Name____________________

Physical Geography

Lab Activity #05

Due date___________

Map Projections

COR Objective 2, SLO 2

5.1. Introduction

The Earth's roundness really screws up our maps. It may not seem like a big deal, but imagine you're peeling an orange. Making a flat map out of a globe is a similar task. We can get the peel off of an orange in one continuous piece, but it's going to be torn and maybe even stretched.

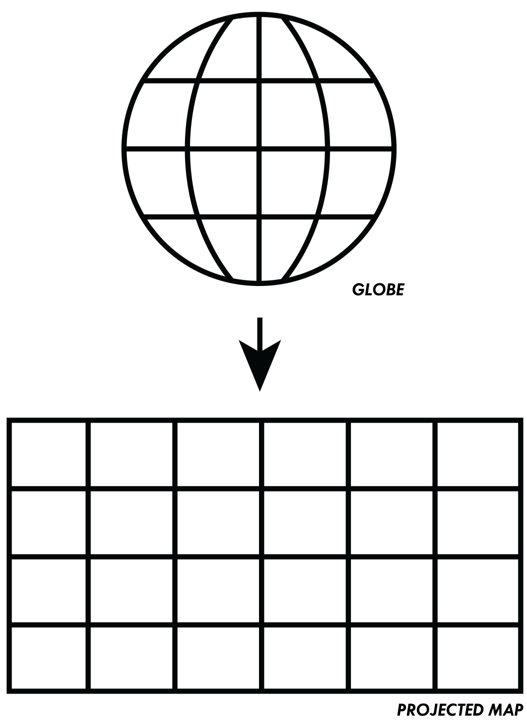


Figure 5.1.Simplified concept of a map projection.

A map projection is an attempt to minimize the distortion that occurs from flatting the globe. We have dozens of common map projections, mainly because there isn't one perfect way to flatten it. Every map projection has a certain amount of distortion in it. It is up to the cartographer and map user to decide where the distortion will be the least intrusive.

5.2. Retained Spatial Properties

A map projection falls into one of three categories based on the spatial properties it retains.

1. Conformal Maps
    a. These maps maintain *conformality*, which is a fancy way of saying countries are the proper shape. The proper angles of coastlines are retained, giving them their proper shape on the map. A clue to a map being conformal is that the latitude and longitude, or graticule, lines cross at 90° angles, which is how they cross in reality.
    b. Proper angles are useful for navigation. Conformal maps allow sailors to find a compass direction on the map and then point their ships in that same direction to get to their destination. Of course, without being able to find their longitude (as discussed in Lab 03) they did not know how close they actually were to arriving at their destination.
    c. A problem with conformal maps is that they maintain shape at the expense of size. The countries and continents look good, but their sizes are distorted when compared to one another.
2. Equal-Area Maps
    a. These maps maintain *equivalence*, meaning the proper sizes of landforms are kept when a map uses this projection. Figure 5.2 shows three separate projections of Peru. The shapes are all different and some look strange, but the size of the country is kept the same. This is useful if you want to measure amount of land use or see disaster effects in terms of area affected.

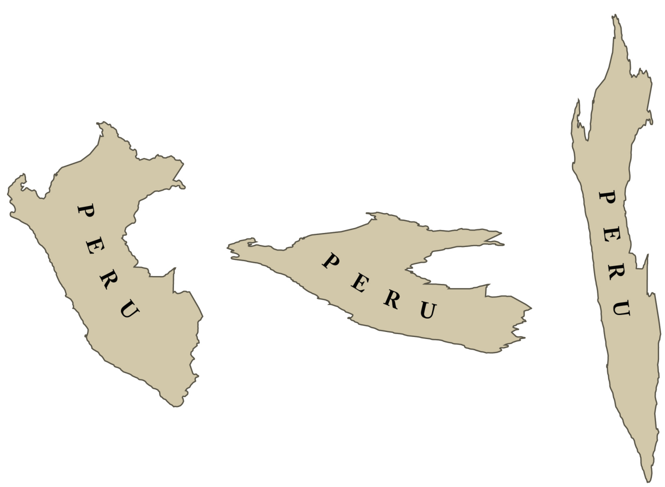


Figure 5.2. Equal-Area Peru

b. When looking at a world map, you can use the countries of Greenland and Mexico to figure out if a map retains equivalence. When looking on the globe the two countries are roughly the same size.

Figure 5.3. Greenland compared to Mexico

3. Compromise Maps
   a. A comprise map attempts to find middle ground between conformality and equivalence. Sometimes you simply need a map to show a pretty good representation of the Earth and you don't plan on using it for navigation or areal measurements.
   b. You can typically tell a map falls into the compromise category if it does not perfectly fit into the other two.

In the next section of this lab you will spend time looking at the globe and maps to see what properties they retain and determine what category they fall under.

5.3. The globe

Using a globe, answer the following questions.

1. Are the cardinal directions (i.e. N, S, E, and W) accurate everywhere on the globe? If not, where are they distorted?

2. If you are in Beirut, Lebanon, in which direction is Murmansk, Russia?

3. Are the distances everywhere on the globe equally accurate? If not, where are they distorted?

4. Are the continental shapes accurate? Where can you find any distortions?

5. Is the area covered by two square inches the same everywhere on the globe? Compare the equatorial regions to the polar regions.

6. Describe the angles at which longitude and latitude lines cross on the globe. Are these angles consistent?

7. Using the globe and a piece of string describe the shortest air route from Los Angeles, California to Moscow, Russia. Use degrees of latitude and longitude from at least five equally spaced locations on this line for the description.

8. Which of the following properties is not accurate using the projection: Direction, distance, shape, or area? Which projection class does this map belong to?

9. What types of information is the globe best used for? What are its disadvantages?

5.4. The Mercator Projection

Using the attached map, answer the following questions.

10. Are the cardinal directions (i.e. N, S, E, and W) accurate everywhere on the map? If not, where are they distorted?

11. If you are in Beirut, Lebanon, in which direction is Murmansk, Russia?

12. Are the distances everywhere on the map equally accurate? If not, where are they distorted?

13. Are the continental shapes accurate? Where can you find any distortions?

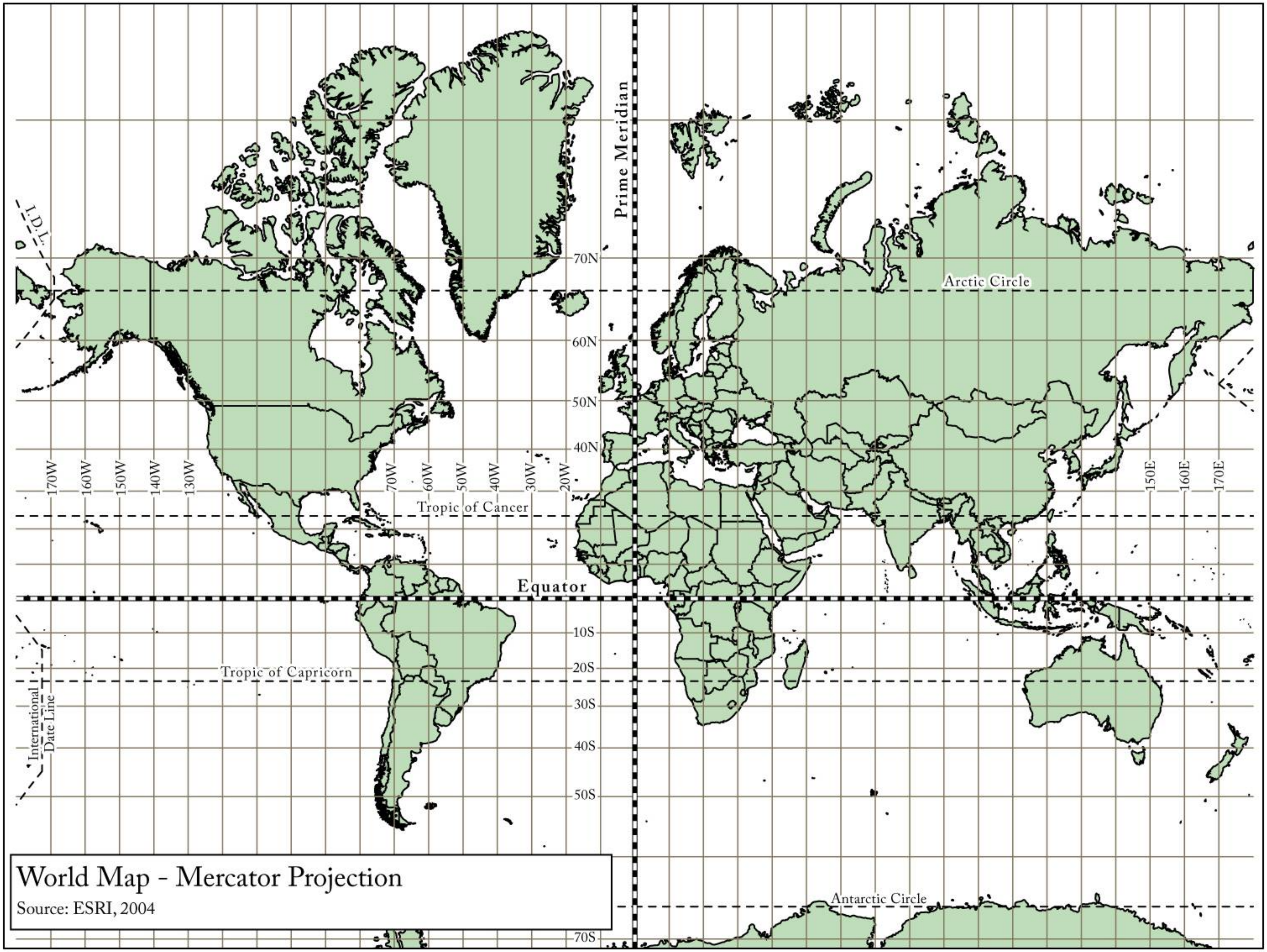
14. Is the area covered by two square inches the same everywhere on the map? Compare the equatorial regions to the polar regions.

15. Describe the angles at which longitude and latitude lines cross on the map. Are these angles consistent?

16. On the attached map, draw a straight line from Los Angeles, California to Moscow, Russia. Then plot the coordinates from question 7 on the same map. What do you notice about the two lines?

17. Which of the following properties is not accurate using the projection: Direction, distance, shape, or area? Which projection class does this map belong to?

18. What types of information is the Mercator projection best used for? What are its disadvantages?



World Map - Mercator Projection
Source: ESRI, 2004
Prime Meridian
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
I.D.L.
International Date Line
70N
60N
50N
40N
10S
20S
30S
40S
50S
70S
170W
160W
150W
140W
130W
70W
60W
50W
40W
30W
20W
150E
160E
170E

5.5. The Sinusoidal Projection

Using the attached map, answer the following questions.

19. Are the cardinal directions (i.e. N, S, E, and W) accurate everywhere on the map? If not, where are they distorted?

20. If you are in Beirut, Lebanon, in which direction is Murmansk, Russia?

21. Are the distances everywhere on the map equally accurate? If not, where are they distorted?

22. Are the continental shapes accurate? Where can you find any distortions?

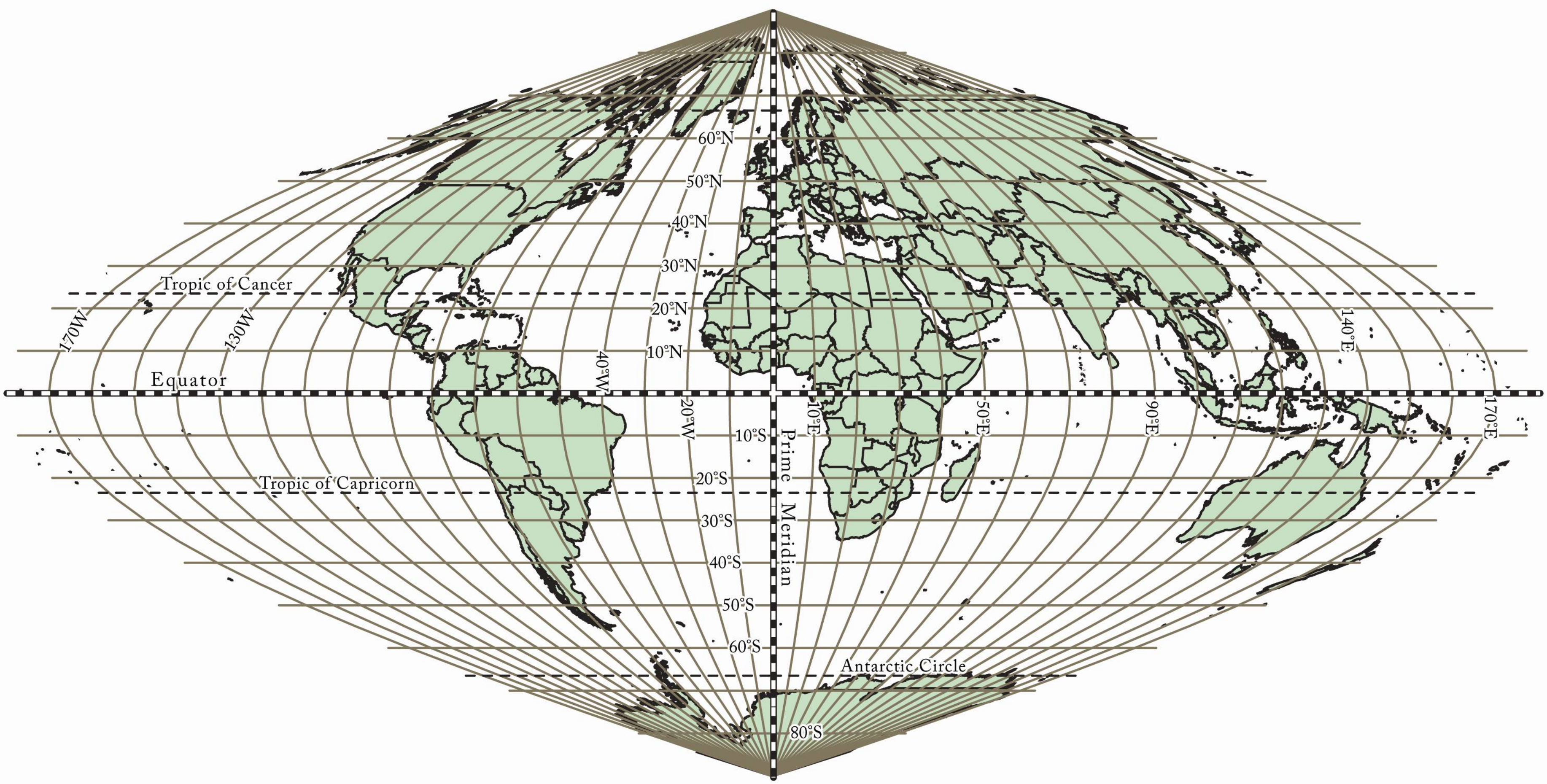
23. Is the area covered by two square inches the same everywhere on the map? Compare the equatorial regions to the polar regions.

24. Describe the angles at which longitude and latitude lines cross on the map. Are these angles consistent?

25. On the attached map, draw a straight line from Los Angeles, California to Moscow, Russia. Then plot the coordinates from question 7 on the same map. What do you notice about the two lines?

26. Which of the following properties is not accurate using the projection: Direction, distance, shape, or area? Which projection class does this map belong to?

27. What types of information is the Sinusoidal projection best used for? What are its disadvantages?



World Map - Sinusoidal Projection

Source: ESRI, 2004

5.6. The Robinson Projection

Using the attached map, answer the following questions.

28. Are the cardinal directions (i.e. N, S, E, and W) accurate everywhere on the map? If not, where are they distorted?

29. If you are in Beirut, Lebanon, in which direction is Murmansk, Russia?

30. Are the distances everywhere on the map equally accurate? If not, where are they distorted?

31. Are the continental shapes accurate? Where can you find any distortions?

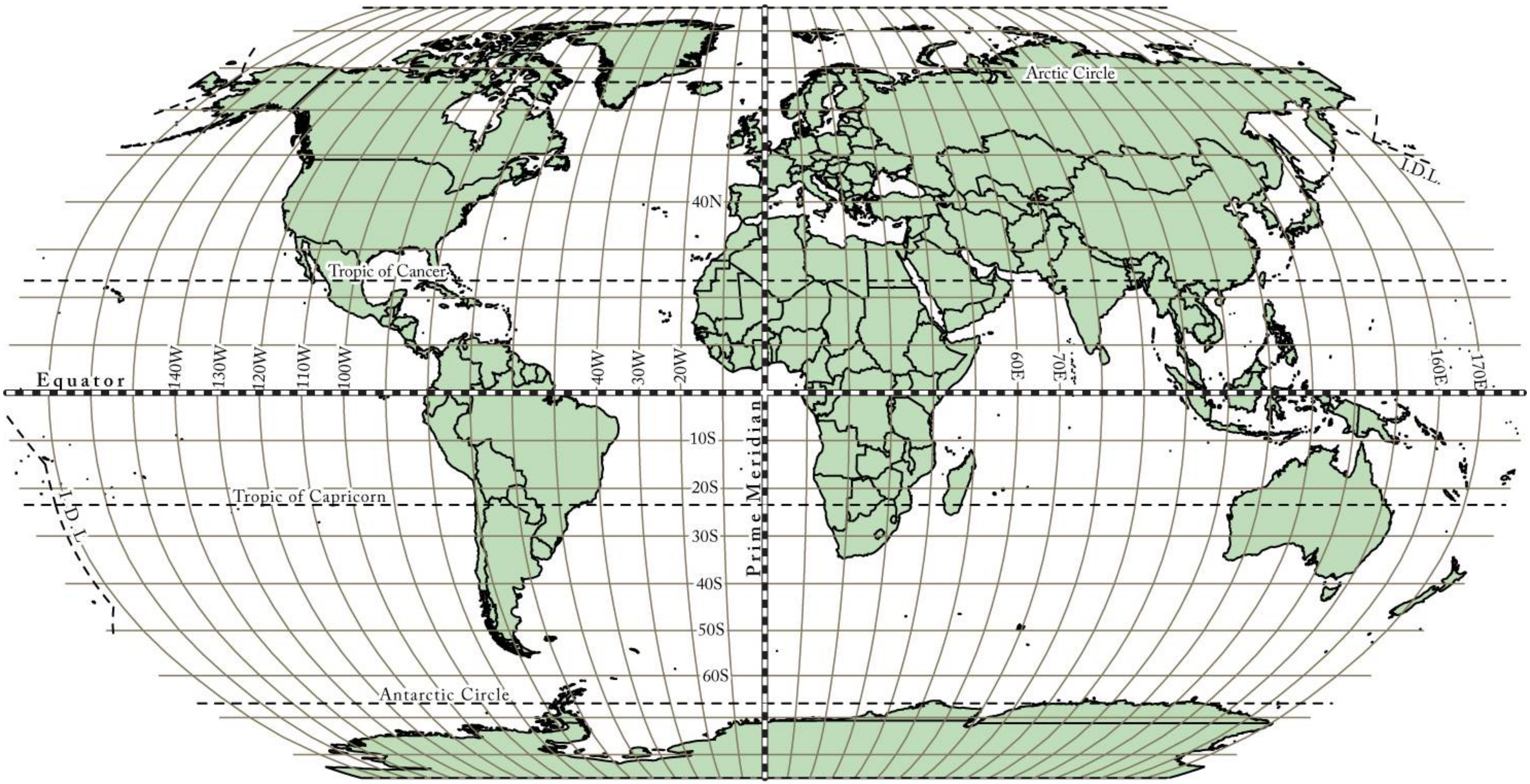
32. Is the area covered by two square inches the same everywhere on the map? Compare the equatorial regions to the polar regions.

33. Describe the angles at which longitude and latitude lines cross on the map. Are these angles consistent?

34. On the attached map, draw a straight line from Los Angeles, California to Moscow, Russia. Then plot the coordinates from question 7 on the same map. What do you notice about the two lines?

35. Which of the following properties is not accurate using the projection: Direction, distance, shape, or area? Which projection class does this map belong to?

36. What types of information is the Robinson projection best used for? What are its disadvantages?



World Map - Robinson Projection

Source: ESRI, 2004

5.7. Deciding on projections

Whether you plan on making maps for a living as a cartographer or use maps in your daily life, it is important to understand which projection is right for the job. Imagine you are a cartographer tasked with creating the below maps. Think about what each map needs to show and what it will be used for. Then, using table 5.1, determine the best possible projection to use.

37. A map comparing the agricultural areas between North America and Australia

38. A map comparing the ocean route distances of three competing cruise lines

39. A map showing hiking trails in Yosemite National Park

40. A map of the world for classroom discussions on global events

41. Navigation charts showing compass directions between Hawaii and New Zealand

42. A map of Antarctica

		Properties							Suitable for mapping							General Use					
Projection	**Surface**	Conformal	Equal Area	Equidistant	True direction	Perspective	Compromise	Straight rhumbs	World	Hemisphere	Continent/Ocean	Region/Sea	Medium Scale	Large Scale	Polar regions	Topographic Maps	Geological Maps	Thematic Maps	Presentations	Navigation	USGS Maps
Globe	Sphere	Y	Y	Y	Y				Y									Y	Y		
Mercator	Cylindrical	Y			P			Y	P			Y				Y	Y			Y	Y
Transverse Mercator	Cylindrical	Y									Y	Y	Y	Y		Y	Y				Y
Oblique Mercator	Cylindrical	Y									Y	Y	Y	Y		Y					Y
Space Oblique Mercator	Cylindrical	Y												Y		Y					Y
Miller Cylindrical	Cylindrical						Y		Y									Y			Y
Robinson	Pseudocylindrical						Y		Y									Y	Y		
Sinusoidal Equal Area	Pseudocylindrical		Y	P					Y		Y							Y			Y
Orthographic	Azimuthal (planar)				P	Y				P					Y						Y
Stereographic	Azimuthal (planar)	Y			P	Y				Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Gnomonic	Azimuthal (planar)				P	Y						P			Y				Y	Y	
Azimuthal Equidistant	Azimuthal (planar)			P	P				P	Y	Y	Y		P		Y					Y
Lambert Azimuthal Equal Area	Azimuthal (planar)		Y		P					Y	Y	Y						Y	Y		Y
Albers Equal Area Conic	Conic		Y								Y	Y	Y					Y	Y		Y
Lamber Conformal Conic	Conic	Y			P						Y	Y	Y	Y		Y	Y		Y	Y	Y
Euqidistant Conic	Conic			P							Y	Y									
Polyconic	Conic			P			Y						P	P		Y					Y
Bipolar Oblique Conic Conformal	Conic	Y									Y						Y				Y

Y = yes, P = partly

Adapted from USGS

End of Lab 5