

# Forecasting Temperature, Precipitation, and Evapotranspiration

An Interview With Geoff Flint and Tom Hauf of CustomWeather, Inc., and Marco Bell of Merced Irrigation District

Close-up look of the gridded precipitation outlook for Merced Irrigation District.

*Rain and snow are prized by irrigation districts, and when districts depend on them to ensure water deliveries, accurate weather forecasts become a necessity. This is the very challenge CustomWeather, Inc., has set out to meet for its customers. Since 2000, CustomWeather has been providing decisionmakers with accurate weather forecast data with which to better predict precipitation type, precipitation amounts, and evapotranspiration rates, all of which makes managing irrigation districts easier.*

*In an interview with Tyler Young, writer for Irrigation Leader, CustomWeather's President and Chief Executive Officer Geoff Flint and Senior Sales Executive Tom Hauf, and Marco Bell, water engineer for Merced Irrigation District, discuss what goes into providing their customers with the CustomWeather model, the success customers have with the model, and the goals for the further development of the model.*

**Tyler Young:** Please tell us about your background in the industry.

**Geoff Flint:** I cofounded CustomWeather in 2000, and I have a background in meteorology and economics. I wrote most of the original software at CustomWeather, so I have extensive programming experience in addition to over 20 years of experience in meteorology. I help to bridge the gap between sales and technology at the company. We're always thinking of innovative solutions to different weather challenges that companies face.

**Tom Hauf:** I am a former Air Force weather officer. I joined CustomWeather in 2003. My primary focus

at CustomWeather is developing and implementing customized weather solutions.

**Marco Bell:** I have been in water resources for about 40 years now. I started when I was a young man working in the Panama Canal. Today, I work for the Merced Irrigation District, where I have been for the past 5 years.

**Tyler Young:** Please give us a brief history of CustomWeather, why it was established, and its mission.

**Tom Hauf:** CustomWeather was founded in 2000 and is headquartered in San Francisco. We have been a leading provider of weather information, focused on providing technical innovations and solutions to decisionmakers. CustomWeather is not a big consumer-facing company, but rather a smaller operation focused on the back end of operations. We like to think of ourselves as the biggest little weather company of the world. We are just as capable as the big weather companies, but we are small enough to offer individual support for our customers. We provide historical, real-time, and high-resolution forecast data, maps, and weather tracking for 80,000 locations in 230 countries and in 80 languages.

The backbone of our entire operation is our proprietary high-resolution forecasting model, the CustomWeather 100 or CW100. The model focuses on the lowest levels of the atmosphere with resolution much finer than that of standard forecast models. We believe the CW100 to be the most accurate high-resolution forecast model in existence. Its ability to project near-surface weather with

unprecedented resolution and accuracy is revolutionary. The model is able to account for mountainous areas that have widely varying terrain. It performs equally well during nighttime and daytime, and in nonpopulated areas and populated areas. Our goal is to help decisionmakers make critical weather decisions based on our data.

**Tyler Young:** Marco, please tell us about Merced Irrigation District and how the district began working with CustomWeather.

**Marco Bell:** The irrigation district became an entity in 1919, and its roots go all the way back to the mid 1800s with previous canal companies. We began building our reservoir in 1964, and we completed construction in 1967. It holds over a million acre-feet of water, which we use to meet our irrigation demands of about 140,000 acres of irrigated land.

Snow and snowmelt in the high mountain elevations significantly affect our management approach. I decided to make models with a gridded approach to better handle our forecasting, especially with snow, snowmelt, and runoff. In researching solutions that could help us, I found that CustomWeather had the perfect product that could provide all the parameters on a gridded basis. We integrated CustomWeather's solution into our operation, and we could not be more impressed. I was very excited to have the company on board. Now after many years of working together and further developing our models, CustomWeather has proven to be the right choice for us. We have expanded the model and are now developing models down to the valley, including the four reservoirs at the lower watersheds in the basin. The models include the San Joaquin River and end on the south side of the district.

**Tom Hauf:** In Marco's business, he has a specific need that a lot of companies are not able to fulfill. He was looking for a company that could work with him one-on-one. This took time to develop; it didn't just happen overnight. After some back and forth, we were able to develop an excellent solution for the district.

**Marco Bell:** We have been developing this process over time, and it's in pretty good shape now.

**Tyler Young:** Tom, please describe the service you provide to Merced Irrigation District.

**Tom Hauf:** In essence, we provide high-resolution gridded observations and forecasts for temperature, precipitation, and evapotranspiration. Our forecast data covers everything that falls from the sky. Those inputs are then used to

inform the hydrology models that Dewberry provides. It is very important for the Merced Irrigation District to be able to predict things like runoff; evaporation; and most importantly, snowmelt, which all have a major effect on water levels and other parameters the district models. The solution is good compared to others because it is high resolution, and as I mentioned before, it is able to account for a diverse microclimate in the mountains. The CW100 model offers a high degree of accuracy. Evapotranspiration is also important, especially in a world that's going dry in many respects.

**Marco Bell:** One of CustomWeather's advantages is that its employees have a meteorological background, so the inputs actually have a meteorological, physical nature to them. It is not just based on observed point data or locations in the mountains. Instead, CustomWeather can actually extrapolate and use models to give us more precise input data than we could ever come up with on our own.

**Tom Hauf:** The CW100 analyzes six different National Oceanic and Atmospheric Administration models and one model from Canada. Then we rate the performance of each model for initialization purposes to determine which model is working best, and that's the one we use to inform our CW100 model.

**Tyler Young:** What are some of the challenges or uphill struggles you have overcome?

**Tom Hauf:** As far as the challenges go, mountain terrain is at the top of the list. It is difficult to accurately estimate precipitation from radar because radar cannot see behind the mountain, so we supplement the radar data with rain gauge observations. There are ways we can fill in where we cannot see precipitation falling, and it has worked out quite well. Another challenge is determining where it is raining and where it is snowing. As you would expect, rain and snow behave differently. Rain runs right off into the rivers, and snow stays there and melts later. It's important to know the precipitation type, which is difficult due to the sparseness of actual observations.

**Geoff Flint:** It is difficult to pinpoint exact precipitation totals in the mountainous and diverse terrain in the Merced Irrigation District because there are few rain gauges and much of the area is outside the typical radar beam. We've had to use a combination of sources to accurately fill in precipitation totals, including elevation-adjusted gauge readings, Doppler radar estimates where available, and modeled data. Our forecast model itself does a nice job of picking up the wide range of rainfall and snowfall totals across the district.

"We like to think of ourselves as the biggest little weather company of the world."  
—TOM HAUF



**Marco Bell:** One of the major challenges we have is moving away from the way models of the past. For example, a basin may be 10 square miles, and in the mountains within those 10 square miles, everything can change significantly. You have high elevation areas, low elevation areas, high slopes, and low slopes, and the storm can come from any direction. We can easily end up not getting the right solution, so we had to grid the basin into different squares or elements and characterize each individual element in more detail.

With the CustomWeather model, we are able to do just that with precipitation and snowmelt. We can now delineate and forecast where the snow falls and where the rain starts with a lot more precision than with the other models. That is important because it can accurately tell us how much water is going into our reservoirs at any given time. There are two major challenges to deal with: dry conditions in which we have almost no water, and periods of time with high water levels. We have been all the way down and all the way up in recent years, but we have managed that successfully. There is a risk that requires us to know what runoff is coming down and to have a handle on snowmelt. The best way to do it in a mountainous area is to do a gridded approach with a physical base model. Our process handles that part of the challenge well. We are better able to conserve our water so that we have a better, more reliable water supply; to reduce the effects of drought; and to better manage reservoir operations to ensure that flood space is available when the flood waters come.

**Tyler Young:** Where do you see CustomWeather going in the future?

**Tom Hauf:** We see a growing need for our high-resolution CW100 modeling techniques, not only to prepare districts for rain events or big precipitation, but also to prepare them for what appears to be lengthening periods of dry weather due to climate change.

**Geoff Flint:** Every year, the forecasts get better, the models get even higher resolution, and the amount of data we process gets more immense. We've developed our own system to handle and process terabytes of weather information each day. We're able to tailor that information to our customers' exact needs. As a company, we constantly stay on top of the latest technologies so we can bring extra value to our clients. Part of that value is the accuracy of our weather forecasts and the custom solutions that we provide. In the coming years, I foresee big improvements in the weather forecasting 3–4 weeks out, which will be beneficial for planning purposes for irrigation districts everywhere.

**Tom Hauf:** We provide two things: current condition observations and forecasts. Precipitation is tricky because much of the area is outside the radar beam, so we rely on multiradar, multicenter data to adjust for elevation. There are ways we can fill in where we cannot see precipitation falling, and it's worked out quite well.


**Marco Bell:** We do those two things with the model. We operate on a real-time basis, because we need to know what is happening right now, and we forecast for the next week. We use hourly time increments with details of what is going to happen in the future. We manage our operations, including our deliveries, flood control, and environmental requirements, by using this system.

We also have a planning version that based on a physical model for analyzing effects such as climate change. For example, we can analyze the climate change effects and start planning the infrastructure we may need to build. Capital projects planning can help ensure that we will be able to meet future operational needs as best as we can. For example, we can prepare climate change scenarios from CustomWeather data to examine what's going to happen in our basin and plan accordingly. So it is useful not only for real-time operations but also for guiding and planning.

**Tyler Young:** What advice do you have for districts that may be considering working with CustomWeather?

**Tom Hauf:** Water engineers and irrigation district managers have a growing need for high-resolution forecasts, and CustomWeather is eager to serve. We have worked directly with many different groups to fine tune what we do, and that is the whole idea behind CustomWeather—we are masters of customization.

**Geoff Flint:** We're able to provide a high-resolution and tailored weather solution to any irrigation district out there. We're partnered with Dewberry for hydrology modeling, and we have many products tailored to the agricultural side of things, such as evapotranspiration. We can certainly help any irrigation district looking for better flood forecasting, both short and long term.

**Marco Bell:** From my perspective, water is one of the most valuable resources, and it becomes more valuable as we stress our environment. With climate change, we are seeing sea levels rise, precipitation dynamics changing, and snowmelt seasons shortening. These challenges demand that we have the ability to meet our water supply requirements within our individual mandates. What CustomWeather can do for districts is help them with forecast and parameter analysis to help better manage risks in their specific area. 

*Geoff Flint is the president and chief executive officer of CustomWeather, Inc. He can be reached at [gflint@customweather.com](mailto:gflint@customweather.com).*

*Tom Hauf is the senior sales executive at CustomWeather, Inc. He can be reached at [tomhauf@customweather.com](mailto:tomhauf@customweather.com).*

*Marco Bell is the water engineer for Merced Irrigation District. He can be reached at [mbell@mercedid.org](mailto:mbell@mercedid.org).*