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

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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 wildfire 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

Results & Discussion

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.

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

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 (i.e. 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

R Value Matrix

<table>
<thead>
<tr>
<th></th>
<th>Area Burned</th>
<th>Soil Moist.</th>
<th>Area Snow</th>
<th>Temp.</th>
<th>Precip.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Burned</td>
<td>1.0*</td>
<td>-0.323*</td>
<td>0.095</td>
<td>0.184</td>
<td>-0.082</td>
</tr>
<tr>
<td>Soil Moist.</td>
<td>-0.122*</td>
<td>1.0*</td>
<td>-0.457*</td>
<td>-0.477*</td>
<td>0.847*</td>
</tr>
<tr>
<td>Area Snow</td>
<td>-0.095</td>
<td>0.458*</td>
<td>1.0*</td>
<td>-0.707*</td>
<td>0.485*</td>
</tr>
<tr>
<td>Temp.</td>
<td>0.184</td>
<td>-0.477*</td>
<td>0.707*</td>
<td>1.0*</td>
<td>-0.05*</td>
</tr>
<tr>
<td>Precip.</td>
<td>-0.282</td>
<td>0.645*</td>
<td>0.564*</td>
<td>-0.50*</td>
<td>1.0*</td>
</tr>
</tbody>
</table>

* Statistically significant at the 5% significance level

General Trend Regardless of EP (Colorado Avgs.)
- Soil moist. expected to decrease by over 2 kg/m²
- Total precipitation expected to decrease (greatly w/o EP)
- Area covered in snow expected to decrease by over 6%
- Area burned expected to increase by over 0.4%
- Surface temp. expected to increase by 4°C

Effect of EP Presence (Colorado Avgs.)
- Reduces this decrease by 0.4 kg/m² (20%)
- Reduces the decrease by 0.07 mm/day (85%)
- Enhances the decrease by 4.7%
- Reduces this increase by 12.5%
- 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.