Understanding Climate Impacts in Colorado Driven by the Eastern Pacific Warming Pattern

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More Info. & References:

Introduction

Main Question?

Will the Eastern Pacific warming pattern cause any substantial change in average climate impacts over the next century, in terms of precipitation, fires, drought, snow cover, and temperature?

Climate Change's Impact on Society

- Floods and droughts have become more intense and frequent. (Fadoul, 2023)
- North America has seen increases of 5x in annual burned area and 8x in forest fire duration. (Williams et al, 2019)
- Warm season temperatures have increased in North America by 1.4°C in recent years. (Williams et al, 2019)
- The US has spent $1.75 trillion managing droughts since 1980. (NIDIS/NOAA n.d.)
- The US spent $1.6 billion in wildire suppression costs in 2002 (Morton et al, 2003)

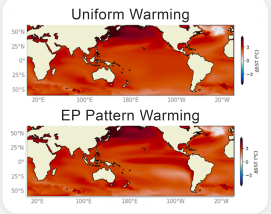
Computer Climate Models

Computer programs using physics, statistics, and mathematics to model future climate responses

Partition Earth into atmosphere, ocean, land, ice-sheet, etc.

For this project, we use CESM2 (Community Earth System Model) programed by NCAR, w/ an SSP585 worst-case scenario for expected green house gases

Eastern Pacific (EP) Warming Pattern



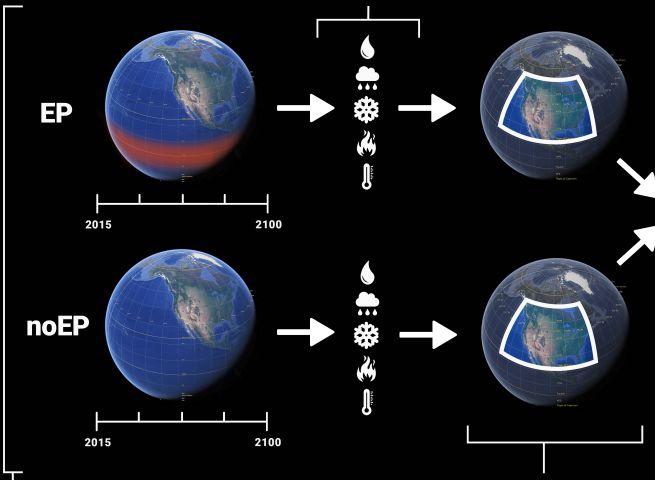
A phenomenon where computer climate models predict enhanced warming rates in the Eastern Pacific Ocean (Heede et al 2023)

Creates uncertainty because it is not in line with observed data (Heede et al, 2023) This research focuses on the 'what if' impacts of EP.

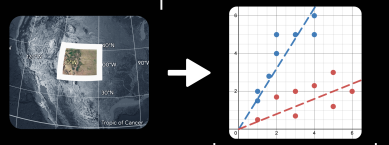
Changes to the Eastern Pacific ocean can impact the climate across the globe (Lee et al, 2023)

Methods

Output variable data is extracted for 5 variables, and the 5 ensemble members averaged out.



Data is sliced geographically again to analyze Colorado only



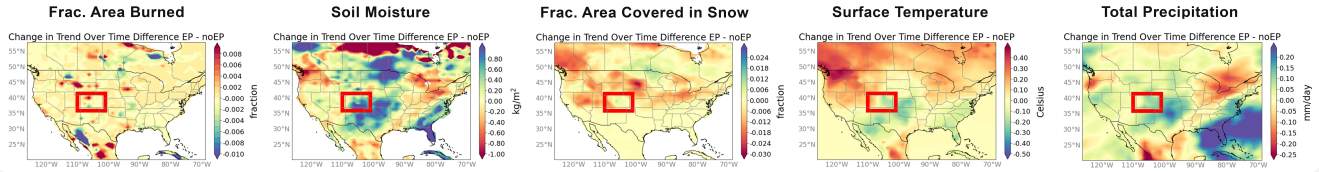
Data from the noEP experiment is subtracted from the EP experiment. This leaves behind the difference (ie. the impact caused by EP)

Colorado data is analyzed statistically for correlation strength values (Pearson R values), statistical significance at the 5% significance level, and average values for Colorado

We conduct 2 experiments (5 ensemble members) on the CESM2 framework, one with EP warming and one without

Data is prepared for analysis. Stored in 3D arrays, sliced geographically, etc.

Results & Discussion



R Value Matrix

	Area Burned	Soil Moist.	Area Snow	Temp.	Precip.
Area Burned	1.0*	-0.323*	-0.095	0.184	-0.282
Soil Moist.	-0.323*	1.0*	0.459*	-0.477*	0.647*
Area Snow	-0.095	0.459*	1.0*	-0.707*	0.604*
Temp.	0.184	-0.477*	-0.707*	1.0*	-0.9*
Precip.	-0.282	0.647*	0.604*	-0.9*	1.0*

* Statistically significant at the 5% significance level

General Trend Regardless of EP (Colorado Avg.)	Effect of EP Presence (Colorado Avg.)
Soil moist. expected to decrease by over over 2 kg/m^2	Reduces this decrease by 0.4 kg/m^2 (20%)
Total precipitation expected to decrease (greatly w/o EP)	Reduces the decrease by 0.07 mm/day (85%)
Area covered in snow expected to decrease by over 6%	Enhances the decrease by 4.7%
Area burned expected to increase by over 0.4%	Reduces this increase by 12.5%
Surface temp. expected to increase by 4°C	Reduces this increase by 0.06°C (1.5%)

Conclusion: Regardless of EP, we observed that global warming significantly increased temperatures, decreased soil moisture, and led to reduced snow cover in Colorado, leading to an increase in area burned. Furthermore, without enhanced EP warming, there was an enhancement in drought and higher temperatures, resulting in lower soil moisture compared to the EP warming scenario. Overall, EP warming may help mitigate climate impacts in Colorado.