# TERMINATOR MECHANICS AND TRANS•POLAR SOLAR BLANKING

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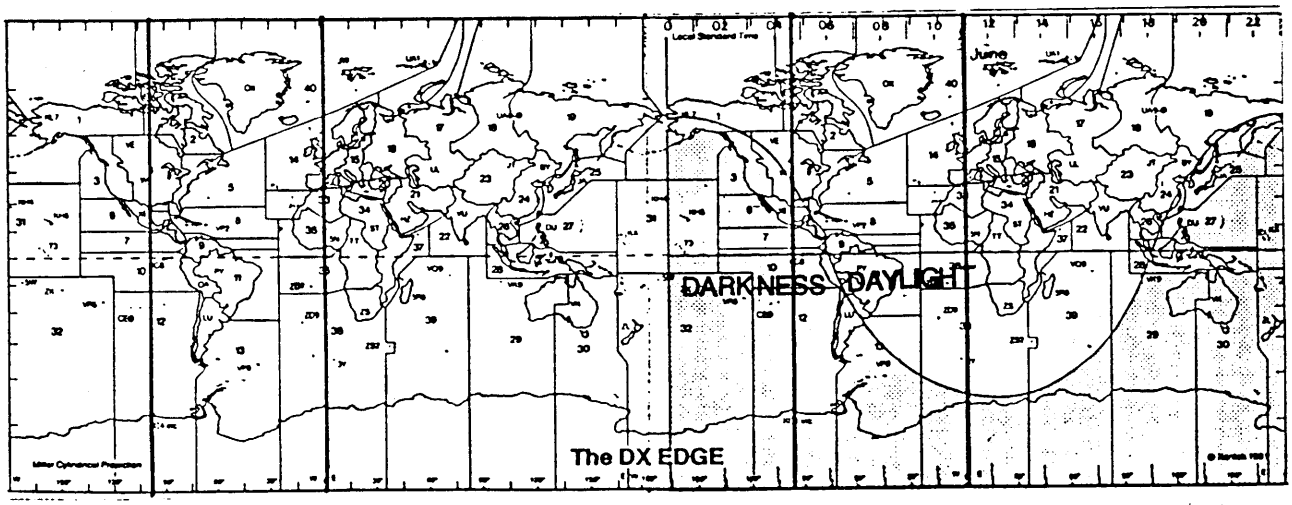
The ability to visualize the ever changing sunrise/sunset lines across the globe throughout the year is one of the most valuable skills for any DX'er. The sunrise/sunset lines are more generally known by their astronomical name: terminator lines. Discussion of how these lines relate to the planet and to specific locations on it is known as terminator mechanics. Understanding the Earth's terminator mechanics and its implications on radio propagation can make each of us better DXers.

The Earth's axis of rotation (through the North and South poles) tilts at about 23° to the imaginary disc created as the Earth rotates about the sun (our plane of rotation). This axial tilt causes a number of effects which are of interest to DX'ers. The first and most well known effect is, of course, the seasons. The longer days of summer and shorter days of winter and the accompanying changes of temperature and weather are directly attributable to the axial tilt of our planet. Another major effect is the changing time of sunrise and sunset (SR/SS) through the year. You should note that SR/SS times do not change at the equator; they change ever more rapidly as you move away from the equator and toward the polar regions. (see END NOTE).

One basic tool for visualizing terminator mechanics is the "DX EDGE". The DX Edge is an 11 1/2" x 5" plastic slide-rule-like device, with an opaque background element, showing a Miller Cylindrical Projection of the world, and interchangeable sliding overlays, one for each month, which show the area of sunlight, darkness and the SR/SS terminator. This device is extremely useful for any shortwave listener, since the reflectivity of the ionosphere and, therefore, radio wave propagation is effected radically by the absence or presence of sunlight.

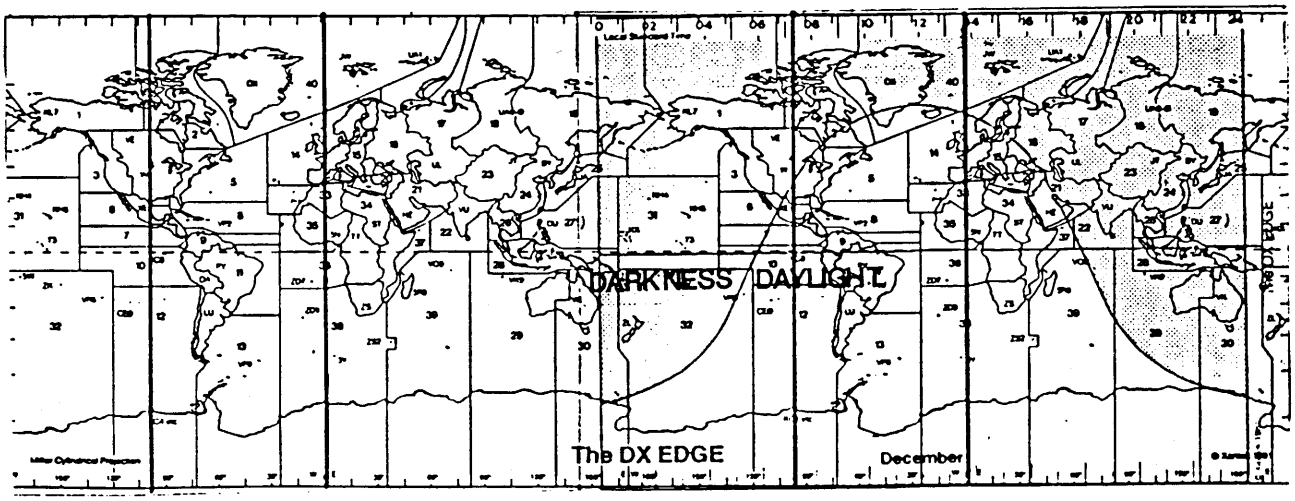
Examining all twelve monthly overlays for the DX Edge, it is easy to see that the angle of the terminator line/plane changes from +23° to -23° with respect to the earth's axis during the year. Knowledge of this change of angle is one of the handiest tools for the DX'er. For instance, in Central North America, since the dawn terminator "lags behind" to our south **in the summer**, we can DX western South America even past local dawn here (See Figure 1). Conversely, if you are an Indonesian RRI Freak, you should love dawn **in the winter**, since the terminator "runs ahead" of us to the south, wiping out those South Americans long before our local dawn. The Indo's then come through without interference (See Figure 2). These subtle seasonal variations in the areas of sunlight and darkness and their inherent DX possibilities become very clear with the regular use of the DX Edge.

The DX Edge has been manufactured by Xantek of New York since 1981. It is available from most shortwave hobby outlets for less than $18.00




# FIGURE ONE

The SR/SS situation at dawn in central North America on 15 June each year. Note that during the last hour before dawn, most of South America is "open" and none of mainland Asia is available. Note that the slope of the Terminator at the Equator is equal to the 23° tilt of the planetary axis to the plane of rotation.




# FIGURE TWO

The SR/SS situation at dawn in central North America on 15 December each year. Note for the last hour before dawn, that almost the entire land mass of Asia is "open for Tropical Band reception while the South American Stations have long been absorbed by the daytime "D" layer of the ionosphere.

One major weakness of the DX Edge is that it perpetuates a dangerously distorted mental picture of our planet. We were all introduced to this distorted view by Mercator projection wall maps in primary school. The DX Edge, like most of our shack maps, uses a modern version of the Mercator projection called the Miller Cylindrical Projection. This view of our planet is dangerous for DXers because it badly distorts most of our planet's "Great Circles." A Great Circle is simply the circle of intersection between a sphere and a slicing plane which passes through the center of the sphere. Slice an orange at any angle that you want it, so long as you divide it exactly in half, and the cut orange rind is a Great Circle.

Another way to imagine Great Circles is that they are "circumference" circles on a sphere. The Equator is an example of a Great Circle. However, remember that Great Circles (unlike the Equator) can run through any location on the surface of a sphere and at any angle. The shortest distance between two points on any sphere is along a segment of the Great Circle which connects those two points. Because of this fact alone, over the over - the - horizon radio waves which we receive travel to our antennas along Great Circle routes. (SEE END NOTES) Also, our SR/SS Terminator is ALWAYS a Great Circle.

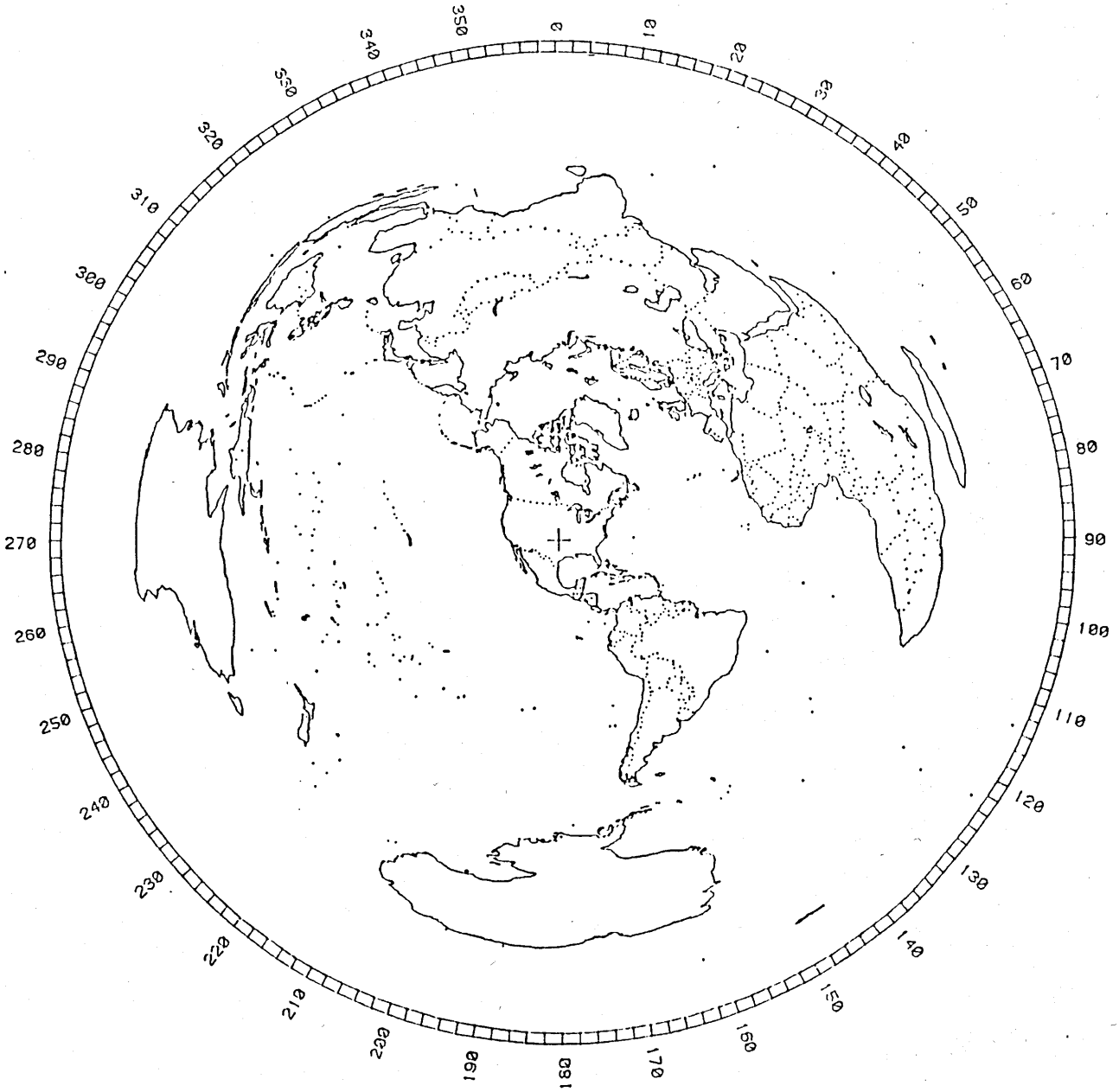
One method to determine Great Circle routes from your location (QTH) to another point on the earth is to use a string or rubber band and a globe. Stretch the string or rubber band between your QTH and the second location on the surface of the globe. Since a Great Circle is the shortest distance between two points on the surface of a sphere, your string will describe what appears to be an arc — the Great Circle. This method is probably accurate enough to aid DXers in orienting antennas, etc. However, a far better method is to find a "Polar Projection" map drawn **with its center** as close to your QTH as possible. Most major "library" atlases printed in North America contain polar projection maps centered on several locations. If you are lucky enough to find one centered near you, it can be an invaluable DX tool. For DXers, the most important attribute of a polar projection map is that **all straight lines drawn from the center of the map to the circumference are Great Circles.**

For the senior DXer, probably the ultimate world map is an Azimuthal Equidistance projection map drawn centered on his shack. An "Azi-Equi" world map is a special member of the family of polar projection maps which is drawn so that distances can be measured accurately from the center to any point on the map. Such maps, computer drawn, have been available for some time from radio amateur N5KR. Figure 3 is a N5KR Azi-Equi map centered on the author's QTH, Stillwater, Oklahoma (50 miles north of Oklahoma City, 60 miles west of Tulsa). It has proven to be an invaluable "real time" DXing tool as well as a very accurate method for orienting directional antennas. Figures 4 and 5 are similar Azi-Equi maps drawn centered on Madang, Papua New Guinea and Victoria, BC.

These Azi-Equi maps have proven to be an invaluable real time DX tool for me from a variety of locations. Some of the uses are very obvious; antenna orientation, analyzing a site for sky blockage, etc. However, these have proven to be the least useful functions of my Azi-Equi maps. The primary use I put them to is to help me vizualize exactly what route "my" radio waves are taking to reach me. DXing Asia from North America means contending with the disk of perpetual light **and with the ring of auroral absorption.** Knowing where those two physical barriers are and how bearings to my DX targets related to them has been extremely helpful. Finally, when I get an unusual "opening." I plot it on the Azi-Eqi, find the exact bearing and search for other targets within 5° of that bearing. It works!

N5KR AZIMUTHAL EQUIDISTANT MAP CENTERED ON

# STILLWATER, OKLAHOMA




SCALE OF DISTANCE FROM CENTER

KILOMETERS

0 5000 10000 15000 20000

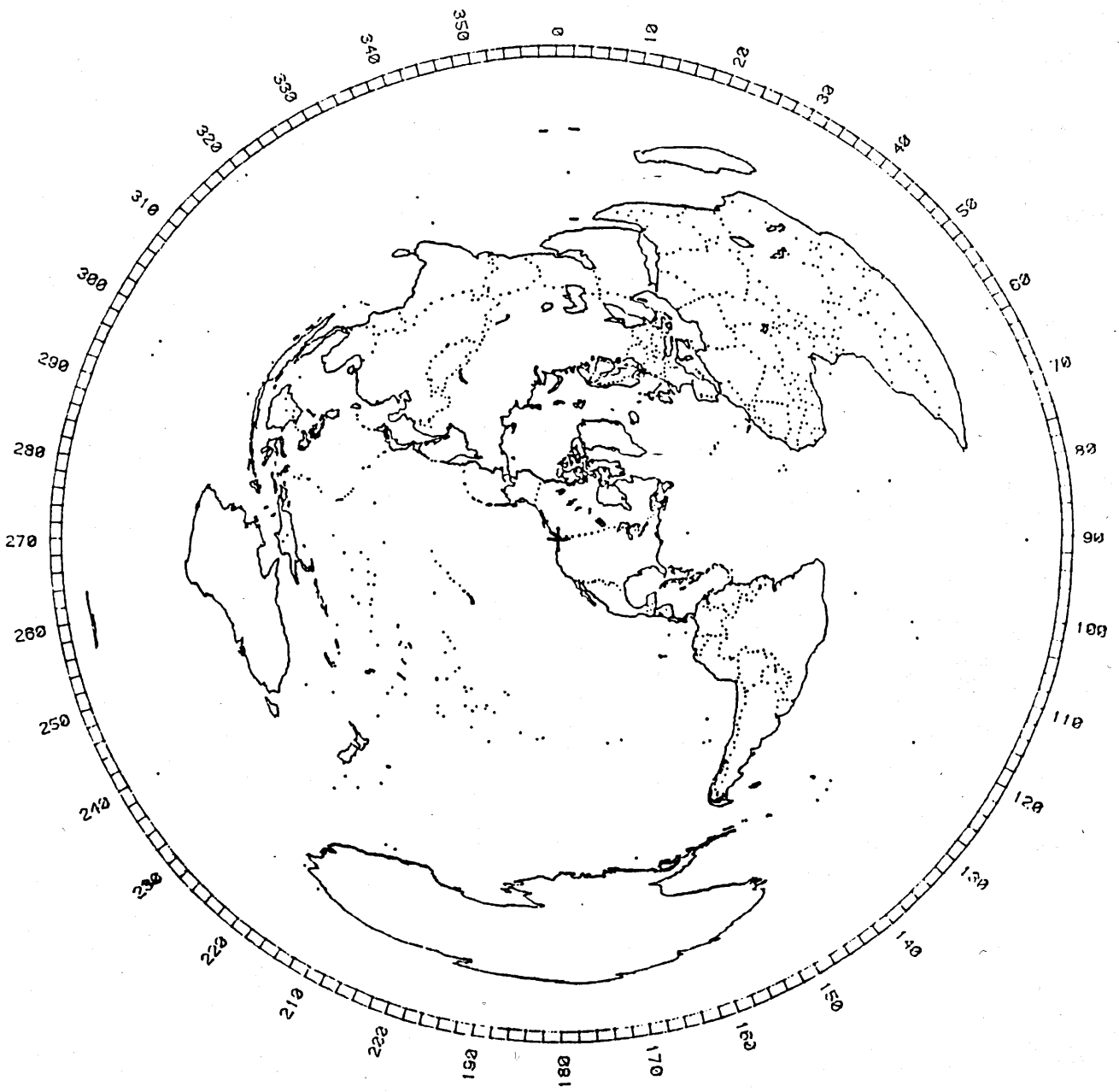
0 2000 4000 6000 8000 10000 12000

MILES

FIGURE 3

N5KR AZIMUTHAL EQUIDISTANT MAP CENTERED ON

# victoria, british columbia




SCALE OF DISTANCE FROM CENTER

KILOMETERS

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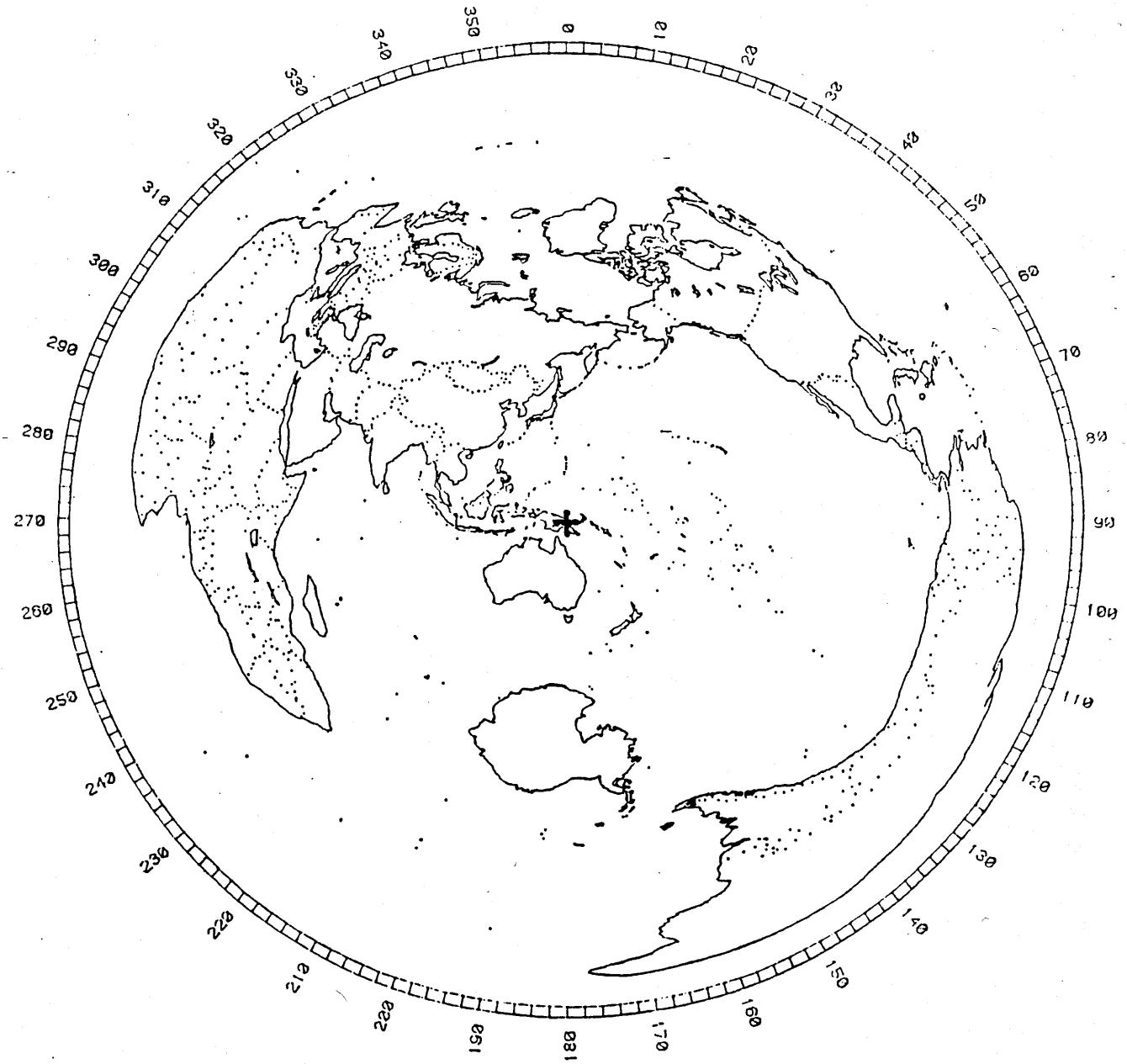
0 2000 4000 6000 8000 10000 12000

MILES

FIGURE 4

NSKR AZIMUTHAL EQUIDISTANT MAP CENTERED ON

# MADANG




SCALE OF DISTANCE FROM CENTER

KILOMETERS

0 5000 10000 15000 20000

0 2000 4000 6000 8000 10000 12000

MILES

FIGURE 5

**Trans-polar Solar Blanking**

Due to too many years spent staring at Mercator-type maps, I had to use N5KR's Azi-Equi map for over a year before I remembered what every third grader in the world learns: That the sun never sets in the Arctic in the Summer, and never sets in Antarctic during our North American winter. However, even though most of our Great Circle routes from North America to Asia pass over the Arctic, the implications of the "perpetual daylight" phenomenon slipped by me for many years as a DXer!

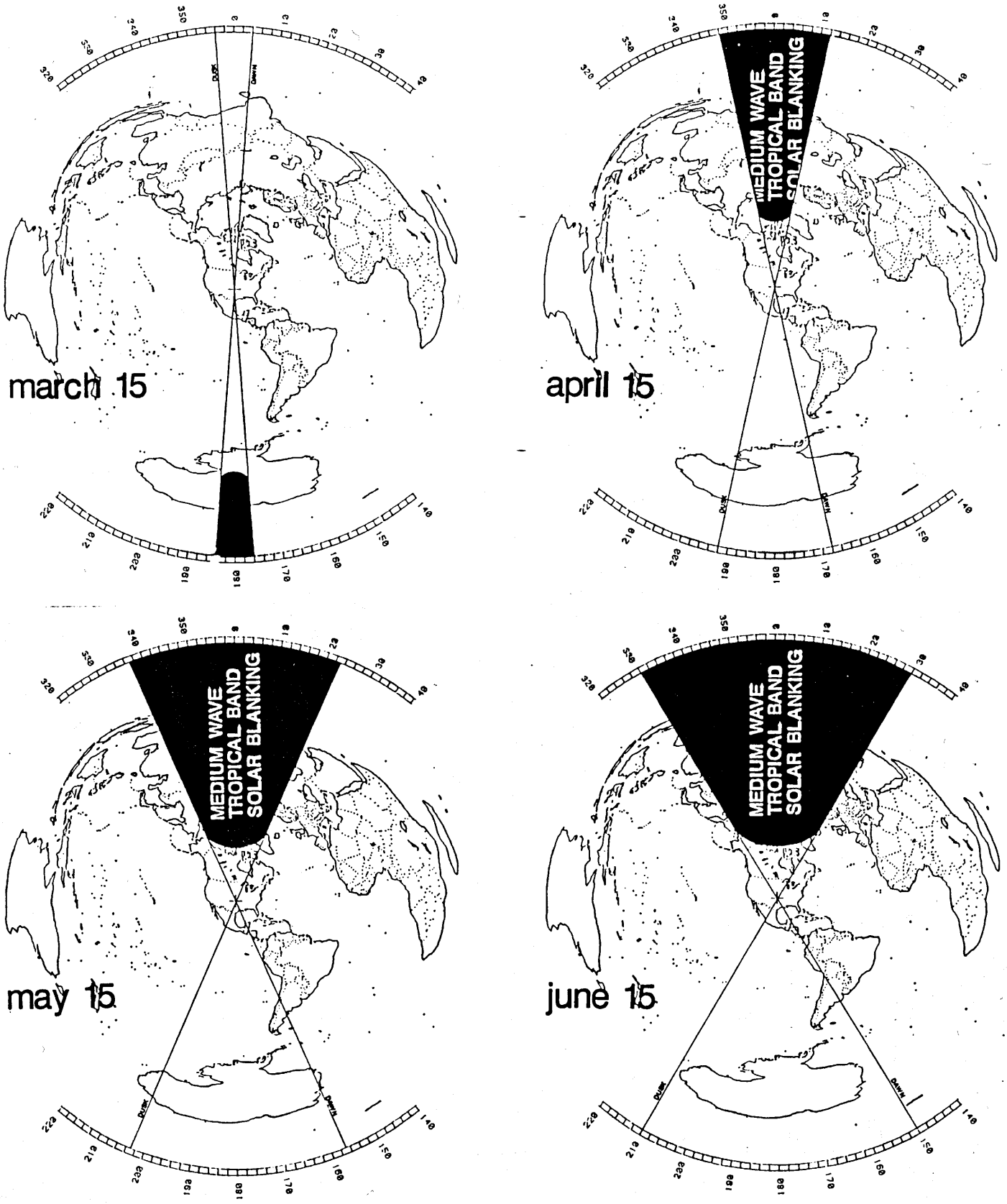
If you view the globe from above the North Pole for 24 hours, there is a circle of perpetual daylight surrounding the geographic north pole every day from 21 March to 21 September. This circle of perpetual light gets larger in diameter as we move from Spring Equinox (March 21) to Summer Solstice (June 21) and then gradually reduces, disappearing on 21 September, the Fall Equinox. A similar disk of perpetual light then begins the same, but inverse, cycle at the South Pole peaking at Winter Soltice (21 Dec). The absorptive "D-layer" of the ionosphere gathers strength at dawn and remains present throughout the daylight hours. This absorptive layer basically blanks out all long distance radio propagation below 8 megaherts from dawn to dusk. Therefore, due to the disk of perpetual light, there is an absorptive circle sitting up at the North Pole blanking all of our Tropical Band and Medium Wave reception from portions of Asia for half the year.(SEE END NOTES). Those very rare instances of Tropical Band reception in North America from these areas during the period 1 May to 15 August almost have to be "coming around the long way" via the southern polar routes. This "long path" reception is very rare because the distances are much greater and because the signals must also contend with so-called polar auroral absorption, as well. Inspection of the attached Azi-Equi maps by month show the extent of Solar Blanking of our Tropical Band and medium wave DX routes to Asia. (SEE FIGURES 6, 7 and 8). As you can see on the maps centered on Stillwater, at this location the blanking begins with loss of a narrow band including central India in April and, at its maximum, the disk of perpetual light blanks out all of Asia.

Since developing the original maps shown as Figures 6, 7 and 8, the author has had the opportunity to DX for two full seasons with a 1200' very directional Beverage antenna aimed exactly at the left hand edge of the May-June-July blanking area (i.e. at the edge of the Arctic Circle and thence down the China Coast to Sumatera). Careful observations were made of Chinese inland and coastal Tropical Band stations throughout the Spring-Summer-Early Fall period. The evidence is pretty conclusive that, for the Tropical Bands, the left-hand edge of the zone of total absorption is about 5° wider than that shown on the map. During this period, from this QTH, all Chinese Tropical Band stations are totally blanked out when general absorption is at moderate or high levels. However, the 80 meter Japanese stations are often audible. On the few mornings when general absorption is at its lowest, the only Chinese station audible were a few of Fuzhou's Taiwan Service outlets.

Why is the area of solar blanking wider than shown? Two reasons, based on conjecture:

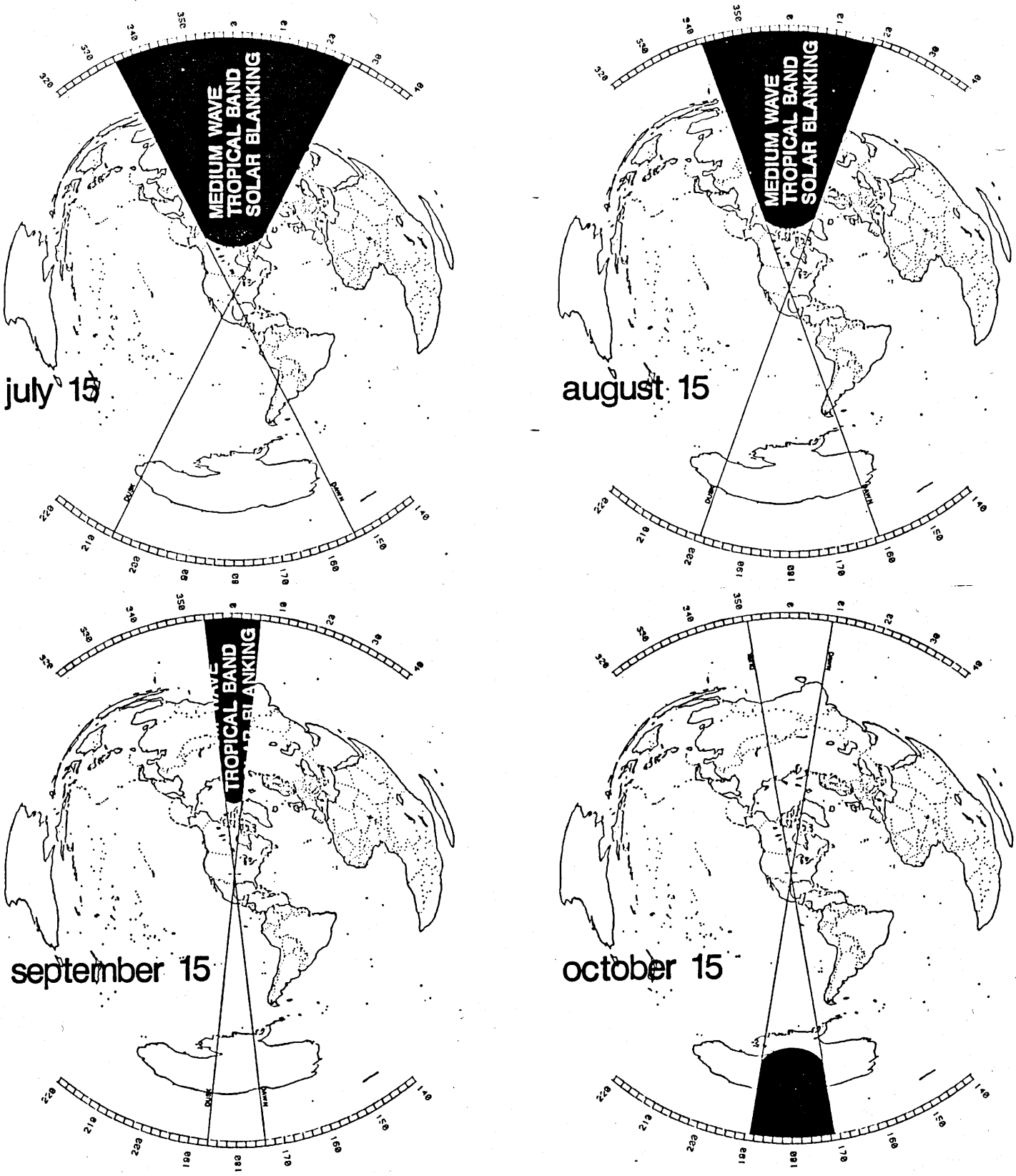
a) The maps were drawn based upon the placement of the SR/SS Terminator at ground level. Since the ionosphere is 60 to 100 miles up, it is slightly more exposed to daylight and hence, has a slightly larger disk of perpetual light on any given date.

b) Since the ionosphere is neither homogeneous nor motionless, there is undoubtedly some "leakage" of highly ionized, highly absorptive gases, across the boundaries of the blanking area (it's got fuzzy edges!).




mediumwave and tropical bands solar blanking study centered on
stillwater, oklahoma

FIGURE 6.




mediumwave and tropical bands solar blanking study
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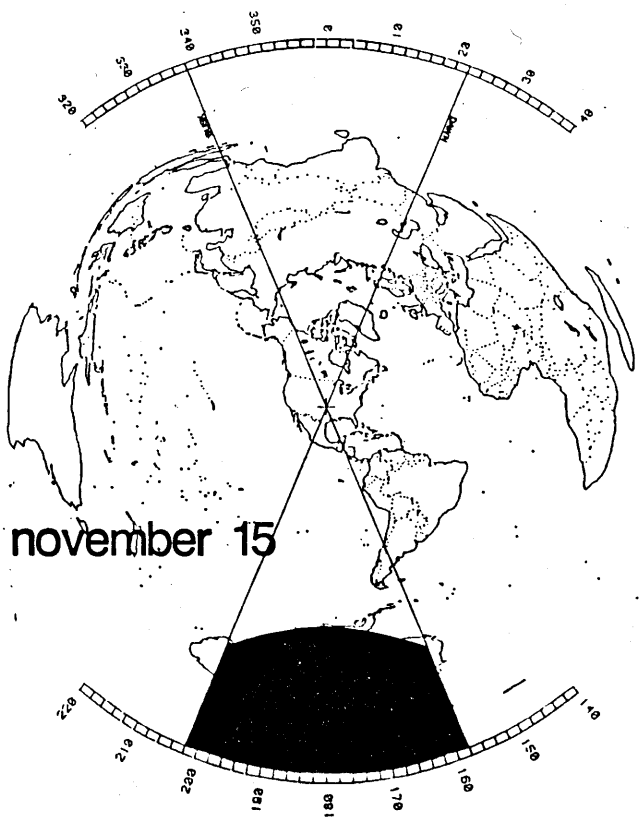
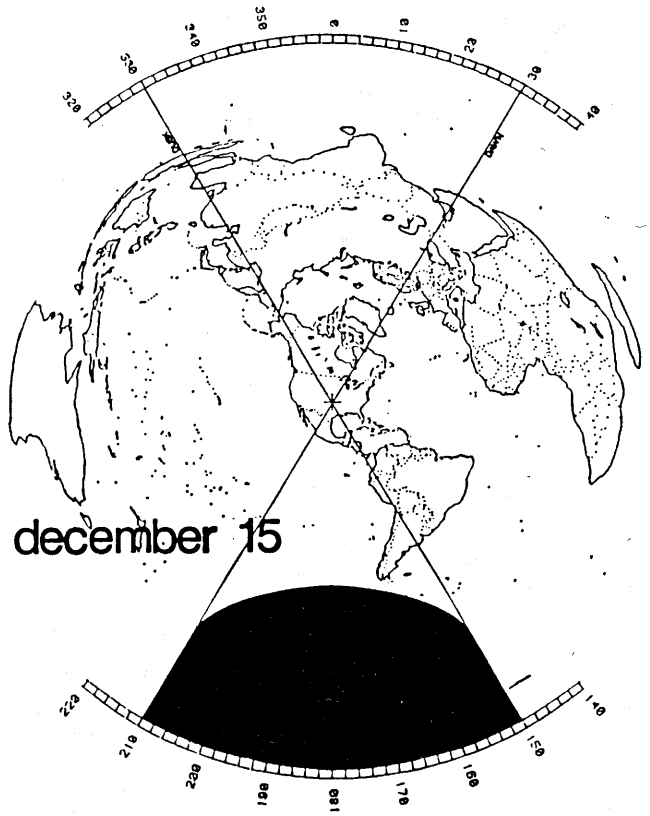
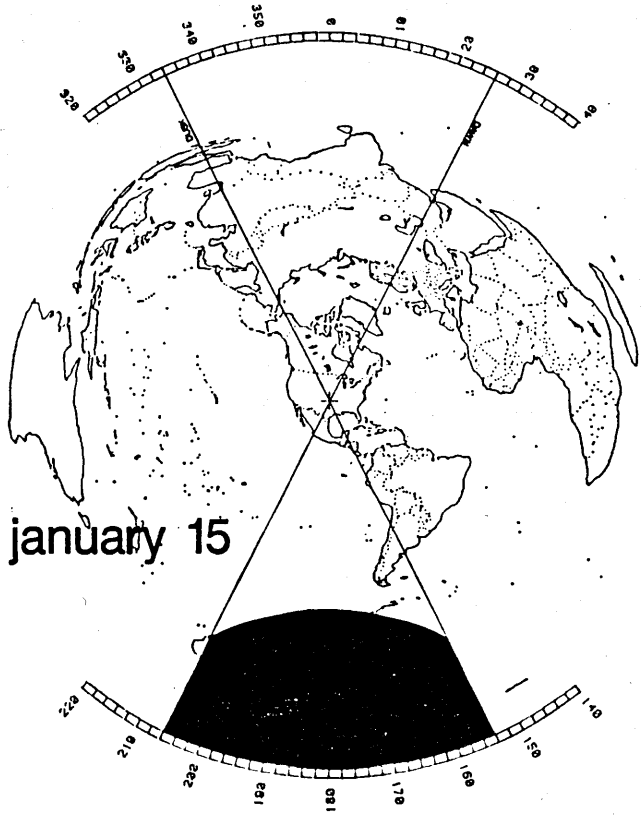
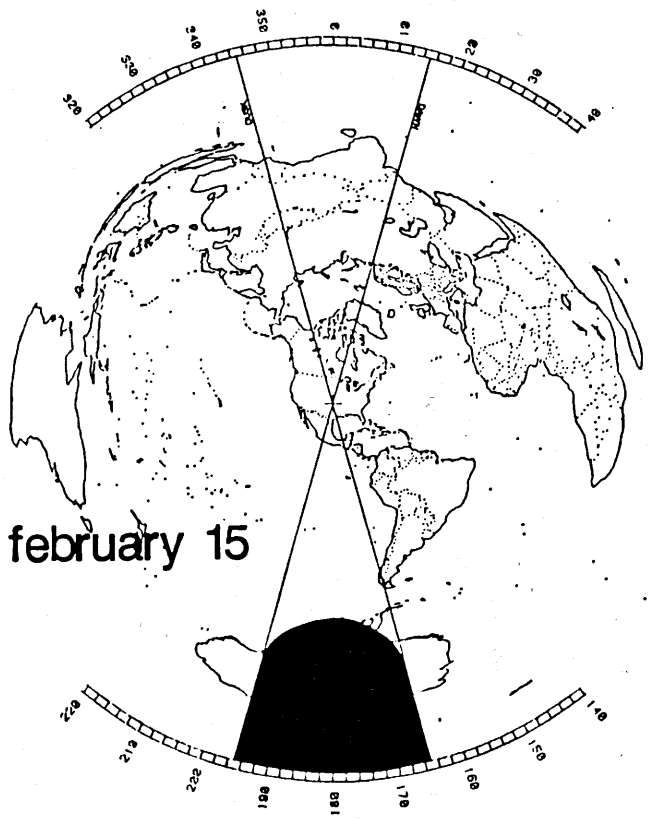
FIGURE 7




mediumwave and tropical bands solar blanking study
centered on
stillwater, oklahoma

FIGURE 8

What are the implications of Solar Blanking? They are fairly simple. Be conscious of what part of the globe is hidden from you by Solar Blanking and don't spend long hours trying to DX those locations at that time of the year on Medium Wave or the Tropical Bands.

You should clearly note and carefully consider an opposite/converse effect to Tropical Band Solar Blanking:

For Asian transmissions which are on frequencies which propagate best during the day (11 to 30 MegaHertz) the large amount of daylight present on our Great Circle paths during the Northern Hemisphere Summer is a real advantage. The sun practically builds a propagational ladder up the far side of the planet for high band signals headed our way during our hours of darkness. It was no accident that Kirk Allen of Ponca City, Oklahoma, finally got Radio Bangladesh on the 15 MegaHertz band in mid-May... He heard them around 0400 UTC!

The subject of terminator mechanics and its implications on DXing is a difficult one to visualize and to comprehend and equally difficult to explain. It is hoped that the tools suggested here can assist you in using this interesting aspect of our hobby to your benefit.

**AUTHOR'S END NOTES**

A) The assumption that SR/SS times do not change at the Equator is common in articles and books published on this subject by senior SWL's and radio amateurs. This assumption is dangerously wrong, if you are attempting to determine relatively accurate SR/SS times for graylining! The "no change" assumption is called "Mean Solar Time" and does not take into account the shift of SR/SS times caused by the "wobble" of the Earth on its own axis annually. The "wobble" phenomenon, and its effect on SR/SS times, was illustrated on most old globes by a large figure 8 pattern called the "analemma". The "wobble" phenomenon really cannot be ignored in graylining because it generates an error in calculation of SR/SS times of as much as +14 minutes (mid-February) to -16 minutes (early November).

B) The fact that long distance radio signals tend to reach us along Great Circle routes is well established experimentally and is used every day by radio amateurs with rotatable beam antennas. However, like much else in physics, this fact is not ALWAYS true. Paths of transmissions which pass near the more intense magnetic fields in the polar regions may experience bending. The transmitted wave or ray may also encounter one of the rogue "clouds" in the ionosphere and actually seem to turn to the side, causing very unusual propagation. However, as a daily experience, it is safe to say that "all" signals follow Great Circle paths.

The same caution should be applied to the idea of solar blanking. It is pretty much of a scholarly catechism to "never say never," since the physical world is distinctly non-homogenous and sometimes quite unpredictable. It may not be impossible to receive Tropical Band signals through the polar disk of perpetual light under some wildly unusual circumstances. However, again as a practical matter, solar blanking of Tropical Band and Medium Wave signals is a very predictable phenomenon.

C) The Azimuthal-Equidistance Maps, drawn on any specified QTH and reproduced about 9 1/2" in diameter are available from Bill Johnston, N5KR, 1808 Pomona Drive, Las Cruces, NM 88001.