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BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

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In re Matter of:	)	
	)	
Amendment of Section 73.622(b) Table of Allotments, Digital Television Broadcast Stations Corpus Christi, Texas	)	MM Docket No. 99-277 RM-9666
	)	

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

To: Chief, Video Services Division

Comments on Notice of Proposed Rulemaking for Station KIII(TV)

The University of Houston System, licensee of noncommercial educational television station KUHT, NTSC Channel *8 (DTV Channel *9), Houston, Texas, by its counsel, files these comments on the Notice of Proposed Rulemaking ("NPRM") proposing the substitution of DTV Channel 8 for the assigned DTV Channel 47 for television station KIII, Corpus Christi, Texas, licensed to Channel 3 of Corpus Christi, Inc.

The University does not oppose the DTV channel substitution, but files these comments so that the Petitioner and the FCC are made aware of the phenomenon known as "Gulf Coast skipping" (also known as "skipping stone effect") and related tropospheric ducting as well as its potential impact on (i) the proposed DTV channel substitution; (ii) KUHT's analog Channel *8 operations and plans to use Channel *8 for DTV operations at the end of conversion; and (iii) KIII's proposed DTV operations on Channel 8.

Gulf Coast skipping, skipping stone effect, tropospheric ducting and related terms refer to the over-the-horizon (*i.e.*, beyond line-of-sight) propagation of radio signals caused by temperature inversion along the Gulf Coast. The University has experienced the effect of Gulf Coast skipping before. At various times, its viewers in the Beaumont, Texas area (which

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receives Station KUHT from a cable system that used an off-air microwave pick-up of the KUHT signal) have received a co-channel television signal from a Channel 8 television station in Florida or Laredo, Texas due to Gulf Coast skipping. The University believes that other television stations along the Gulf Coast would report similar experiences. Attached are printouts from various websites attesting to the existence of the phenomenon of "skipping stone effect" or tropospheric ducting and its impact well beyond the traditional "line-of-sight" limitations on signal propagation.

Obviously, the University is concerned that the substitution of DTV Channel 8 for KIII's assigned DTV channel (at the requested power level) will, as a result of Gulf Coast skipping or a related phenomenon, cause interference to the University's NTSC Channel 8 during the period of digital transition, as well as the University's eventual DTV operation on Channel 8.

The University requests that the FCC staff consider the phenomenon known as Gulf Coast skipping in reaching its decision in this rulemaking. The University also requests that, in the event that Gulf Coast skipping (or a similar phenomenon) does occur and result in interference to KUHT or KUHT-DTV due to the substitution of DTV Channel 8 for KIII's assigned DTV channel, the licensee for Station KIII should be required to ameliorate the problem. Moreover, the University requests that the Commission acknowledge now that, if the interference problem caused by KIII's DTV channel substitution cannot be resolved, the Commission will consider other long-term solutions to eliminate the interference, such as

conditions imposing power reduction or a directionalized antenna on Station KIII, substitution of another DTV channel for KIII, or other appropriate relief.

Respectfully Submitted,

The University of Houston System

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NOVEMBER 1, 1999

NDT: The history of VHF propagation beyond line of sight

Although one of Marconi's first spectacular demonstrations of communication by radio waves used a frequency around 1000 MHz, in 1896, his work on LF, MF and HF bands prevented him from experimenting further with VHF and above until 1928. Returning to Italy to assume the Presidency of the Italian Royal Academy, he took his research staff and their work with him. The Italian government requested him to experiment with communications in the low VHF region (just above 30 MHz) between Sardinia (Golfo Aranci) and the Italian mainland at Fiumicino. Using an effective radiated power of about 40 kW, Marconi demonstrated that communication was possible over a path of 270 km, about 8 times the optical range. Among these early observations was the fact that signal strengths in the winter were some 20 dB less than in summer.

Marconi first presumed that the radio waves were being refracted within the troposphere, saying in 1930:

From measurements effected recently it would seem that along the route between Sardinia and the Italian mainland this wave is refracted and contained within a space lying between the surface of the earth and a layer situated somewhat lower than the Heaviside layer.

At this time, theory was based on Watson's solution of diffraction around a smooth spherical earth (1919), which predicted an exponential decrease in signal strengths beyond the optical horizon of about 1.2 dB per mile (at 500 MHz). Thus, beyond line of sight propagation at VHF and above was considered to be a freak phenomenon, rather like optical mirages.

Further pioneering work at VHF and higher frequencies was carried out by Uda (Japan, 1930s), Pistor (Germany, 1930), and Clavier & Gallant (who established the first 2-way communication link across the Channel in 1933, using a frequency of 1500 MHz). However, it was still technically very difficult to construct transmitters and receivers capable of working reliably and accurately at these higher frequencies.

In 1932, Marconi and his team of scientists and engineers started a series of experiments designed to extend the range of communication at VHF and above. Using the steam yacht *Elettra* and stations on the Italian mainland, they demonstrated repeatedly that signals could be received reliably to about 3 or 4 times the optical range, although fading became deep and relatively rapid once beyond line of sight. They established that the angle of arrival of these signals was tangential to the horizon and in the direction of the transmitter, the basic geometry of tropo modes of propagation.

Unfortunately, attempts in 1932 to achieve a path of 400 km (between Rocca di Papa, Rome, and the *Elettra* in Venice Harbour) failed. In the autumn of 1933, though, Marconi achieved a total distance of 258 km (9 times optical) in spite of two groups of high hills in the path. This was probably the first evidence of tropospheric propagation which could not be explained by simple diffraction and refraction. This was reported to the Royal Academy of Italy on 14th August 1933, and an account has been given by G A Isted, one of Marconi's team at the time (see below).

BBC research also started in 1932, with the establishment of an experimental transmitter using 38.7 MHz at Broadcasting House, London, which was assessed at distances of up to 100 miles. The inauguration of BBC television transmissions in 1936 brought regular reports of signal reception up

to 200 miles away, and the BBC Research Department conducted tests over short periods at up to 500 miles distant.

The massive effort devoted to the development of radar systems by the USA and UK during the Second World War brought the next fruits. Although much of this work focussed on ducting tropo, which was beautifully demonstrated in many of the early radar experiments, interest in non-ducting modes was also fostered. The most accessible account of this work is the compilation by Kerr, which is still to be found in some bookshops (including Foyle's, Charing Cross Road, London). The contribution of amateurs, particularly Ross A Hull in the period 1934-1937, has been widely acknowledged.

Tropo propagation beyond line of sight became commercially important in 1949, when the USA licensing authority had to freeze the introduction of new TV stations because co-channel interference proved to be much greater than had been expected from the smooth sphere theory. A rapid growth in research resulted in the Booker-Gordon theory (1950), and later signal contributions by many others including Tatarskii. The BBC conducted further experiments between 1946 and 1957, using frequencies around 90 MHz, and others between 45 MHz and 560 MHz, and these are described by Rowden et al.

Eventually, tropo scatter links were used for commercial and military communications: early systems were installed in 1953, and they were popular during the 1960s and 70s, before satellites took over. Amateurs took advantage of the availability of VHF equipment following the Second World War, and from the 1950s onwards have regularly worked well beyond line of sight on VHF and above, particularly using single sideband (SSB, mode J3E) and Morse (CW, mode A1A).

So the next time that someone suggests that VHF propagation is only 'line of sight plus a third', tell them that they are 70 years out of date, and that the BBC knows they are wrong too!

Bibliography:

Bullington K (1955) Characteristics of beyond-the-horizon radio transmission. *Proceedings of the IRE* Oct 1955, 1175-1180.

Isted G A (1958) Guglielmo Marconi and communication beyond the horizon: a short historical note. IEE Symposium on Long-Distance Propagation above 30 Mc/s, 28 Jan 1958. Pp. 79-83.

Kerr D E (1951)(editor) *Propagation of Short Radio Waves.* Reprinted by Peter Peregrinus, 1987, ISBN 0-86341-099-5.

Rowden R A, Tagholm L F & Stark J W (1958) A survey of tropospheric wave propagation measurements by the BBC, 1946-1957. IEE Symposium on Long-Distance Propagation above 30 Mc/s, 28 Jan 1958. Pp. 84-90.

- and the books cited on the NDT Inner Sanctum page.

NDT Inner Sanctum

Home Page

Last updated 27 Dec 1998
Howard Oakley
Mail howard@quercus.demon.co.uk

NDT: Refraction as a mode of NDT

There are three likely refractive modes which can give rise to NDT:

- refraction through one or more convective cells
- refraction through natural discontinuities in radio refractive index, such as fronts, particularly occlusions
- refraction through other alterations in radio refractive index gradient, such as lee waves.

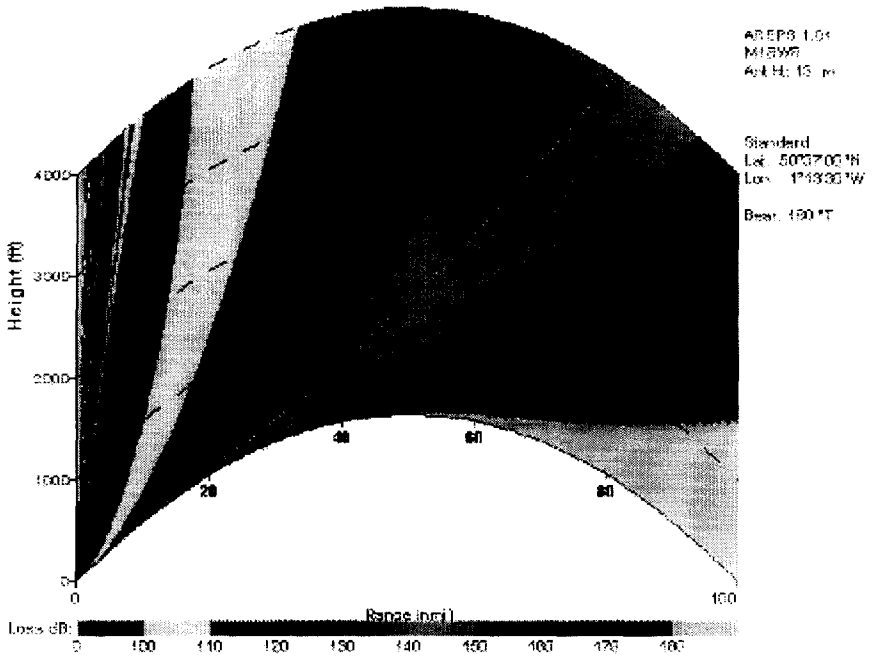
If you can think of others, particularly if you can give experimental evidence for them, please let me know.

You can estimate the height of convective cells responsible for the first mode of propagation, according to the time of day at which it first occurs. Because convective cells normally start near to the ground and ascend at about 1 km every 3 hours, on a long summer's day you are likely to see refractive tropo as follows:

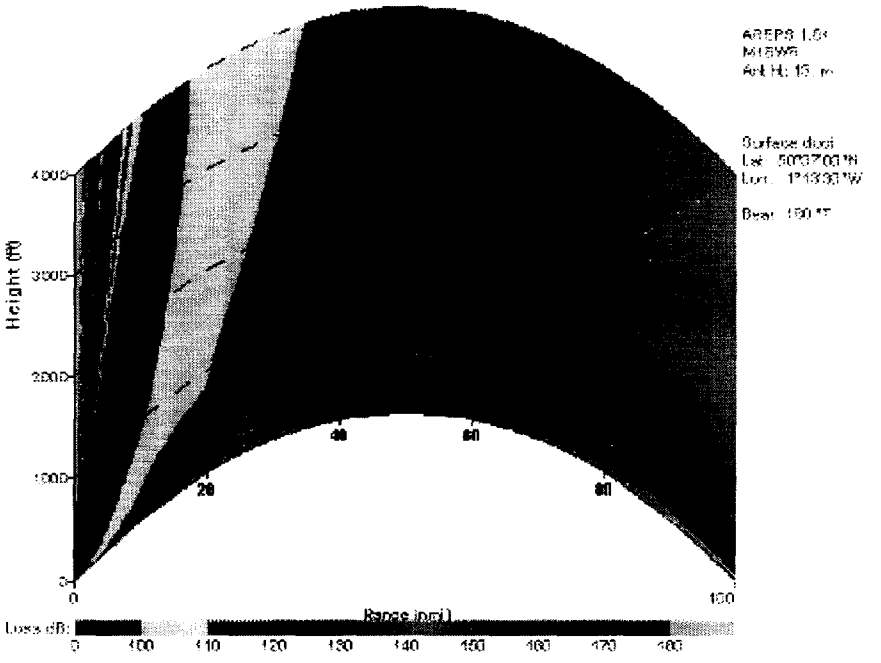
local time	height (km)
0900	1
1200	2
1500	3

It is much easier to model refractive modes than scatter. AREPS 1.01 is the US Navy's advanced refractive propagation modelling tool, which uses a combination of ray tracing and the parabolic equation method of predicting signal strengths. The following images produced by AREPS illustrate some important points about refractive modes. In each, the software has been used to predict signal loss (in dB, at 144.3 MHz) over a ground path of 100 nautical miles, and up to 4000 feet into the air (i.e. the lowest part of the lower troposphere). Regions with different losses are represented by colours, as shown in the key at the bottom of each (red, yellow = low loss, to dark green and blue = high loss). Although set up to model conditions at my home QTH, the numbers are relative rather than absolute.

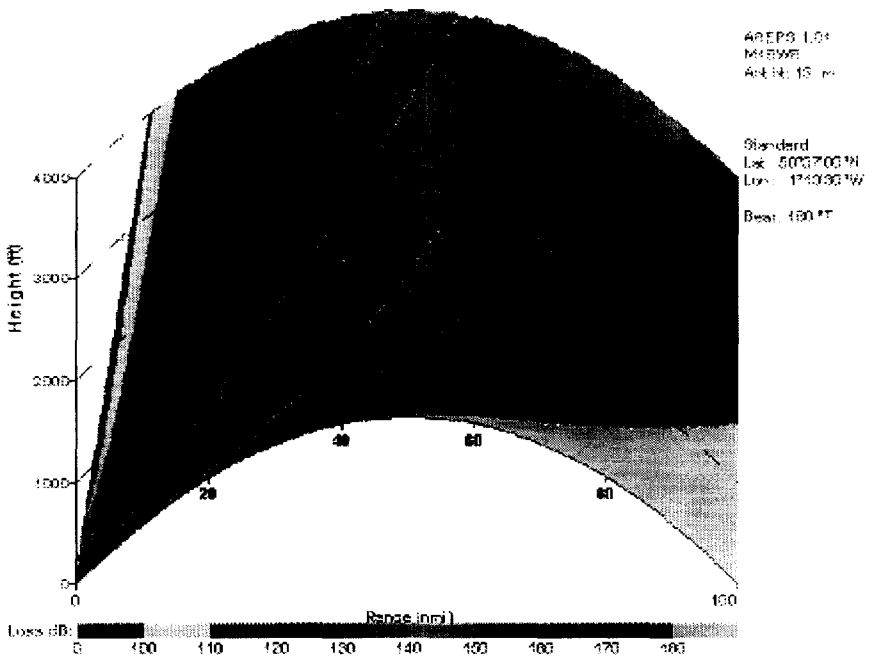
Signal loss over a sea path - standard conditions, no ducting or refractive NDT modes



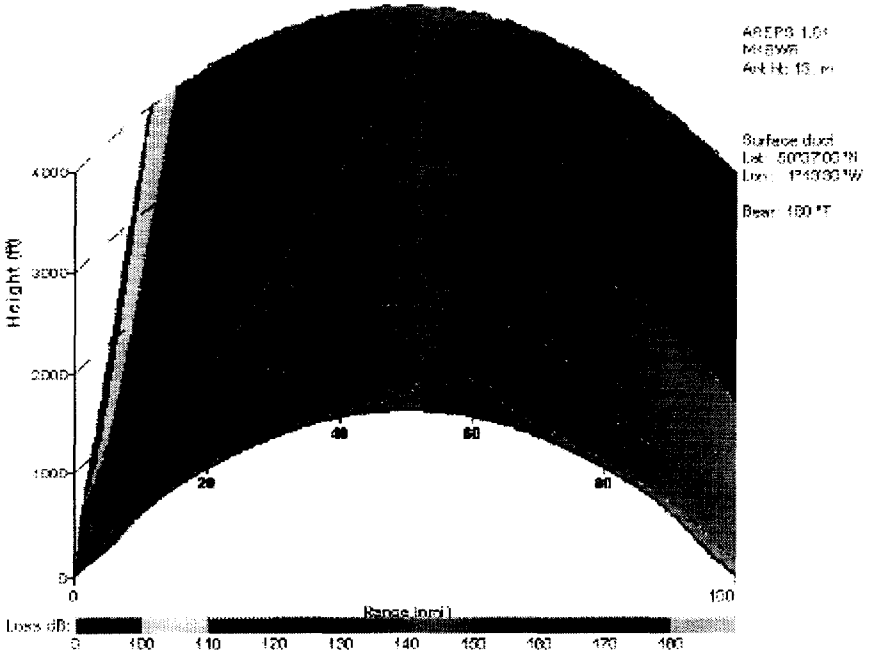
Signal loss over a sea path - surface ducting (at 1000 feet) present, showing its effect on both ducted and non-ducted radio waves



Signal loss over an obstructed path - standard conditions, no ducting or refractive NDT modes, illustrating how a poor take-off increases losses at elevation, but not at the greatest distances



Signal loss over an obstructed path - surface ducting (at 1000 feet) present, showing the increased losses resulting from a poor take-off



Although two of these examples are for surface ducts, the effect of convective cells should be similar, although the pseudo-duct produced by a series of cells would of course be considerably more leaky, resulting in higher losses.

NDT Inner Sanctum

Home Page

Last updated 27 Dec 1998

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TROPOSHERE PROPAGATION

THE KEY: Watch the Weather, Look for Temperature Inversions.

Weather patterns over the earth's surface at heights from a few thousand feet to a mile or two at times can create boundaries between air masses of different temperature and humidity characteristics. Stratified warm air over cool moist air may be responsible for bending wave downward to the earth. Under stable weather conditions large air masses can retain their characteristics for hours or even days.

At sunrise the air aloft is warmed more rapidly then the air near the earth's surface. As the sun goes lower late in the day the upper air is kept warm while the ground cools. In fair calm weather look for some Troposphere propagation during sunrise and sunset that may improve line of sight communication as much as 20db.

Tropospheric effect can show up "any" time in any season. However late spring and early fall are likely time for Temperature inversion but not rule out a winter warming trend to create a strong and stable temperature inversion.

Tropospheric ducting is the condition when communications of greater than a few hundred miles occurs. Instead of the wave propagating between the temperature inversion and the ground, the radio wave is between two atmospheric layers thus creating a duct. Distances of 1000s of miles may be experienced, for example between California and Hawaii. The trick is that both stations must be in the atmospheric duct or capable or transmitting into it. This type of propagation is most likely of 50Mhz and 144Mhz. Most likely any extra long communication in the UHF and VHF range can be attributed to tropospheric ducting.

Back to W7PXL's VHF UHF page.

Re: [RT] FM Signal Degrade

Lyle Henry-RADIO DOCTOR (*lyleh@almaak.usc.edu*)
Fri, 3 Oct 1997 20:43:03 -0700 (PDT)

- **Messages sorted by:** [date][thread][subject][author]
- **Next message:** Jim Turvaville: "Re: [RT] FM Signal Degrade"
- **Previous message:** Dave Fazakas: "Re: [RT] FM Signal Degrade"

Date: Fri, 3 Oct 1997 20:43:03 -0700 (PDT)

From: Lyle Henry-RADIO DOCTOR <lyleh@almaak.usc.edu>

To: radio-tech@broadcast.net

Subject: Re: [RT] FM Signal Degrade

In-Reply-To: <3435A3CF.176@btsg.com>

> *glen@mail.gmd-electronics.com wrote:*

> *One of the stations I contract for has been getting calls this week*
> *from listeners that used to pick them up and now can't. They are at*
> *90.5FM and 3KW. They are asking if it could be antenna problems?*
> *The transmitter reading haven't changed and VSWR is low. Could it*
> *only be atmospheric? Could it be transmission line? Could there be*
> *damage to the antenna? What steps should I take to find out?*

Don't worry about the antenna. This sounds like typical tropospheric behavior. We have it the better share of the year here along the California coast. Signals will get weaker than normal in the regular coverage area when they get trapped in a duct that is at the height of the transmitting antenna. Ducts are not as common, however, as single temperature inversions. When that happens, and the refractive index change is just a little below the transmitting antenna, a skipping stone effect occurs (as in throwing a stone at a low angle and bouncing it along on the surface of water) This seems to dramatically reduce the local signal strength as the signal is deflected up and into space or up to the underside of the next refractive layer (the duct situation). Only stable lapse conditions where the temperature and water vapor drop uniformly going up from the surface of the earth, result in the "normal" propagation mode in the lower atmosphere.

The example of the skipping stone effect that we see here is that stations at lower elevations suffer loss of signal strength locally coupled with strong signals for sometimes hundreds of miles. The stations on Mt. Wilson, high above the inversion layers hit it at a steep enough angle to go right on through and remain very stable in strength locally. And they tend to be much weaker at great distances with relatively little variation unless an inversion is very high. Our inversions tend to be at a fairly low elevation early in the spring, and higher as the summer and fall drag on. The inversions usually disappear in rainy or cold weather.

* *

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* *

- **Next message:** Jim Turvaville: "Re: [RT] FM Signal Degrade"
- **Previous message:** Dave Fazakas: "Re: [RT] FM Signal Degrade"

CERTIFICATE OF SERVICE

I hereby certify that a true copy of the foregoing Comments on Notice of Proposed Rulemaking for Station KIII(TV) was mailed first-class, postage prepaid, this 1st day of November, 1999 to the following:

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