FREQUENCY OF EXTREME TEMPERATURE EVENTS AT REGIONAL AND GLOBAL SCALES

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RESEARCH GOALS

- Investigate frequency of extreme temperature events, defined as daily departures of more than 2 standard deviation RELATIVE TO the historical mean (1981-2010)
- Compare projected changes of these events in the future as simulated by the different "Shared Socioeconomic Pathways" of phase 6 of the Coupled Model Intercomparison Project (CMIP6)
- 4 Regions of study: Global, Arctic, Alaska, and Eastern North America

DATA

- CMIP6 combines models from modelling teams around the world under shared guidelines for forcing scenarios and outputs
- 7 models were used for this study: ACCESS-CM2, ACCESS-ESM1-5, NorESM2-LM, NorESM2-MM, CanESM5, MPI-ESM1-2-HR, MPI-ESM1-2-LR
- We look at surface air temperature under 3 scenarios: historical simulations (1980-2014), ssp2-4.5 and ssp5-8.5 (2015-2100)
- NCEP/NCAR (National Centers for Environmental Prediction/ National Center for Atmospheric Research) Reanalysis data is used for comparison with the historical models to observe accuracy

ANALYSIS

- Remove the linear upward trend in temperature over the historical period to calculate the year-to-year standard deviation of surface temperature anomaly for each day of the year in 1981-2010
- Calculate the number of days per year in Dec-Jan-Feb (Northern hemisphere winter) that are above 2 standard deviations, both in the raw anomaly and anomaly after removing the linear trend
- For each model the analysis is done separately, with the final number of extreme heat days per year averaged over the ensemble

DISCUSSION

- For Alaska, the arctic, and eastern North America, the standard deviation is much higher during the winter than the summer, and the smaller regions (Alaska & NE America) have more variability than the arctic and global, which is expected.
- Over the forecasted time period, the number of days with a >2σ anomaly (from the 1980-2010 mean) increases significantly, but some of this is due to the overall increase in surface temperature over time
- After removing the linear trend from the anomaly timeseries, global and arctic plots still show a scenario-dependent increase in the number of anomalous hot days. Alaska and NE America plots show a high year-to-year variability among all the models.
- In the Arctic, the number of >2σ days (with the trend removed) rises from <5 days per year in the historical period to >20 days for both scenarios by 2060, to >30 for ssp2-4.5 and >50 for ssp-5.85 by the end of the century.

Figure 1 (a,b,c,d): standard deviation in daily surface temperature over the period 1980-2010, measured for each model (blue lines), with the red line representing the mean of all models.

Figure 2 (a,b,c,d): Number of days per winter (December, January, February) with an anomaly above 2 standard deviations. The transparent lines represent the number calculated for each model, with the opaque lines representing the ensemble means for each period.

Figure 3 (a,b,c,d): Number of days per winter (December, January, February) with an anomaly above 2 standard deviations, after removing the linear upward trend from the anomaly. The transparent lines represent the number calculated for each model, with the opaque lines representing the ensemble means for each period.