

Science Report: Atmosphere

Data Quality Report for GLOBE Atmosphere and Climate Data

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Abstract

There are reporting errors among a small number of schools currently providing atmosphere and climate data on a regular basis. This paper will point out these errors discovered so far with clouds, temperature, precipitation, and barometric pressure reports as well as the site definition of the school's atmosphere sites. The authors will present the predominant reasons why these errors may be occurring and offer suggestions to prevent them from happening in the future.

Introduction

An error evaluation software program has been developed to review the GLOBE Atmosphere and Climate Data. Currently, this program only looks at data collected by GLOBE schools that have been entered into the GLOBE data server on a daily and weekly basis. Once the error evaluation plan has been developed and successfully implemented, this process will be used to analyze the quality of the atmosphere and climate data reported by schools from years past.

Finding the common errors with current data reporting will allow us to contact the teachers and students to clear up any misunderstandings they may have with the GLOBE Atmosphere and Climate Protocols. Working with the GLOBE Science, Systems and Training teams, this will prevent the problems from persisting and beginning with future GLOBE schools.

Process

GLOBE provides a variety of useful methods to extract the atmosphere and climate data from its server. Currently, a comma –delimited text file is retrieved daily using a script designed to run in the MS Windows' Scheduled Task. Once a week, this process is redone to retrieve data that may have been entered at a later date than the collection date. The evaluation program takes the values entered by the schools through some stringent range checks to identify school reports that need to be reviewed. These range checks look at the atmosphere site information, temperature ranges, number of cloud reports, rainfall amounts, and sea level barometric pressure values. Once flagged for further review, the school's data are further analyzed to determine if the values they are reporting are appropriate.

Site Definition

The atmosphere site provides a wealth of information to scientists reviewing schools atmosphere and climate data. The majority of the errors discovered within the GLOBE database are incorrect elevations, latitude, and longitude information, which are the most important.

The evaluation software was developed to compare the school's atmosphere site definition with the USGS Global Digital Elevation Model from the ERSO Data Center. The school's latitude, longitude, and elevation are compared to this dataset with a 1 km spatial resolution, which revealed problems for many of the schools' locations that were analyzed.

Schools with their elevation reports off by more than 50 meters were flagged for further review. Upon checking these sites, the following problems were discovered,

- Elevation set as zero
- Elevation values entered as feet
- Data entry errors
- Wrong hemisphere

Several schools have their atmosphere site (ATM-nn) elevations set to zero meter. This indicates that the school did not define their atmosphere site following the GLOBE GPS Protocols.

This comparison also revealed that many schools had reported their elevations in feet and not meters. For example, a school in Minnesota reports their school and atmosphere site are 1065 meters high. The USGS GTOPO30 dataset has a value of 309 meters, nearly 3 times less than the site information for this school. Visiting a popular topography site, www.topozone.com, reveals the town's elevation is 1029 ft.

Data entry errors are common with latitude and longitude information. Students may have inadvertently left out a digit when they typed in the information.

Schools have been found with the wrong hemisphere selected. For example, the west longitude entry selected as east longitude.

Although, these problems persist within many schools, they can be corrected by the teacher or students. Even schools that do not have errors with their sites are encouraged to review their atmosphere site information at least once a year, since surroundings change with vegetation growing, new buildings constructed, and technology advances.

Clouds

The cloud protocol is one of the easiest protocols a school can do, but can be one of the most difficult as identifying the different clouds types can be challenging. Especially, separating the high and middle clouds is very challenging as they look nearly the same to an untrained eye.

Some schools have reported all ten types of clouds or all five high and middle clouds. These reports do not help the scientists.

Temperature

Checks are made with the difference between the maximum and minimum temperatures reported by the schools. Schools are flagged for further evaluation when the maximum and minimum temperatures are less than 5 degrees or greater than 25 degrees. These ranges are designed to help determine if the schools are reporting temperatures in Fahrenheit or not reading the multi-day digital thermometers correctly.

Although the multi-day thermometers are great, a few teachers and students are not reading the panel correctly. The schools are inputting the maximum and minimum values for the last 24-hour period which may actually have been only 15 to 20 minutes old. You must push the maximum and minimum button until the D1 field appears. These are the values you report in the GLOBE data entry pages.

Precipitation

Range checks are set to look for schools reporting more than 254 mm of rainfall, the maximum amount of rain the GLOBE rain gauge can hold (inner and outer tubes). Also, schools reporting more than 50.8 mm are also indicated for further review. When reports exceed 75 mm, these are major flooding events. When they exceed 100 mm, these are storm totals of a lifetime.

Using the data search features among GLOBE's web pages reveals 171 entries from 48 schools during the first 5 months of 2004 exceed 254 mm, with 10 reports from 8 GLOBE sites that exceed 1000 mm.

A common error appears to be that teachers and students are misinterpreting the graduations on the inner tube of the GLOBE approved rain gauge as centimeter (cm). As GLOBE requires rainfall reports as millimeters (mm), they are converting the cm to mm, thus inflating the rain reports by 10 times.

Once discovered, schools can be informed that they need to adjust the rainfall amount by placing the decimal in the correct spot.

Remember - "No conversion is necessary!"

Barometric Pressure

Barometric Pressure is used by other protocols within the GLOBE program. Range checks are set to identify schools with sea level barometric pressure less than 950 mb and greater than 1045 mb.

Errors with barometric pressure reports can be seen in two areas. The site location needs to be accurate as GLOBE does sea level calculations based on the latitude and longitude location and their elevation provided by the GLOBE schools. If the site definition is incorrect, the sea level pressure value for the station is incorrect.

Another common error with barometric pressure reports is selecting station level pressure on the GLOBE data entry pages, instead of the sea level pressure. Schools are calibrating their barometers correctly from nearby professional weather stations, but then selecting the report level as station level, which leads to incorrect sea level pressure reporting for their location.

Future Work

The quality evaluation of the GLOBE data has been done with range checks determined from known extremes of temperatures, rainfall, and sea level barometric pressure. Further studies will be conducted with reports from professionally run weather stations. This method will be used to locate reports that fall within data extremes, but may not be appropriate for the day of the report.

Conclusion

This paper is not designed to discourage the GLOBE schools from reporting data, but instead, to encourage them to continue. Reporting errors in atmosphere and climate data have been seen in other volunteer professional programs. The GLOBE school reports can and have provided useful information that scientists can trust and use in their environmental studies. The data evaluated to date are from schools that report on a regular basis, which should be congratulated for their dedication.

Although this report is focused on the errors in the data that have been seen on the GLOBE data server, the biggest concern with the atmosphere and climate data is the reports not seen. Over 14,000 schools are listed by GLOBE with trained teachers, but less than 1% of the GLOBE schools actually report their atmosphere and climate data in a given week. Scientists would greatly appreciate further reports from GLOBE schools to assist in their environmental studies, either by accessing them for further review or applying them to their studies.