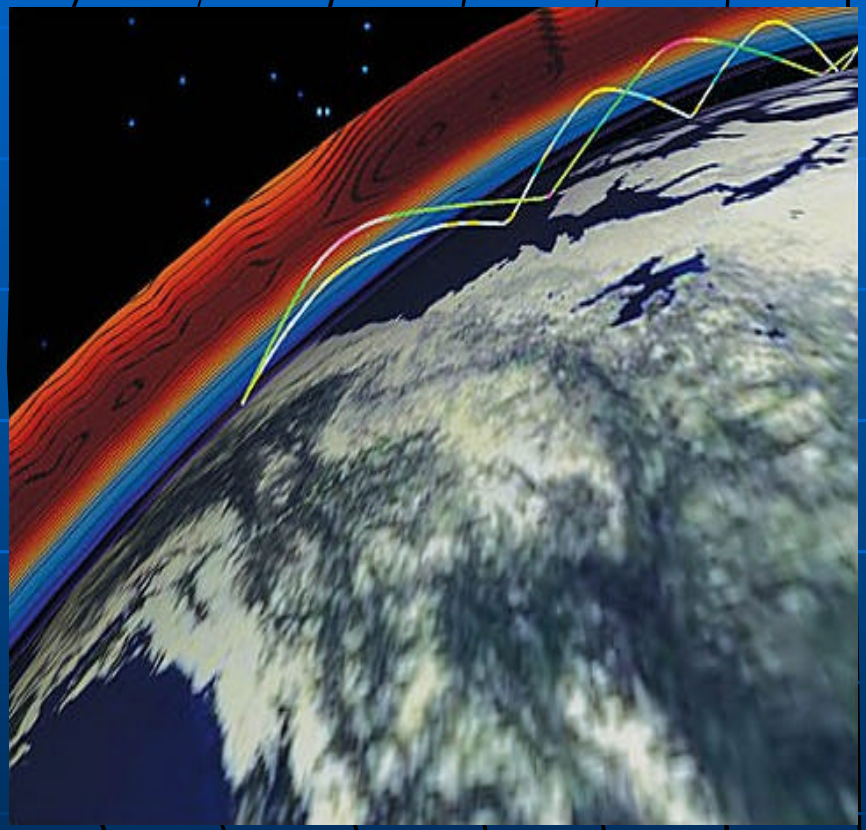
Chapter 4 – Section B: 160 meters Path Analysis



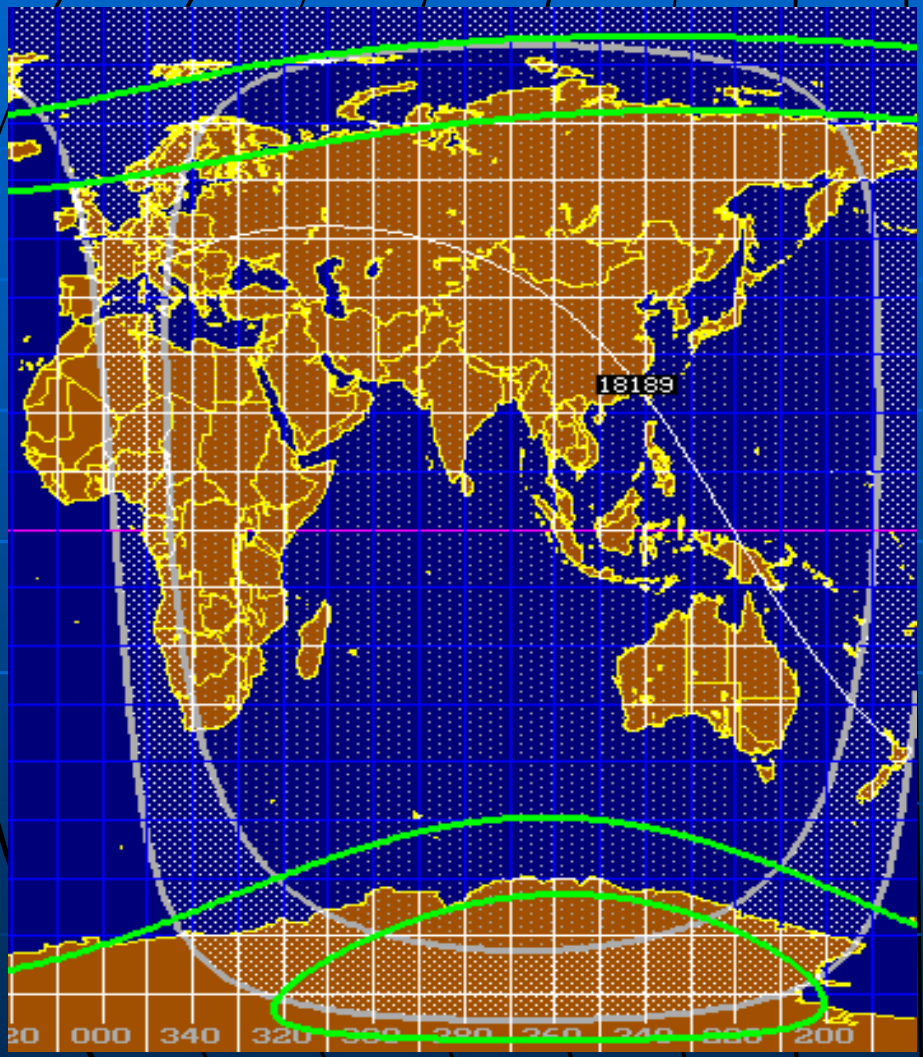
- Most difficult 160 m. path analysis from IV3PRK to
  - ZL - New Zealand
  - KH6 - Hawaii is.
- With the programs
  - Proplab-Pro by Solar Terrestrial Dispatch
  - Prop7R by Roger Graves, VE7VV

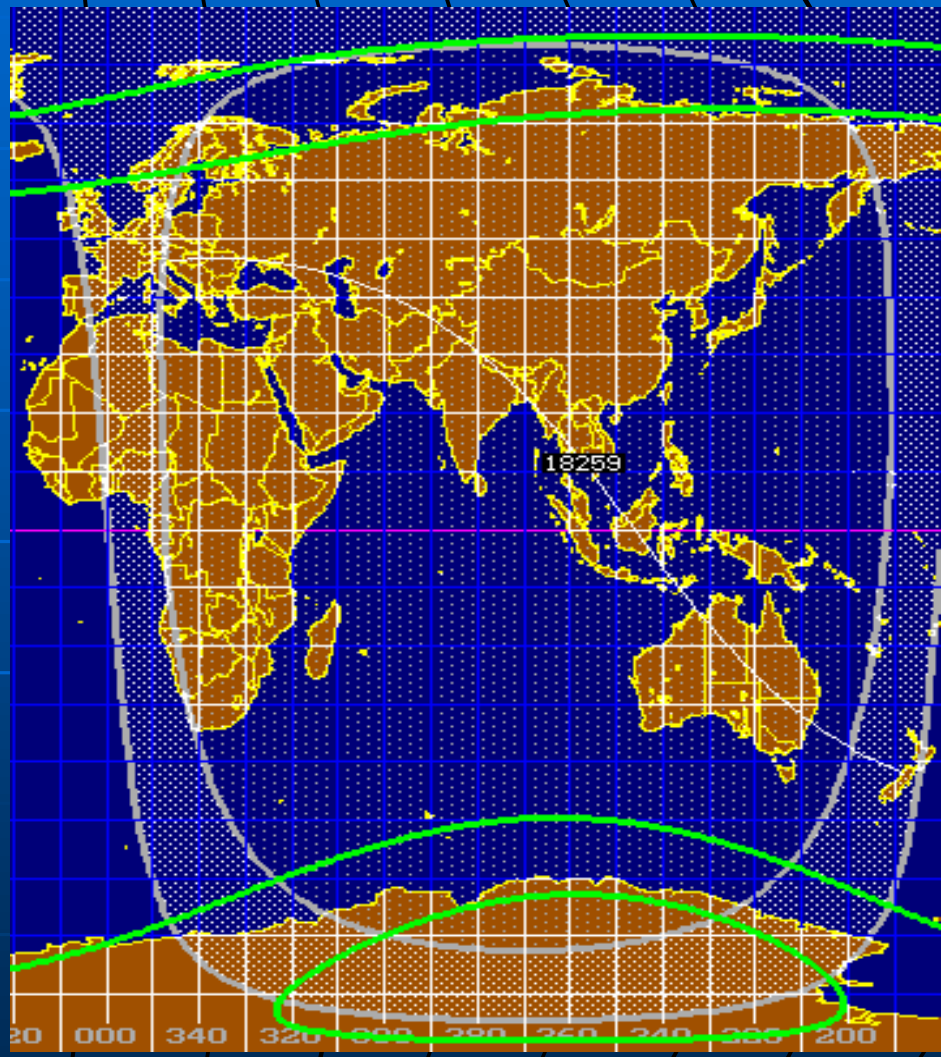
Let's further investigate on the ZL path

- Usually the signal strengths on this paths are very low, as they should be due to the distance, absorption and reflection losses, but
- on March 5, 2004 we enjoyed an exceptional opening with very strong signals:
  - ZL1MH, Mike was 599 at 18.08 z – his sunrise
  - ZL3IX , Greg was 589 at 18.22 z – his sunrise
- I tried to find with Proplab Pro the ducting path that should have allowed such signal strengths.
- I started with the correct SSN 47 for that period, but I could find at best only a half ducting path after increasing it to 59, which was the current mean number in march 2004.
- I swapped also the Tx and Rx locations and swept the elevation angles, with the best one resulting always at 10° (neither 9° nor 11° were able to get into ducting!)
- No better with higher or lower solar numbers and in every case the signal strength too low to be heard at the receiver (98 dB below 1 microvolt at maximum!)
- So the path seems to be impossible but if we look at the reduction in absorption (around 40 dB) with half ducting, we could hope to get further 40 dB with full ducting… could it be possible?
- Propagation predictions are statistical in nature, but they don't show daily variations. In the real ionosphere there are holes and irregularities which cause "spotlight propagation" and keep us "On the Edge".

Proplab Pro: March 5, 2004 - 18.00Z Tx at IV3 = 46.17N 13.13E

Two paths to ZL : Rx at ZL1 = 37.5S 175 E Rx at ZL3 = 42 S 172 E

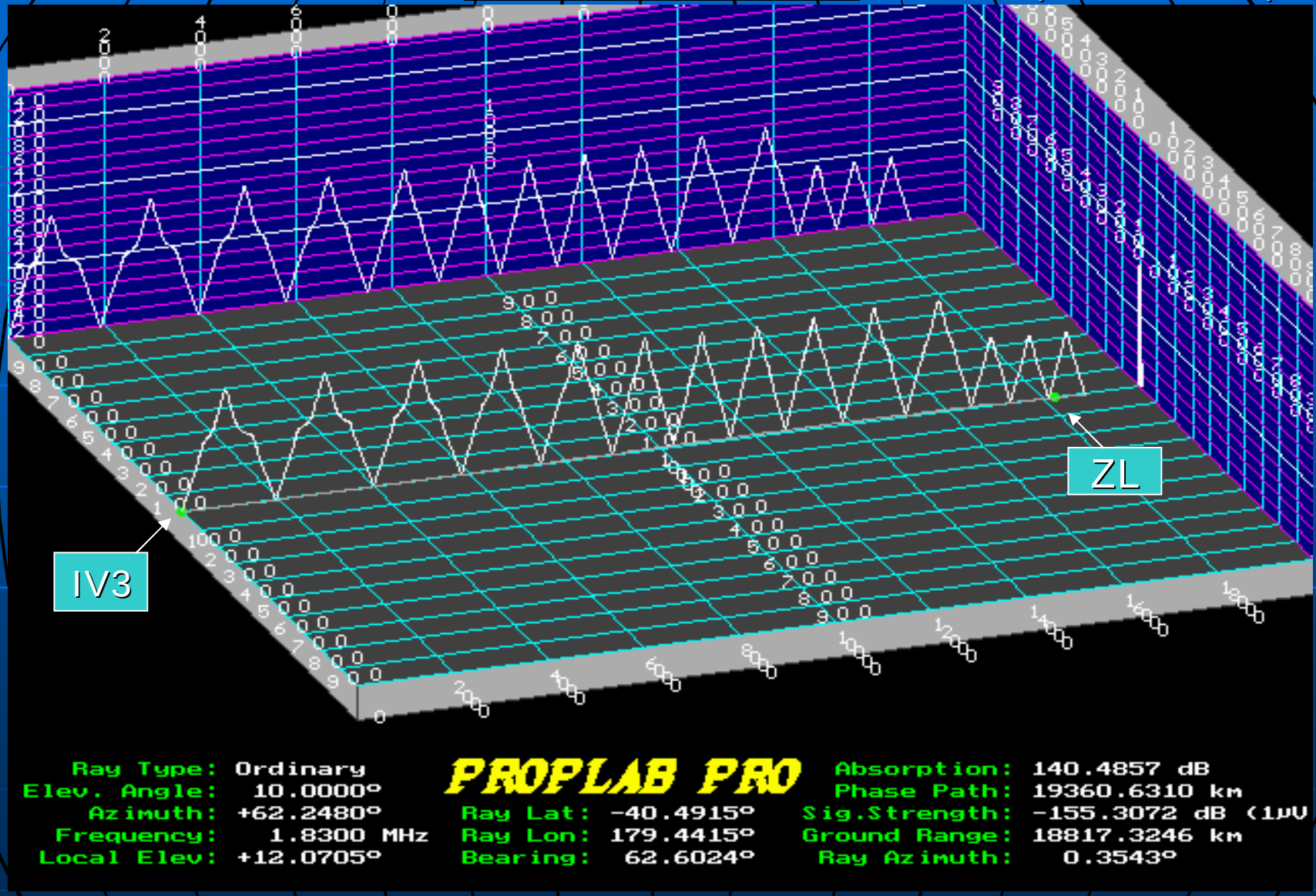




IV3PRK

Mar. 5, 2004 - 18.15Z **SSN: 47** A Ind.: 5 - Elev. 10°

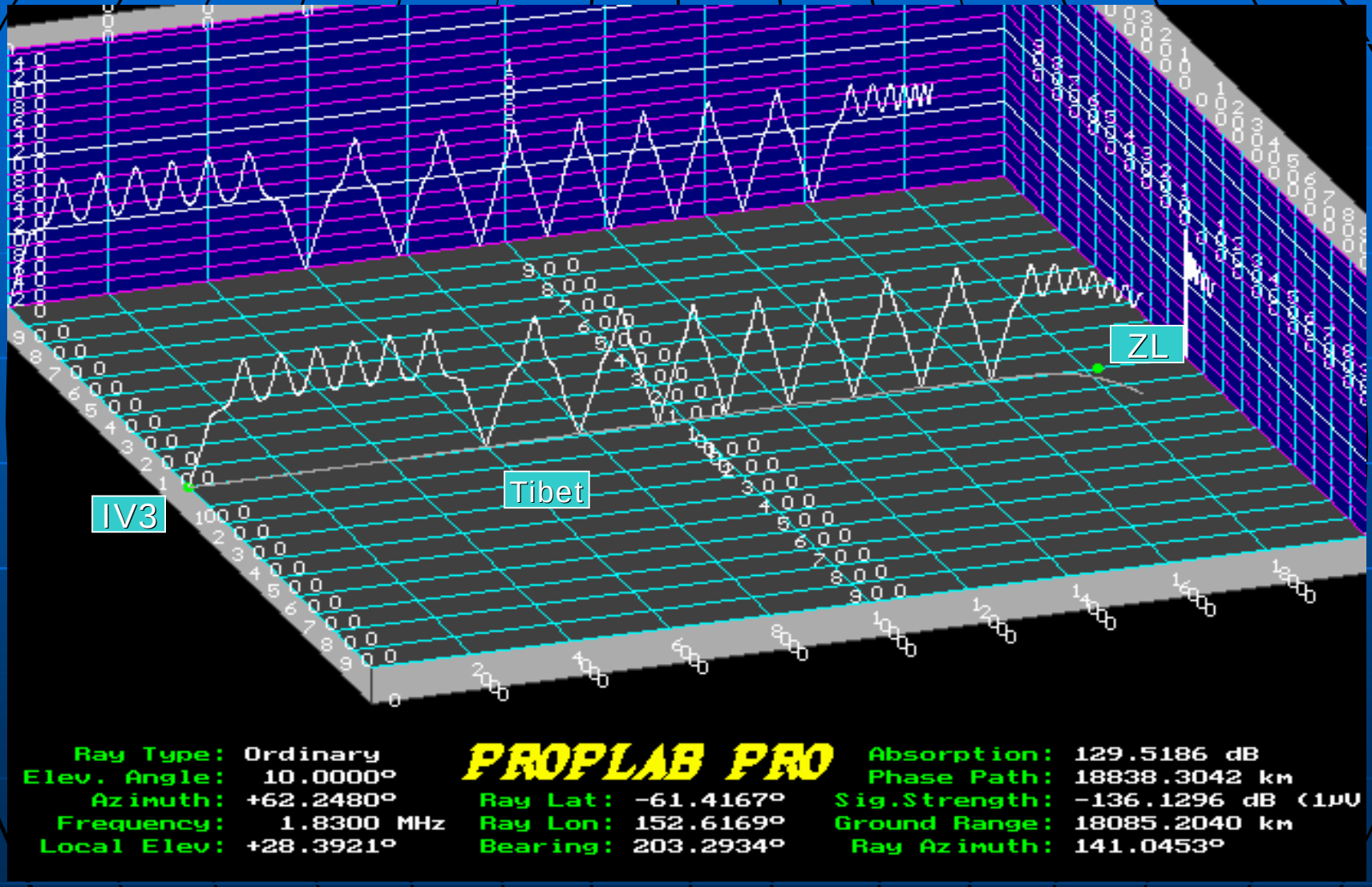
Tx at IV3 = 46.17N 13.13E Rx at ZL = 37.5S 175 E - 11 F hops and 2 E hops



Mar. 5, 2004 - 18.15Z - SSN increased to 59 (sunspots of march 2004)

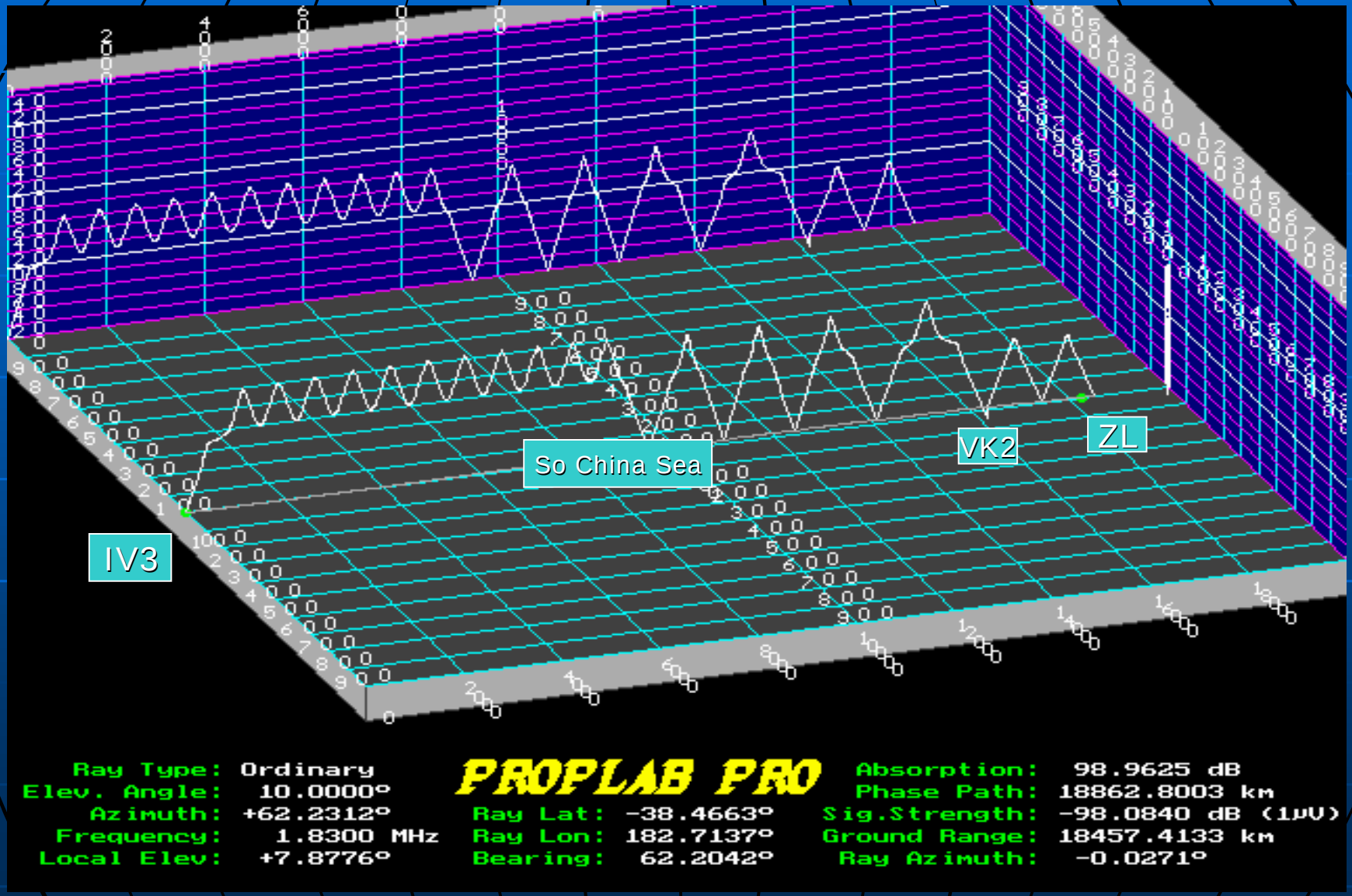
Ducting in the first 6000 km – n. 7 F hops – Duct and skewed south at ZL end

Increased ionization at sunrise does not allow the ray to go down through the E layer anymore !



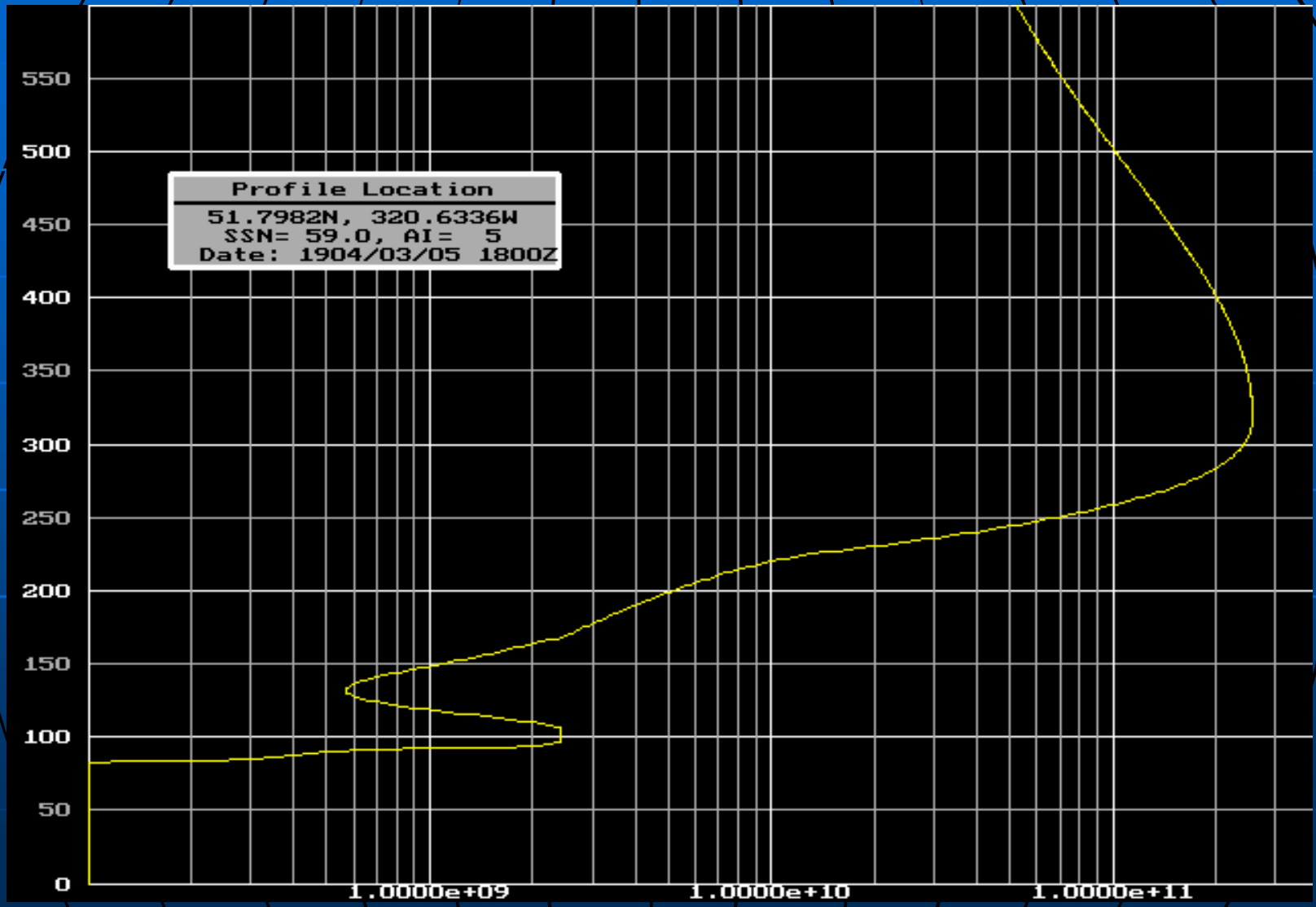
Mar. 5, 2004 - 18.00Z (15 minutes before) **- SSN 59 - best case**

Ducting up to 10000 km – Less reflections – **Less Absorption 40 dB**



Mar. 5, 2004 - 18.00Z SSN: 59 A Ind.: 5 - best case

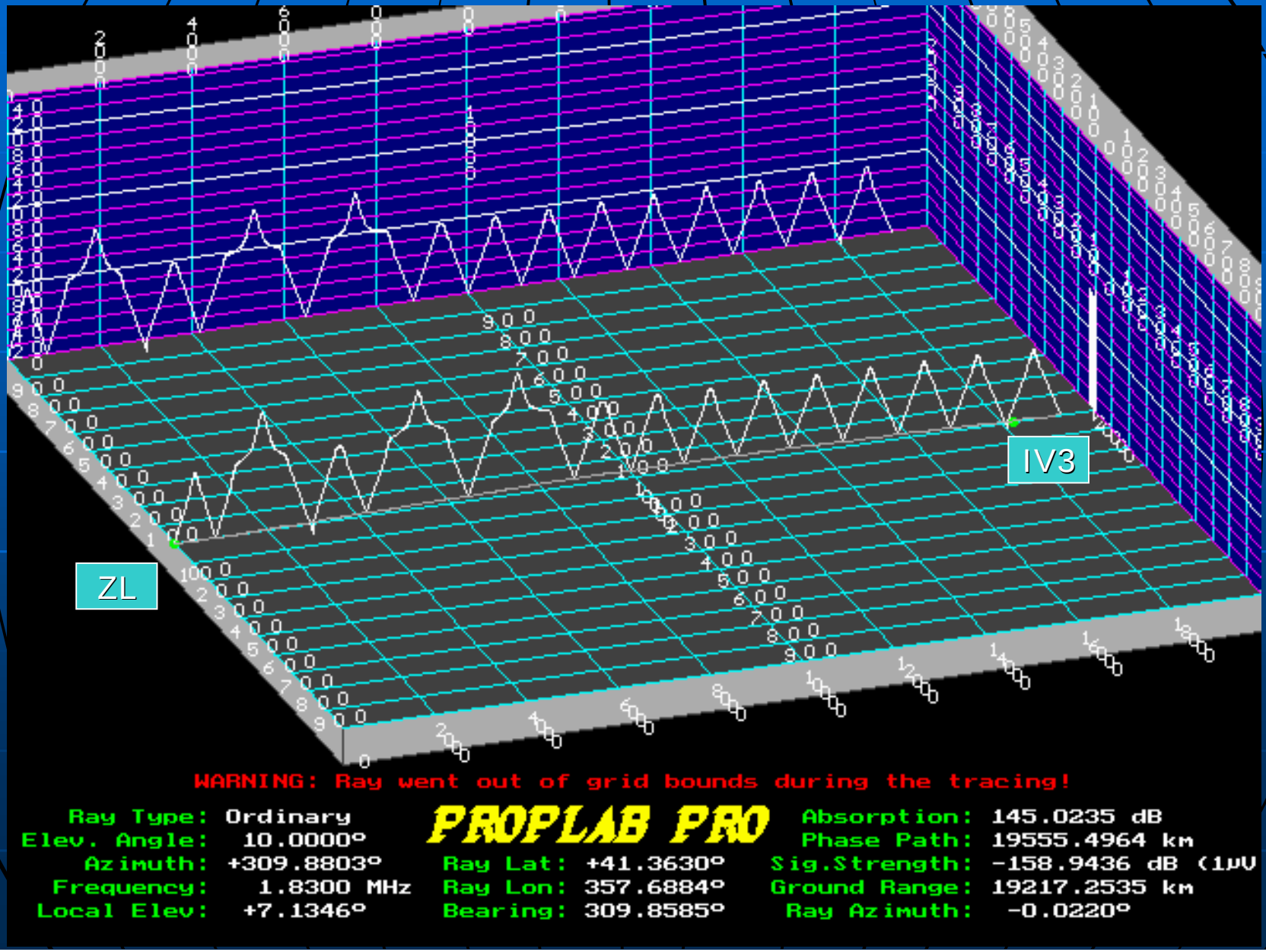
Tx at IV3 = 46.17N 13.13E Rx at ZL = 37.5S 175 E - Elev. 10°



IV3PRK

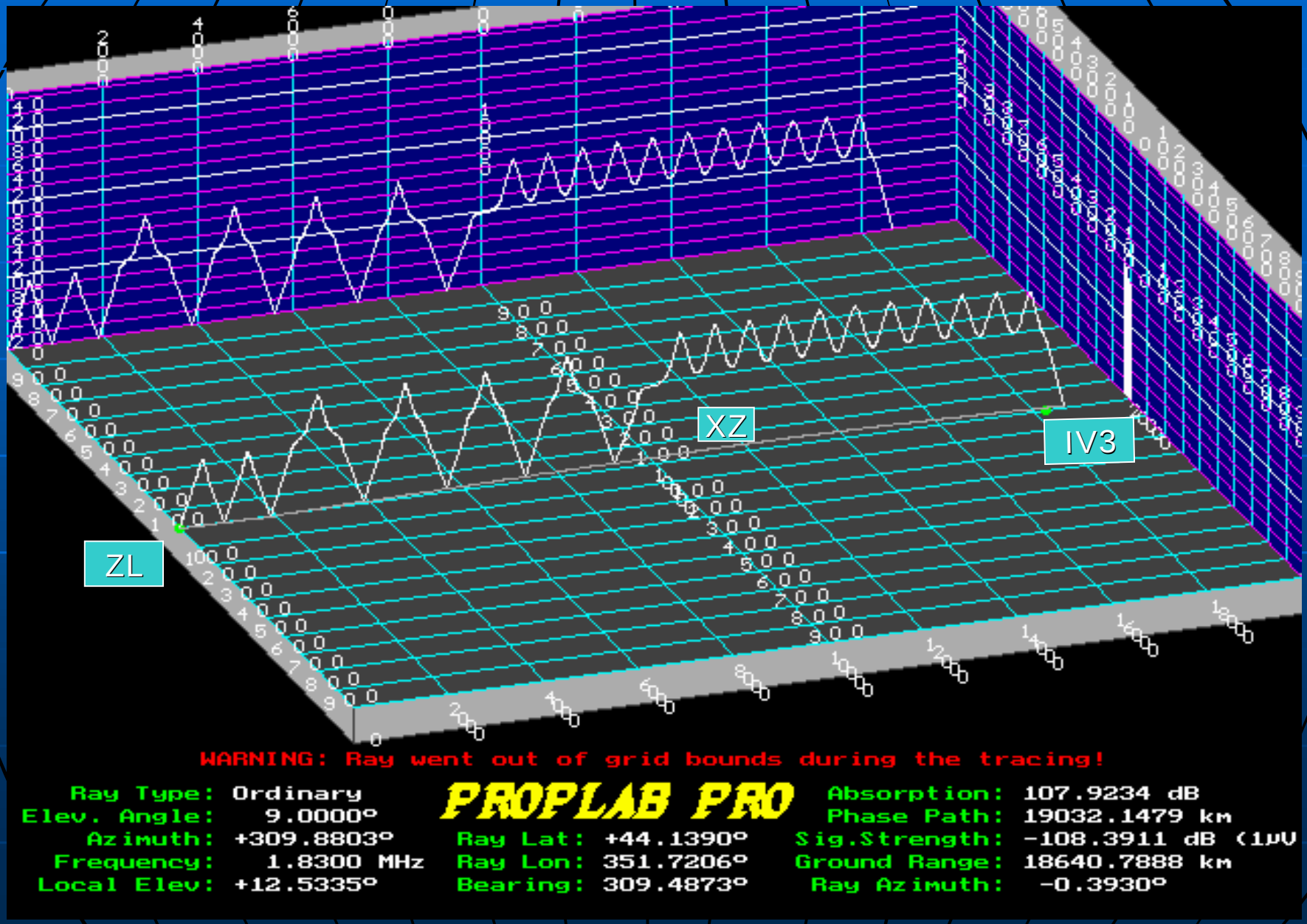
Mar. 5, 2004 - 18.00Z - SSN: 59 - **SWAPPED Tx and Rx locations**

Tx at ZL = 37.5S 175 E - Rx at IV3 = 46.17N 13.13E (It doesn't enter in duct)



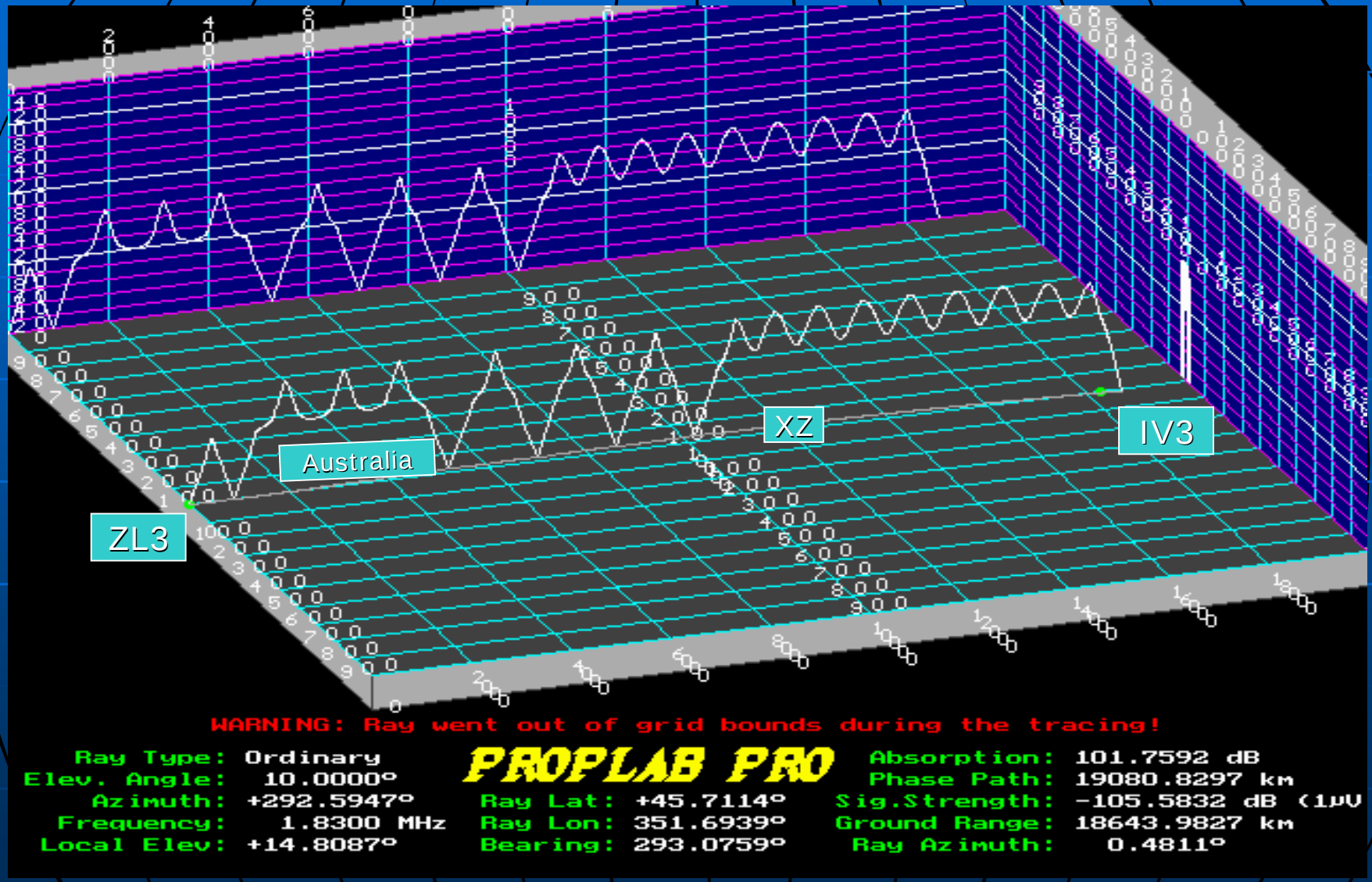
Mar. 5, 2004 - 18.20Z (20 minute later) - SWAPPED Tx and Rx loc.

Tx at ZL = 37.5S 175 E - Rx at IV3 = 46.17N 13.13E **(last half in ducting mode)**



Mar. 5, 2004 - 18.20Z – Moved Tx loc. down to ZL3 = 42S - 172 E

1 E hop – Ducting mode over Australia -3 F hopes – Ducting again from XZ to IV3



Prop7R by Roger Graves VE7VV

- With Proplab Pro we have been able to find the possible path to ZL through a ducting mode, but the signal strength resulting is not sufficient to be received.
- At last I got the reply from this very interesting program developed by Rod, VE7VV (ex VE7FTP), and not yet on the market
- It performs 160 m. path analysis with three options:
  - Ray tracing method
  - Zone method (an innovative approach)
  - Zone method with skew path option

```
PROP7R1 PROPAGATION PROGRAM, COPYRIGHT 8 MAY 1998 BY R. GRAVES

THIS PROGRAM WAS WRITTEN BY R. GRAVES, VE7VV.
THE RAY TRACING ALGORITHMS ARE BASED ON THE 'IONPRED'
PROGRAM WRITTEN BY R. FRICKER OF THE BBC.
THE F2 LAYER ALGORITHM IS THE 'COMB7B' MODIFICATION OF 'MAXIMUF'
WRITTEN BY R. FRICKER.
R. BROWN, NM7M, PROVIDED A NUMBER OF CONTRIBUTIONS, SUGGESTIONS,
AND MUCH ENCOURAGENT TO THE DEVELOPMENT OF THIS PROGRAM.
```

Prop7R by VE7VV: 5 mar. 2004 = path from IV3 to ZL

Time: from 17.30 to 18.30 UTC SSN = 59

With ray tracing method: NO possibility

```
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 5 MAR 2004   FREQ: 1.83 MHz  SOLAR FLUX: 110

      QTH                N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK              46.1      -13.1      0546      1654     +/- 21 MINS
  TO: NEW ZEALAND        -37.5      -175       1805      0700     +/- 10 MINS

DISTANCE: 18226 KM      BEARING (TX/RX): 64 / 308    XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BEST MODE BETWEEN 1 AND 30 DEGREES.   MIN MODE: 5 HOPS

UTC                          MODE        DEG    % DAYS  DB>0.5 uV   QI

 17.5
 17.75
 18
 18.25
 18.5

UTC      LUF, MHZ  MUF, MHZ   MODE        DEG    % DAYS  DB>0.5 uV   QI
```

Prop7R by VE7VV: 5 mar. 2004 = path from IV3 to ZL

Time: from 17.30 to 18.30 UTC SSN = 59

With zone method: 4% days possibility by ducting mode (7R) only at 17.45 UTC

```
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 5 MAR 2004   FREQ: 1.83 MHz  SOLAR FLUX: 110

      QTH                N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK              46.1      -13.1      0546      1654     +/- 21 MINS
  TO: NEW ZEALAND        -37.5      -175       1805      0700     +/- 10 MINS

DISTANCE: 18226 KM      BEARING (TX/RX): 64 / 308    XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD

UTC                          MODE        DEG    % DAYS   DB>0.5 uV   QI

 17.5
 17.75                       7R         29/ 0/29     4       6
 18
 18.25
 18.5

UTC              MUF, MHZ   MODE        DEG    % DAYS   DB>0.5 uV   QI
```

Prop7R by VE7VV: 5 mar. 2004 = path from IV3 to ZL

Time: from 17.30 to 18.30 UTC SSN = 59

With zone / skewed bearing method: 5% days possibility by ducting mode and 30 deg. skewing from 17.30 to 18.15 UTC

```
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 5 MAR 2004   FREQ: 1.83 MHz  SOLAR FLUX: 110

      QTH                N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK              46.1      -13.1      0546      1654     +/- 21 MINS
  TO: New Zealand        -37.5      -175       1805      0700     +/- 10 MINS

DISTANCE: 18226 KM      BEARING (TX/RX): 64 / 308    XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD, SKEWED BEARING PREDICTION

UTC    RX SKEW    TX SKEW     MODE        DEG    % DAYS  DB>0.5 uV   QI

 17.5       25         30    7R        29/ 0/23     5       12
 17.75      30         30    7R        29/ 0/29     4       5
 18         30         25    7R        23/ 0/29     5       12
 18.25      35         25    7R        23/ 0/37     3      -1
 18.5

UTC    RX SKEW    TX SKEW     MODE        DEG    % DAYS  DB>0.5 uV   QI
```

Prop7R by VE7VV: 5 mar. 2004 = path from IV3 to ZL3
Time: from 17.30 to 18.30 UTC SSN = 59
With zone / skewed bearing method: 5% days possibility by ducting mode and 30 deg. skewing from 17.30 to 18.15 UTC
Picking time at 17.45 with 14 dB better signal than ZL1

```
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 5 MAR 2004   FREQ: 1.83 MHz  SOLAR FLUX: 110

      QTH                 N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK               46.1      -13.1      0546      1654     +/- 21 MIN
  TO: ZL3                  -42       -172       1812      0716     +/- 10 MIN

DISTANCE: 18258 KM      BEARING (TX/RX): 82 / 292    XMIR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD, SKEWED BEARING PREDICTION

UTC    RX SKEW    TX SKEW     MODE        DEG     % DAYS  DB>0.5 uV   QI

 17.5       25         30    7R        29/ 0/23      5       12
 17.75      25         30    7R        23/ 0/23      8       19
 18         30         25    7R        23/ 0/29      5       13
 18.25      35         25    7R        23/ 0/29      5       12
 18.5
```

Behind the Northern Auroral Oval

W4ZV asked about my experiences in that extremely difficult area:

- I had only five QSO's with KH6 in the years of minimum, from 1994 to '97 (and one in 2000) in the months of January and March.
- In all cases the signals seemed to come from South/South West
  - the time was always between 05 and 05.30z, more than one hour before my sunrise and one hour after sunset in KH6;
  - that was NOT a long path – impossible with a sunlit path through the southern summer hemisphere;
  - For sure it was NOT coming from the North Pole - it could have been a SKEWED path, almost along the Gray-line, at about 200/220 degrees.
- So I did never work anybody behind the Auroral Oval, and I never had a true long path experience on 160 meters from my QTH.
- I had also about 20 contacts with Alaska, most of them from 1995 to '98 in the months from Oct. to Dec., and mainly with stations operating up in the North – inside the Polar Cap.
- I have been unable to analyze the KH6 path with Proplab Pro (the path is skewed out of the screen … and the program crashes!)
- But I could get interesting replies from Prop7R by VE7VV, the only program which seems to find also the odd openings on 160 meters.

Prop7R by VE7VV: 7 Jan. 1994 = path from IV3 to KH6

Time: from 04.00 to 06.00 UTC - Short Path - SF = 100

With standard ray tracing method: **NO possibility**

```
                                VE7VV
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 7 JAN 1994   FREQ: 1.83 MHz  SOLAR FLUX: 100

      QTH                  N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK                46.1     -13.1      0650      1537     +/- 40 MINS
  TO: KH6                   20.6      157.5     1708      0404     +/- 15 MINS

DISTANCE: 12527 KM      BEARING (TX/RX): 350 / 7     XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BEST MODE BETWEEN 1 AND 30 DEGREES.   MIN MODE: 4 HOPS

UTC                          MODE        DEG    % DAYS  DB>0.5 uV   QI

 4
 4.25
 4.5
 4.75
 5
 5.25
 5.5
PRESS ANY KEY TO SCROLL DISPLAY
```

Prop7R by VE7VV: 7 Jan. 1994 = path from IV3 to KH6

Time: from 04.00 to 06.00 UTC - Short Path - SF = 100

With zone method: 33% of days available

Best signal (but lower % days) by ducting mode at 05.00 Z

```
      QTH                    N.LAT      W.LONG     SUNRISE   SUNSET     GRAYLINE
FROM: IV3PRK                  46.1       -13.1       0650      1537      +/- 40 MINS
  TO: KH6                     20.6        157.5      1708      0404      +/- 15 MINS

DISTANCE: 12527 KM       BEARING (TX/RX): 350 / 7      XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd    ANT HT: 0 MTRS             POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd    ANT HT: 0 MTRS             POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD

UTC                            MODE         DEG     % DAYS   DB>0.5 uV    QI

 4
 4.25                          11F        29/29/29     32        9
 4.5                           11F        29/29/29     33        10
 4.75                          11F        23/23/23     33        10
 5                             5R         19/ 0/19     12        31
 5.25                          11F        23/23/23     34        10
 5.5                           11F        23/23/23     33        9
 5.75
 6                             11F        29/29/29     33        8

UTC                  MUF, MHZ   MODE         DEG     % DAYS   DB>0.5 uV    QI
```

Prop7R by VE7VV: 7 Jan. 1994 = path from IV3 to KH6

With zone/skewed bearing method: 33% of days available

Best signal by ducting mode, picking 47 dB at 05.00 Z - (One star in the Quality Index).

```
                                VE7VV
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING SHORT PATH FOR: 7 JAN 1994   FREQ: 1.83 MHz  SOLAR FLUX: 100

      QTH                  N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK                46.1     -13.1      0650      1537     +/- 40 MINS
  TO: KH6                   20.6      157.5     1708      0404     +/- 15 MINS

DISTANCE: 12527 KM      BEARING (TX/RX): 350 / 7     XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS          POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS          POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD, SKEWED BEARING PREDICTION

UTC    RX SKEW    TX SKEW     MODE        DEG     % DAYS  DB>0.5 uV   QI
 4
 4.25       30          0    11F       29/29/29     32        9
 4.5        25          0    11F       29/29/29     33        10
 4.75       25          0    11F       23/23/23     33        10
 5          20          0    5R        19/ 0/19     33        47      *
 5.25        0         25    11F       23/23/23     34        10
 5.5         0         25    11F       23/23/23     33        9
```

Prop7R by VE7VV: 7 Jan. 1994 = path from IV3 to KH6

Time: from 04.00 to 06.00 UTC - LONG PATH – SF = 100

With zone/skewed bearing method: 10% of days available by ducting mode at 05 Z with a signal 40 dB weaker than on short path

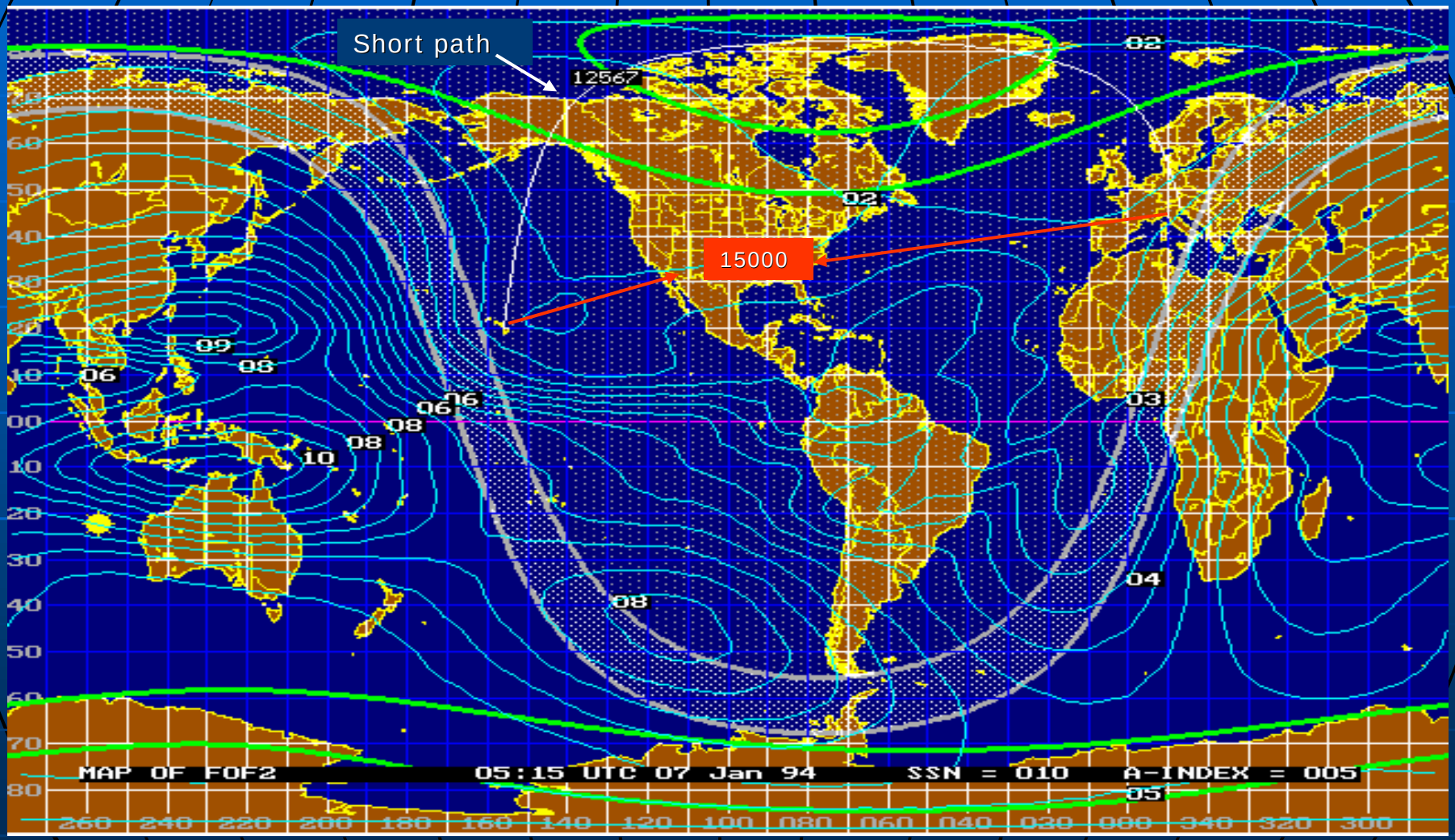
```
                                VE7VV
                    PROP7R1 PROPAGATION PROGRAM

PREDICTING LONG PATH FOR: 7 JAN 1994   FREQ: 1.83 MHz  SOLAR FLUX: 100

      QTH                N.LAT     W.LONG    SUNRISE   SUNSET    GRAYLINE
FROM: IV3PRK              46.1      -13.1      0650      1537     +/- 40 MIN
  TO: KH6                 20.6       157.5     1708      0404     +/- 15 MIN

DISTANCE: 27546 KM      BEARING (TX/RX): 170 / 187   XMTR PWR: 1 KW
TRANS ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
RCVR  ANT GAIN: 0 DBd   ANT HT: 0 MTRS           POLARIZATION: VERTICAL
PREDICTING BY THE ZONE METHOD, SKEWED BEARING PREDICTION

UTC    RX SKEW    TX SKEW     MODE        DEG    % DAYS  DB>0.5 uV   QI

 4
 4.25
 4.5
 4.75
 5          20         20    10R        19/ 0/23    10      8
 5.25
 5.5
```

At the search of a crooked western path to KH6

- The program by VE7VV is very innovative with its “zone method”, but does not take into consideration the geomagnetic activity (no A or K index input is required)
- So we should be very careful with such good polar path results!
- In all the real cases the signals were apparently coming from the South to the West quadrant, during good openings with South Eastern U.S.
- The A index was always low (for several days and with good openings into West Coast), but no W6 or W7 heard in the days of the KH6 contacts.
- Particularly on Jan.7,1994 (at the time of this analysis) we find in my log KH6CC at 05.12z among QSO’s with FL-AL-LA-TX and El Salvador.
- So let’s try to find a skewed path along the horizontal gradients on a global ionospheric map for that day/hour.

Proplab Pro: Global Map of FoF2 = IV3 to KH6

Short path through North Pole: 12.500 km - Skewed path through Southern USA along the same ionospheric horizontal gradient: about 15.000 km



W6ELProp: the KH6 path with the first supposed, but impossible SSW skewing

IV3PRK (A) to Hawaii (B)
07/01/1994

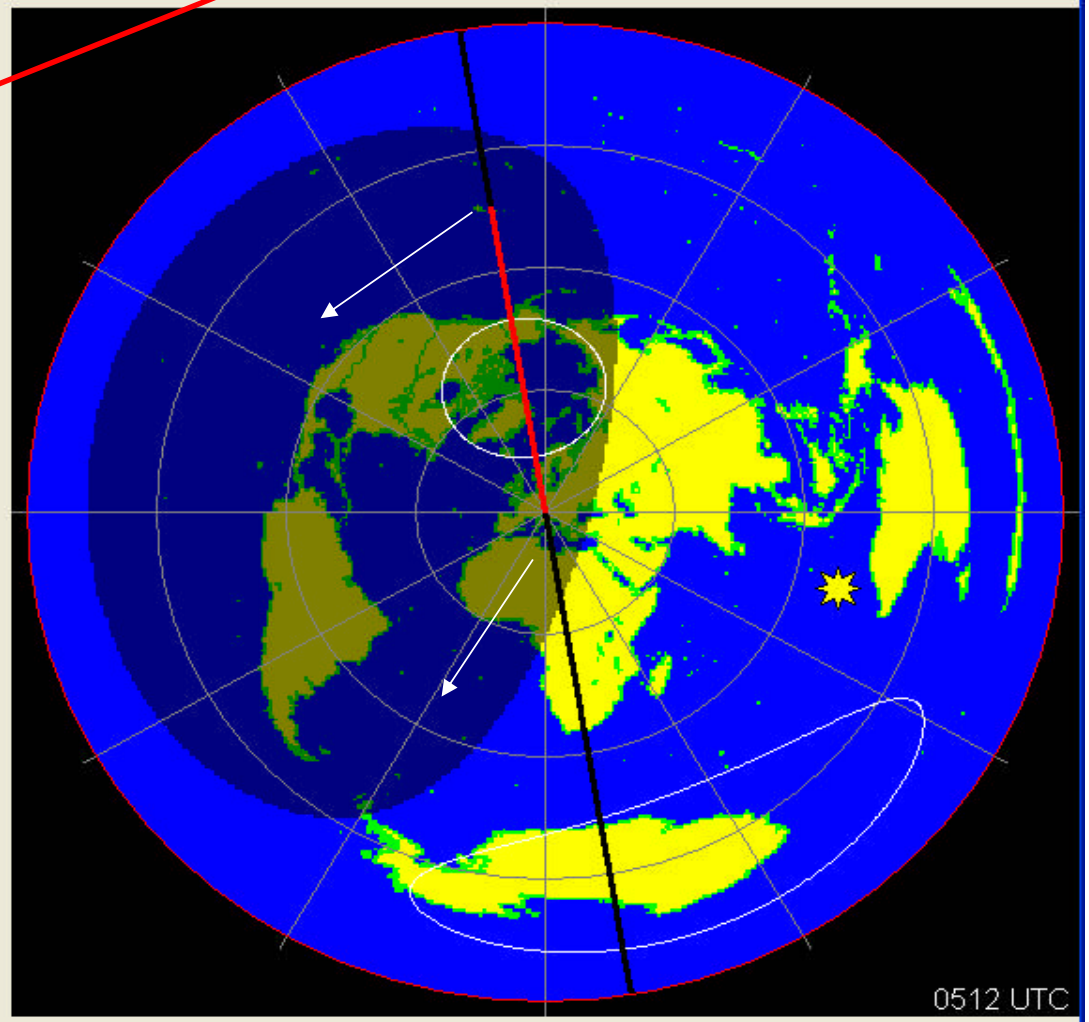
	TERMINAL A	TERMINAL B
Latitude	46.10 N	20.60 N
Longitude	13.10 E	157.50 W
Sunrise	0652 UTC	1711 UTC
Gray line	32/212 deg	23/203 deg
Sunset	1535 UTC	0401 UTC
Gray line	328/148 deg	337/157 deg

Bearings	**A to B**	**B to A**
Short path	350.5 deg	7.1 deg
Long path	170.5 deg	187.1 deg

Short-path Length 12539 km (Polar)
6770 nmi 7791 mi (U.S.)

Long-path Length 27493 km (Polar)
14845 nmi 17083 mi (U.S.)

New Date... | New Time... | Now | Auto Update | Close



This map is centered on IV3PRK 46.10 N 13.10 E

Conclusion …and still in the mystery

- My receiving antennas at that time were a good Beverage to NNW (330°) and a phased verticals mini-array which appeared to give a better copy on the SSW direction
- So my first assumption was on a 200/220 degrees skewing almost along the gray-line
- But after examining the FoF2 global map I realized that path should be impossible due to:
  - Too many steep horizontal gradients to cross through
  - High ionization in the southern summer hemisphere
  - More difficult bending on a 20.000/25.000 km path
- Much more feasible is the 15.000 km crooked path through southern USA, along a way under the same level of ionization, and so far from the Aurora oval...
  - This skewed path is almost perpendicular to the terminator at both ends, a preferred condition as shown in the last ON4UN book, “Low Band Dxing” Vol.4
- If so, why worry about A or K numbers for the KH6 path?
  - But we know that such openings happen always with low numbers, and then there is no aurora skewing!
- So, why not a more straightforward direct short path ?
  - It should be, but how a professional program like “Proplab Pro” is unable to find such a path even with the lowest A index? What’s wrong with all these hypothesis?

W6ELProp: the KH6 path skewing through Southern USA, about 15.000 km. length, almost at right angles with the gray line at both ends

IV3PRK (A) to Hawaii (B)
07/01/1994

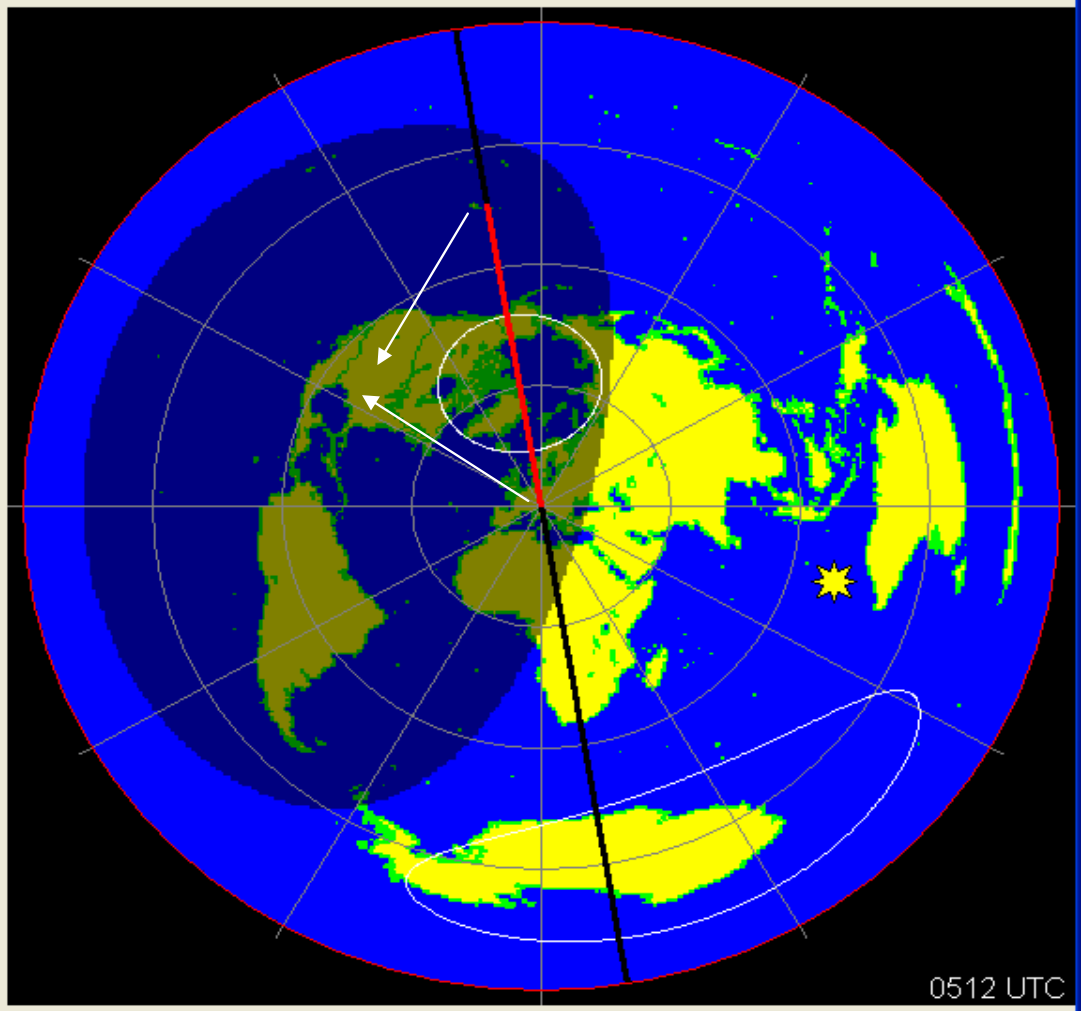
	TERMINAL A	TERMINAL B
Latitude	46.10 N	20.60 N
Longitude	13.10 E	157.50 W
Sunrise	0652 UTC	1711 UTC
Gray line	32/212 deg	23/203 deg
Sunset	1535 UTC	0401 UTC
Gray line	328/148 deg	337/157 deg

Bearings	**A to B**	**B to A**
Short path	350.5 deg	7.1 deg
Long path	170.5 deg	187.1 deg

Short-path Length 12539 km (Polar)
6770 nmi 7791 mi (U.S.)

Long-path Length 27493 km (Polar)
14845 nmi 17083 mi (U.S.)

New Date... | New Time... | Now | Auto Update | Close



This map is centered on IV3PRK 46.10 N 13.10 E

Final comments to the whole series

- So we saw how things are extremely critical and changeable: predictions may be useful, but we have to be there !
- We started from the Sun, its activity and the effects on the ionosphere and the geomagnetic field;
- We learned the propagation physics and modes and then, after analyzing some HF prediction programs, we came down to the low bands.
- In the last 20 years I have been active only on 160 meters, attracted by its challenge and the enigmas of the propagation.
- My main objective, more than DX competition, is the propagation study trying to find, through daily activity and systematic records, any correlation between observed DX conditions and the solar and geomagnetic events that should have influenced them.
- But we all know that such correlation does not exist … sometimes the band is dead with low numbers, but sometimes we enjoy great openings despite high numbers, and sometimes fuzzy by skewed or spotlight propagation … that's the mystery of 160 meters and the challenge to be on the Edge!

Udine, May 2005 Pierluigi "Luis" Mansutti, IV3PRK

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