DO STRATWARMS AFFECT 160M PROPAGATION?
A Look at the North America to Europe Path

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(this article appeared in the January 1998 issue of The Low Band Monitor)

Stratwarms (stratospheric warmings) occur quite regularly throughout our winter months. Figure 1 shows the number of days per month averaged over the last 10 years that a stratwarm was reported.

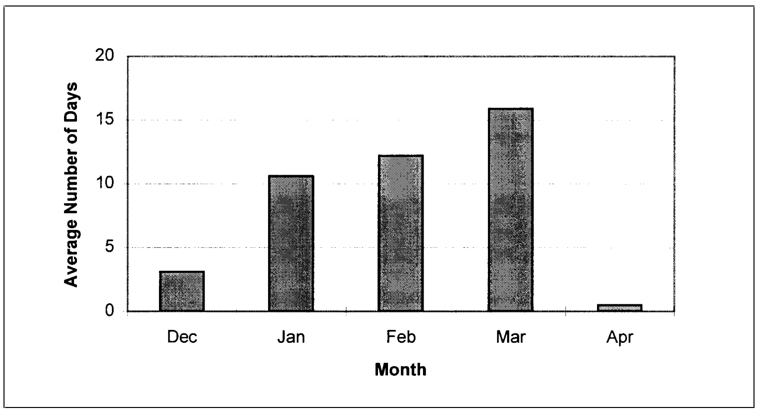

Figure 1 Average Number of Stratwarm Days per Month for the Last 10 Years (Dec 87 - Apr 97)

Note that stratwarms have only occurred in December, January, February, March, and April for these past 10 years. For a more detailed description of the how's and why's of stratwarms, see my Technical Correspondence column article "Stratwarms and Their Effect on HF propagation" in the February 1997 issue of QST.

Stratwarms occur in the polar regions of Siberia, in the northern extremities of the US and Canada (KL7 and VE8), in the North Atlantic, and in northern Europe. As explained in the QST article, this warming spills out NO (nitric oxide) from the polar cap into the lower latitudes. This NO is easily ionized by solar radiation, resulting in increased absorption in the D region during daylight hours and potential degradation of paths in and equatorward of the warming area. But as mentioned in the QST article, when applied to our 160m work at night when the D region is almost non-existent, it is unlikely that stratwarms impact 160m propagation.

This is supported by some cursory observations. First, since starting my quest for 160m DXCC in the fall of 1995, I've had several notable nights when conditions to Europe from Northeast Indiana were excellent for my modest station (Kenwood TS-180S, Commander HF-1250 amp, inverted-L with elevated radials for transmit and receive, and a EWE receiving antenna to the northeast). For example, 1/11/96, 3/2/96, 1/26/97, and 2/16/97 were nights that signals were above average for me and I worked an above average amount of Europeans. It is interesting to note that the first two dates were on days with stratwarms reported, while the last two dates weren't. Second, in the August 1994 issue of The Low Band Monitor (edited by K0CS), 13 operators reported which days of 1993 they considered best. Of the 95 total best days reported, 48 of those best days fell in stratwarm months (December through April). Half of those best 48 days were on days when stratwarms were reported. These two observations, admittedly not very scientific, suggest that stratwarms do not affect our 160m propagation conditions.

In order to do a better study, I asked IV3PRK for his 160m log for the period September 1995 to September 1997 (his article "160M Propagation - A Long Term Look" in the July 1997 issue of The Low Band Monitor alerted me that he had some good log data that would help in a study of this nature). With this data, it is now possible to take a more objective look at the effects (if any) that stratwarms have on 160m propagation. Figure 2 shows the paths from Italy to the East Coast, Midwest, and West Coast of North America.

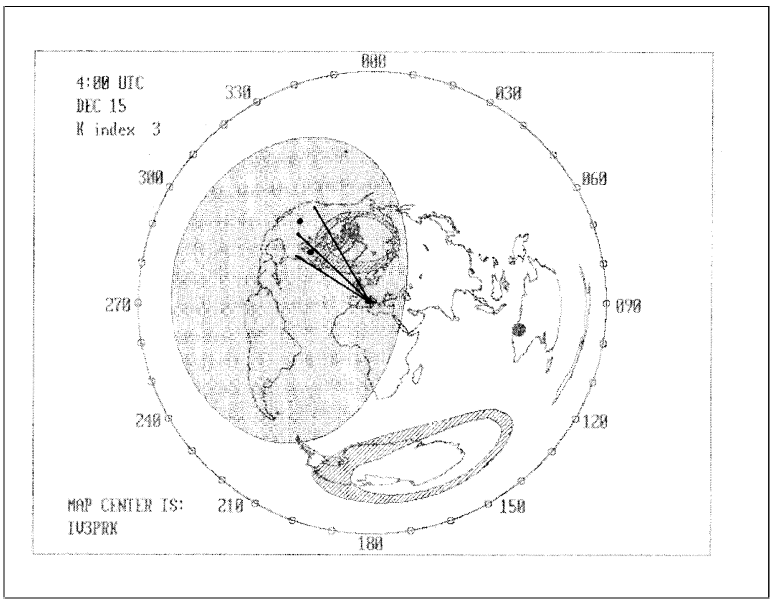

Figure 2 Italy to North America Paths

If stratwarms do affect our night-time 160m DXing, these three paths would be affected based on the previous discussion of where stratwarms and increased absorption occur.

My first thought was to compare the number of QSOs in the non-stratwarm months of September through November with the number of QSOs in the stratwarm months of January through March. This would allow a comparison that straddles the winter solstice - in other words, solar illumination along the path would be similar for the two periods as long as September was compared to March, October was compared to February, and November was compared to January. But there's a problem with this approach. The so-called stratwarm months have many days without stratwarms. This drove me to approach the comparison in a different way - by comparing QSOs on a daily basis during stratwarm months.

The first analysis was to take a macro view of the number of QSOs and number of stratwarm days during the stratwarm months of Dec 95 through Apr 96 and Dec 96 through Apr 97. This data is tabulated in Figure 3.

Month/Year	Number of QSOs	Number of Stratwarm Days
Dec 95	203	0
Jan 96	113	20
Feb 96	103	17
Mar 96	71	30
Apr 96	24	4
Dec 96	77	5
Jan 97	122	5
Feb 97	85	6
Mar 97	122	0
Apr 97	50	0
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totals	970	87

Figure 3 Number of QSOs versus Number of Stratwarm Days

A linear regression analysis of the ten pairs of QSOs versus stratwarm days only gave a correlation coefficient of 0.14. That initial look says there's not much of a correlation between IV3PRK's 160m QSOs and stratwarms. Remember that +1 indicates a direct correlation, 0 indicates no correlation, and -1 indicates an inverse correlation.

This led me to go further into the details of IV3PRK's log. But first one parameter must be addressed. That parameter is the k-index - its effect must be separated out to assure that a day with no QSOs was due to a stratwarm day and not a day with a high k-index.

To do this, I'll use the data from the Ottawa magnetometer (located at 45N/76W). It has two advantages over the Boulder magnetometer - it's closer to the paths in question and it's closer to the auroral zone. Figure 2 shows the location of Ottawa (the dot near the Midwest path just above the Great Lakes) and Boulder (the other dot) relative to the auroral zone and relative to the three paths from Italy to the East Coast, Midwest, and West Coast.

To assess the impact of the Ottawa k-index on the Italy to North America path, the month of December 1995 was chosen. During the 00-09 UTC time period for this month, IV3PRK had 199 QSOs to North America (that's 98% of the total QSOs in December - the other 4 were in the 21-00 UTC period). There were no stratwarms reported in Dec 95, allowing us to look at the effect of the k-index only.

Figure 4 shows the correlation of these QSOs to the Ottawa k-index (00-09 UTC was broken down into 00-03, 03-06, and 06-09).

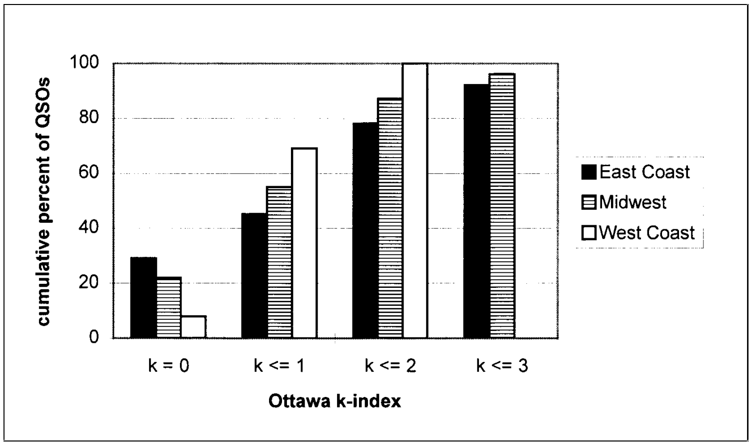

Figure 4 The Effect of the K-Index on the Number of QSOs

Note the different dependence based on the path. To summarize the figure, 92% of the East Coast QSOs were with the Ottawa k-index less than or equal to 3, 96% of the Midwest QSOs were with the k-index ≤ 3, and all of the West Coast QSOs were with the k-index ≤ 2. This makes sense based on how close each path is to the auroral zone. I then chose k less than or equal to 3 as the break point.

With the k-index separated out with pretty good certainty, the next step is to go to the stratwarm months and eliminate those days for which the Ottawa k-index was greater than 3. This should assure that if there were no QSOs on a given day, at least it wasn't due to a high k-index. Now the number of QSOs on stratwarm days can be compared to the number of QSOs on non-stratwarm days.

Before this is done, some general comments on stratwarms are in order. Stratwarms were first observed by German personnel in 1952. Stratwarms are still observed and recorded by the Free University of Berlin, and this is where the reports of stratwarms on the WWV announcements come from. Stratwarms occur in the areas discussed earlier, and they are categorized as Major or Minor. For the following comparison, I made the assumption that all stratwarms are equal - more on this later.

The results of this exercise are shown in Figure 5. I didn't use Apr 96, Dec 96, Jan 97, and Feb 97 because of the small quantity of stratwarm days (see Figure 3).

	non-stratwarm days			stratwarm days		
	# of non-stratwarm days	# of QSOs	QSOs/day	# of stratwarm days	# of QSOs	QSOs/day
Jan 96	10	18	1.8	20	81	4.1
Feb 96	8	10	1.3	15	13	0.9
Mar 96	1	3	3.0	25	45	1.8

Figure 5 Non-Stratwarm Days versus Stratwarm Days

So what does the data say? Dividing the number of QSOs by the number of available days gives a rough idea of how good propagation was. Feb 96 and Mar 96 suggest a slight adverse effect. Jan 96 suggests a significant enhancement in QSOs due to stratwarms.

What's going on here? Perhaps the assumption that all stratwarms are equal was wrong. To check this, I first looked at the data considering that Minor stratwarms had no impact and counted them as non-stratwarm days. The results were very similar to my initial assumption. Next I sorted out the stratwarms by location to make sure only those possibly affecting the path were analyzed. Doing that also gave results similar to my initial assumption.

The contradictory results of Figure 5 not only say that stratwarms do not affect 160m propagation, but they really hint that there's another variable, in addition to the k index, affecting 160m propagation. This is supported by the fact that there were many days with a low k-index and no stratwarms reported, but there weren't any QSOs. It could have been because IV3PRK wasn't on, but I strongly suspect it's an unknown variable in 160m propagation - something to do with the E region and the subsequent hop structure. Perhaps it's tied to ducting as hypothesized by NM7M in his Communications Quarterly article.

In summary, a detailed look at 160m log data for an Italy to North America path says that stratwarms do not affect 160m propagation. There's a physical reason for this as was explained earlier - the increased absorption mechanism essentially disappears at night when we do our 160m DXing. To those who turn off your 160m rig when you see a stratwarm report, I suggest you leave it on - you're probably missing QSOs.

Although this was a study of 160m propagation during night-time conditions, a comment about stratwarms during daylight hours on the higher HF bands is in order. The additional absorption due to a MAJOR stratwarm is indeed significant at low frequencies - around 50dB at 1MHz at noon and vertical incidence. But going through polar regions at noon dictates we'll probably be on 14MHz and above. With absorption decreased by one over the frequency squared, the resulting absorption is insignificant.

Thanks to IV3PRK for his 160m log data and to VE7BS for sending me the Ottawa k-index data. For those interested in the historical and present stratwarm data, it's at ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/stratwarms.