SECURE Water Act Section 9505 Assessment

Effects of Climate Change on US Federal Hydropower Generation

Innovations in Climate Resilience
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Congress Authorized a Study of Climate Change Impacts on Federal Hydropower in 2009

The SECURE (Science and Engineering to Comprehensively Understand and Enhance) Water Act has multiple parts, assigned to different agencies

Section 9501. Findings

Section 9502. Definitions

Section 9503. Reclamation Climate Change and Water Program
- *Reclamation's 9503 Report to Congress*

Section 9504. Water Management Improvement

Section 9505. Hydroelectric Power Assessment
- *DOE's 9505 Report to Congress*

Section 9506. Climate Change and Water Intragovernmental Panel

Section 9507. Water Data Management by the U.S. Geological Survey

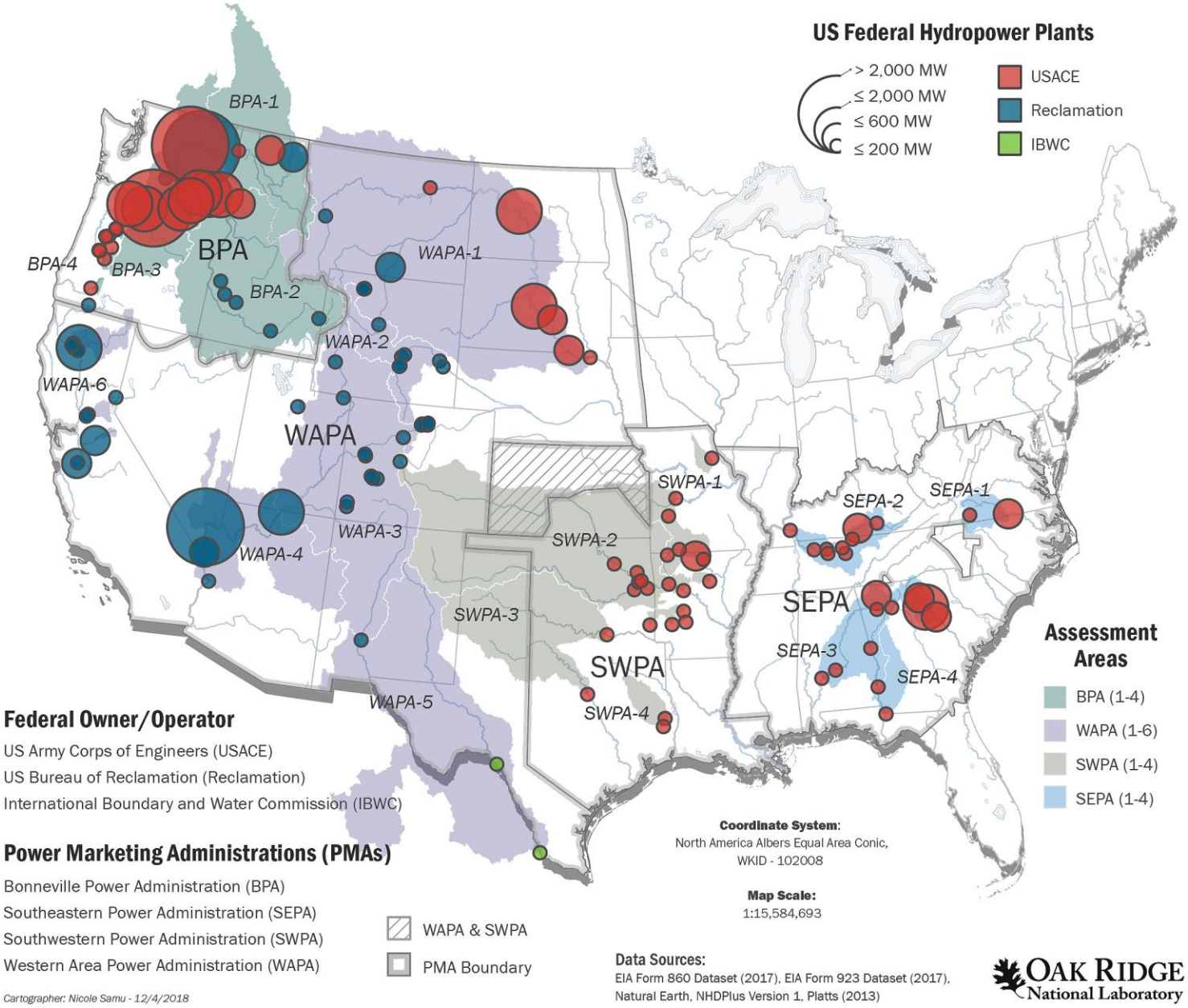
Section 9508. National Water Availability and Use Assessment Program
- *USGS Report to Congress*

Section 9509. Research Agreement Authority

Section 9510. Effect

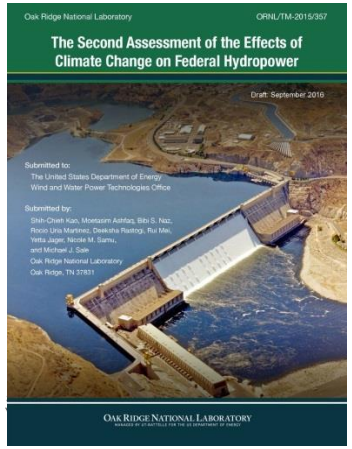
132 Power Plants in 18 Study Areas

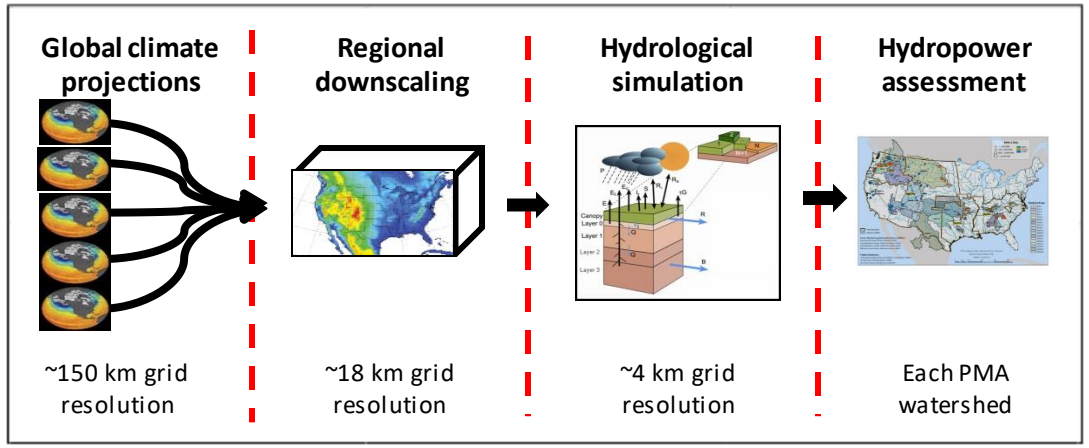
PMA	# of Plants	Capacity (GW)
BPA	31	20.5
WAPA	55	10.2
SWPA	24	2.2
SEPA	22	4.1
Total	132	37.0

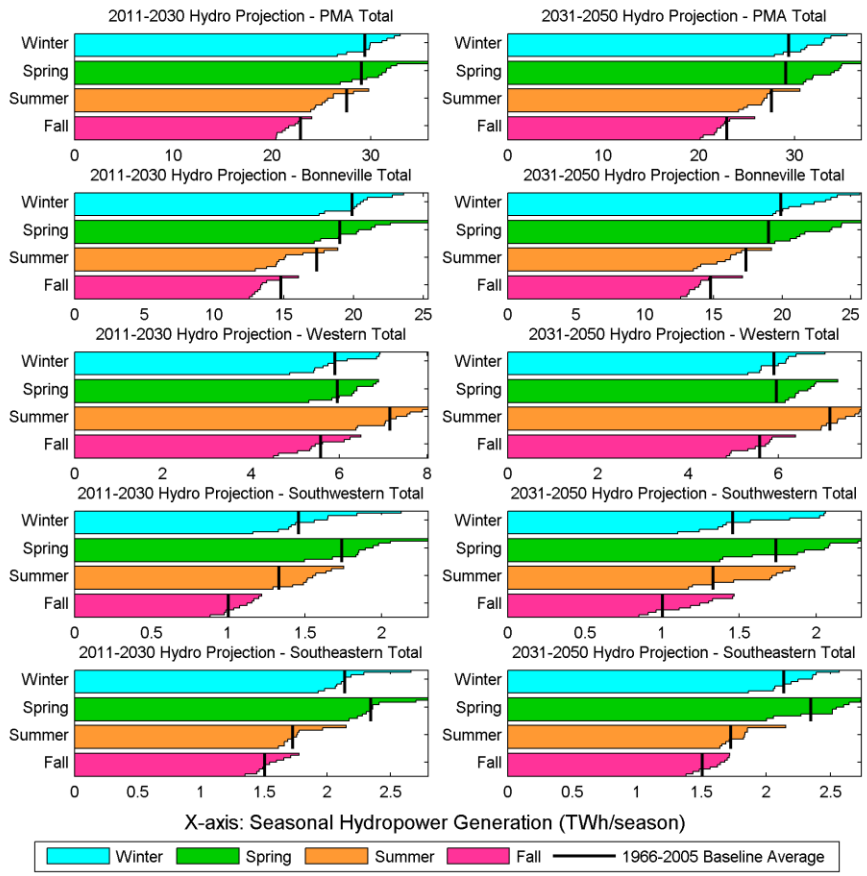


The 2nd 9505 Assessment (2013–2017)

- Based on downscaled IPCC-CMIP5 global climate projections.
- The results suggested that earlier snowmelt and change of runoff seasonality are the main factors affecting future US federal hydropower generation.
- The assessment focused on regional scale and provided a first-order assessment to identify areas with the highest risk under projected future climate conditions.
- **Limited treatment of uncertainty.**



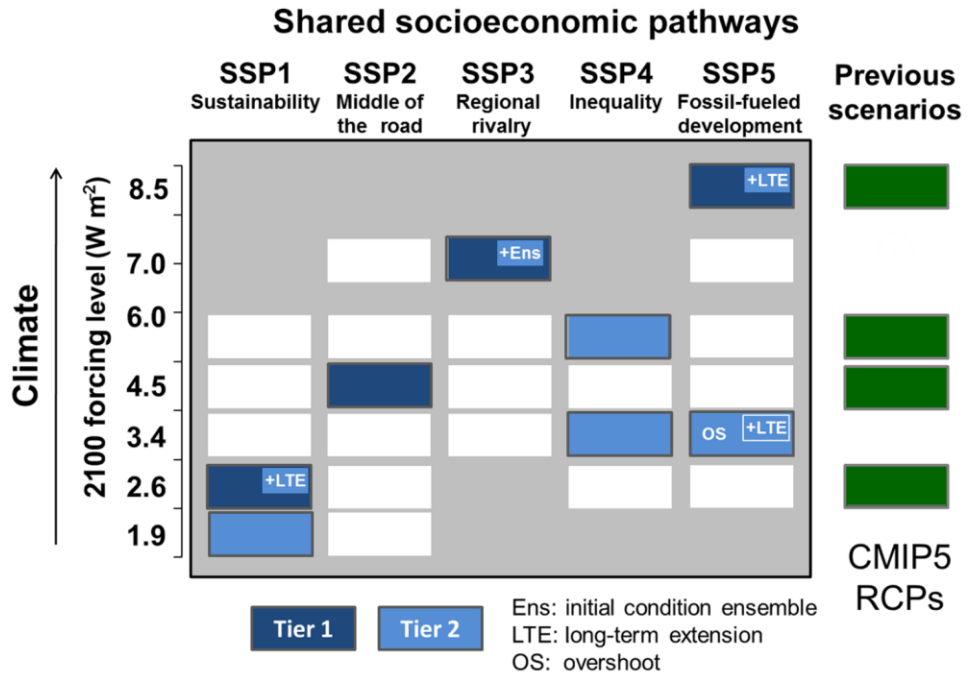




CMIP5-based projection of seasonal hydropower generation in the near-term (2011–2030) and midterm (2031–2050) future for 132 US federal hydropower plants.

What's New in the 3rd Assessment (2018–2022)

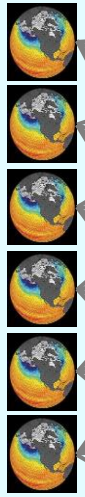
- **Based on the latest IPCC-CMIP6 global climate projections.**
- **Better inform uncertainties**
  - Six CMIP6 models under SSP585 scenario
  - Two downscaling approaches
    - RegCM4 (dynamical), DBCCA (statistical)
  - Two reference meteorological observations
    - Daymet (V4), Livneh (unsplit)
  - Two hydrologic models
    - VIC5, PRMS
  - Two regional hydropower models
    - ORNL-WRES, PNNL-WMP
- **Additional analysis**
  - Reservoir evaporative loss analysis
  - PMA energy demand analysis
  - Analysis of variance (ANOVA)



CMIP6 Emission Scenarios (O' Neill et al., 2016)

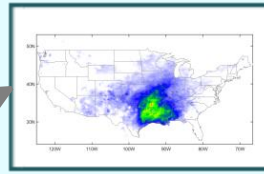
Better Address Uncertainty through A Model-model Framework

CMIP6 GCM Selection
(6 projections)

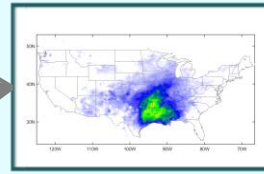


Base: 1980–2019
Future: 2020–2059
SSP585 scenario

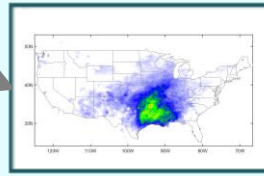
Regional Downscaling
(24 projections)



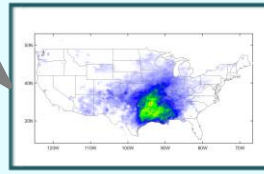
RegCM corrected by Daymet



RegCM corrected by Livneh

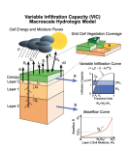


DBCCA trained by Daymet

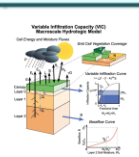


DBCCA trained by Livneh

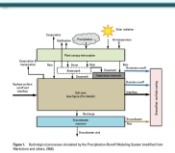
Hydrologic Modeling
(48 projections)



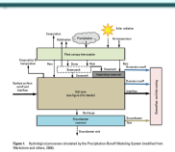
VIC calibrated by Daymet



VIC calibrated by Livneh



PRMS calibrated by Daymet



PRMS calibrated by Livneh

Demand Analysis
(24 projections)

Hydropower Modeling
(96 projections)

ORNL WRES

PNNL WMP

Evaporative Loss Analysis
(48 projections)

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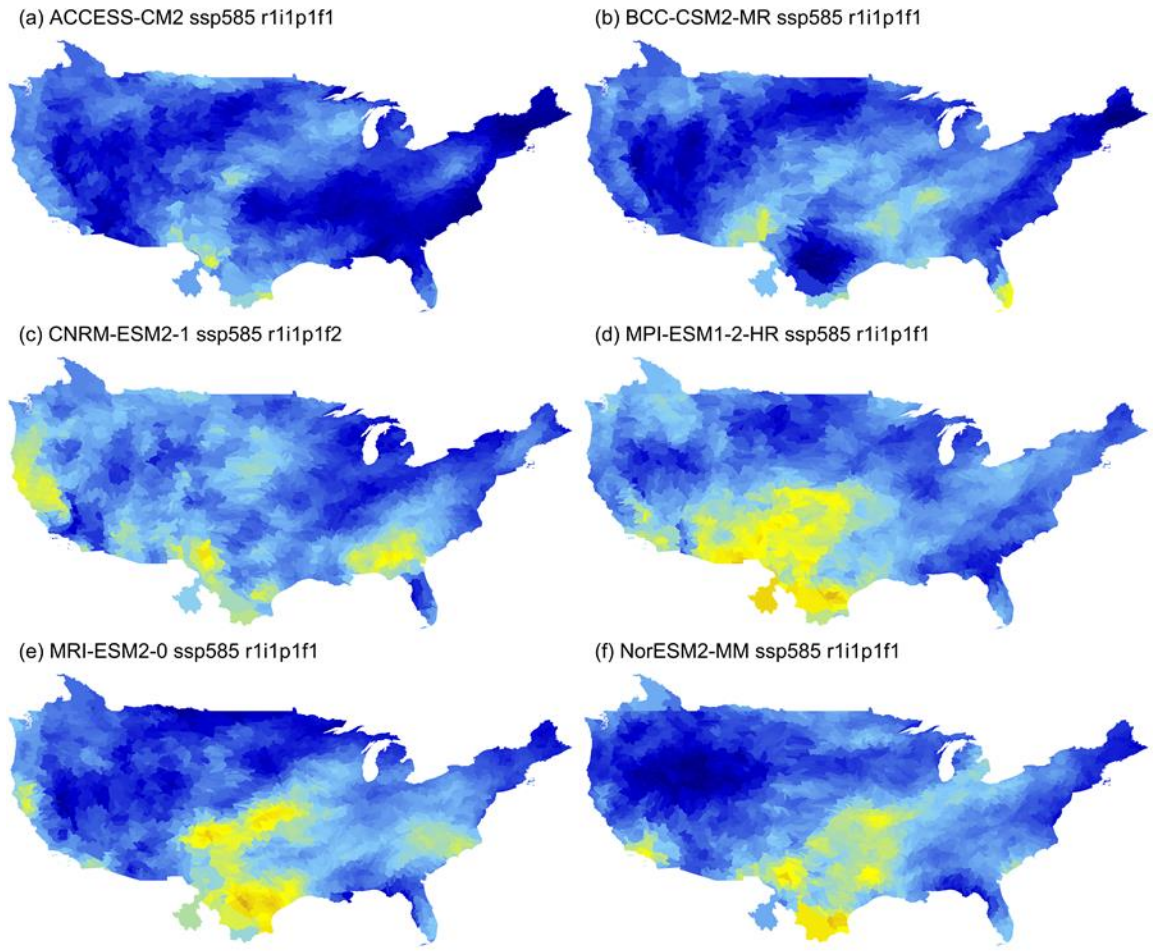
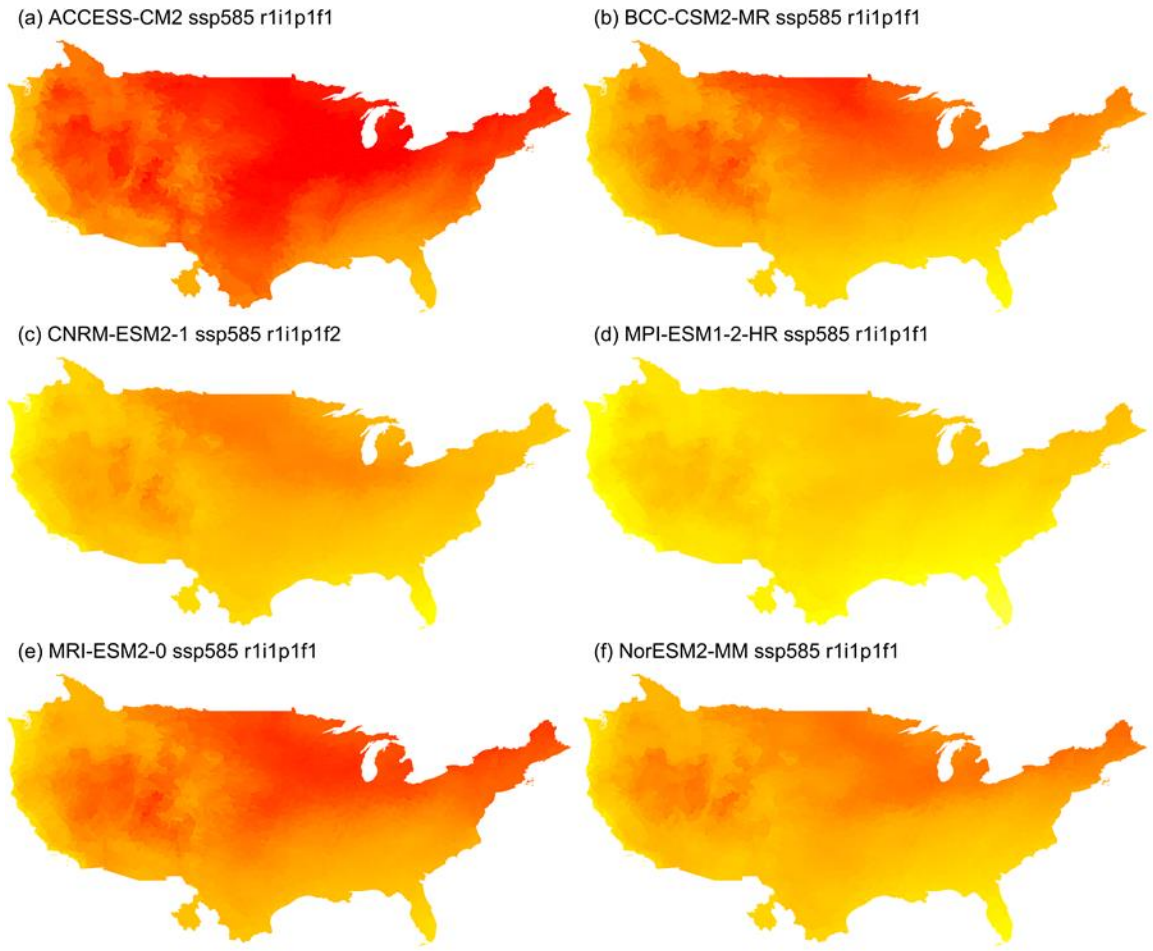
Projected Change in Annual Precipitation and Temperature

Change in Precipitation (%)

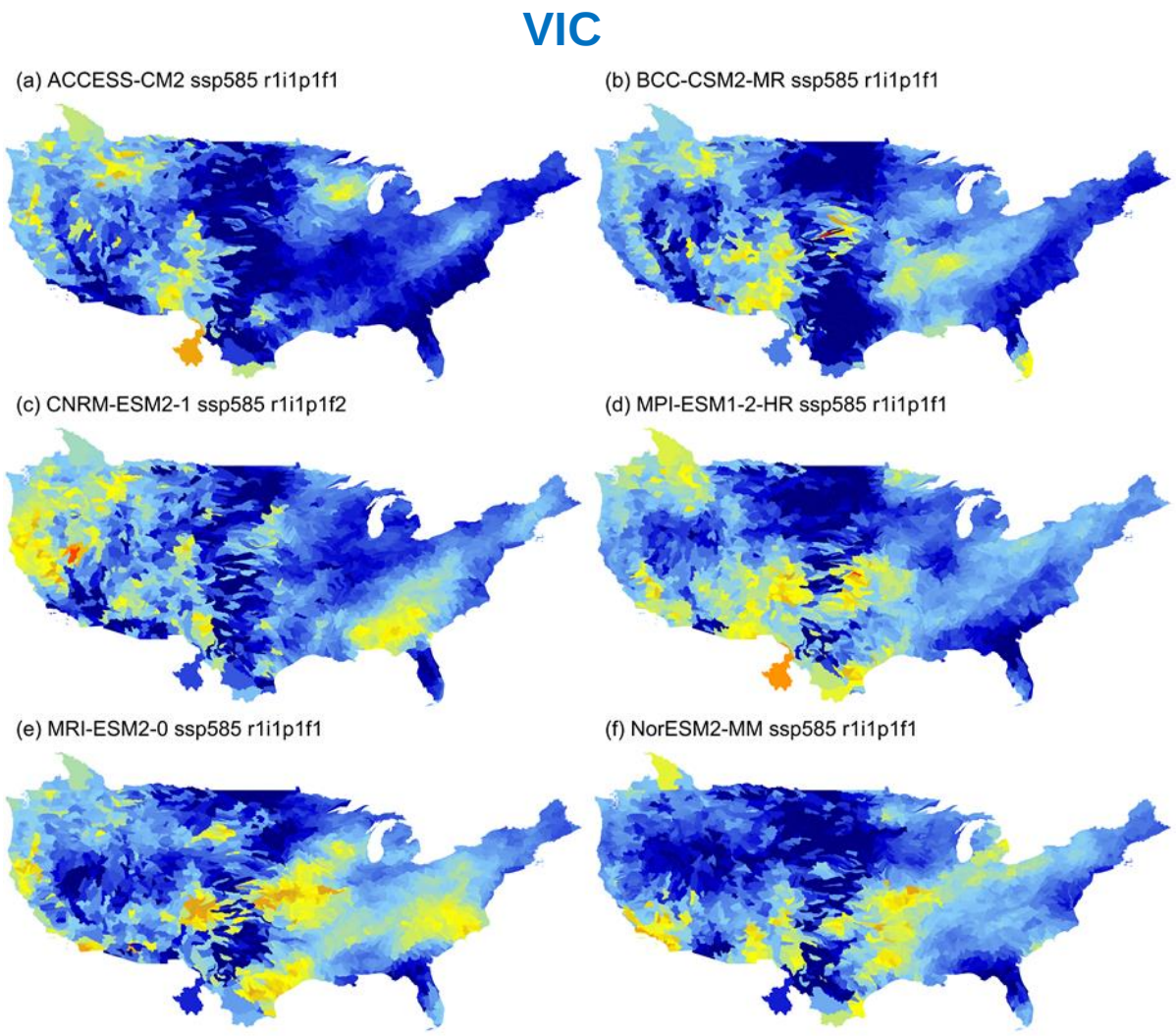


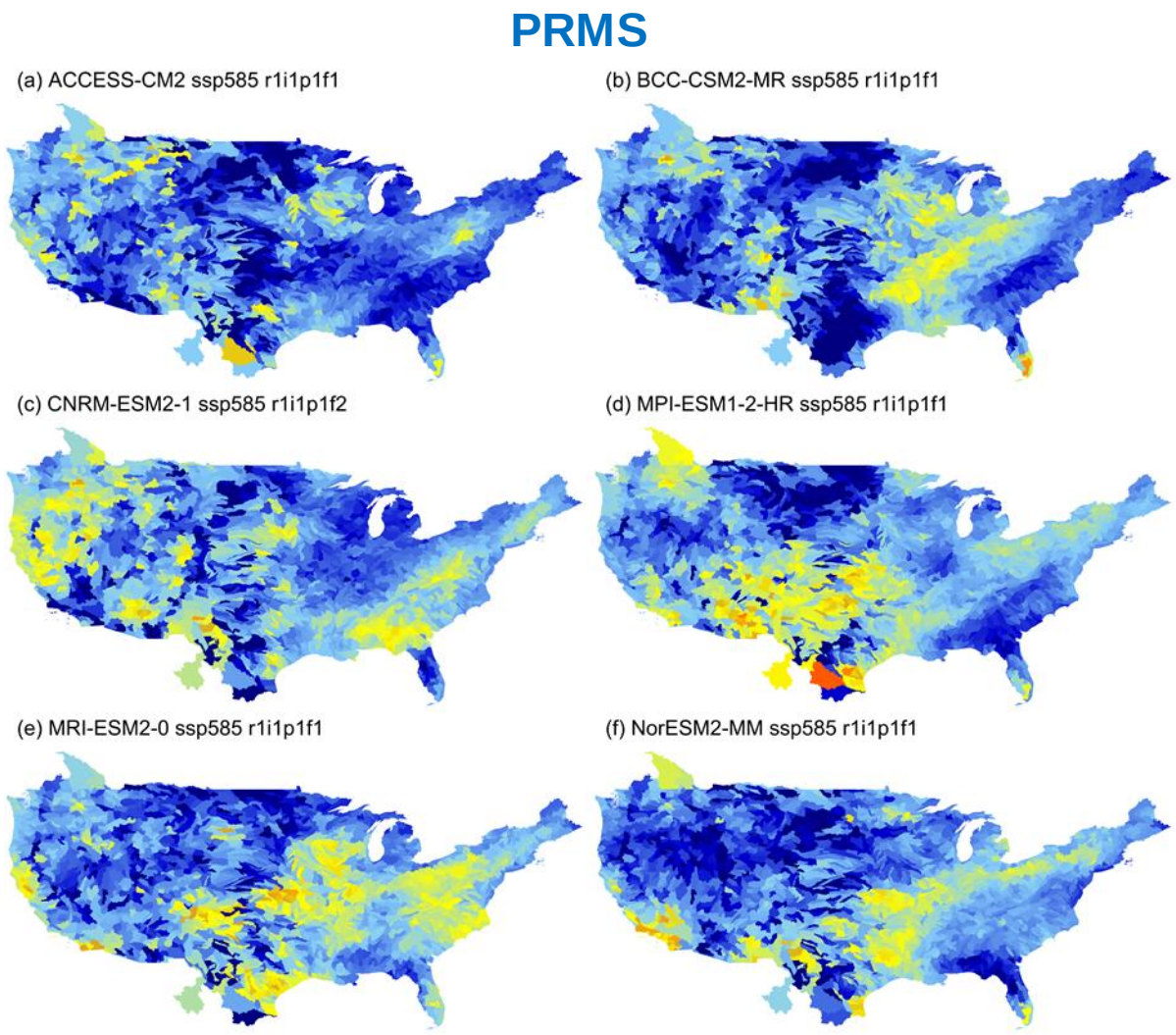
Change in Temperature (°C)



B: 1980–2019
F: 2020–2059

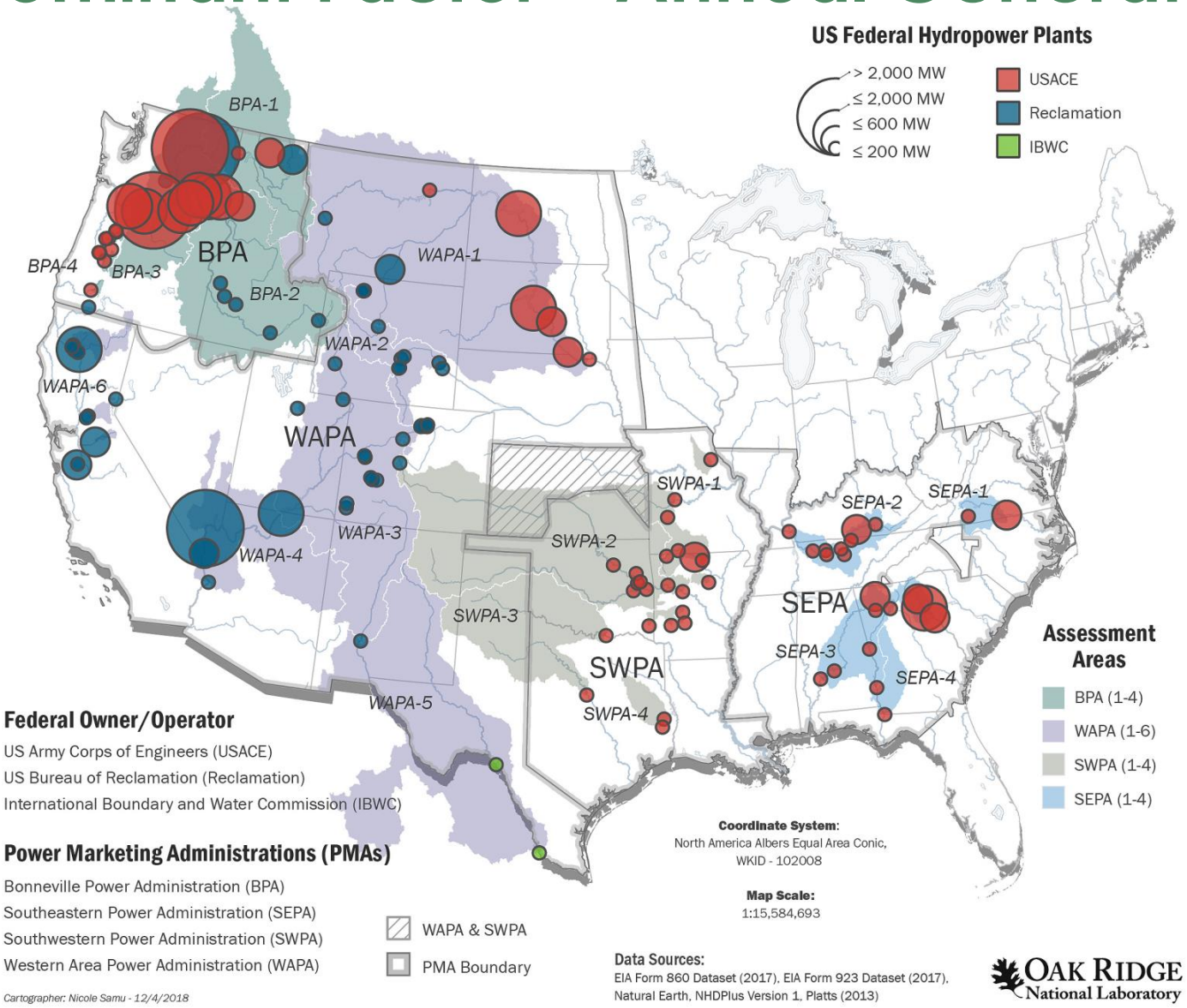
Projected Change in Annual Runoff

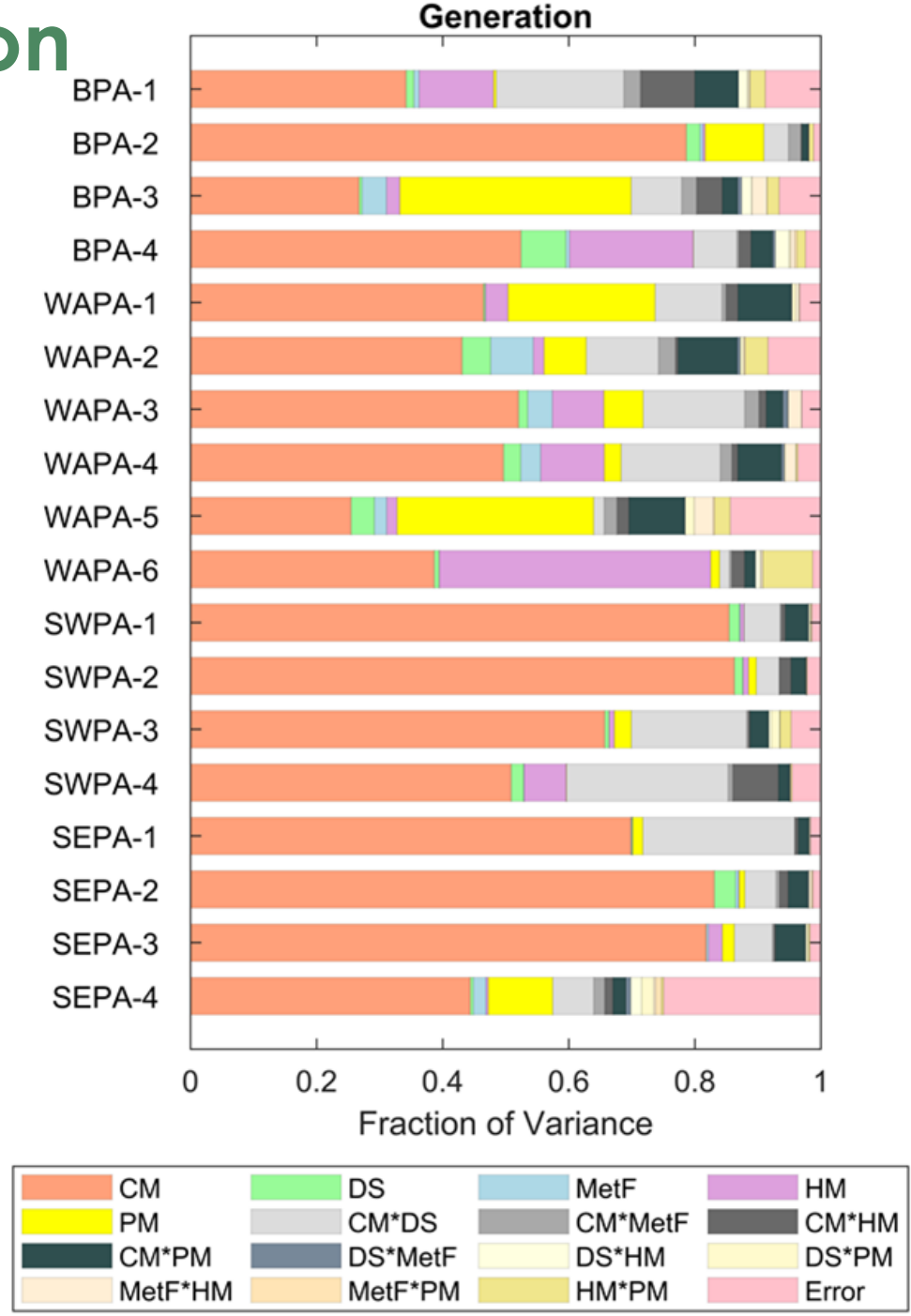




B: 1980–2019
F: 2020–2059

Dominant Factor – Annual Generation





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Overview of Potential Risks

- **Hydrologic extremes are intensifying**
  - Floods: the 2017 Hurricane Harvey has exceeded the conventional probable maximum precipitation (PMP) estimates
  - Droughts: the 2021 western US drought seriously disrupted water supply and hydropower generation
- **Conflicting timing of supply/demand change**
  - Faster snowmelt making earlier supply
  - Increasing summer demand making later demand
  - Intensifying flood risks reduce reservoir flexibility
- **Indirect effects**
  - Other issues outside the scope of 9505 (e.g., in-stream temperature, wildfire)
  - Sensitive topics to address jointly with PMAs

Future Research Needs

- **Need actionable, climate-informed data support**
  - Hydroclimate modeling is not within a utility's original mission space. A utility may not have sufficient resources or dedicated in-house expertise.
  - Provide the 9505V3 atmospheric and streamflow projections in the non-federal extension project as a first step.
- **Need to conduct basin-specific studies**
  - Require "operation-capable" reservoir management models and cost production models
  - "Best" models mean differently for industry and researchers.
  - A "co-development" approach works better to build consensus.
- **Need to address the broader risks**
  - Climate-related: in-stream temperature, methane, dam safety, wildfire
  - Non-climate: land use land cover change, population growth, aging infrastructures

Non-federal Extension

- **Based on the 9505V3 framework, provide data and assessment for the entire US hydropower fleet (covering both federal and non-federal).**
  - Provide multi-scenario future streamflow projection
  - Provide multi-scenario future regional hydropower projection
  - Identify region-specific risks due to long-term trend and variability
  - Identify region-specific water/energy management challenges
  - Support energy-water long-term planning
- **Provide relevant data, models, and parameters to support utilities' own future planning studies.**
  - Reduce utilities' burden in conducting the full-scale hydroclimate simulations
- **Stakeholder engagement RFI and workshop coming soon!**

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Thank you!