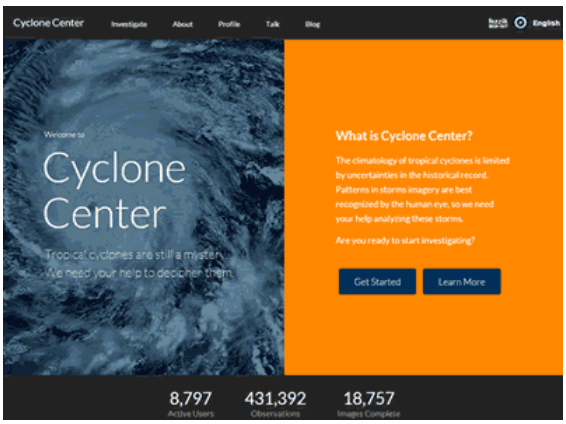
Cyclone Center: Crowdsourcing Hurricane Intensity Estimates

Case Study Overview



Are tropical cyclones (what we in the Americas call hurricanes) becoming stronger? How is their intensity changing in a changing world? Unfortunately, these are questions science can't answer with much certainty right now.

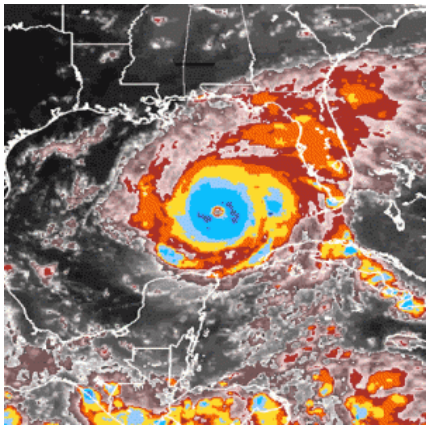
Hurricanes can have catastrophic and long-lasting impacts on coastal regions around the world. Hurricanes are classified by maximum wind speed, a value usually estimated from satellite imagery. Scientists use special techniques to estimate storm intensity from satellite imagery based on patterns recognized by the human eye.

Since the 1970s, scientists have amassed more than 300,000 satellite images of tropical cyclones, with more than 10,000 new images added yearly. If we could analyze this massive quantity of imagery, we might be able to better understand whether and how tropical cyclones are changing. But the remaining workload is far too great for scientists to handle alone.

Through a partnership with Zooniverse, the University of North Carolina at Asheville, and the Cooperative Institute for Climate Studies in North Carolina, the National Centers for Environmental Information (formerly the National Climatic Data Center in Asheville, North Carolina) at the National Oceanic and Atmospheric Administration is co-sponsoring a crowdsourcing website called Cyclone Center. By recruiting thousands of classifiers and comparing results, scientists can analyze images faster than ever before.

Project Description

Volunteers get started by visiting the Cyclone Center website. After a brief tutorial, they answer basic questions about satellite imagery.

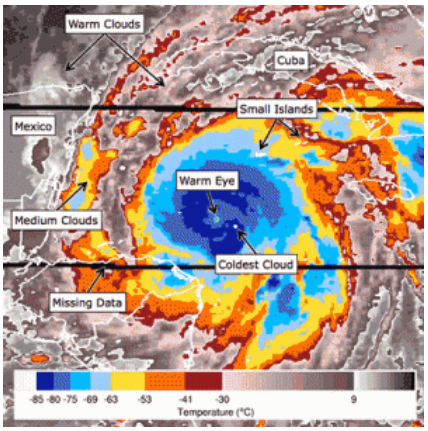


The images volunteers see are from infrared sensors on weather satellites. These sensors measure the temperature at the tops of clouds. Cloud-top temperatures are important because they give an idea of how tall the clouds are. Cold clouds are taller than warm clouds since temperature decreases with height. The colder, taller clouds are responsible for the heavy rain and thunderstorms that drive tropical cyclones.

Even more important are questions about the shapes of clouds in the satellite imagery. Scientists have found that cloud formations are related to hurricane intensity.

By comparing the classifications made by different volunteers, scientists can discard the outliers and choose the correct classifications. The project is designed to help resolve differences in the global tropical cyclone record and improve our understanding of how the nature of these storms may be changing through time.

Challenges

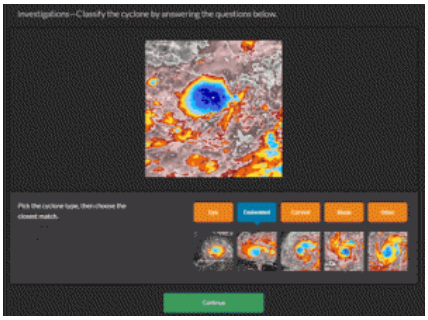


The biggest hurdle was translating techniques that professionals use to analyze satellite imagery into something that anyone can do. In the 1970s, Vern Dvorak developed a satellite analysis technique to discern hurricane intensity from satellite imagery using a multi-step flowchart. Each analysis can take several minutes and is generally done by forecasters or tropical meteorologists.

By transforming this technique into a set of questions for the general public, Cyclone Center met the challenge. Volunteers can complete an image assessment in a minute or less. Some volunteers have completed more than 10,000 classifications — the equivalent of assessing every image of every tropical cyclone in a given year!

Another challenge was creating the satellite imagery. In the Dvorak analysis, experts assessed satellite imagery based on their professional experience. Volunteers don't have time to develop that experience, so Cyclone Center developed a color scale that matched the Dvorak technique. The project also worked with online tools to ensure that people with colorblindness (which affects about 1 in 10 males) could easily discern the color scale.

Another challenge was community acceptance. Some tropical experts who spent a lifetime studying and analyzing the data considered the idea that volunteers could analyze satellite imagery absurd. Cyclone Center's approach was to move slowly, keep the tropical community informed, and assure the experts that it follows the standard scientific process involving peer review. The Center used tropical cyclone email lists to send information and answer questions, and it presented the Center's approach at scientific conferences. Cyclone Center has a peer-reviewed journal article in the most widely read meteorological journal (the Bulletin of the American Meteorological Society).



Benefits and Outcomes

More than 20,000 volunteers have classified over 450,000 images of cyclones, giving scientists a better picture of historical storms and their relative strengths. Crowdsourcing is helping the scientific community reanalyze the global hurricane record. By developing a series of simple questions that citizen scientists can answer on a website, the project is working toward a new dataset that resolves intensity discrepancies in recent tropical cyclones.

Preliminary results suggest that the performance of human classifiers in some cases exceeds the performance of an automated technique applied to the same data.

Tips

The Cyclone Center case study illustrates the following steps in the Federal Citizen Science and Crowdsourcing Toolkit:

- **Scope Out Your Problem — Know Your Tools; Engage Your Stakeholders and Participants**
  Cyclone Center worked with project developers in many teleconferences to help them understand project goals so that they could design a website for the masses. The project developers had a good understanding of potential citizen scientists, and they were able to simplify a complex analysis process for mass consumption.

- **Scope Out Your Problem Know — Where Your Project Fits**
  Project developers came to realize that participation is inversely proportional to complexity: The easier the task, the more citizen scientists will participate. In hindsight, the developers' expectations would have been a bit more realistic. The project is now working to maintain relationships with the more active participants and looking for ways to draw others in.

- **Build Community Relationships — Nurture Your Community**
  Cyclone Center maintains an active blog with information on the project as well as educational posts on tropical meteorology. Numerous posts describe project status (such as participation rates and conference presentations), but the most popular blog post is "How do tropical cyclones form?" This post draws hundreds of visitors each day. The project blog both informs users on project status and draws in new potential citizen scientists. Additionally, the project sends out mass emails near key dates, such as the start of the North Atlantic hurricane season.

Learn More

- Website: *Cyclone Center*
- Peer-Reviewed Journal Article on Cyclone Center

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