Converting a Lunar Distance to GMT

Subject: Converting a Lunar Distance to GMT
From: Bruce Stark (*Stark4677@XXX.XXX*)
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Dan Allen, George Huxtable and others pointed out some time ago that the cookbook explanations provided with my Tables for Clearing didn't satisfy everyone. Some people like to know more than just WHAT to do. It's a good point, and I finally began, in an April 28th posting, to deal with it. This is a continuation of that posting.

The next step has to do with converting a cleared distance to GMT. That, in turn, will lead to a discussion of the whys and hows of the Tables for Clearing the Lunar Distance.

Until about ninety years ago the Nautical Almanac gave pre-calculated comparing distances every third hour. Suppose you'd measured and cleared the distance between the moon and Regulus. You'd find, in the Almanac, the two tabulated distances of Regulus from the moon that your observed distance fit between. Then, proportioning change in time to agree with change in distance, you'd find what your watch would have read, had it been keeping Greenwich time, at the moment you measured your distance.

The Almanac doesn't give distances now, but it does give the GHAs and declinations of the bodies for every hour. With an electronic calculator and the law of cosines for spherical triangles you can work out comparing distances yourself.

But if you don't like to depend on electronics you'll need a more refined formula than the law of cosines. The cosine-haversine is ideal. You can use it with a set of nautical tables, such as Norie's, or those in the WW II era Bowditch.

Or, if you like, you can do the job with my Tables for Clearing. They include a form for entering the Almanac data and the functions you'll need from the Tables. Then, after you've calculated comparing distances, you can use tables 7 and 8 to proportion for GMT. There are advantages to using the Tables:

1) You don't have to know anything about logarithmic calculation.

2) You don't have to interpolate, or do any other mental arithmetic.

3) The reliable precision will be slightly better, since nothing is lost in interpolation or in the conversion of logarithms to natural values.

The formula I use to calculate comparing distances is simply the cosine-haversine. Fred has pointed that out. But the formula that clears the distance, and that led to the development of the tables, is more complicated. I had combined the old time sight formula with the cosine-haversine, and was trying to work it into an all-haversine equation. Three quarters of the way through a sheet of notebook paper the term (cos M cos S)/(cos m cos s) appeared in the equation. Everything else was in haversines, and that ratio of cosines obviously had a narrow range of values. Might its logarithm fit into a table? Later I realized it already was in a table, the "logarithmic difference" table used with Dunthorne's, Borda's, and similar methods of clearing.

Here is the equation. Since I don't know how else to indicate it in this e-mail program, the phrase "sq. root of" will have to stand in for the radical sign.

hav D = sq. root of {hav [d - (m ~ s)] * hav [d + (m ~ s)]} * [(cos M * cos S)/(cos m * cos s)] + hav (M ~ S)

I've already pointed out that you don't have to understand logarithms to use the Tables for Clearing. You don't have to know you're using logs. In case anyone is interested, here's a brief explanation of why:

The log of a number greater than one is positive. The log of a number less than one is negative. Nautical tables were designed to handle calculations that included a mix of positive and negative logarithms. Some calculations called for summing from three to six logs at once. Not handy if some were positive and some negative. So +10 was applied to everything that went into the trig-log table. That way all the logs could be treated the same. But the navigator had to discard and borrow tens to suit his calculation.

In the equation above only the logarithmic difference (the log of that ratio of cosines) and log haversines are needed. Both are always negative. So is the log cosine used to calculate comparing distances from the Almanac. All three are left negative. The Gaussian log, used to get past the + sign in front of "hav (M ~ S)," is always positive, so is subtracted. This simplifies matters, and saves figures.

I'll try before long to post something about the individual tables in the set.

Bruce

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