WHAT ELSE SHOULD WE BE DOING WITH THE GCM-BASED FLOOD SIMULATIONS?

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Death of Stationarity?

Stationarity never existed!

(Hirsch, Webb, ..., this meeting)
Death of Stationarity?

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So what ARE the challenges we face?

* Statistical characterization:
  Adaptive & projective frequency estimation
  Detection of change

Operations:
  Eroding margins for error

* Planning & design:
  Death of Optimality?
GHG forcings have not been growing steadily, so longer (older) records will not necessarily characterize GHG responses more accurately.

**Statistical characterization: estimation**

- Rising 8x as fast since 1970s

**Global Radiative Forcing, 1870-2100**
Statistical characterization: estimation

Sierra Nevada Summer Temperatures From Tree Rings & Current Projections

Deviations from 1928-1988 mean. 50-yr filter

Graumlich, 1993
Carrying along the weight/advantages of historical records

Estimating flood frequencies from observations:

• Use all the historical data?
• Weight the recent past more? How?
• Use sliding windows of only past 50-yr of record? N-yr?
  GHG-weightings (crtsy Bob Hirsch)?
• Adaptive estimators (e.g., Kalman filter, FARMA)?
A Modest Proposal

We need anthropogenic-climate-change-suited estimation heuristics. The “best” estimation methods will depend on mixes of variability & trends, steepness of trends, etc.

Warts & all, GCM-based flood-series projections provide the most specific available basis for testing and/or developing methods.
Statistical characterization: detection

• SHOULD we have seen detectable flood changes by now?

• Early warnings of change

Flood frequency analyses of the Santa Cruz R, Tucson, AZ

Webb & Betancourt, 1992, USGS WSP 2379
Statistical characterization: detection

Observed change in flood mechanisms!

From a couple of my favorite rivers in Southern Sierra Nevada

USGS: science for a changing world
Statistical characterization: detection

Simulating daily flows with U of Wash’s VIC hydrologic model under CA-downscaled climate projxns

Simulated 99%-ile flows under climate projections

GCM: GFDL
Emissions: A2

◆ Same number of 99%-ile flow events, despite declining precipitation totals

◆ Mix of snowmelt vs rainfed floods changes in SoSN

Blue x = rain-driven
Red o = snowmelt

Dettinger et al 2009 CEC; Das et al, in prep
Long before flood-regime change shows up in annual-flood series stats, they will be heralded by changing flood types and/or contributing mechanisms.

We should be focusing on possible changes in flood mechanisms for indications of the future, in both models & data.
Death of Optimality?

Simulated 99%-ile flow events under future-climate projections

Under this particular GCM, flood magnitudes increase through the 21st Century DESPITE a 10-15% DECLINE in overall precipitation

Dettinger et al 2009 CEC; Das et al, in prep
Death of Optimality?

Northern Sierra
50-yr flood magnitudes

Southern Sierra
50-yr flood magnitudes

These kinds of ensemble scatter are unlikely to decline much in the coming decade.
Even 30- or 50-yr blocks of time provide few extreme events upon which to draw conclusions or uncertainty estimates.

Phil Mote, with climateprediction.net, and some of us others are beginning a MASSIVE-ENSEMBLE simulation process with a nested 25-km regional climate model of Western US. This time, outputs have been designed to be water-centric, e.g., annual flood series. 10,000s realizations on their way… Wanna play along?
Scatter among GCM-based flood statistics is unlikely to be reduced much in the next decade. So, “get over it!”—to echo Bob H

The Death of Optimality → We need to be focusing as much effort on revising or reinventing “Harvard Program” design METHODS as on reducing these uncertainties.

Ensembles of GCM-based future flood stats can provide a useful (if incomplete) resource for developing revised design & planning methods.
### Roles for GCM-based flood simulations

**Statistical characterization:**

- Development of climate-change adapted estimation heuristics and methods
- Should we expect to have seen changes by now?
- Early warnings from changing flood processes

**Planning & design:**

- A developing massive-ensemble flood-projections archive
- Death of Optimality → Developing New Robustness-centric Paradigms/Methods & testing them on myriad plausible flood projections