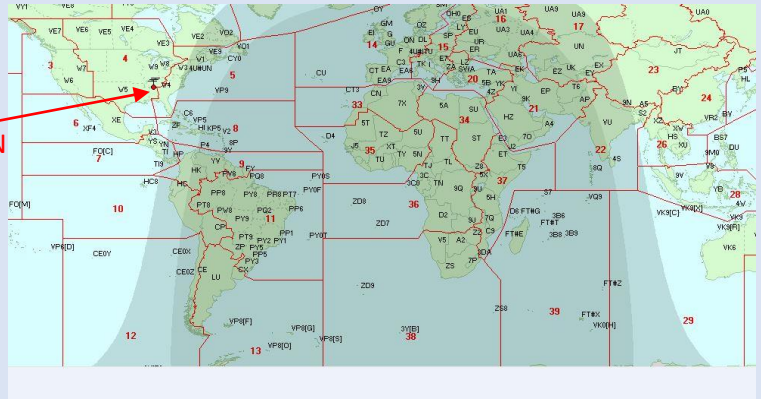
The Magic of SW Morning Propagation "Enhanced-Path"

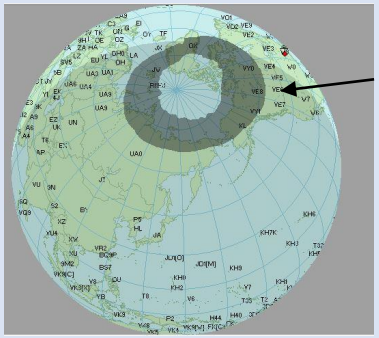
Presented by: Bruce Smith/AC4G

Date: 12 May 2020

Discussion Topics

- Why discuss this topic?
- Propagation Primer
- Definitions (Short, Long, Skewed Paths, Grayline, etc.)
- Why Longpath (LP) propagation?
- Examples of QSOs achieved other than “short” path
- Analysis of Path Propagation Theories for DX QSO(s)





*DX Atlas software tool used for maps/plots

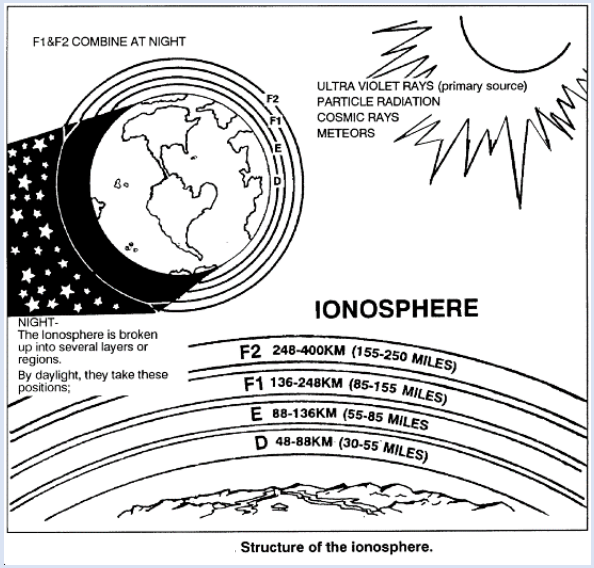
Why discuss this topic?

- Hams make QSOs via Shortpath and Longpath propagation
- Sometimes the only way to make a QSO with some distant DXCC entities is via a “long” path not Shortpath
- Examples of QSOs that can be made on the other side of the world via the Longpath to SW & SE Indian Ocean areas
- Hams should understand this capability in order to make very long distant QSOs to the other side of the world to increase DXCC totals
- Recent long distant QSOs prompted some research & analysis

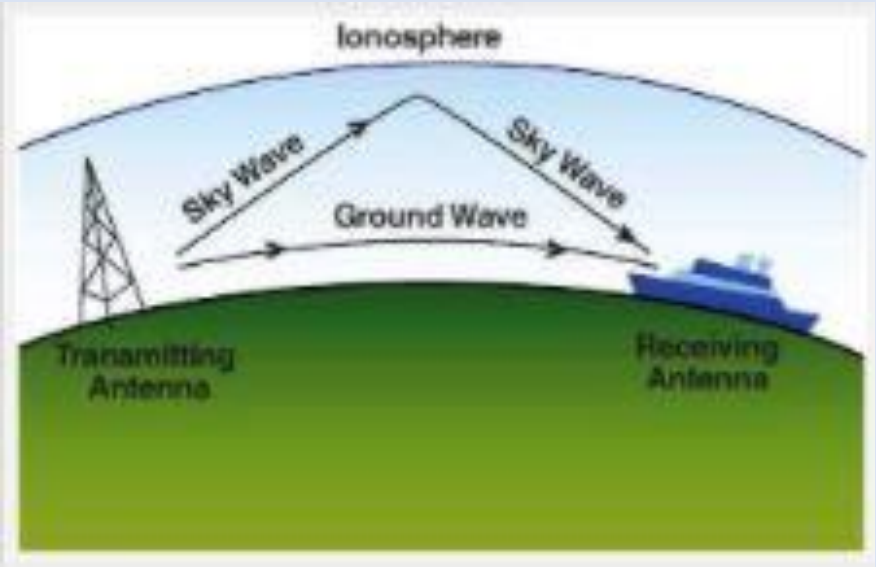
We will briefly examine PROPAGATION “paths” in this presentation with QSOs made with DX Stations NEAR our antipode!

Ionosphere Layers Affect HF Propagation

- Daytime solar radiation generate free electrons from collisions with molecules in our ionosphere causing electron density to increase determining maximum usable frequency (MUF)
- Solar radiation causes ionization to form distinct layers (D, E, F1 & F2)
- The D-Layer (absorption layer) absorbs HF signals & disappears rapidly on the unlit side of the Earth
- E-Layer & F-Layers reflect signals back to the Earth if below the MUF allowing QSOs w/ DX
- At Sunset, free electrons recombine causing electron density to decrease, forcing MUF down, explaining why 10m, 12m, & 15m typically die after sun down

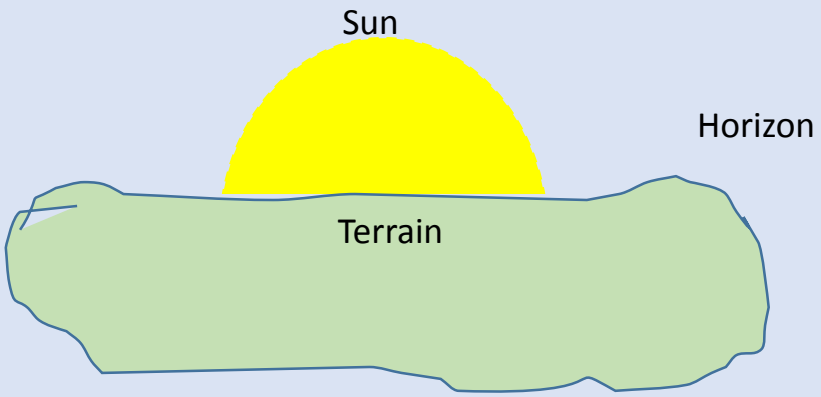


Structure of the ionosphere.



Communication Path Definitions

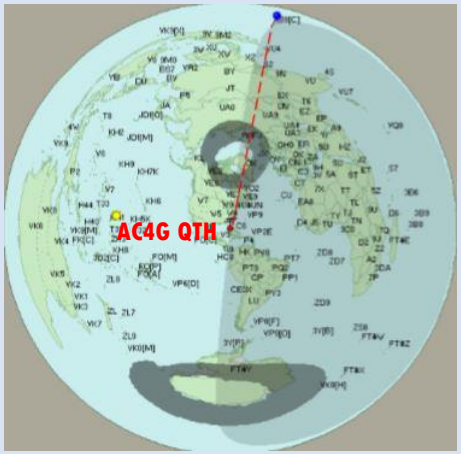
- **The definition of SUNSET and SUNRISE is when the *CENTER* OF THE SUN is at the horizon**
- **Sunset and sunrise is NOT at first light or last light**



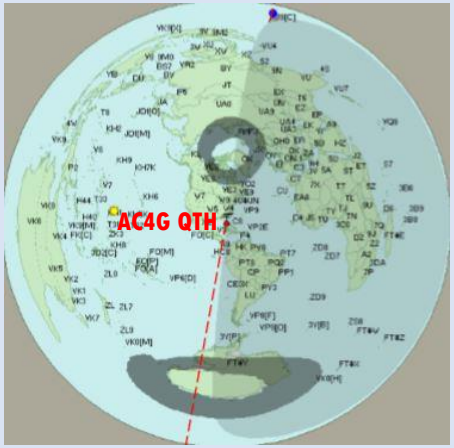
It's all one's perspective - Sunrise at one QTH may be sunset or darkness at another QTH

Communication Path Definitions

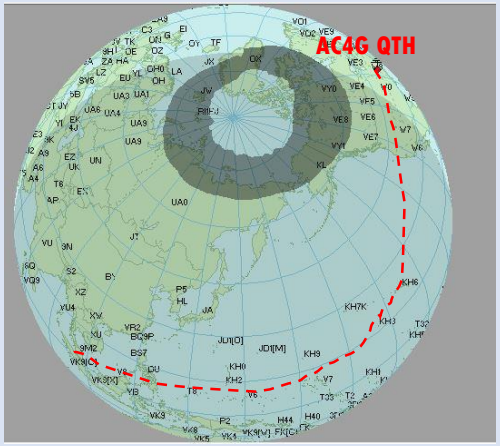
- **Shortpath – Straightest communications path between two locations**
- **Longpath – Longest communications path between two locations also called the Great Circle Route (Not referring to NADXC Newsletter)**
- **Scattered Path - Scattered signals from other directions (back scatter, etc.)**
- **"Skewed" Path – The path between two locations deviating from longpath as a result of sufficient horizontal gradient in electron density (perpendicular to the path) to significantly skew the signal off of one great circle path to a new great circle path**



Shortpath



Longpath

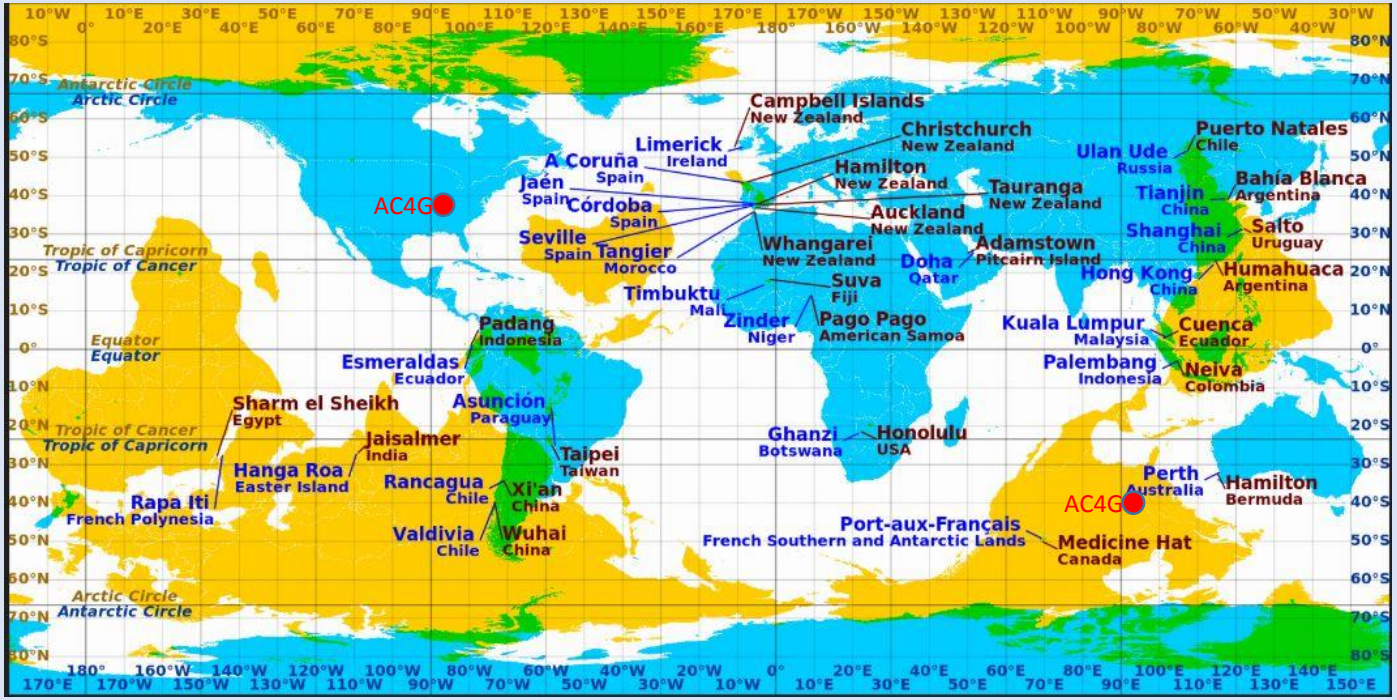


Skewed Path (morning shown)

*DX Atlas software tool used for maps/plots

Communication Path Definitions

- **ANTIPODE is the spot on Earth location diametrically opposite to it [i.e. pair of points connect by a straight line through the Earth's center & furthest from each other]**

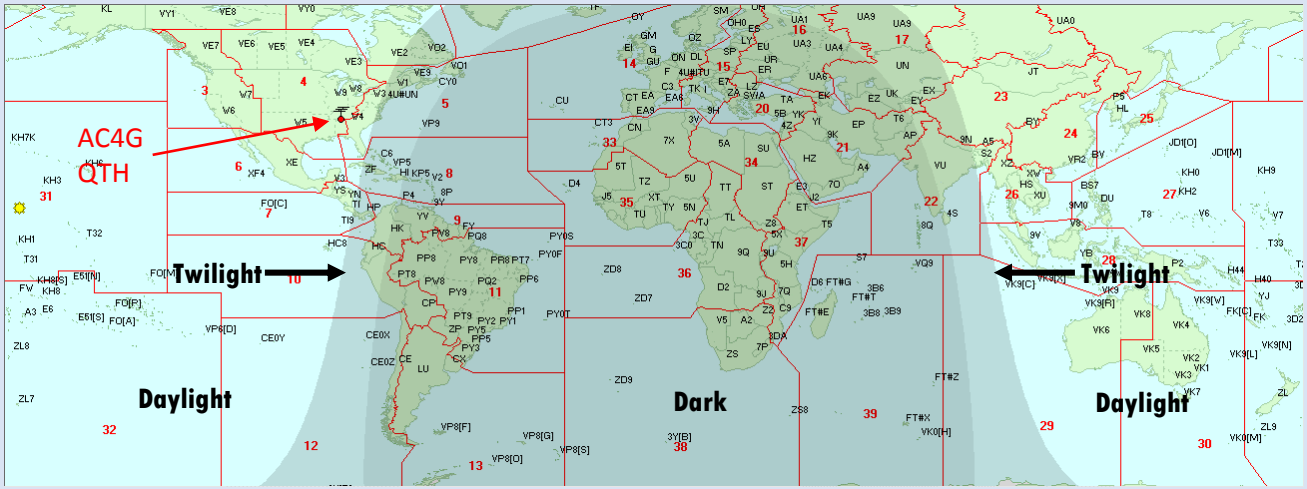


Orange rectangular map is a mirror of the blue rectangular map indicating AC4G antipode

Antipode is the farthest point from on Earth from your location!

Communication Path Definitions

- **GRAYLINE (Grey Line) is the band around the Earth separating sunlight from darkness**
- **GRAYLINE effects refer to locations along this terminator, encircling the globe along a great circle route**
- **GRAYLINE typically provides a low loss path of varying width and duration (duct) depending on frequency with very efficient propagation**
- **On 160 through 30 meters, these openings may last only a few minutes (and are NEVER shown on computer predictions) - At the other end of the spectrum, there are also openings along the terminator on 10 through 20 meters**

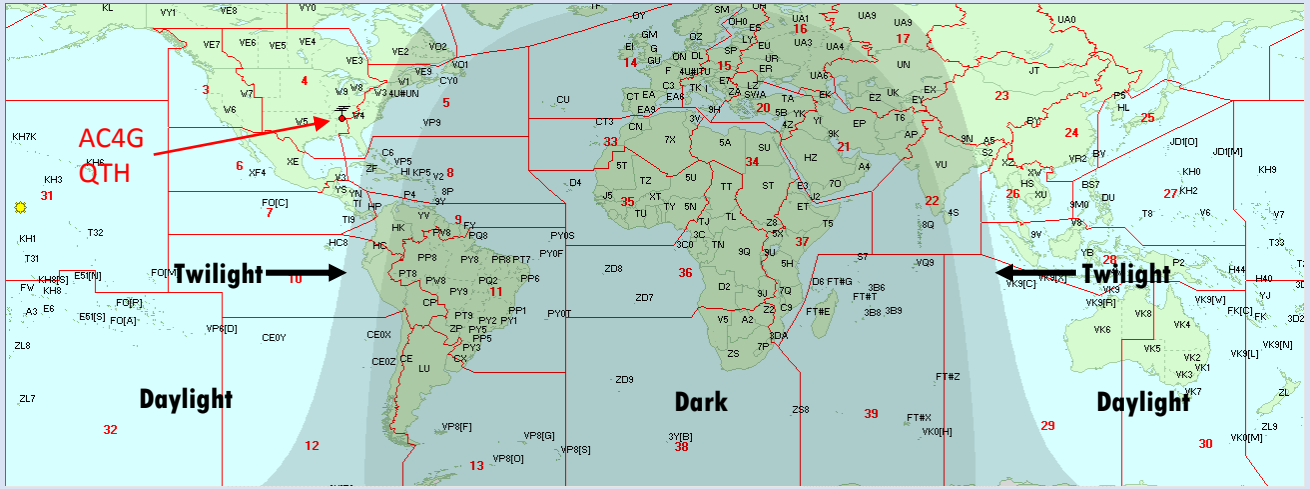


Grayline or Terminator

*DX Atlas software tool used for maps/plots

How Does Grayline Work?

- **Just prior to sunset or just after sunrise (during twilight), D-Layer suddenly causes little absorption allowing signals to pass through**
- **E-Layer & F-Layer are being ionized making several minutes of fantastic propagation with almost no signal attenuation, while the MUF remains stable**
- **While the sun starts (morning) or continues (afternoon) heating the D-Layer, eventful long distant QSOs can take place reflecting signals off the ionized portions of the E & F layers**



*DX Atlas software tool used for maps/plots

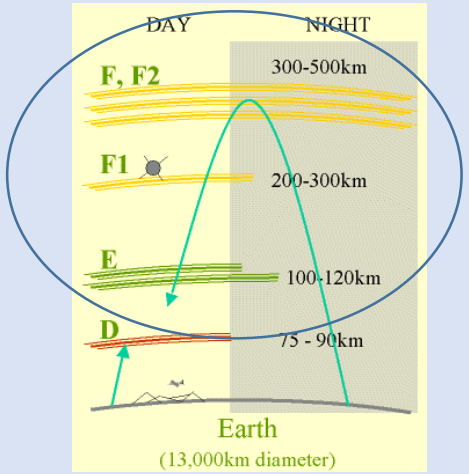
Grayline or Terminator

Sunrise Phenomena (SSW)
(from S. Tennessee/N. Alabama)

- **SUNRISE ENHANCEMENT accounts for the peak associated with signals coming from the westerly directions (NOT on the GRAYLINE), but often mistakenly referred to as grayline**
  - **These enhancements always occur AFTER sunrise on 30, 40, and 80 meters**
  - **Tends to occur at sunrise (+/- a few minutes) on 160 meters**
  - **There appears to be refractions from the normal F layer propagation plus another refraction from the E-layer which combine to produce significant gains (on the order of 6 to 10 dB, sometimes even more) forming a duct**
  - **Enhancement duration ranges from a <u>few minutes</u> on 160 meters, <u>10 to 20 minutes</u> on 80 meters, and <u>30 to 60 minutes</u> on 30/40 meters**
- ***Robert R. Brown, NM7M, "On the SSW Path and 160-Meter Propagation," QEX, November/December 2000, pp. 3-9, discusses & describes these findings above**
  - **Propagation from the SSW at SR has been explained***
  - **Propagation from the SSE at SS has not been explained, but is similar to morning SSW opening**
- **Tom Russell, N4KG (SK) NADXC past member also emphasized these same findings and is documented in ON4UN's Low Band DXING book**

Sunset Phenomena (SSE)
(from S. Tennessee/N. Alabama)

- **SUNSET ENHANCEMENT accounts for the peak associated with signals coming from the south easterly directions (NOT on the GRAYLINE)**
- **Horizontal ionization gradient results in more ionization on sun side resulting in very "lossy", noisy path**
  - **Appears to be a combined F and E layer condition as above, occurring BEFORE SUNSET with durations similar to those of the above mentioned SUNRISE enhancement also forming a duct**



It takes a little LIGHT for the low band enhancements to materialize!

When does Grayline/Sunrise/Sunset Enhancement(s) Occur?

- **Grayline/sunrise/sunset enhancement propagation is most common on the lowbands and best experienced in the mornings or evenings in late Fall, Winter, and early Spring**
- **Morning "long" path from Southern, Mid-Tenn/North AL occurs as sun rises (morning terminator) with enhanced signals toward SSW in Fall thru early-Spring**
- **Afternoon "long" path from Southern, Mid-Tenn/North AL occurs as sun sets (afternoon terminator) with enhanced signals toward SSE in Fall thru early-Spring**

Longpath QSOs have been made on 10m thru 15m!

Propagation Mapping Tools

- Propagation prediction tools for the serious LOW BAND DXer include a good mapping program
  - DX Atlas (Used in this presentation)
  - DX EDGE
  - GEOCLOCK
  - MiniProp by W6EL
  - IONCAP

- Tools should include accurate tables indicating SUNRISE and SUNSET
- Many computer propagation programs UNDERESTIMATE MUF by a significant percentage. Example: "IONCAP" will often predict the MUF to Europe to be just above 21 MHz and yet we find 12 and even 10 meter openings.
  - However, these tools are useful for indicating peak TIMES on the HIGH BANDS (10 thru 20m) and when the HIGH BANDS will open and close

Most computerized propagation programs DO NOT account for the SUNRISE and SUNSET effects on the LOW BANDS

Why Longpath Propagation?

- **QSOs with some DX stations cannot be made via Shortpath propagation (shortest, straightest path)**
- **True Longpath propagation allows for very long distant QSOs**
- **Some QSOs must be made via an unusual path at sunrise or sunset to be discussed in future slides**

The casual ham (may require some extra RF power) should take advantage of Longpath propagation!

Examples of "Long" Path Propagation QSOs with AC4G

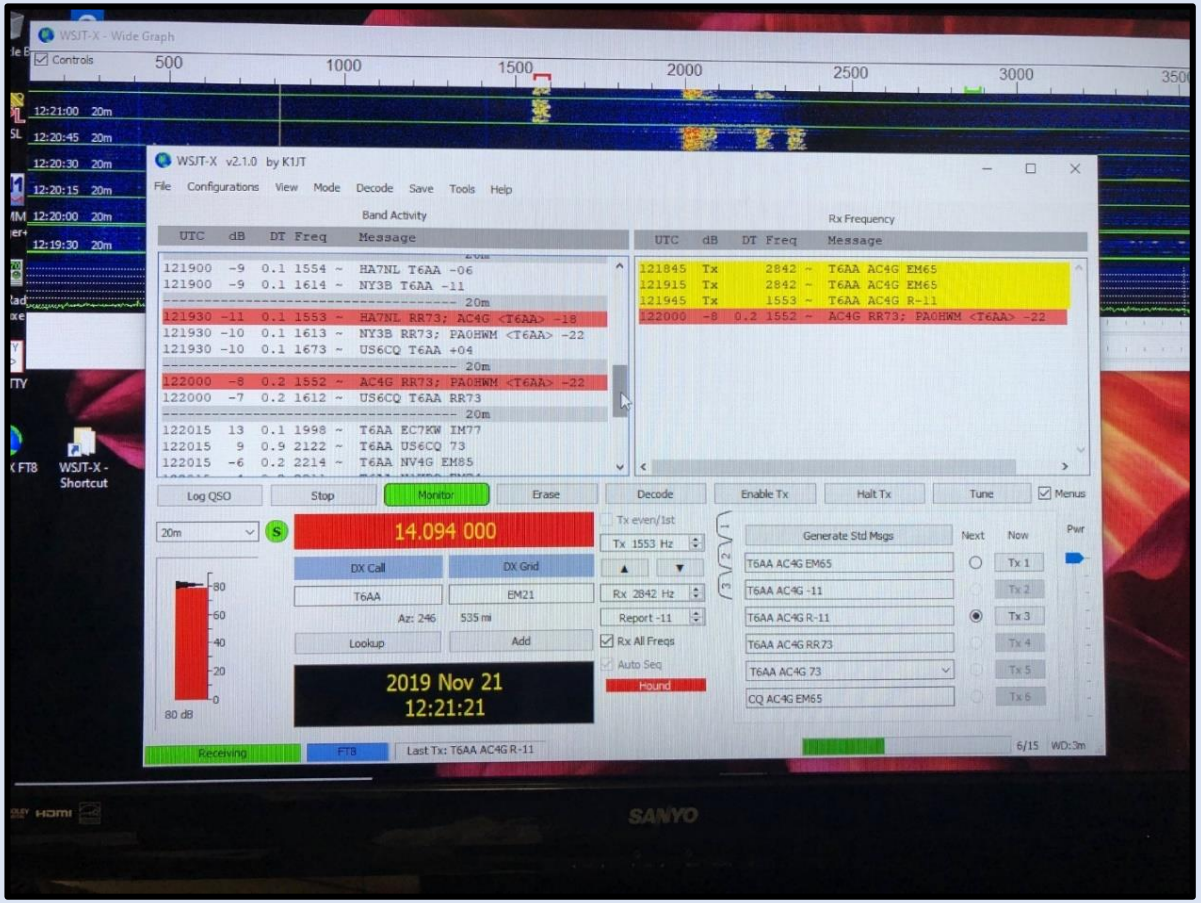
More discussion on propagation to follow:

1. **9M2AX on 80m CW at 2310Z; SSE direction; 30 Dec 2016 with 539 signals**
2. **T6AA on 40m FT8 at 1212Z; SSW direction; 7 Nov 2019 with loud signal**
3. **VU2GSM on 40m CW at 1259Z; 6 Feb 2016 with 579 signals both ways**
4. **VK9CZ on 80m CW at 23:43Z (5:00 p.m. CDT local time); Signal 579; 3 April 2013 in the Spring season; Longpath or Not?**
5. **VK9CZ on 80m CW at 22:57Z (4:57 p.m. CDT local time); 1 November 2017 – Fall season, 4 years later; Signal 599; Longpath or Not?**
6. **VK9CZ on 80m CW November 2019 – Fall season, 6 years later [Signal strength 529 at 22:53Z]; Longpath or Not?**

80m Signals for the 2019 VK9CZ Dxpedition have been weak to negligible

T6AA 20m Longpath FT8 QSO (Nov 2019)

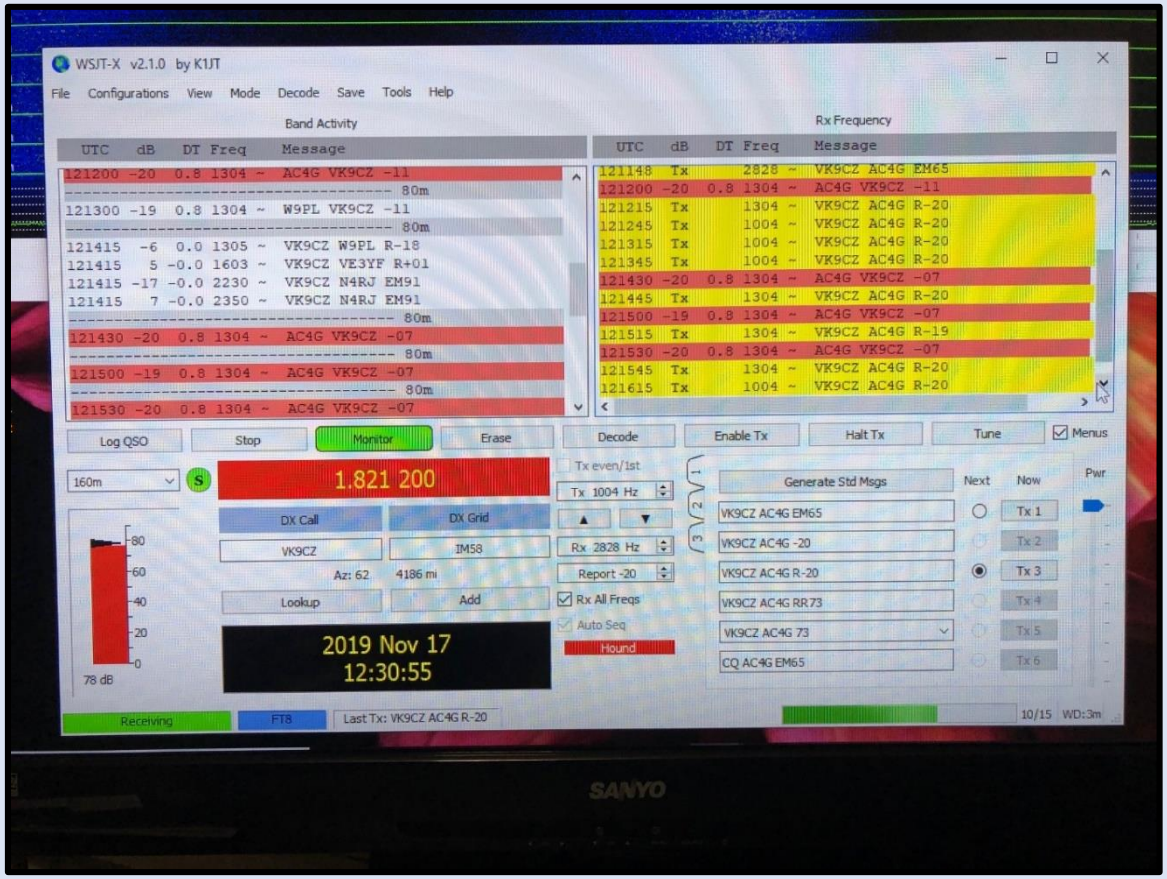
- First QSO attempt resulted in unsuccessful QSO to SSW
- Signal report received, but did not receive “RR73” before T6 operator dropped AC4G out of loop
- A few days later, longpath returned to 20m and AC4G made successful QSO finally receiving :RR73” to complete QSO and be logged



Morning longpath or skewed path?

Example of Failed “Long”Path QSO

- FT8 QSO attempt on 80m to VK9CZ in 17 Nov 2019
- NO “RR73” ever received
- Path began fading and dropped like a rock prior to “RR73” being received
- Analysis of VK9CZ online logs revealed no QSO & resulted in the saddened “not in the log”
- This is the drawback to short duration “long” path propagation – PATH FADE



Hams have to contend with “path fade” if riding a classical “long” path

Rest of Our Discussion will Focus on Analysis of AC4G-VK9CZ Path

- We will focus our attention to one QSO to the Indian Ocean area on the (80m) lowband near our antipode
- Late afternoon QSO around 4:45 p.m.(local)
- VK9CZ signal was very strong! So What?????
- QSO between AC4G and VK9CZ located 10,843 miles away NOT via Short Path
- QSO confirmed!

DETAILS TO FOLLOW…

Where is Cocos Keeling (VK9C)?

British Indian Ocean Territory

VQ9

A very tough location for W4's to make QSO! Near AC4G antipode??

Cocos (Keeling) Islands

VK9C

Christmas Island

VK9X

YB

VK6

Indian Ocean

Location of the Cocos (Keeling) Islands (circled in red)

Sovereign state	Australia
Annexed by the United Kingdom	1857
Transferred from Singapore to Australia	23 November 1955
Capital	West Island 12°11'13"S 96°49'42"E
Largest village	Bantam (Home Island)
Official languages	None
Spoken languages	Malay · English[a]
Government	Directly administered dependency
• Monarch	Elizabeth II
• Governor-General	David Hurley
• Administrator	Natasha Griggs
• Shire President	Seri Wati Iku
Area	
• Total	14 km² (5.4 sq mi)
• Water (%)	0
Highest elevation	5 m (16 ft)
Population	
• 2016 census	544[1]
• Density	43/km² (111.4/sq mi) (not ranked)
Currency	Australian dollar (AUD)
Time zone	UTC+06:30

AC4G Distance to Cocos Keeling (VK9C)

Beam Heading Charts Provide LP Headings

DXCC COUNTRY LIST/BEAM HEADINGS - AC4G

PREFIX	COUNTRY NAME	SHORT PATH	LONG PATH	DISTANCE
1A0KM	SOVEREIGN MILITARY ORDER OF MALTA	51	231	5088
1S, 9M0	SPRATLY ISLANDS	335	155	9258
3A	MONACO	51	231	4797
3B7	AGALEGA & SAINT BRANDON ISLANDS	63	243	9534
3B8	MAURITIUS ISLAND	74	254	10012
3B9	RODRIGUEZ ISLAND	67	247	10293
3C	EQUATORIAL GUINEA	86	266	6509
3C0	ANNOBON	90	270	6362
3D2C	CONWAY REEF	257	77	7554
3D2	FIJI ISLANDS	258	78	7223
3D2	ROTUMA	264	84	7052
3DA	SWAZILAND	99	279	8745
3V	TUNISIA	56	236	5183
3W, XV	VIET NAM	343	163	9227
3XA	GUINEA	92	272	4948
3Y	BOUVET ISLAND	138	318	8128
3Y	PETER 1 ISLAND	181	1	7128
4J	AZERBAIJAN	32	212	6543
4L	GEORGIA	35	215	6331
4O	MONTENEGRO	47	227	5349
4S	SRI LANKA	21	201	9398
4U1ITU	ITU HQ	49	229	4655
4U1UN	UNITED NATIONS HQ	60	240	777
4W	TIMOR - LESTE	305	125	9707
4X	ISRAEL	47	227	6516
5A	LIBYA	59	239	5431
5B	CYPRUS	45	225	6238
5H	TANZANIA	74	254	8506
5N	NIGERIA	85	265	5671
5R	MADAGASCAR	80	260	
5T	MAURITANIA	85	265	
5U	NIGER	80	260	
5V7	TOGO	86	266	
5W	SAMOA	256	76	
5X	UGANDA	73	253	

Shortpath to VK9CZ: 353 Degrees
Longpath to VK9CZ: 173 Degrees
Skewed path: 225-240 Degrees (mornings)
Example: Distance to VK9CZ from AC4G - 10,849 miles per table

PREFIX	COUNTRY NAME	SHORT PATH	LONG PATH	DISTANCE
VK	AUSTRALIA	278	98	9783
VK0H	HEARD ISLAND	148	328	10860
VK0M	MACQUARIE ISLAND	226	46	9133
VK9C	COCOS (KEELING) ISLANDS	353	173	10849
VK9L	LORD HOWE ISLAND	254	74	8668
VK9M	MELLISH REEF	271	91	8481
VK9N	NORFOLK ISLAND	253	73	8151
VK9W	WILLIS ISLAND	276	96	8784
VK9X	CHRISTMAS ISLAND	334	154	10569
VP2E	ANGUILLA	123	303	1872
VP2M	MONTSERRAT	124	304	2016
VP2V	BRITISH VIRGIN ISLANDS	124	304	1825
VP5	TURKS & CAICOS ISLANDS	133	313	1319
VP6	DUCIE ISLAND	216	36	4758
VP6	PITCAIRN ISLAND	221	41	5027
VP8	FALKLAND ISLANDS	162	342	6219
VP8G	SOUTH GEORGIA ISLAND	153	333	6860
VP8O	SOUTH ORKNEY ISLANDS	160	340	6988
VP8	SOUTH SANDWICH ISLANDS	151	331	7280
VP8	SOUTH SHETLAND ISLANDS	167	347	6900
VP9	BERMUDA	93	273	1333

Most modern logging software provides beam headings to DXCC Entities

VK9CZ Dxpedition(s) Operations

- One of the farthest DXCC entities from southern, middle TN / Northern AL at approximately 10,850 miles away located in the Southeast Indian Ocean on Cocos Keeling Island
- VK9CZ Dxpedition #1 from Cocos Keeling Island (East Indian Ocean) occurred 30 March to 13 April 2013
- Alternated transmissions between 80m and 160m every sunrise (SR) and sunset (SS) except after 6 April operated only 80m due to bad conditions
- VK9CZ Dxpedition #2, November 2017 (Similar operating techniques as 2013)
- VK9CZ Dxpedition #3, November 2019 (Similar operating techniques as 2013)
- Operators: GM3WOJ and GM4YXI

Several NADXC Members have made many successful longpath QSOs

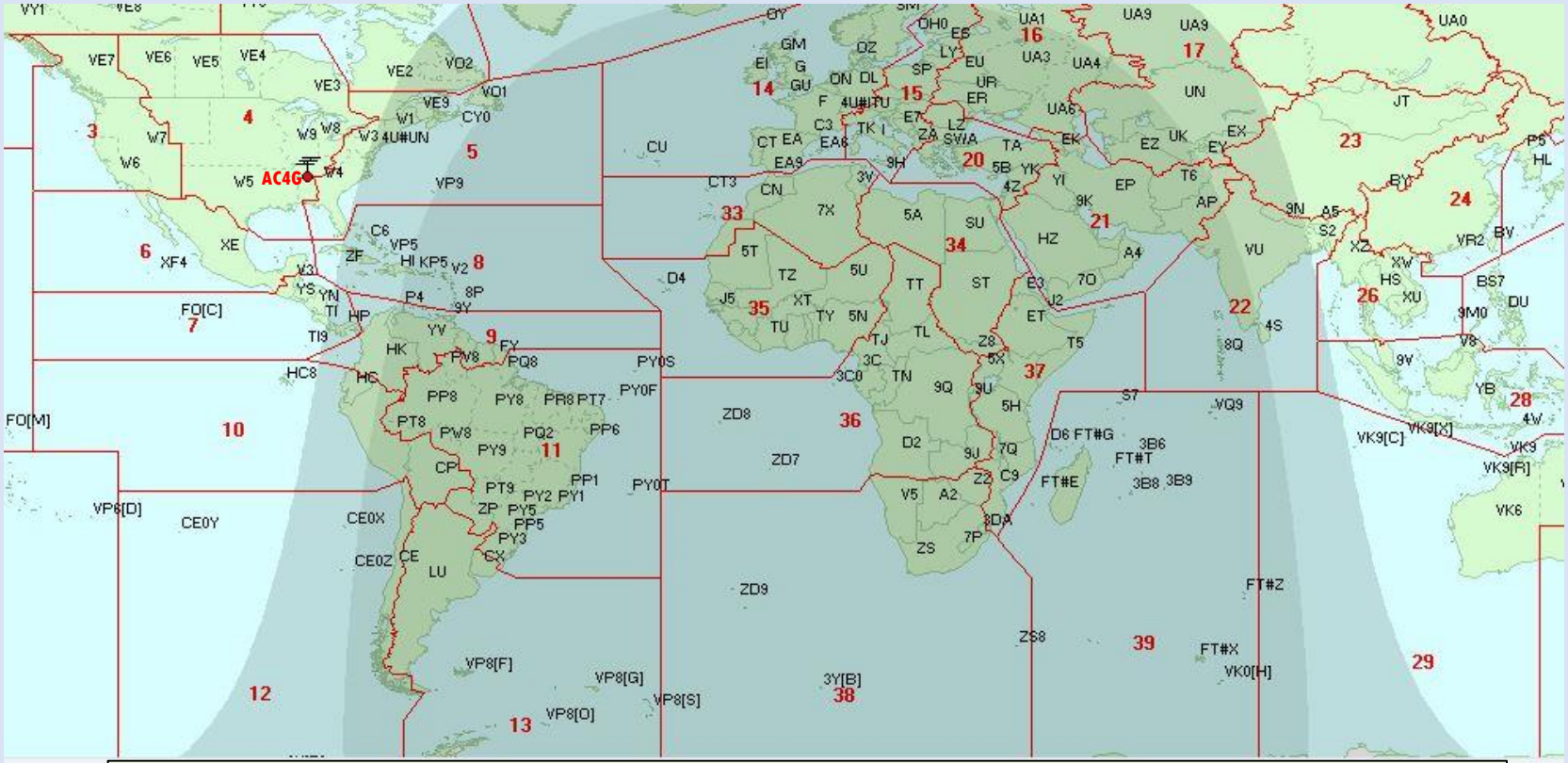
AC4G-VK9CZ QSO Description

- **Started monitoring 80m CW at 2300Z on 3 April 2013 (before SS) listening for any stations [not aware of this Dxpedition]**
- **Began hearing a signal at 2335Z, but was not sure who it was, but began to pound in to my receiver a few minutes later & copied call as VK9CZ**
- **Heard one station work VK9CZ and afterwards VK9CZ called CQ and QRZ**
- **No other stations calling via my beverage antenna SE direction**
- **AC4G called at 2343Z sending 579 and received a 599 signal report back**
- **Announced on NADXC repeater (147.30) but no takers**
- **VK9CZ kept calling until fading out about 7 minutes later**
- **Same thing happened in 2017 and repeated the same actions to make QSO and announce to NADXC repeater**

QSO made between AC4G (21 minutes before sunset) & VK9CZ (4 minutes after sunrise) - no mutual darkness!

Sunlight AC4G and VK9CZ

April 2013 (2340 Z)



QSO made between AC4G (21 minutes before sunset) & VK9CZ (4 minutes after sunrise) - no mutual darkness!

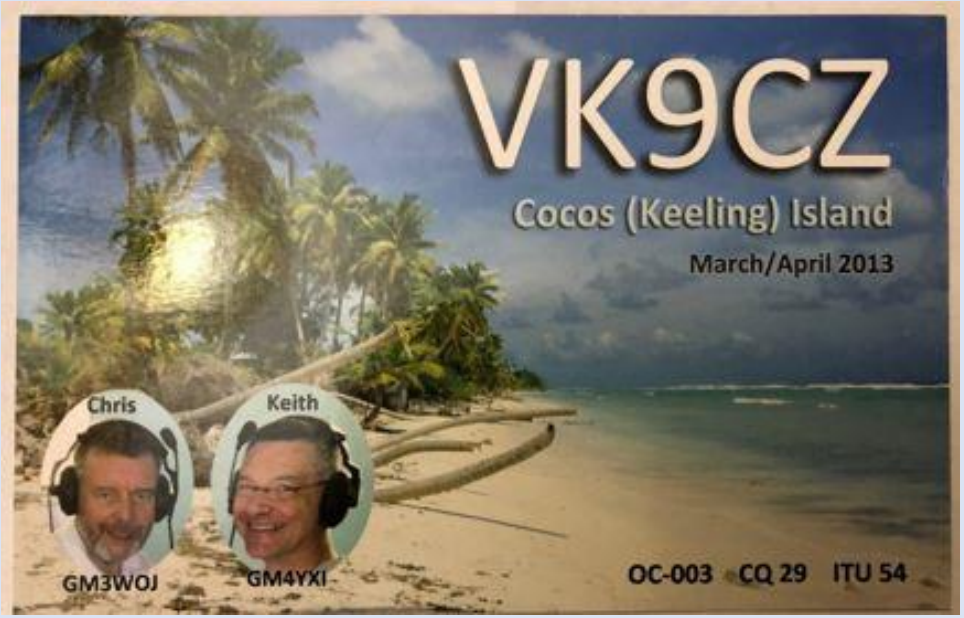
DX Atlas software tool used for maps/plots

AC4G Station

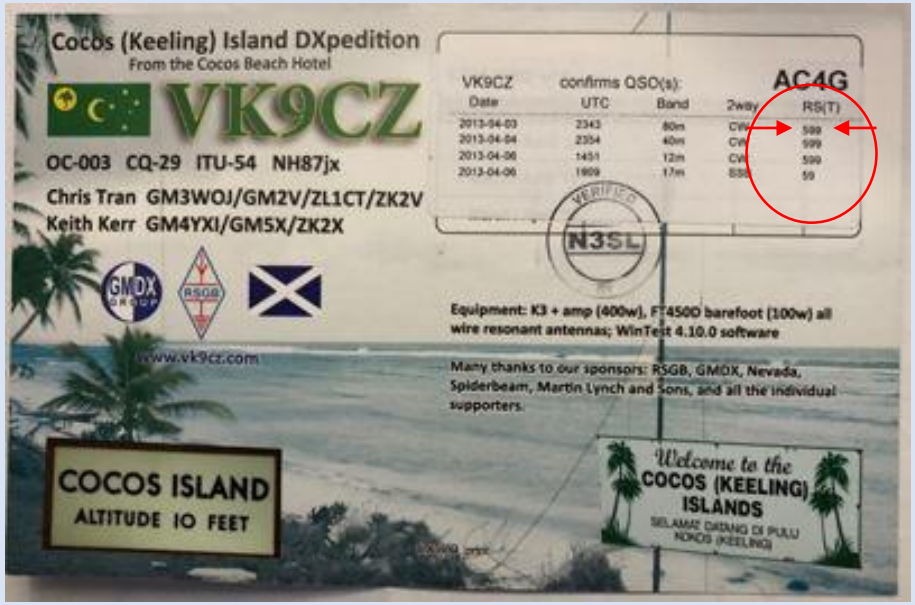
- AC4G Equipment
  - Yaesu FTDX3000 Transceiver
  - HF Amplifier (KW)
  - 80m Vertical antenna
  - 800 feet long beverage antenna to the southeast (Beverage antenna not needed)
  - No internet connectivity, but 2m repeater to announce DX spots to NADXC members

Longpath is an asset at SR/SS using the low bands for even the modest station, but sometimes operators forget to check this path!

VK9CZ QSL Card (Verifying QSO)



Front of QSL Card



Back of QSL Card

AC4G 80m QSO with VK9CZ confirmed!

AC4G Report to ARRL Propagation Report 2013

12 April 2013 ARRL Propagation Bulletin:

"I was so excited to QSO VK9CZ on 80m CW that I had to write in. Our QSO took place on 3 April around 2345Z when VK9CZ and my location in southern Tennessee were in sunlight at the edge of the terminator. This had to be one of my best QSOs ever due to the level of difficulty, the distance, and no darkness at either location (so my terminator map showed).

"The VK9CZ signal was S5-S7 on my transmit antenna (vertical). The signal was so strong that my separate receive antenna was not required. Since that date, I have not been able to copy their 80m signal. I guess it was one on my luckiest days to be able to make this QSO."

AC4G Report to ARRL Propagation Report 2013

12 April 2013 ARRL Propagation Bulletin:

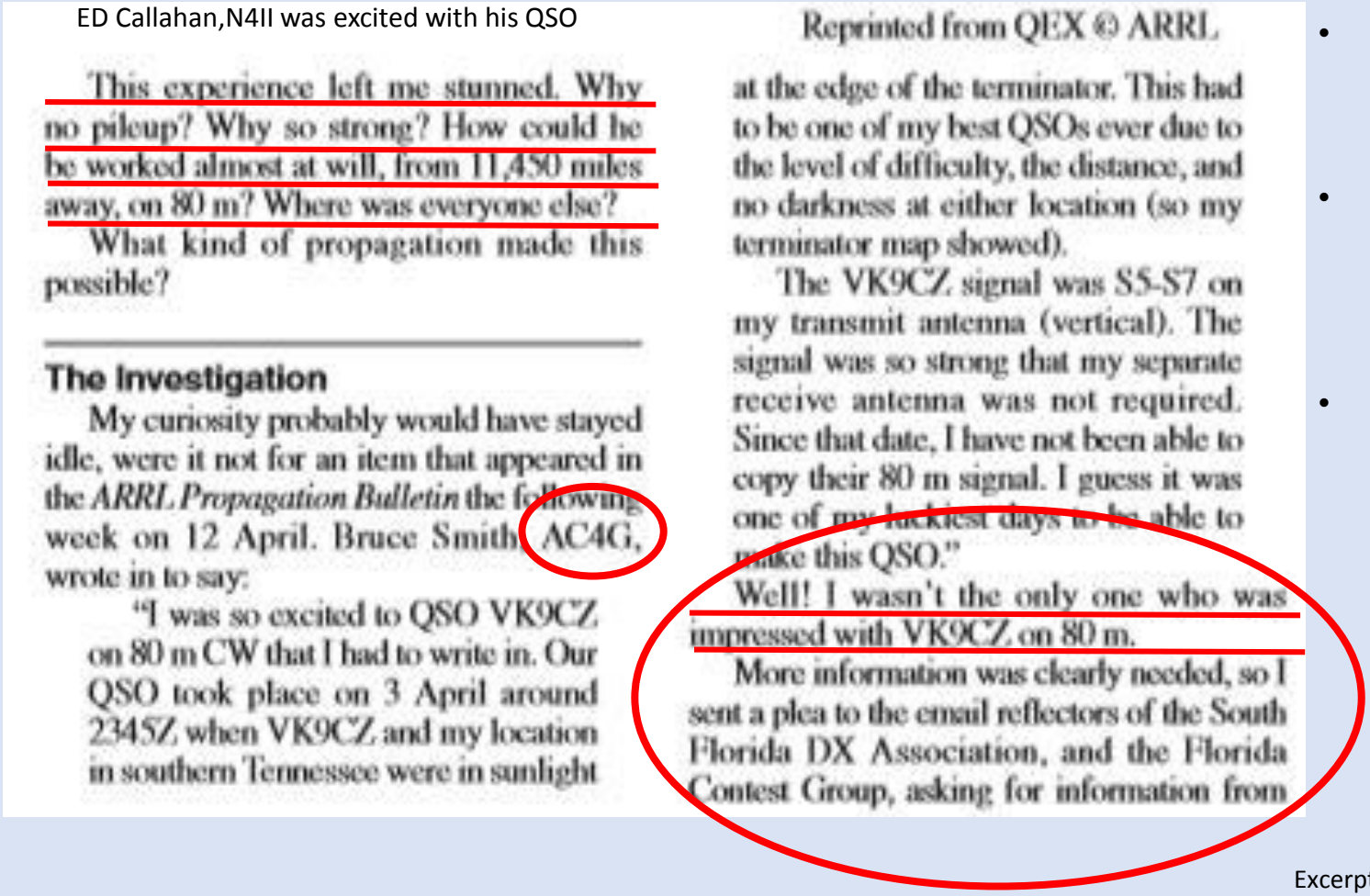
K7RA replied:

"Sounds like fun! At that day and time, I would expect good propagation on 15 and 17 meters! VK9CZ is the Cocos-Keeling DXpedition, and the path was exactly 10,843 miles, or 17,450 km.

Time given of 2345 UTC was 4 minutes after sunrise at the South Pacific [sic] end, and 21 minutes prior to sunset on the Tennessee end.

Another Ham (in Florida) Excited about VK9CZ QSO

ED Callahan,N4II was excited with his QSO



This experience left me stunned. Why no pileup? Why so strong? How could he be worked almost at will, from 11,450 miles away, on 80 m? Where was everyone else?

What kind of propagation made this possible?

The Investigation

My curiosity probably would have stayed idle, were it not for an item that appeared in the *ARRL Propagation Bulletin* the following week on 12 April. Bruce Smith, AC4G, wrote in to say:

"I was so excited to QSO VK9CZ on 80 m CW that I had to write in. Our QSO took place on 3 April around 2345Z when VK9CZ and my location in southern Tennessee were in sunlight

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Well! I wasn't the only one who was impressed with VK9CZ on 80 m.

More information was clearly needed, so I sent a plea to the email reflectors of the South Florida DX Association, and the Florida Contest Group, asking for information from

- **Ed Callahan, N4II was also excited and wanted to know how this happened**
- **Much research, several slides, and videos discuss this phenomena allowing an amazing QSO by N4II**
- **Searching the internet will reveal these articles**

Excerpt from ARRL QEX article

AC4G Report to ARRL Propagation Report in 2017 Again with VK9CZ

Bruce Smith, AC4G in Taft, Tennessee wrote on November 9:

"In April 2013, I was so excited to hear and make a QSO with VK9CZ, Cocos-Keeling on 80m CW as reported in the ARRL Propagation Report. The VK9CZ signal appeared all of a sudden out of nowhere with 579 signals at my sunset 2343Z via long path. Other stateside operators made the QSO including N4II who studied the technical aspects (science) and wrote a few articles on the path of the VK9CZ signal at gray line for April 2013.

"Recently, in Nov 2017, 4 years and 7 months later, VK9CZ put on another DXpedition to Cocos-Keeling. To my surprise, I heard their signals once again pop out of nowhere on 80 CW at my sunset (from 2235Z until 2325Z) early-November renewing my excitement. The signals long path (SE Beverage antenna) were surpassing 599.

"I could not pass another chance to say hello this year by giving the op on that side a 599 signal report. His sigs peaked via long path at 10 dB over S9 at my Taft, TN QTH this year Nov 2017. Perhaps Fall long path sigs are better than April sigs? There were several stateside hams who made the 1 Nov logs on 80m. The online log only showed about 36 QSOs in NA who had made the logs according to the Clublog statistics that I was monitoring on 1 Nov. On 5 Nov, I could barely hear the VK9CZ signals long path via SE Beverage antenna. Since then, a few other lucky operators logged an 80m QSO via LP with VK9CZ for a total of 71 80m QSOs as late as 6 Nov. 6 Nov was one of their last operating periods closing out their operation with another long path opening. The VK9CZ signals peaked via LP about 539 on this day in Taft, TN. All other days not described above, there were no apparent signals being received at my location in southern Tennessee on 80m.

"My observations revealed one great long path opening at my sunset and one mediocre opening, while the other long path openings were nil to barely readable. As it was in 2013, both VK9CZ and my QTH were in sunlight for both QSOs taking advantage of another sunrise enhancement.

"I also monitored 160m on days no sigs were heard on 80m, but not a whisper from the VK9CZ 160m signals at my sunset on many days monitored or when 160m cluster spots indicated VK9CZ operations on 160m.

"By the time the readers read this, the DXpedition will have ended. Hopefully, the next few years may bring other surprises on 80m/160m for us all renewing the DX Spirit for all low band operators.

"73, Bruce/AC4G/Taft, TN/EM65"

The earlier QSO that Bruce referred to was covered in the April 12, 2013 issue of Propagation Forecast Bulletin ARLP015.

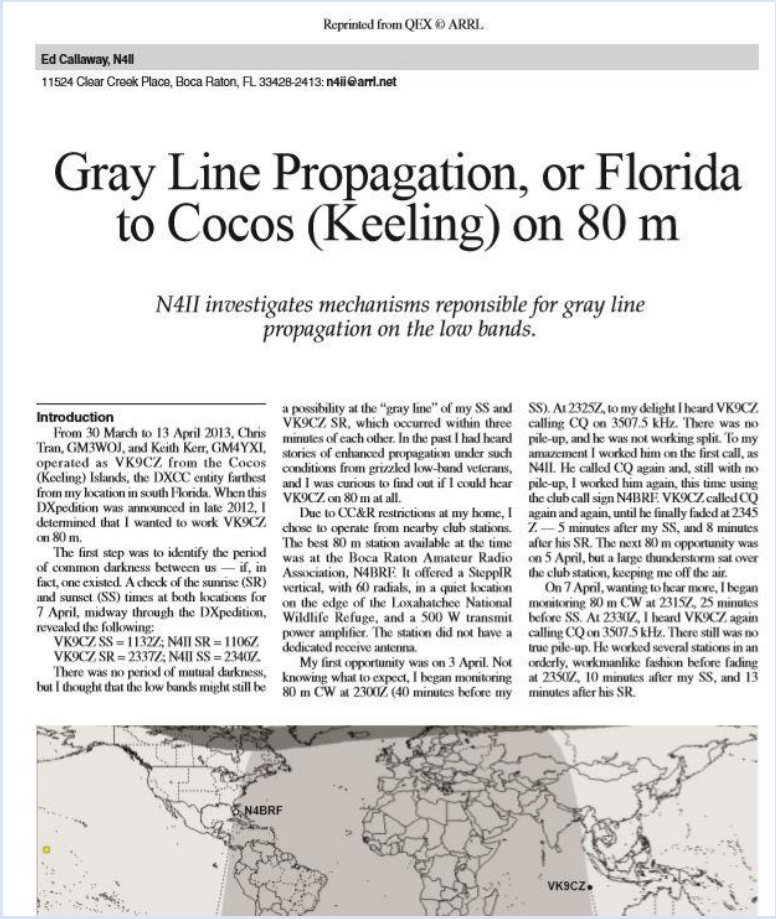
See http://www.arrl.org/w1aw-bulletins-archive/ARLP015/2013

Excerpts from ARRL Propagation Report, November 2017

- **AC4G makes another 80m QSO with VK9CZ four (4) years later in 2017 and recently Nov 2019**
- **Signals via the SSE path in afternoon once again**
- **Is this path longpath?**

N4II Published QEX Article

- **Dr. Ed Callahan, N4II did much research on the path from N4BBF to VK9CZ**
- **Reference ARRL QEX Article; Subject: Gray Line Propagation, or Florida to Cocos (Keeling) on 80m**
- **Permission received by AC4G from N4II to show his online presentation to DX club; AC4G rather researched topic to present from the AC4G perspective, but look at some of N4II's research**



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Ed Callaway, N4II

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Gray Line Propagation, or Florida to Cocos (Keeling) on 80 m

N4II investigates mechanisms reponsible for gray line propagation on the low bands.

Introduction

From 30 March to 13 April 2013, Chris Tran, GM3WOJ, and Keith Kerr, GM4YXI, operated as VK9CZ from the Cocos (Keeling) Islands, the DXCC entity farthest from my location in south Florida. When this DXpedition was announced in late 2012, I determined that I wanted to work VK9CZ on 80 m.

The first step was to identify the period of common darkness between us — if, in fact, one existed. A check of the sunrise (SR) and sunset (SS) times at both locations for 7 April, midway through the DXpedition, revealed the following:

VK9CZ SS = 1132Z; N4II SR = 1106Z.
VK9CZ SR = 2337Z; N4II SS = 2340Z.

There was no period of mutual darkness, but I thought that the low bands might still be a possibility at the "gray line" of my SS and VK9CZ SR, which occurred within three minutes of each other. In the past I had heard stories of enhanced propagation under such conditions from grizzled low-band veterans, and I was curious to find out if I could hear VK9CZ on 80 m at all.

Due to CC&R restrictions at my home, I chose to operate from nearby club stations. The best 80 m station available at the time was at the Boca Raton Amateur Radio Association, N4BRF. It offered a SteppIR vertical, with 60 radials, in a quiet location on the edge of the Loxahatchee National Wildlife Refuge, and a 500 W transmit power amplifier. The station did not have a dedicated receive antenna.

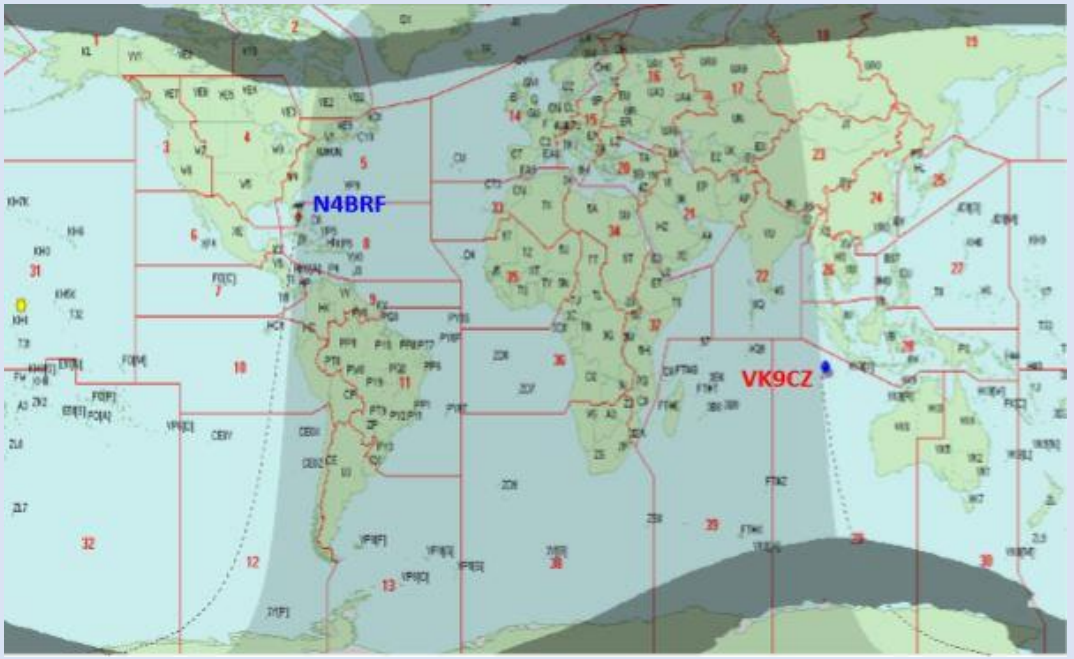
My first opportunity was on 3 April. Not knowing what to expect, I began monitoring 80 m CW at 2300Z (40 minutes before my SS). At 2325Z, to my delight I heard VK9CZ calling CQ on 3507.5 kHz. There was no pile-up, and he was not working split. To my amazement I worked him on the first call, as N4II. He called CQ again and, still with no pile-up, I worked him again, this time using the club call sign N4BRF. VK9CZ called CQ again and again, until he finally faded at 2345 Z — 5 minutes after my SS, and 8 minutes after his SR. The next 80 m opportunity was on 5 April, but a large thunderstorm sat over the club station, keeping me off the air.

On 7 April, wanting to hear more, I began monitoring 80 m CW at 2315Z, 25 minutes before SS. At 2330Z, I heard VK9CZ again calling CQ on 3507.5 kHz. There still was no true pile-up. He worked several stations in an orderly, workmanlike fashion before fading at 2350Z, 10 minutes after my SS, and 13 minutes after his SR.

Screenshot of N4II's ARRL QEX Article

N4II - 80m QSO w/ VK9CZ from Florida

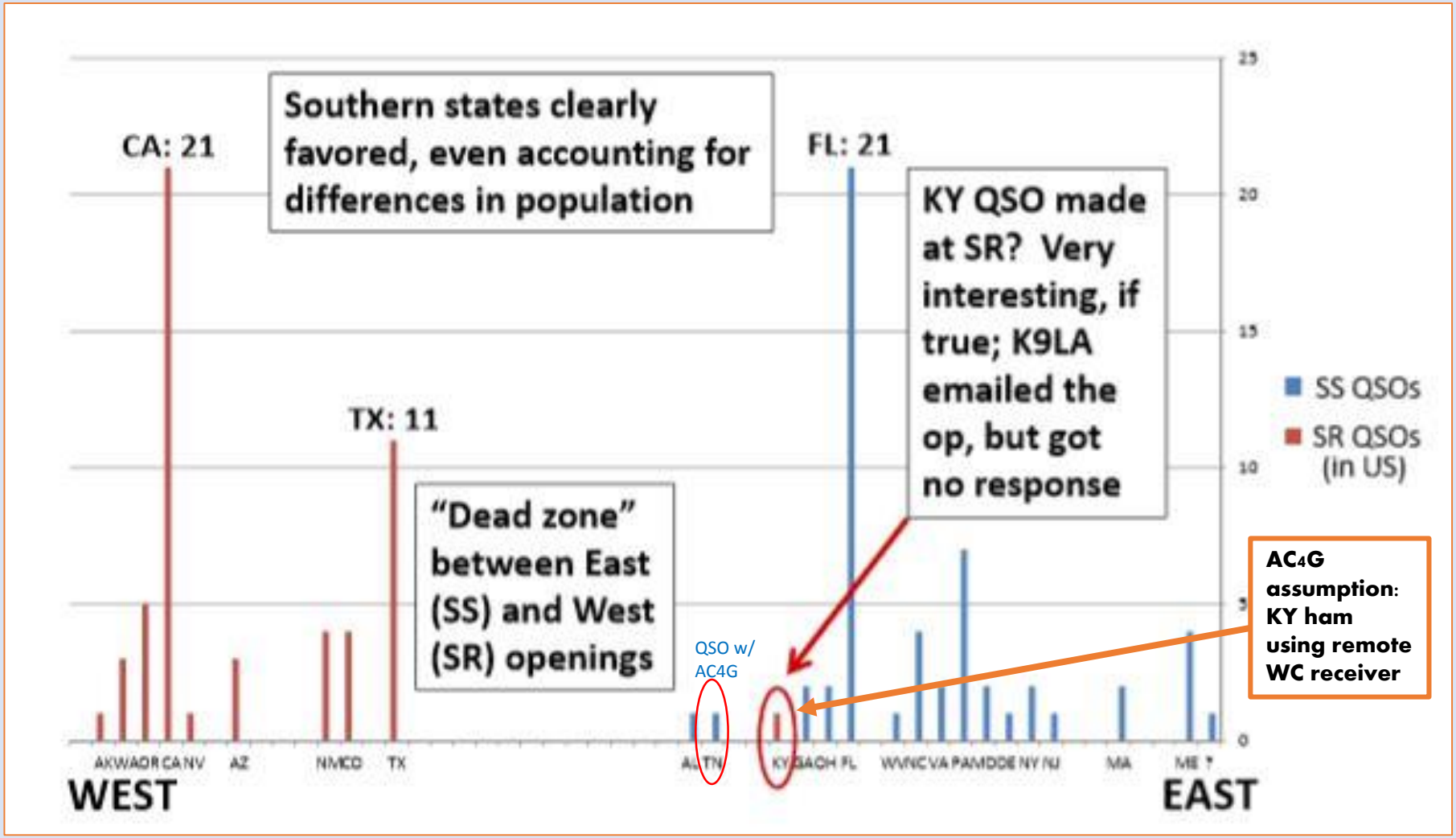
- **N4II operated Club Station N4BRF to make QSO with VK9CZ from Florida on 3 April 2013**
- **21 Florida QSOs**
- **Several N.E. U.S.A. QSOs**
- **1 Tennessee QSO (AC4G)**
- **1 Alabama QSO (Who?)**
- **Several West Coast QSOs**
- **Total 108 US QSOs made with VK9CZ on 80m during2013 DXpedition:**
  - **54 made @ SR**
  - **54 made @ SS**



Picture/info courtesy N4II's ARRL QEX article(s)

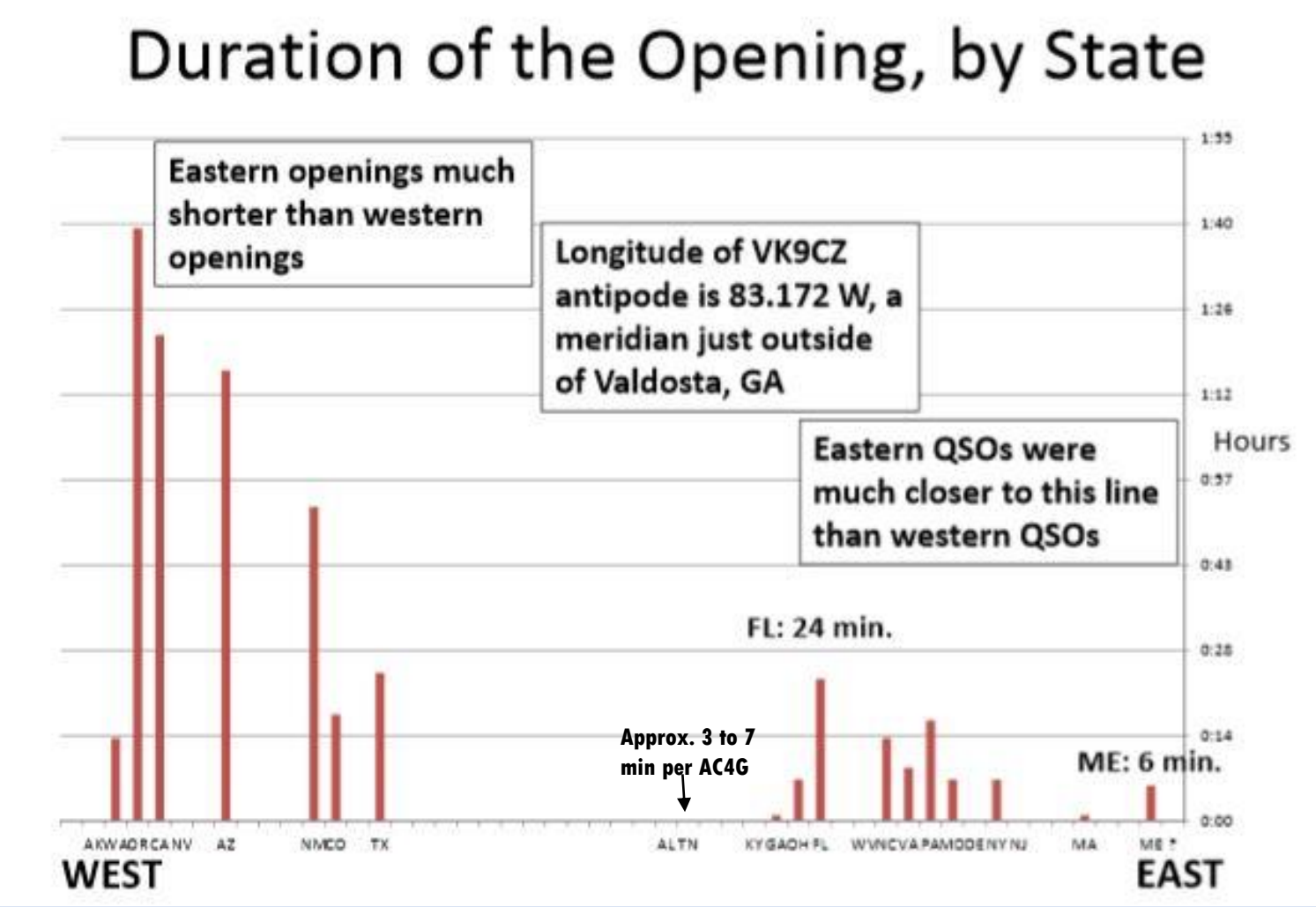
N4II obtained and examined 80m logs from VK9CZ Operators

QSOs by State - Ordered West to East



Picture & info from N4II ARRL QEX article

Duration of the VK9CZ Opening



Picture & info from N4II ARRL QEX article

Number of QSOs w/ VK9CZ by State

- Mid-USA had no QSOs – big zero (0)!
- Only West Coast USA and East Coast USA made the logbook on 80m
- Wow! WHY?
- Let's discuss further!

Why No Other Hams Making QSO with VK9CZ?

- Why no pileup?
- Why was signal so strong on 80m (a typical night band) during daylight hours?
- What path was used (Short, Long, Skewed, Other) to make QSO?
- Many call it longpath propagation, but does not follow true longpath direction
- What is the path?
- Let's examine the propagation path

What caused this fascinating phenomena to occur??

Propagation FACTS (1 of 2)

- Serious low band operators use directional receive antennas (Beverages, Array Loops, Delta Loops, directional wires, etc.)
  - Receive antennas are optimized for SNR not signal strength
  - Strongest signal for AC4G-VK9CZ QSO came from S.E. direction prior to NA sunset, while the best SNR was pointed other directions (Note: Optimal directions for low band transmit & receive may be different)
- Propagation along the terminator is unlikely and “lossy”
  - Horizontal ionization gradient results in more ionization on sun side, less at night side forcing signal away from sun side into the dark ionosphere
  - High ionization results in increased absorption compared to the dark ionosphere

Propagation FACTS (2 of 2)

- Long distance low band propagation involves the E and F layers
  - E-F Layers exhibit excessive ground loss and ionospheric absorption
  - Propagation in the duct can be very efficient (similar to VHF ducting)
  - Signals entering and departing duct are enhanced by ionosphere tilting [signals may exit at any location if irregularities exist in the E-Layer]
- Lowest loss propagation for low band signals occur far from the sun in the dark ionosphere where absorption is lowest
- Low radiation angles for transmission/reception required

Potential Paths to VK9CZ

- **Shortpath**
- **Longpath**
- **Terminator path**
- **Scattered path**
- **Skewed path (Special Path through dark ionosphere)**

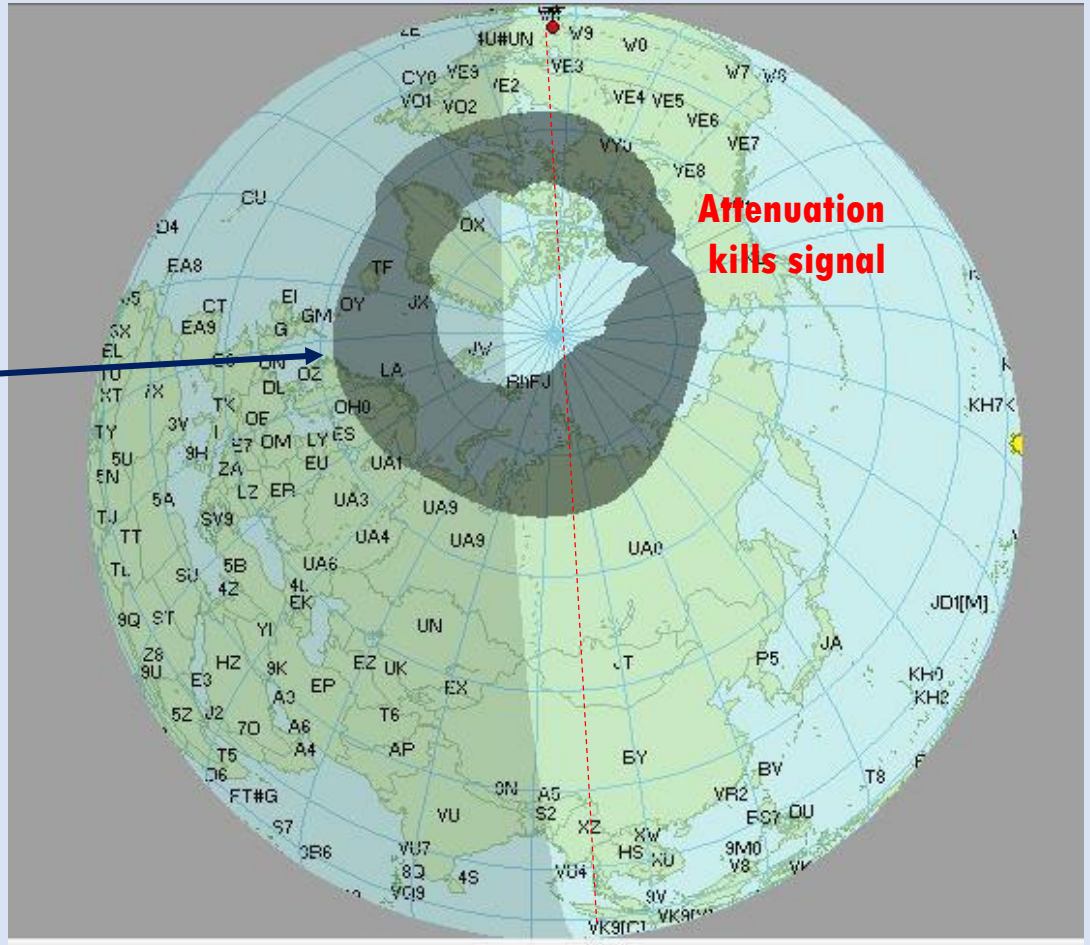
Further analysis with more details and diagrams

Assumptions for AC4G-VK9CZ 80m QSO

- Auroral oval ionization (at North & South poles) closes the E-F duct and refract the incoming signal toward the equator
- Path is to the SSE direction for NA stations (not SSW) for late-afternoon QSO
- Path is to the SSW direction at VK9CZ (for their early-morning QSO)
- Both AC4G & VK9CZ used vertical antennas (VK9CZ used Top-loaded vertical with 2 elevated radials & ground screen [54 ft Spiderbeam pole]
- E-F duct propagation occurred for this 80m QSO

Shortpath (not likely)

- **Sunlight fading around 2245Z-0005Z**
- **Passes through the high attenuation of the northern auroral oval**
- **353 degree beam heading unlikely**

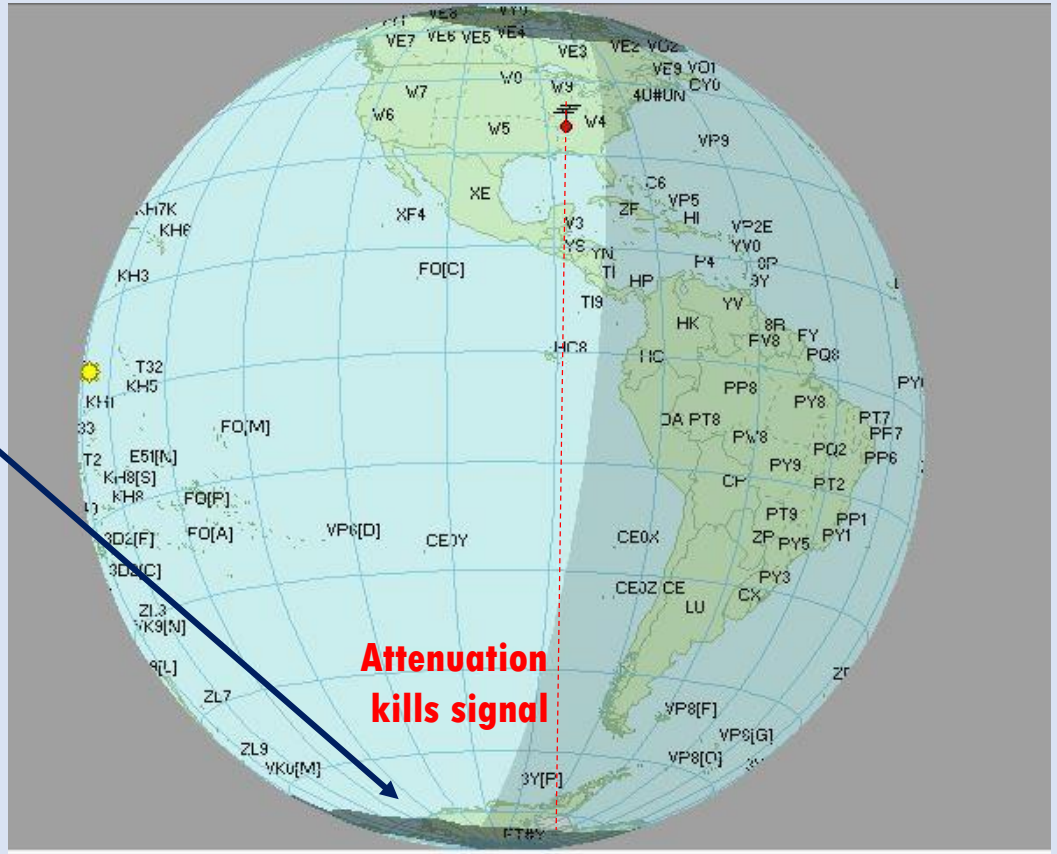


DX Atlas software tool used for maps/plots

RED line indicates shortpath route

True Longpath (not likely)

- **Sunlight fading around 2245Z-0005Z**
- **Passes through the high attenuation of the <u>southern auroral oval</u>**
- **172 degree beam heading unlikely**
- **Stays in sunlight almost the entire path**

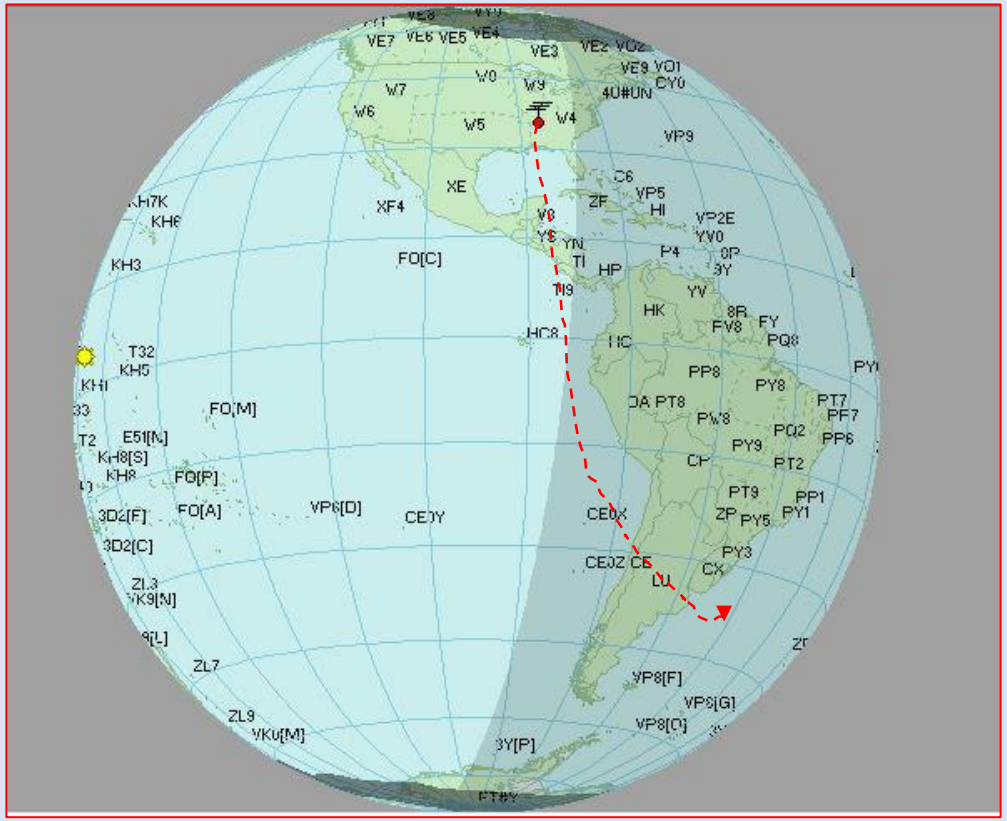


RED line indicates true longpath route

DX Atlas software tool used for maps/plots

Terminator Path (not likely)

- **Shows late-afternoon sunlight fading around 2245Z-0005Z**
- **Terminator Path is very “lossy”**
- **Signal is bent away from sun**
- **E-F Layer electron density is not developed along terminator resulting in little chance of ducting**



Propagation Along the Terminator

DX Atlas software tool used for maps/plots

Scattered Path (not likely)

***Scattering region forms at sunrise and short path signals scatter producing a signal coming from the SE or SW**

- **Unlikely as scattered signals from other directions should be heard (back scatter, etc.)**

There is no way backscatter signals could be heard from the distance of 10843 miles!

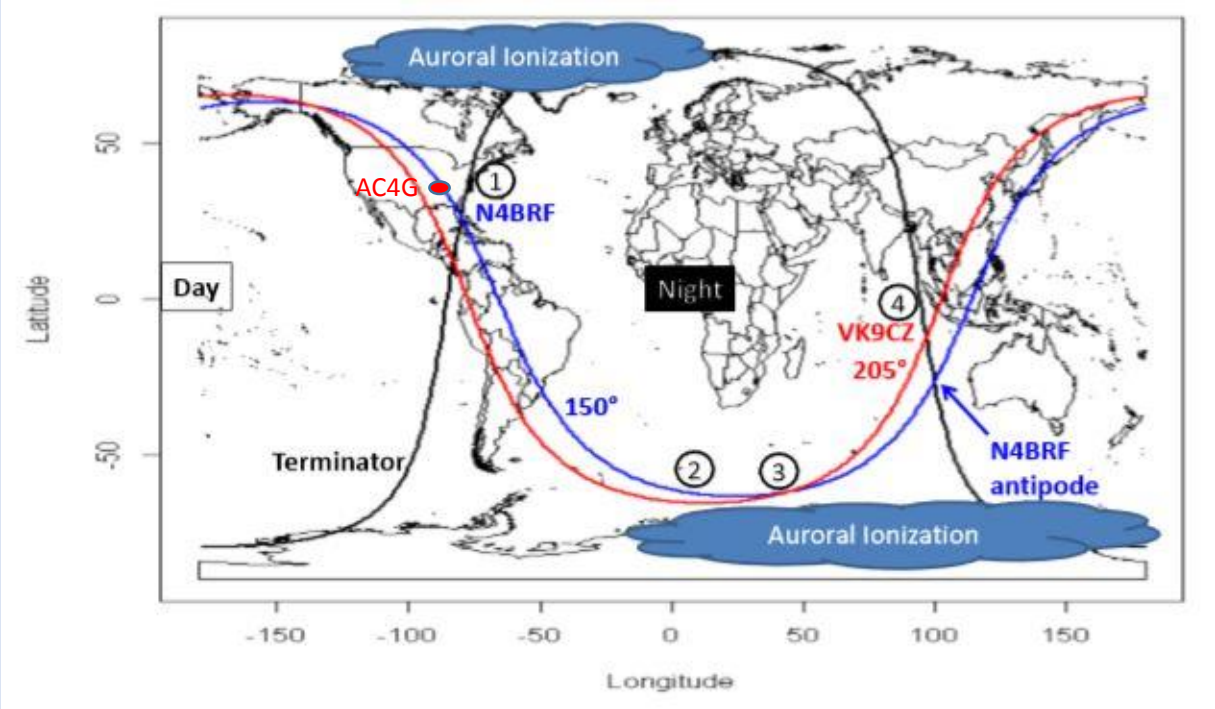
Skewed Path Through Dark Ionosphere (YES)

- Signal leaves NA station at sunset and enter the E-F duct on a Great Circle route to the SSE
- Signal approaches the southern auroral oval at a small angle (almost tangential) where ionization closes the E-F duct
- This ionization refracts the signal onto a new Great Circle route (toward equator of previous route) via a new E-F duct
- Signal exits the E-F duct due to some irregularity on a Great Circle route from the SSW and reaches VK9CZ at sunrise [Map next slide]

Southern polar oval is the skewing mechanism refracting the signal towards the equator

Skewed Path Through Dark Ionosphere (YES)

1. Signal leaves NA station at sunset and enter the E-F duct on a Great Circle route to the SSE
2. Signals approach the southern auroral oval at a small angle (almost tangential) where ionization closes the E-F duct
3. This ionization refracts the signal onto a new Great Circle route (toward equator of previous route) via E-F duct
4. Signal exits the E-F duct on a Great Circle route from the SSW and reaches VK9CZ at sunrise



N4II plot showing club station N4BRF Boca Raton, FL moving thru E-F duct to VK9CZ (Same explanation applicable to AC4G QSO): Exerpt from ARRL QEX Article

“Skewed” Path is Answer to AC4G-VK9CZ QSO(s)

- Explains why low band propagation occurs to SSE at sunset (AC4G QTH) and SSW at sunrise (VK9CZ QTH)
- Explains why the path to the North is never open
- Explains why east coast US mainly the southern states were favored
- Explains why north-south grayline paths are never experienced due to the auroral oval attenuation

CONCLUSION

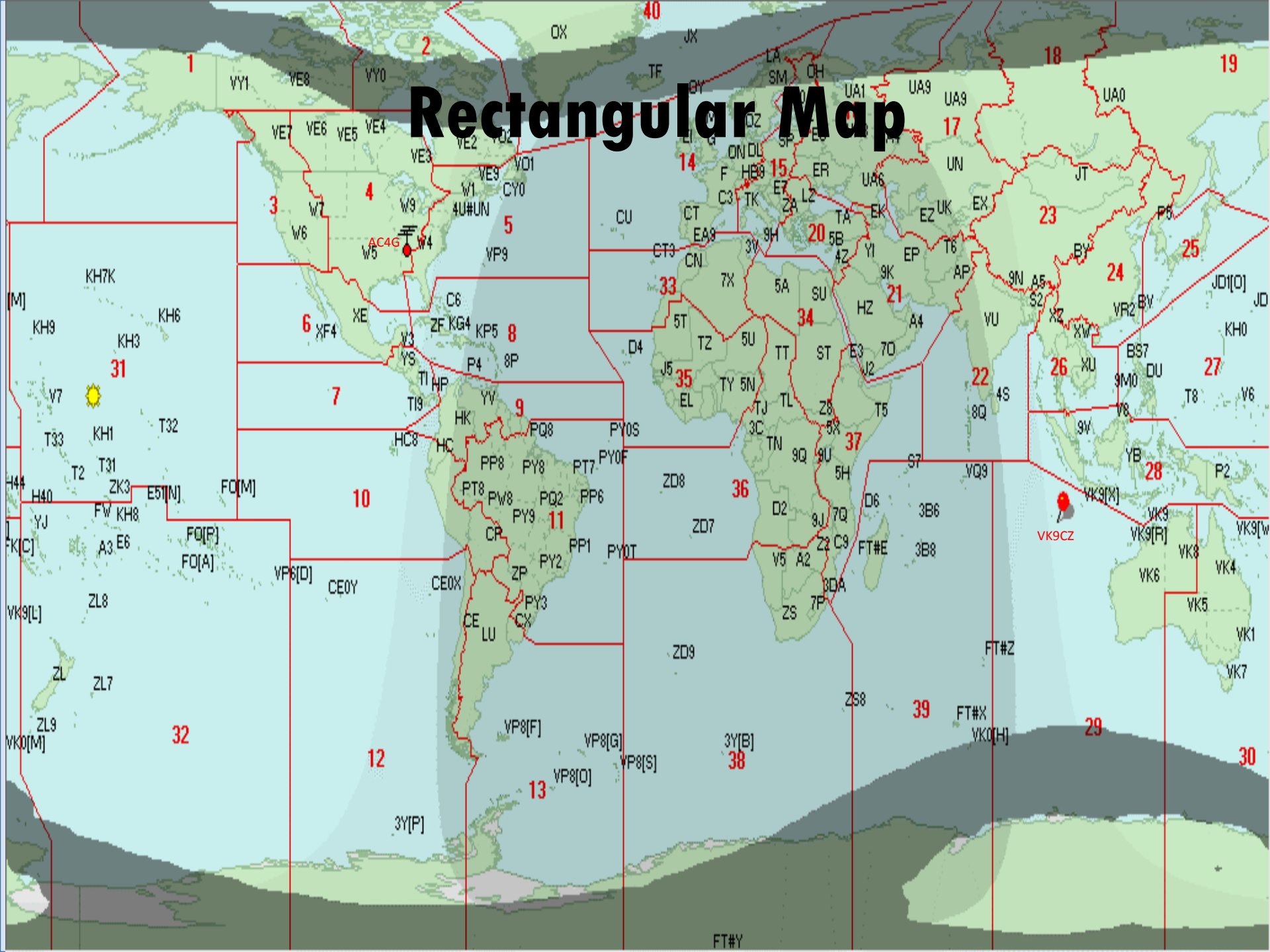
- Longpath propagation can help the DX'er achieve rare long distant DX contacts
- Hams have made LP & Skewed Path QSOs on 10 thru 160m over the years to reach difficult DXCC locations
- Not uncommon for the LP & Skewed paths to fade in the middle of a QSO
- Various paths can be utilized around the clock and with changing seasons
- Requires experienced DX operators understanding SR/SS enhancement, polar affects, propagation to make QSO w/ East Coast Hams (Some ops end 160m transmissions at dawn – big mistake)

Give it a try – Point antenna at dawn to SSW and/or dusk to SSE

References

- Dr. Ed Callahan (N4II), ARRL QEX, November/December 2016, "Gray Line Propagation, or Florida to Cocos (Keeling) on 80m"
- ARRL Propagation Bulletins (April 2013 and November 2017)
- Robert R. Brown, NM7M, "On the SSW Path and 160-Meter Pro pagation," QEX, November/December 2000, pp. 3-9
- ARRL Handbook
- ARRL Antenna Book
- ON4UN's Low Band DXing Book
- DX Atlas software available free download (30 days)

BACKUP SLIDES


Rectangular Map
AC4G
VK9CZ