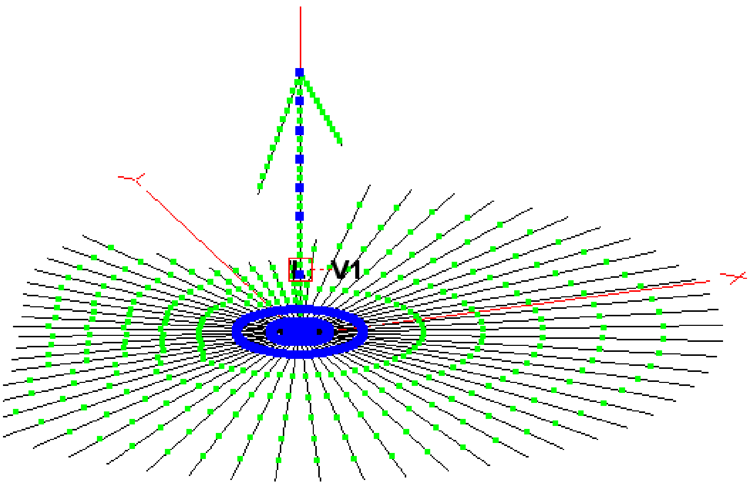
Polarization on the Low Bands

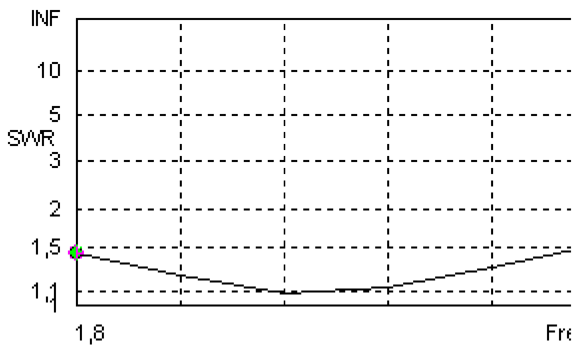
At the search of the best Tx antenna for a low-latitude location

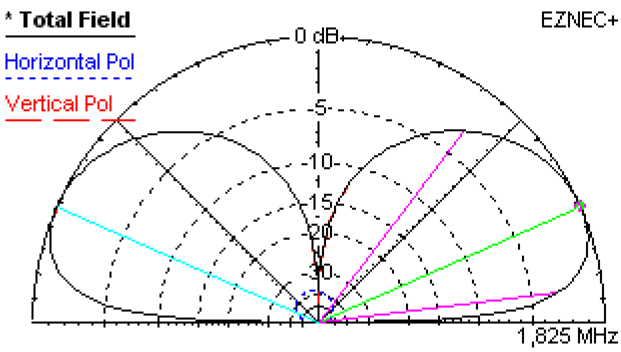
By Pierluigi "Luis" Mansutti IV3PRK

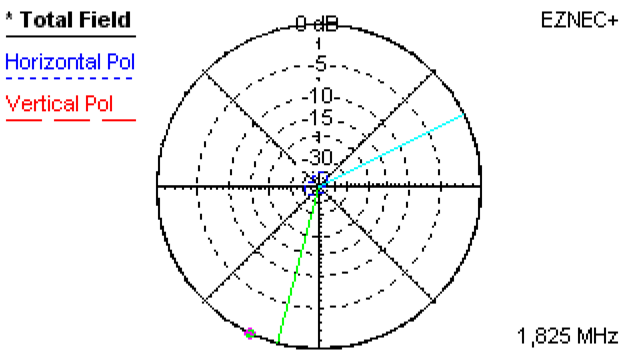
I'm going to move permanently to Ecuador, near Quito at 2.400 meters altitude. There I bought a 1.896 sq.meters terrain on a corner of an urbanization with two free sides which should let me put down the needed antennas for my 160 m. activity.

At the search of the most efficient transmitting antenna for 160 DXing I came out with the following design: a vertical T 27 m.high with two sloping wires each 13 m. long. Most of the 60 radials are ¼ wave long and only some of them are shorted where necessary. This model has a source impedance of 23,42 –j 1,12 ohms which is brought to a perfect match by means of an L Network with a shunt capacitance of 1.848 pF and a series inductor of 2,20 µH.









The resulting lobe is as desired for DXing, with most of radiation at low angles and total suppression of the high angle horizontal field.

But, wait a moment: this is the antenna we are wanting to use for efficient low-band DXing in Europe, Nord America, Japan and also Australia or New Zealand, which are all at high latitudes…. <u>will it be also the best for a low latitude location, right on the equator ?</u>

I remember having read in the past something about magneto-ionic theory and polarization loss at low latitudes, so I went through my papers and found some interesting ones on this matter.

On the <u>Low Band Monitor – March 2002, Carl K9LA</u> wrote the following article:

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Know Your Dip Angle- by Carl Luetzelschwab, K9LA

Carl explains that the power coupling of our 160m. transmitted signal into the ionosphere at various locations around the world is depending on:

- The magnetic dip angle (the angle between the horizontal and the direction of the Earth's magnetic field)
- The angle of incidence of the wave on the ionosphere
- The direction of propagation (relative to magnetic north)

The following are the azimuth patterns (the dotted line on each plot) of a vertical antenna in the presence of the Earth's magnetic field at two different QTH for an elevation angle of 15 degrees:

Patterns of Vertical Antennas at Various Worldwide Locations with the Earth's Magnetic Field Taken Into Account

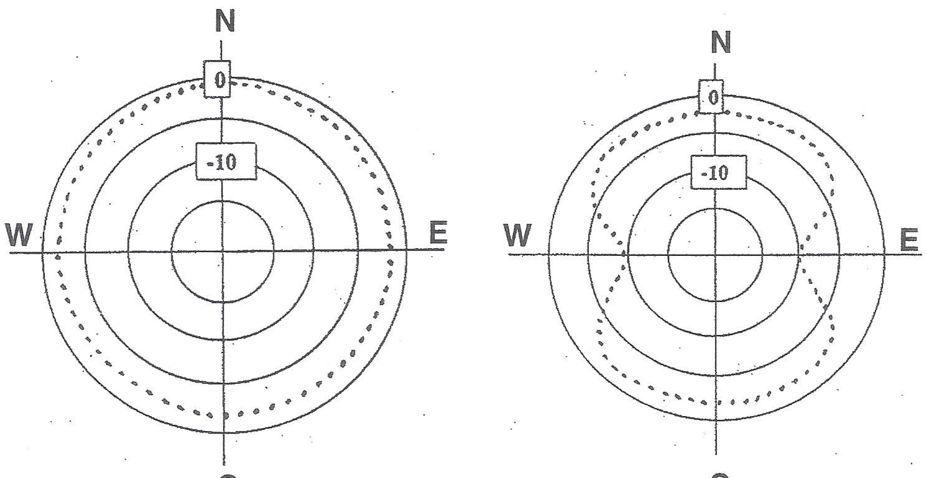
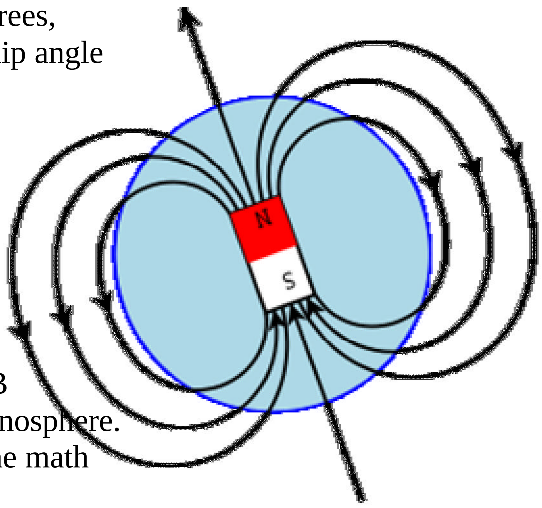


FIGURE 3
IV3PRK -ITALY

FIGURE 4
D4 - CAPE VERDE

THE LOW BAND MONITOR - MARCH 2002

Most of the DX activity in the world (Europe, North America, Japan, Australia and South Africa) is located at mid-latitudes, above or below 45 degrees, and the azimuth pattern is like Fig.3. Here the magnetic dip angle is high and couples better with vertical antennas, which are, with reason, always preferred. Fig.4 is for D4 at 16N/24W. The dip angle for Cape Verde is +20 degrees and the Earth's magnetic field has a profound effect on propagation to the East and West. This is due to the fact that the polarization that best couples into the ionosphere (and comes out) at low dip angles is approximately linear and horizontal in these directions.



One may argue that the coupling loss is only 10 dB or so for D4, but this is only for one encounter with the ionosphere. To get the total coupling loss, you'd have to go through the math for each entry and exit point in a multi-hop path.

That’s what had been done by Prof. Robert Brown, NM7M (SK), who sent me in December 2005, and posted also on the Topband Reflector, an interesting short paper: “Bang“ per KW.
Using the magneto-ionic theory he worked out the amount of power per kW ERP that goes into low-loss O-waves in the ionosphere for various DX directions, e.g., 750 W / kW for W0 calling PY.

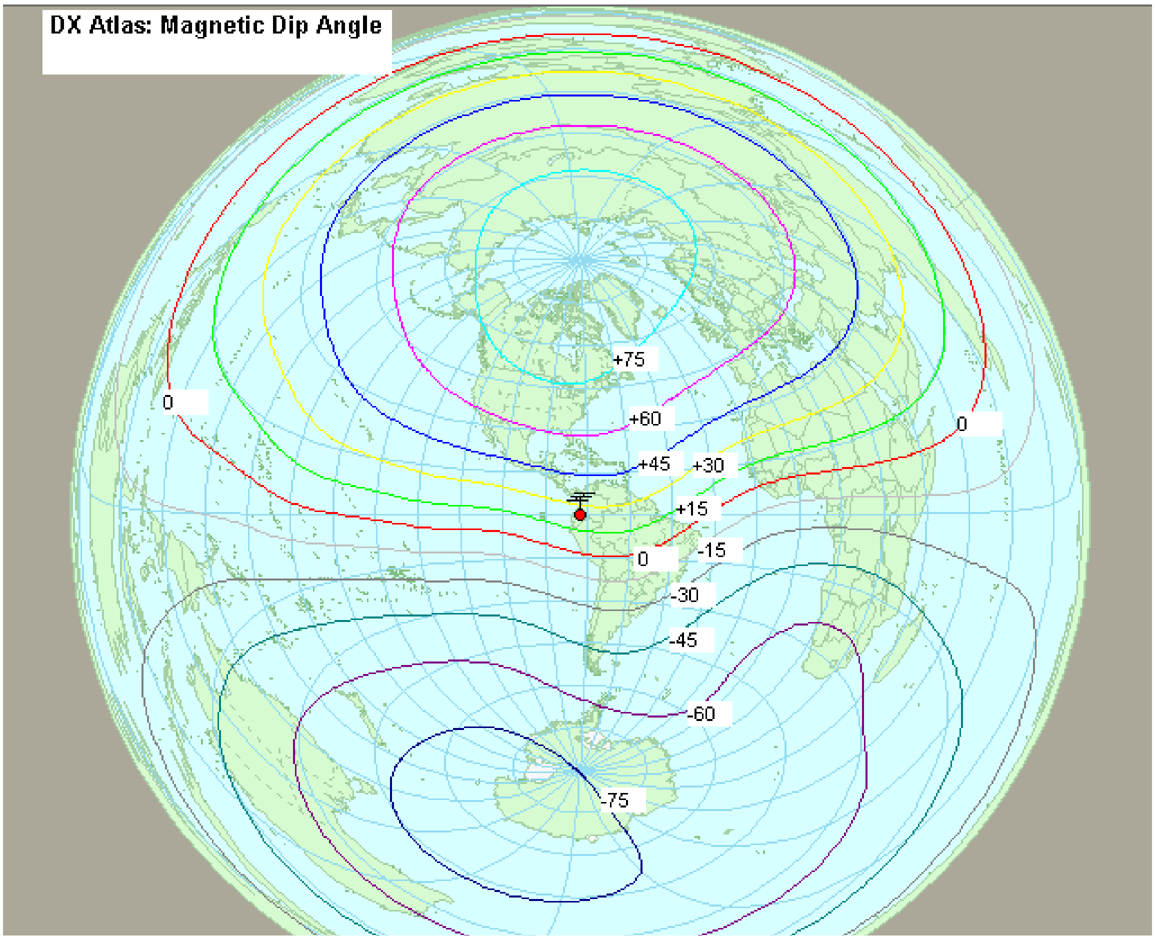
In the Table below, the targets are listed in the top horizontal row and the other horizontal rows show how the power at a given location is transferred to the ionosphere as O-waves by a vertical antenna.

The difference between those numbers and 1000 W goes into high-loss X-waves which are rapidly absorbed and contribute only to global warming, not DXing. (But this happens only on 160 m. band because it is very close to the electron gyro-frequency, which absorbs most of the X-waves; on the higher bands both modes usually propagate and end up at the receiving location).

Power transfers for PY are much lower than the others as the field in the South Atlantic Magnetic Anomaly is close to horizontal, giving a large mis-match with the vertical antenna.

T\R	W0	HB	BY	VK	ZS	PY	AVE.
W0	1000	930	980	770	820	750	875
HB	860	1000	910	770	640	650	805
BY	860	800	1000	600	620	760	773
VK	680	740	720	1000	880	960	830
ZS	590	590	660	820	1000	700	727
PY	490	410	360	510	790	1000	593

Thus, operators in mid-latitudes have an advantage over those at low-latitudes, just because the field is more vertical there and provides a better polarization match with vertical antennas.



Above is the DX Atlas azimuthal magnetic dip angle map centred on Ecuador, my future home QTH, which shows a wide low values area crossing all the globe.

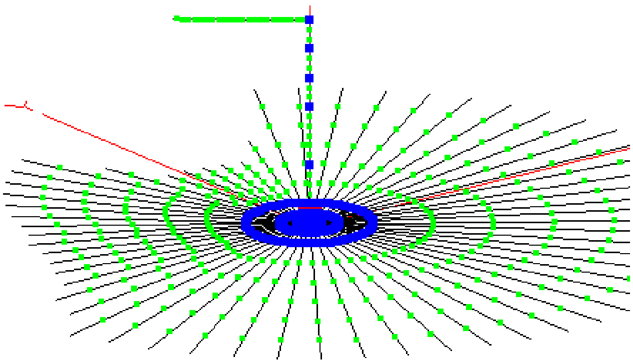
Probably a good vertical antenna, like that modelled at the beginning, should be fine to work Europe and North America, which both situated above the 45 degrees dip angle.

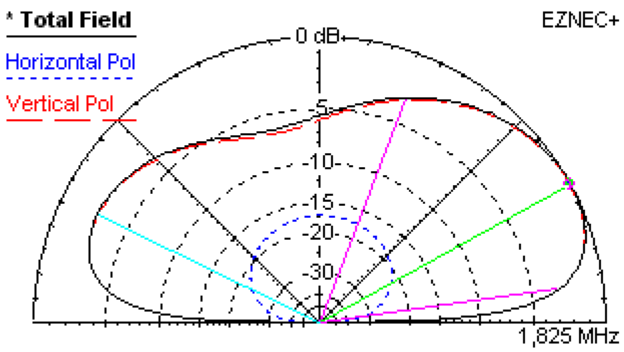
For sure we remember many strong signals by DXpeditions at low-latitudes using vertical antennas, specially those located directly on the sea, but their main target is always to maximize the number of QSO's with the northern most populated areas and don't bother too much to work rare DX countries. Thus the pattern indicated for D4 in fig.4 works well in these situations.

On the contrary I want to continue my usual 160m DX activity, with the challenge to begin DXCC all over again, and I need an efficient antenna to cover also East and West directions.

Thus an inverted L, with an higher elevation angle and some horizontal polarization will be my choice.

On this page I put a PDF file with a lot of EZ. plots, tables and graphs at the search of the most suitable design, which came out to be an Inverted L 21m. high and 23n. horizontal wire.





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