3

Map projections

Lab questions
Items needed to complete this lab:

- Protractor for measuring angles
- Engineer’s scale for measuring distances

Using the gnomonic projection

Note: Remember that a straight line drawn between any two points on the surface of a gnomonic projection is the great circle route between the points.

1. On the north polar aspect gnomonic projection below, label all the latitude and longitude graticule lines. Then draw the great circle route from Los Angeles to Istanbul, Turkey.
2. What is the approximate latitude reached by an aircraft flying this great circle route as it crosses the following meridians?

(a) 100°W  
(b) 80°W  
(c) 60°W  
(d) 40°W  
(e) 20°W  
(f) 0°W  
(g) 20°E

3. What is the approximate angular difference between true north and the flight path at these same seven meridians?
   (Hint: Use a protractor to measure the angle from the meridian line to the flight path at the point where they intersect.)

(a) 100°W  
(b) 80°W  
(c) 60°W  
(d) 40°W  
(e) 20°W  
(f) 0°W  
(g) 20°E

Using the azimuthal equidistant projection

The azimuthal equidistant map projection is useful for long-distance navigation planning because (a) all straight lines drawn radially outward from the projection centerpoint are great circle routes, and (b) the map scale along each straight line is constant, so that all radial distances are correct. Given this information, answer the following questions:

4. This Portland-centered azimuthal equidistant projection has circular range rings drawn at 1,000-nautical-mile (nm) increments. Plot the great circle routes from Portland, Oregon, to the six other cities labeled on the map.
5. For each route, estimate the distance from Portland, Oregon, to each city and fill in the following table:

<table>
<thead>
<tr>
<th>Distance from Portland, Oregon</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
</tr>
<tr>
<td>Nautical miles</td>
</tr>
<tr>
<td>Statute miles</td>
</tr>
<tr>
<td>Kilometers</td>
</tr>
<tr>
<td>Bangkok</td>
</tr>
<tr>
<td>Buenos Aires</td>
</tr>
<tr>
<td>Cape Town</td>
</tr>
<tr>
<td>London</td>
</tr>
<tr>
<td>Sydney</td>
</tr>
<tr>
<td>Tokyo</td>
</tr>
</tbody>
</table>

1 nautical mile = 6,076.1 feet
1 statute mile = 5,280 feet
1 statute mile = 1.609 kilometers

**Mercator world projection**

Using the Mercator world map on the following page, answer the questions below:

6. Label the parallels and meridians with the correct latitude and longitude, then label and place small dots for Seattle and London, Los Angeles and Istanbul, Sydney and Tokyo, Cape Town and Miami, and Buenos Aires and New York (consult a world map or atlas if you are unsure of the location of these major world cities).

7. Plot rhumb lines between the five pairs of cities listed in the question above.

8. List the constant true azimuth from the following:
   - London to Seattle
   - Los Angeles to Istanbul
   - Tokyo to Sydney
   - Cape Town to Miami
   - Buenos Aires to New York

9. Determine the RF of the map at 0°, 30°, and 60° latitude, then create a scale bar for the map at each of these three latitudes (these scale bars are usually placed together at the bottom of the map). Make each scale bar 5,000 statute miles in 1,000-statute-mile increments (remember that on the globe the distance between meridians decreases by the cosine of the latitude).

   \[
   \begin{align*}
   0^\circ &= \text{ } \quad \text{Scale bar length} = \quad \text{Increments} = \_
   \\
   30^\circ &= \text{ } \quad \text{Scale bar length} = \quad \text{Increments} = \_
   \\
   60^\circ &= \text{ } \quad \text{Scale bar length} = \quad \text{Increments} = \_\
   \end{align*}
   \]