T40-4-1 SOME NON-TECHNICAL THOUGHTS ABOUT LONG DISTANCE RADIO RECEPTION IN THE MEDIUM WAVES

by Gene Martin

(Ed. note: "Medium wave," as used herein, means the AM broadcast band, 540 to 1600 kHz, as opposed to "longwave" or "shortwave.")

Introduction

This is going to be an essay, not any kind of technical treatise. Let those who feel comfortable and informed about such obscure matters as the upper F region and the lower E region, signal absorption, as well as the vertical gradient of ionization density, speculate about them to their heart's content. I am not on speaking terms with any of them and there will be no reference to them in this writing. These ideas about long-distance radio reception have been taking form for several years, mainly inspired by the repeated failures of conventional propagation theories to account for what often happened. I have outlined these thoughts and new concepts to both Father Jack Pejza and Glenn Hauser. Neither one of these two veteran DXers either endorses these new ideas nor do they reject them. Both agree that I should publish them.

What I bring to this subject is considerable knowledge of the whole atmosphere. Since 1955, I have been writing on that subject, incidentally making my living in that manner, a writer on weather and all sorts of related atmospheric phenomena. Add to that the curiosity of a specialized DXer for many years, whose list of countries logged has been stuck at 66 now for more than a year. Toward the end of this essay, I will offer a possible explanation for the famous Midwinter Anomaly which, as I understand it, has escaped logical explanation thus far. Now let us proceed with this essay.

Looking for a pattern --

What are the major characteristics of long distance radio reception in these medium waves -- involving distances from 5,000 to 9,000 miles? Is it possible to find any kind of pattern in this panorama of weak and erratic signals from far places across the round earth? I believe there are patterns which have to do with seasons and geography, the upper atmosphere, the distribution of cold and heat at the earth's surface. Possibly there is some new light to be thrown onto certain long-standing mysteries in the medium waves.

The first step into any kind of scientific inquiry is to describe the subject under investigation -- put down in one-two-three order its most conspicuous characteristics. In this connection, radio skywave theorists seem to display a minimum of curiosity about one thing which surely has excellent credentials as the outstanding fact about long-distance reception.

This often-disregarded fact is that every month of the year, broadcast-band signals are able to cross the Equator in both directions between the North and South Temperate Zones. This is a pattern of regular reception year-round over distances from 6,000 to 9,000 miles. Students of propagation are well-acquainted with it, although they seem to take it for granted rather than seek an explanation for it. I believe this dependable year-round interchange of signals between these Northern and Southern portions of the earth may have something to tell us about radio reception over extensive areas where there is no regularity in reception patterns. It may be quite instructive, for example, in understanding the mysteries of trans-Atlantic and trans-Pacific reception in North America.

When Argentina is heard in Europe or North America -- when Australia is heard in Europe or Japan — when a European station is heard in Australia or South Africa -- this is medium-wave signal transmission right across the Tropics, a belt of heat 3,300 miles wide at its minimum. The interchange of Australian and North American signals crosses the Tropics at such an angle that the radio wave involved crosses a tropical distance closer to 5,000 miles than a mere 3,300.

A re-evaluation of summer --

Far-ranging medium wave transmissions cross this wide belt of heat on the earth on a regular basis every month of the year. The fact is so striking, it demands attention!

The Tropics offer no handicap to long distance reception, although what the Tropics amount to is a permanent zone of summer on the earth -- and DXers for many years have viewed summer as their worst enemy.

Perhaps the DXer's opinions about summer need some reconsideration, maybe some qualifying. Could it be that except for its static levels and the brevity of summer nights, summertime signals from distant places might be as strong as in any other season? DXers in Western North America who often hear such places as Chile, New Zealand, Australia, and even Eastern Asia in the atmospherically-quiet period just before dawn on summer mornings already know that this is the case. At my location, in fact, the summertime signal strength from 1YA-760 in New Zealand has proved itself to be much better in years past than wintertime New Zealand signals. In recent years, KFMB, San Diego, on the same frequency 24 hours a day, prevents my hearing 1YA.

So this perpetual summertime in the Tropics does not handicap the radio waves that cross it from North to South or from South to North. Orthodox thinkers about propagation accept this as a fact of life and then go on to other considerations. But wait a minute! Another question cries out to be asked. Is it possible that the existence of this wide area of heat is a factor that is actually highly-favorable to long distance signals in the medium waves? And a secondary question is whether there are other places on the earth where warmth in the lower atmosphere has a favorable effect on long distance reception? That question will be explored later on in this essay, but for the time being, let us look for the atmospheric mechanism at work in the Tropics which aids and abets radio signals across the area.

A possible, and perhaps even probable, explanation of the mechanism is to be found in some elementary facts about the earth's atmosphere.

An area of extensive ignorance --

The atmosphere is arranged in layers: the troposphere, the stratosphere, the mesosphere, and the ionosphere -- the electrified upper-air region where radio signals strike certain reflecting layers and bounce back to earth. The troposphere next to the earth is the region where all weather occurs, where air currents move up and down, as well as laterally. At the top of the troposphere, meteorologists have found that the temperature is 70 below zero, Fahrenheit, year-round and worldwide. In the next layer up, the stratosphere, temperature rises, perhaps up to 30 or 40 degrees above at a height of 25 to 30 miles. Next layer up is the little-known mesosphere, and above that the radio-significant ionosphere. But sure knowledge about these atmospheric layers decreases all the way up. Our ignorance about the mesosphere and the ionosphere is so extensive that some atmospheric scientists have coined the word, "ignorosphere" -- put the accent on Ig -- to describe the atmosphere above the 25-mile mark.

Two scientists who prepared Encyclopedia Britannica articles on the ionosphere disagree as to whether that layer begins at 40 miles or 50 miles up.

The most likely reason for uncertainty and disagreement about the upper atmosphere is that all the boundaries between layers and the layers themselves are changeable. Scientists agree that the ionosphere varies in height above the earth. It varies between day and night. It varies with the seasons and with latitude. Radio's reflecting layers in the ionosphere are also subject to this variation with latitude, with the seasons, and between day and night. Apparently there are no fixed boundaries, no fixed elevations in the upper atmosphere.

The troposphere, the air's bottom layer, has a more definite upper level, for we can get up there and locate it without any reasonable doubt. Here are the highly-pertinent facts about the troposphere: it is 10 or 11 miles thick over the

Equator, but only five miles over the Poles. This brings into being the atmospheric oddity that it is colder ten miles above the Equator than it is that same distance over the Poles. Ten miles over the Poles you are in the stratosphere, not the troposphere!

These circumstances may have everything to do with the observed patterns of long-distance radio transmission all over the earth.

A hypothesis is presented --

If the troposphere rises high above the earth over the Tropics and clings low to the earth in Polar regions, it's a reasonable assumption that the atmospheric layers above it are correspondingly affected. This would include the ionosphere and its reflecting layers.

So here is my theory: Year-round interchange of medium-wave radio signals between the North and South Temperate Zones occurs because these reflecting layers are always at high, favorable levels over the Tropics. (I wonder if this hypothesis has ever been put into words before.) Isn't this circumstance the possible, or probable, mechanism which facilitates the reception of Japan in Australia -- Argentina in Europe -- New Zealand in North America? And vice-versa for all of them?

Doesn't this also account for the regular, dependable, day-in and day-out reception of many stations in the Northern Tropics throughout North America, signals which do not hurdle the Equator? They too would be benefitted by this greater height of the reflecting layers.

If we accept the concept of a high and favorable ionosphere always over the Tropics, we may be on the road to understanding the patterns of medium-wave reception from Western North America to Northern Europe, from North America to Northeast Asia, and from Western Europe to Northeastern Asia. All of these involve transmission paths across far-northern or Arctic regions, and there is a conspicuous absence of the regularity which marks radio transmission between the two temperate zones.

Reception of European stations in the Eastern part of North America occurs many nights of the year, even including summer nights. But hearing one of the Northern Europeans along the Pacific Coast is a much rarer event, although it happens in most of the years. There is a somewhat large family of Pacific Coast international DXers who listen for Europe at all possible times, so we have good information as to how often and when the Europeans reach the West Coast.

Northern Europe to the Pacific Coast is a path which crosses the Arctic.

In the early summer, Europe is never heard on the West Coast because the Arctic is having its annual visit by the midnight sun, no night-time at all over millions of square miles around the top of the earth. By August, change is coming on, and the sun withdraws 10 degrees during the month. By the end of August, the 24-hour period of daylight extends outward from the Pole only 600 miles. Its summer solstice extension had been just over 1600 miles.

It is usually during September in the good DXing years when the first European stations are heard in Western North America. By then, a substantial amount of darkness has been restored across the high latitudes which European signals have to cross, and there is one more consideration which deserves to be noted.

In September and October, the Arctic and sub-Arctic regions of North America are still held in the afterglow of their brief summertime. It is not truly warm, but relatively warm in the high latitudes of Greenland, Labrador, and Keewatin. In any event, it is much milder up there in late summer and early fall than it will be in January, February, and March.

A condition highly favorable to the far-ranging skywave --

It is during this period of late summer and early fall during the great DXing years when the Pacific Coast DXers hear Europe most often and with the best signals. The statistical dominance of this period is so remarkable that it surely points to some factor highly favorable to long distance signal propagation. It is the same period, late summer and early fall, when European DXers hear such places as Japan and Northeast Asia most often and with the best signals.

These events concentrate themselves in the fall, rather than in deep winter when night-time has stretched out to its greatest extent.

In Western North America, after the first Europeans are heard in September, they are heard again at intervals during October, November, and December. October is probably the best month, better than November, as November in turn is better than December. It was early October, 1969, when Dr. Richard Wood found German medium-wave signals arriving in the Hawaiian Islands, virtually over the Pole.

After January 1, in the great majority of the years, West Coast DXers listen in vain for any signals from Europe. The A and K indices may remain at low levels for weeks at a stretch without producing any European reception on the West Coast, and this pattern customarily holds across January, February, and March. You can add April and May for good measure.

So it becomes appropriate to inquire what is the difference between the days around the autumnal equinox and those around the vernal (spring) equinox as it pertains to propagating medium-wave signals between Northern Europe and the Pacific Coast. Both of them provide the same hours of darkness, close to 12 hours more or less. Britain, France, Germany, and other Europeans display a conspicuous preference for reaching the West Coast on dates near the autumnal equinox, and for a few weeks afterwards. But any European reception by the Pacific on dates near the vernal equinox is virtually unknown or unprecedented. (It is always hazardous to declare that such a thing never happens, in discussing any atmospheric phenomenon. Exceptions to the usual rules do occur, and sometimes the exceptions are vastly informative, and serve to reinforce the general rule. More on this later.)

There is only one difference between the two equinoxes which you can lay a finger on. September 23 comes at a time when Arctic regions remain relatively warm, still held in the afterglow of summer. By March 21, these same latitudes are intensely cold, the Arctic winter having relaxed hardly at all.

At 63 degrees north latitude, Chesterfield Inlet, Canada, has an average January temperature of 26 below zero. The October average is 22 degrees above zero.

At Fort Good Hope, Canada, virtually on the Arctic Circle, the January average is 23 below, and the October average 21 above. Midwinter temperature averages from 40 to 50 below zero are also known in some Arctic locations, and the higher elevations of the Greenland ice cap feature averages as low as 60 below zero.

But ignoring Greenland, for the time being, it may be said that when Northern Canadian average temperatures are near 20 degrees, Northern European stations may reach the West Coast. But after January's bone-chilling minus quotations, and before any substantial warming has occured in the Arctic, these same stations fail to make it to the West Coast in the great majority of the years.

Intense cold -- friend or enemy?

So these Northern latitudes of North America are another place on the earth where relative warmth in the lower atmosphere appears to be the handmaiden of long-distance radio transmission across the area. A couple of other places remain to be mentioned.

DXers have always considered cold weather a favorable factor in their pursuit of remote places on the earth, but perhaps this is another notion that needs reconsideration.

The evidence suggests that extreme cold in high latitudes may become an adverse factor to propagation of radio signals across the area. If so, what possible atmospheric mechanism could be involved in shutting off medium-wave signals on the route from Europe to Western North America?

I offer the following hypothesis: The Arctic ionosphere and its reflecting layers settle closer and closer to the earth as summer gives way to fall in these latitudes. This settling is in response to the ever-increasing chill in the lower atmosphere. By deep winter and beyond, the reflecting layers may lie so close to the earth that they act to shut off skywave signals across the area.

Remember, the troposphere is only five miles high over the Poles to begin with, and the atmospheric layers above it are likewise stationed at lower levels, even when they are at their maximum heights.

An Arctic ionosphere gradually settling closer to earth across the autumn months might explain the month-by-month decline in European reception on the Pacific Coast. The reception pattern goes downhill across October-November-December, and by mid-January, if not before, the European frequencies are empty on the Pacific Coast.

Now, the Midwinter Anomaly --

Even during the most favorable DXing seasons, there come flare-ups of the aurora, geomagnetic storms, which eliminate European signals in Western North America. However, it is beyond dispute that some other something, not connected with auroral activity, also brings on the vanishing of European signals. This other something comes eventually in every winter, and it has been named the Midwinter Anomaly. The MWA is the mysterious disappearance of mainly European signals for the Western DXer, even though the A and K indices may remain at favorable low levels for days and days. To the DXer in Western North America, the MWA is primarily an Eastern thing, not really a Western condition.

It is my speculation that the Midwinter Anomaly sets in whenever the Arctic ionosphere has settled close enough to the earth that its reflecting layers no longer are able to expedite European signals across these high latitudes. The skywaves die out, disappear, and waver away, brought to earth before reaching Western North America. A lower reflecting layer would mean that any radio wave reflecting from it would not go as far, and would have to reflect more times in order to reach any distant point. Perhaps another way to say the same thing is that a lowered ionosphere in the Arctic might convert September's three-hop proposition into January's six-hop proposition.

The MWA makes its appearance in every winter, ranging over the calendar from mid-November in some years to about January 1 in many others. This uncertainty of its time of arrival is typical of the manner in which recurring atmospheric events invariably occur. The atmosphere is a poor time-keeper, so its recurring events come over a range of several weeks. The atmosphere never schedules them on the same calendar date each year. Thus, the MWA behaves in the same manner as many other atmospheric events, and we should never forget that the ionosphere is a part of the atmosphere. It is not something different and distinct.

DXers in Western Europe experience an apparently identical MWA of their own, which shuts off signals from Eastern Siberia and Japan when the deep chill of Northern Siberia settles down over the path of transmission. They hear these trans-Eurasian stations in the relatively-warm period of late summer and fall -- experience a period of fewer and fewer loggings as Christmas approaches -- and find January, February, March, and into April quite unproductive. In some years, Western Europeans find these trans-Eurasians beginning to return in April, but these spring loggings are small in number -- a minor percent of the stations heard the previous October.

I have taken this information from a trans-Eurasian reception report published a few years ago by "Sweden Calling DXers" (SCDX) and sent to me by Tom Carlsson, Uppsala, Sweden.

Western Europe to Northeastern Asia is the only other transmission path on earth which geographically and climatically duplicates in its mid-portions the conditions that prevail from Northern Europe to the North American West Coast.

It is also a third place on earth where the time of relative warmth in the lower atmosphere coincides with the time when far-ranging medium-wave signals are most likely to cross the area. Another one will be mentioned in a few more paragraphs.

I do not mean to suggest that the ionosphere in these boreal latitudes responds immediately to every incursion of Arctic chill that takes place in the fall. More likely, it responds to cumulative temperatures below, the steady decline of the temperature average from September into December.

Nor do I offer any estimate as to how low the ionosphere may sink before its reflecting layers begin hampering rather than promoting trans-Atlantic skywaves en route from England to the Pacific Coast. But inasmuch as the ionosphere is not at a fixed elevation above the earth -- inasmuch as it does alter its height as conditions change, I do suggest that it sinks low enough to bring on this vanishing of European signals on the West Coast.

Across the Northern Pacific --

This structure of speculation links the elevation of the ionosphere at any time to the temperature regime in the lower atmosphere: the warmer, the higher. The pattern of reception of Japan, Korea, and Eastern Siberia in Western North America bears out this hypothesis.

Stations in these places continue to be heard in the West all through the heart of winter and across the months of spring. There is no Midwinter Anomaly for them, although the transmission paths may reach points as far north as the vanished European signals. The difference is that the routes from Northeast Asia to Western North America are entirely oceanic. There is no intensely cold land mass to cross between Tokyo and San Francisco, as there is between San Francisco and London. The Northern Pacific is a veritable hot stove throughout the winter, contrasting greatly with the deep chill that settles over the Labrador-Greenland area. Therefore, I would surmise, the ionosphere over the Northern Pacific remains at a relatively high level throughout the winter and spring and often expedites the Northern Asiatics en route to the U.S. at times when no Europeans can be heard.

Of course, this Northern Pacific transmission path may be put out of business any time of year by the same solar activity which often hampers Northern trans-Atlantic signals.

However, the Northern Pacific is a readily-identifiable fourth place on the earth where warmth or relative warmth in the lower atmosphere seems to be highly favorable to the far-ranging signals which cross it.

Only the facts -- no theories --

To condense what has been submitted up to now in this essay into its main points can be accomplished in only a few words, for it is essentially a simple picture:

I Signal-interchange occurs year-round across the warm Tropics between the two temperate zones.

II Northern European signals reach the West Coast only during the time of year when relative warmth exists in the Arctic across the mid-portions of that transmission path.

III Western European DXers find the early months of fall by far the most favorable time for trans-Eurasian signals arriving on relatively-warm Arctic paths.

IV Finally, Northern Asiatics reach Western North America all through the winter and spring across a "hot stove" Pacific and are not affected by the Midwinter Anomaly.

Note that the preceding four points are all readily-observable facts about radio reception in the medium waves. They require no theory or hypothesis of any sort to be accepted.

What I have done is to take these four facts and come up with a hypothesis which might account for them. My hypothesis is a changeable ionosphere and the resulting changing heights of reflecting layers, now enhancing long-distance radio communication, now handicapping it. Surely, this is something less than a daring excursion into theory, for atmospheric scientists have been aware of the ionosphere's changeable nature for many years. So the hypothesis amounts to nothing more than applyin a known fact to observed phenomena.

An apparent contradiction becomes an affirmation --

This developing theory connecting warmth in the Arctic to skywave propagation across the region came under severe strain on March 1 and 6, 1977. Here in Denver on those dates, I found obviously European signals at 665, 683, 1205, and 1214. This was the first time I had ever detected

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European signals in March, that far into a new year. In addition, Nick Hall-Patch in Victoria, B.C., reported European carriers on 647, 665, 827, 863, 872, 1016, and 1043 on March 6. On the same date, Jim Young, Wrightwood, Calif., reported European carriers on 647, 665, 926, 1034, 1205, and 1214. It would seem these cases of reception might invalidate my theorizing, and I thought so too until one day in July, 1977, I came upon some information of great interest in Science News, June 11 issue. This was an item reporting on the abnormal atmospheric circulation that accompanied the extraordinarily severe winter of 1976-77 in the Eastern U.S. It was stated that winter had coincided with Arctic temperatures far above normal. All the way from Alaska to Labrador, the winter of 1976-77 had been unprecedentedly mild from November into March. Another publication, National Observer (Feb. 12, 1977), quoted Dr. Stephen Schneider of the National Center for Atmospheric Research, Boulder, Colorado, on that winter's abnormal warmth in the Arctic. Schneider said, "The upper level atmosphere over the Arctic, and even over the North Pole, had been warmer than it had been over the Great Lakes." (Schneider is the atmospheric scientist who often guests on Johnny Carson's Tonight Show.)

Now, in the light of this information about Arctic warmth during that winter, European signals reaching the Pacific Coast and Colorado in out-of-season March no longer seemed strange. They had been accounted for from a totally unexpected quarter, and the accounting was entirely in line with my theory about the importance of Arctic warmth to skywave propagation over the area. Briefly then, it would seem that Europeans reach the West Coast only when it is relatively warm in the Arctic, and if the season of warmth is extended abnormally long, then the Europeans reach the West Coast abnormally late in the season.

(Perhaps some stations, highly directional and packing a megawatt or two, are able to survive a trans-Arctic passage, overcoming any increase in number of required hops between distant points. Example: two million watts in anti-Soviet service from Western China blasting away in Moscow's direction on 1525, vaulting over Greenland into Eastern North America at times when the season and the A-index would seem to be against it. Second example: the now-phased-out VOA-Okinawa radiating a million watts at Korea on 1178, which often came into Denver at times when high latitude conditions were not favorable. It would be something less than revolutionary to learn that, with enough watts at work, all manner of unfavorable factors may be conquered in the medium waves.)

I have intentionally omitted here any extensive comment on trans-Atlantic reception in Eastern North America, for it isn't very far to Europe from points near the Atlantic. The transmission paths involved lie outside the Arctic; they would be much less affected by any lowering of reflecting layers in the Arctic ionosphere.

However, many DXers who pursue distant signals across the high latitudes of the earth have wondered why the months of the fall usually provide better reception conditions than they find in the depths of winter. So a lowered ionosphere in the mid-winter Arctic might explain why October is often such a fine month for DXing while January turns out poor. Even the East Coast international DXer is familiar with fine Octobers followed by not-so-fine Januarys, and this suggests the effects of a lowered Arctic ionosphere also may extend far southward to perhaps 35 to 40 degrees north latitude.

The picture of European reception on the Pacific Coast is one that can be seen with reasonable clarity, and it involves distances much greater than on the Atlantic Coast. By dealing mainly with Western North America and Europe, I have been concentrating on genuine long-distance signals similar to what you find from Buenos Aires to London.

So this is to lay these hypotheses on the table for consideration, comment, and criticism. Some of these are new ideas on the mysteries of international DXing and what may affect skywave propagation over great distances. At the least, I hope these ideas may point a direction where additional and future inquiry should be directed.

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