

Teacher preparation: Data download and visualization

1. Request that the NOAA Weather and Climate Toolkit software package be downloaded on school computers so students can use this application to determine the cloud-top height of storms that produced tornadoes. The Weather and Climate Toolkit is made freely available to the public from NOAA and can be downloaded onto Mac or Windows operating systems from www.ncdc.noaa.gov/oa/wct. A video introduction to the capabilities of the program can be accessed at: www.climate.gov/news-features/decision-makers-toolbox/weather-and-climate-toolkit.
2. To select the tornado instances to be observed, go to the Storm Prediction Center's (SPC) website (www.spc.noaa.gov/wcm). Scroll down to the Severe Weather Database Files table and download tornado data from 2011 with the file name 2011_torn.csv, which can be opened in Microsoft Excel or other spreadsheet software. The direct link to the data file is www.spc.noaa.gov/wcm/data/2011_torn.csv. By inputting this URL, the data are automatically downloaded to the teacher's computer. The database includes multiple types of data that characterize tornadoes. The data needed for this lesson are the tornado number given to the tornado by the National Weather Service (NWS), date, time, state, intensity based on the Enhanced Fujita scale, and starting latitude and longitude. Other information that is also provided by the database includes the width of the tornado, fatalities, length in miles, property loss, and ending latitude and longitude. As the columns of the spreadsheet are not labeled, there is a PDF file that has the spreadsheet labels. Above the table on the

SPC's WCM page, within the text, there is an image of a PDF file. Next to the image, it says "Document," which has a hyperlink. Click the hyperlink to get the spreadsheet labels for the raw data; a direct link to the file containing data labels is available at

www.spc.noaa.gov/wcm/data/SPC_severe_database_description.pdf. The PDF explains what the data in each column of the spreadsheet is. On the PDF, the number next to the spreadsheet label represents the column on the spreadsheet that the data correspond with. For example, one of the labels says "11-(f)." This means that column 11 on the Excel spreadsheet has the data for the intensity of the tornadoes.

3. Upon opening the data file, the data can be sorted or filtered to examine tornadoes with varying intensities, damage costs, fatalities, and locations. In order to access a sufficient pool of interesting storms to be examined by students, it is recommended to order data on tornadoes of EF3 intensity. To eliminate all the tornadoes aside from those of EF3 intensity, go to the top toolbar and select "Data." Then choose "Filter" and select "Autofilter." Each column will then have drop-down arrows on the right side of each box in the top row. Click on the arrows for the column corresponding to tornado intensity and select EF3 from the list. Once the EF3 tornadoes have been isolated, identify the tornadoes to be used in the lesson and write down the tornado number, date, starting longitude and latitude, and time.
4. One, two, or more sets of tornado-storm event data can be ordered for groups of students, pairs, or individual students. Teachers should choose the best

arrangement for their classroom and time constraints, but for most settings we recommend two data orders per pair to balance student peer-to-peer learning, sufficient statistics, and the amount of prelesson data ordering. Once a sufficient number of appropriate tornadoes have been identified (based on student group numbers), use the tornado touchdown location (latitude and longitude given in the data file) to identify the nearest radar station from which to retrieve data from the National Climatic Data Center (NCDC) to be inputted into the Weather and Climate Toolkit. This can be accomplished by entering the starting latitude and longitude values in the Weather and Climate toolkit via the “Add a Marker” tool. This tool is the red marker icon on the top of the screen. After clicking the icon, to plot a point, the latitude and longitude appears on the bottom of the screen and changes as the cursor is moved. When the latitude and longitude desired has been found by moving the cursor over the country, click the screen and select “Add.” Then overlay the NEXRAD radar station sites and labels via the “Layer” menu. Select the NEXRAD radar station site closest to the plotted point.

5. Once the date, location, and proximate radar station are identified for a tornado event, add six hours to the touchdown time listed on the spreadsheet to convert to GMT (Greenwich Mean Time) used by the NCDC database. This is essential because although all the data in the spreadsheet have been put into CST (Central Standard Time), the data on the NCDC website have been input in terms of GMT, which is six hours ahead of CST.
6. To then order radar data on this event, the teacher should go to www.ncdc.noaa.gov/nexradinv. On the map of the United States, click on the

desired radar station. On the next screen that pops up, select the date and the “Enhanced Echo Tops” product from the list of radar data products. After this, put your email address in and select the date and time frame. The time frame selected should begin at least one hour before and end one hour after the touchdown time, which is the time that has been converted to GMT. Upon pressing submit, a HAS Order Number will appear on the screen and is emailed to the teacher. Record the HAS Order Number and note for which tornado the HAS Order Number is for, as students input this order number into the NOAA Weather and Climate Toolkit.

Teacher preparation: Online learning resources for teachers and students

Source	Description	URL
Radar		
National Weather Service (NWS) online “Jetstream School”	Comprehensive overview of Doppler weather radar: physical principles, operations, and national infrastructure	http://www.srh.noaa.gov/jetstream/doppler/doppler_intro.htm
NWS	Real-time Doppler radar images (nationwide)	http://www.nws.noaa.gov/radar_tab.php
Weather Underground	A guide to understanding weather radar products, with an extensive FAQ guide	http://www.wunderground.com/radar/help.asp
National Severe Storms Laboratory (NSSL)	A description of advances in “dual polarization” radar technology that have been accomplished in the last few years	http://www.nssl.noaa.gov/tools/radar/dualpol
Tornadoes		
Storm Prediction Center (NWS-SPC)	Comprehensive FAQ on tornadoes, with great links to tornado basics, history, forecasting, climatology, research, and safety	http://www.spc.noaa.gov/faq/tornado
NSSL	Answers to many FAQs about tornadoes, with links to in-depth answers and examples	http://www.nssl.noaa.gov/education/svrwx101/tornadoes
Public Broadcasting Service: NOVA program	<i>Deadliest Tornadoes</i> hour-long episode investigating and discussing the historic 2011 tornado season	http://video.pbs.org/video/2220853400
Federal Emergency Management Agency (FEMA)	Information and activities to help individuals plan for tornado safety	http://www.ready.gov/tornadoes
Atmospheric-science education		
American Meteorology Society	Collected links for teachers and students to learn about topics in weather and climate or careers in atmospheric science	http://www.ametsoc.org/amsedu/educationresources.html
NWS	Collected weather resources for educators	http://www.nws.noaa.gov/om/edures.shtml
NOAA/NWS	“Jetstream Online School for Weather”—a collection of short lessons on a	http://www.srh.noaa.gov/jetstream

	comprehensive set of weather and climate topics	
National Science Digital Library	A huge collection of science education resources, categorized by subject, level, and standards; select subject “geoscience” or keyword search	http://nsdl.org