

North American Tour

Coordinates and measurement



Lesson

Your band has been working hard for months and has finally come up with a hot, new sound—you're ready to take it on the road! The band wants to play in cities across North America, and you've been appointed to plan the tour. You have a limited travel budget so you'll want to set up the most cost-effective tour possible.

1. What is the name of your band?

Planning your tour

 Launch ImageJ, and open the **NA_Satellite.tif** image.

This image is not a map, but a satellite image of the most populated part of North America. North America never actually looks like this because much of the land is always covered by clouds, but the colors are approximately what you would see on a cloud-free day. The image was assembled from hundreds of smaller images produced by the MODIS instrument on the Terra satellite. Each pixel in the image represents a square on Earth's surface that is approximately 3.75 miles (6 km) on a side.

Adding state outlines

Political boundaries aren't visible to a satellite, but you need to show where they are to give the band a good picture of the proposed tour. Next, you will add state (US and Mexico) and province (Canada) outlines to the image.

 Open **NA_States.tif**.

 Use the following procedure to add boundaries to the image.

- Activate the **NA_States.tif** image.
- Choose **Edit > Selection > Select All**.
- Choose **Edit > Copy**.
- Activate the **NA_Satellite.tif** image.
- Choose **Edit > Paste**.
- Choose **Edit > Paste Control...**
- In the **Paste Control** window, set the **Transfer Mode** to **Transparent**, then close the **Paste Control** window.
- To make the paste permanent, choose **Edit > Selection > Select None**.

 Close the **NA_States.tif** image.

 If you are allowed to save files, you may wish to save your map with the state outlines.

 File > Open... > NA_Satellite.tif

Terra/MODIS

To learn more about the Terra satellite and the MODIS instrument, visit <http://modis.gsfc.nasa.gov/about/>.

 File > Open... > NA_States.tif

 File > Save ...

Marking tour cities

You have received offers to play in thirty major cities around North America. Your time and budget are limited, so you will only play concerts in seven cities, including your home town. Your tour must include at least one city in Canada and one in Mexico, plus one city each in the eastern, central, and western United States.

Using the list below, select six venues you will visit on your tour. On your Data Sheet, list your six selected cities. (Do not write on the list below.)

Table 1 - Major Cities of North America

√	Name	X	Y	Code	√	Name	X	Y	Code
	Atlanta, GA	570	298	ATL		Montreal, Canada	689	534	YMX
	Boston, MA	734	484	BOS		New Orleans, LA	484	222	MSY
	Calgary, Canada	196	641	YYC		New York City, NY	700	446	JFK
	Chicago, IL	514	444	ORD		Ottawa, Canada	665	526	YOW
	Cleveland, OH	595	442	CLE		Phoenix, AZ	150	320	PHX
	Dallas, TX	382	276	DFW		Quebec, Canada	714	563	YQB
	Denver, CO	271	416	DEN		Salt Lake City, UT	181	450	SLC
	Detroit, MI	575	459	DTW		San Diego, CA	72	325	SAN
	Houston, TX	400	220	IAH		San Francisco, CA	28	426	SFO
	Los Angeles, CA	62	352	LAX		Seattle, WA	82	609	SEA
	Mazatlan, Mexico	210	121	MZT		St. Louis, MO	478	383	STL
	Mexico City, Mexico	326	36	MEX		Toronto, Canada	621	489	YYZ
	Miami, FL	650	158	MIA		Vancouver, Canada	84	641	YVR
	Minneapolis, MN	437	500	MSP		Washington, DC	667	405	DCA
	Monterrey, Mexico	315	149	NTR		Winnipeg, Canada	393	593	YWG

At the end of your concert tour, you will give a final concert in your home town, to thank them for supporting the band.

 Using a map or atlas, estimate the location of your home town on the image.

2. What are the approximate X,Y coordinates of your home town on the image?

Use the following techniques to mark and label the locations of your home town and the six cities you chose for your tour.

 Double-click the Color Picker tool , and choose a high-visibility color for your labels. (Hot pink works well.) Close the **Color Picker** window.

 Double-click the Paintbrush tool , set the paintbrush diameter to between 5 and 10 pixels, and click **OK**.

 Reading the X,Y coordinates in the status bar, move your cursor to the location of each city, and click to draw a dot to mark the city's location. If you make a mistake, immediately choose **Edit > Undo**.

 If appropriate (ask your instructor), you may wish to save your work again.

 Double-click the Text tool  to set the text font, size, and style.

What is the Code in the major cities table?

The **Code** column lists the airport code for the major (international) airport serving each city. This information may be useful later in your planning.

Tip: Inverting the Y coordinates

To ensure that your Y coordinates increase from the bottom of the image, select **Analyze > Set Measurements**, and click the **Invert Y Coordinates** box.

How much is diesel fuel?

For current diesel prices, visit <http://www.fuelgaugereport.com>.

What if I don't Undo immediately?

If you make a mistake and don't **Edit > Undo** immediately, or if **Undo** is not available for some reason, you will have to start the entire process over. Choose **File > Revert**.

-  Click , then click near one of the cities you marked to type that city's name. Drag the text selection to the desired location, then press **Ctrl-D** to permanently draw it on the image.
-  Repeat this process to label all of the cities you marked on the map, including your home town.
-  You may wish to save your labeled image.

Making your flight plan

Now that you have marked all the tour stops on your map, you need to create your flight plan. A local business executive has offered to let your band use her Learjet 60, an 8-passenger private jet, at cost. She has asked that you pay only the fuel and operating costs of the jet. A breakdown of these costs is provided at right.

Setting scale

To make meaningful measurements on your map, you must first set the scale for the image. This means telling the computer the actual distance represented by some distance in the image.

-  Use  to zoom in on the scale bars in the lower left corner of the image.
-  Decide which measurement units you wish to use, and use the Straight Line Selection tool  to select a line from one end of the appropriate scale bar to the other. Hold down the **shift** key as you drag the selection to keep the line horizontal.
-  Choose **Analyze > Set Scale....**
-  Enter the **Unit of Length** for the scale bar you chose (mi or km).
-  Enter **500** for the **Known Distance**.
-  The **Scale** reported at the bottom shows how the computer will convert pixels to the units you chose. Click **OK**.

Once the scale is set, you can measure any distance or area on the image and the results will be reported in the units you chose.

Measuring distances

Use the three tables on your **Data Sheet** to help you plan an itinerary (order of cities) that will take you to the six cities you selected in the shortest total travel distance. Start and end each itinerary in your home town.

Insert the city names into the tables to create three different itineraries to choose from. Choose  to select and measure each segment (leg). The length of each segment is displayed in the status bar of the ImageJ window as you drag the line selection. Record the distances in the tables on your data sheet.

3. Fill in the tables to show the distances traveled for three possible tour itineraries. For each itinerary, add the individual distances to find the total distance you would have to travel. (Note: since the range of your jet is 2,680 mi (4,300 km), you must eliminate any segment longer than that range.)

Learjet 60 specs

- Operating cost (excluding fuel) = \$1,100/hr [Current 4/2005]
- Cost of jet fuel = \$3.25/gallon, (\$0.86 per liter) [Current 4/2005]
- Burn rate = 190 gallons/hour (720 liters/hour)
- Average cruising speed = 460 mi/hr (644 km/hr)
- Maximum range = 2,680 mi (4300 km).
- For updates on aviation fuel prices, visit <http://www.airnav.com/fuel/local.html>.

4. What is the total distance of your shortest route?

On your own

If the cost of traveling by jet was too high, you might decide to tour by bus instead.

- Open another copy of **NA_Satellite.tif**.
- Using the same procedure as in the lesson, open the **NA_States.tif** image and copy and paste the state boundaries onto the satellite image. Open the **NA_Highways.tif** image, and copy and paste the highways onto the satellite image.
- Mark, label, and measure out a bus tour just as you did for your flight plan. Use the Segmented Line Selection tool  to measure distances along major highways. (You may need to refer to a road atlas to help you identify the names of major highways.)

Create a brochure advertising your band's tour. Cut and paste images, or use the drawing tools to add flair to your flyer!

More measuring

The ability to make measurements from images on a computer screen, rather than from the real thing, is changing research, manufacturing, and medicine.

Things that are too big, too small, too fast, or too slow to measure in real life can be studied by measuring images. Images created by X-ray machines, magnetic resonance sensors, radiotelescopes, and other devices that measure wavelengths the human eye cannot see, allow us to measure things we can't detect directly.

- Open any of the images in the **More Measuring** folder to practice setting scale and measuring images.





Data Sheet

North American Tour

1. What is the name of your band?
2. What are the approximate X,Y coordinates of your home town on the image?
X = _____ Y = _____
3. Fill in the tables to show the distances traveled for three different tour itineraries. For each itinerary, add the individual distances to find the total distance you would have to travel.

a. Tour Itinerary 1

Depart	Arrive	Distance
Home town	City 1 -	
City 1 -	City 2 -	
City 2 -	City 3 -	
City 3 -	City 4 -	
City 4 -	City 5 -	
City 5 -	City 6 -	
City 6 -	Home town	
Total distance traveled		

b. Tour Itinerary 2

Depart	Arrive	Distance
Home town	City 1 -	
City 1 -	City 2 -	
City 2 -	City 3 -	
City 3 -	City 4 -	
City 4 -	City 5 -	
City 5 -	City 6 -	
City 6 -	Home town	
Total distance traveled		

c. Tour Itinerary 3

Depart	Arrive	Distance
Home town	City 1 -	
City 1 -	City 2 -	
City 2 -	City 3 -	
City 3 -	City 4 -	
City 4 -	City 5 -	
City 5 -	City 6 -	
City 6 -	Home town	
Total distance traveled		

4. What is the total distance of your shortest route?

5. Estimate the total number of hours you will be in the air. (Divide the total distance by the average ground speed of the jet: 460 mi/hr or 700 km/hr, depending on the units you used for your measurements.)

6. Estimate the amount of fuel you will need. (Multiply the total number of flight hours by the fuel burn rate: 190 gallons/hr or 720 liters/hr.)

7. Estimate your total fuel cost. (Multiply the amount of fuel you will use by the average cost of jet fuel: \$3.25/gallon or \$0.86/liter.)

8. Estimate your maintenance and operation cost. (Multiply the total number of flight hours by the hourly cost: \$1,100/hr.)

9. Calculate the total cost of the tour by adding the estimated fuel cost and the estimated maintenance and operation cost.

10. If you are playing a total of seven concerts, how much income will you have to average at each venue to cover the cost of the jet? (Divide the total cost of the jet by the number of concerts.)

11. On another sheet of paper, write a paragraph describing your tour.

