Are we loading the dice?

Climate change and recent Northwest droughts

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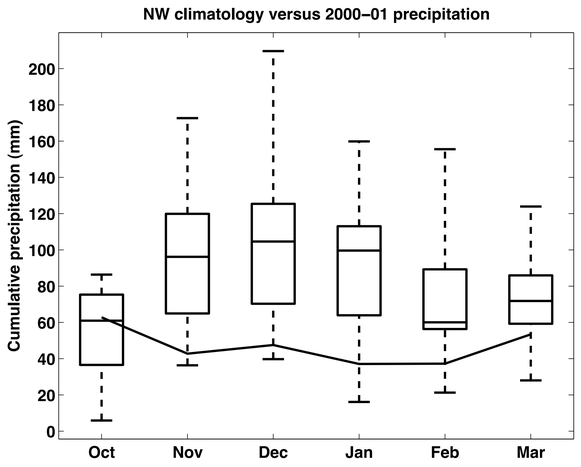
climateprediction.net

QUESTION:

Could climate change be influencing the probability of Pacific Northwest droughts?

BACKGROUND:

The Pacific Northwest (PNW) experienced a severe drought in the winter of 2000-2001. For Nov-Mar, precipitation remained in the lowest 5th to 10th percentiles relative to 1979-2006 precipitation:



This is notable for two reasons:

1. ***Weak La Niña conditions suggested an increased probability of a wet winter***
2. ***Research indicates that climate warming will result in wetter winters in the PNW***

APPROACH:

New, probabilistic approach to attribution, developed by Pardeep Pall (2006) and colleagues at ClimatePrediction.Net (CPDN)

Key distinctions:

1. **Instead of evaluating future impacts relative to a historical baseline, use a controlled experiment to investigate the influence of climate change on a specific event in the past.**
2. **Perform thousands of simulations to enable investigation of changes in extreme events.**

METHOD:

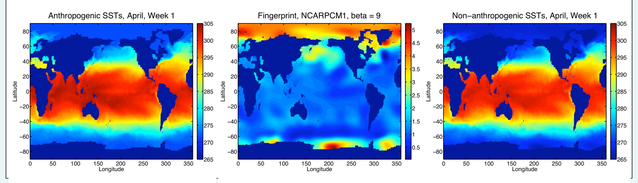
Use HadAM3 to simulate a single year: 2000-2001

Run ~10000 simulations using perturbed initial conditions, varying the forcings as follows:

Anthropogenic Climate:
- **Observed GHG concentrations (annual)**
- **Observed SST distribution (weekly)**

Non-anthropogenic Climate:
- **Year 1900 GHG concentrations**
- **Subtract "fingerpring" of 20th century warming from anthropogenic SSTs, using coupled model simulations. Generate a range of estimates for each of 4 coupled GCMs: HadCM3, GFDLR30, NCAR PCM1, MIROC3.2**

Example showing SST fingerprinting for 1st week of April:

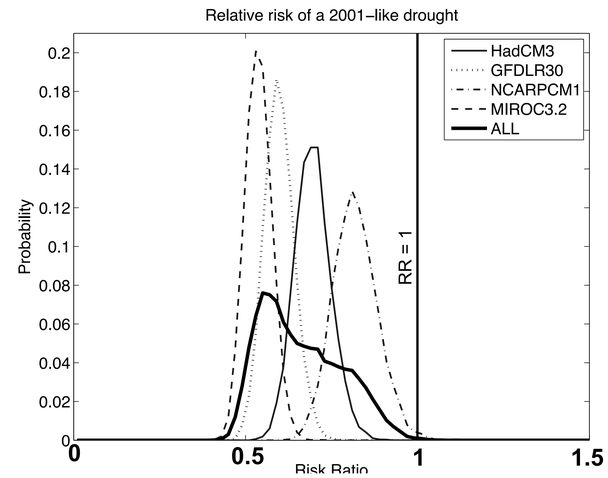


RESULTS:

We investigate changes in the statistics of precipitation for the region bounded by 41.3-49.6N and 124.4-110.6W

For each ensemble of anthropogenic and non-anthropogenic simulations, we calculate the "Relative Risk" (RR) of a 2001-like winter drought. We then use a bootstrap approach to estimate probability distributions of RR. The plot below shows these distributions, calculated separately for each SST "fingerprint".

$$RR = \frac{P_{\text{anthro}}}{P_{\text{non-anthro}}}$$



The concept of Relative Risk is often used in epidemiology.

RR = 1 implies no change in risk
RR < 1 implies a decreased risk
RR > 1 implies an increased risk

Note that the distributions of RR are almost exclusively less than 1.

CONCLUSION:

Anthropogenic climate change appears to *decrease* the risk of winter drought in the Pacific Northwest.

CAVEATS:

- **Technically, results are only applicable to the winter 2000-2001**
- **Results are susceptible to biases in both HadAM3 and the coupled models used to generate SST fingerprints.**
- **Though we believe the method is robust, errors in the SST fingerprinting could significantly impact PNW precipitation**
- **We do not have the data needed to diagnose the meteorological source of the differences between anthropogenic and non-anthropogenic simulations.**

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