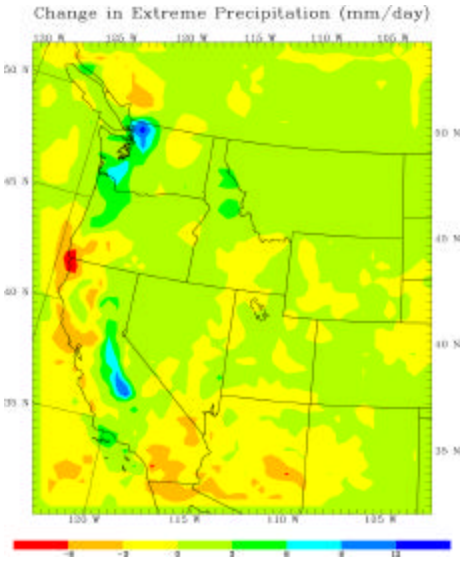
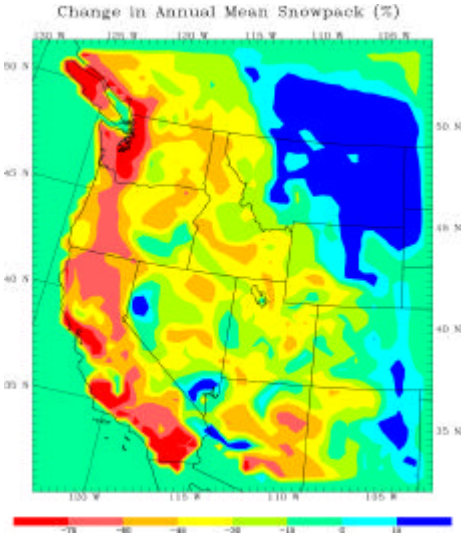
Mid-Century Effects of Climate Change on Water Resources in the Western United States



Projected changes in cold season extreme precipitation



Projected changes in mean annual snowpack.

Pacific Northwest National Laboratory (PNNL) atmospheric scientist L. Ruby Leung is a part of a multi-institutional team of a DOE Accelerated Climate Prediction Initiative (ACPI) pilot project to develop the scientific and computational infrastructures for performing a full assessment of possible effects of human-induced climate change and to develop strategies for adapting to such changes. DOE's ACPI is a bold response to previous findings of the National Research Council Report (NRC, 1998: *Capacity of U.S. Climate Modeling To Support Climate Change Assessment Activities*) that "…the U.S. lags behind other countries in its ability to model long-term climate change," and that "…it is inappropriate for the U.S. to rely heavily upon foreign centers to provide high-end modeling capabilities." Results of this project demonstrate that climate change can have significant effects on water resources in western U.S. in 50 years. The warming associated with the projected build-up of greenhouse gases can potentially lead to more than 50% reduction in snowpack along coastal mountains, along with increased likelihood of wintertime flooding and decreased summertime water supply in major river basins.

This ACPI pilot project is led by Tim Barnett of the Scripps Institution of Oceanography (SIO), with participation from the National Center for Atmospheric Research (NCAR), SIO, Los Alamos National Laboratory, Naval Postgraduate School, PNNL, and the University of Washington. Major high performance computing support was provided by the Center for Computational Sciences (CCS) at the Oak Ridge National Laboratory. In this project, PNNL leads the effort on climate downscaling and impact assessment. First, ensemble global climate simulations were produced at NCAR to simulate changes in global climate with increasing greenhouse gas concentrations that followed the Intergovernmental Panel on Climate Change (IPCC) “business as usual” scenario. Regional climate models were then used to downscale the global simulations of present and future climate conditions to provide climate change information at the regional scale needed for impact assessment.

Using a regional climate model developed at PNNL, Ruby Leung and colleagues have compared the present climate and three possible realizations of future climate between 2040-2060. Results show that by mid-century, the warming of 1-2.5^{o}C strongly affects snowpack in the western U.S. along coastal mountains and can lead to a reduction in annual snowpack greater than 50%. In addition to changes in mean temperature, precipitation and snowpack, cold season 95-percentile extreme precipitation is found to increase by 5-15 mm/day along the Cascades and the Sierra. These changes in snowpack and extreme precipitation suggest higher likelihood of wintertime flooding and reduced water supply in the summer. Such changes could have serious impacts on water resources in the western U.S. The ACPI pilot project is currently investigating the potential for mitigating these anthropogenic threats by using alternative water management strategies in the Columbia River and Sacramento-San Joaquin Basins.

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