Department: About the Cover

# Killing Rainbows

**Gary Singh**

**To model carbon** flow in the ocean, Riley Brady and Stephanie Zeller killed rainbows and discovered garbage. To be more precise, they knew that the bright RGB band of color used by scientists to represent data since time immemorial was useless to explain three-dimensional carbon distribution in the Southern Ocean, so it became crucial to implement fresh color maps and video storytelling, even if they wound up modeling the Pacific Garbage Patch by accident (see cover image and Figures 1, 2, and 3).

Brady, a Ph.D. student with the University of Colorado Boulder, was already doing cutting-edge research in climate visualization to understand how carbon flowed around the ocean, but was working with very complex models that were difficult to visualize in conventional ways. So he was limited to creating simple videos to accompany his talks and lectures. Then, via connections related to his summer work at Los Alamos National Laboratory, Brady came into contact with Zeller, along with Annie Bares, who were both working on the viz team at the Texas Advanced Computing Center at UT Austin. Zeller comes from a studio art and communications background, while Bares is a Ph.D. student in English literature.

In a true collaboration between the arts, sciences, and humanities, the three of them together created a project for the American Geophysical Union's annual Digital Storytelling Contest. Brady's work utilized the Lagrangian method for visualizing ocean climate model simulations, as opposed to the traditional Eulerian perspective, which depends upon static calculations within individual grid cells. Zeller provided custom color palettes, whereas Bares wrote scripts and storyboards. Unfortunately, the team did not win the contest, but everyone learned quite a bit.

"The emphasis for this competition was just to visualize and explain to people how these cutting-edge climate models we're working with use this [Lagrangian] perspective to directly simulate the flow of the ocean, instead of just this conventional perspective where you create this big grid and compute averages inside each box," Brady said.

Yet they needed real color to explain everything. The classic RGB rainbow scheme—(for instance, how The Weather Channel might use bright green to designate precipitation)—is a leftover artifact from a previous era when artists and scientists never collaborated. The RGB rainbow with gaudy saturated colors fails on several fronts. For one, it is not how the human eye perceives color. Highly saturated hues right next to each other tend to confuse the eye and create vibrating edges. If viewers look at something for an extended period of time, they are not able to draw as many conclusions and see as many features over time because their eyes get fatigued due to the combination of extremely bright colors. When it comes to semantics, even more problems arise, especially when using a rainbow scheme to designate "warm" or "cool" temperatures. Even worse, if the viewer is colorblind,

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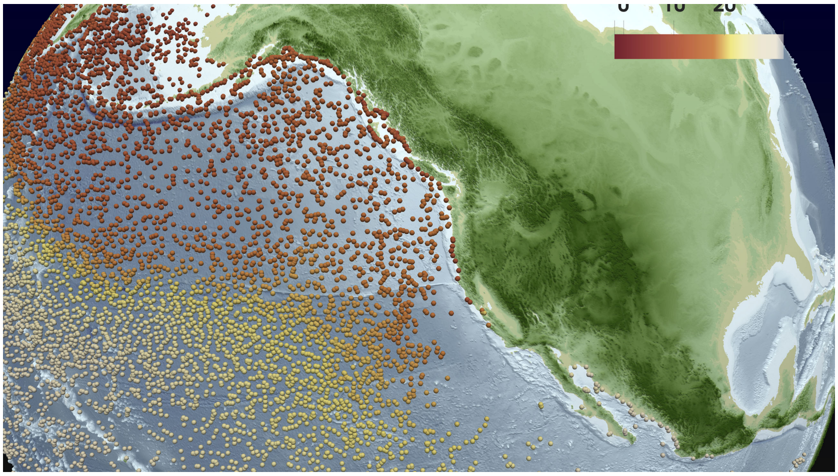

**Figure 1.** Visualization of particles moving into the Pacific Garbage Patch over time. The colors of the particles represent temperature.

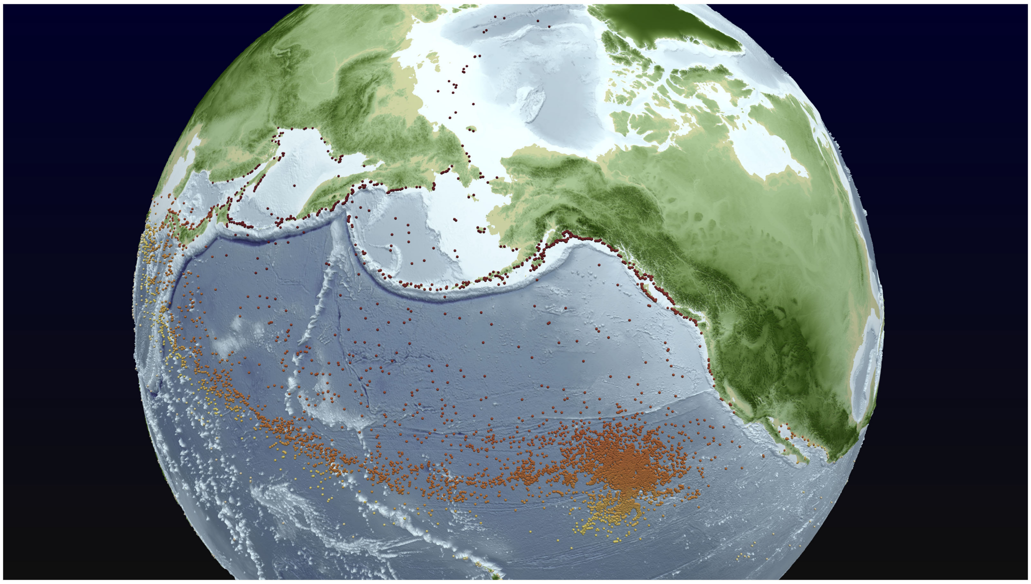

**Figure 2.** Visualization of particles moving into the Pacific Garbage Patch over time. The colors of the particles represent temperature.

certain degrees of brightness in the colors tend to blur together. Even though many have previously articulated the disadvantages of using the RBG rainbow, it still remains a staple in many disciplines.

"I understand where the rainbow color map came from," Brady said. "It's just taking a while to kill, especially in the atmospheric sciences, in the climate science."

As a result, Zeller created a custom palette, with a just a few colors scaled from really dark to really light because the human eye can better perceive the luminosity. There is a logical order—darker colors on one end of the scale and lighter colors on the other—without all the random brightness changes that emerge when using gaudy RGB rainbows.

"If you actually change it to a scientifically accurate color map, you realize the rainbow color map's actually been misleading you," Brady said. "So, it's not only this nice union where our visualization looks nicer, but we were actually misleading ourselves with the arbitrary color maps we were using in the past."

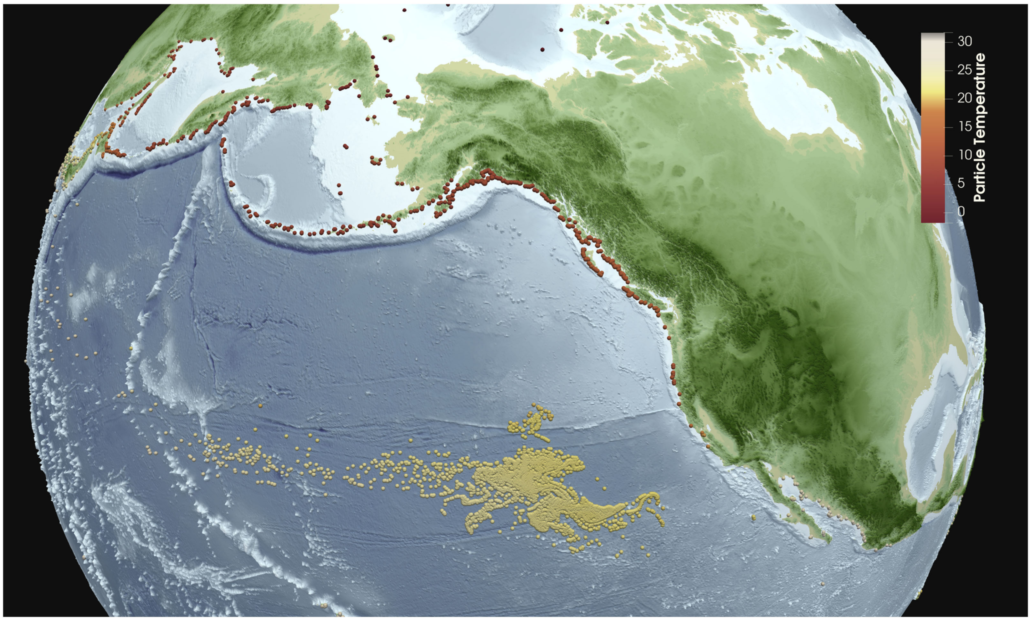


**Figure 3.** Visualization of particles moving into the Pacific Garbage Patch over time. The colors of the particles represent temperature.

The cover image, as well as Figures 1, 2, and 3, are visualizations of particles moving into the Pacific Garbage Patch over time, using Zeller's custom color palette. She chose blue for the ocean because that is what everyone sees in real life, but instead of a solid color, she went from deep blues to grayish hues because the water would essentially function as background to the brownish-orange points, which she needed to raise up and place in the foreground. She colored the land masses green for semantic reasons, but also because it set up a distinct contrast with the points, red being complementary to green.

"This draws your attention to what I want you to be looking at, which are those points, which then represent temperature," Zeller said. "It makes it much easier for you to understand intuitively what you're looking at, and then I can direct your attention with the colors based on what is important."

In the end, the team discovered that a true collaboration is one in which everyone learns each other's languages and skillsets, enhancing their own fields in the process. On one hand, there was an art-and-science, communication, public-facing side to the project, and yet also a more rigorous, quantitative-science, community-focused angle going on at the same time.

"Something as simple as just going the extra mile to create a better visualization can do wonders for helping communicate your science to a broader audience," Zeller said. "That's really what we need now, especially in climate science. That's the extra steps that you need to push yourself to in order to get this information out there in a way that appears trustworthy and appears intuitive and is easy to understand. This is just such a simple way to do that."

Brady concurred: "I think it's really cool that all this perception and visualization science comes out—and this art-driven side of things—because it's not only improving the aesthetics of these visualizations, but it's actually ensuring that we're interpreting them correctly."

**Gary Singh** lives and writes in San Jose, California. Contact him at http://www.garysingh.info/.