2.2 **USING NOAA DATA IN THE CLASSROOM**

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1. INTRODUCTION

In 2008, the National Data Centers archived around 500 terabytes of data from NOAA's *in situ*, satellite, radar, and modeling systems. The vastness of these rapidly growing archives not only poses technical challenges for NOAA, but also many opportunities for persons interested in accessing environmental data. Traditionally, these data archives have used very cumbersome and non-intuitive interfaces, especially for the unfamiliar user. Some of these challenges, such as confusing archive taxonomy, slow browsing, compressed files, and FTP delays, have been identified and NOAA is working on the newest generation of data archive browsers.

Nevertheless, there is still a demand for these products, and teachers are a growing sector of data users. With the recent surge of public interest in climate issues, the need to demonstrate how such data is collected and analyzed will (hopefully) become regular points of discussion in the classroom. To compliment these discussions, environmental data needs to be provided to teachers in usable forms to incorporate into their classroom activities and lesson plans. However, designers of these data access systems should keep in mind the need for simplicity—and what I call the teacher's litmus test for usability: if it cannot be found, downloaded, and used during those precious 15 minutes of spare time that a teacher might have during lunch, it will probably not be used.

With this litmus test in mind, several data products have been selected that are routinely generated by NOAA, are easily browsed and accessed, and can be used for a variety classroom activities, both instructional and participatory in nature.

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2. USING NOAA DATA

To use of these data products in a way that is applicable to just about any science curriculum and standard, I will frame them within the context of teaching components of the scientific method—part of every science curriculum from elementary through high school, and even introductory college courses. The following datasets all use Google Earth as a portal into the more complex data archive systems.

Hypothesis testing

Every three hours, the National Weather Service assembles millions of observation, generates thousands of hypotheses, and makes them available to the public in the form of weather forecasts. These statements, just like any other hypothesis, are sometimes correct, sometimes not. One of their most scrutinized sets of hypotheses are hurricane path predictions—the "skinny black line." We are used to seeing a single projection on the news, typically the GFS or GFDL model, but in fact, there are many other models, each with their own strengths. TropicalAtlantic.com assembles all of the hurricane model predictions into a single KMZ file (http://www.tropicalatlantic.com/plots/ge/Atlantic-Spaghetti.kmz). These variant model projections are excellent examples of hypotheses and alternative hypotheses. Implicit in making a hypothesis is the assumption that the hypothesis will be tested—and students can, in fact, test and analyze the accuracy of the model by pinpointing (on Google Earth) where the model predicts landfall, and where the hurricane actually strikes. Measure the distance between the points, and there is a measure of accuracy. For added interest, use Google Earth's real-time geostationary cloud data, or import archived cloud data using the National Climate Data Center's Weather and Climate Toolkit (http://www.ncdc.noaa.gov/oa/wct).

Random sampling and replication

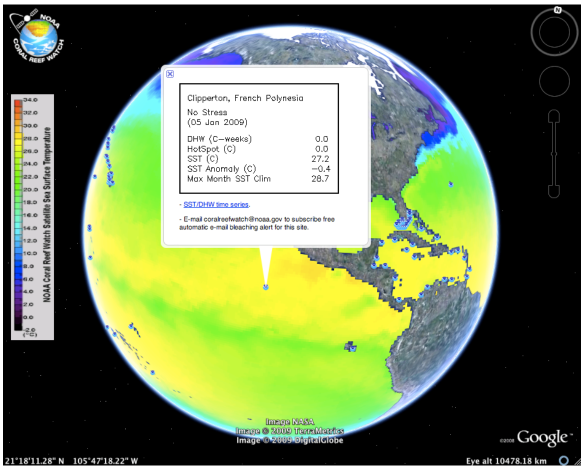
Science fairs are the best way to judge how well a student can apply the scientific method. Typically, one of the weakest points of any methodology (and this also applies all the way through academia) is the design of the sampling method, and its two most important tenants: randomness and replication. The Argo Profiling CTD Floats can provide one of the best (and most interesting) ways to demonstrate proper sampling methodologies. Available on Google Earth from the National Oceanographic Data Center (http://www.nodc.noaa.gov/argo/data/kmz/argo_latest.kmz), students can access repetitive CTD profiles (salinity, temperature, and depth), of a single Argo (pseudo-replication) or of the entire observing system (true replication). Graphing the lat/lon positions vs. time will also allow them to see how currents determine the movement of the floats.

Variability and graphing

One of the best ways to explain variability is, in fact, using weather examples. People understand that the weather changes from day to day, and sometimes there are heat waves, sometimes cold spells. The National Climatic Data Center provides their Global Surface Observation Data (GSOD) via their GIS web mapping service—which can be tricky for the new user. A huge improvement is making the GSOD available in KMZ files (http://gis.ncdc.noaa.gov/aimstools/kml/gsod.kmz). Using Google Earth, the user can select any of the 100's of weather stations, access the observations for a single date or a date range, and retrieve the data in either text file form or graphical output using an interactive Java-based time-series plot. An excellent classroom activity would be to record each day's temperature (at a fixed time), and plot that along with the temperature from the closest weather station, or any other in the world. This activity has natural extensions to teaching basic statistics such as average, correlation, min, and max. By scaling the Java-based graph output to its extremes, the user can view either the weather for a day, or the entire climatology for any location.

Data analysis

Data analysis is where discoveries are made. Unfortunately, it's usually seen as the necessary evil by budding scientists. To overcome this aversion, let's try to use more interactive and interesting examples rather than height and weight of students in the classroom. NOAA's Coral Reef Watch (CRW) provides excellent examples of how to access satellite sea surface temperature (SST) data and analyze it to create derived products related to monitoring the health of coral reefs



NOAA's Coral Reef Watch provides operational SST and other remotely sensed ocean data products in Google Earth. Also shown is the point information (virtual station) from reefs around the world.

(http://coralreefwatch.noaa.gov/satellite/ge/products/CRWGE_CurrentProducts.kmz). A great example is how to calculate a SST anomaly—or deviation from the average. There are 190 virtual stations in the Coral Reef Watch network.... *randomly* assign one per student, and allow them to track how temperature changes from day to day, calculate a mean, and then from that mean calculate an anomaly. Luckily, CRW has setup access to the SST and derived product data on Google Earth, and classroom curriculum using the data (http://coralreefwatch.noaa.gov/satellite/education/index.html). Using these datasets, not only will students learn basic statistics, but also learn to interpret false-color data—and assumed skill that is becoming more and more important.

3. ANALYSIS

The flexibility and familiarity of Google Earth and Google Maps is serving as a much-needed conduit to browse and visualize spatial datasets. Though at first, KML and KMZ files were generated at the program level, more and more these files are being created as an operational product from NOAA offices and data centers. This level of appreciation for the importance of virtual globe-accessed data for outreach and education is an important step, and will greatly improve the ability of educators to incorporate relevant and timely examples of environmental data into their classroom activities.