Stratospheric Warmings Revisited
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Way back in 1998 I wrote an article titled "Do Stratwarms Affect 160M Propagation?" It was published in the January 1998 issue of The Low Band Monitor. As a side note, The Low Band Monitor was published by Steve KØCS under the pen name Lance Johnson. It was a monthly newsletter for low band enthusiasts (160m, 80m and 40m) that ran from 1993-2010.

As you've probably guessed, the term 'stratwarm' is short for stratospheric warming. Historically stratwarms have occurred in the months of December, January, February, March and April 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. For a more detailed description of the how's and why's of stratwarms, see my Technical Correspondence column in the February 1997 issue of QST. In addition to the how's and why's, I made the statement that topbanders shouldn't worry about stratwarms, as the effect is minimal at night.

Thus the purpose of The Low Band Monitor article was to assess if my statement in the earlier Technical Correspondence column was correct. To do this, I used 160m log data from Luis IV3PRK from September 1995 through September 1997 to the East Coast, the Midwest and the West Coast of North America. I only used data from the months in which stratwarms occurred.

That narrowed the data down to ten total months. I totaled the number of QSOs in those months, and compared it to the number of stratwarm days in each month. The results of that analysis showed there wasn't much correlation between the number of QSOs and the number of stratwarm days.

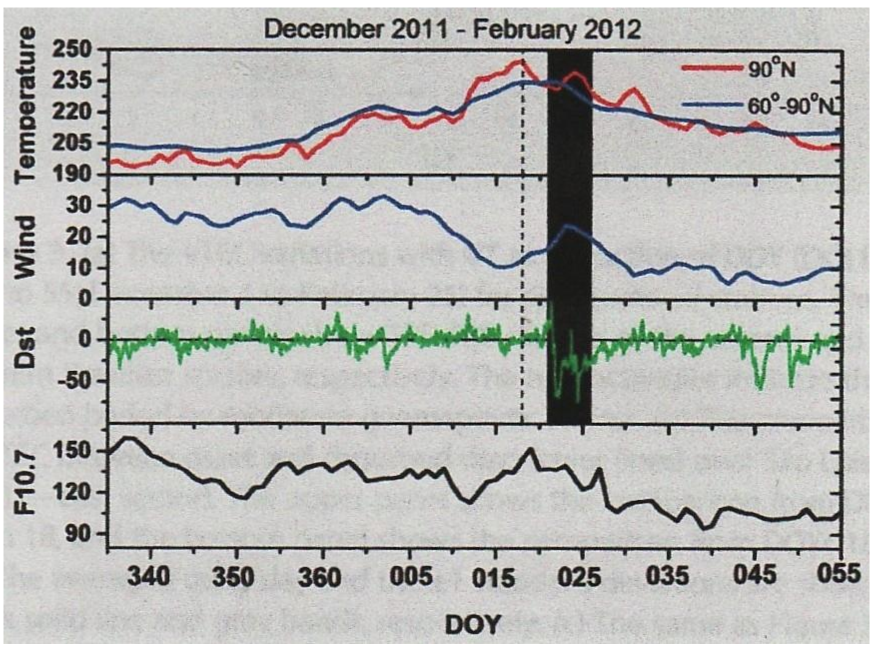
Next I looked at the effect of the K index, as that could decrease the number of QSOs and fool one into thinking that a stratwarm decreased the number of QSOs. That analysis showed that 92% of IV3PRK's QSOs to the East Coast were made when the Ottawa K index was less than or equal to 3. Similarly, 96% of the Midwest QSOs were made with the Ottawa K index less than or equal to 3. Finally, all of the West Coast QSOs were made when the Ottawa K index was less than or equal to 2. Doing this allowed me to eliminate those day/time pairs that had a prohibitive Ottawa K index (greater than 3 for the East Coast and Midwest paths, and greater than 2 for the West Coast paths). The results were:

	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

As can be seen, it just doesn't appear that stratwarms affect our 160m operations at night. In fact, there's a hint that stratwarms may help – but I'm guessing there's another variable in there that wasn't taken into account.

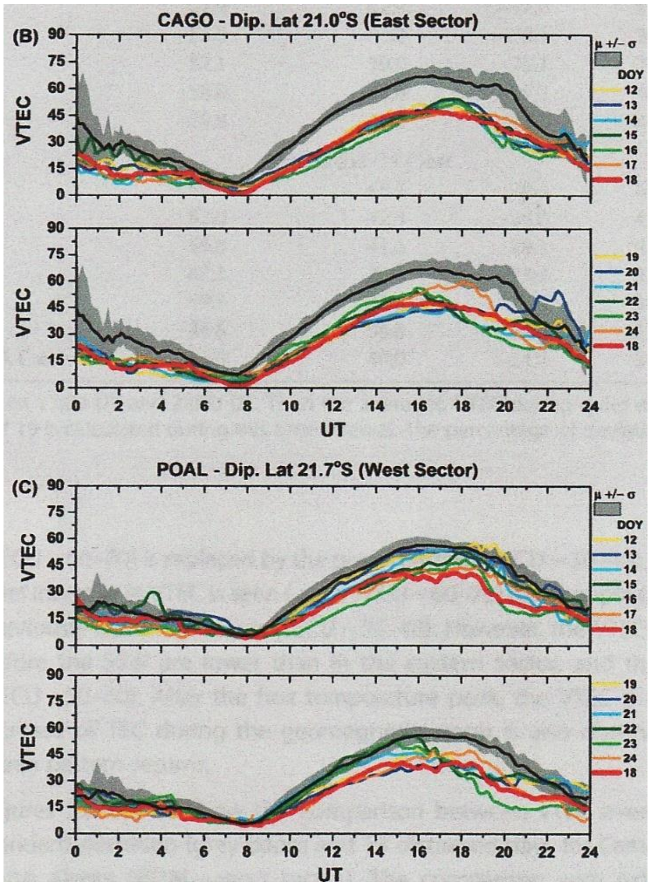
That's as far as I took it back in 1998. Since then, the GPS system allows us to measure TEC (Total Electron Contest) in the ionosphere. This is the total number of electrons in a square meter column from the bottom of the D region to well above the F2 region peak. Although TEC doesn't measure electrons in each region, we can approximate the number of electrons in the D region, in the E region and in the F region by using the well-known characteristics of electron density profiles. The bottom line is this will give us a good idea of what's happening electron-wise under stratospheric warming conditions.

A recent paper in the Journal of Geophysical Research [note 1] looked at a stratospheric warming and measured TEC on several days (including a non-stratwarm day) throughout the entire day. The following shows the temperature (at 90º N and at an average from 60º-90º N) in the stratosphere in the northern hemisphere.



The authors state that the warming began on December 24, 2011 (DOY = day of year = 359) and lasted until February 3, 2012 (DOY = 34). Also plotted are the stratospheric zonal wind, the Dst (an indication of how disturbed the Earth's magnetic field is, with negative values being more disturbed) and the 10.7 cm solar flux. The black rectangle highlights the days when the Earth's magnetic field was most disturbed.

Now let's look at the TEC over two GPS ground stations at 21-22 degrees south of the magnetic equator. The two stations (CAGO and POAL) are in the Brazilian sector, with one in the eastern sector and one in the western sector to see if there are any differences due to longitude.



The black line with the gray shading around it is an average non-stratwarm days, with the gray shading indicating the plus/minus 1 standard deviation limit. The different colors are the different days, with the DOY legend on the right next to the color legend.

The VTEC (Vertical TEC) is less during the day for both stations and essentially all the days, showing that a stratwarm does affect the daytime ionosphere. But during the night, the VTEC values pretty much trend towards the nighttime ionosphere on a non-stratwarm day. Thus we again conclude that stratwarms have a minimal impact on our 160m operations at night. I say 'minimal' as the small deviation at night from non-stratwarm conditions is likely to be in the F region, which doesn't affect 160m signal strength to any significant degree.

I should point out that the authors also presented data from four other GPS ground stations, with very similar results. Also, the authors stated that this event was a minor warming. Regardless of this last fact, I don't think this will change the conclusion.

Note 1 F. Vieira, P. R. Fagundes, K. Venkatech, L. P. Goncharenko, and V.G. Pillat; *Total electron content disturbances during minor sudden stratospheric warming over the Brazilian region: A case study during January 2012*; **Journal of Geophysical Research: Space Physics**; 10.1002/2016JA023650; February 2017