Making a Contour Map

Purpose

To learn how contour maps can be made by hand

Overview

Students plot data from GLOBE schools on a map with latitude and longitude lines and draw contours based on the values plotted.

Student Outcomes

Students gain an understanding of contour mapping.

Science Concepts

Geography

Geographic visualizations help organize information about places, environments, and people.

General

Visual models help us analyze and interpret data.

Scientific Inquiry Abilities

Identify answerable questions.
Use appropriate tools and techniques.
Use appropriate mathematics to analyze data.
Develop and construct models using evidence.
Communicate procedures and explanations.

Time

One class period

Level

Middle, Secondary

Materials and Tools

Pens or pencils (several colors optional)
Copy of the blank map

Preparation

Make a copy of the *Making a Contour Map Work Sheet* and the Data Table for each student or team

Prerequisites

None

Background

Contour maps are a useful way to visualize the spatial relationships among data and the spatial distribution of data values (e.g., where is it warmer or cooler, where did it rain and how much).

What To Do and How To Do It

1. Provide every student or team with a copy of the blank map and the table of data provided as part of this activity.
2. Discuss the map with the students to ensure that they recognize and understand the latitude and longitude lines shown and recognize that negative longitude is the same as West longitude and positive latitude is the same as North latitude.
3. Discuss with students the concept of a contour line. Emphasize that contour lines connect places on a map where a variable (e.g., mean air temperature) has the same value and that on one side of the line values would be above this value (e.g., 20˚ C) while on the other side of the line values would be below this value. Weather maps are good examples along with topographic maps, and both may be familiar to students.
4. Demonstrate how to plot the first value given for mean temperature on April 5, 2000, for Portola High School (the first row of the *Data Table*).
   a. Locate longitude -120.5˚ (=120.5 W) that is mid way between the 120W longitude line and the first line to its left.
   b. Trace along this line to latitude 39.8˚ (=39.8N) that is just below the 40N

latitude line.

c. Write the value 8.0 at this spot on the map.

5. Have students plot the values for Mean Temperature for the first three schools in the *Data Table*.
6. Ask students to locate and mark the places on their maps where they estimate that the mean temperature would be 10˚ C and 20˚ C.
7. Discuss with students the point that with just three values plotted it is hard to know where the contour line should be drawn except between these three points.
8. Have students plot the values for the next three schools in the *Data Table* and extend their initial 10˚ C and 20˚ C marks to become contour lines.
9. Have students plot values for the next three schools and extend their contour lines as far as they think is reasonable given these nine data points.
10. Have students look at the values for the next three schools and ask them where they will go and if there is a problem plotting them. (There is a problem because these three schools are all in the same community and their values would probably be on top of one another on the map.) Let students decide how best to cope with this difficulty.
11. Have students plot the remaining values and add contour lines for 15˚ C and 25˚ C if they can.
12. Ask students if they could add a contour at 5˚ C. The discussion should bring out the point that since there are no schools with values below 5˚ C, there is no reason to suppose that any place on the map would have had a mean temperature this low on this day.

Extensions of Basic Learning Activity

Have students create a contour map using the total precipitation for April 2000 data. In this case with one school having a value more than five times as large as the school with the next most precipitation, even increments in the contour lines may not be appropriate. In mathematical terms, a linear interpolation between the values may not be a good approximation of the distribution of values.

Have students create a contour map using the cloud cover values for April 5, 2000. The contour lines should be those marking the boundary between cloud cover classifications (e.g., between scattered and broken or 50% cloud cover). In this case the data reports are not numbers but represent ranges. Students should discuss how this affects their placement of contour lines. Two schools (Birch Lane and Millview) reported data using the GLOBE 2000 categories; you may choose to have students omit these two schools for simplicity or discuss how to account for the different quantitative meaning of their data reports.

Have students create an elevation map by plotting the elevation data provided for the schools. Now the contours should show mountains and valleys. There are too few points provided to do this accurately. Discuss with students what would be their strategies for making a better elevation map using actual data. How many points do they think would be required? How closely should data points be located? Should they be collected on a regular grid? Could other GLOBE data help?

Have students find on the GLOBE Website the explanation of how GLOBE contour map visualizations are done. They can read this explanation and then apply the formulas themselves on the Mean Air Temperature data in the *Data Table* and compare these results with the contour maps they did interpolating between points by eye.

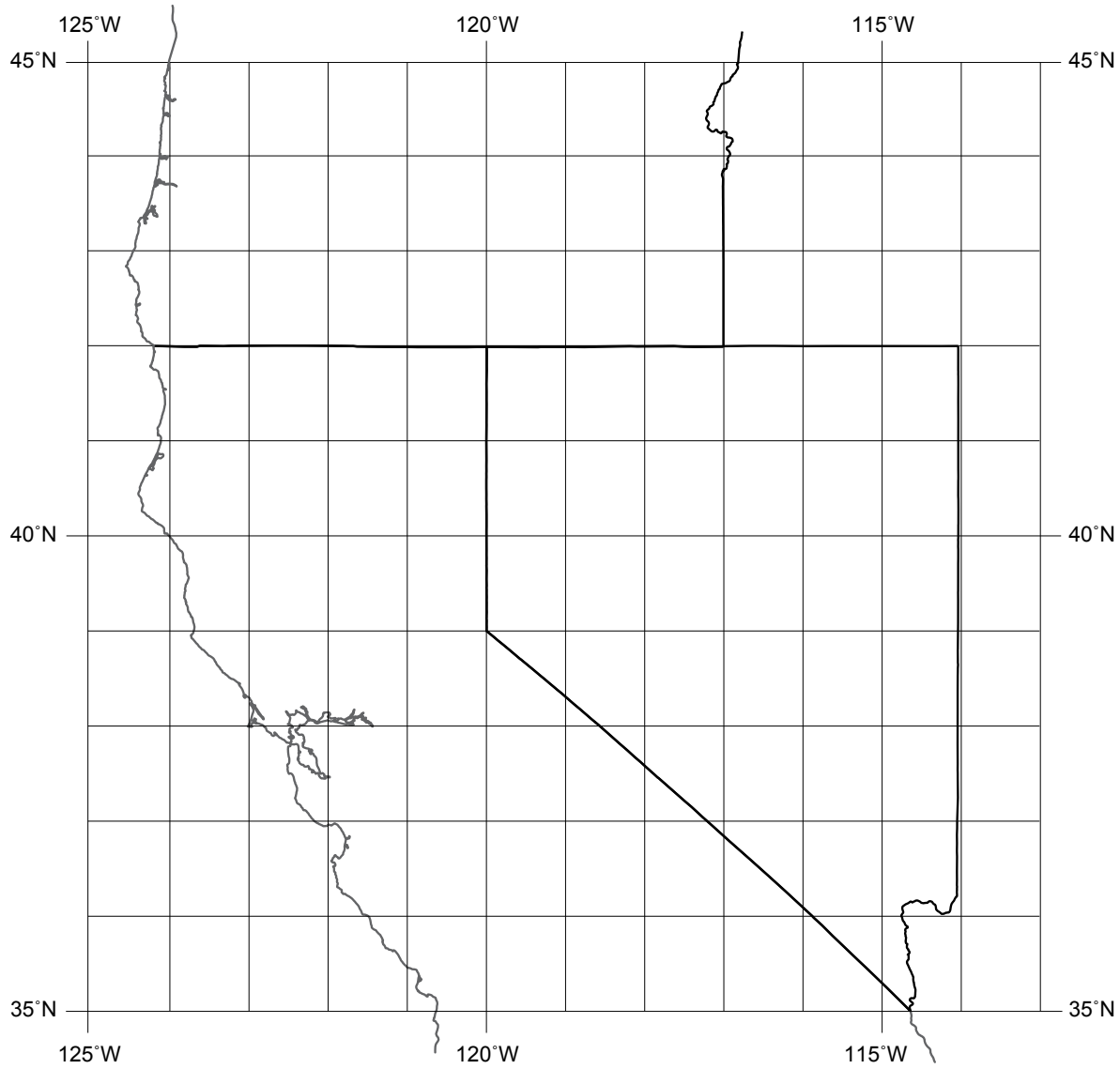
Students may explore the relationship between elevation and temperature described in the *Earth As A System Investigation*. Mean temperature values can be adjusted for differences in elevation and a new contour map drawn of what the values might have been if every school was at sea level. This concept is explained in the *Barometric Pressure Protocol* for pressure but it may be extended to temperature as an exercise. Students should discuss the flaws in this approach as a form of scientific analysis and on which temperature data it might prove useful. The flaw is that the relationships

between elevation and air temperature or latitude and air temperature are approximately correct for long-term averages in temperature and not for the values on a single day.

Student Assessment

Either of the first two items suggested as extensions to the basic learning activity may be assigned to assess overall student understanding and proficiency in making contour maps. Alternatively, a data table with different parameters can be assembled for this area from the GLOBE Web site and students assigned to make a contour map using these data.

Making a Contour Map Work Sheet



Data Table

Mean T (C) 5-Apr-00	Cloud Cover* 5-Apr-00	Total Precipitation April 2000 (mm)	Latitude (degrees)	Longitude (degrees)	Elevation (meters)	School Name and Location
8.0		7.2	39.8	-120.5	1500	Portola High School, Portola, CA, US
16.0	SCT	22.1	38.8	-120.9	454	Gold Trail School, Placerville, CA, US
21.0	BKN	0.0	38.0	-121.3	12	Lincoln Elementary School, Stockton, CA, US
15.3	OVQ	34.5	38.6	-121.7	16	Birch Lane Elementary School, Davis, CA, US
22.5	BKN		37.7	-120.9	18	Stroud Elementary School, Modesto, CA, US
15.5	SCT	70.8	38.0	-122.6	82	San Domenico School, San Anselmo, CA, US
12.0	CLR	32.6	37.8	-122.2	70	Piedmont Independent Learning High School, Piedmont, CA, US
14.0	SQT	44.9	37.0	-122.0	2408	Happy Valley Elementary School, Santa Cruz, CA, US
22.0	BKN	27.8	37.0	-120.1	91	Madera High School, Madera, CA, US
22.0	BQN	29.1	37.0	-120.0	106	Millview Elementary School, Madera, CA, US
20.5	BKN	27.2	37.0	-120.1	90	Berenda Elementary School, Madera, CA, US
26.0	BKN		37.1	-119.5	2408	Auberry Elementary, Auberry, CA, US
16.5	BKN		37.4	-118.4	1364	Round Valley Joint Elementary School District, Bishop, CA, US
12.5		452.0	41.8	-124.2	202	Crescent Elk School, Crescent City, CA, US
21.0	CLR		36.5	-119.6	77	Washington Elementary School, Kingsburg, CA, US
20.0	BKN	51.6	36.8	-119.9	70	Steinbeck Elementary School, Fresno, CA, US
		38.5	36.7	-119.7	81	John Burroughs Elementary School, Fresno, CA, US
19.8	SQT	8.1	36.3	-119.3	86	La Joya Middle School, Visalia, CA, US
		1.0	36.8	-121.7	60	North Monterey County High School, Castroville, CA,
12.0	CLR	24.7	43.5	-115.3	1307	Pine Elementary/Junior High School, Mountain Home, ID, US
19.0	CLR	11.0	36.6	-119.4	99	Reedley High School, Reedley, CA, US
	OBS	19.6	36.6	-121.9	150	Spanish Bay Academy, Pebble Beach, CA, US
	SCT	0.0	36.2	-115.2	637	Mabel Hoggard Magnet School, Las Vegas, NV, US
15.0	CLR		43.5	-116.6	862	South Middle School, Nampa, ID, US
		48.9	44.1	-123.2	192	Fairfield Elementary School, Eugene, OR, US

*Cover: Cloud Cover.

Cloud Cover Codes: (GLOBE 1 and 2): CLR=Clear (0-9%), SCT=Scattered (10-50%), BKN=Broken (51-90%), OVC=Overcast (91-100%). (GLOBE 2000): NON=No clouds (0% coverage), QLR=Clear (1-9%), ISO=Isolated (10-24%), SQT=Scattered (25-49%), BQN=Broken (50-89%), OVQ=Overcast (90-100%), OBS=Obscured Sky.