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Development of Risk Informed Climate Scenarios: DCR Application

California Water and
Environmental Modeling Forum
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Andrew Schwarz P.E.

Collaborators

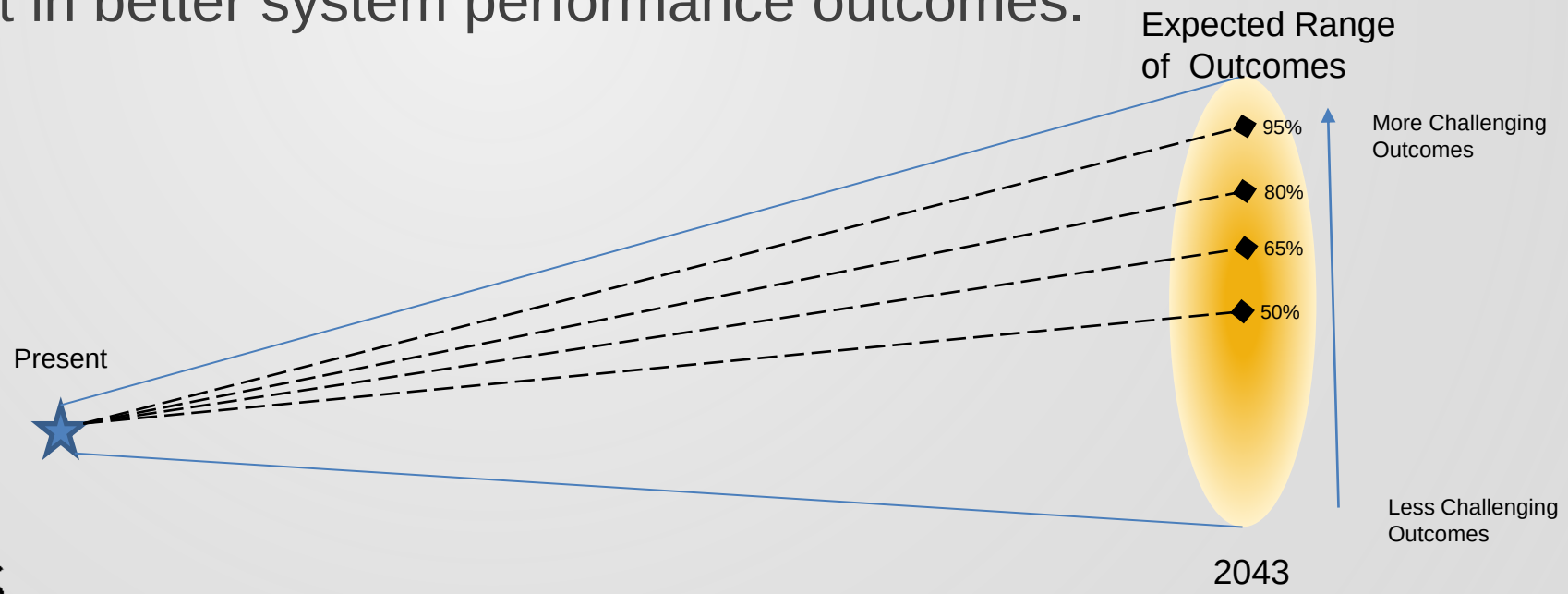
- Romain Maendly
- Wyatt Arnold
- Nazrul Islam
- Nicole Osorio
- Jay Wang
- Richard Chen
- Jeff Weaver -HDR

Goals and Objectives

- DWR is committed to using best available science and driving innovation toward better water management
- DWR is working toward greater alignment of climate change modeling data, tools, and strategies across its programs
- Develop a tractable array of climate scenarios for use in SWP/DWR and water agency planning efforts
- Scenarios should be risk informed, providing a quantified “level of concern” that describes the relative severity of the scenario with respect to SWP performance

New Risk Informed Future Projections

- Future conditions scenarios will evaluate combinations of climate changes (temperature, precipitation, and sea level rise) that represent different levels of risk tolerance. The risk tolerance will be represented by a probability number that describes the percent of climate outcomes that would result in better system performance outcomes.



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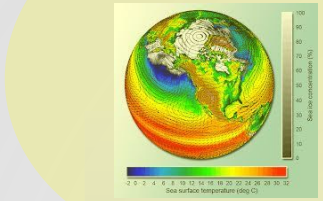
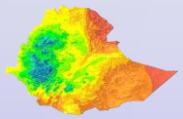
How do we approach Climate Change Analysis?

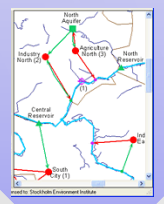
Top-Down Scenario Analysis



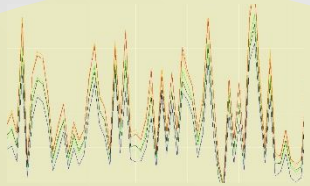
Select a couple of GCM Projections



Downscaling, Hydrologic Modeling



Operations and Planning Models



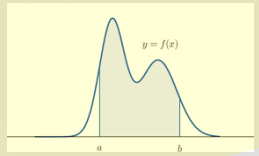
Conditional System Performance Projections

Source of Greatest Uncertainty

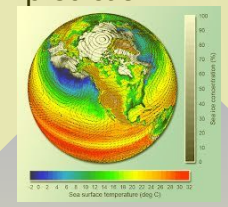
Lots of scenarios

1 or a few scenarios

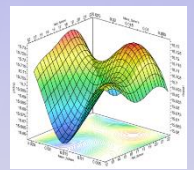
Bottom-Up Systems Analysis



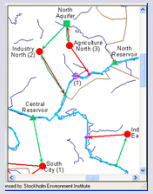
System performance prediction



Climate Model Ensemble



System response surface



Operations and Planning Models

- Top-down approaches do a good job of exploring and communicating the potential range of outcomes from climate change in just a few scenarios—but don't provide risk information.

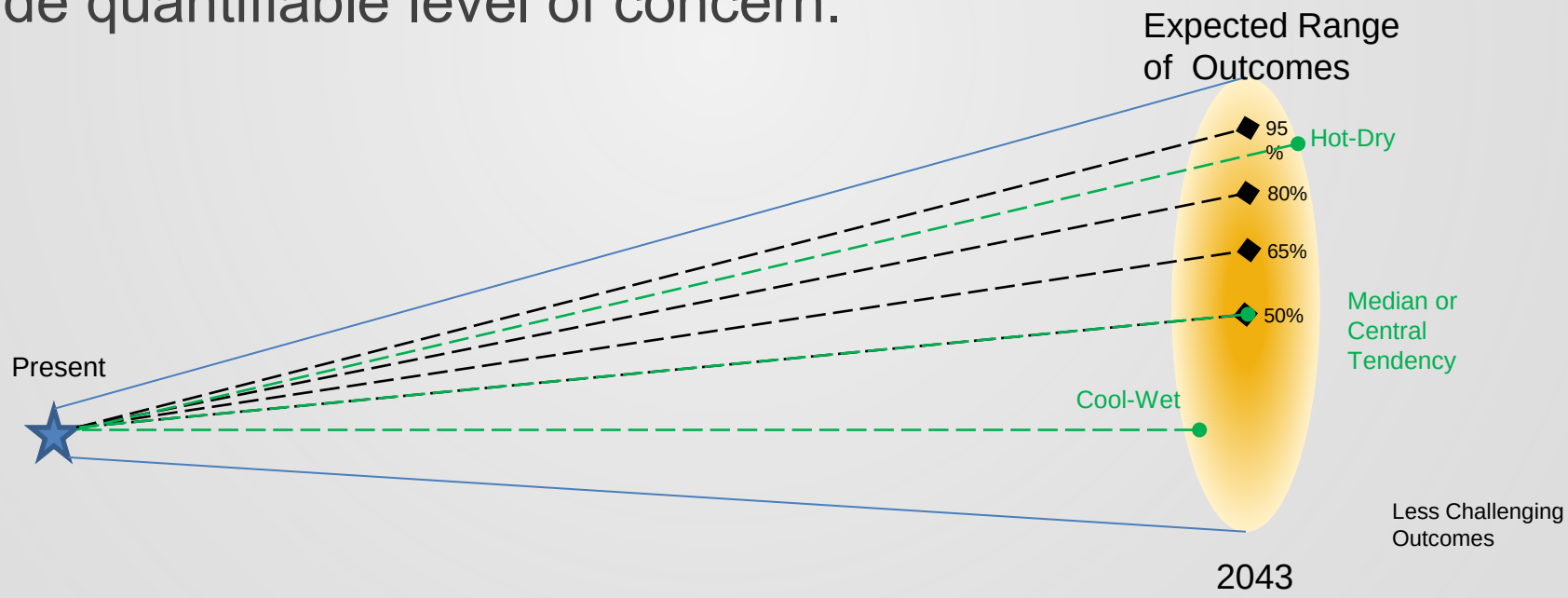
- Bottom-up approaches focus on system response to stressors and do a good job of providing information that fits into decision making frameworks—but don't provide timeseries info.

- **We need both**…new DCR scenarios will draw on the strengths of both approaches, combining new tools, datasets, and technical advances.

Hybrid Risk Informed vs. Top-Down Scenarios

Top-Down Scenarios span the range of possible climate outcomes but don't necessarily align with system risk (i.e., system more vulnerable to decrease in precipitation than increase in temperature).

Don't provide quantifiable level of concern.



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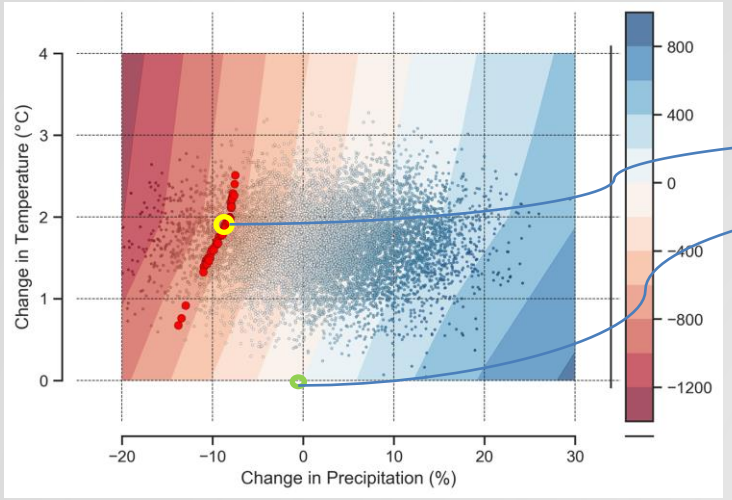
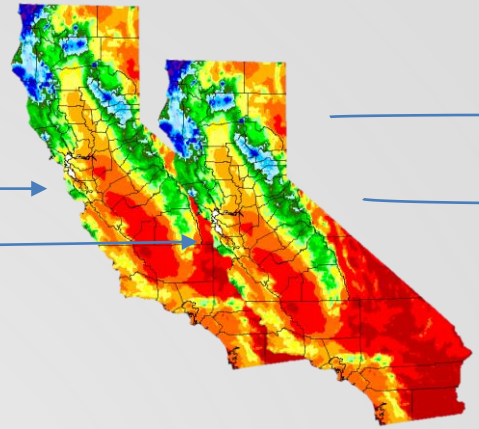
New Process Steps



Weather Generator
([Steinschneider and Brown 2013](#) with substantial updates and improvements)

Provide the selected ΔT, ΔP_{ave} for input to the weather generator.



Use the weather generator to create a complete, statewide 100-year daily gridded T and P dataset (Historical and Climate Scenario)

Adjust inputs to CalSim3

Use the method developed by Jacobs for adjusting the historical streamflow, precipitation, temperature, and ET input datasets for climate changed future scenarios to generate all necessary Calsim3 inputs for each climate change scenarios.

CalSim3 Climate Scenario Runs/Operational Adjustments and Refinements

Apply latest NOAA/OPC SLR guidance to inform levels of SLR to pair with each scenario

DCR 2023 *(December 2023)*

- 1 Historical CalSim3 Run
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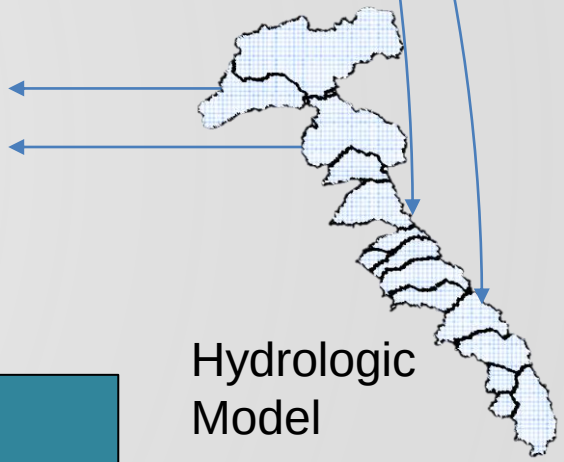

Hydrologic Model

Run the climate changed and baseline T and P datasets through the VIC hydrologic model to generate streamflow at 201 streamflow points needed for CalSim3.

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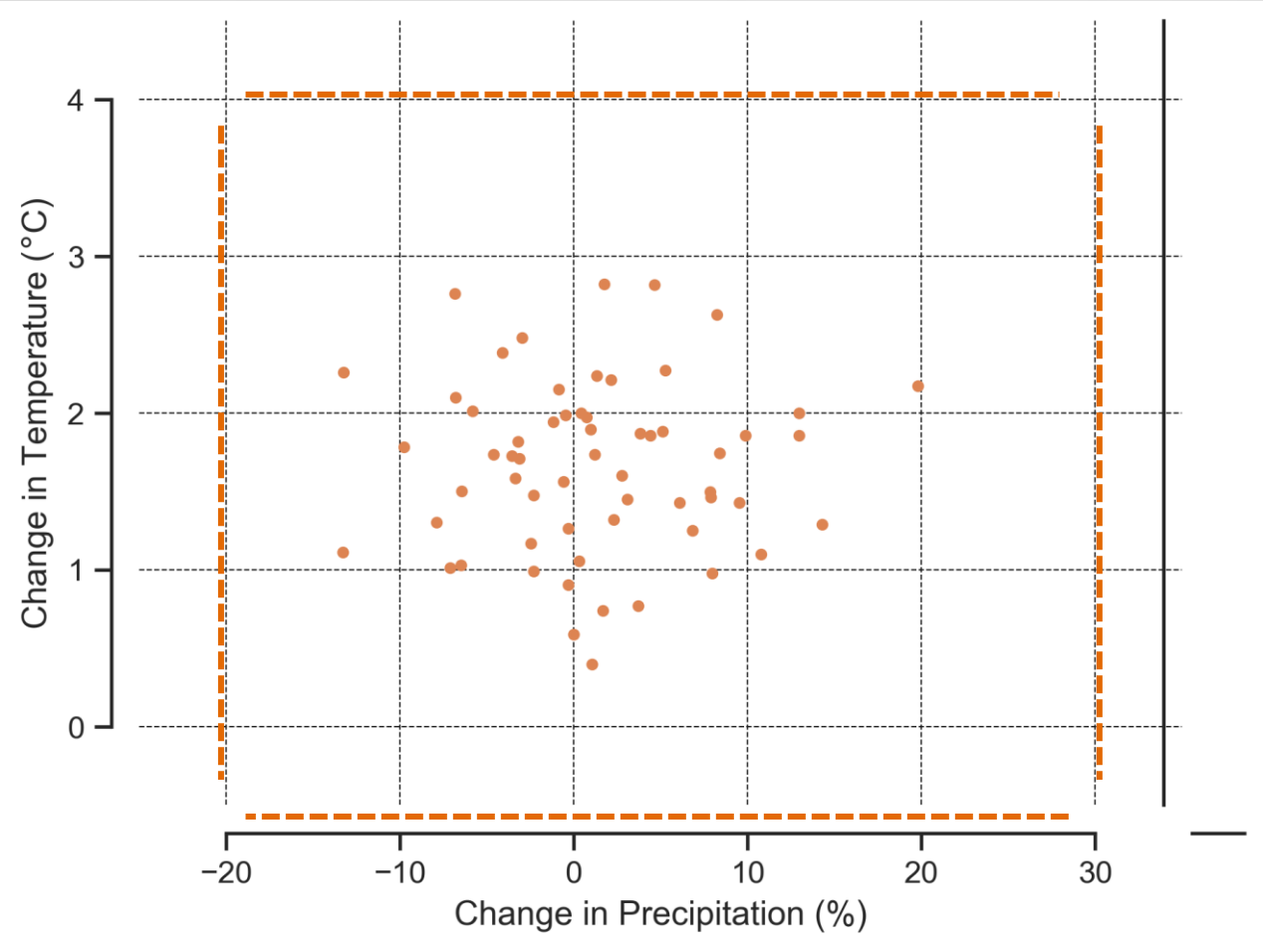
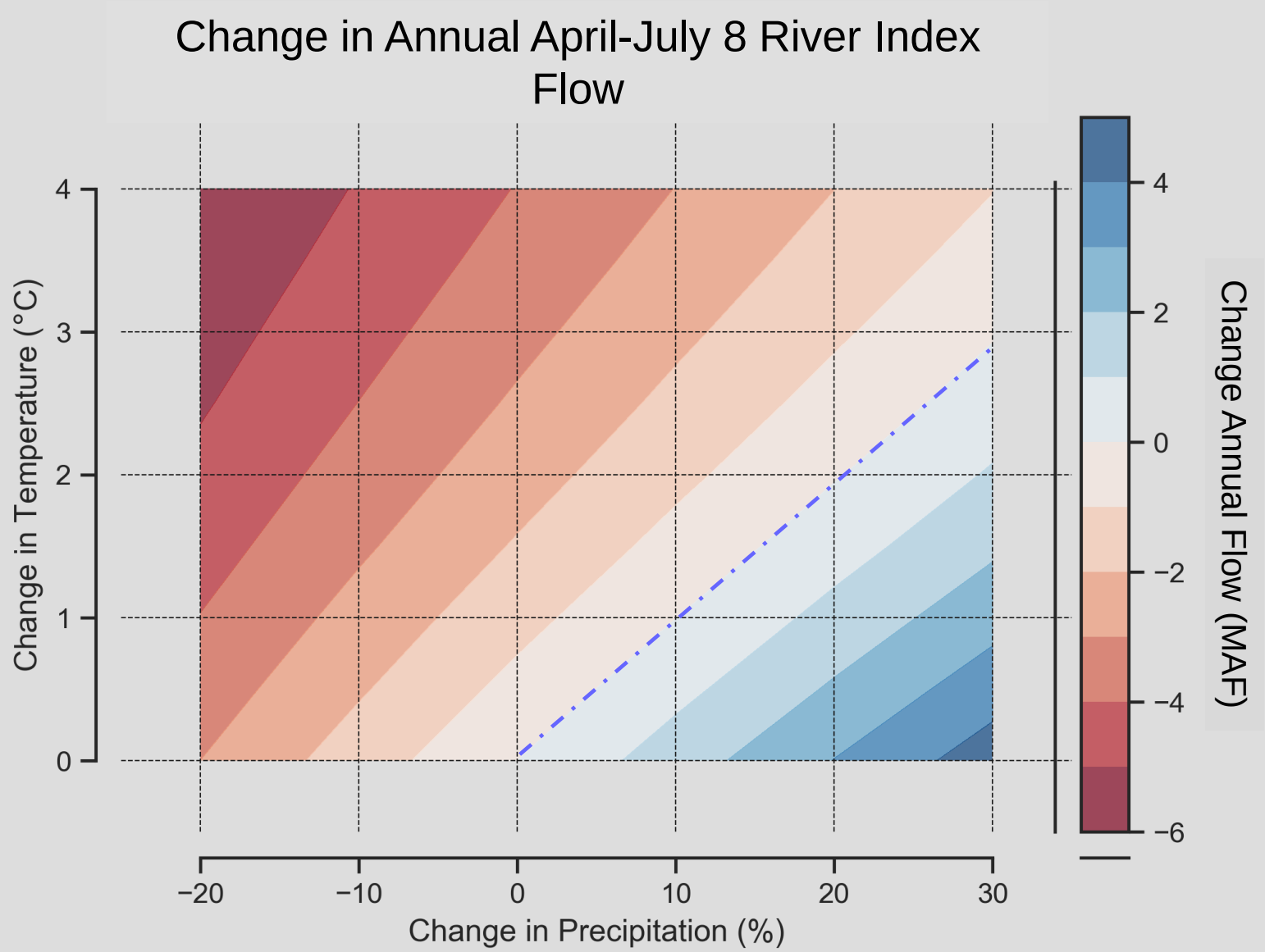


There are a wide range of possible climate outcomes by 2043…

Note: Data on this image are for CMIP5 models. We plan to use latest CMIP6 + LOCA downscaling.



Stress Test the system across that entire range

Note: This response surface is based on older modeling and data and will be updated. Values for example only.

For a deeper dive into decision scaling and the development of stress tests for the SWP see:

Brown, C., Wilby, R.L., 2012. An alternate approach to assessing climate risks. Eos Trans. Am. Geophys. Union 93, 401–402. https://doi.org/10.1029/2012EO410001

Ray, P., Wi, S., Schwarz, A., Correa, M., He, M., Brown, C., 2020. Vulnerability and risk: climate change and water supply from California's Central Valley water system. Clim. Change 161, 177–199.

https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Action-Plan/Files/CAP-III-Decision-Scaling-Vulnerability-Assessment.pdf

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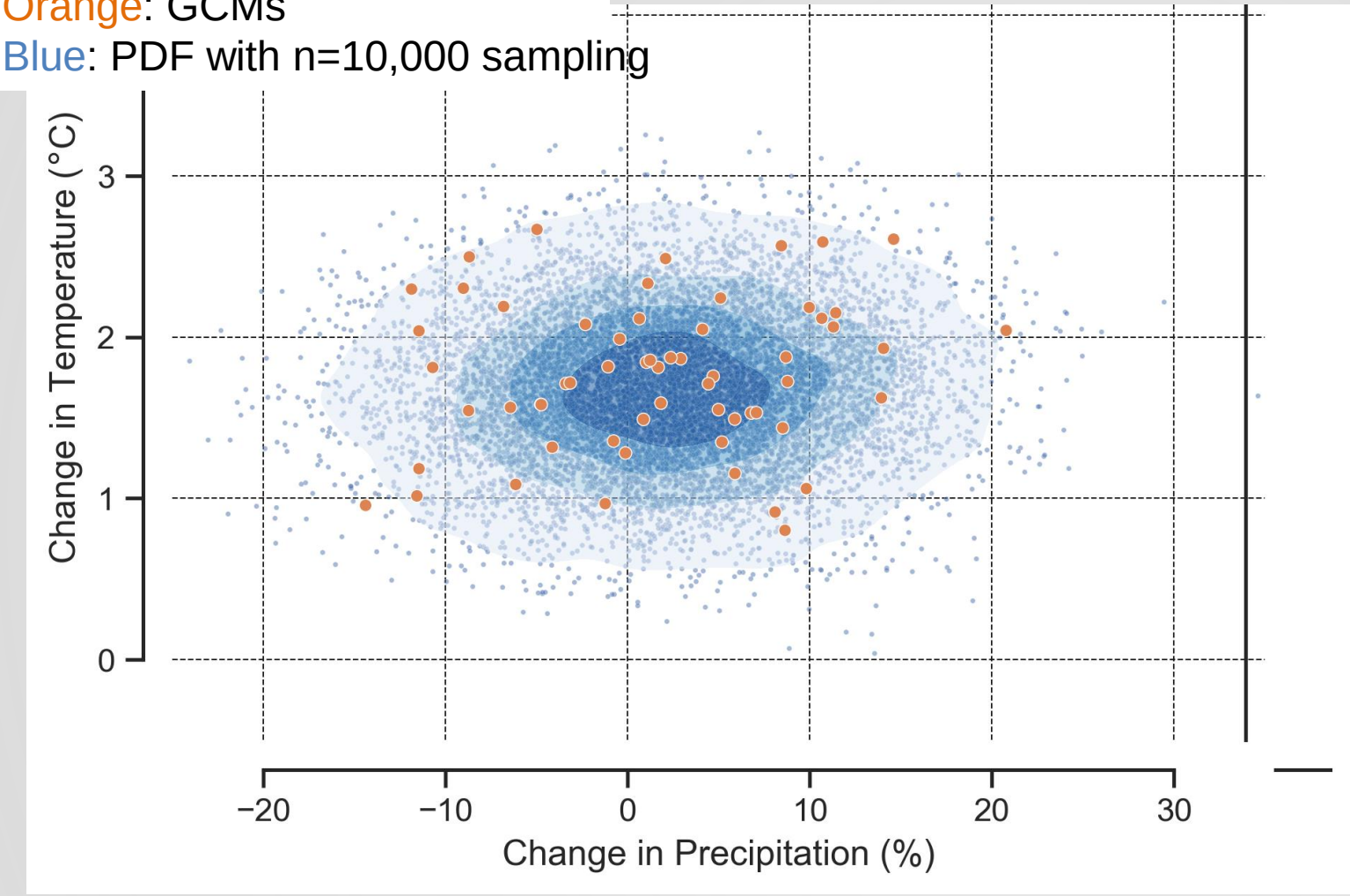
Planning Horizon 2043
Orange: GCMs
Blue: PDF with n=10,000 sampling



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Extract model informed relative likelihood or "*Level of Concern*"* information about future conditions

(Moody and Brown, 2013; Whateley et al., 2014)
**Francois et al. (In reivew)*

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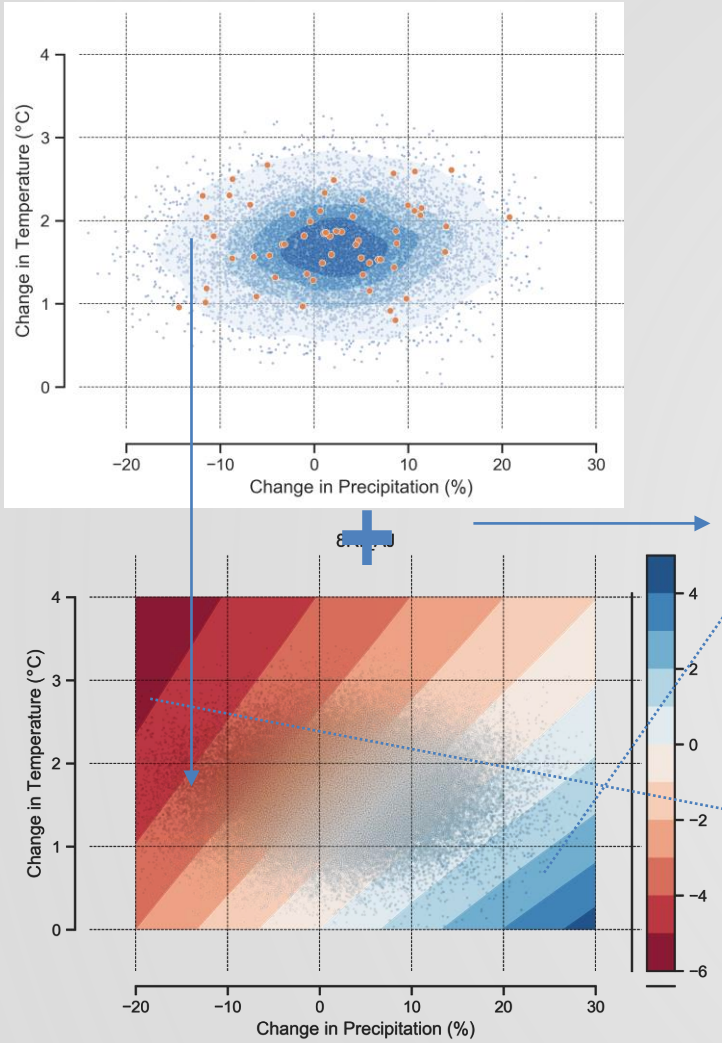
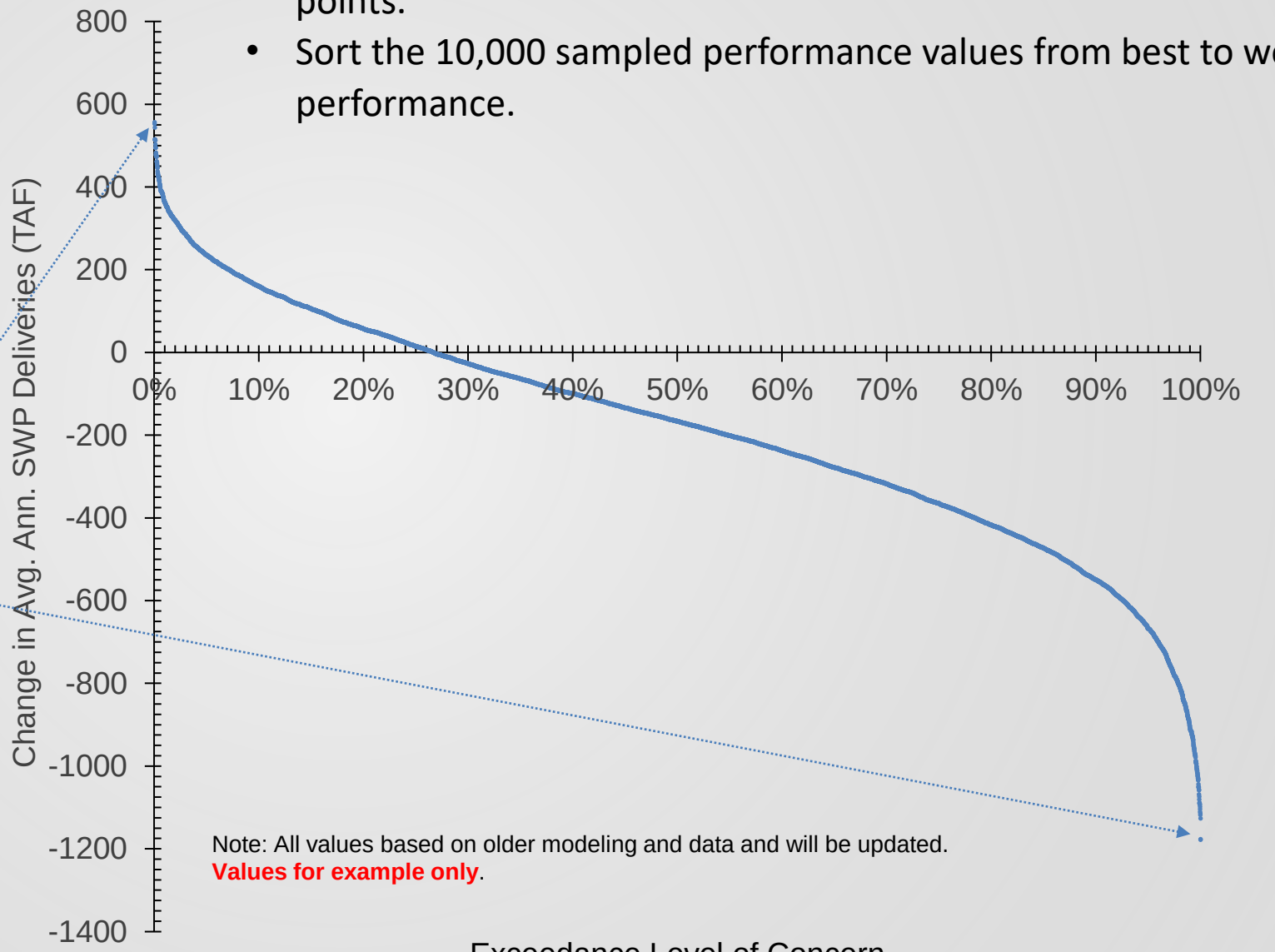
Planning Horizon 2043

n=10,000 sampling



Francois et al (in review)

- Find the performance value for those 10,000 ΔT, ΔP_{ave} combinations using the response surface of concern at those points.
- Sort the 10,000 sampled performance values from best to worst performance.



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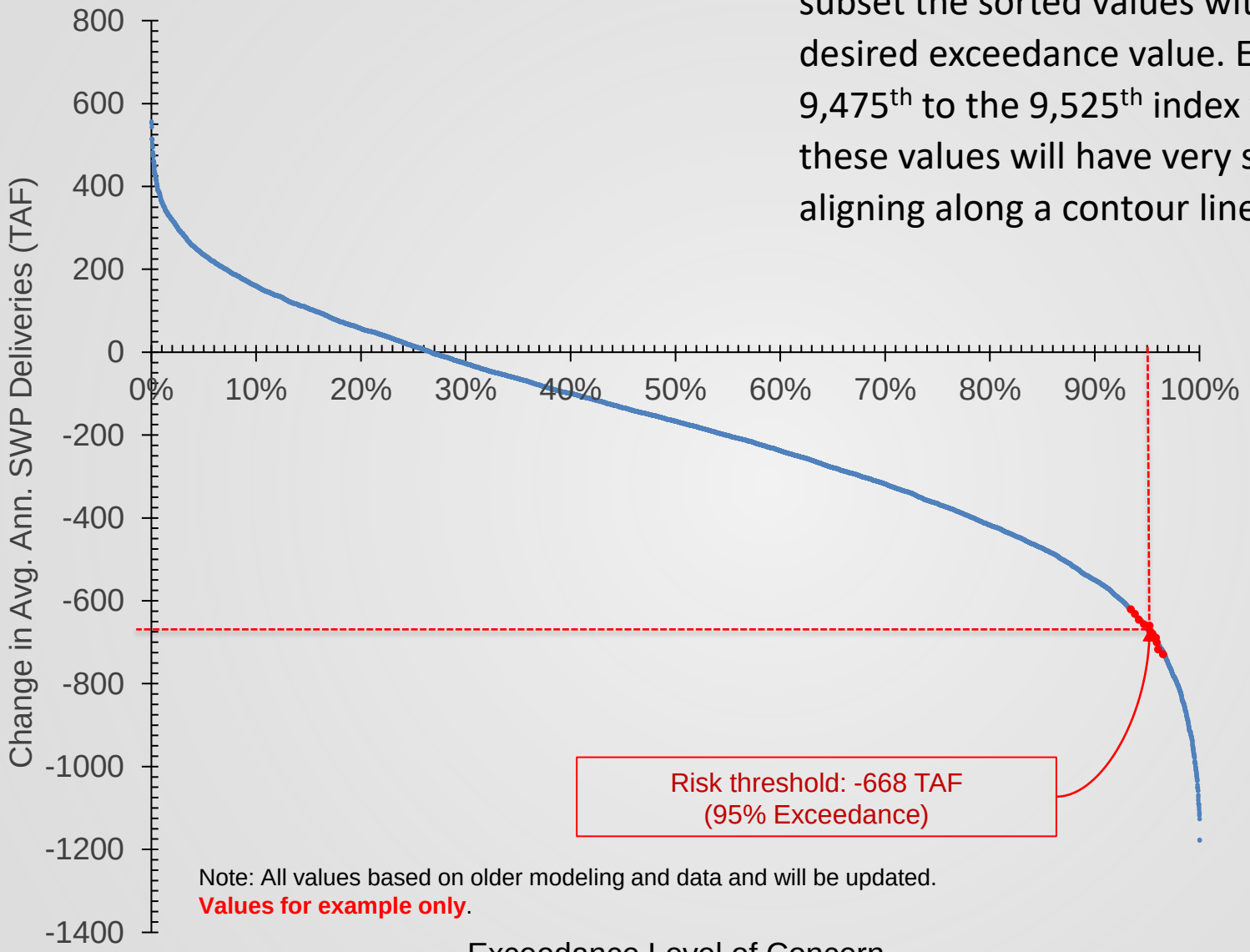
Planning Horizon 2043
n=10,000 sampling

- For each desired non-exceedance value [50, 65, 80, 95] subset the sorted values within +/- 25 (or 0.25%) of the desired exceedance value. E.g., for 95% non-exceedance the 9,475th to the 9,525th index values would be selected. All of these values will have very similar performance values, aligning along a contour line of the response surface.



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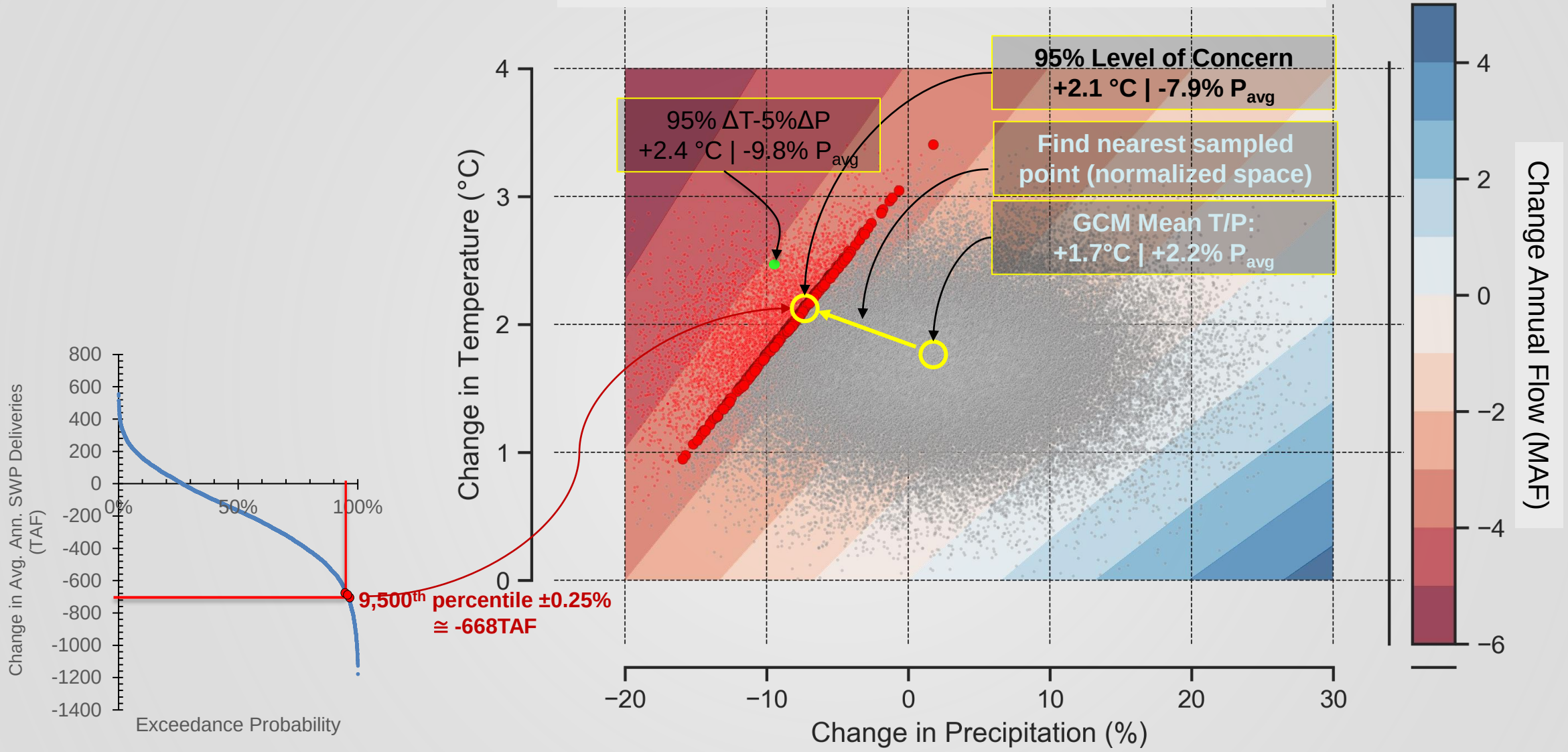
Change in Annual April-July 8 River Index Flow



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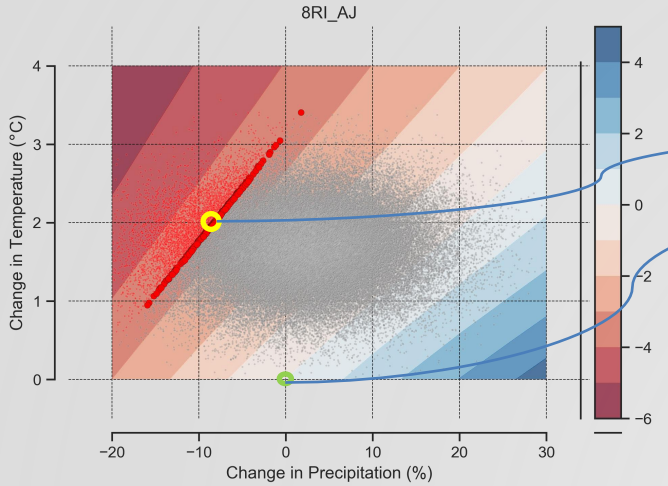

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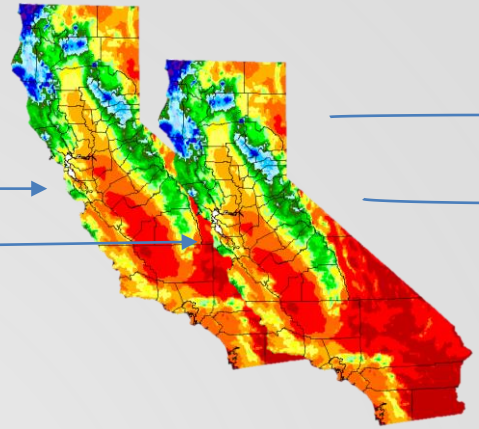

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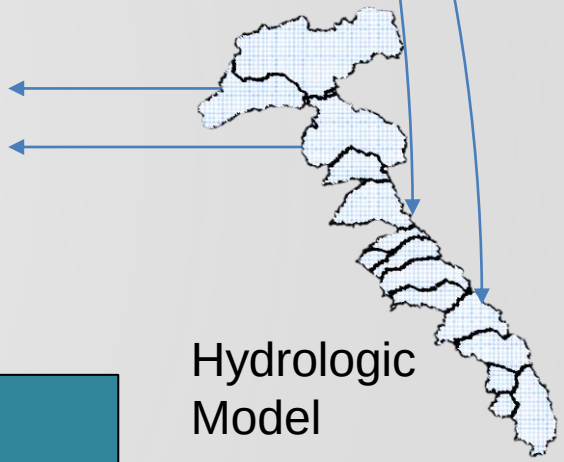

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Key Take Aways

- Hybrid Risk Informed scenarios will explore future conditions that specifically stress the SWP/CVP system
- Model-informed levels of concern will provide quantification of relative likelihood
- All primary data and tools are based on peer reviewed science
- End products will also be peer reviewed
- Preliminary reviews of this approach from experts have been very positive