The Current California Drought and Climate Change: Are They Related?

San Gabriel Reservoir in the Angeles National Forest

AOS
the science surrounding us all

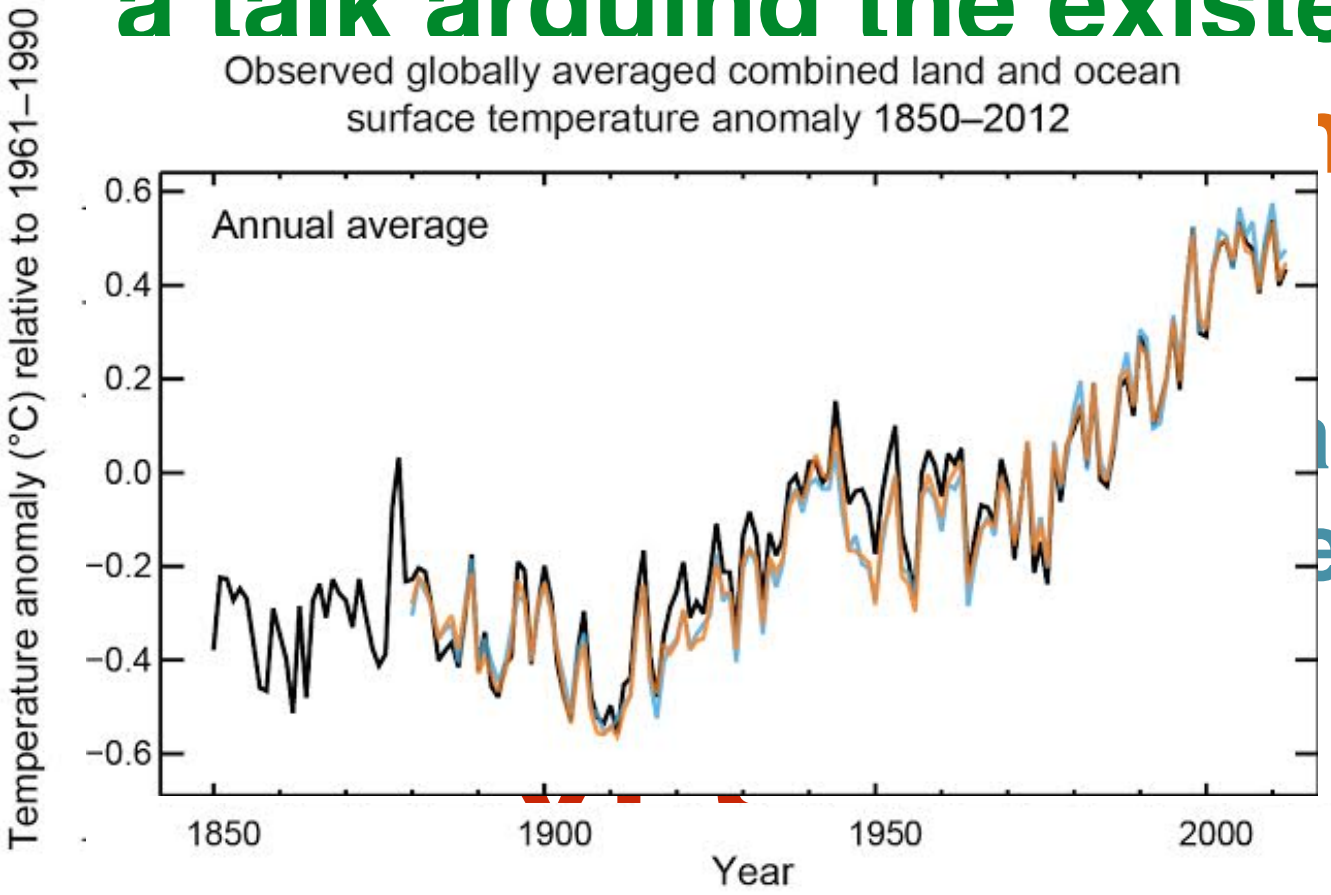
Daniel Dauhajre
Baird Langenbrunner

Your role in today's talk

Draw your own conclusion

Is th a talk arguing the existence of a ge?

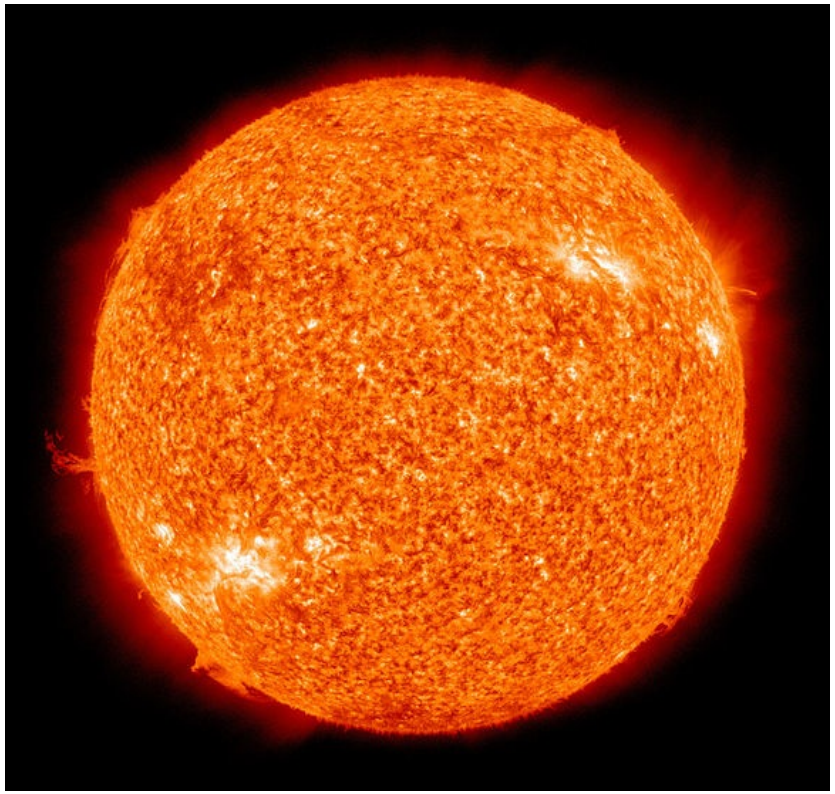
Is ar real phen erage



Can we attribute a single extreme event to anthropogenic climate change?

…work in progress

Scientific Foundation: Why does the wind blow?



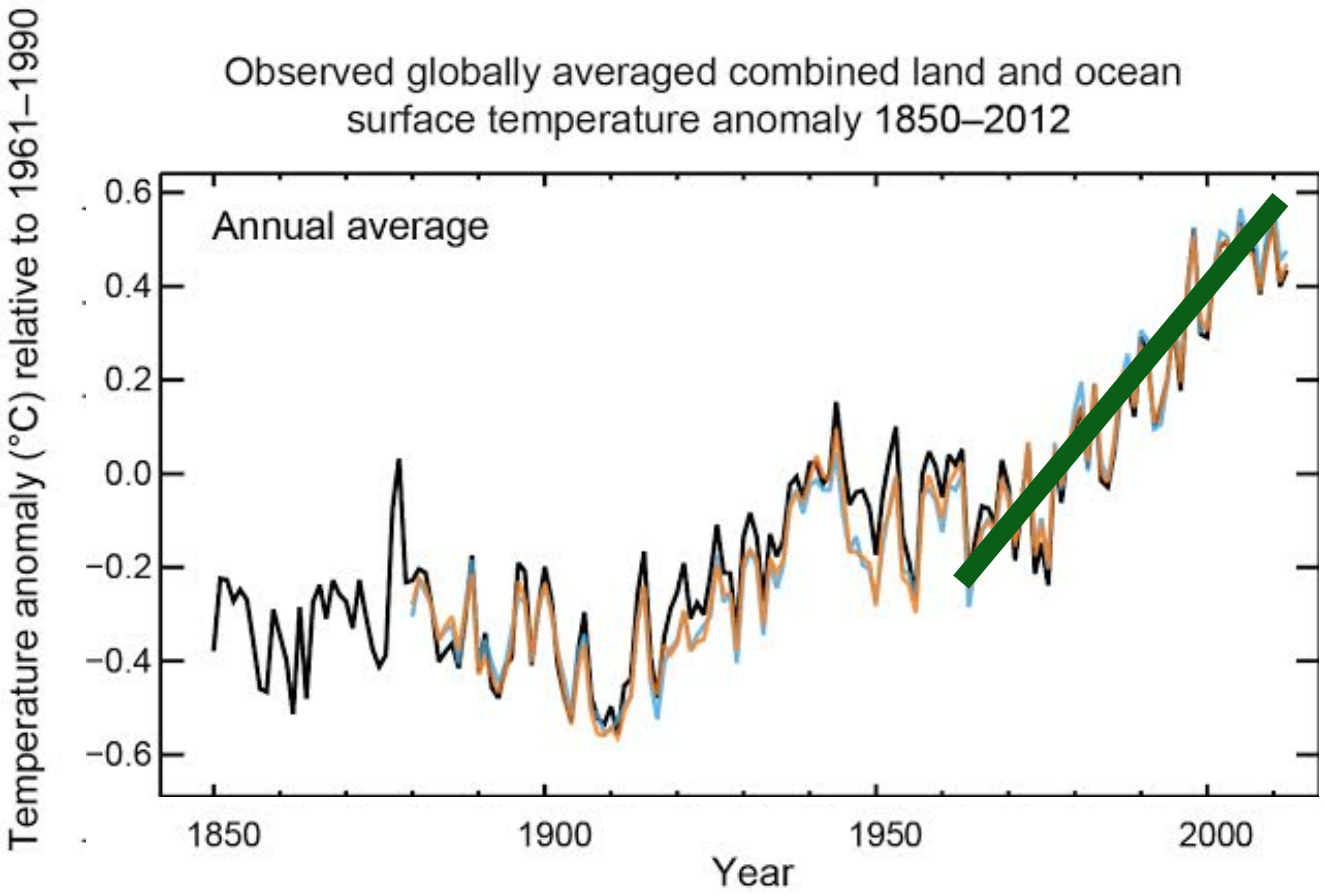
HEAT

Input at equator

The Earth system (atmosphere, ocean, land) is in a constant battle to balance out HEAT!

Climate and weather are manifestations of the Earth attempting to balance the HEAT BUDGET

Variability and Trends



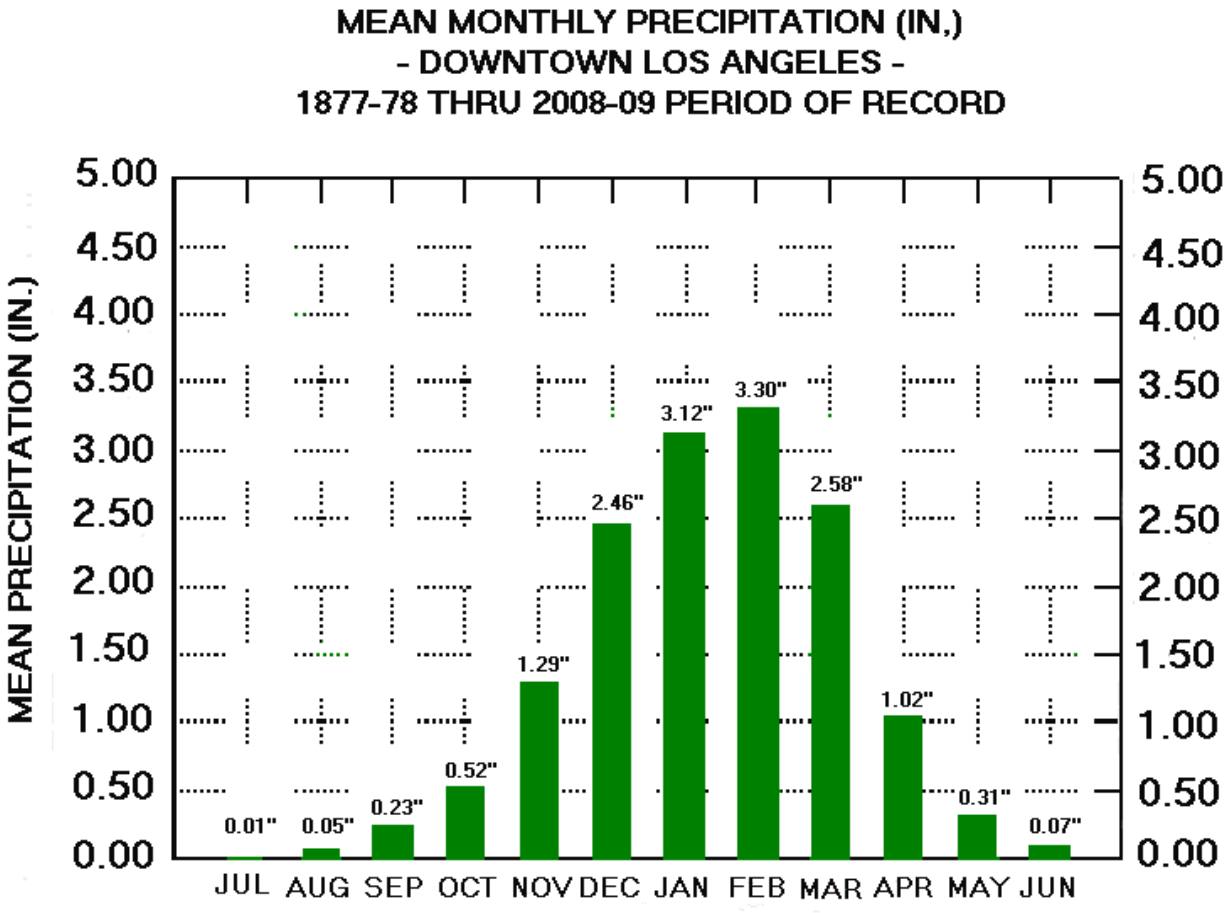
Wiggles = Variability

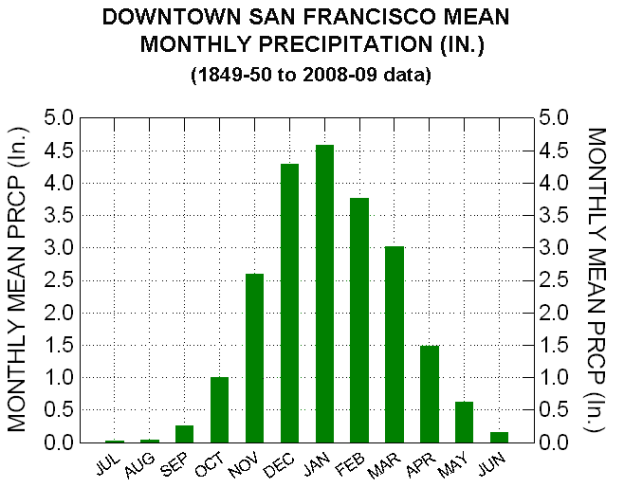
What is the trend?

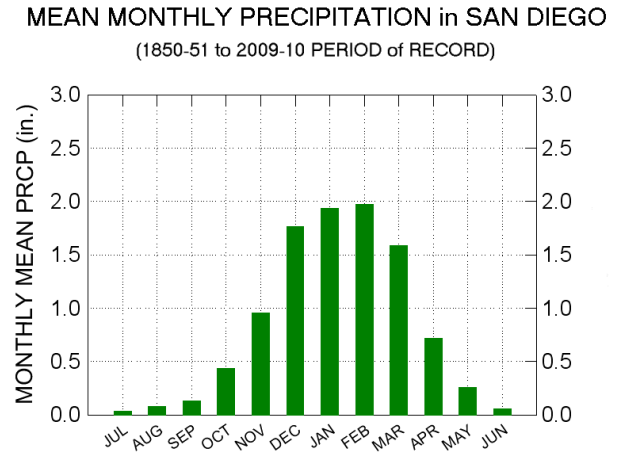
California precipitation: Big seasonal cycle

Only a few storms define the annual total of precipitation

October–March is the “wet season” for California, and this is true throughout most of the state



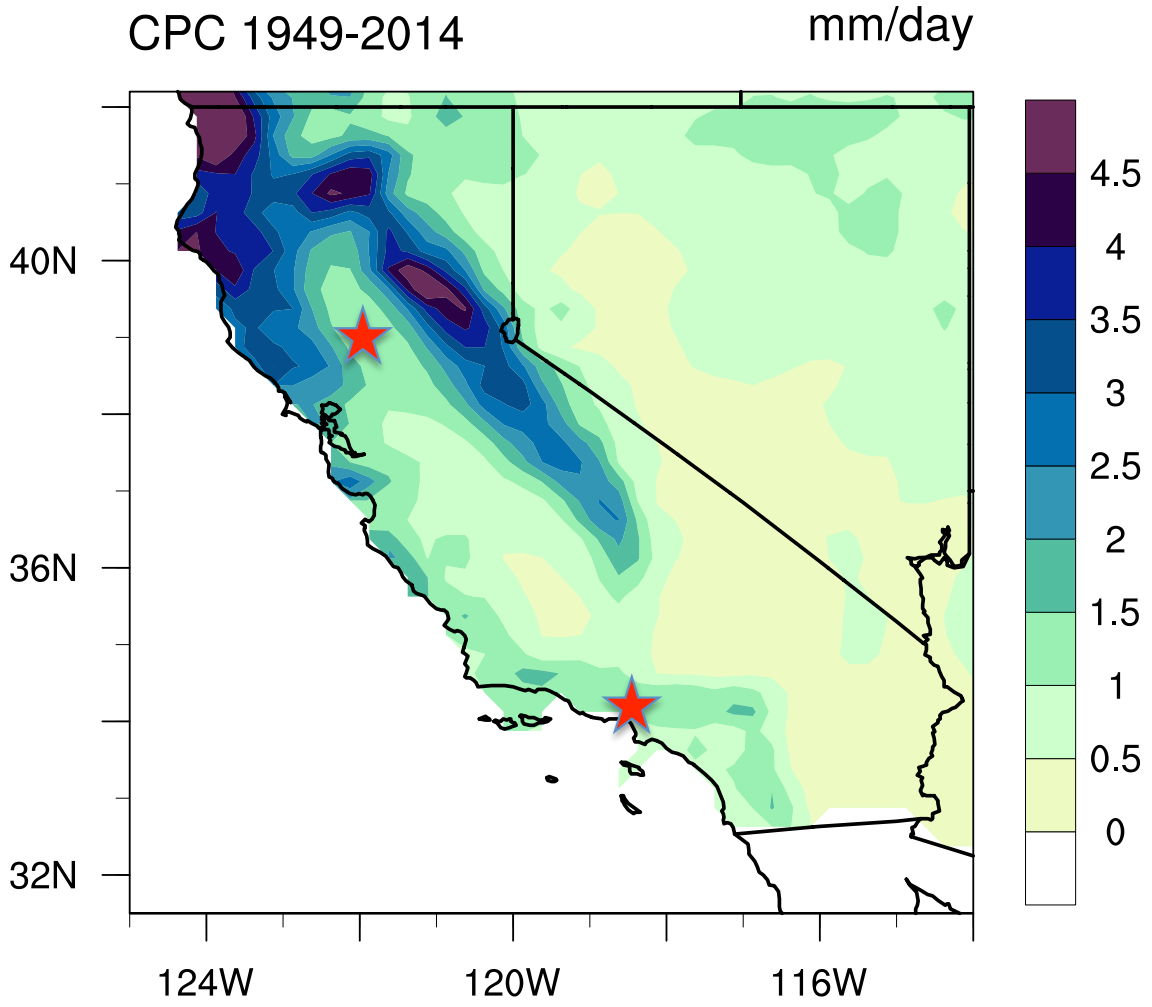




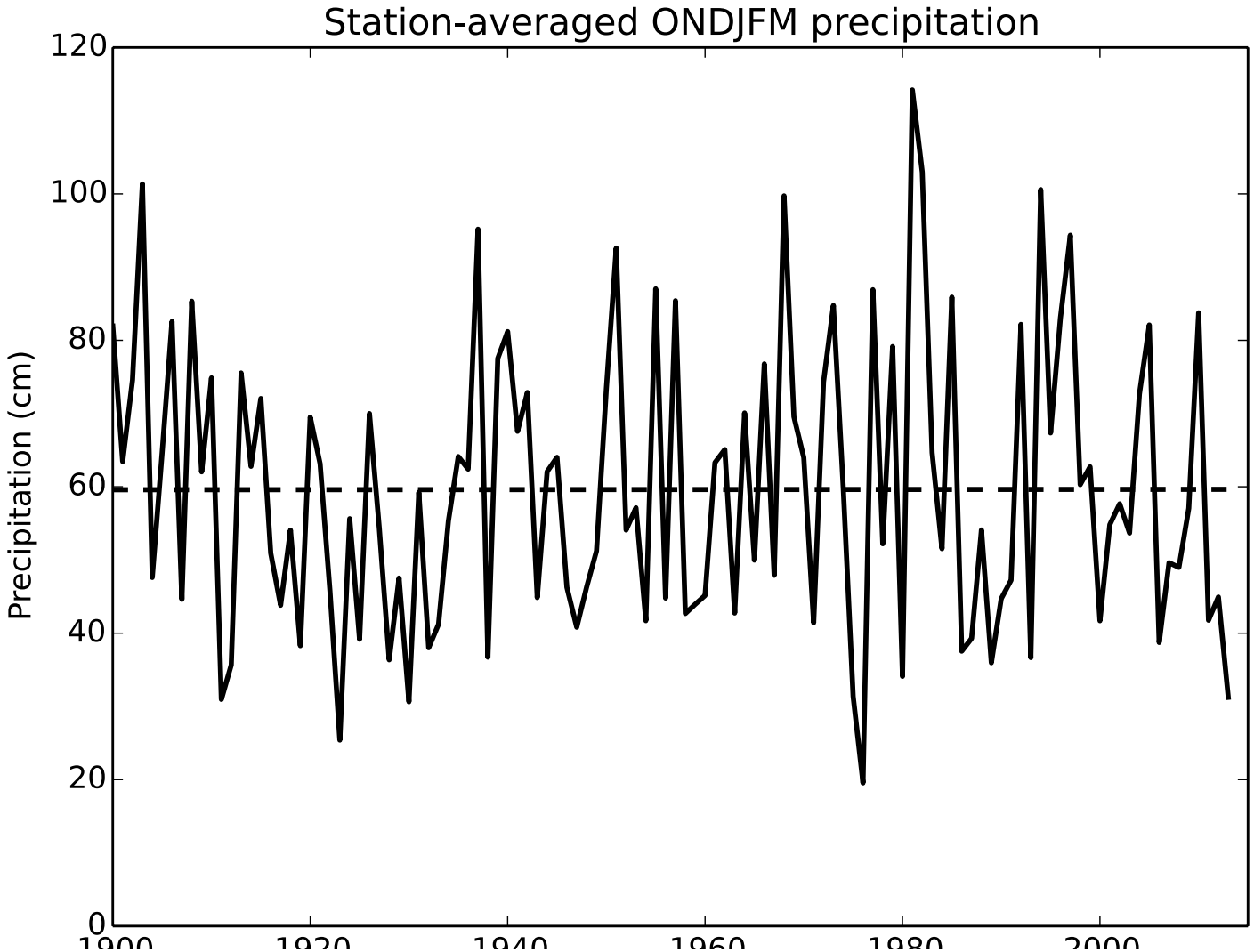
California precipitation: Increases with latitude

60% of California water resources originate in the Sierra Nevada mountains

About 75% of California's water supply comes from north of Sacramento, while 80% of water demands occur in the southern two-thirds of the state



California precipitation: Varies a lot from year to year



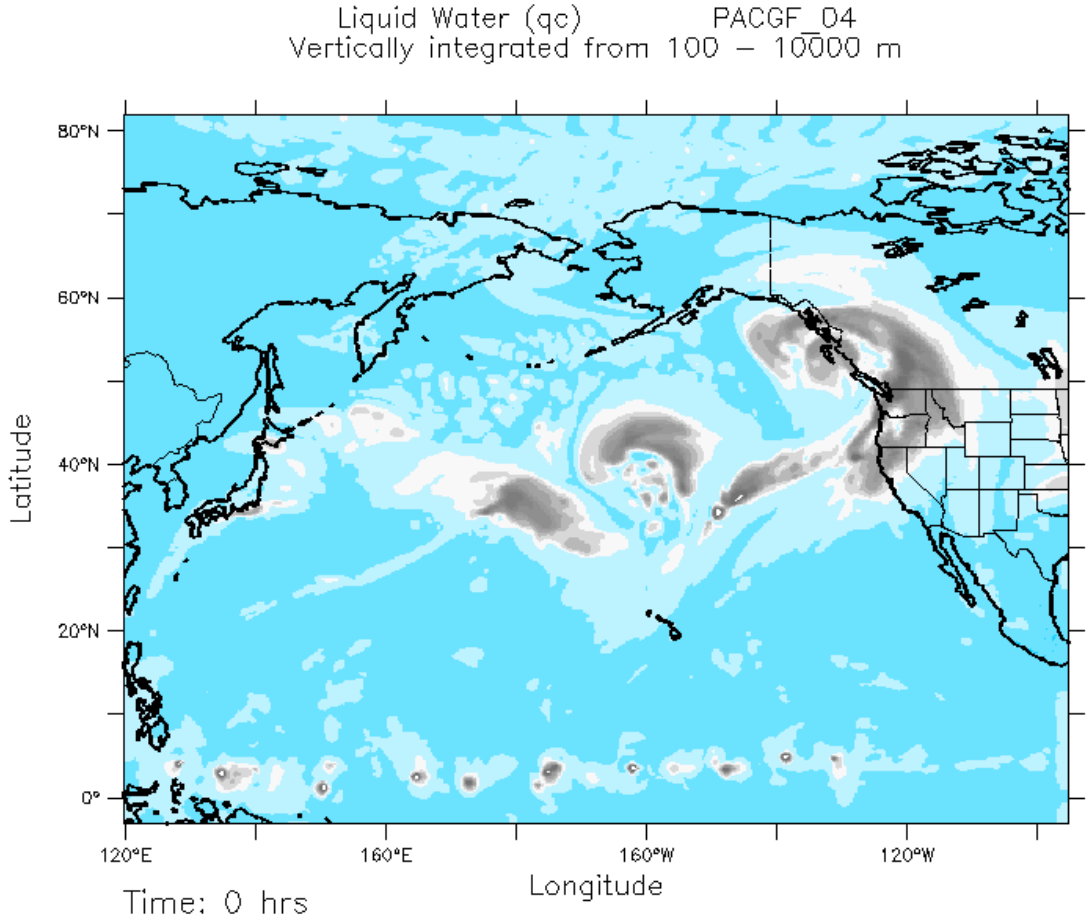
California precipitation: Why does most fall during the winter?

The Pacific **storm track** is a region of storm activity during the **winter**

In the storm track, storms **travel across the Pacific** and hit the North American west coast. The general path of these storms is steered by the **jet stream**, which is a region of really high winds that blow about 10 km (~6 miles) high

A typical simulation of storm track activity

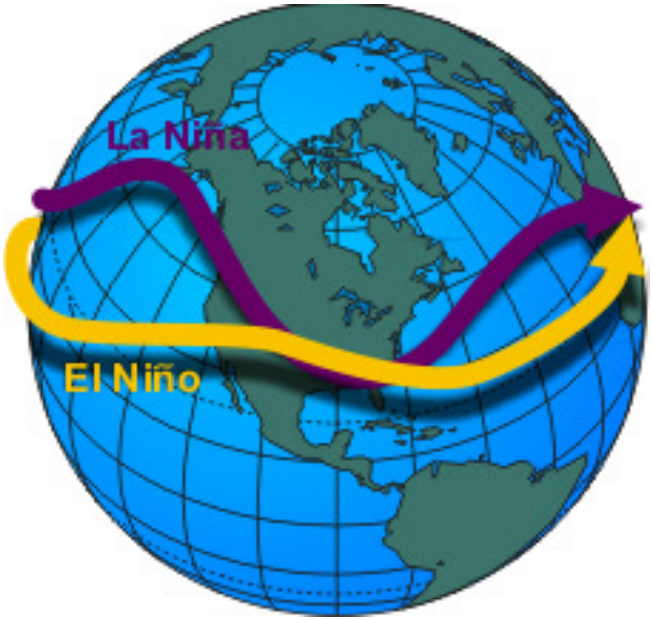
The jet stream wobbles north to south naturally

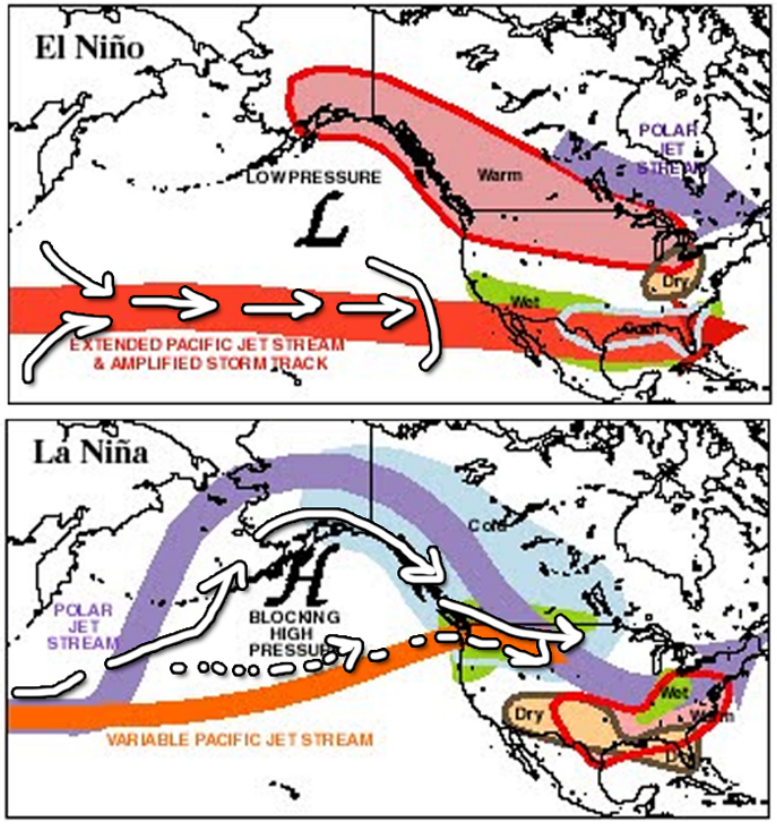


California Precipitation: Why does it vary winter to winter?

El Niño is a phenomenon in the Pacific Ocean at the equator. Sea surface temperatures increase, causing a huge ripple effect in the atmosphere. **This causes the jet stream to shift south in the winter** so that **more storms hit Southern California.**

La Niña is the **opposite**, causing storms to veer north toward the **Pacific Northwest**.

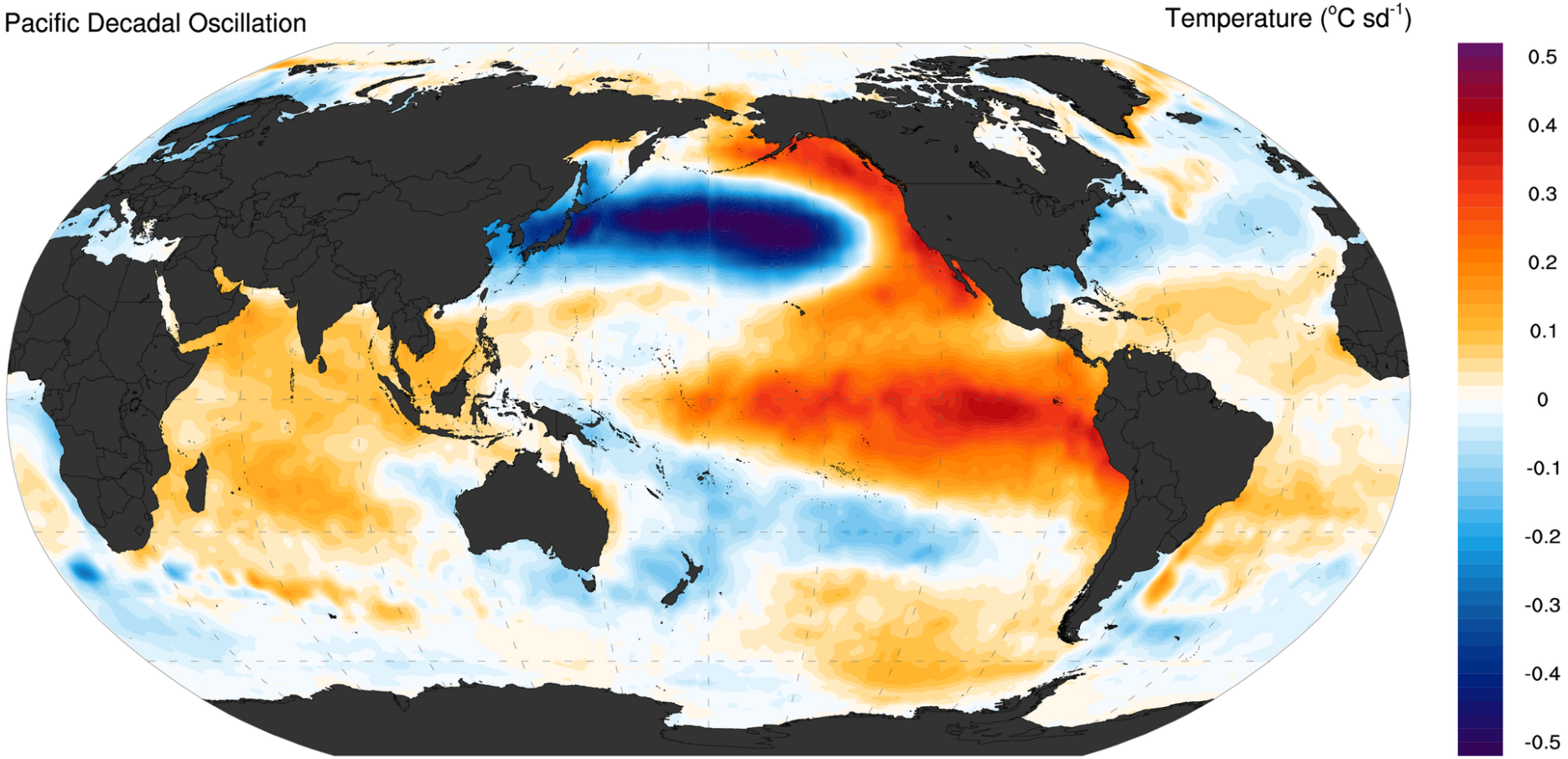




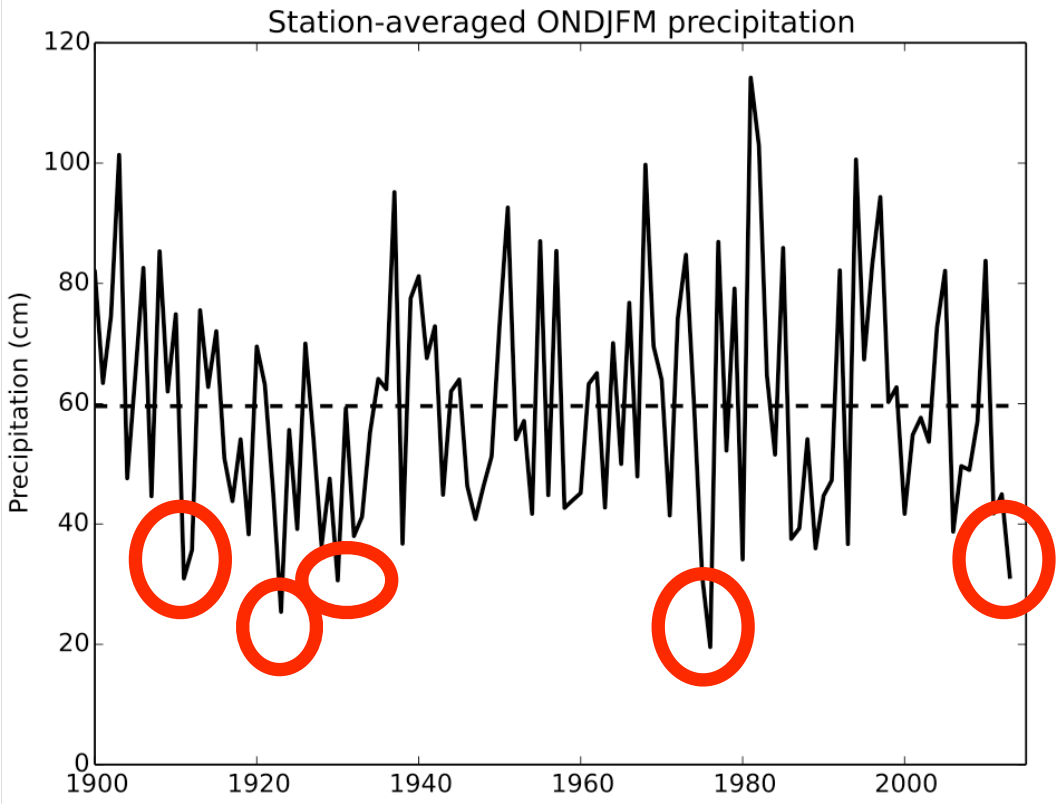
California Precipitation: Why does it vary winter to winter?

Another ocean-atmosphere process similar to El Niño/La Niña is the **Pacific Decadal Oscillation**

All of these phenomena start with **big sea surface temperature changes**, which have a ripple effect on the atmosphere and **cause large pressure changes**.



The 2013/2014 Drought: Historical Context



Trend: 0.0005 cm/year

Variability: 19.4 cm/year

Driest wet seasons

Year	Precip (cm)	% avg
1. 1976/77	***19.5***	***32.8***
2. 1923/24	25.4	40.6
3. 1930/31	***30.6***	***51.4***
4. 1911/12	30.9	51.9
5. 2013/14	***31.2***	***52.4***

What is contributing to the current drought?

Can we attribute any of these to anthropogenic climate change (warming)?

?

No CAL)

Global scale temperature differences (LARGE SCALE)

Drought Attribution: anthropogenic climate change to blame??

Swain et al. 2013: "we find that extreme geopotential height values in this region, which are a defining metric of this type of atmospheric configuration, much more frequently in the present climate than in the absence of human emissions"

YES

Wang and Schubert 2013: "The 2013 SST anomalies produced a predilection for California drought, whereas the long-term warming trend is to make no appreciable contribution because of the counteraction between its dynamical and thermodynamic effects."

NO

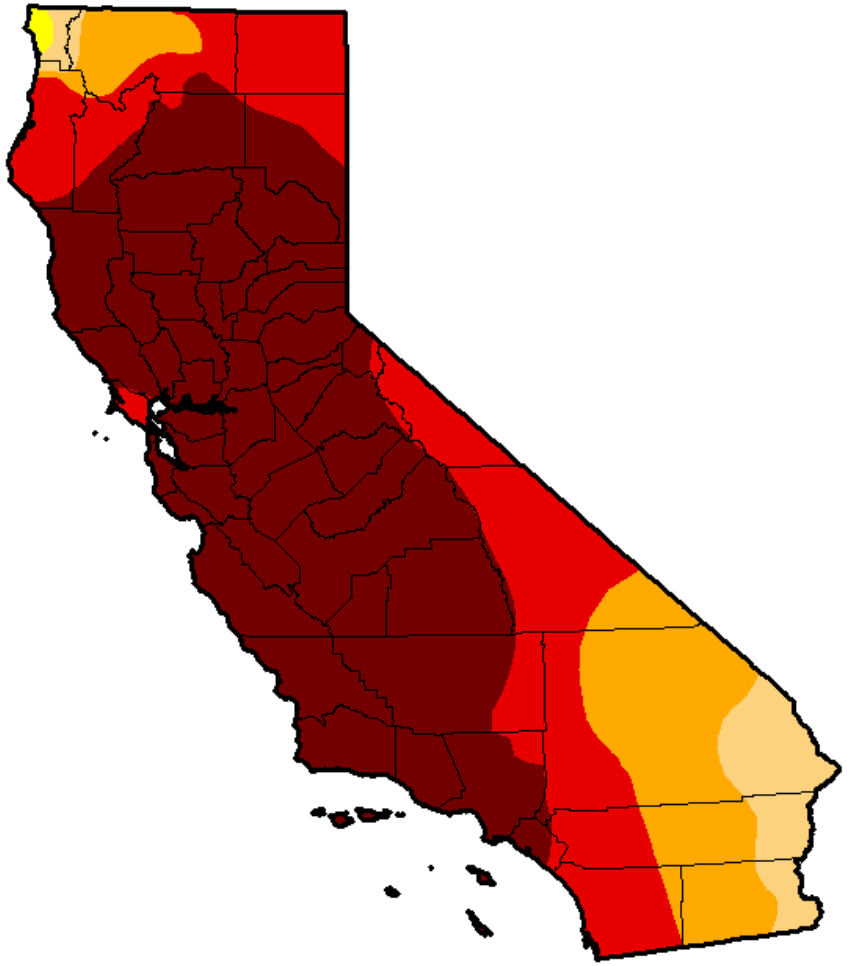
Funk et al. 2013: "Long-term SST warming trends did not contribute substantially to the 2012/13 and 2013/14 California droughts. North Pacific SSTs were exceptionally warm, however, and coupled models indicate more frequent extreme precipitation."

NO

Defining Drought

U.S. Drought Monitor

California



November 11, 2014

(Released Thursday, Nov. 13, 2014)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.72	94.42	79.69	55.08
Last Week *11/4/2014*	0.00	100.00	99.71	94.42	79.69	55.08
3 Months Ago *8/12/2014*	0.00	100.00	100.00	99.80	81.92	58.41
Start of Calendar Year *12/31/2013*	2.61	97.39	94.25	87.53	27.59	0.00
Start of Water Year *9/30/2014*	0.00	100.00	100.00	95.04	81.92	58.41
One Year Ago *11/12/2013*	2.61	97.39	96.00	84.12	11.36	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

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CPC/NCEP/NWS/NOAA

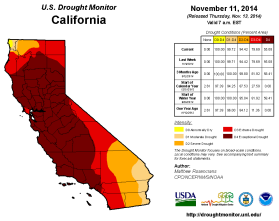
http://droughtmonitor.unl.edu/

Defining Drought

Drought Severity Classification

		Ranges					
Category	Description	Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	0-2

Short-term drought indicator blends focus on 1-3 month precipitation. Long-term blends focus on 6-60 months. Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Keetch-Byram Drought Index (KBDI), and NOAA/NESDIS satellite Vegetation Health Indices. Indices used primarily during the snow season and in the West include snow water content, river basin precipitation, and the Surface Water Supply Index (SWSI). Other indicators include groundwater levels, reservoir storage, and pasture/range conditions.



Take home points!

- Anthropogenic climate change is real and measurable
- California precipitation is subject to natural variability; the current deficit in precipitation is within the limits of this natural variability
- The 2013/2014 lack of precipitation has been attributed to a 'blocking ridge' of high pressure over California.
  - While still being disputed, the current evidence suggests NATURAL VARIABILITY as the cause
- HOWEVER!! This does not minimize the detrimental effects that rising temperatures will have on water resources for California