The C20C+ Detection and Attribution Project

http://portal.nersc.gov/c20c

Dáithí Stone (dstone@lbl.gov), Hideo Shiogama, Piotr Wolski, Oliver Angélil, Shreyas Cholias, Nikos Christidis, Andrea Dittus, Chris Folland, Andrew King, Jim Kinter, Hari Krishnan, Seung-Ki Min, Michael Wehner

BERKELEY LAB

U.S. DEPARTMENT OF ENERGY
Office of Science

Current data products are not designed for investigating extreme weather under a changing climate

The emerging field of event attribution aims to estimate the degree to which anthropogenic emissions has contributed to recently experienced extreme climate events.

Current data products relevant for assessment of event attribution:

- Observed trends in frequency or extreme value parameters: assumption of causation
- CMIP5-class atmosphere-ocean model historical attribution simulations: poor probability of resolution, poor spatial resolution
- Ad hoc data generated with atmospheric model for specific event: transferability to other events unclear

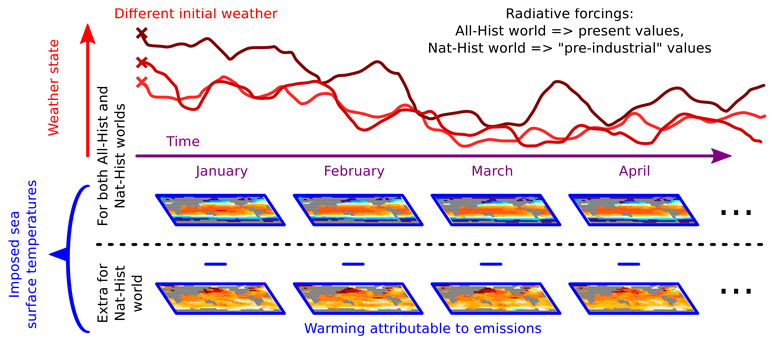
Need to develop data products which:

- Allow characterisation of sensitivity of conclusions to experimental design (e.g. type of data product) and product realisation (e.g. climate model)
- Provide high resolution of event probability
- Provide reliable representation of extreme event climatology, variability, and trends
- Allow analysis of extremes around the world, facilitated by public distribution

Experimental design

Running a number simulations with slightly different initial states produces a sample of plausible weather given boundary conditions. Larger ensembles provide greater resolution in the tails of the probability distributions.

- **Large ensemble of simulations driven by the "real world" (All-Hist) that we have experienced.**
  - Observed changes in concentrations of greenhouse gases and anthropogenic pollutants, volcanic aerosols, solar luminosity, ocean surface temperatures and sea ice coverage
- **Large ensemble of simulations of the counterfactual "world that might have been" (Nat-Hist), repeated to represent uncertainties in boundary conditions.**
  - Anthropogenic drivers set to year 1850 values
  - Ocean cooled and sea ice advanced according to warming attributable to emissions



Spanning across sources of uncertainty

Simulations with multiple models, across boundary condition uncertainty.

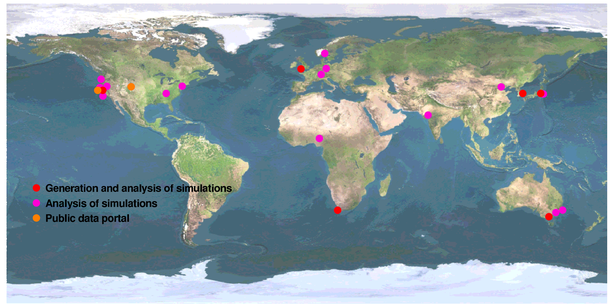
Model	All-Hist	Nat-Hist
ACCESS1.3	5, 55 pending	CMIP5-est1: 10 pending
CAM5.1-0.25degree	1-5	
CAM5.1-1degree	50-400	CMIP5-est1: 50-400 Other ΔSSTs: 4x50
ECHAM6	10-50 pending	CMIP5-est1: 50 pending
HadAM3P-N96	10-100	CMIP5-est1: 10-100
HadGEM3A-N216	15-500	CMIP5-est1: 15-500
MIROC5	10-60	CMIP5-est1: 50

Public data distribution

Approximately 200TB of output publicly available, much more pending.

- **No registration required.**
- **Portal services by NERSC**
  - Small files via http://portal.nersc.gov/c20c/data
  - Large files via http://portal.nersc.gov/archive/home/projects/cascade/www/C20C
  - Developing unified web directory page
  - Also available through the Earth System Grid Federation
    - (http://esg.nersc.gov, project label "c20c")
- **Portal services by NOAA-ESRL**
  - Selected monthly output at http://www.esrl.noaa.gov/psd/repository/alias/facts
- **Updated information at http://portal.nersc.gov/c20c/data**

Map of current users of C20C+ D&A data



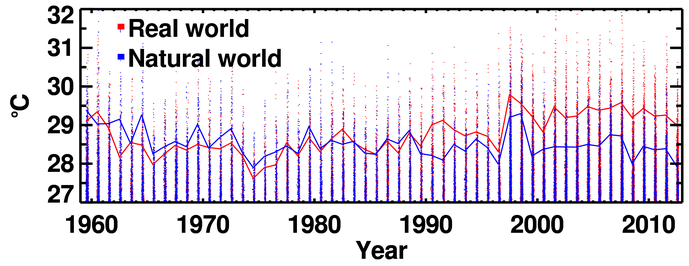
Coordinated plans

- LBNL hosted an analysis hackathon during 7-11 December
- Preparation for a special issue in 2016 of the journal Weather and Climate Extremes: open invitation
- Will comprise results of first analyses of the C20C+ D&A Project data

Estimating probabilities of extreme weather

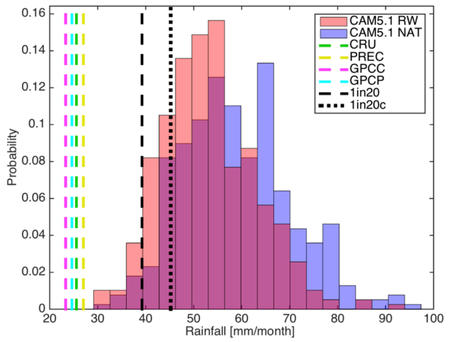
Hot days over California

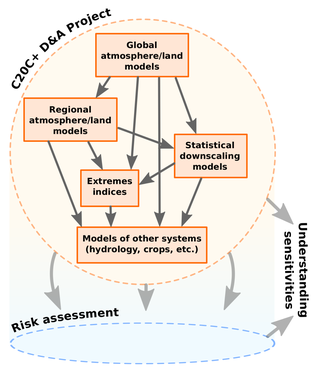
Dots show the hottest daily surfaces air temperatures over the State of California from 100 simulations of CAM5.1-1degree. The lines show the average 364/365 quantile for each year. There is some year-to-year predictability, as the "real world" and "natural world" lines vary together. But scenarios diverge after 1990, such that the hottest days are about 1°C warmer today than they would have been without emissions.



Dry March-August 2011 over Texas

The chance of a dry summer is estimated to be higher in the world we have experienced (red) than in the natural world that might have been in the absence of emissions (blue), according to simulations of the CAM5.1-1degree model run at LBNL. Vertical lines indicate various dry-summer thresholds.





Toward understanding changes in risk

Current phase involves running global dynamical models of the atmosphere.

Future phases will run:

- Higher spatial resolution regional dynamical models
- Statistical downscaling models
- Hydrology models
- Crop models

Acknowledgments

This work has been funded by:

- The U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research's Regional and Global Climate Modeling Program;
- The Program for Risk Information on Climate Change, Ministry of Education, Culture, Sports, Science, and Technology of Japan;
- The Water Research Commission, South Africa;
- The E.U.'s Seventh Framework Programme;
- The Australian Research Council