5.3 Azimuthal Projections

5.3.1 Lambert Azimuthal Equal-Area (–Ja or –JA)

This projection was developed by Lambert in 1772 and is typically used for mapping large regions like continents and hemispheres. It is an azimuthal, equal-area projection, but is not perspective. Distortion is zero at the center of the projection, and increases radially away from this point. To define this projection in GMT you must provide the following information:

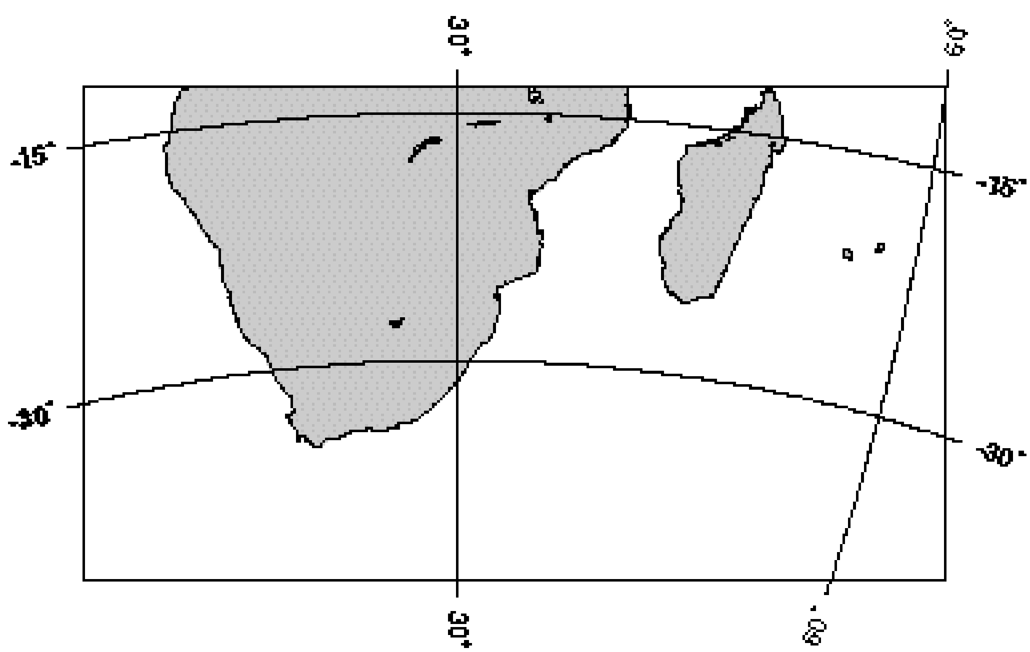
- Longitude and latitude of the projection center
- Scale as 1:xxxxx or as radius/latitude where radius is distance on map in inches from projection center to an oblique latitude (**–Ja**), or map width in inches (**–JA**).

Two different types of maps can be made with this projection depending on how the region is specified. We will give examples of both types.

Rectangular map

In this mode we define our region by specifying the longitude/latitude of the lower left and upper right corners instead of the usual *west*, *east*, *south*, *north* boundaries. The reason for specifying our area this way is that for this and many other projections, lines of equal longitude and latitude are not straight lines and are thus poor choices for map boundaries. Instead we require that the map boundaries be rectangular by defining the corners of a rectangular map boundary. Using 0˚E/40˚S (lower left) and 60˚E/10˚S (upper right) as our corners we try

```
pscoast -R0/-40/60/-10r -JA30/-30/4.5 -B30g30/15g15 -Dl -A500 -G200 -W1 -P -X0.5 -Y0.5 >
   lambert_1.ps
```

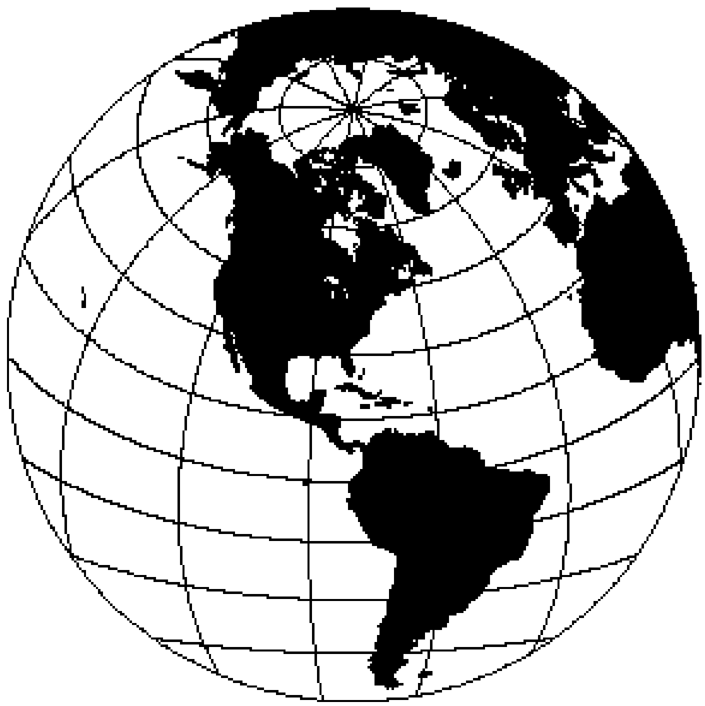


Note that an 'r' is appended to the **–R** option to inform GMT that the region has been selected using the rectangle technique, otherwise it would try to decode the values as *west, east, south, north* and report an error since *'east'* < *'west'*.

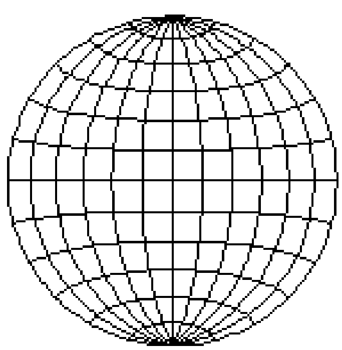
Hemisphere map

Here, you must specify the world as your region (-R0/360/-90/90). E. g., to obtain a hemisphere view that shows the Americas, try

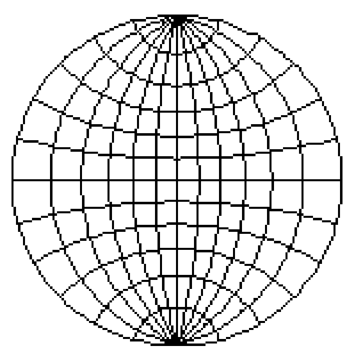
```
pscoast -R0/360/-90/90 -JA280/30/4 -B30g30/15g15 -Dc -A1000 -G0 -P -X0.1 -Y0.1 >
lambert_2.ps
```



To geologists, the Lambert azimuthal equal-area projection (with origin at 0˚/0˚) is known as the equal-area (Schmidt) stereonet and used for plotting fold axes, fault planes, and the like. An equal-angle (Wulff) stereonet can be obtained by using the stereographic projection (discussed later). The stereonets produced by these two projections appear below.



EQUAL-AREA (SCHMIDT) NET



EQUAL-ANGLE (WULFF) NET

5.3.2 Stereographic Equal-Angle Projection (–Js or –JS)

This is a conformal, azimuthal projection that dates back to the Greeks. Its main use is for mapping the polar regions. In the polar aspect all meridians are straight lines and parallels are arcs of circles. While this is the most common use it is possible to select any point as the center of projection. The requirements are

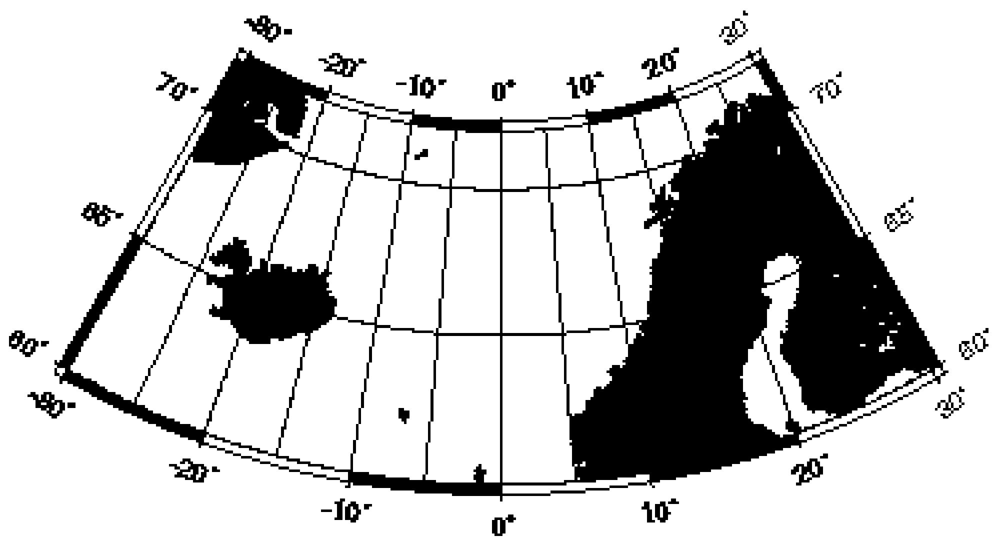
- Longitude and latitude of the projection center
- Scale as 1:xxxxx or as radius/latitude where radius is distance on map in inches from projection center to a particular [possibly oblique] latitude (**–Js**), or map width (**–JS**).

We will look at two different types of maps.

Polar Stereographic Maps

In our first example we will let the projection center be at the north pole. This means we have a polar stereographic projection and the map boundaries will coincide with lines of constant longitude and latitude. An example is given by

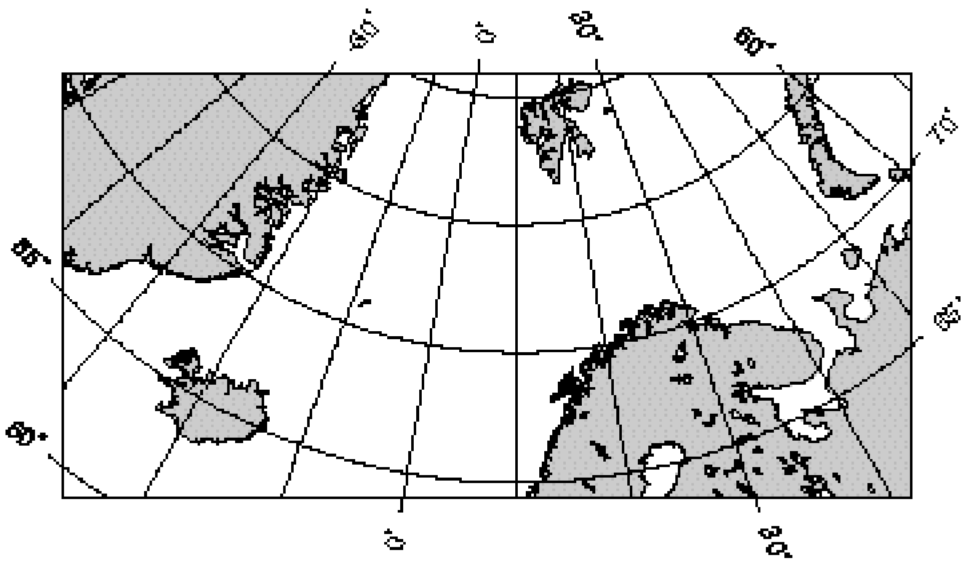
```
pscoast -R-30/30/60/72 -Js0/90/4.5/60 -Ba10g5/a5g5 -Dl -A250 -G0 -P -X0.3 -Y0.3 > polar.ps
```



As with Lambert's azimuthal equal-area projection we have the option to use rectangular boundaries rather than the wedge-shape typically associated with polar projections. This choice is defined by selecting two points as corners in the rectangle and appending an 'r' to the **–R** option:

```
pscoast -R-25/59/70/72r -Js10/90/4/60 -Ba30g10/a5g5 -Dl -A250 -G200 -W1 -P -X0.5 -Y0.4 >
    stereo_1.ps
```

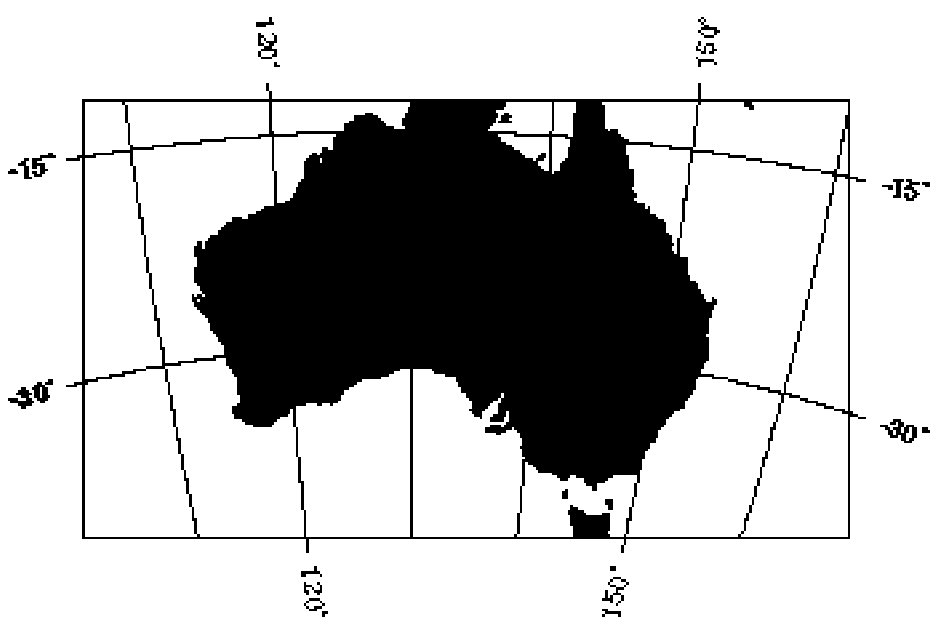
This command produces a map as presented below.



General Stereographic Map

In terms of usage this projection is identical to the Lambert azimuthal equal-area projection. Thus, one can make both rectangular and hemispheric maps. Our example shows Australia using a projection pole at 130E/30˚S. The command used was

```
pscoast -R100/-40/160/-10r -JS130/-30/4 -B30g10/15g15 -Dl -A500 -G0 -P -X0.5 -Y0.5 >
stereo_2.ps
```



By choosing 0˚/0˚ as the pole, we obtain the conformal stereonet presented next to its equal-area cousin in the section on the Lambert azimuthal equal-area projection.

5.3.3 Orthographic Projection (–Jg or –JG)

The orthographic azimuthal projection is a perspective projection from infinite distance. It is therefore often used to give the appearance of a globe viewed from space. As with Lambert's equal-areal and the stereographic projection, only one hemisphere can be viewed at any time. The projection is neither equal-area or conformal, and much distortion is introducted near the edge of the hemisphere. The directions from the center of projection are true. The projection was known to the Egyptians and Greeks more than 2,000 years ago. Because it is mainly used for pictoral views at a small scale, only the spherical form is necessary.

To specify the orthographic projection you must supply

- Longitude and latitude of the projection center
- Scale as 1:xxxxx or as radius/latitude where radius is distance on map in inches from projection center to a particular [possibly oblique] latitude (**–Jg**), or map width (**–JG**).

Our example of a perspective view centered on 75˚W/40˚N can therefore be generated by the following *pscoast* command:

```
pscoast -R0/360/-90/90 -JG-75/40/4.5 -Dc -A1000 -G0 -P -X0.1 -Y0.1 -B15g15 > ortho.ps
```

5.3.4 Azimuthal Equidistant Projection (–Je or –JE)

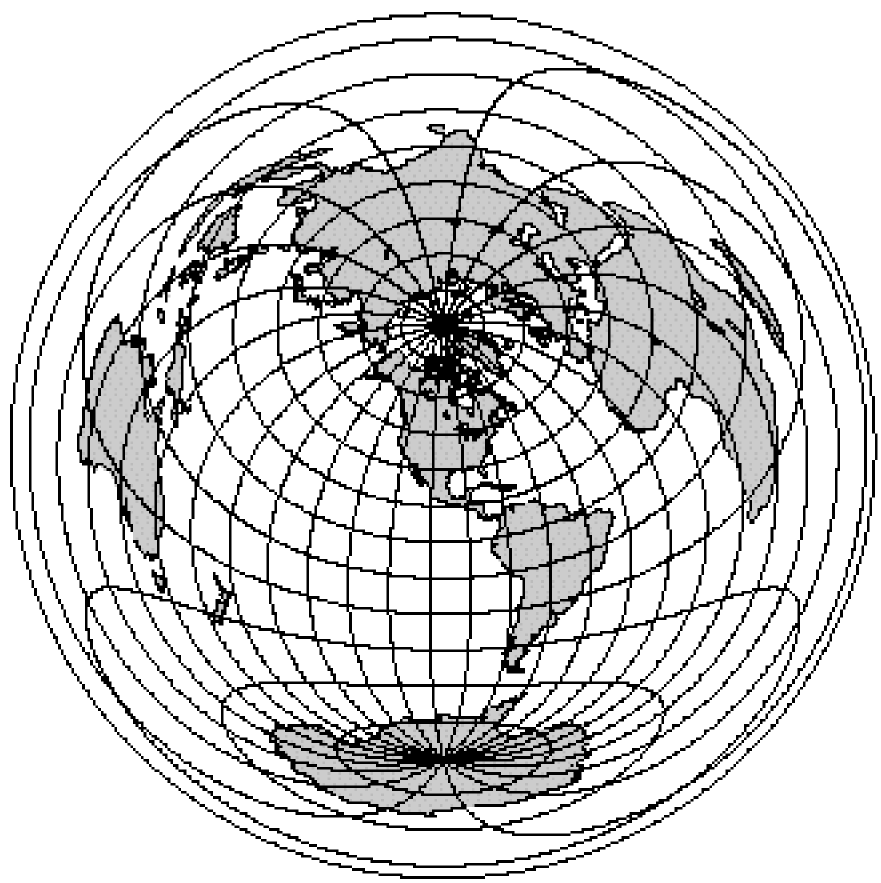
The most noticeable feature of this azimuthal projection is the fact that distances measured from the center are true. Therefore, a circle about the projection center defines the locus of points that are equally far away from the plot origin. Furthermore, directions from the center are also true. The projection, in the polar aspect, is at least several centuries old. It is a useful projection for a global view of locations at various or identical distance from a given point (the map center).

To specify the azimuthal equidistant projection you must supply

- Longitude and latitude of the projection center
- Scale as 1:xxxxx or as radius/latitude where radius is distance on map in inches from projection center to a particular [possibly oblique] latitude (**–Je**), or map width (**–JE**).

Our example of a global view centered on 100˚W/40˚N can therefore be generated by the following *pscoast* command. Note that the antipodal point is 180˚ away from the center, but in this projection this point plots as the entire map perimeter:

```
pscoast -R0/360/-90/90 -JE-100/40/4.5 -B15g15 -Dc -A10000 -G200 -W1 -P -V -X0.1 -Y0.1 >
equidist.ps
```



5.3.4 Gnomonic Projection (–Jf or –JF)

The Gnomonic azimuthal projection is a perspective projection from the center onto a plane tangent to the surface. Its origin goes back to the old Greeks who used it for star maps almost 2500 years ago. The projection is neither equal-area or conformal, and much distortion is introducted near the edge of the hemisphere; in fact, less than a hemisphere may be shown around a given center. The directions from the center of projection are true. Because it is mainly used for pictoral views at a small scale, only the spherical form is necessary.

To specify the Gnomonic projection you must supply

- Longitude and latitude of the projection center
- The horizon, i.e., the number of degrees from the center to the edge. This must be < 90˚.
- Scale as 1:xxxxx or as radius/latitude where radius is distance on map in inches from projection center to a particular [possibly oblique] latitude (**–Jf**), or map width (**–JF**).

Using a horizon of 60˚, our example of this projection centered on 120˚W/35˚N can therefore be generated by the following *pscoast* command:

```
pscoast -R0/360/-90/90 -JF-120/35/60/4.5 -Bg15 -Dc -A10000 -G200 -W1 -P -X0.1 -Y0.1 >
gnomonic.ps
```