New effort helps power utilities and others better plan for the future

May 5 2017, by Carla Reiter

Credit: Argonne National Laboratory

If you're an electric utility planning a new power plant by a river, it would be nice to know what that river will look like 20 years down the road. Will it be so high that it might flood the new facility? Will the water be so low that it can't be used to cool the plant?

Generally, such projections have been based on records of past precipitation, temperature, flooding and other historical data. But in an era when temperature and precipitation are changing rapidly, historical patterns won't do you much good. That's where a new initiative by the U.S. Department of Energy's (DOE) Argonne National Laboratory, which combines climate data and analysis with infrastructure planning and decision support, promises real help.

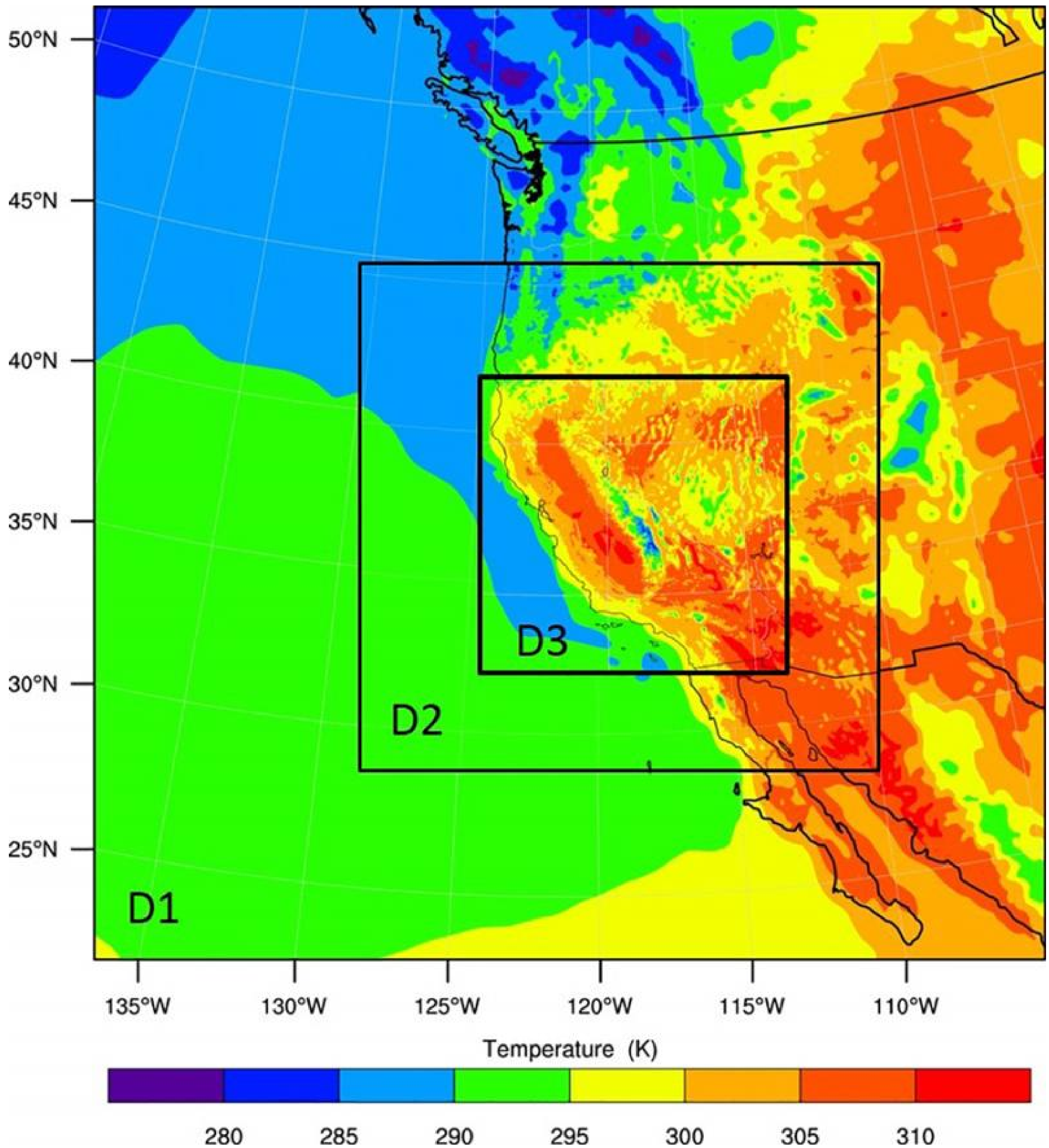
"What we're doing is combining expertise and tools that are available only within Argonne to take something that is incredibly complex—understanding what's going on with climate—and distilling it down to something that is really actionable for the energy provider or the engineer," said John Harvey, a business development executive at Argonne who acts as a liaison between power utility companies and the Argonne research team.

The initiative offers power utilities and other customers access to extremely localized climate models run on supercomputers, as well as the expertise of the climate scientists who run them. Other experts include the lab's environmental modelers (who can, for example, model how changes in precipitation translate into changes in flooding) as well as infrastructure modelers and risk assessment experts (who can forecast how that flooding will affect electric infrastructure and the grid).

Together, they help utilities make informed decisions about how to improve infrastructure to avoid future outages. Advance planning can help utilities both protect themselves and take advantage of new opportunities.

"This really helps utilities plan for their infrastructure investments," said

Ushma Kriplani, a business development executive who, like Harvey, helps customers work with the scientists and facilities at Argonne to ensure they get the information and advice they need to make more informed decisions. "Infrastructure investments are both huge in size and look out many years. When you need to plan on time scales that span 30 or 40 years, you need to factor in all the things that are going to change."



A snapshot of the surface air temperature (K) predictions from 10-year high-resolution regional climate model simulations Argonne conducted recently for a California fire risk mapping project. The outermost domain (D1) has a spatial resolution of 18 kilometers. The two inner domains have resolutions of 6 kilometers (D2) and 2 kilometers (D3), respectively. Credit: Argonne National Laboratory

Power lines can sag if temperatures rise, for example, becoming weaker, less efficient and prone to failing. Changes in air temperature and humidity can also affect power plant cooling. "These things have a real impact on the operations of a plant," said Thomas Wall, an infrastructure and preparedness analyst in Argonne's Risk and Infrastructure Science Center and one of the co-leads of the new initiative. "Maybe in the future I can't generate as much power at that location because I can't cool it as effectively."

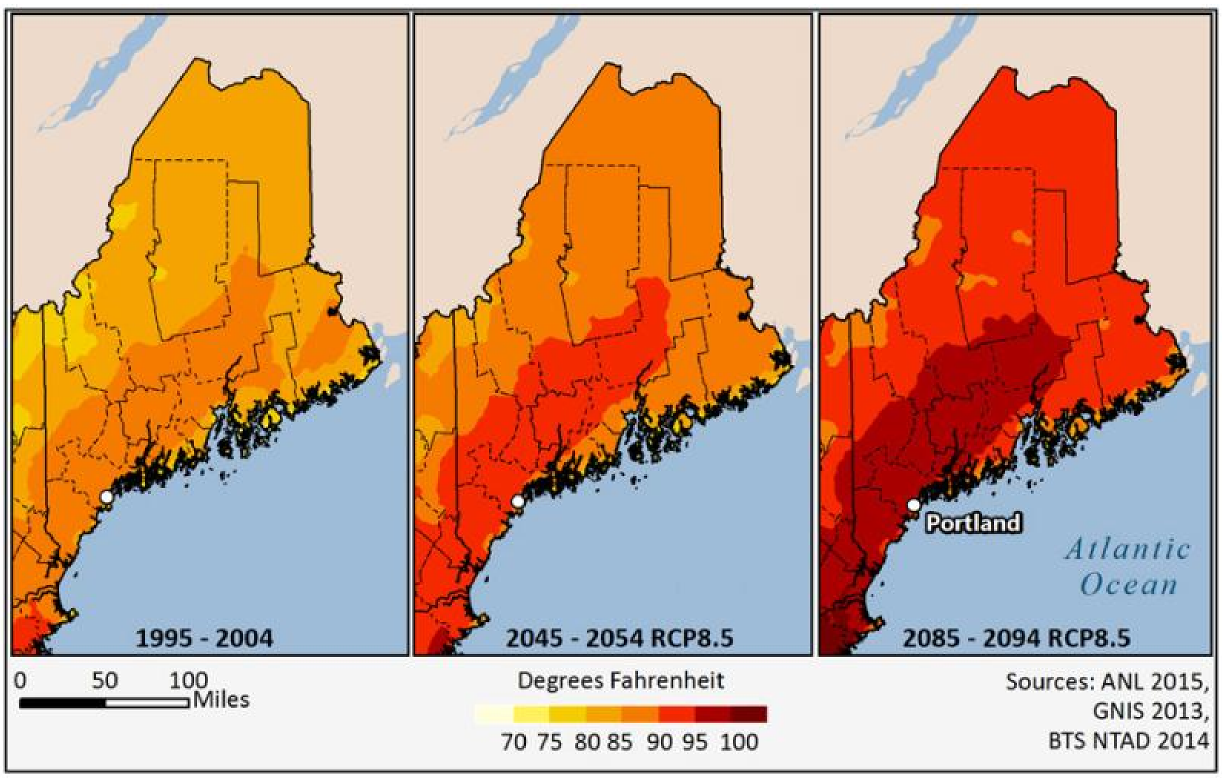
After an unusually intense rain flooded one of its substations a year or so ago, a utility in the northeast approached Wall and his colleagues. The substation provides power to one of the largest employers in the state; the utility wanted to know if it would be increasingly likely to flood in the future—and if so, how badly, and what could be done to mitigate it.

Wall's team did an analysis that took into account factors such as sea level rise and storm surge from a hurricane. They looked at the flood vulnerability of six nearby substations and used a model of the electric transmission grid to see what would happen if those six substations failed simultaneously. Would there be cascading failures across the grid that would cause a much larger problem in the region?

"The good news was the answer was no, there wouldn't," Wall said. But there would be local blackouts, and the substation that motivated the analysis would indeed be increasingly prone to flooding. The team recommended that the utility build a new substation on higher ground and steered them to locations in the area that would be less vulnerable.

Climate modeling has only lately developed to the point where these kinds of studies are realistic. The models dice the world into a grid of cells and calculate the state of every cell repeatedly through time. With supercomputers, researchers have the ability to model smaller cells and shorter time steps, resulting in finer resolution. And the finer the resolution, the more specific the model can be about what will happen at a given location.

At the Argonne Leadership Computing Facility, a DOE Office of Science User Facility, scientists can now simulate the climate at a resolution of a few kilometers. "It's a huge improvement," said Yan Feng, an Argonne climate scientist and the initiative's other co-lead. "So it becomes easier for the climate model output to be used for decision-making."



In another project, Argonne coupled projected changes in mid-century air temperatures with regional electrical power generation and transmission models to identify that, under a projected 9° F temperature increase by 2055, electrical transmission line capacity would decrease by as much as 8 percent, while demand would increase by as much as 10 percent as more residents demand more air conditioning. Credit: Argonne National Laboratory

Feng and Argonne colleague John Krummel recently helped researchers from Nevada's Desert Research Institute develop a high-resolution fire hazard map. The project, funded by the California Public Utilities Commission, will help utilities manage and site overhead utility infrastructure.

"They came to us because they needed to model the regional climate—winds, relative humidity and temperature—as a function of time for 10 years at a resolution of two square kilometers," she said. "It's not affordable for them to do that on their own computers." The climate simulations used approximately 7 million core-hours on the Argonne Leadership Computing Facility's Mira supercomputer.

Both Wall's flood assessment project and the fire map effort would have been difficult to put together elsewhere, Wall said.

"There are lots of places that can do climate modeling or infrastructure modeling; there are places that have decision science and risk analysis capabilities. But what makes this unique is that we have all of these in one place and we're all talking with one another," he said.

John Harvey agrees: "The great thing about Argonne is we're a multi-disciplinary lab," he said. "Working together, we can provide a lot more value to utilities and become a wonderful resource for them. They really can't get this information in one place anywhere else."

Provided by Argonne National Laboratory