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

Andy Hoell
California is Home to a Large Annual Rainfall Spread

(a) Water Year Average

(b) Coefficient of Variation

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?
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• 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

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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
SIM: Core of the Rainy Seasons is Nov-Apr
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Cumulative precipitation during (a) all, (c) wet and (d) dry water years
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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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OBS: Significant Changes in Heavy Precipitation Days Separates Wet and Dry Years

Average daily precipitation percentile during (a) wet and (b) dry water years
All but wet/dry years shown in gray. Dots denote changes relative to no wet/dry significant at \( p<0.05 \)

Dry Days = 265, -8%

Dry Days = 305, 6%
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OBS: El Niño Increases Odds of Wet Extremes

(a) Wet - N.Sierra Nino3.4 Index Distribution

(b) Dry - N.Sierra Nino3.4 Index Distribution

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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(b) Wet - SoCal PDay Distro
(c) Dry - SoCal PDay Distro

Precipitation days histogram during (b) wet and (b) dry water years. No wet/dry years in gray.
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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

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