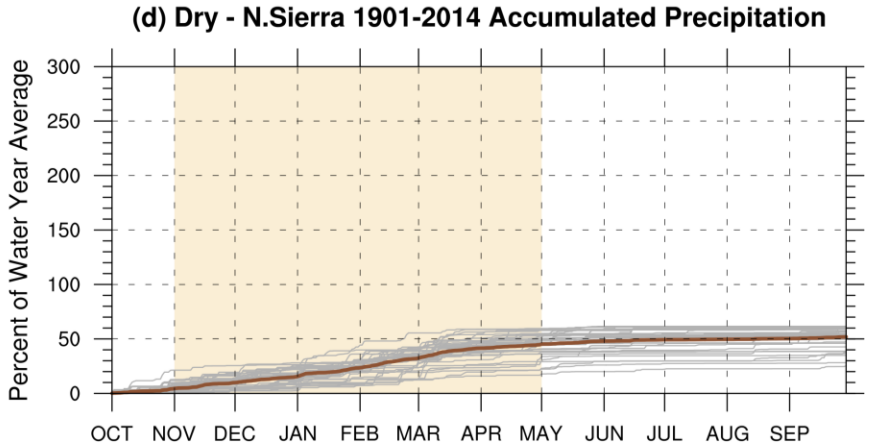
- OBS: A water year for each station during 1901-2014 is included if >90% of the days report precipitation
  - N.Sierra: 379 years from the 4 stations (~95 years per station)
  - SoCal: 558 years from the 6 stations (~93 years per station)
- SIM: 24-member ensemble of atmospheric model simulations from CAM5 model forced by observed boundary conditions during 1901-2014
  - N.Sierra: 39.0˚N – 40.5˚N and 120.0˚W – 121.75˚W, *land points only*
  - SoCal: 33.0˚N – 35˚N and 117.0˚W – 121.0˚W, *land points only*
- Wet and dry years are defined by the top and bottom 10%, respectively, of cumulative Sep. 30 precipitation

OBS: Core of the Rainy Seasons is Nov-Apr
Nov-Mar Separate Wet/Dry Years









Cumulative precipitation during (a) all, (c) wet and (d) dry water years
(b) Histogram of water year accumulated precipitation

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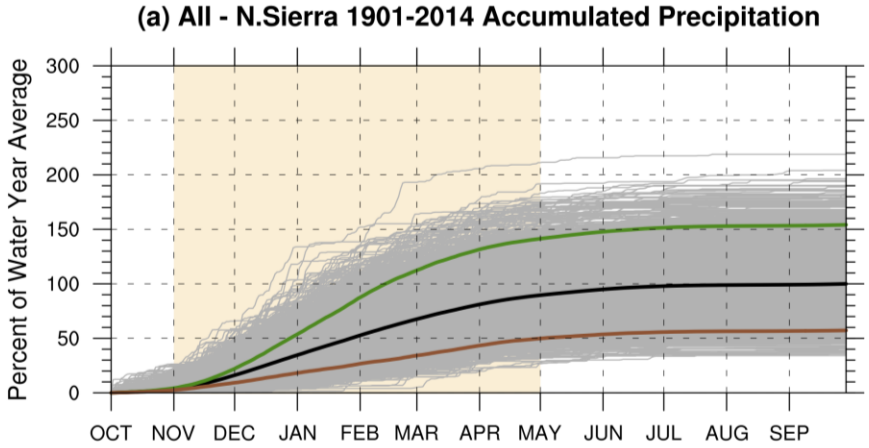

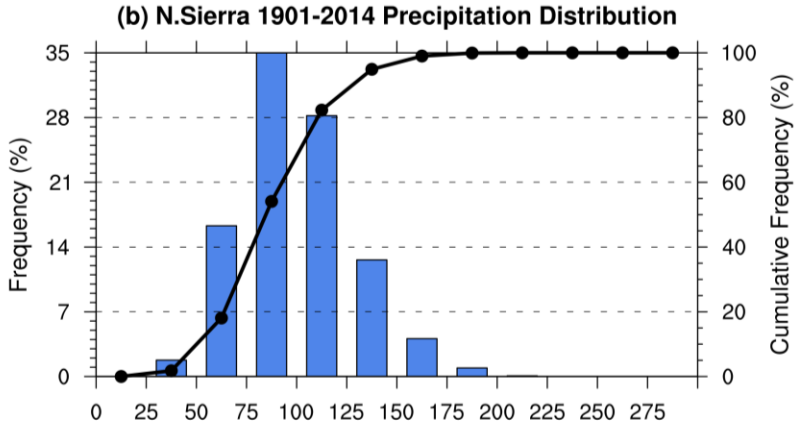

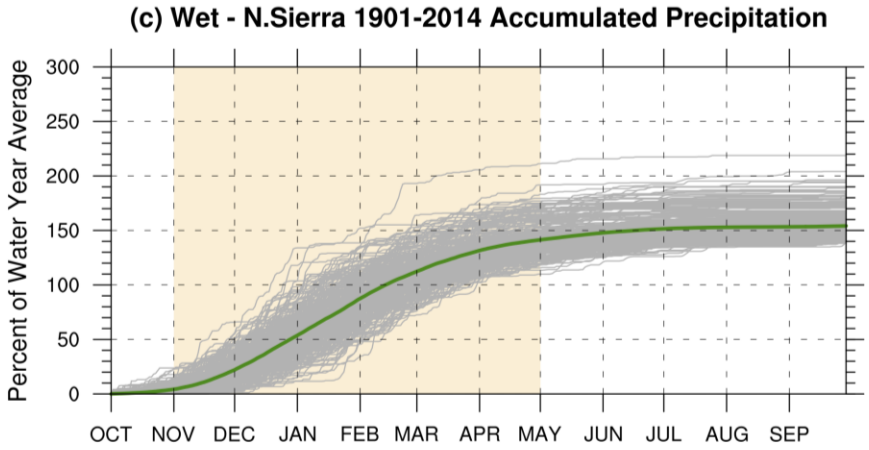

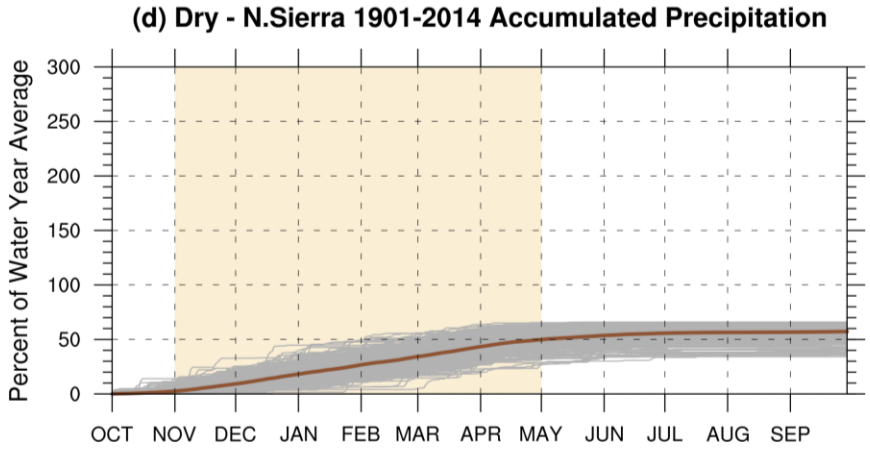

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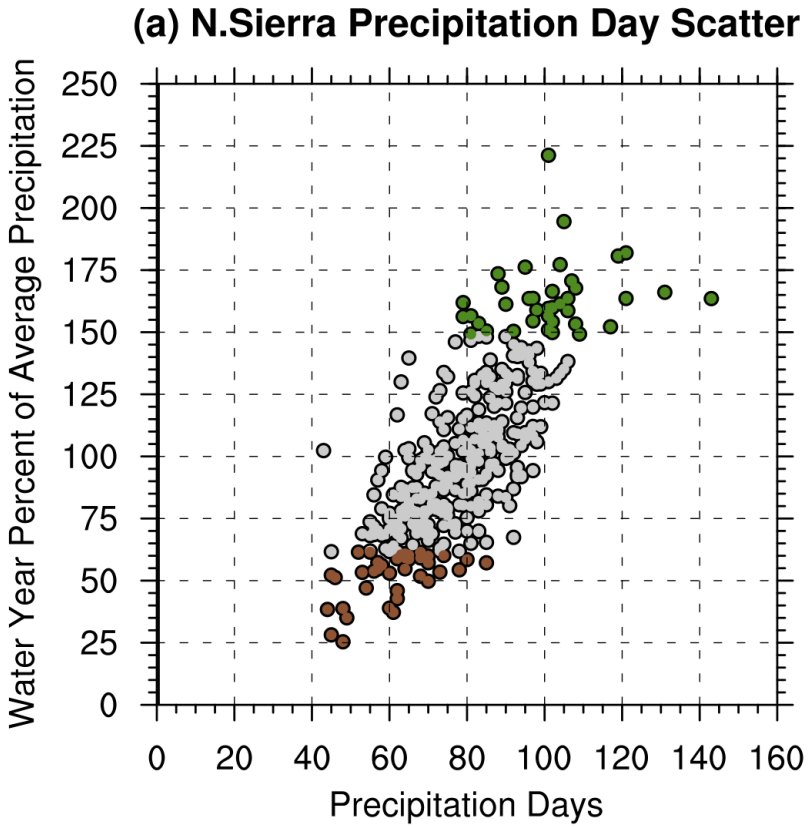
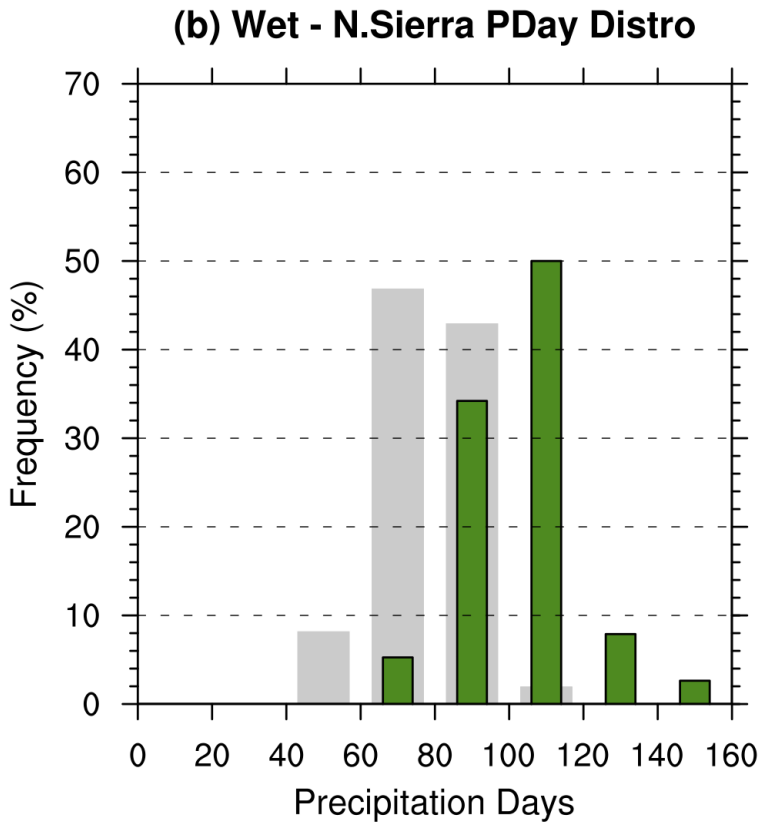
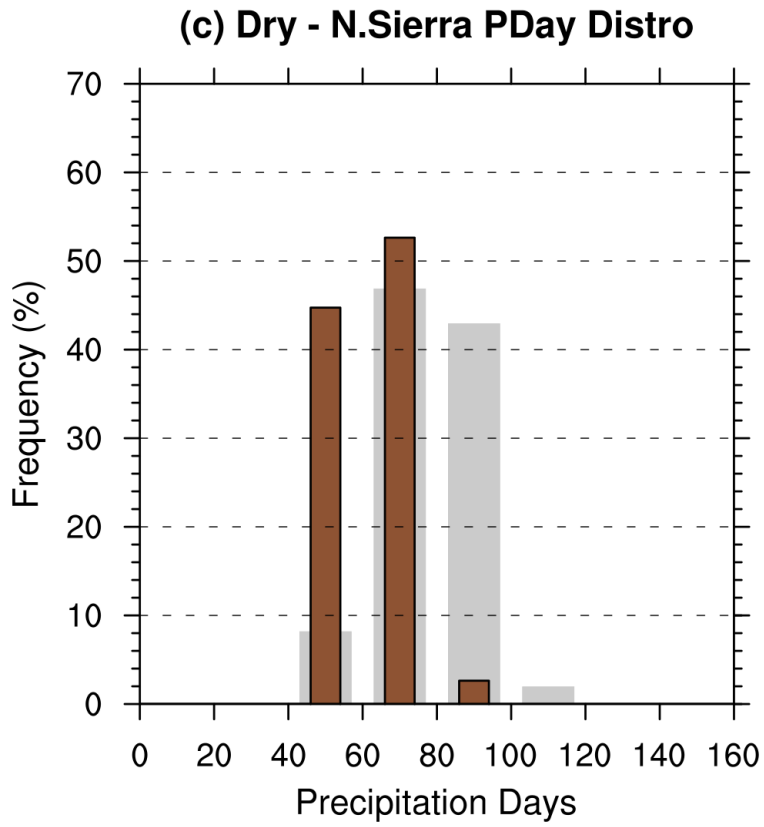
OBS: Precipitation and Precipitation Days Generally Scale Range of Precipitation Days Exist for Wet/Dry Years







(a) Scatter of water year precipitation and precipitation days
Precipitation days histogram during (b) wet and (b) dry water years. No wet/dry years in gray

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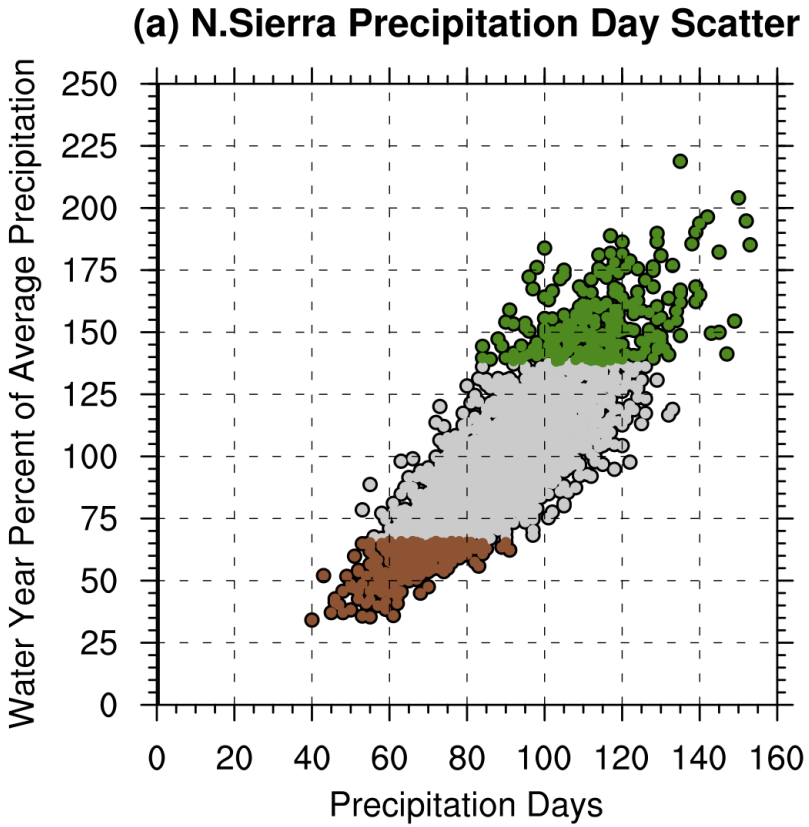

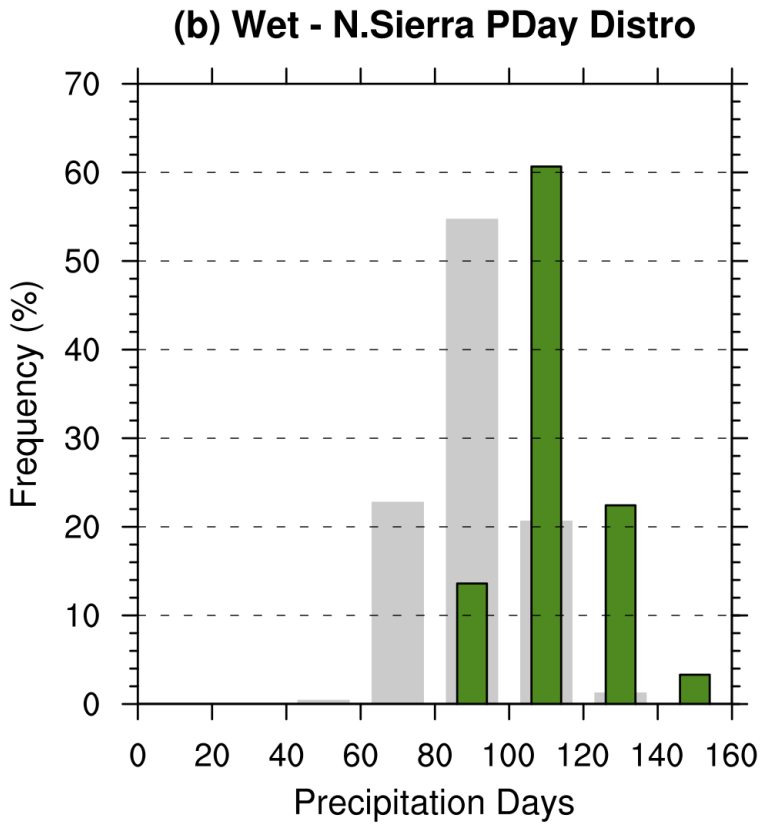

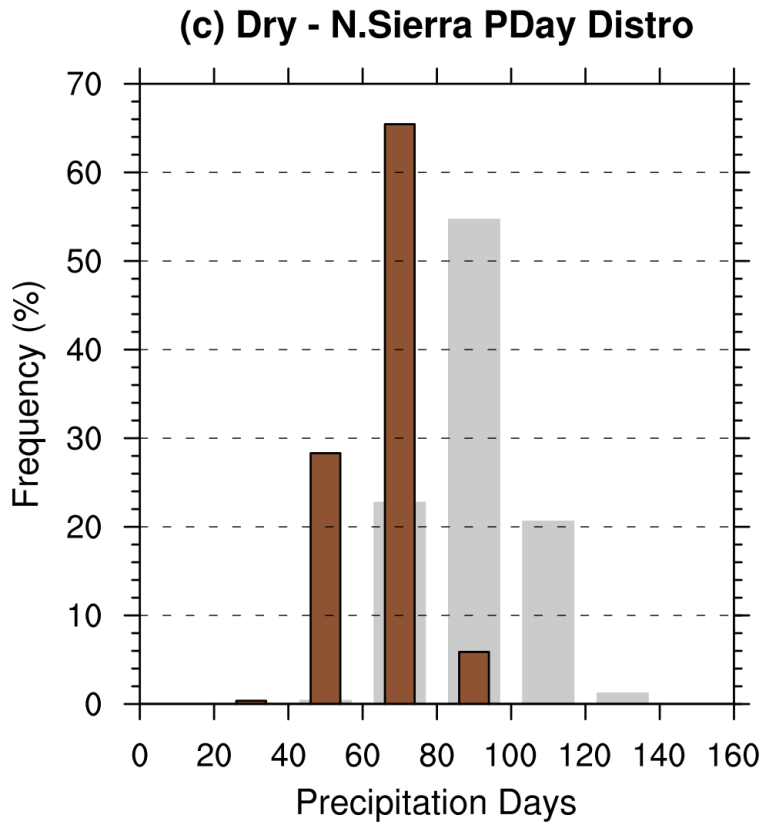

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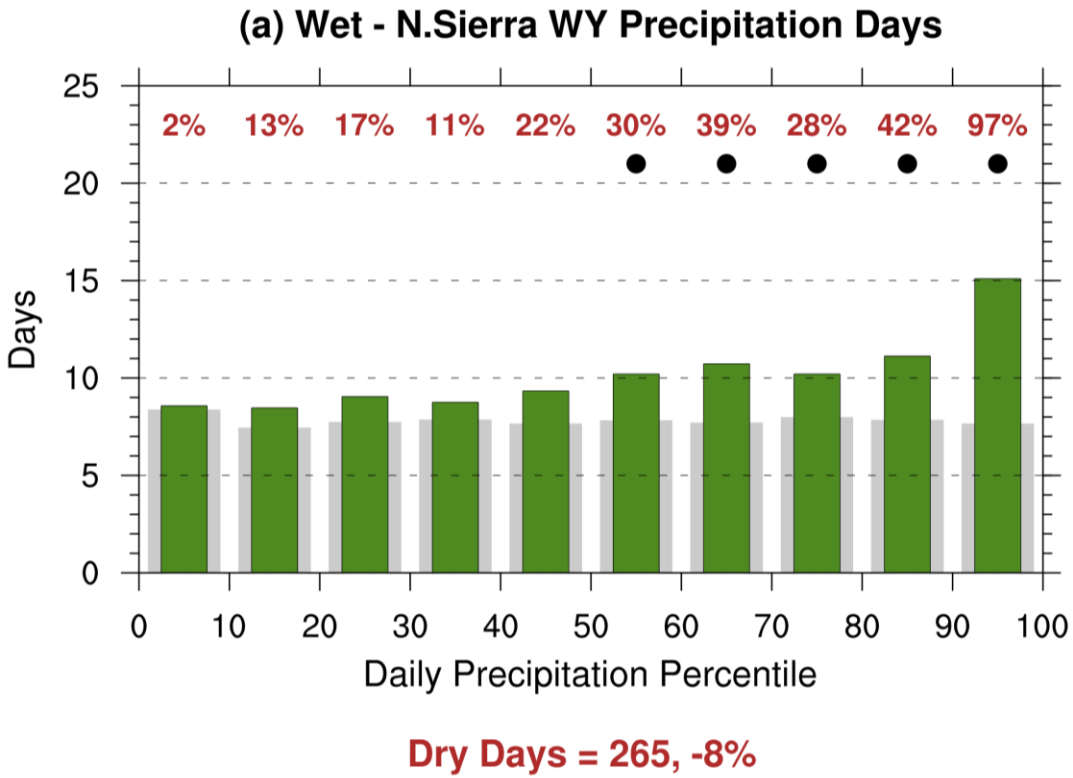

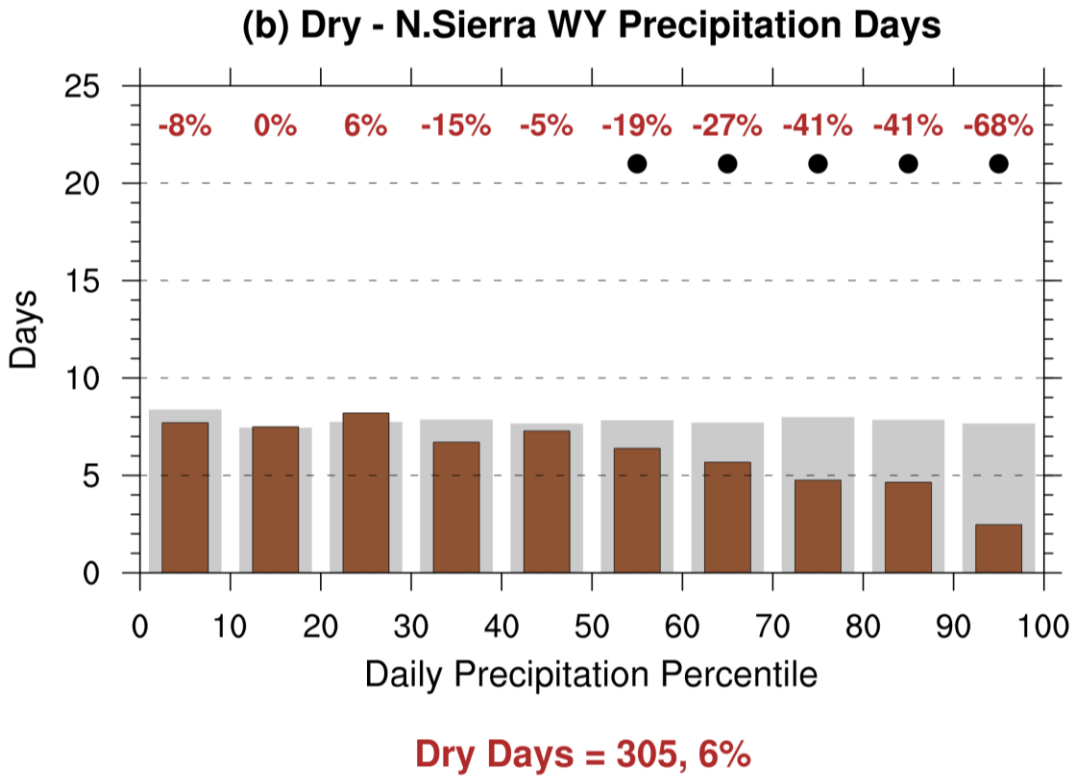

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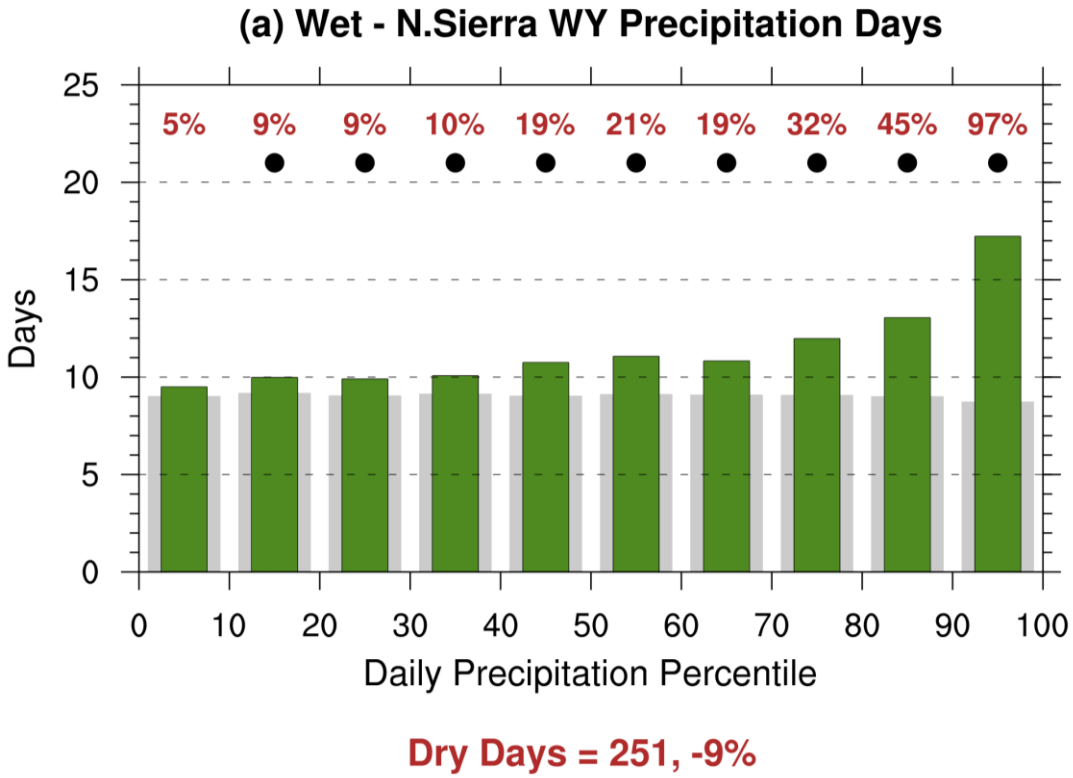

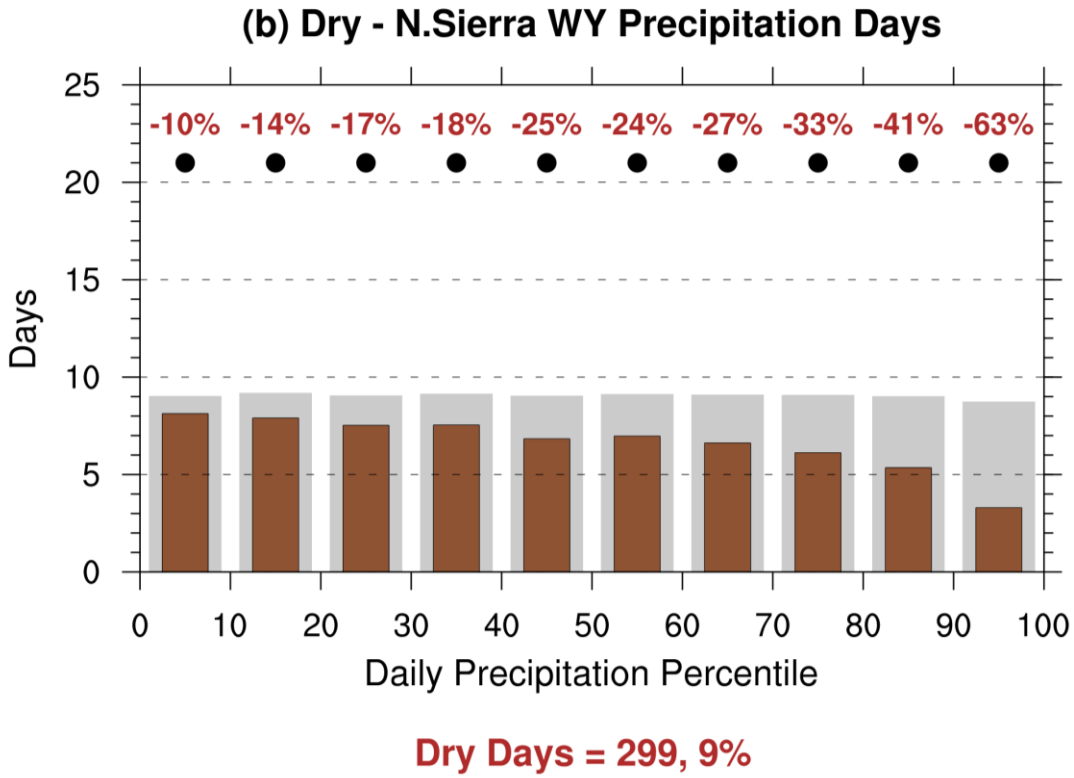

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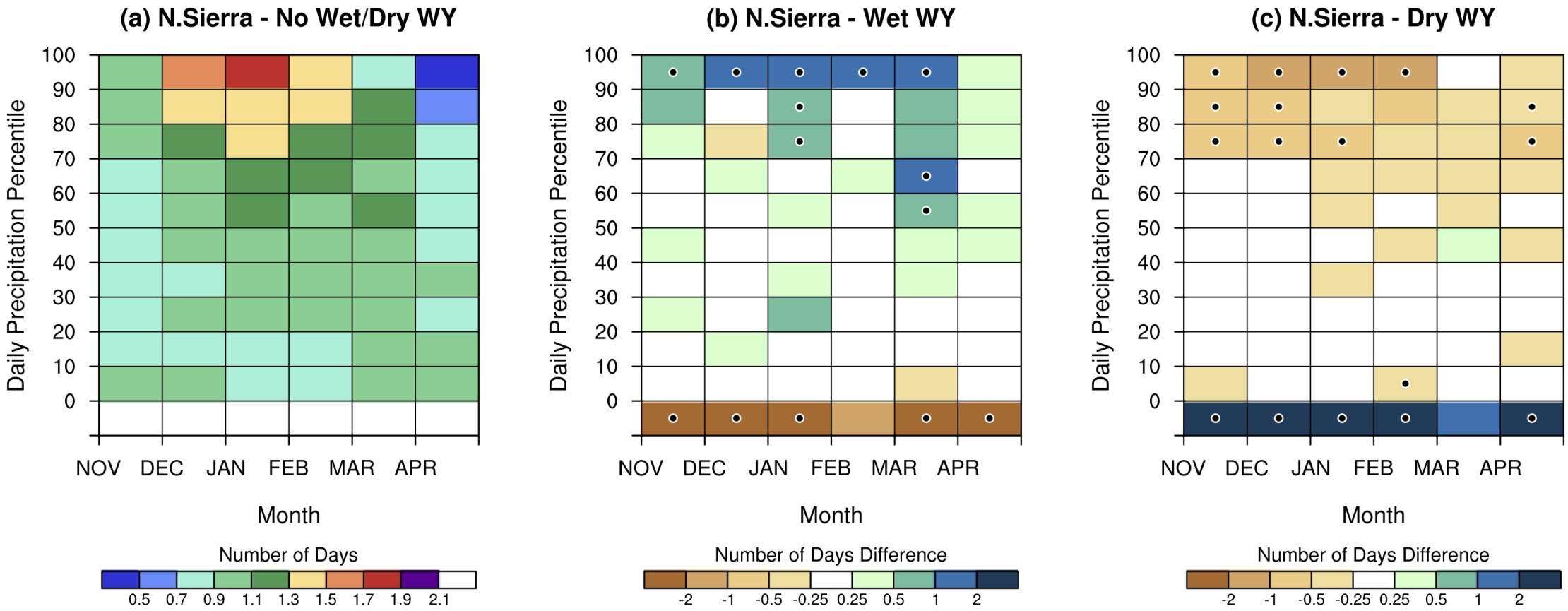

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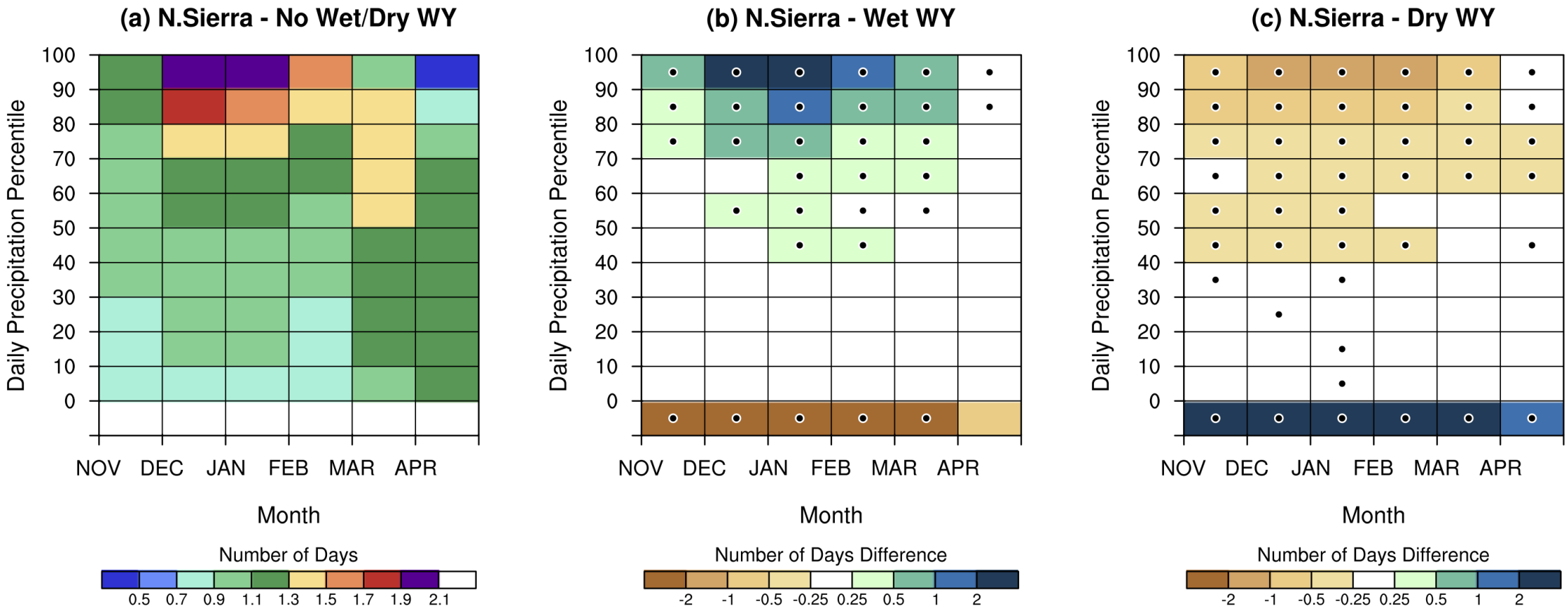

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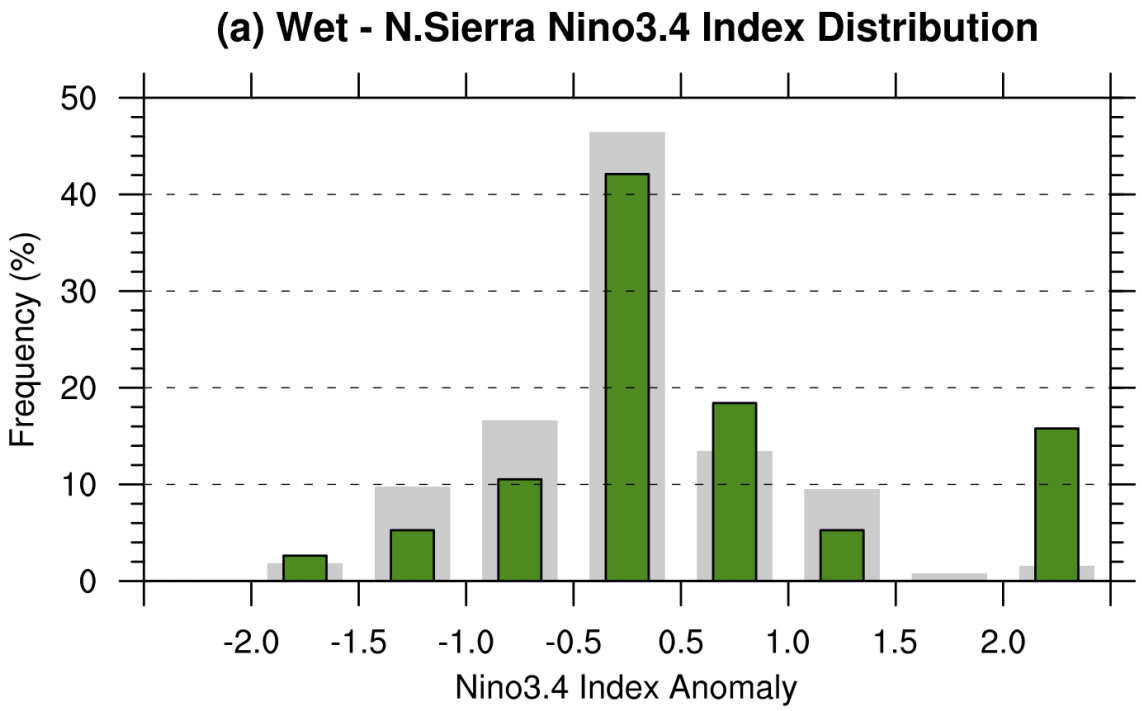

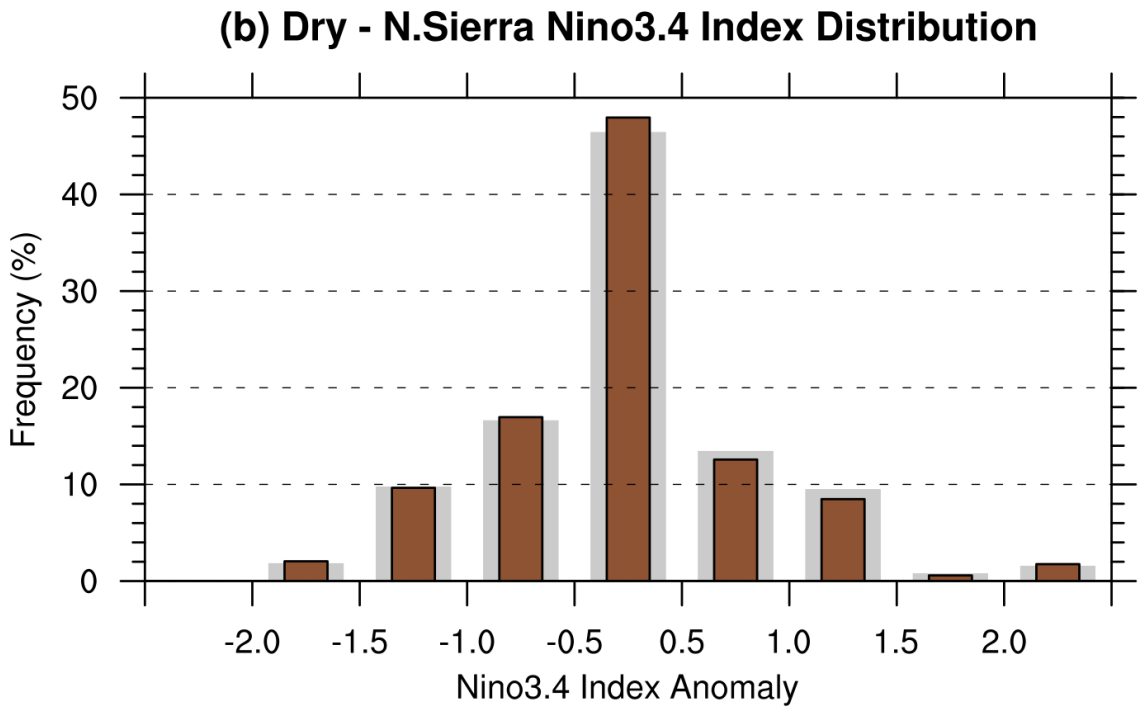

Nov-Apr histogram of Niño3.4 index anomaly during (left) wet and (right) dry water years
No wet/dry water years shown in gray

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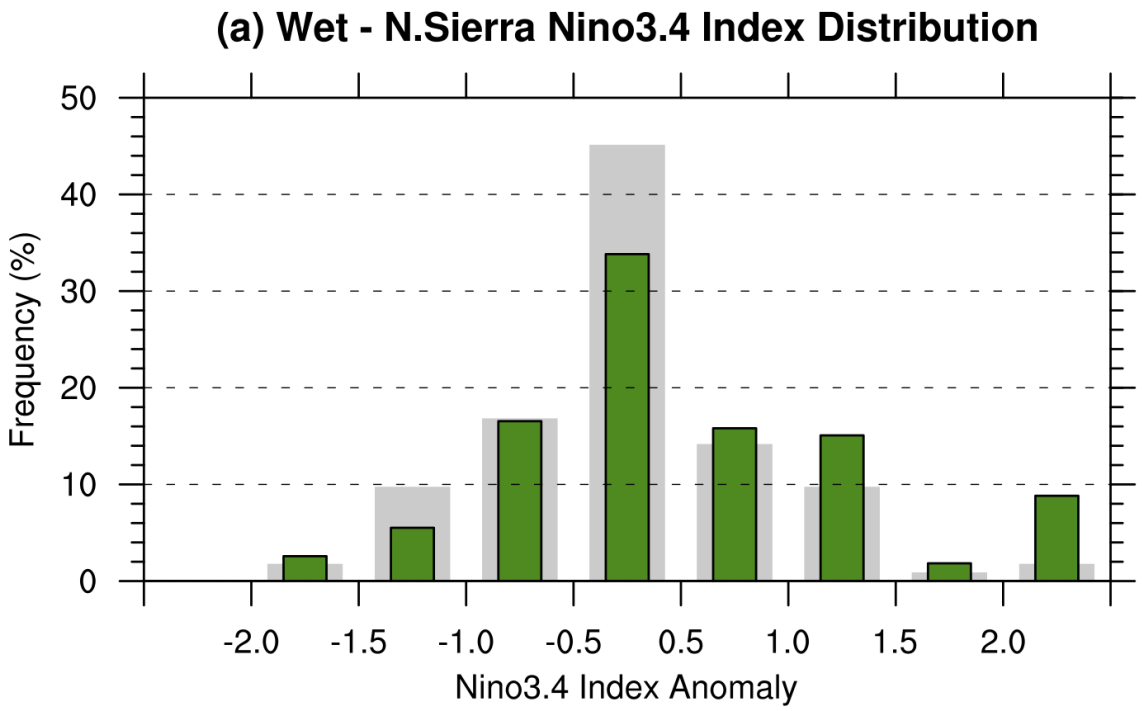

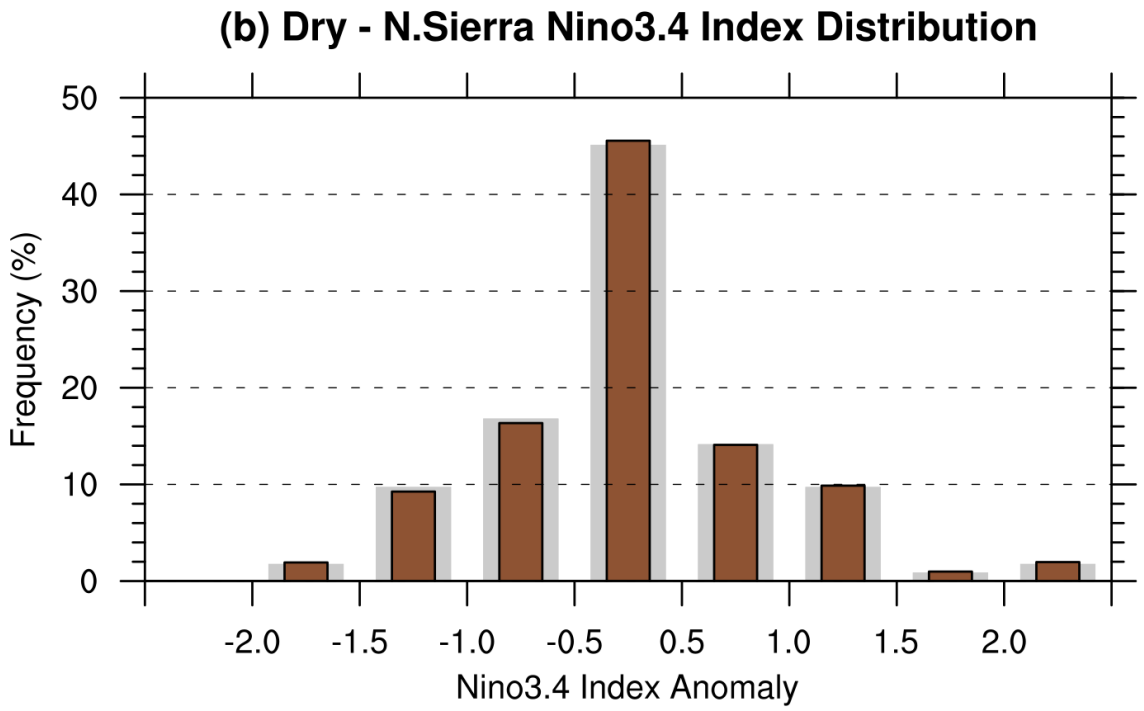

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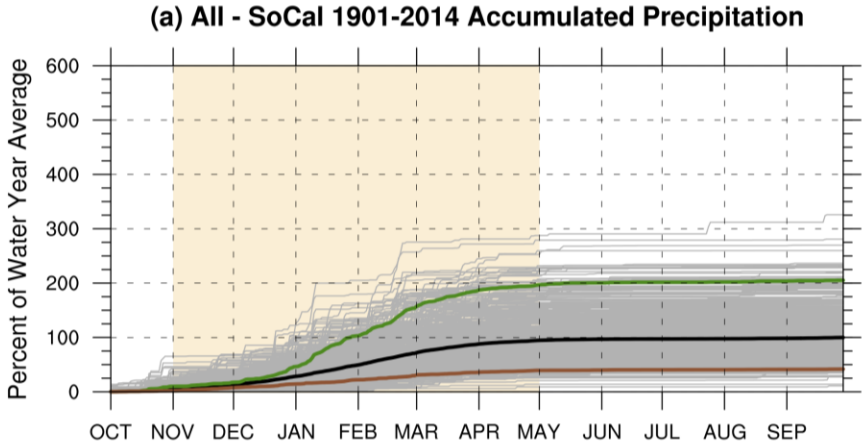

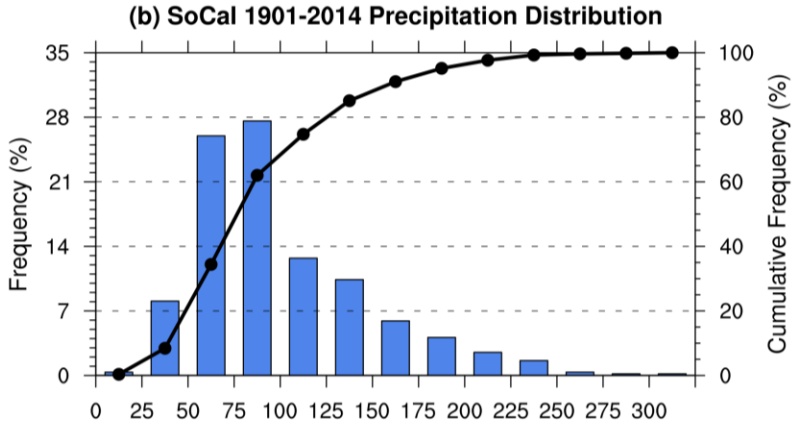

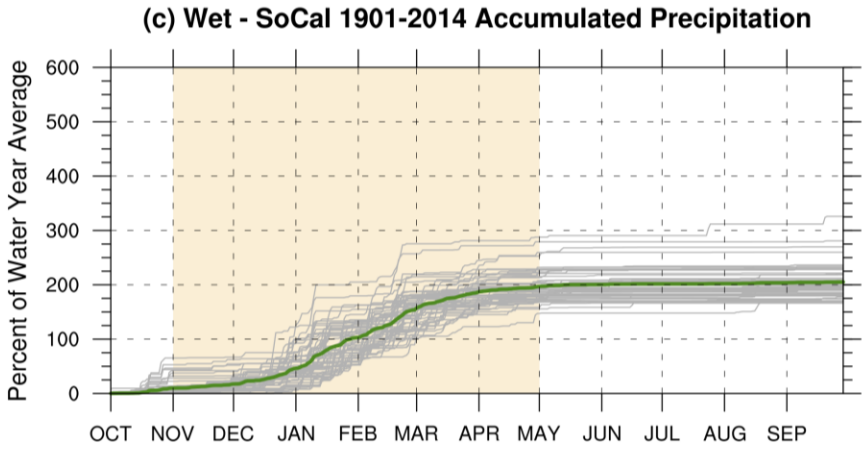

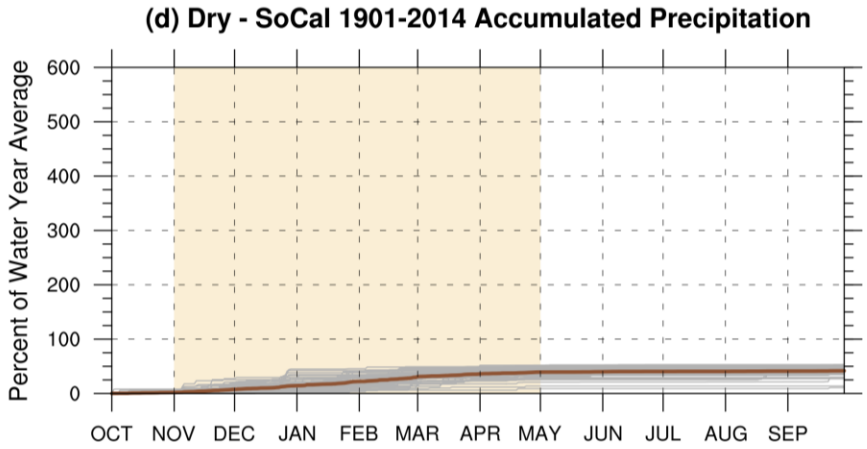

Cumulative precipitation during (a) all, (c) wet and (d) dry water years
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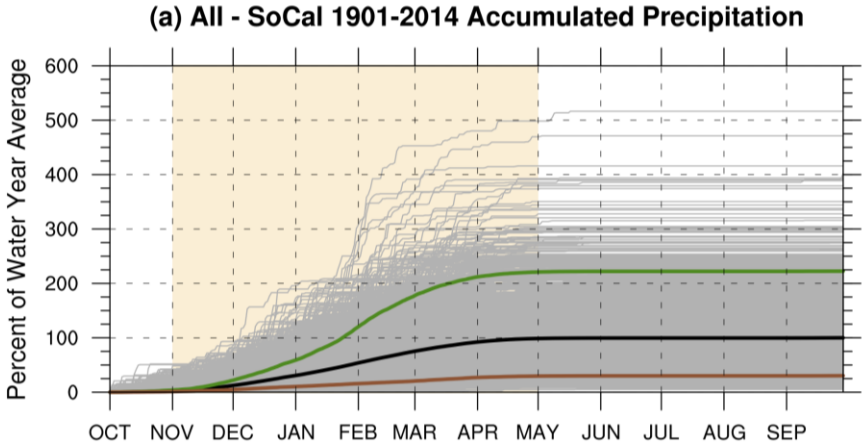

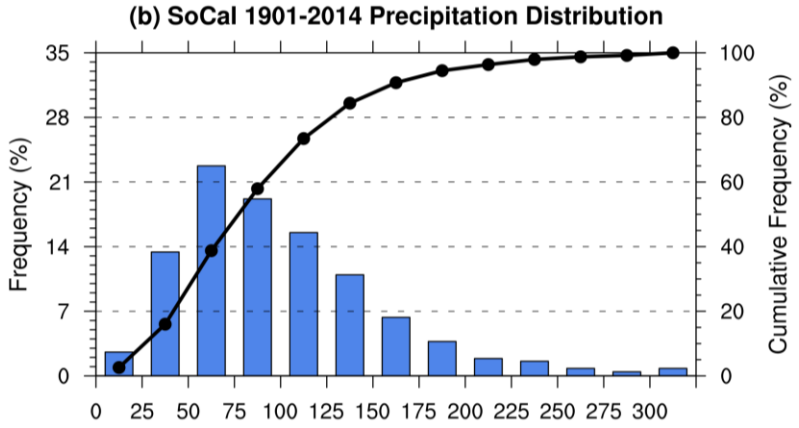

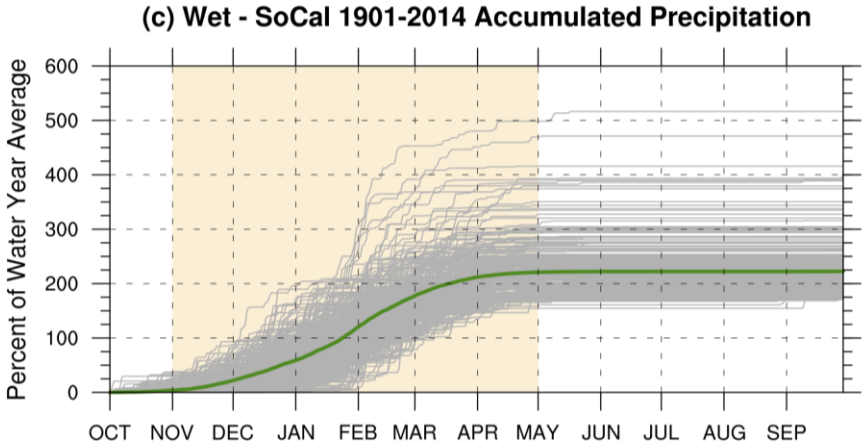

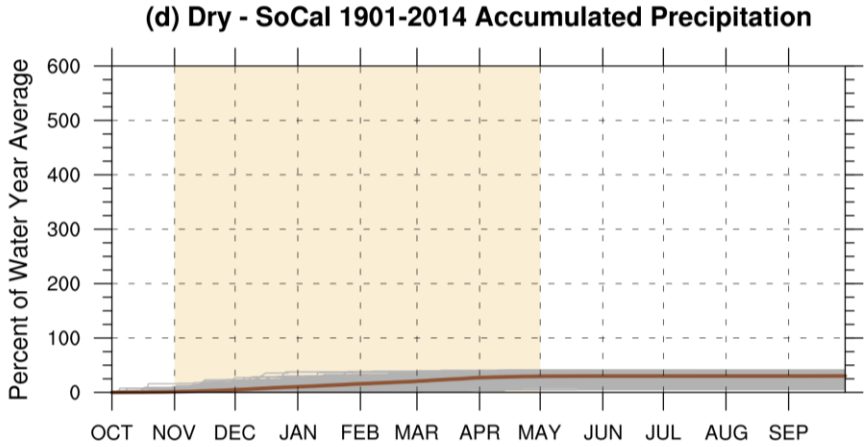

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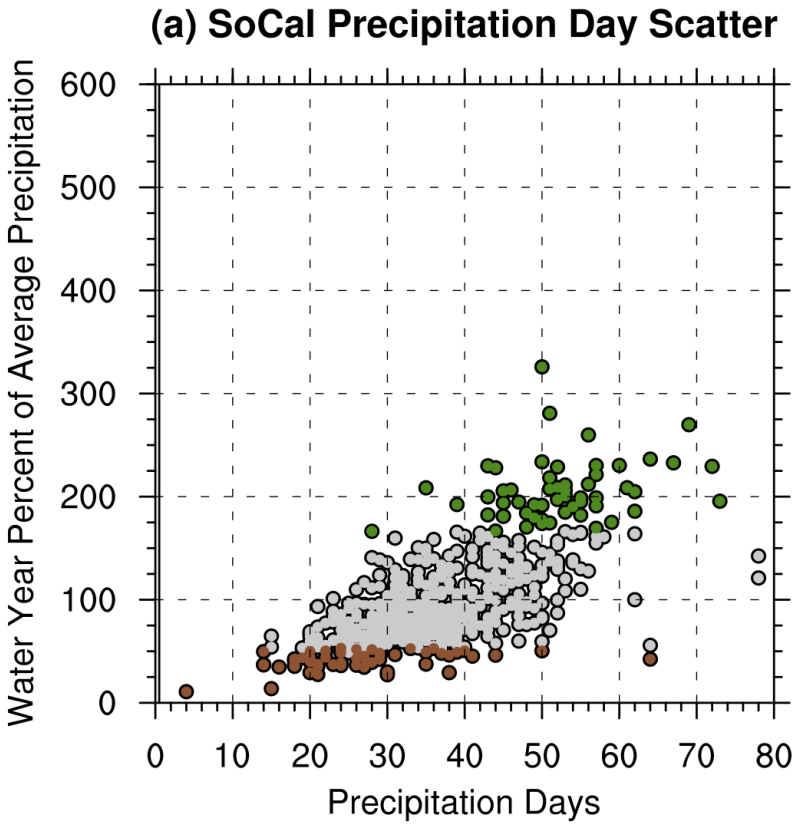
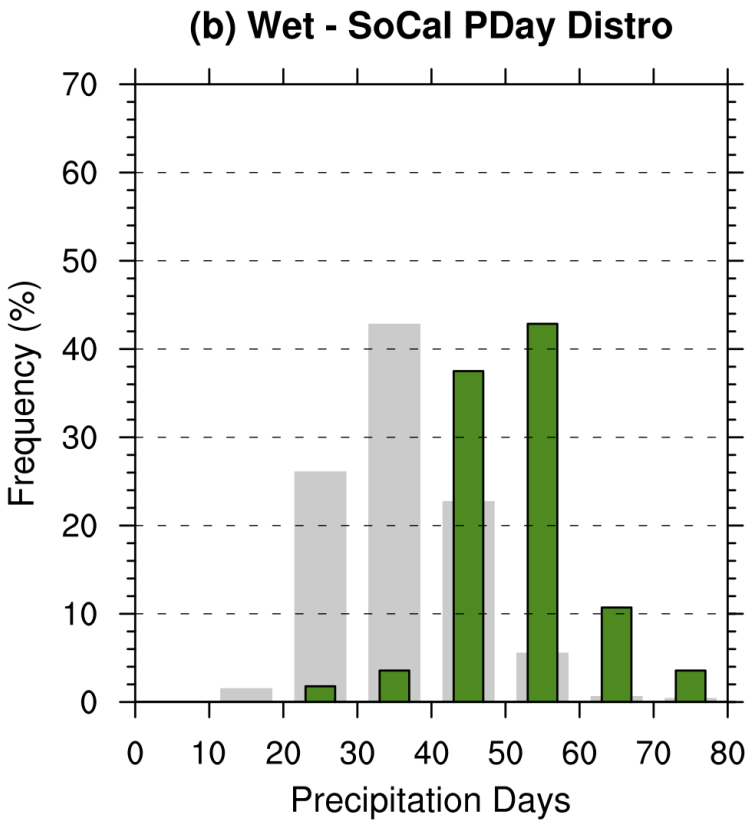
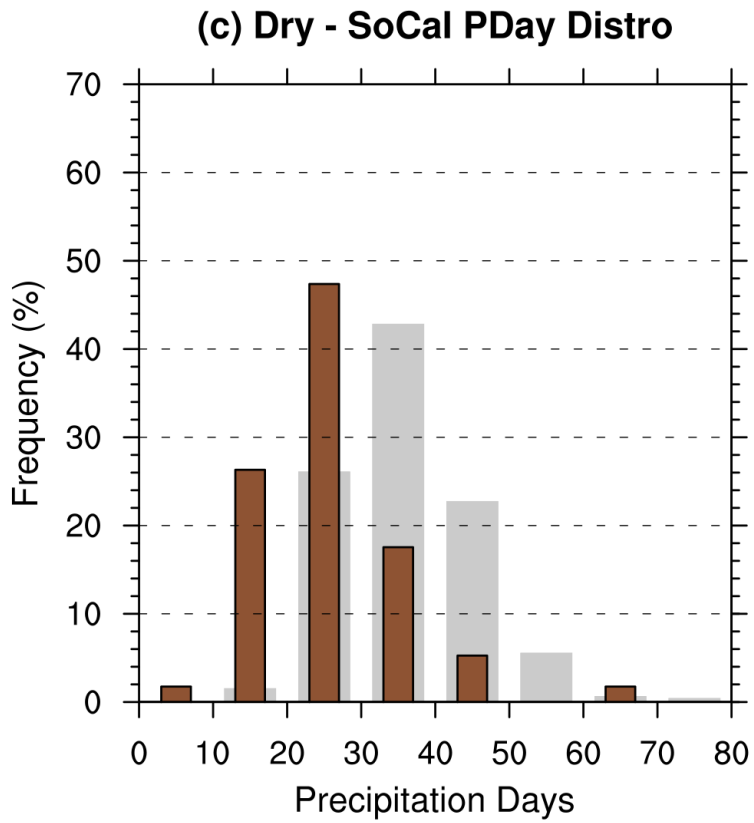
Obs: Precipitation and Precipitation Days Generally Scale Range of Precipitation Days Exist for Precipitation Categories







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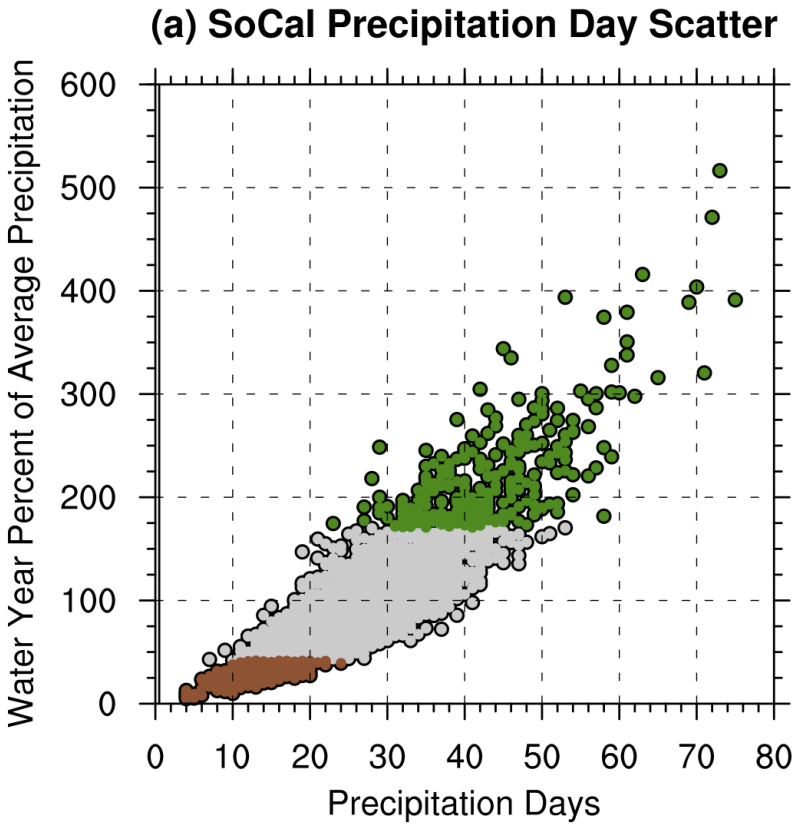

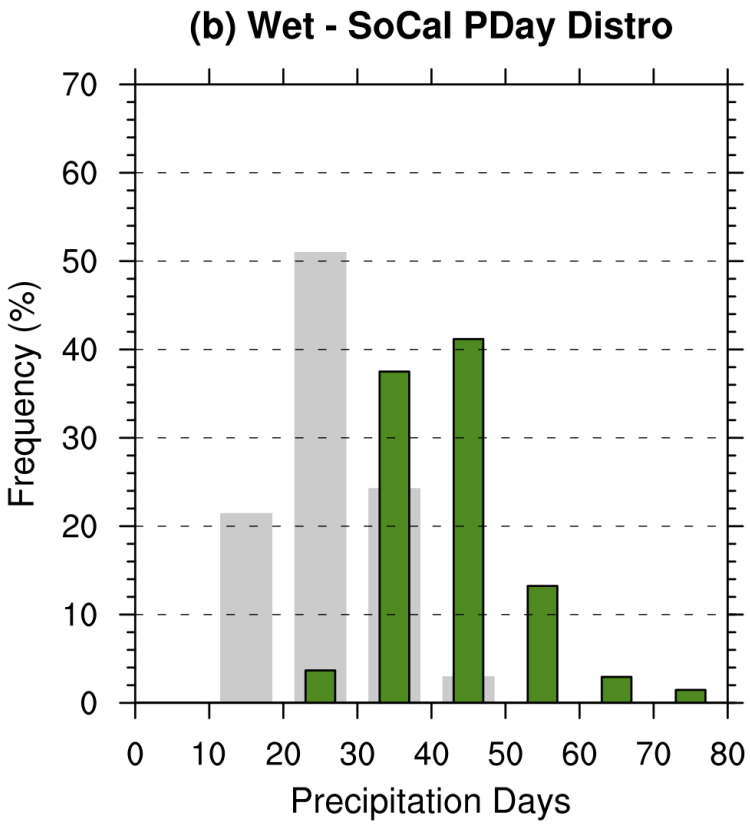

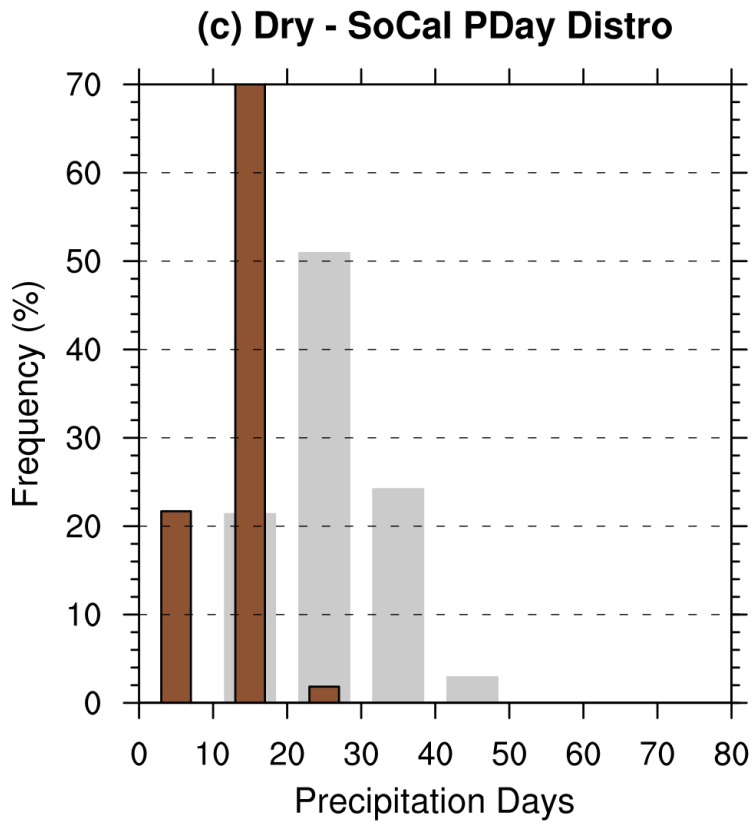

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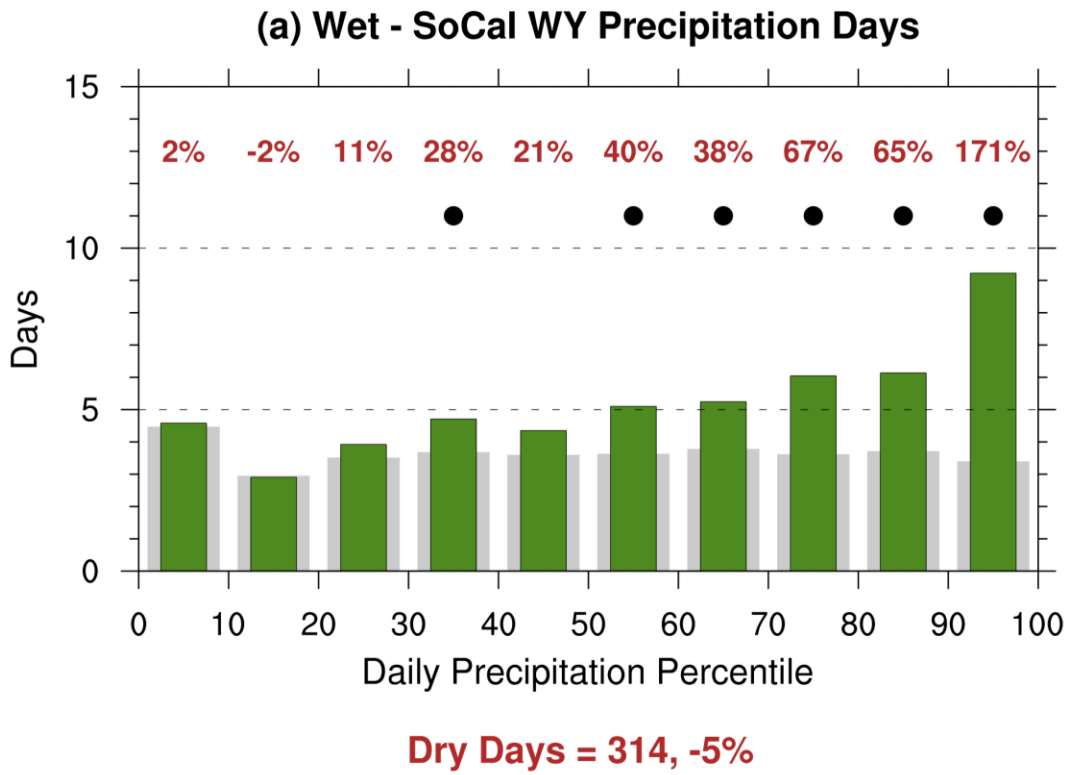
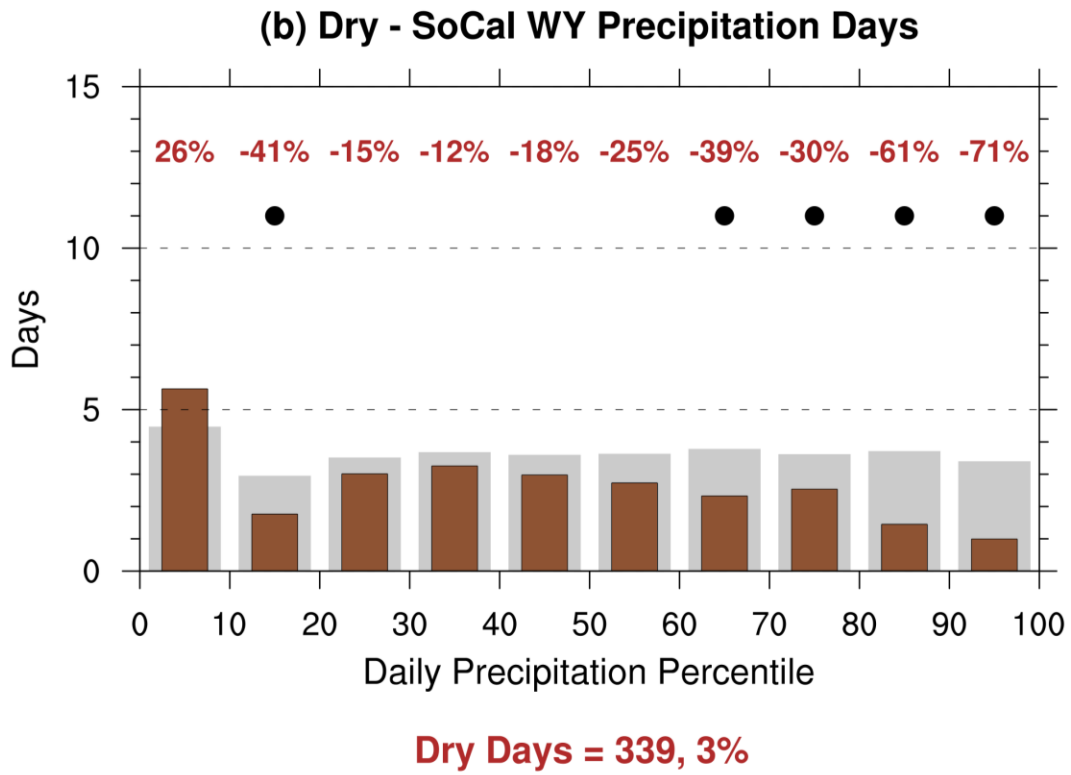
Obs: Significant Changes in Heavy Precipitation Days Separates Wet and Dry Years





Histograms of average daily precipitation percentile during (a) wet and (b) dry water years
Histograms for all but wet and dry years shown in gray. Dots denote changes significant at $p<0.05$

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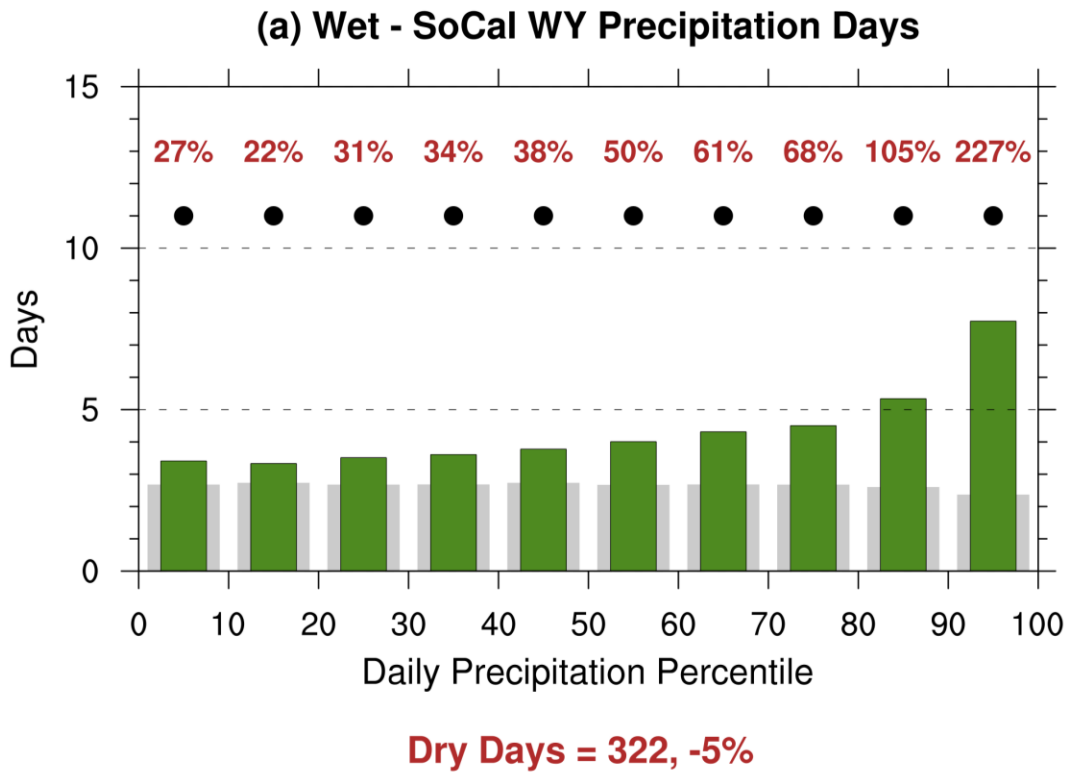

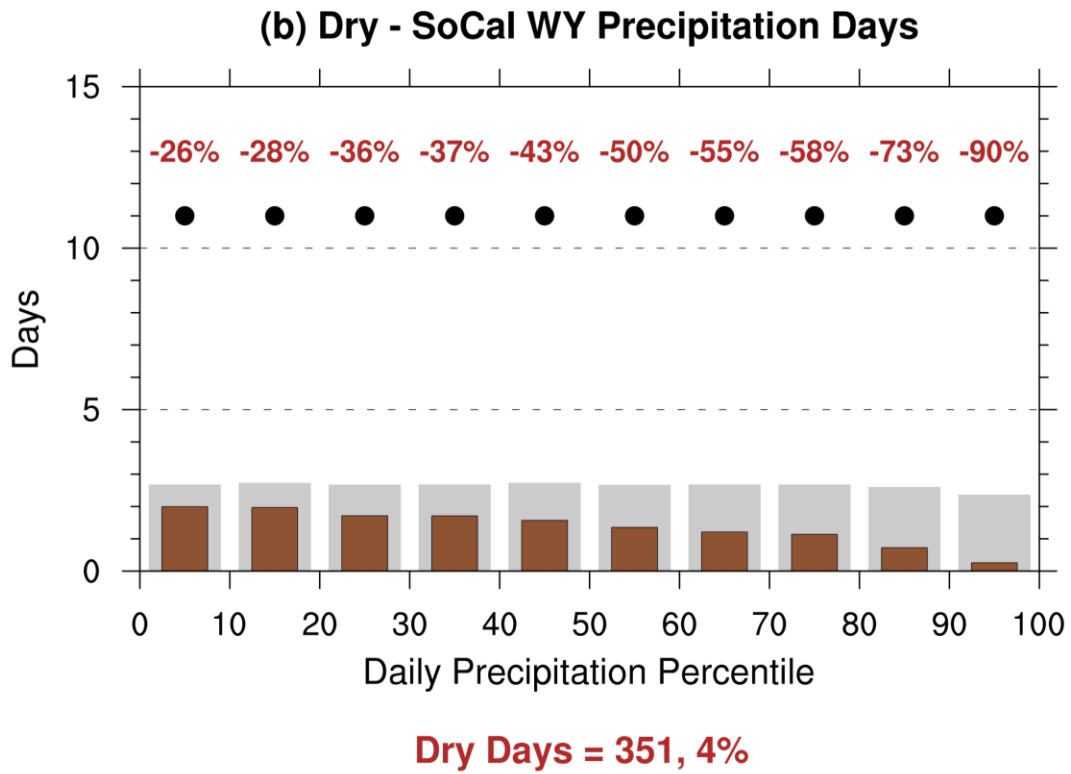

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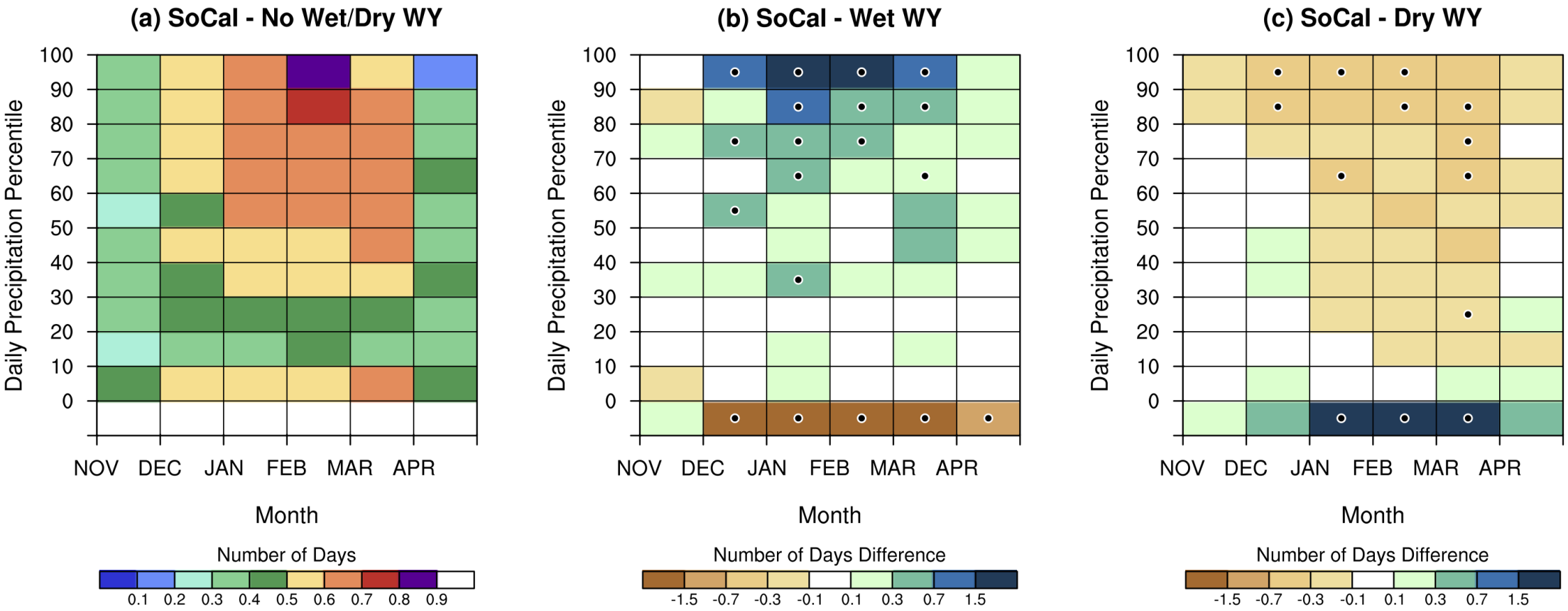
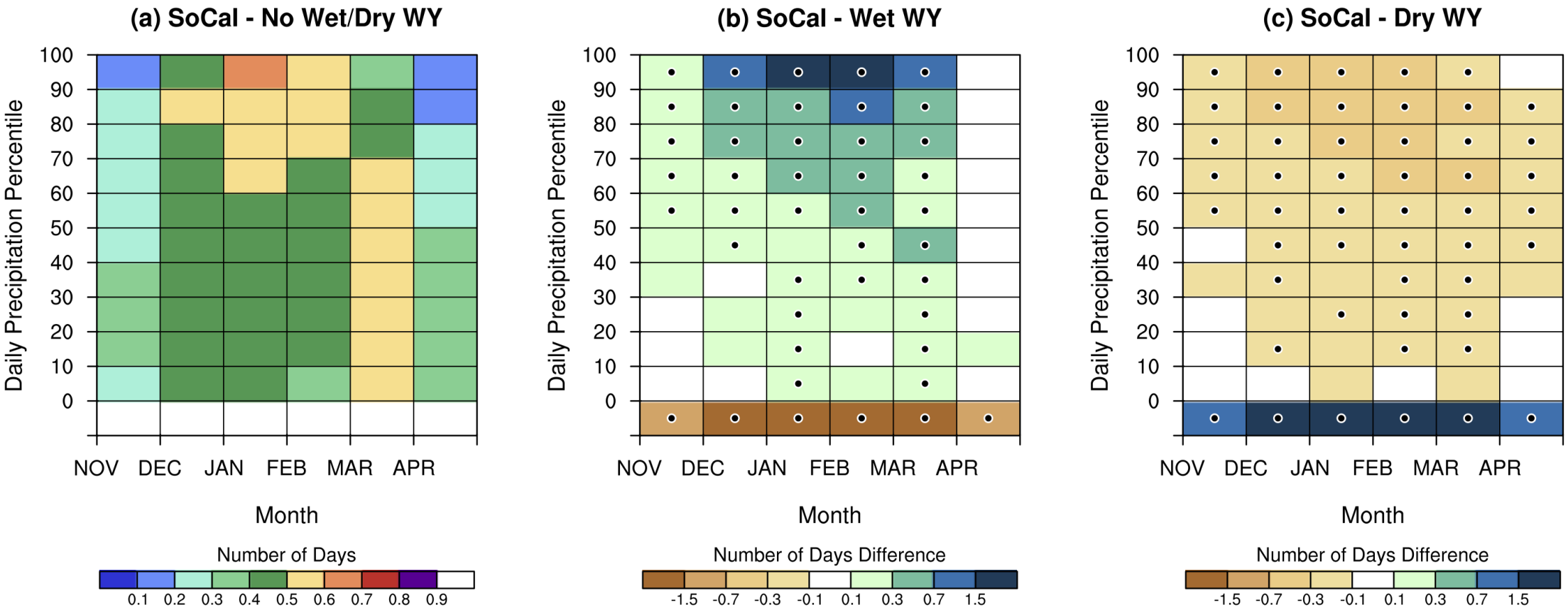


Monthly occurrences of daily precipitation percentiles during (a) no wet/dry, (b) wet and (c) dry water years

Sim: Significant Changes in Heavy Nov-Mar Precipitation Days Separates Wet and Dry Years



Monthly occurrences of daily precipitation percentiles during (a) no wet/dry, (b) wet and (c) dry water years

What Determines the Amount of Precipitation During Wet and Dry Years Over California?

- A change in the occurrences of light and/or heavy precipitation days?

  Both, with a stronger preference toward heavy

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  November-March

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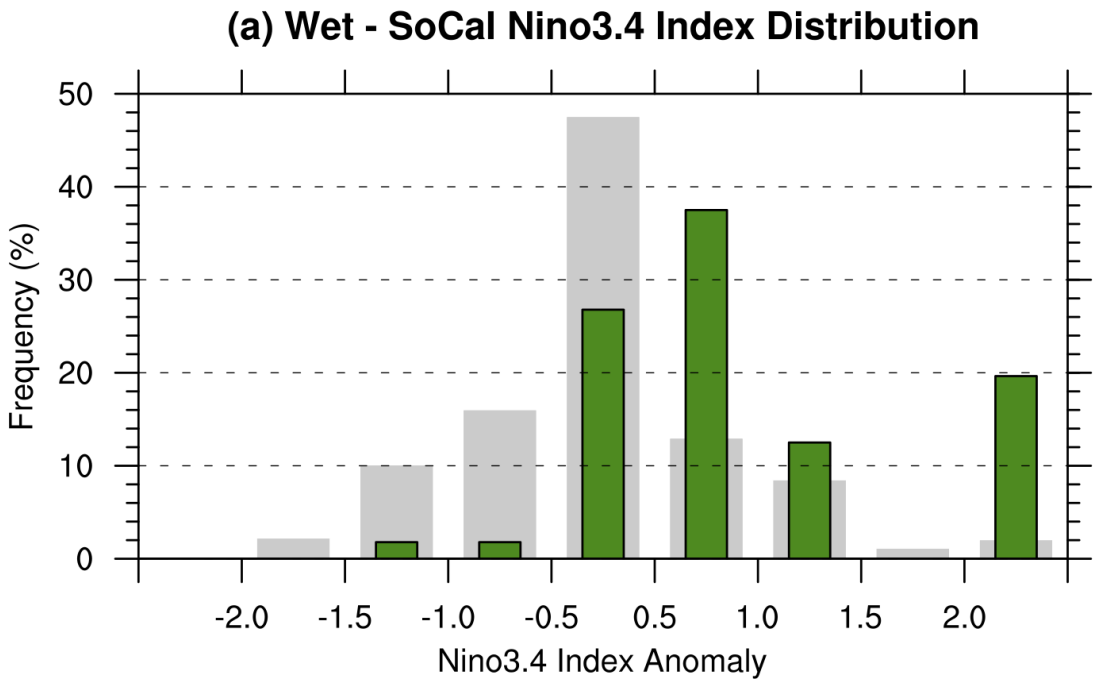
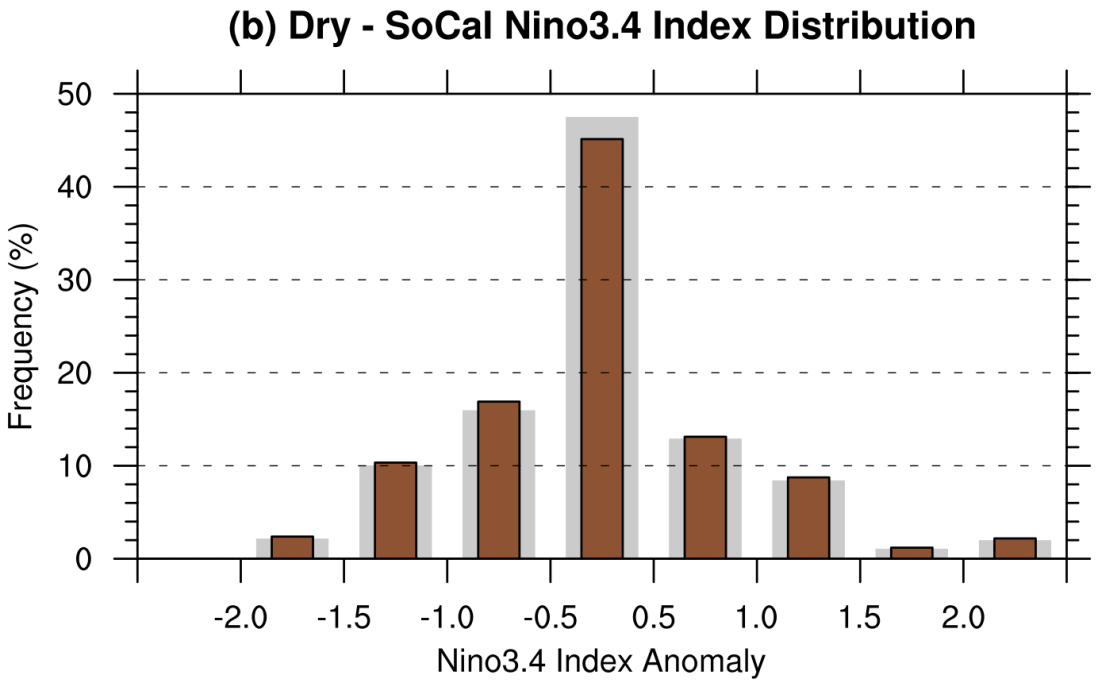
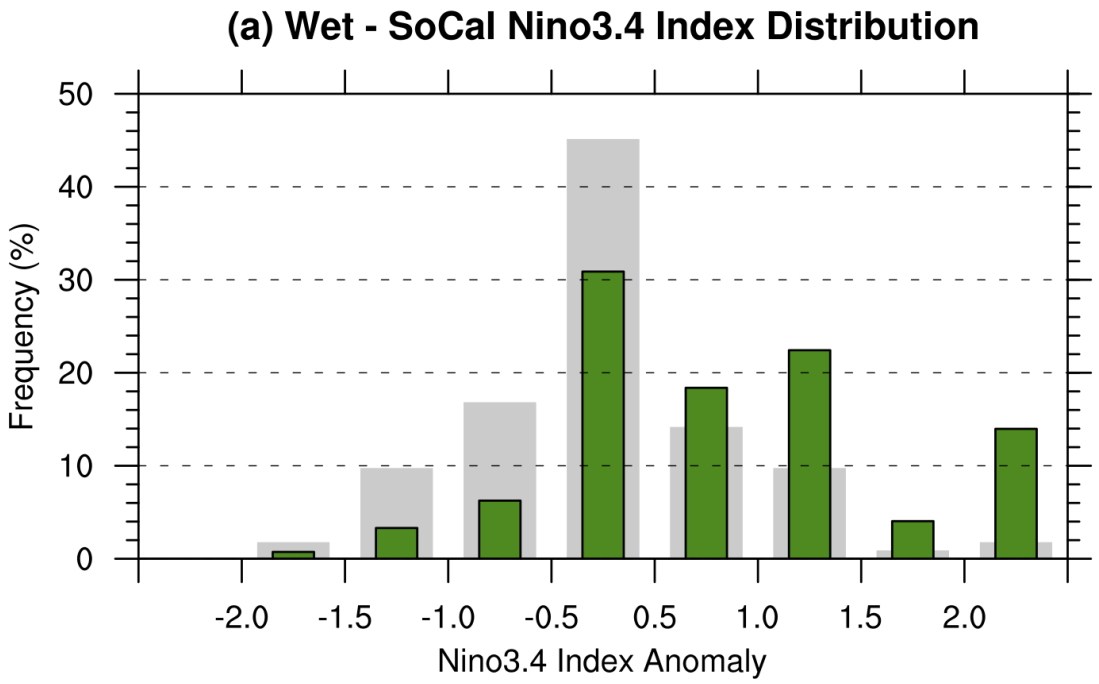
Obs: El Niño Increases Odds of Wet Extremes

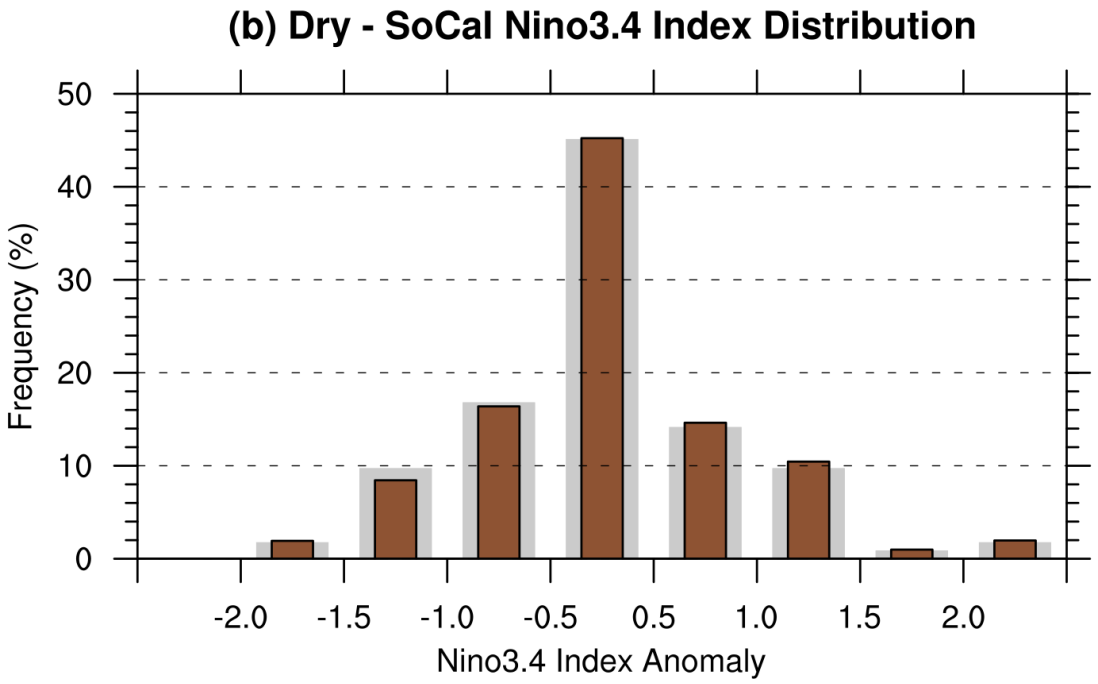




Nov-Apr histogram of Niño3.4 index anomaly during (left) wet and (right) dry water years
No wet/dry water years shown in gray.

Sim: El Niño Increases Odds of Wet Extremes





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  El Niño