Building Resilience to a Changing Climate:

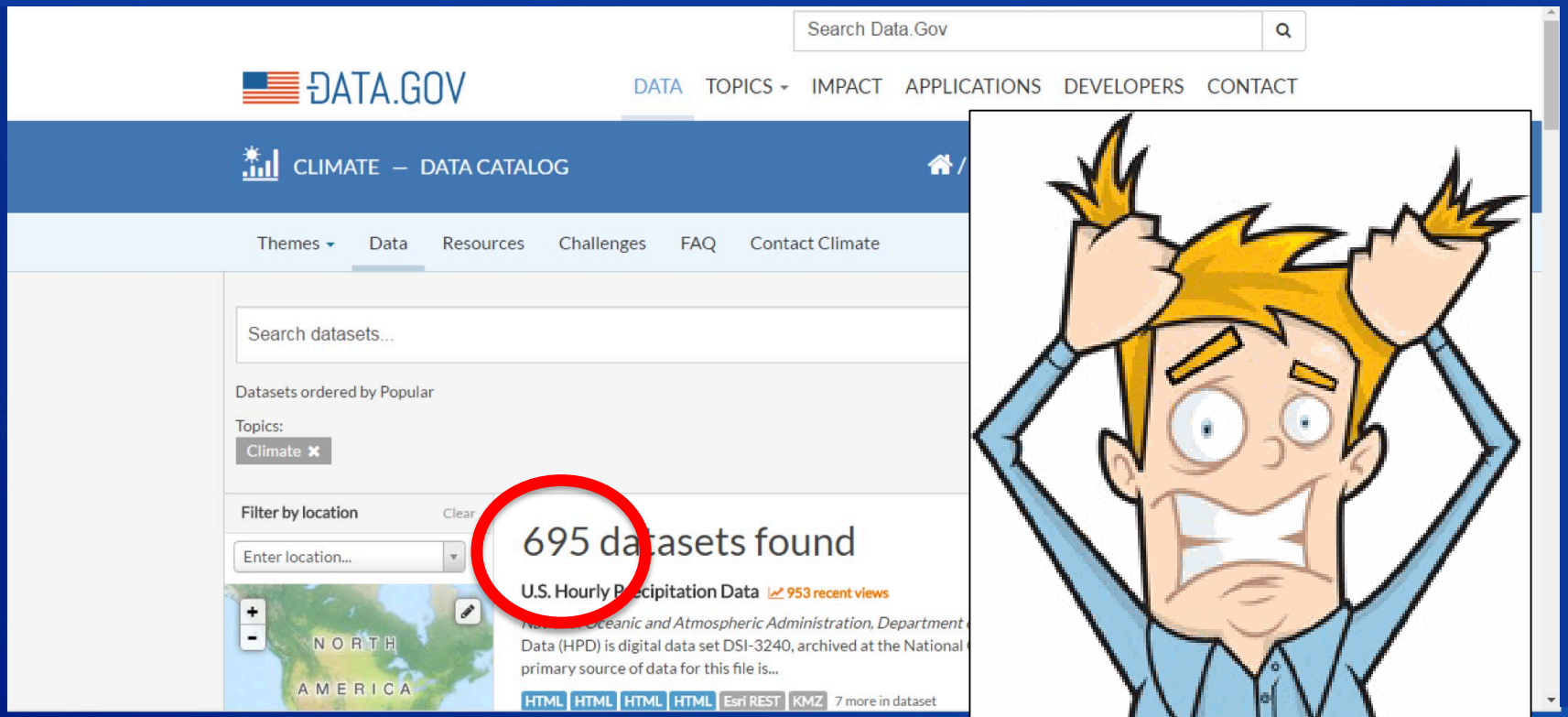
A Technical Training in Water Sector Utility Decision Support

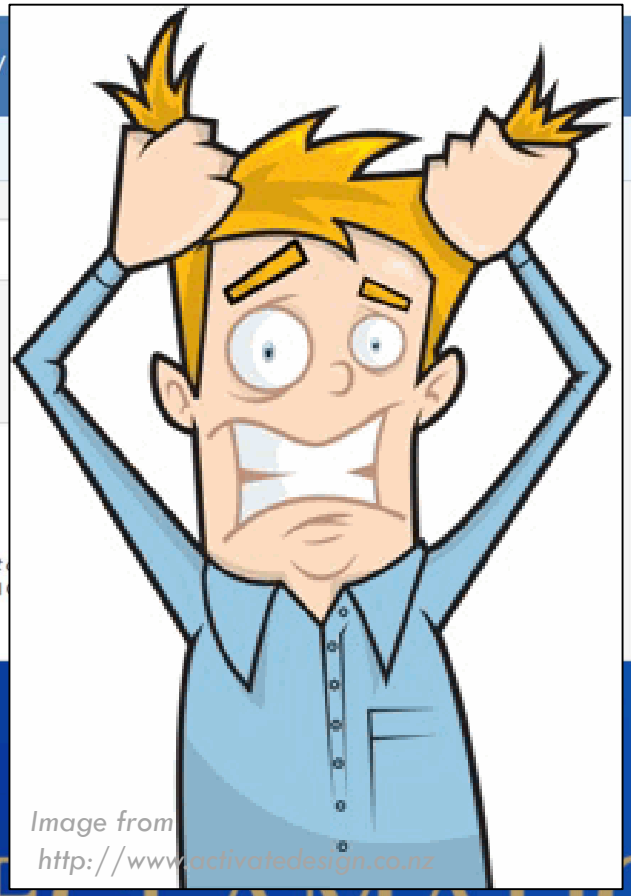
WUCA
Water Utility Climate Alliance
10 YEARS · 2008-2018

Using Climate Change Information for Water Management

Julie Vano, National Center for Atmospheric Research

What information should water managers and planners use??

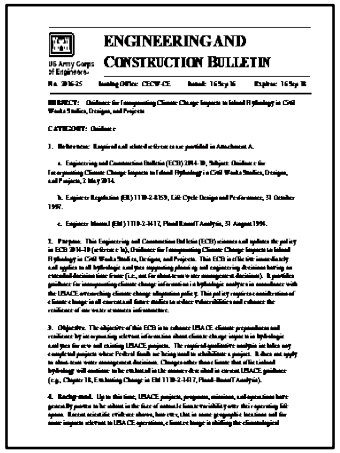


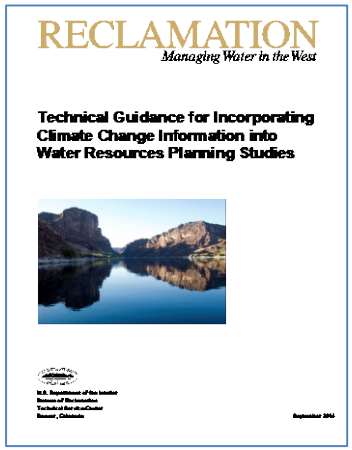


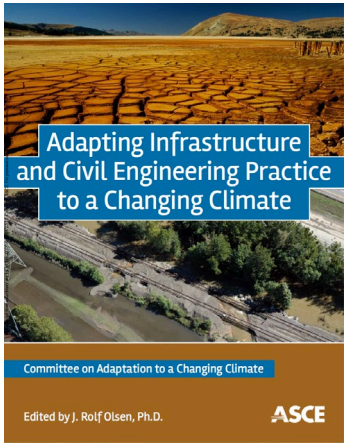
Slide from Ken Nowak at Reclamation

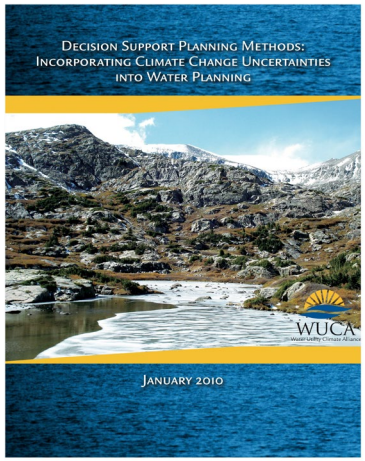
RECLAMATION

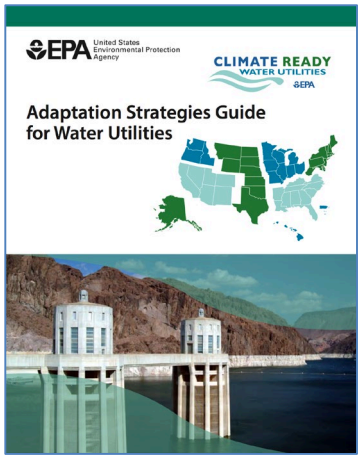
Climate Information Guidance











U.S. Climate Resilience Toolkit

and others, including NRC reports, IPCC, NCA…

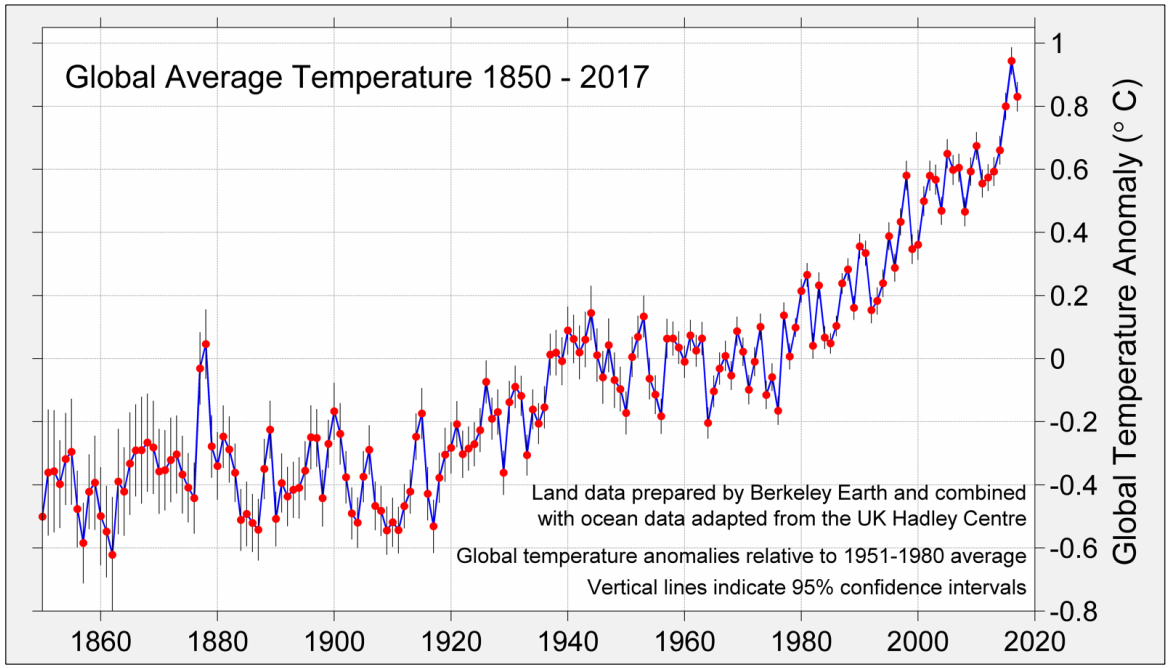
Increasingly more guidance…

DOS and DON'TS for using climate change information in water management

- ✗ DON'T focus on any single year or even single decade
- ✗ DON'T expect every question is answerable with currently available models and datasets
- ✓ DO recognize a single global climate model realization does not capture uncertainty
- ✓ DO identify your decision and assess their magnitude
- ✗ DON'T start from work and experti
- ✓ DO recognize a single hydrologic process representation does not capture uncertainty
- ✓ DO start t that fits y
- ✓ DO plan for iterations as the first time you download climate data shouldn't be your last
- ✓ DO understand how geog inform model selection
- ✗ DON'T use a finer spatial or temporal resolution that what is appropriate
- ✗ DON'T wait until n will always be new
- ✓ DO be aware of multiple ways to evaluate future change
- ✓ DO interpret probabilistic information with the appropriate context
- decide evaluation criteria
- climate impacts

Guiding Principles

I. It is important to evaluate climate risk

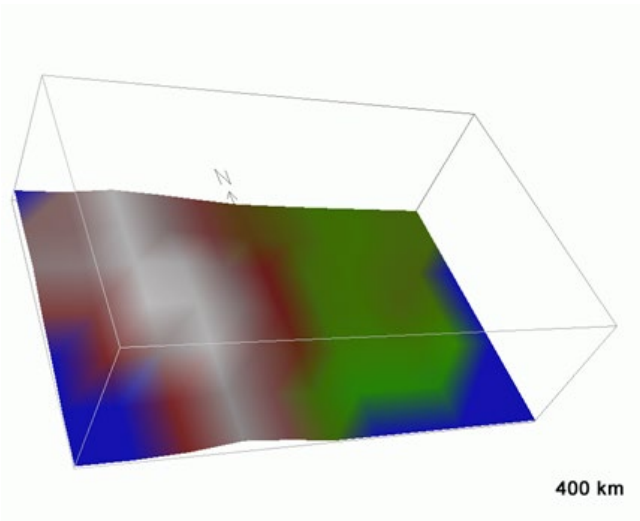


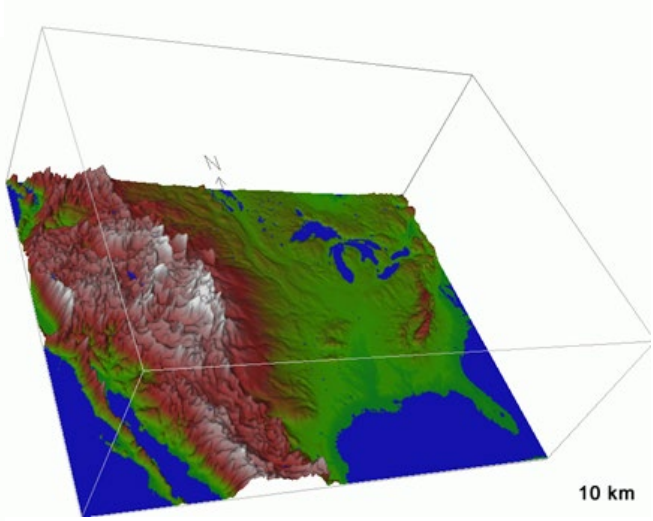
Source: http://berkeleyearth.org/wp-content/uploads/2018/01/TimeSeries2017.png

Guiding Principles

I. It is important to evaluate climate risk.

II. Models can be helpful tools, if used appropriately.





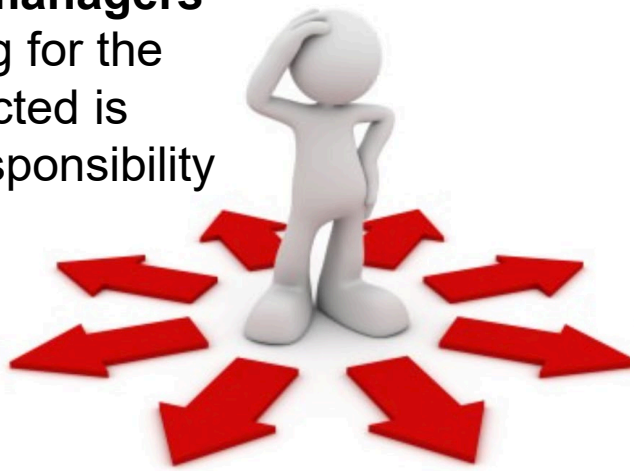
Guiding Principles

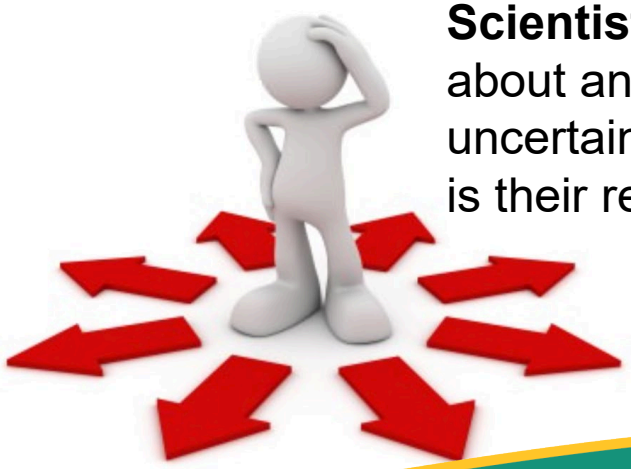
I. It is important to evaluate climate risk.

II. Models can be helpful tools, if used appropriately.

III. Uncertainty is everyone's responsibility.

Water managers planning for the unexpected is their responsibility





Scientists being clear about and placing uncertainties in context is their responsibility

DO's and DON'TS Guidelines

Organized into:

1. Guiding principles (3)
2. DOS and DON'TS for:
   - Study design recommendations (9)
   - Model selection recommendations (6)
   - Interpreting results recommendations (8)
3. Foundations
   - Earlier guiding documents
   - Key uncertainties

Why?
a short explanation with references

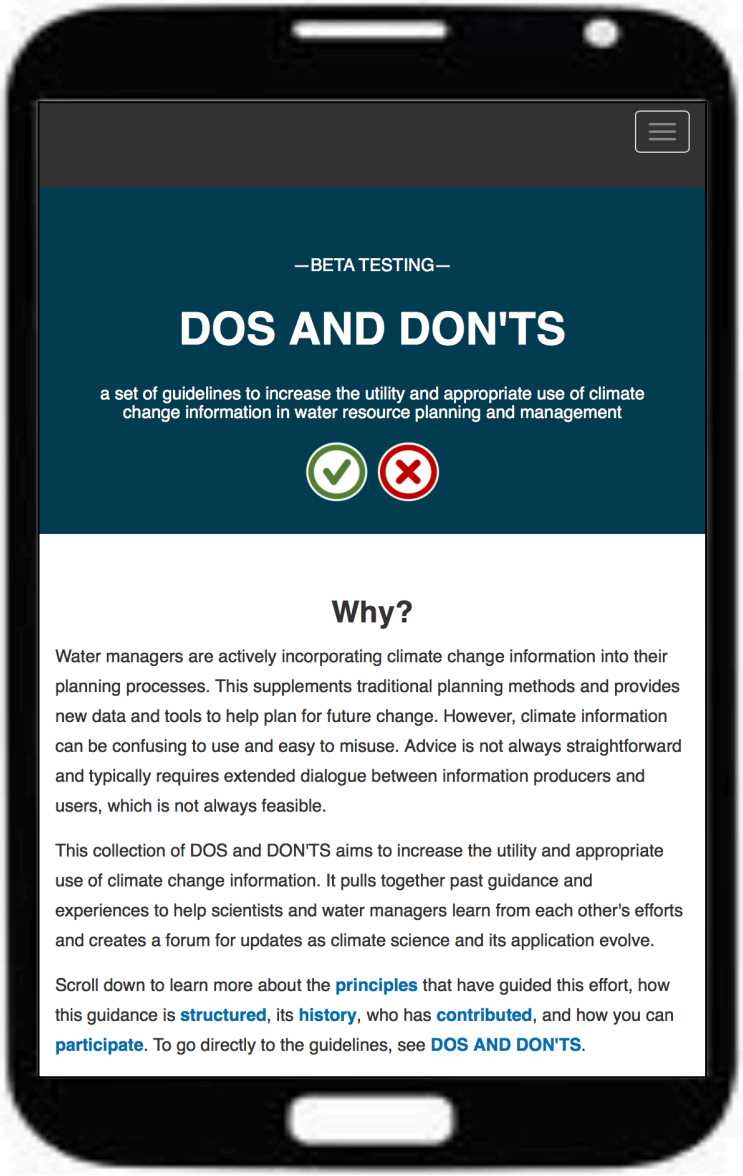
Frequently asked questions, real world examples
place for asking questions and sharing examples

Path forward
what should you do

PRIMARY AUDIENCE:

Water resource managers

however, the applications framing may be (more) helpful for researchers



- Built on previous guidance
- Promotes more understanding, applications framing helpful for research
- Fosters two-way conversation
- Provides multiple levels of engagement, designed in layers
- Allows updates that are transparent and version controlled
- Promotes a community effort
- Version 1.0 coming soon…

https://github.com/NCAR/dos_and_donts

Do Understand How the Decision Being Evaluated is Important to Model Selection

What are the questions we are trying to answer?

How will flows in April-September change in the future?

How should facilities be sized to prevent sewer overflows?

How will the magnitude, duration, and frequency of drought change?

How much warmer will streams be in 20 years?

water supply, streamflow timing, drought, stormwater, wastewater

FIT FOR PURPOSE

Do Start by Determining the Level of Details that Fits Your Need and Resources

Additional Considerations:

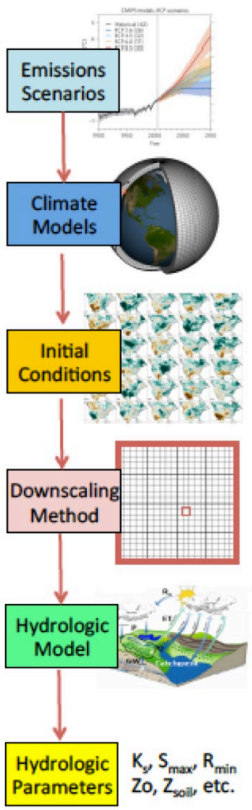
- How much will it cost?
- How long will it take?
- To what extent will the analysis improve the decision?
- Can appropriate data and information be obtained?
- Who will undertake the analysis?




List from UK Climate Impacts Programme's report Climate adaptation: Risk, uncertainty and decision-making

Do Be Aware of Multiple Ways to Evaluate Future Changes

Scenario studies



Clark et al. 2016; connect models in a chain

Stochastic hydrology

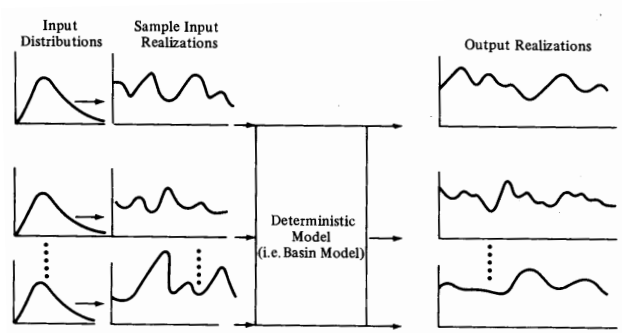
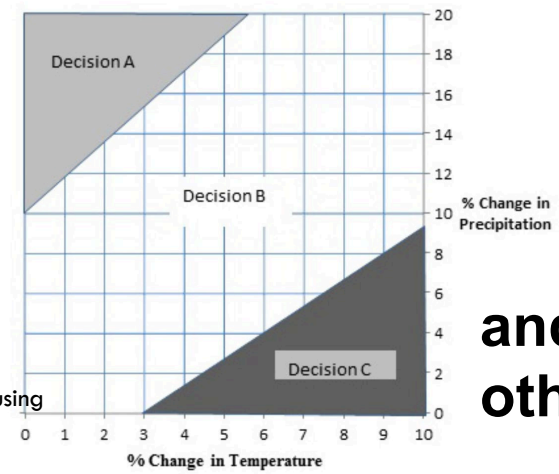


Figure 1.3 Concept of Monte Carlo experiments.

Bras and Rodriguez-Iturbe, 1985; generate synthetic timeseries using statics from the past

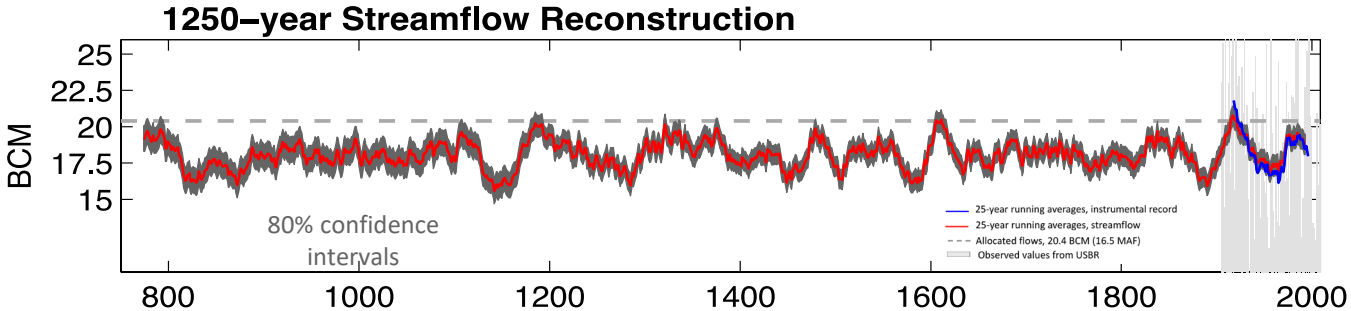
Climate-informed vulnerability analysis



Brown et al., WRR, 2016; explore system vulnerabilities with perturbations

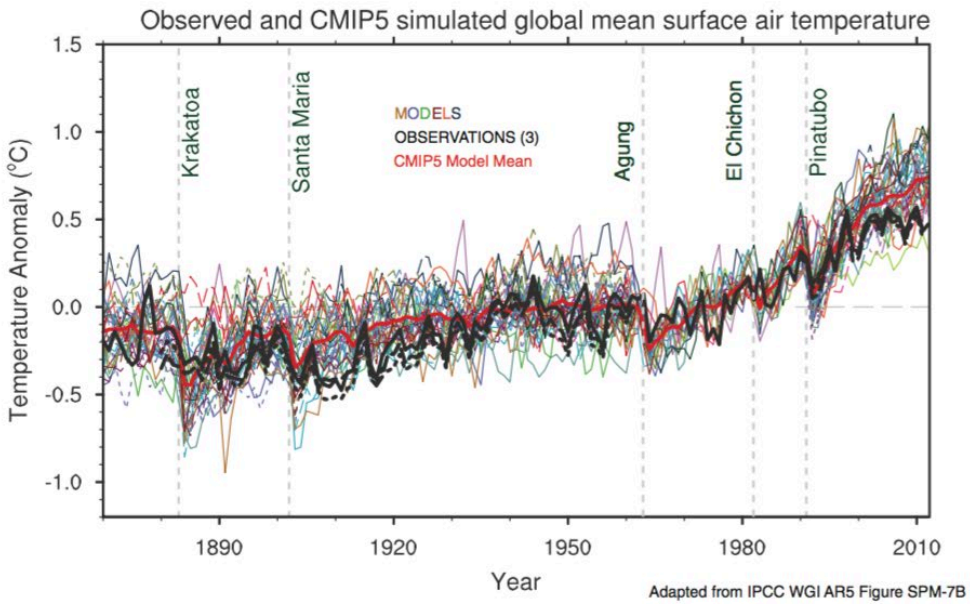
and others…

Paleoclimate studies



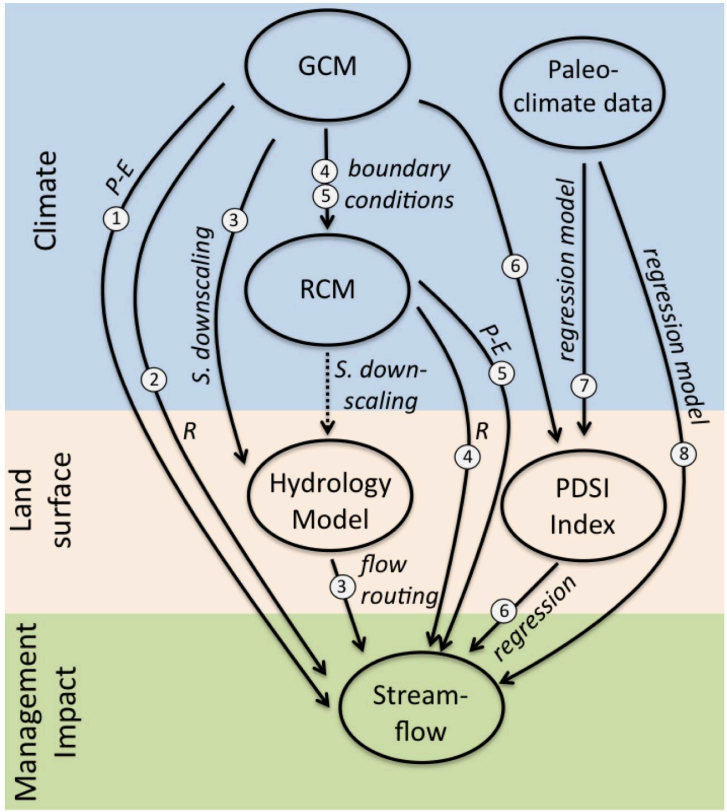
Vano et al., BAMS, 2016; generate timeseries using reconstructions of the distant past

Do Average Across Models Appropriately



- Probability distributions are helpful as they provide a range and more likely outcomes
- However, the true underlying distribution is unknown
- Know what is in an ensemble (emissions, GCMs, …)
- Ensemble averages and individual runs both provide value (10/90th percentile used by Reclamation)

Don't Treat All Future Projections or Methods Equally



Different: GCMs, emission scenarios, spatial resolution, hydrology, +

- Certain models and methods are more appropriate
- Certain spatial and temporal scales are more appropriate for certain questions
- Realize some questions may not be possible to answer with current knowledge
- Finer resolution in space and time is not necessarily better
  - Higher Resolution ≠ Higher Accuracy

Be a savvy consumer and remember…

Figure from Vano et al., BAMS, January 2014

No Model is Perfect

"The accuracy of streamflow simulations in natural catchments will always be limited by simplified model representations of the real world as well as the availability and quality of hydrologic measurements." (Clark et al., WRR, 2008)

- **Don't expect perfect results,**
  - Not prediction, but a tool to test how system responds (what if scenarios)
- **BUT we can make better choices…**
  - Seek simple yet defensible (don't need a Cadillac)
  - Be aware of models shortcomings (know the warts)

Key Takeaways

- It is important to evaluate climate risk
- Models can be helpful tools, if used appropriately
- Uncertainty is everyone's responsibility
- Tools and guidelines for navigating climate information are available and will continue to evolve
- Coming soon: **https://github.com/NCAR/dos_and_donts**

EXTRA SLIDES

The Washington Post

Democracy Dies in Darkness

Capital Weather Gang

Record heat put thousands of Californians in the dark Friday. Scientists predicted this from climate change.

By Jason Samenow July 9 Email the author

A surfer attempts to beat the heat in San Diego on Sunday. (Jim Grant via Twitter)

"Temperatures shot up over 110 degrees in Southern California on Friday, obliterating all kinds of long-standing heat records, and the lights went out for tens of thousands of customers. Californians were powerless, without air conditioning, in the hottest weather many had ever experienced."

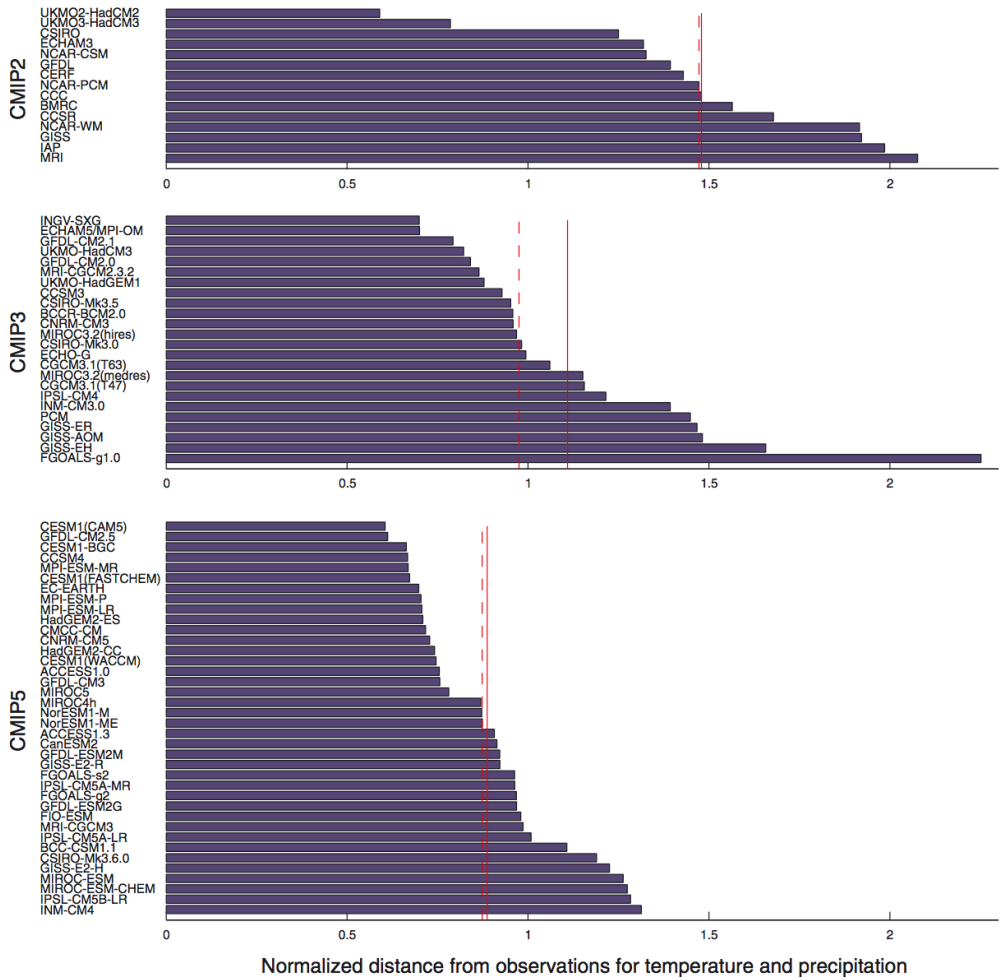


Figure 3. Normalized distance from observations in the CMIP2, CMIP3, and CMIP5 models. The distance metric is calculated as the root mean square of the surface temperature and precipitation distance as in Figure 1 but relative to observations (NCEP, ERA40, and MERRA for temperature; GPCP and CMAP for precipitation, see MK11). Mean and medians for the different ensembles are indicated by red solid and dashed lines, respectively. Note that most models in CMIP2 (including HadCM2, but not HadCM3) used flux corrections.

Models are improving

Knutti et al., Geophysical Research Letters 2013

no model is perfect

Trying to find the best model is like squeezing a balloon—whatever portion is picked and held onto creates a bulge of less satisfactory solutions elsewhere.

Source: Carslaw et al., EOS, 2018