Rich Giannola, Atmospheric Scientist, The Johns Hopkins University, APL

CHALLENGE

To better understand meteorological events and their effects on technology, temperature and precipitation.

SOLUTION

Atmospheric scientist Rich Giannola is using JMP software's tools, including the Prediction Profiler and the Distribution, Time Series and Bubble Plot platforms, for robust data analysis and visualization.

RESULTS

Giannola is helping to solve critical and complex research, engineering and analytical challenges in his work at The Johns Hopkins University Applied Physics Laboratory supporting US Navy programs and in his research on El Niño and La Niña.

Today's forecast – enhanced data visibility

An atmospheric scientist recognizes the power of data visualization and analysis using JMP®

Located just north of Washington, DC, the Applied Physics Laboratory (APL) is a division of one of the world's premier research universities, The Johns Hopkins University, and is dedicated to solving some of the most critical and complex research, engineering and analytical challenges facing our nation.

Such challenges generally involve the gathering and analysis of vast amounts of data – which makes JMP statistical discovery software a tool well-suited for the work at hand.

Rich Giannola, an atmospheric scientist, has found that to be the case.

Much of Giannola's work is in support of US Navy applications, including research that involves determining how meteorological factors affect a wide variety of Navy systems.

"There's a wealth of information out there," Giannola says, "information that has opened a whole world of opportunity. But you have to have an effective means of processing and analyzing it."

In January 2011, Giannola decided to enroll in a class on JMP offered at APL. The experience was a revelation.

"It was amazing," Giannola says today. "It just seemed like such a very easy way to do complex analytics."

"JMP provided confidence in the data, which is what I was really looking for. You can have the correlations, but how good are the fits to the data? I didn't know what to expect there."

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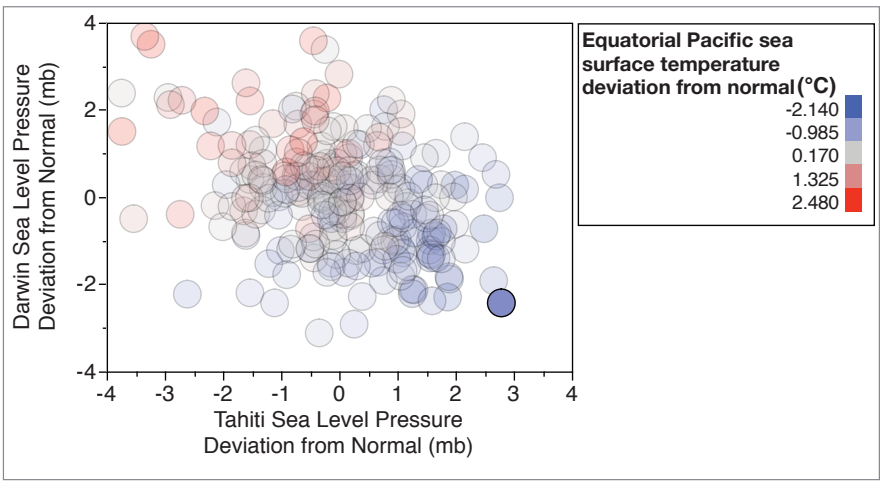

Bubble plot showing the inverse sea-level pressure relationship between Darwin, Australia, and Tahiti for all winter months (December-March). El Niño events are typically represented by the red bubbles, and La Niña events by the blue bubbles.

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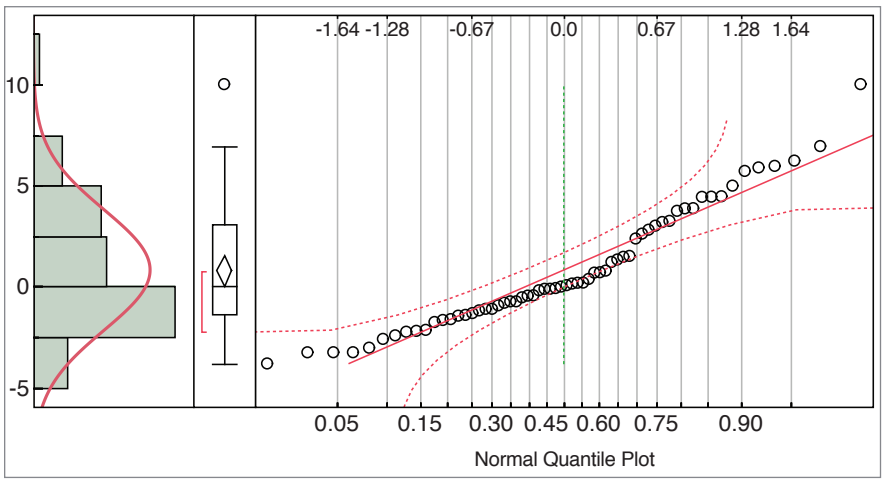


Distribution plot showing San Francisco precipitation deviation from 61-year mean during El Niño winter months of December through March. San Francisco winters are generally wetter than normal during El Niño events.

Giannola has recently worked on two projects with the Navy in which he's used JMP. Meanwhile, he undertook a study of his own, examining El Niño and La Niña patterns, a project that would have been quite a chore to accomplish without JMP.

A confidence booster

One Navy project involved measuring electrical transmissions between two points to determine the threshold level at which a reliable connection could be made. In the lab, Giannola and his colleagues would start out with a high level of system noise, and then decrease it step by step to a level at which they were reasonably confident the desired signal would pass through nearly every time.

This is similar in concept to two people having a conversation with each other on their cellphones. Sometimes the transmitting path between them and the cell tower is poor due to noise interference (such as from nearby buildings) or from ground influences (hills and valleys, for example). Reducing the noise by moving away from these disturbances can generally make the connecting signal more reliable.

"In the past, we would decide on the number of times we would test at each noise level, and if the tests were successful, we'd say, 'Let's go with it,'" Giannola explains. There are approaches to determining an adequate sample size based on the study under investigation.

An objective then was to determine how to statistically validate laboratory procedures. JMP provided the solution.

"Based on laboratory experience," Giannola continues, "our standard threshold for stopping a given test was when we achieved 10 successful transmissions in 10 attempts at a given noise level. We collected data from several tests and applied a logistic regression fit to the data using JMP. "The results from JMP told us that there was generally only a very small probability, less than 1 percent, that we would get enough interference to block the signal if we had tried more attempts. The logistic regression analysis provided statistical validity for using our standard methodology in our laboratory testing. It gave us confidence that we were on target."

The second project involved an assessment to characterize a particular Navy system. Giannola and his colleagues used the JMP platform for design of experiments (DOE) to set up the data-collection experiment.

"We found that the DOE approach ensured an efficient data-collection process and provided data to describe how well our system was working," Giannola said. "We also used JMP model-fitting techniques to predict how the system would work under different conditions, since many factors were involved."

Giannola's experience using DOE with this system led him to write a paper that introduced his team members to using DOE in JMP for data collection and analysis of the results.

Charting the winds

Giannola's own project using JMP, examining the effects of El Niño and La Niña, was an ambitious one.

Both El Niño and La Niña are events that originate in the equatorial Pacific Ocean. El Niño brings warmer than normal sea surface temperatures, while La Niña causes cooler than normal temperatures. Accurate long-lead forecasts of these events are important

for agriculture, the fishing industry and the management of water resources, grain reserves and energy.

Giannola had long been interested in the effects of El Niño and La Niña, but he had never before examined the statistics associated with them to learn how they behave. In JMP, he found the ideal tool for the analysis and visualization of the physical indices that are used for correlations with observed climate conditions, such as temperature and precipitation.

"I knew there were general correlations between El Niño and La Niña and the weather," Giannola says, "so I wanted to collect the data to do my own analysis and explore the behavior of these two phenomena. I wanted to see how they behave over time."

Monthly indices for both were available going back to 1950. Averaged monthly data from US weather stations was also available for the same time period. Giannola recognized that several JMP platforms – including Distribution, Time Series and Bubble Plot – were well-suited to analyze and visualize the data.

"I wanted to collect a lot of data so that I could correlate the strength of El Niño and La Niña versus normal temperature and precipitation patterns," he says.

He'd seen the National Weather Service maps, which indicate what can be predicted under strong El Niño and La Niña conditions, but he wanted to analyze the data for himself. He picked eight locations, airports spread across the country, to see whether the conditions there were consistent with the documented conditions over the larger regional areas.

"I analyzed 61 years, a lot of data, and it was interesting to see this semi-irregular pattern that these phenomena follow. It showed me some fascinating things that I hadn't seen before about their behavior." For example, El Niño events occur slightly more often than La Niña and are generally shorter in duration.

In conducting the correlation analysis, "JMP provided confidence in the data, which is what I was really looking for. You can have the correlations, but how good are the fits to the data? I didn't know what to expect there."

Giannola says that it was helpful to see how, in general, the data fit quite well with the analysis that had been done previously by the National Oceanic and Atmospheric Administration, National Weather Service and Climate Prediction Center.

"In general, it worked out very well; they did indeed match up," he says.

Giannola foresees practical use for his data: "The data I have could be used to develop other kinds of statistical models to predict the behavior and strength of El Niño and La Niña up to a year in advance. Statistical models are an important part of NOAA's and other institutions' predictions of these events. So if you have the data and you want to use JMP in a predictive sense, you could do so. I think that could be of great value."

Otherwise tedious

JMP has expanded the bounds of Giannola's research.

"I wouldn't be doing the things I'm doing now if I didn't have JMP," he says. "The opportunity just wasn't there. The GUI

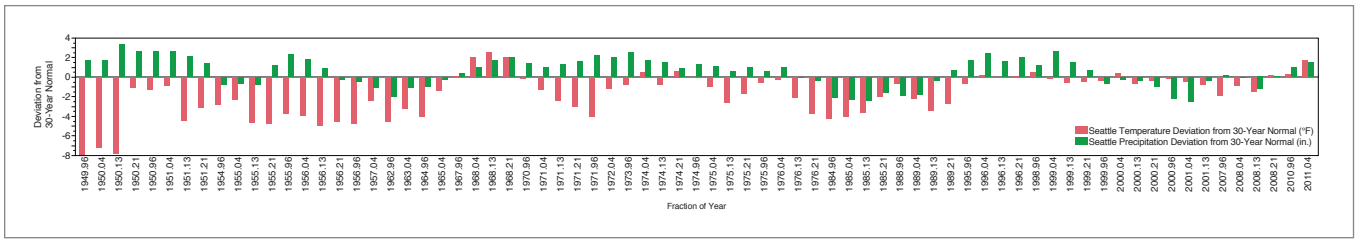
THE PRO

Researchers at the Applied Physics Laboratory have recently gained access to JMP Pro, introduced by in-house JMP guru Manny Uy, a member of the Principal Professional Staff at APL.

JMP Pro includes everything in JMP plus advanced techniques for predictive modeling, cross-validation, model comparison and one-click bootstrapping. It combines data management, data and information visualization, and statistical modeling in an in-memory application made for the desktop. Uy says the university is using JMP Pro in model simulations with massive data sets. He's using it, for example, to simulate radar returns generated by various microwave generators on a variety of objects, also simulated, both in the air and on the ground.

"JMP Pro appears to be faster than JMP on our 64-bit computers," Uy says, "and in large simulation experiments requiring, say, a thousand runs, saving 10 minutes per run means a savings of a week's time.

"That is a substantial amount of savings."



Rich Giannola used JMP to create this Chart plot. This visualization shows Seattle temperature (red) and precipitation (green) deviation from 30-year climatological normal during the La Niña winter months of December through March. Seattle winters are generally cooler and wetter than normal during La Niña events.

was easy to learn, and the more you use it the more you discover tools to do things that otherwise would be tedious."

Giannola now looks forward to using JMP Pro (see sidebar), which was recently introduced to the Applied Physics Laboratory by fellow APL researcher and longtime JMP user Manny Uy, whose Design of Experiments and Statistical Analysis Using JMP classes Giannola took.

"I've only been using JMP for less than a year," Giannola says, "but it's opened my eyes to a new way of analyzing data. Now I look for opportunities to use JMP whenever I can."

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