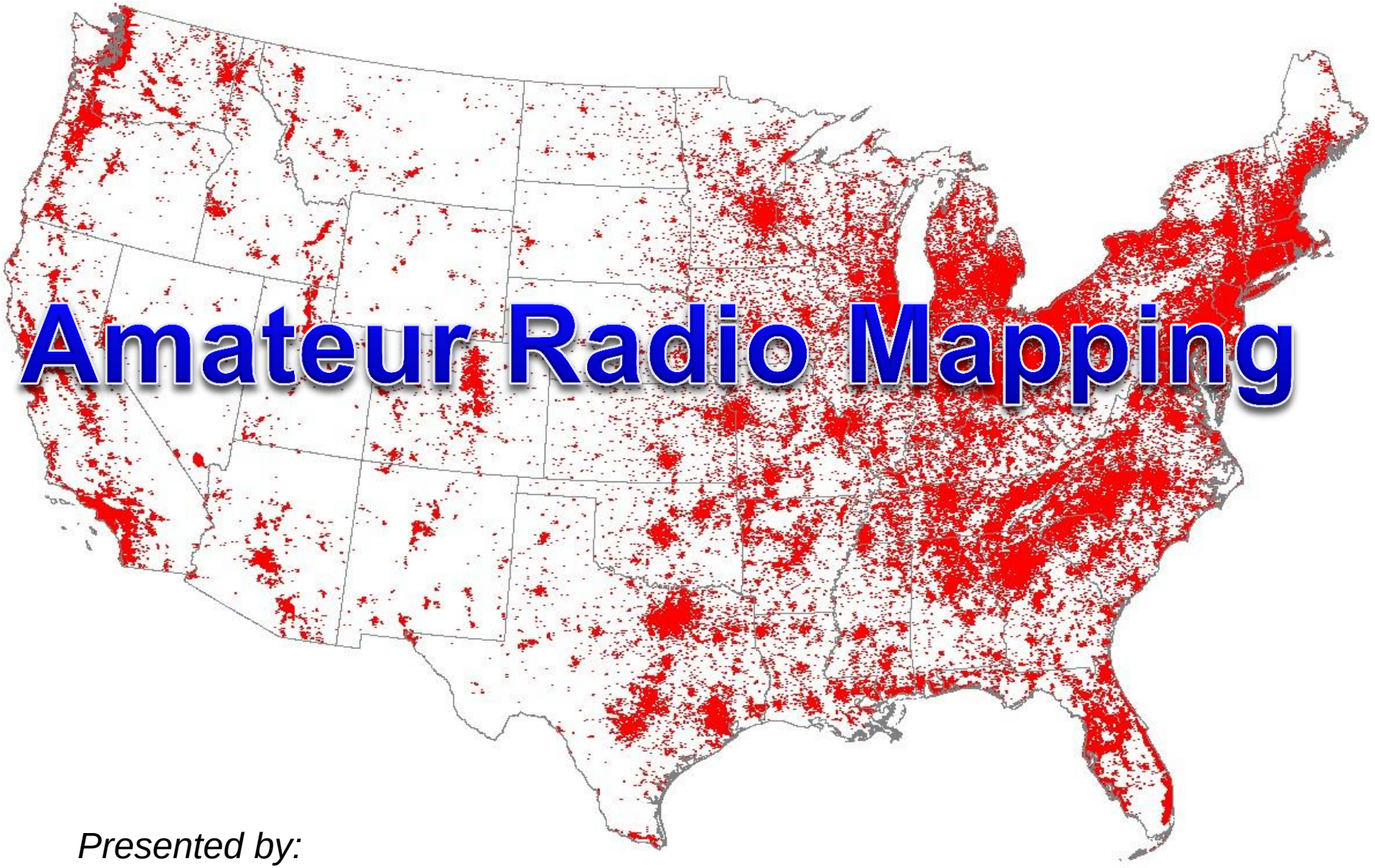


Amateur Radio Mapping

Presented by:
Mark Landress
WB5ANN

Distribution of Licensed Amateur Radio Operators in the US 2016 Courtesy ARRL

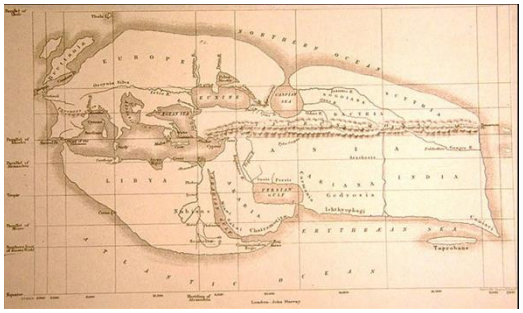
Outline

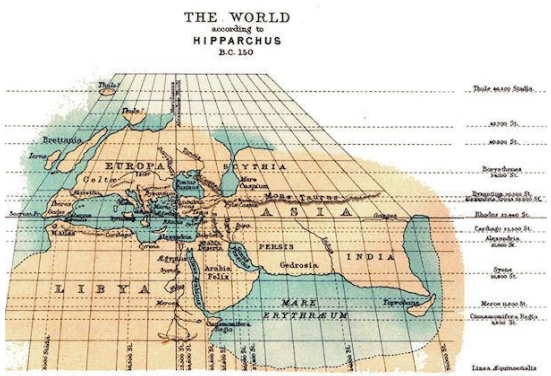
Basics
Latitude and Longitude
Map Types and Projections
Maidenhead Grid System
Prefix Maps
Contest Maps
Propagation Maps
Repeaters, IRLP, Viewshed, Modelling &
Satellite and Coverage
Conclusion

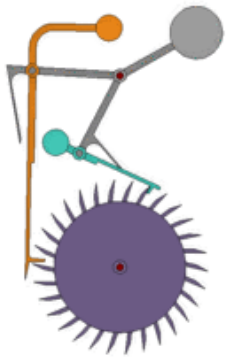
Basics

- Ham mapping involves some basic principles for locating transmitted and received points.
- Knowing the map types, systems and grids, helps in obtaining a fix and computing distance to a point.
- Computerized mapping has dramatically improved the ability to locate stations.
- Manual mapping is still handy since it is quick and is always ready.

History



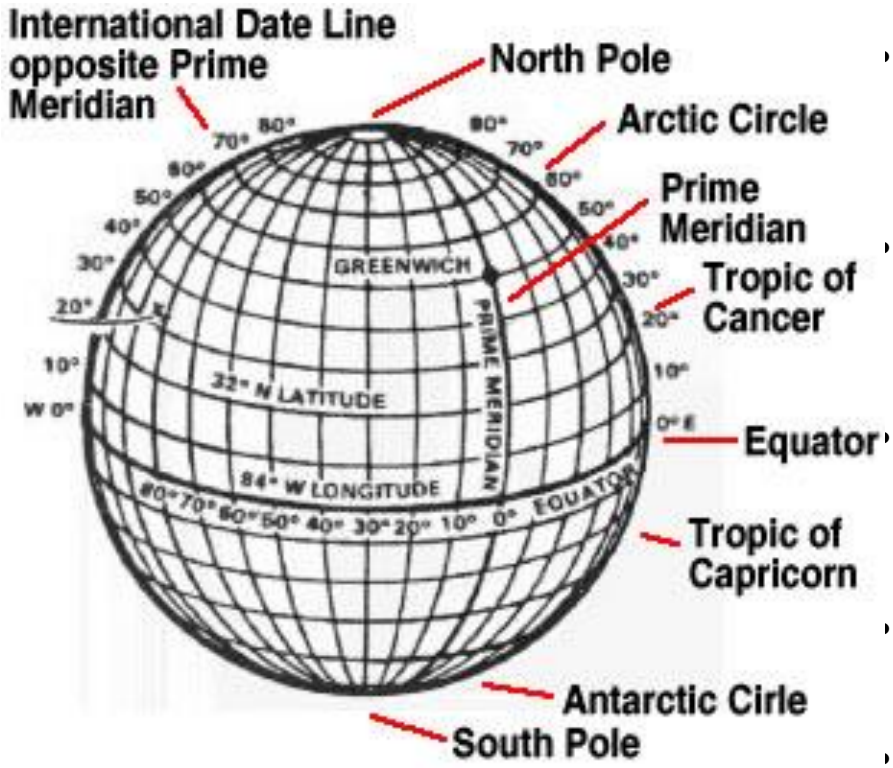




3rd Century BC – Erathosnes (inventor of Geography, keeper of the library in Alexandria. First to determine the circumference of the earth. First to calculate tilt of earth axis, all around smart guy. First to devise longitude and latitude as a concept.

2nd Century BC – Hipparcus (inventor of spherical geometry and first to set places in a spherical projection. Discoverer of equinox precession, calculation of solar eclipses, first to determine heliocentric placement of solar system, calculate distances to sun and moon. Determined method that local time can be used to calculate position of longitude. Once the compass was discovered in the 11th century, maps started to come into use. Latitude easy to determine since it relates to axis position. Longitude requires accurate time to determine position for navigation. Done originally by lunar and solar measurements. Better defined by Decartes (cartography) Finally solved when accurate clocks were devised. This was finally solved by John Harrison in 1761.

Longitude and Latitude



- The Earth is divided into **vertical lines of Longitude and horizontal lines of Latitude.**
- Zero longitude is at the Prime Meridian in England. West longitude is negative, East longitude is positive.
- Zero latitude is at the equator. North latitude is positive. South latitude is negative.
- Each is measured in degrees, minutes and seconds or decimal degrees.
- 360 degrees for the whole. 60 minutes per degree. 60 seconds per minute.
- Each minute of longitude equals 1 nautical mile (6028 feet)

Longitude and Latitude

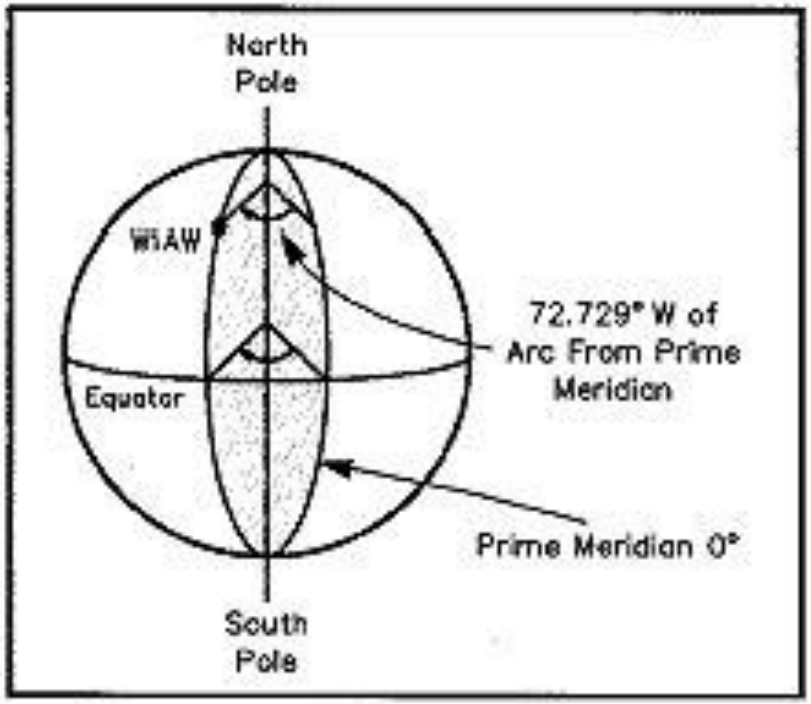


Figure 2—Longitude lines run north and south from pole to pole. Zero degrees longitude is known as the *prime meridian*. The longitude of W1AW is 72° 43' 43" W (or 72.729° W).

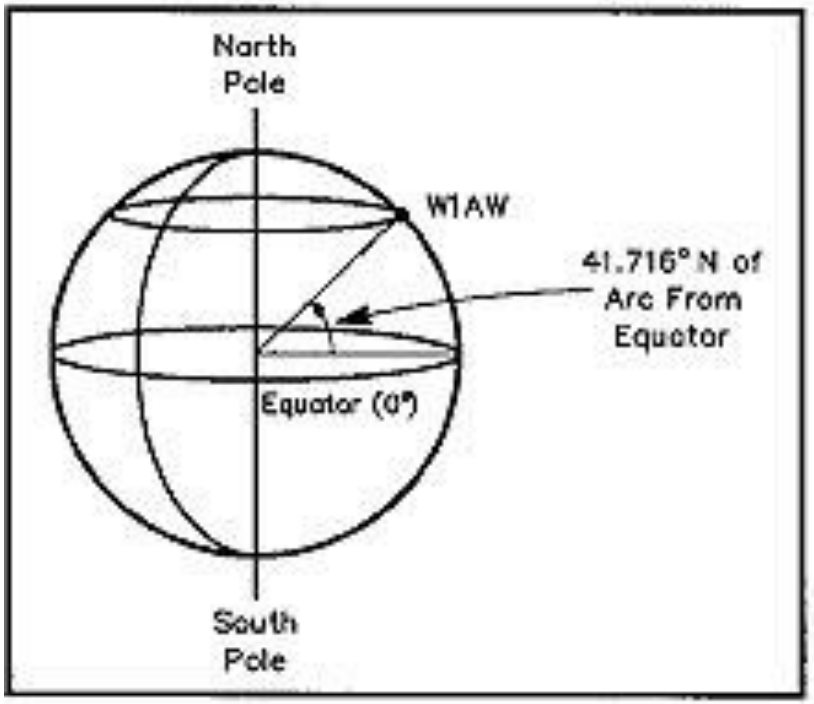
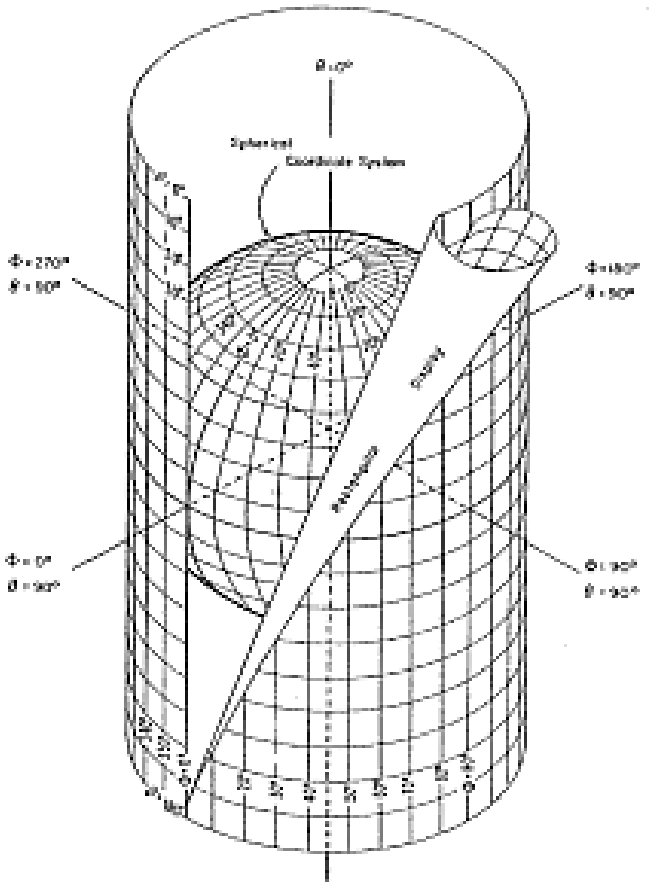


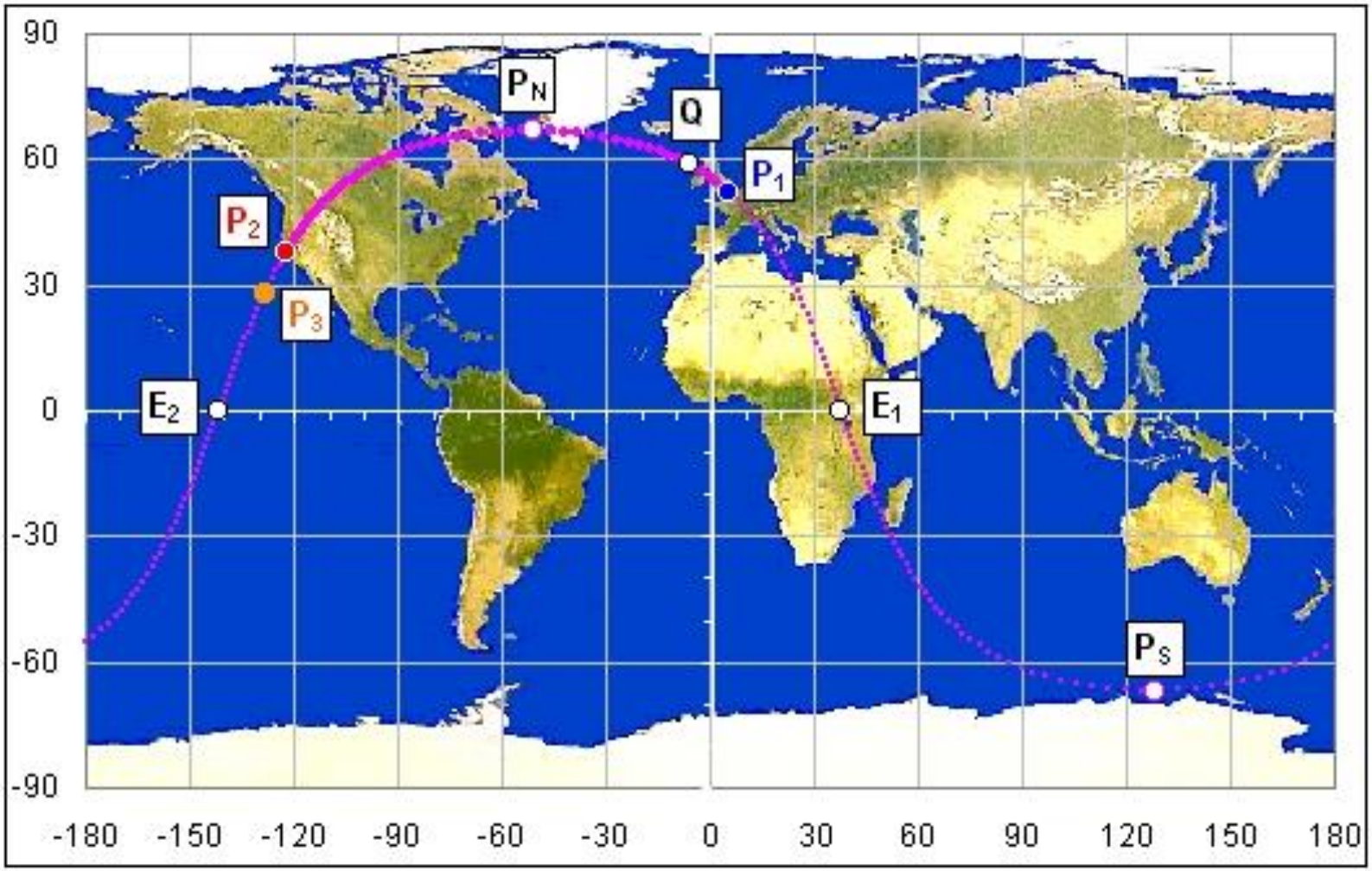
Figure 1—Latitude lines circle the Earth at positions north and south of the Equator. The latitude of station W1AW is 41° 42' 57" N (or 41.716° N).

Mercator Projection

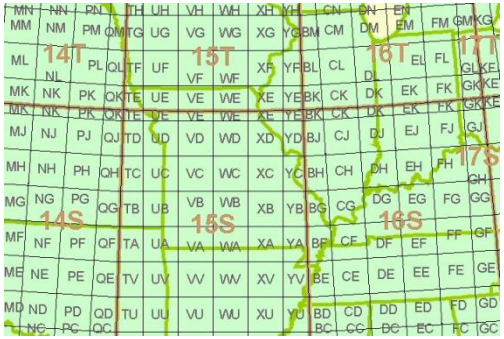


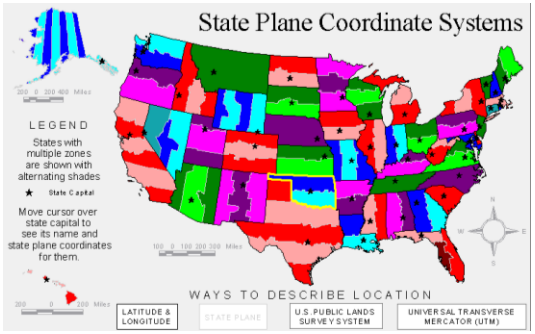
The Mercator projection is still one of the most common types of map.
On this type of map the direction remains true, making it particularly practical for navigation at sea.
Most maps projected to flat surfaces are Mercator projection. The problem is it is hard to measure distance with a Mercator map.

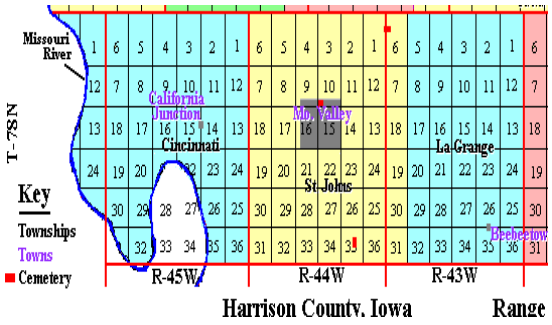
Distance Problem with Mercator



Point to point measurement is distorted in a Mercator map.
This is solved with projections that accurately portray the great circle.







Other Grid Systems

Universal Transverse Mercator - XY type metric grid widely used for mapping by USACOE

MGRS – Military grid system based on Lat/Lon with letter/number grid designation

State Plane Coordinate System – XY type English grid system specific for each state

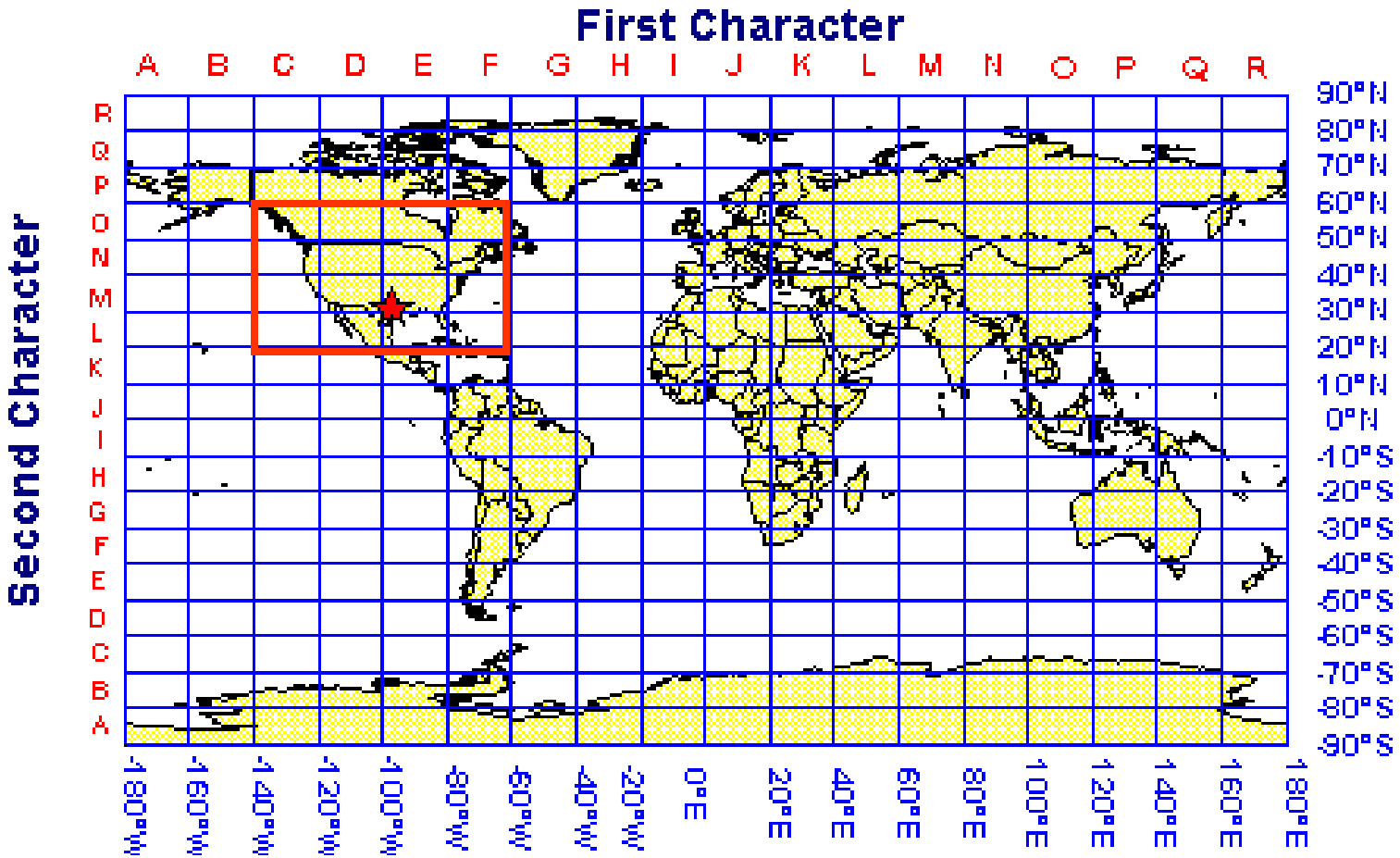
PLSS - Township & Range – Mile square sections within a 36 square mile block.

Maidenhead Grid

- Maidenhead grids or Grid Squares is the standard designation for map location in ham radio. Named for the city Maidenhead England it was developed in 1980 and divides the earth into grids based upon latitude and longitude.
- Zones are separated into 18 fields 10 by 20 degrees designated with 2 letters A through R
- Grids are designated by 1 by 2 degrees with 2 numbers 0-9
- Subgrids are designated by 2 letters 2.5 x 5 minutes with letters A-X

Maidenhead Grid System (1)

Mercator Projection



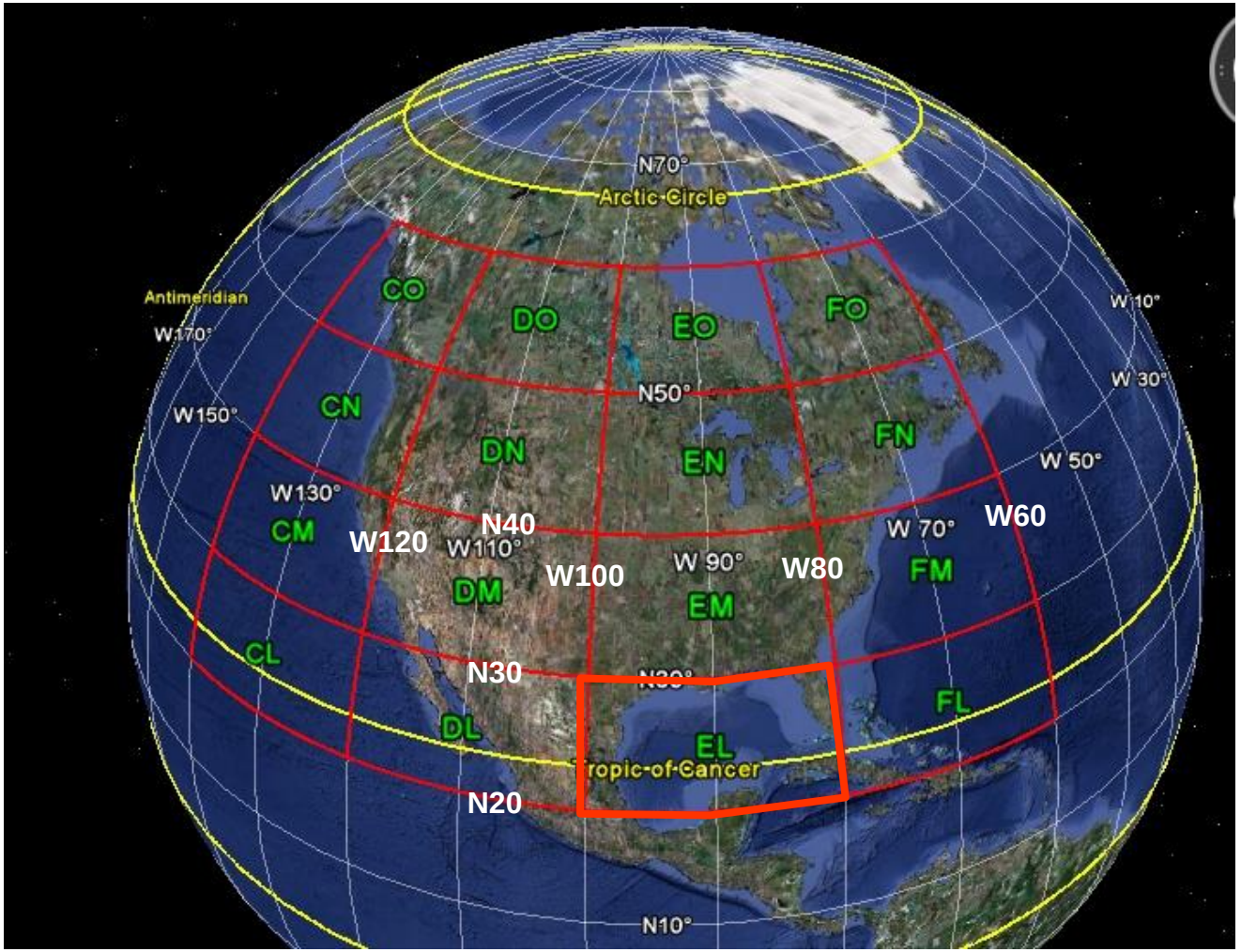
Maidenhead Grid Square Field Designation

10 degrees of latitude by 20 degrees of longitude

Houston, TX = EL

Maidenhead Grid System (1)

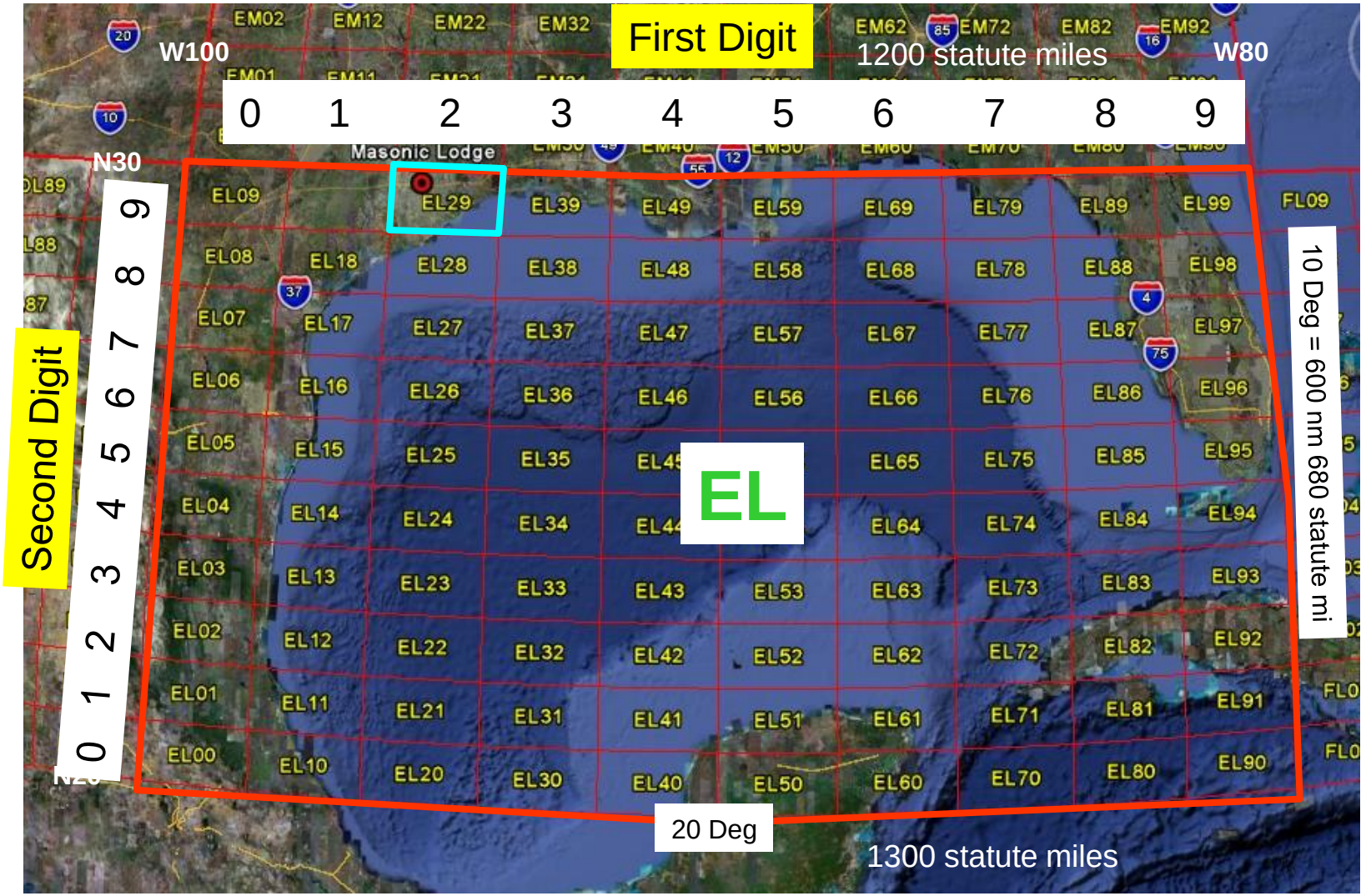
Global Projection for North America



What grid is this?

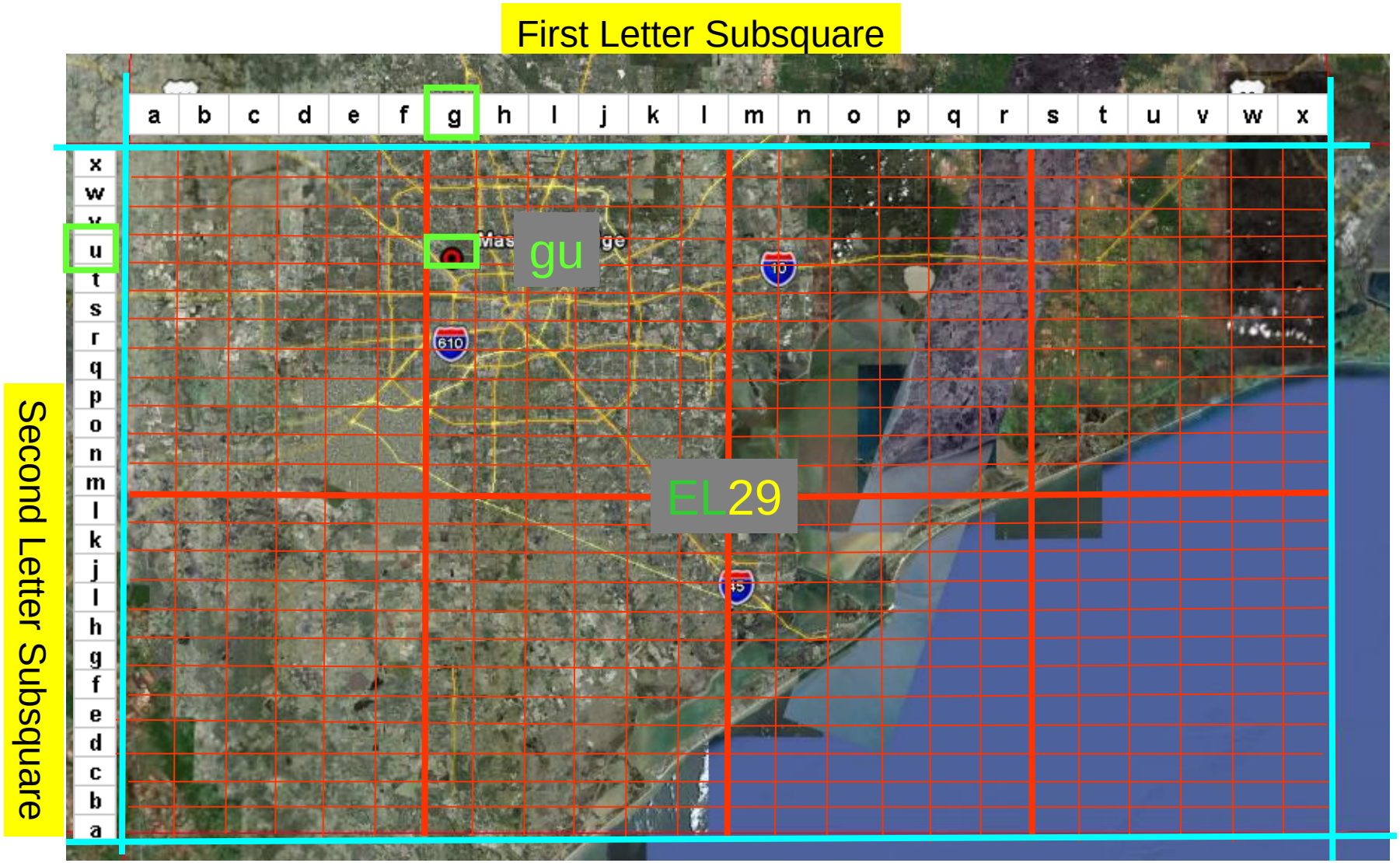
Maidenhead Grid System (2)

EL Grid is 10 x 20 degrees. EL29 is 1 x 2 degrees



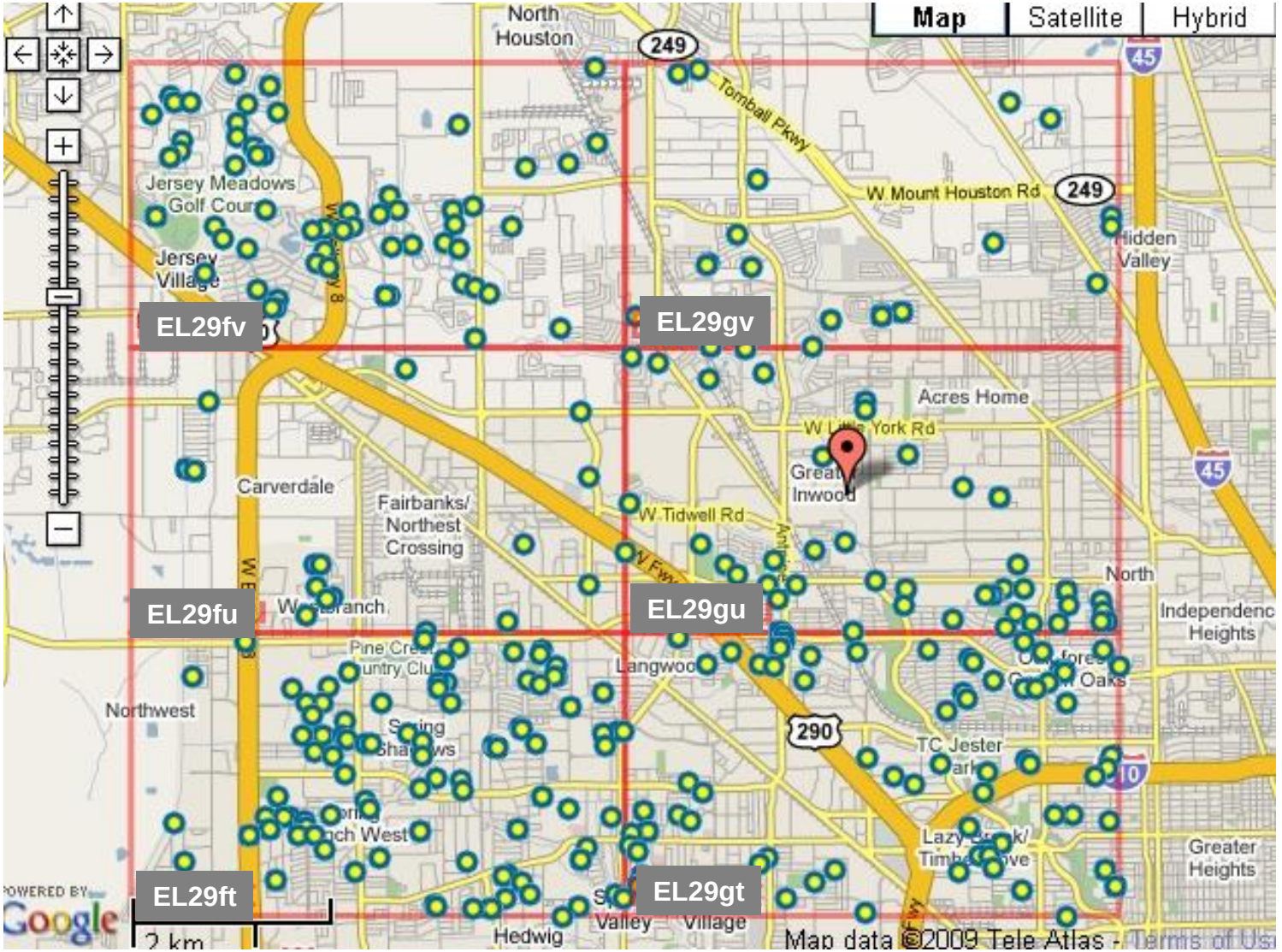
Maidenhead Grid Sub Square

5 minutes of longitude by 2.5 minutes of latitude

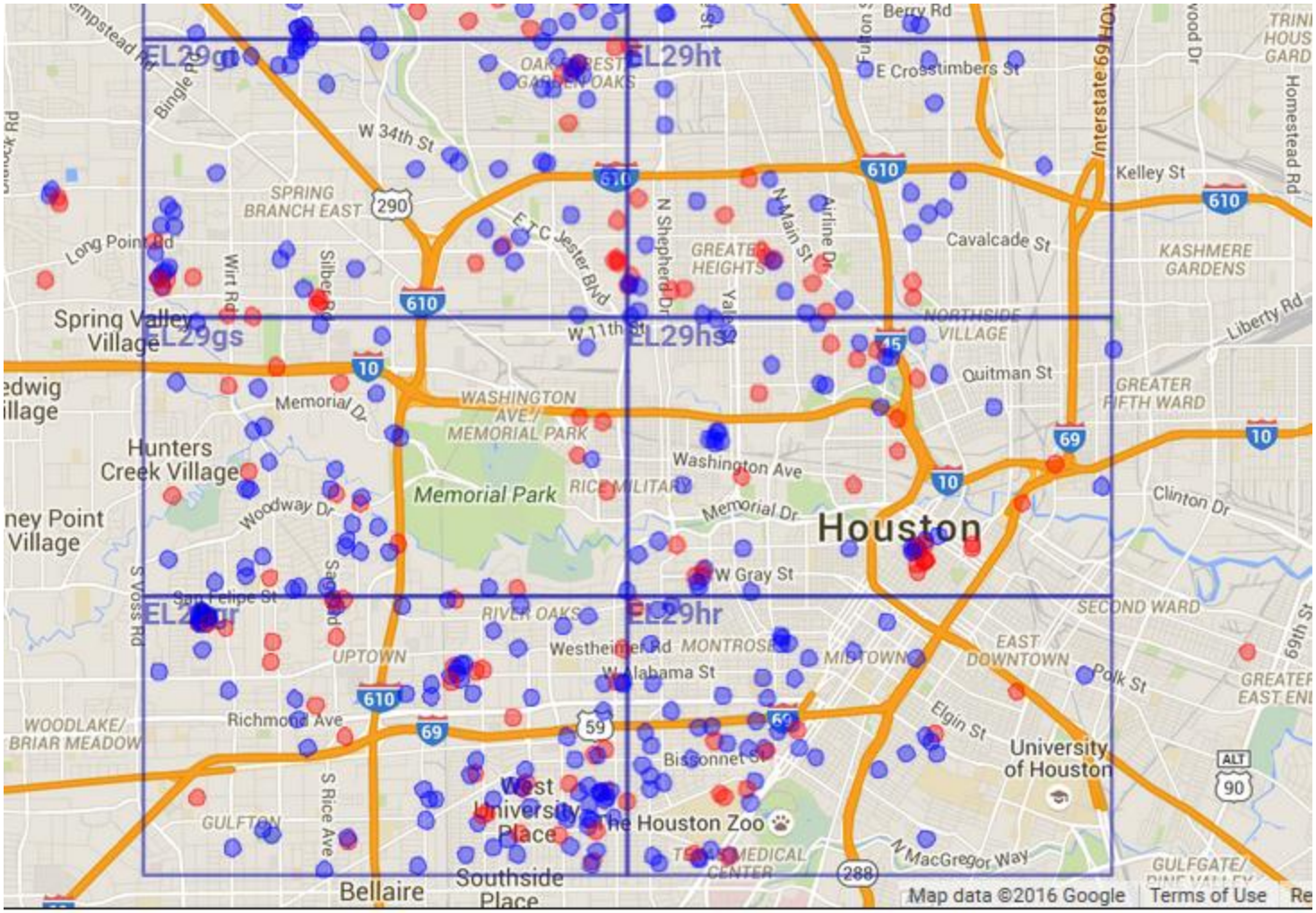


Ham Location Mapping by Grid

Location mapping from QRZ.com

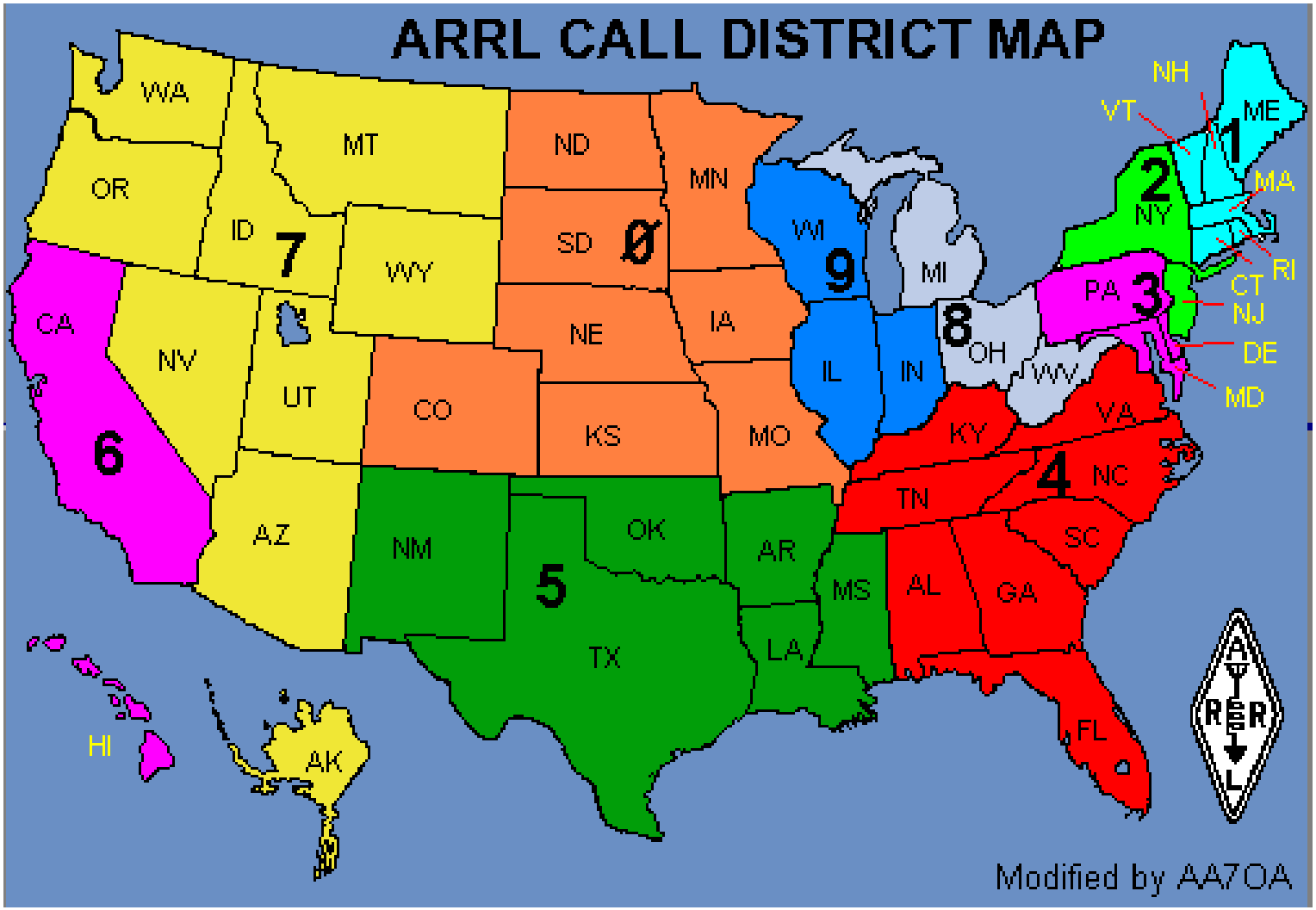


Ham Location Mapping by Grid



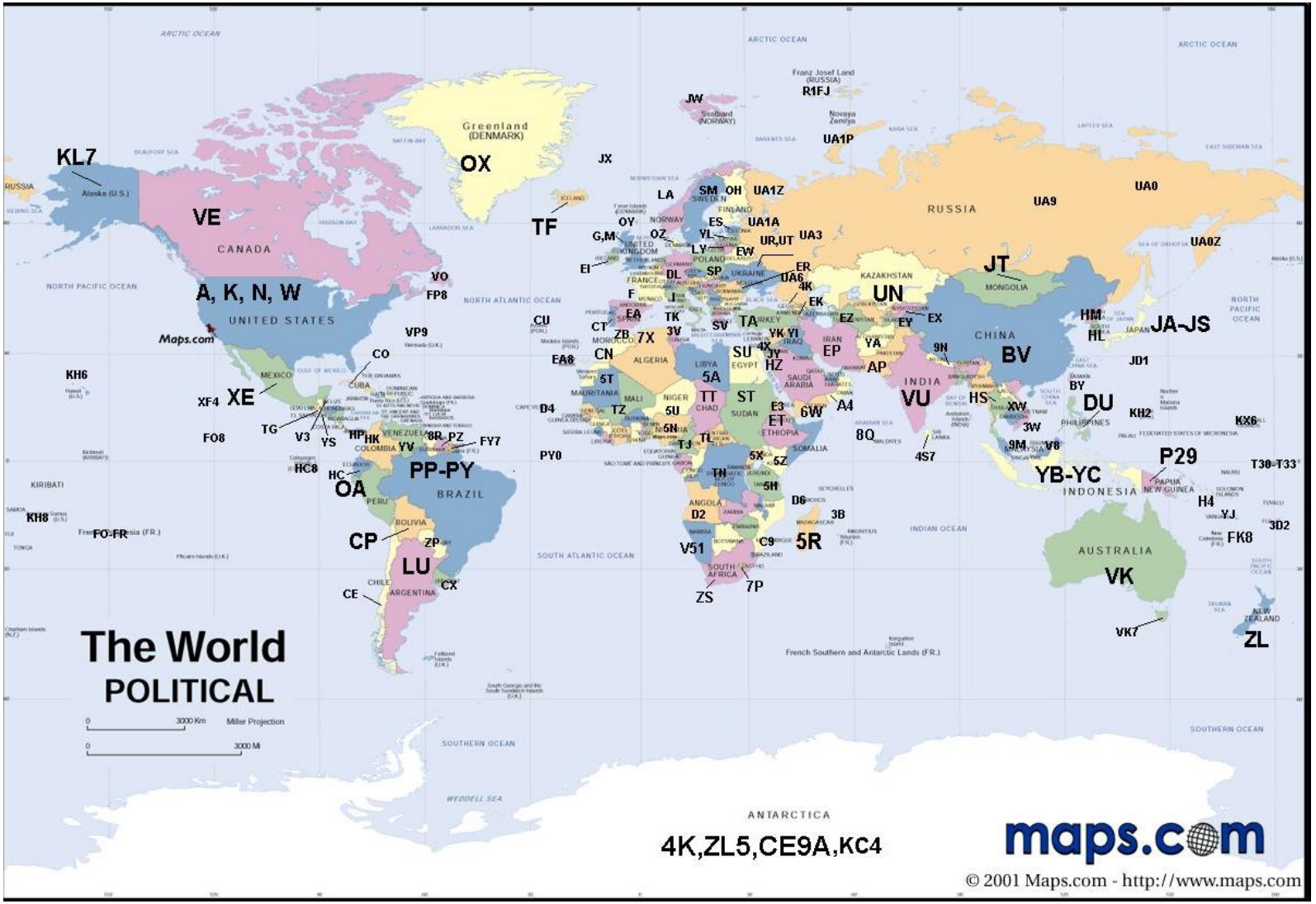
Prefix Maps

US Call Sign Prefix Map



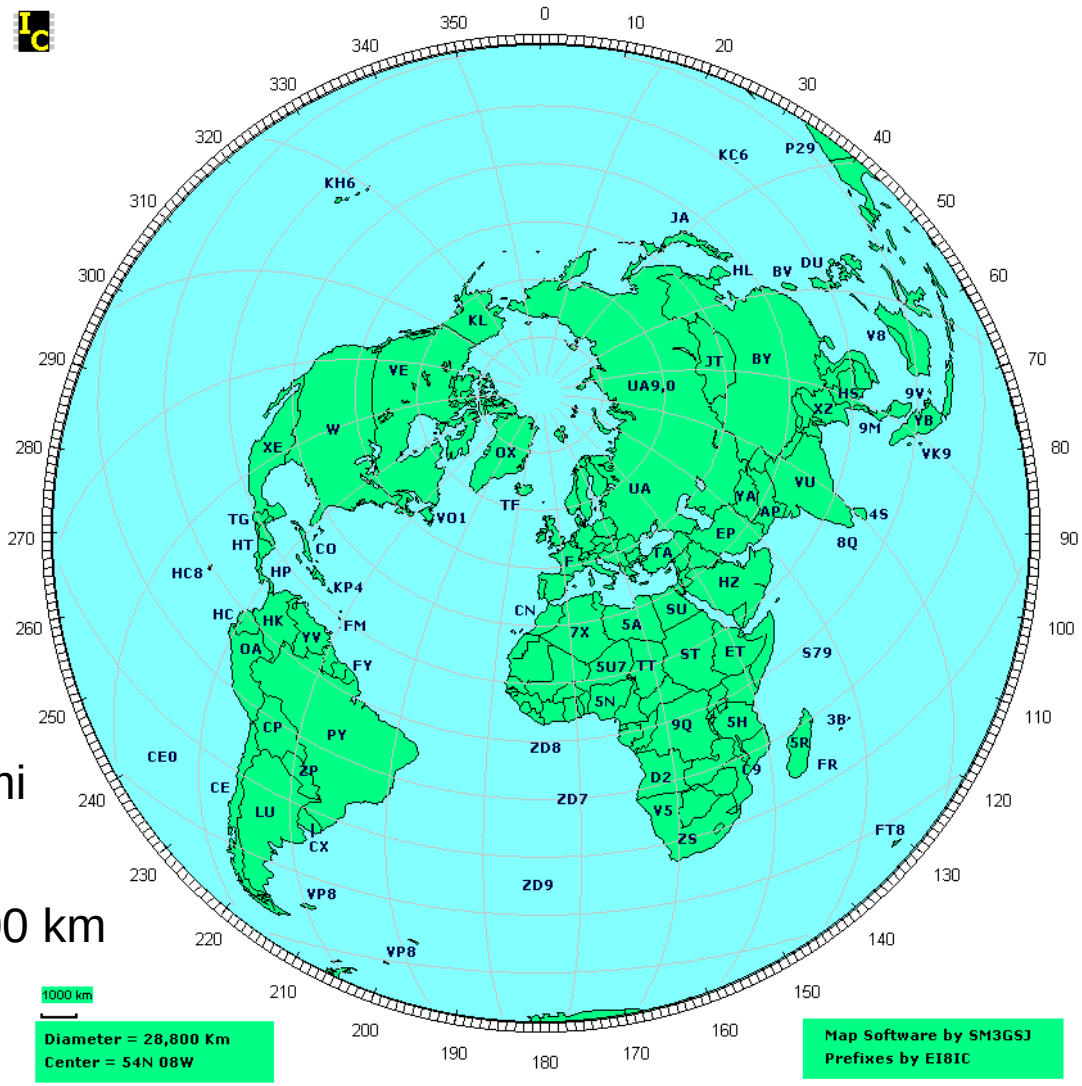
World Prefix Map

Mercator Projection



Great Circle Prefix Map

Great circle maps are equidistant from all points.



1000 km 621 mi

—

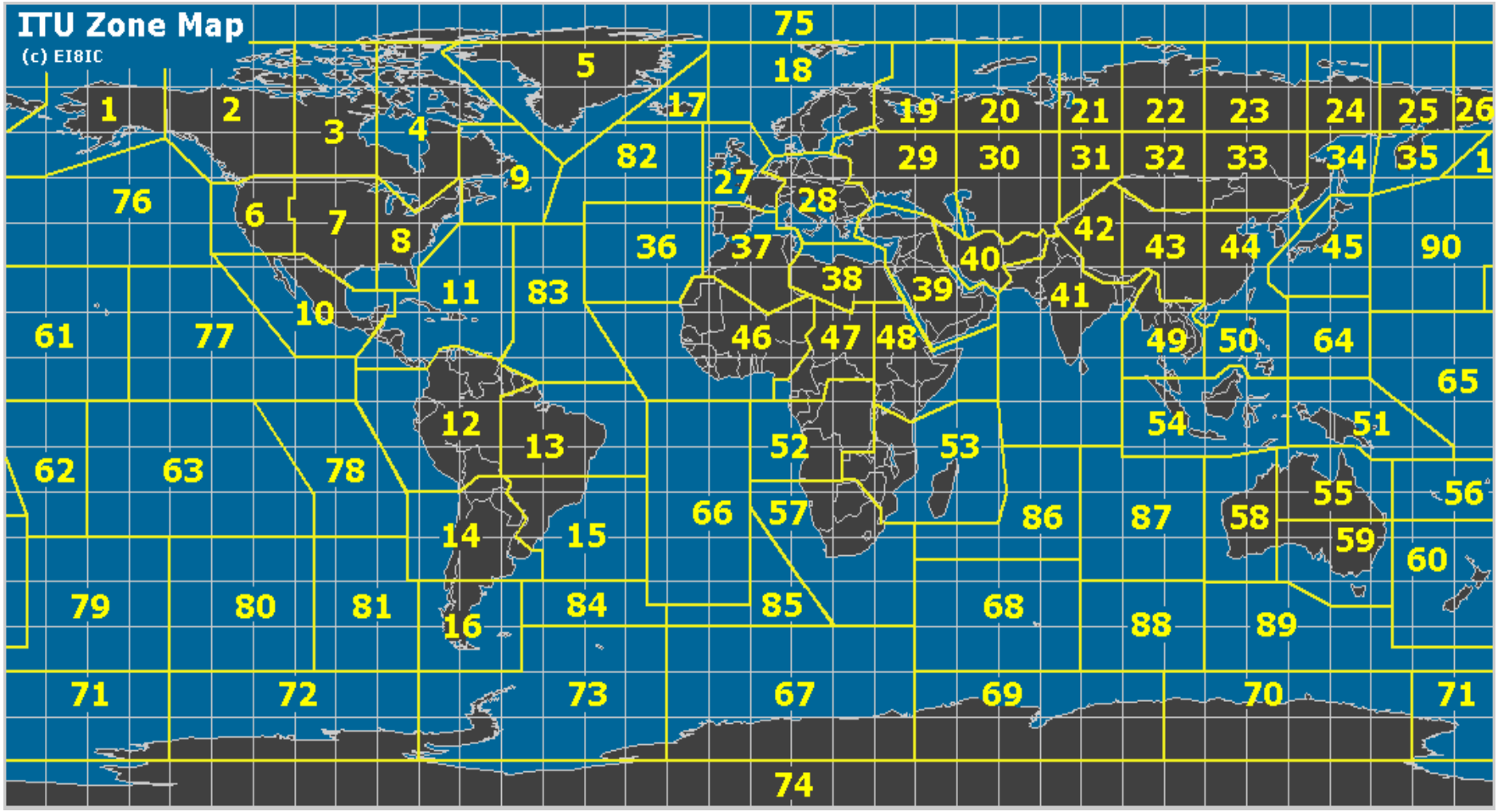
Diamater 28,000 km

Contest Mapping

ITU Zone Map

ITU is the international body that mediates the radio spectrum

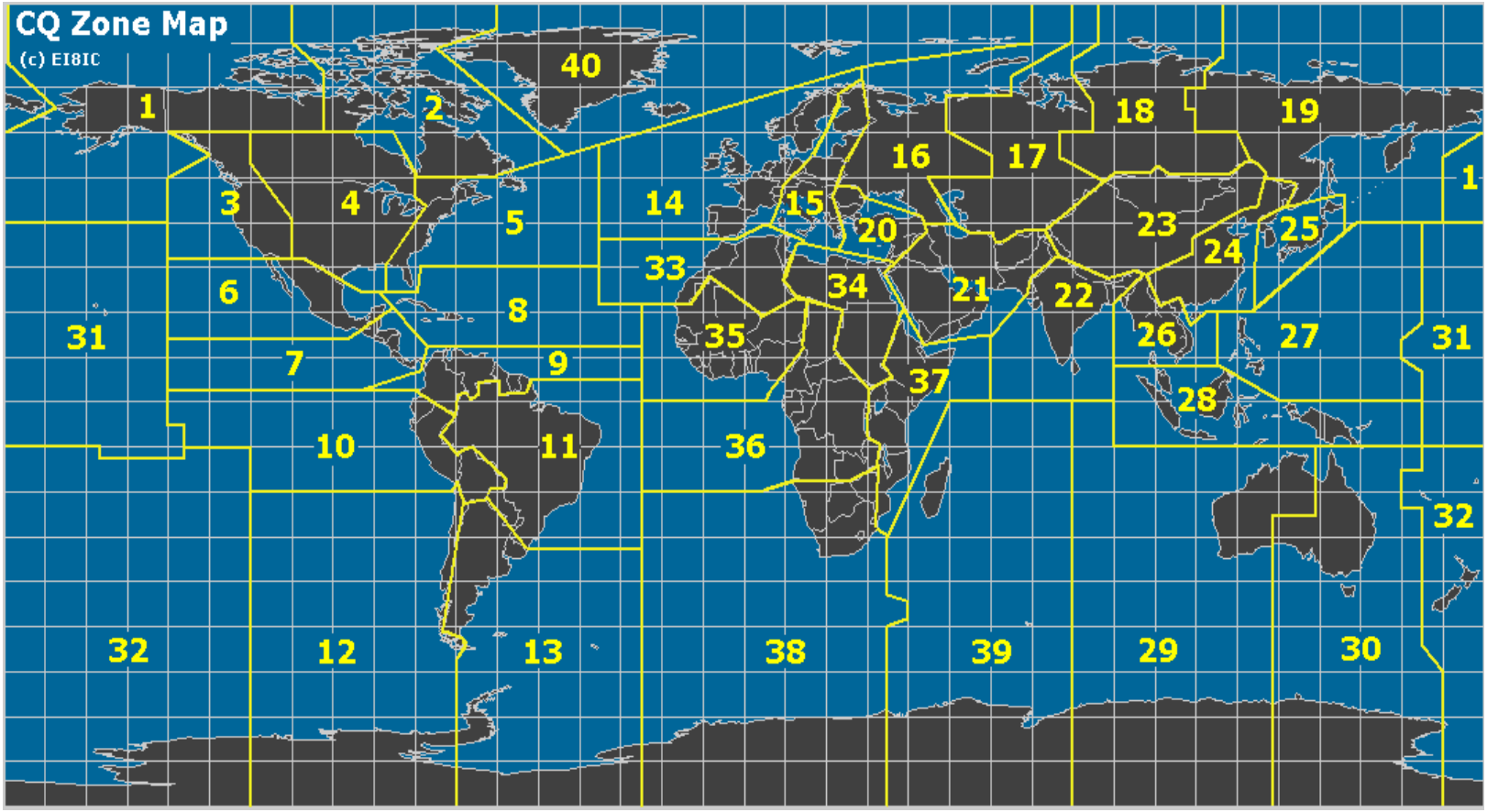
ITU zones are used for contests and award hunting



CQ Zone Map

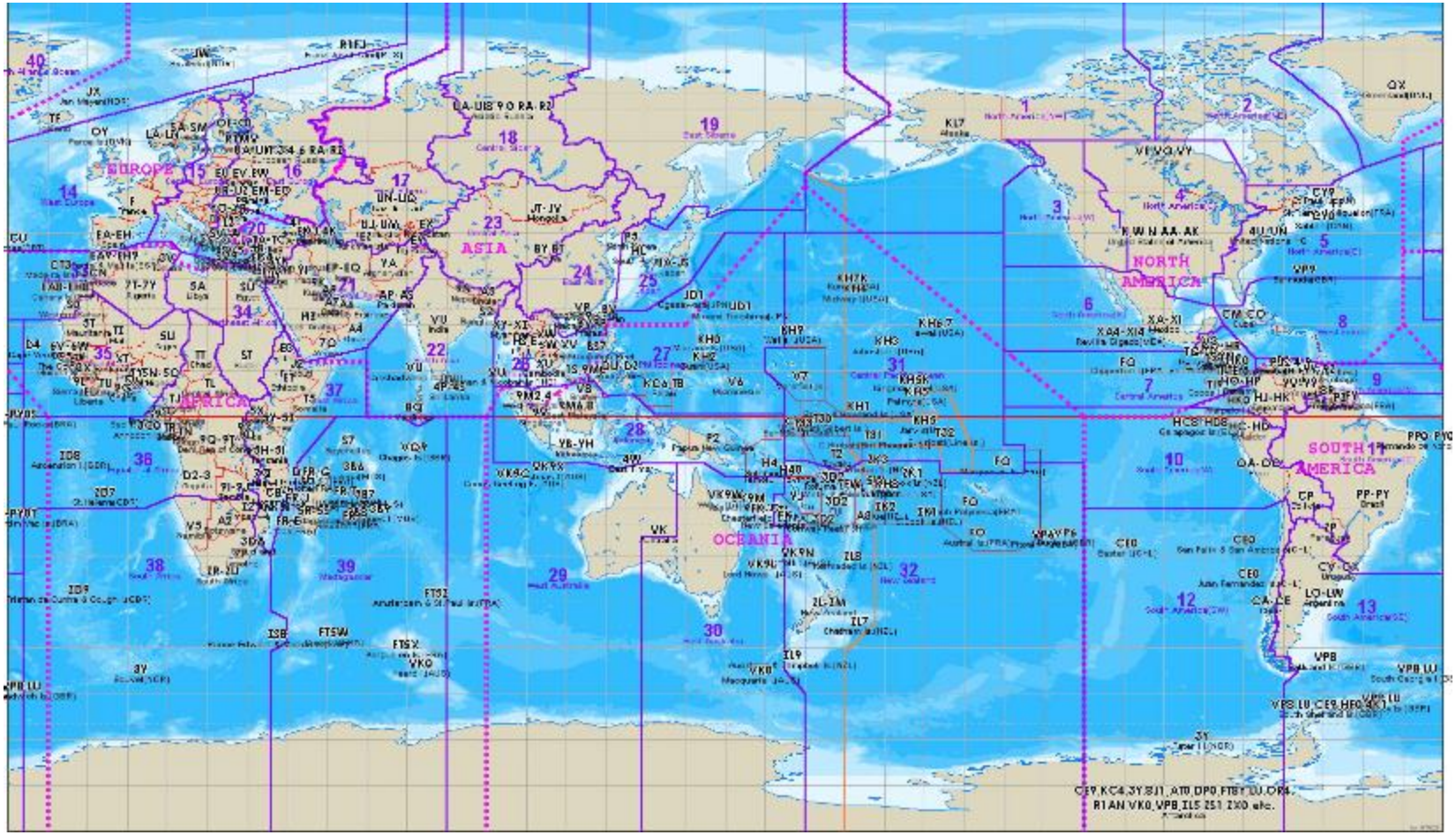
CQ Magazine Contest Zones

CQ zones are used for contests and award hunting

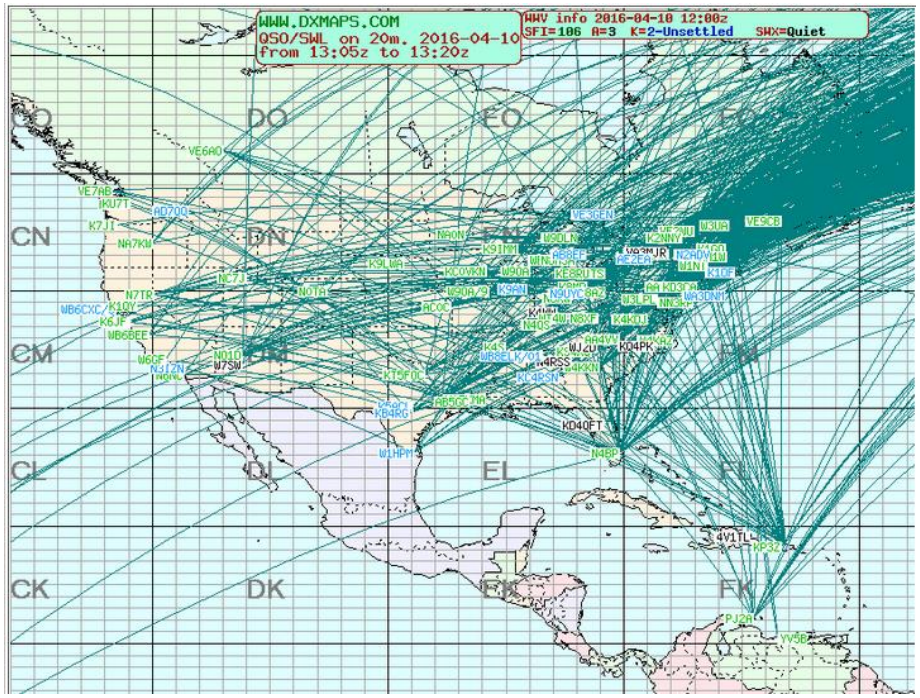


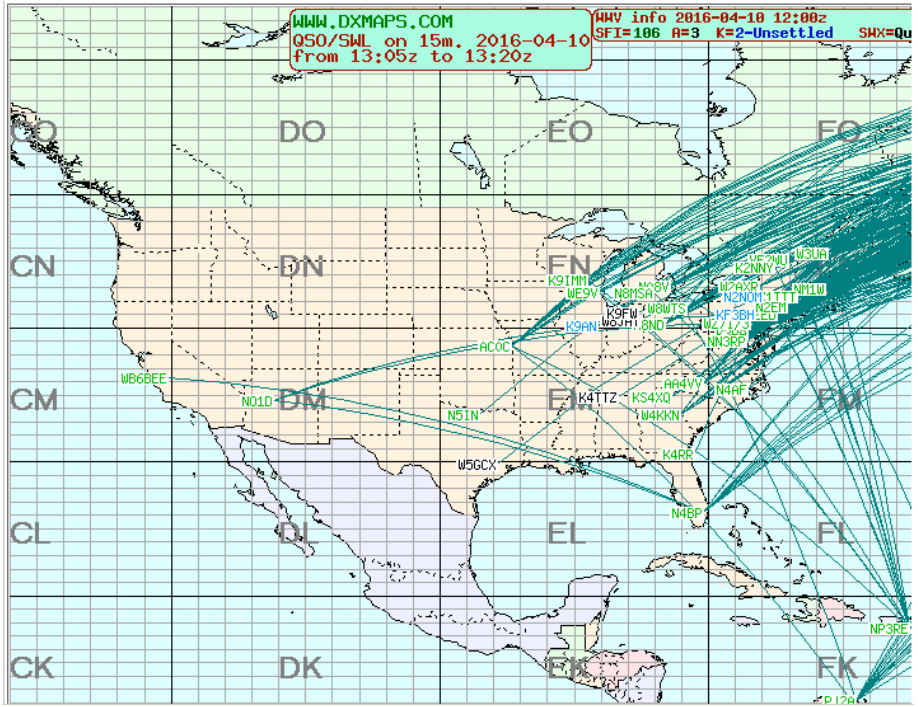
DX Century Club Map

DXCC is the top award in Amateur Radio via ARRL
100 confirmed contacts to DXCC entities needed for award



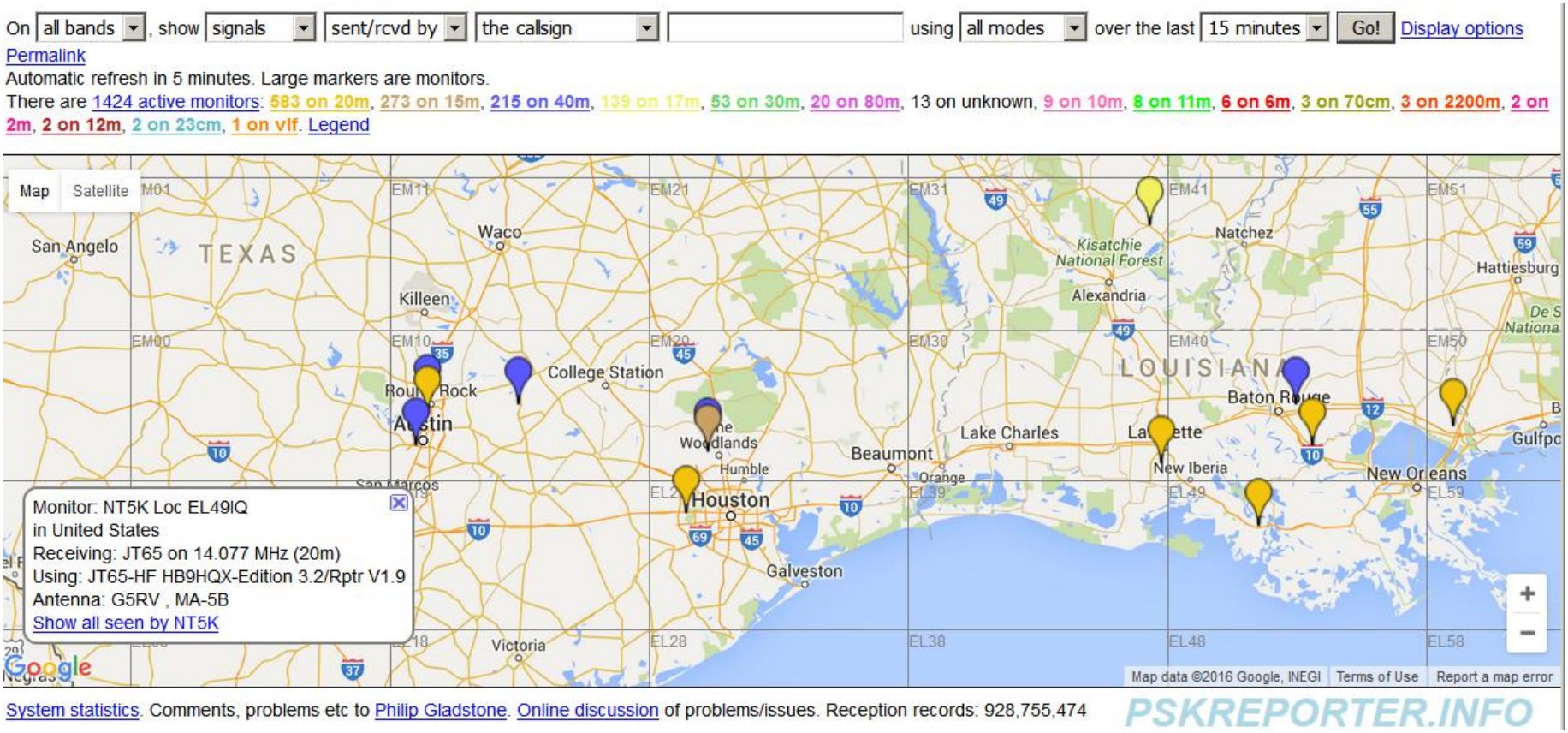
Contact Mapping



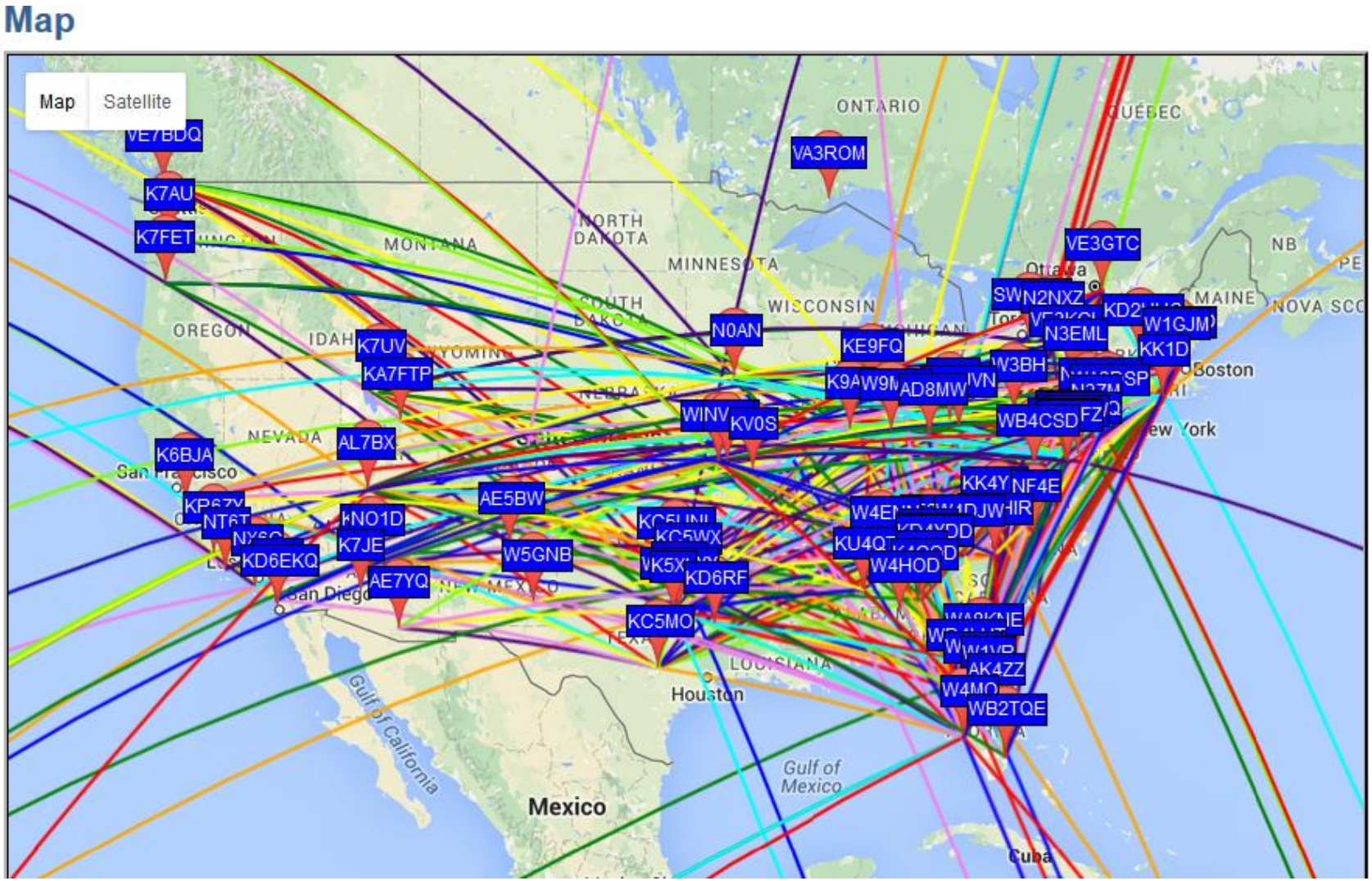


DXmaps.com

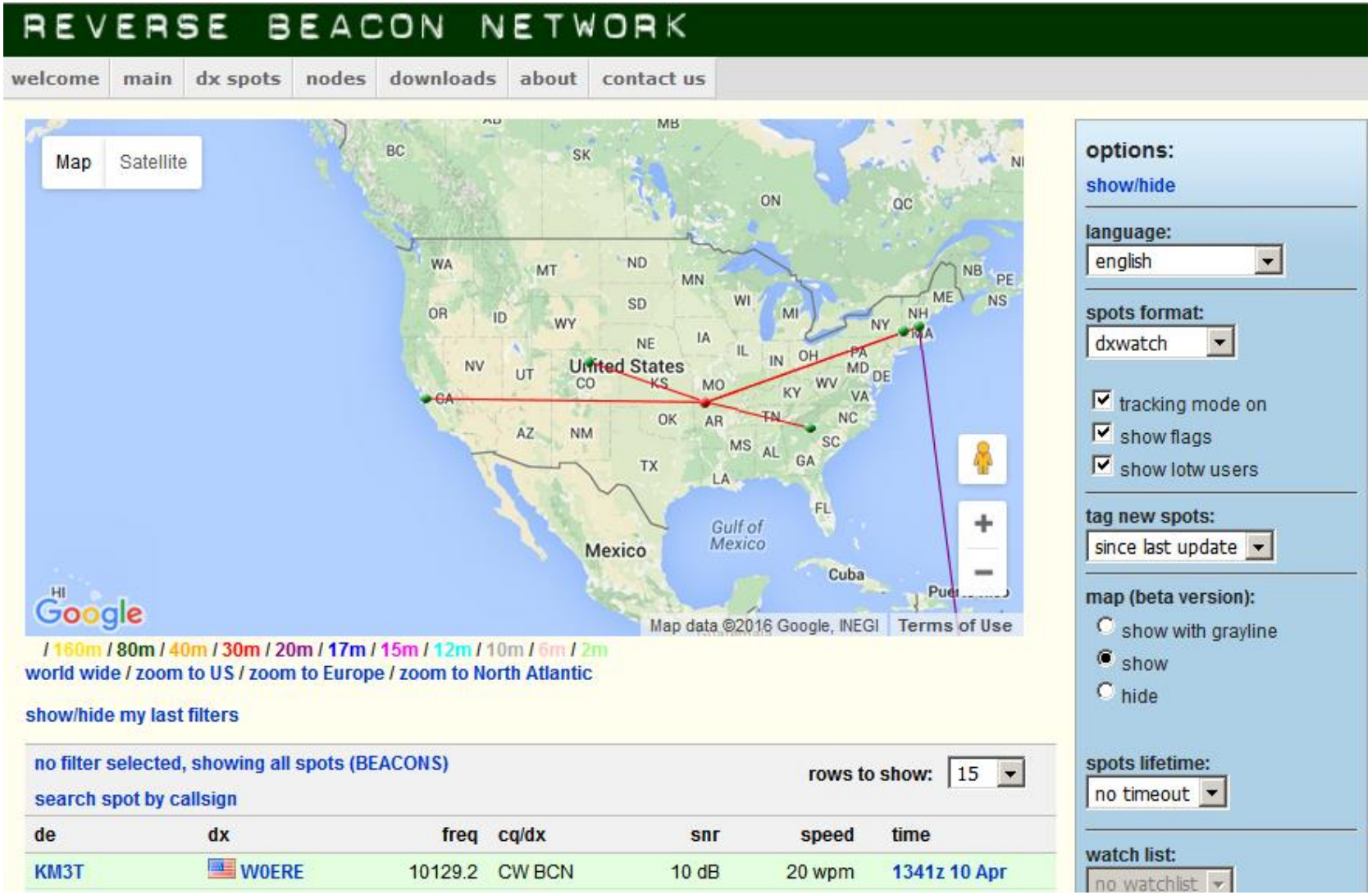
Automatic Spot Mapping



Weak Signal Propagation



Reverse Beacon

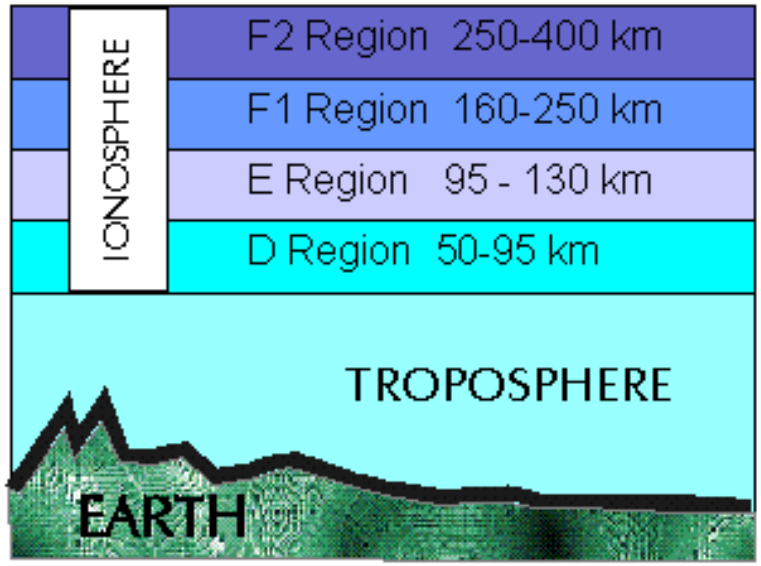


Propagation Mapping

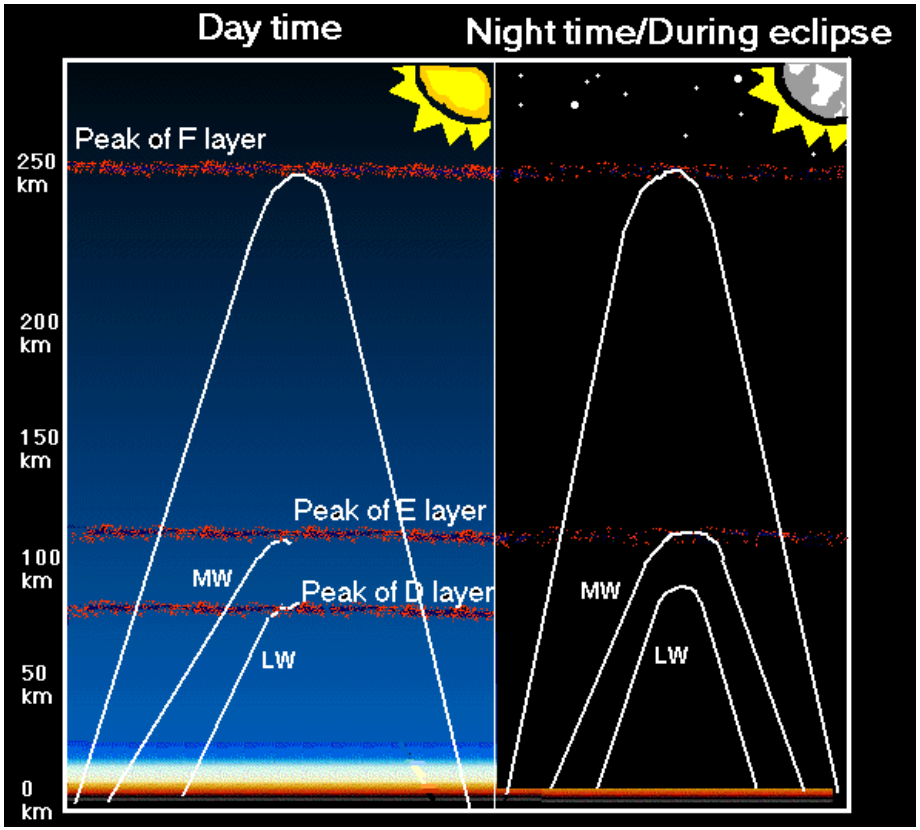
Charged Particle Layers

Charged particle layers, solar activity and cosmic effects control propagation.

Maps of the effects of space weather, aurora and other features are made more or less real time and are useful for predicting band openings.

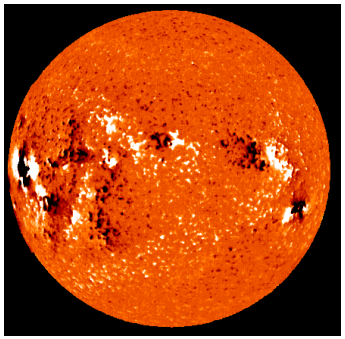


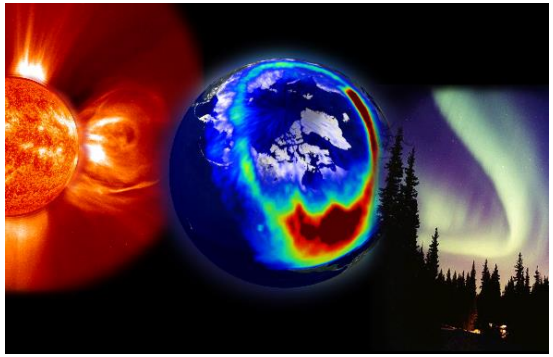
ionosphere

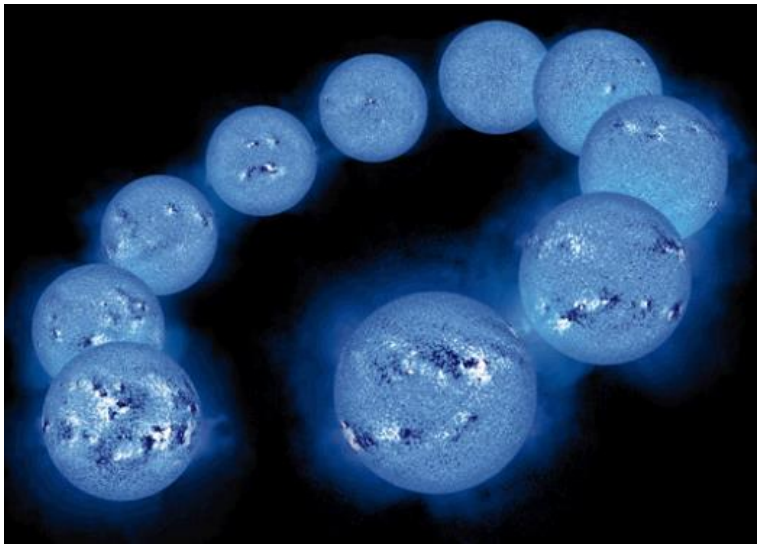


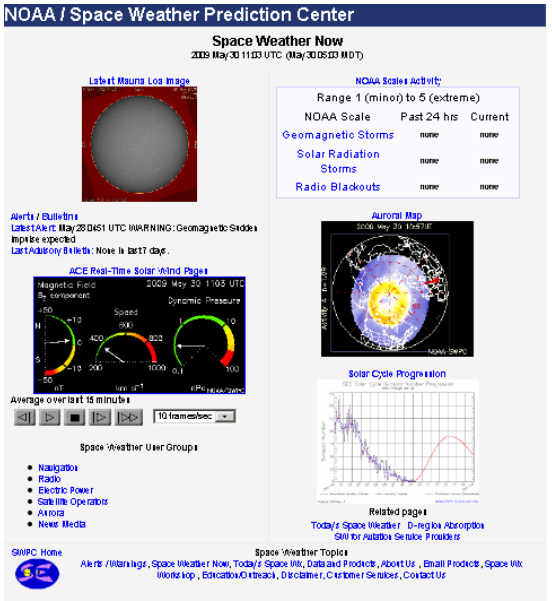
Space Weather Maps

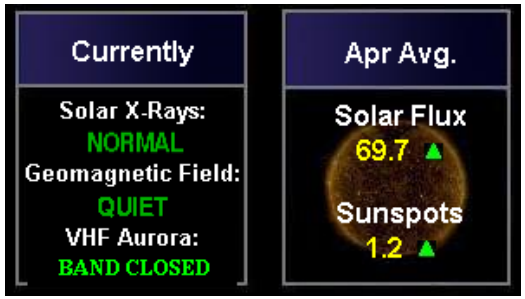
Space weather prediction primarily involves watching solar flares, solar wind, sunspots and aurora activity. All affect the charged particle layers around the earth and affect both terrestrial communications and satellites. This also impacts the magnetic field.



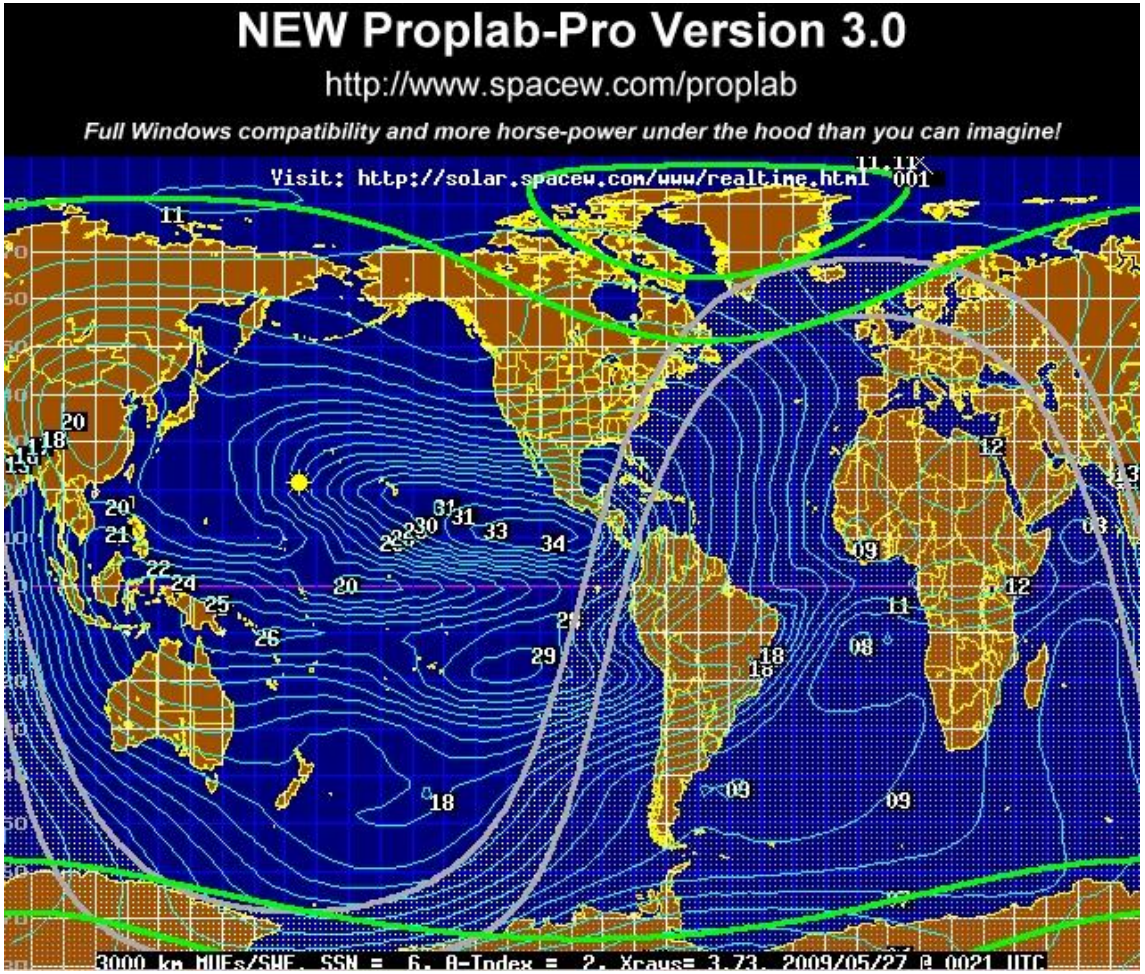




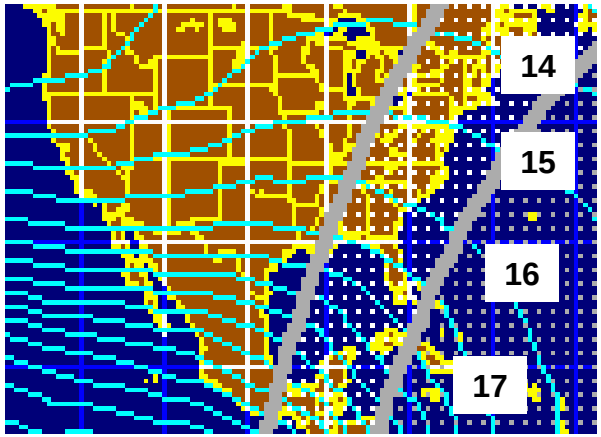




MUF Maps (HF)

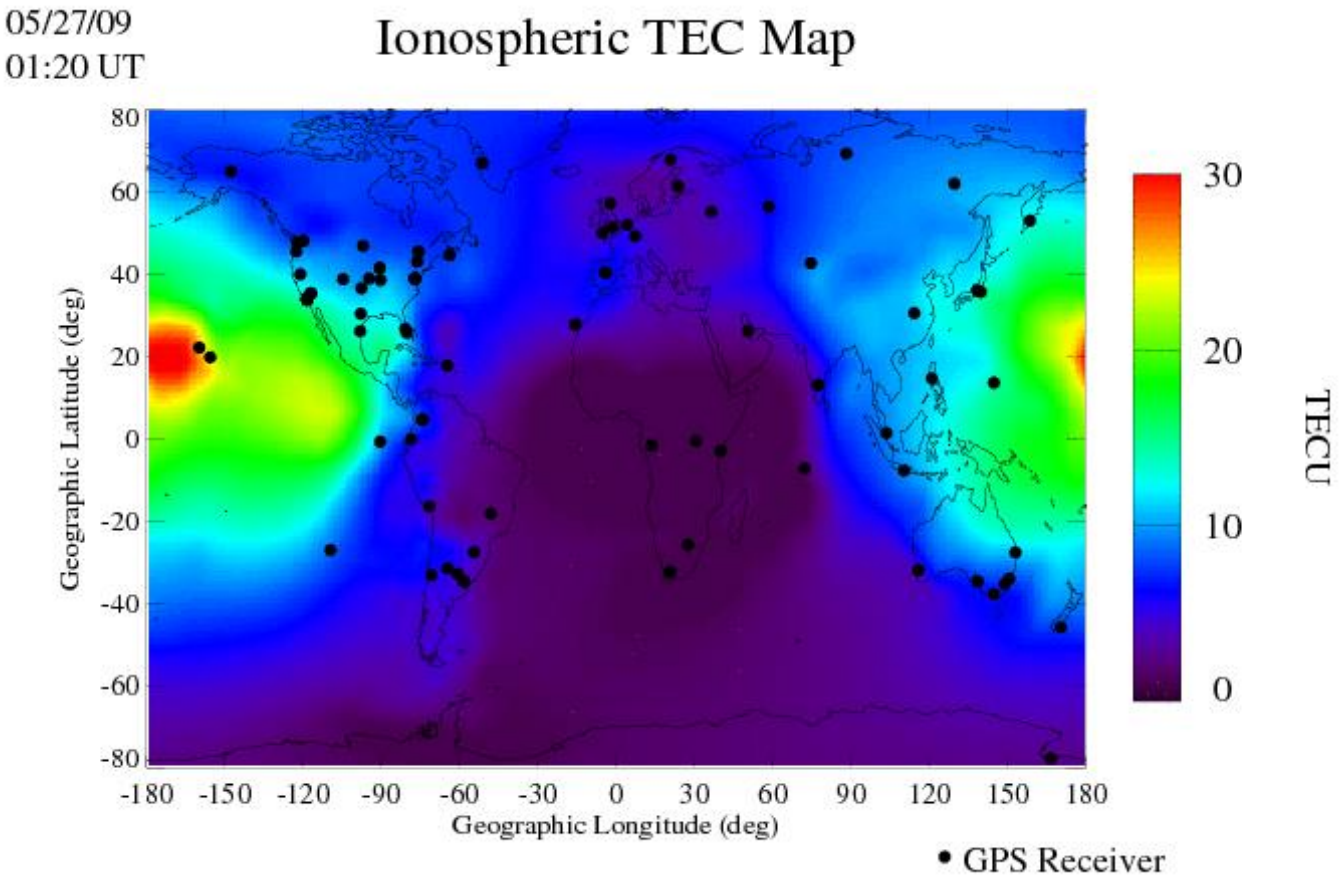


Maximum Useable Frequency Map is the frequency where long range signals will propagate.
Real-time MUF is available online from space weather sites.



Real time MUF for May 27, 2009. MUF typically tracks the sun position which is affected by sunspots and charged particles.

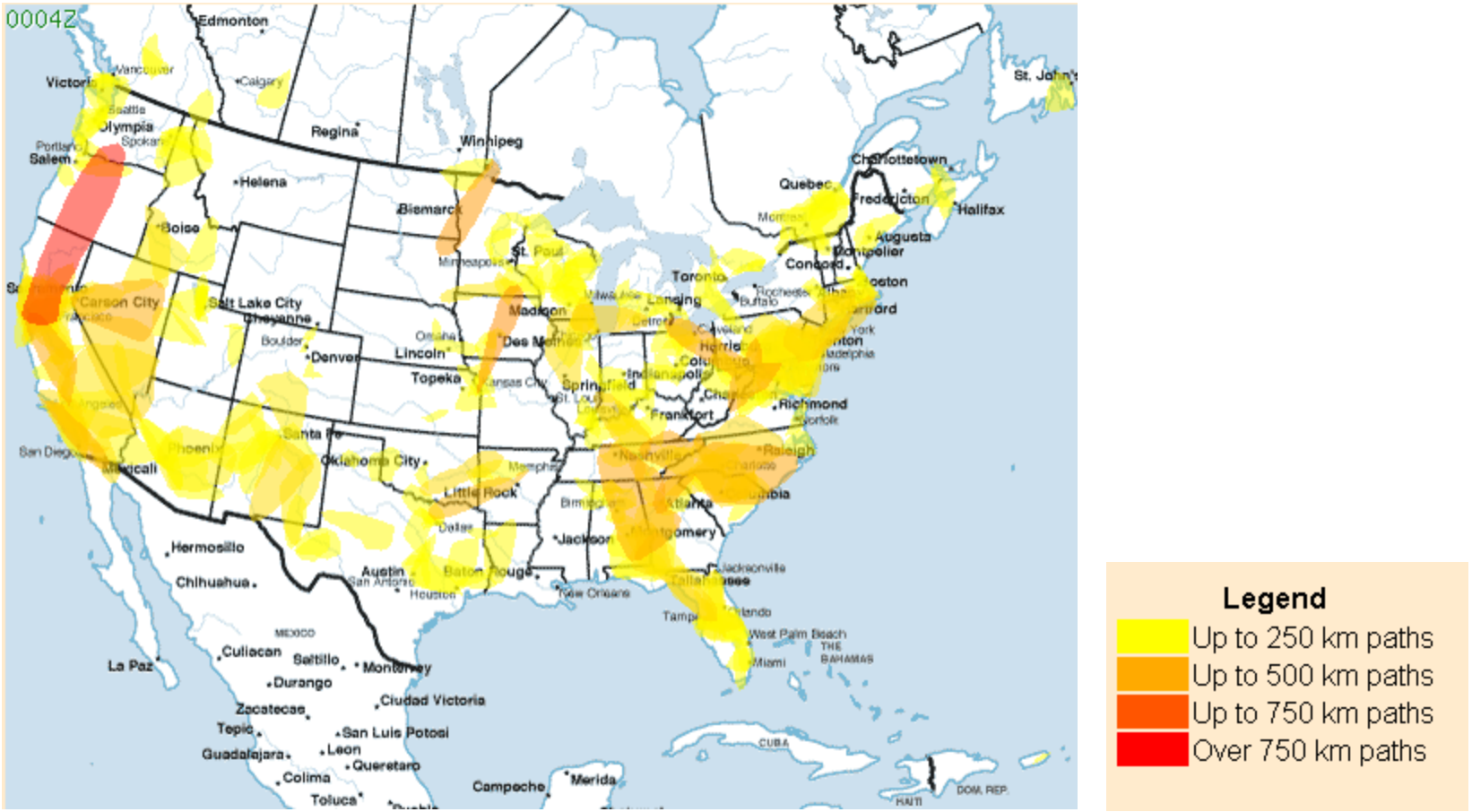
Total Electron Count

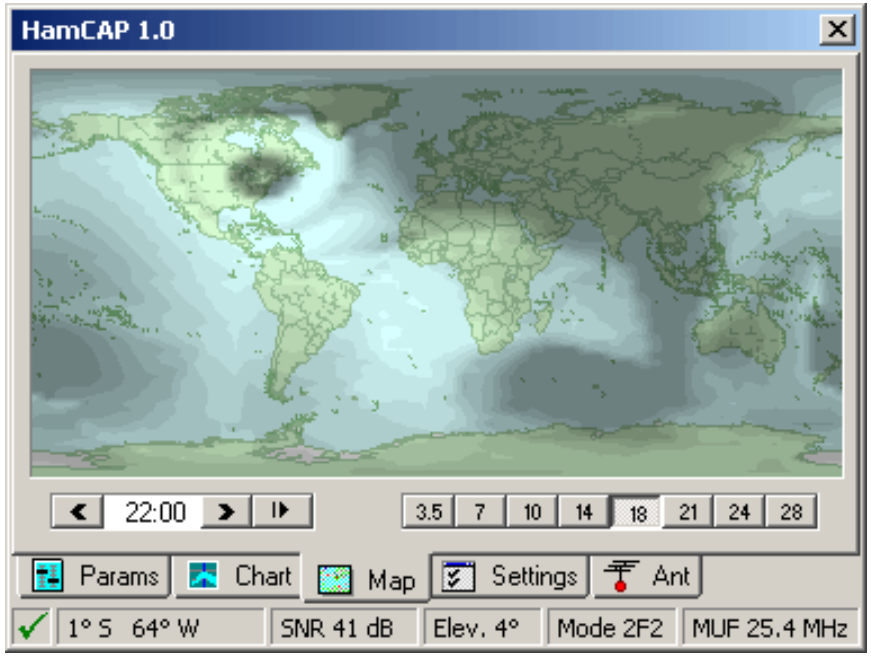


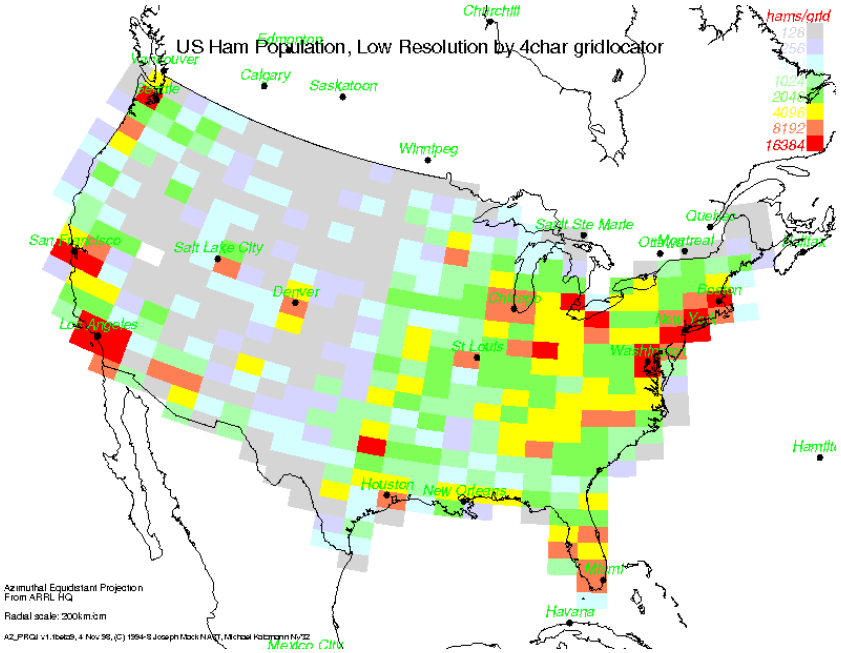
These maps are also used to monitor ionospheric weather, and to nowcast ionospheric storms that often occur responding to activities in solar wind and Earth's magnetosphere as well as thermosphere. The electron count affects the MUF along with proton flux. Note TEC map tends to mirror MUF.

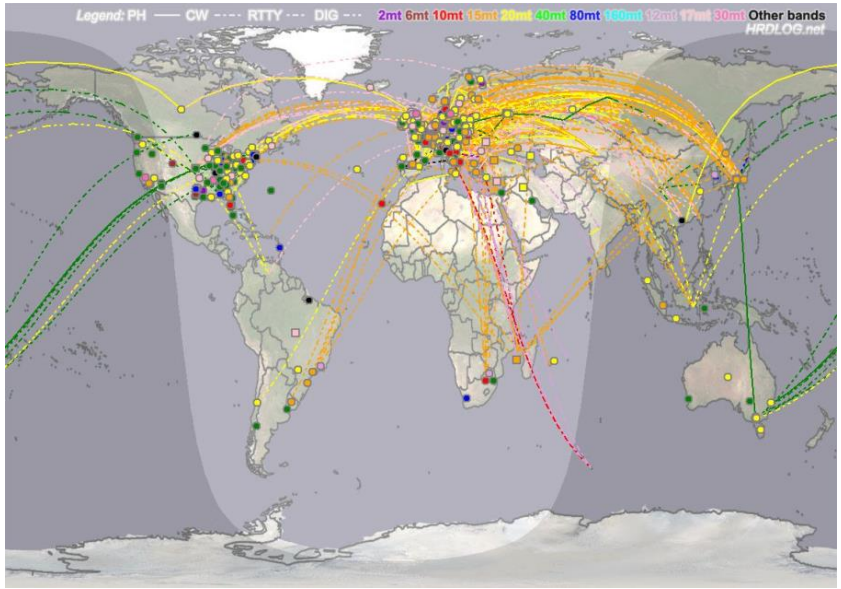
Propagation Maps (VHF)

144 mHz Propagation from APRS




HamCAP 1.0
22:00
3.5
7
10
14
18
21
24
28
Params
Chart
Map
Settings
Ant
1° S 64° W
SNR 41 dB
Elev. 4°
Mode 2F2
MUF 25.4 MHz


US Ham Population, Low Resolution by 4char gridlocator
hams/grid
Churchill
Edmonton
Vancouver
Calgary
Saskatoon
Winnipeg
Sault Ste Marie
Quebec
Montreal
San Francisco
Salt Lake City
Denver
Chicago
Boston
New York
Los Angeles
St Louis
Houston
New Orleans
Miami
Havana
Azimuthal Equidistant Projection
From ARRL HQ
Radial scale: 200km/cm

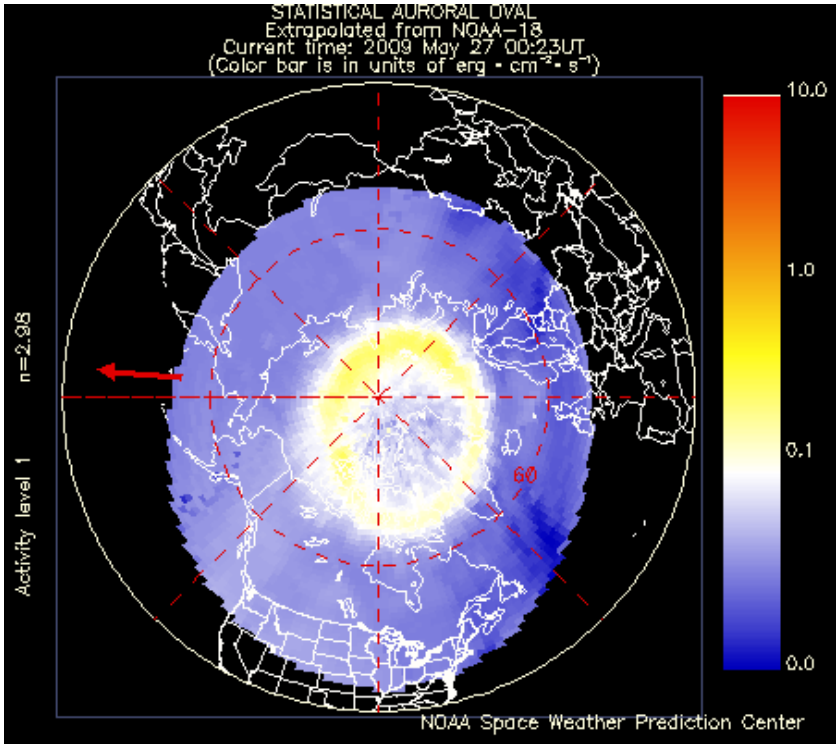

Legend: PH CW RTTY DIG
2mt 6mt 10mt 15mt 20mt 40mt 80mt 160mt 12mt 17mt 30mt Other bands
HRDLOG.net

Magnetic Field Map

The magnetic field, generated in the core and measured at the surface, continues upward through the ionosphere, the electrically-conducting, ionized layer of the Earth's upper atmosphere. The ionosphere extends in height from about 90 km to about 600 km, and it is electrically conducting because ultraviolet radiation from the Sun is absorbed by the electrons of nitrogen and oxygen molecules in the atmosphere. This absorption causes electrons to be dislodged from their molecular orbits, thereby producing free negative charges (electrons) and free positive charges (ions). As the Earth rotates underneath the Sun, periodic differential heating of the atmosphere causes it to expand on the day-side and contract on the night-side. Superimposed upon this variation is an atmospheric tide, similar to the oceanic tide and driven most substantially by the rotation of the Earth under the gravitational field of the Moon. The combination of these periodic forces drive winds in the ionosphere, and with the resulting fluid motion across magnetic-field lines, electric currents are induced. These currents support their own magnetic fields, and thus a diurnal perturbation in the magnetic field is generated. The diurnal-field variation can be measured at the Earth's surface, and with an array of magnetometers it is possible to map the electric currents in the ionosphere.

Ionospheric Electric Currents. Schematic diagram of the electric-current pattern in the ionosphere driven by diurnal heating from the Sun. Note that the current is concentrated on the day side, consisting of two oppositely oriented circuits.

Auroral Map (N Polar)



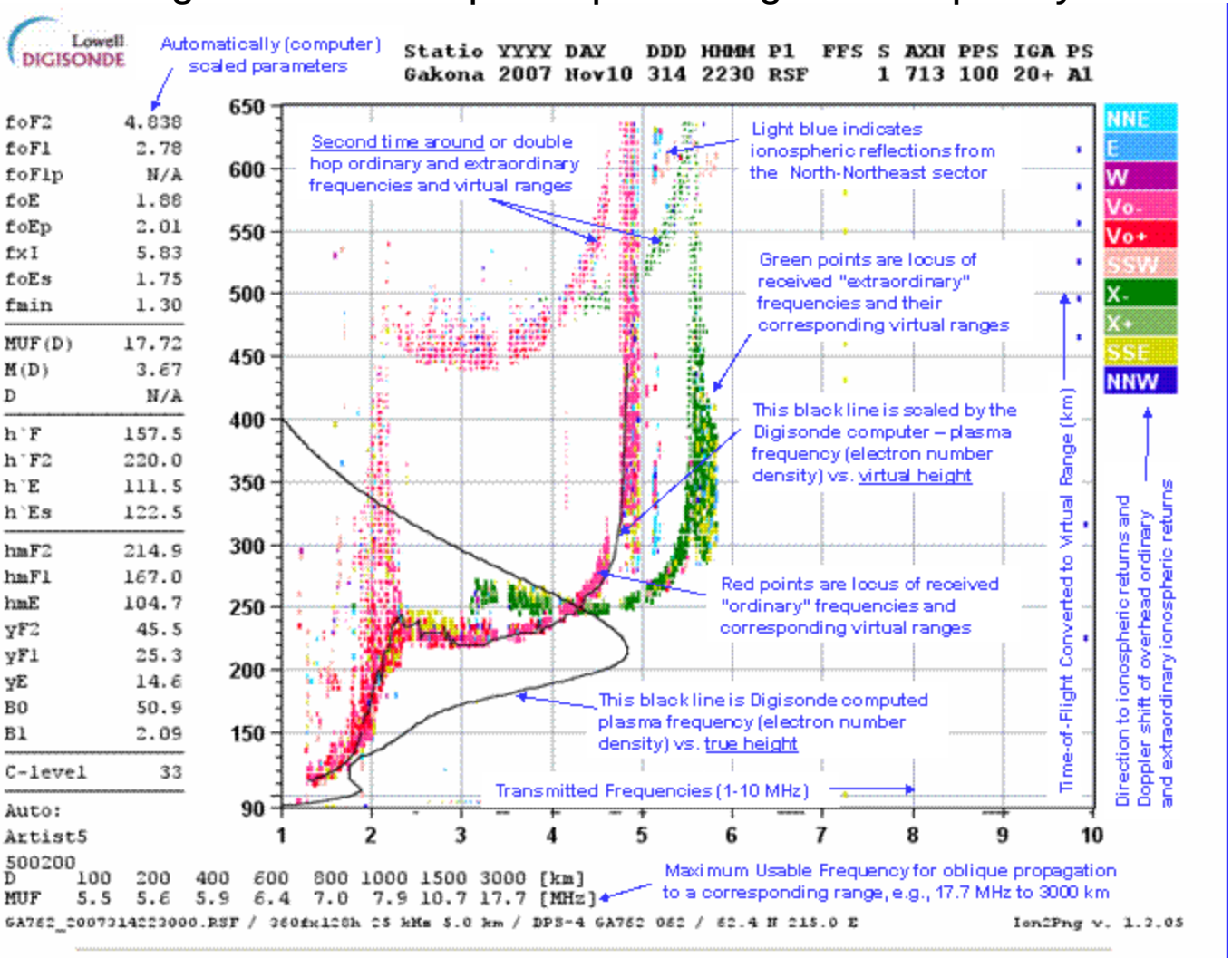
Estimated shape and character of the northern polar auroral oval, as derived from measurements of energy deposition into the auroral oval by the NOAA/TIROS spacecraft

The color bar at the right denotes the estimated power flux input into the auroral zone, in ergs*cm^-2*sec^-1. The yellow arrow points in the direction of the noon sector, where sunlight would prevent observations of auroral activity.

Auroral propagation is typically important at high latitudes

Ionogram Maps

The height of the ionosphere plotted against frequency.

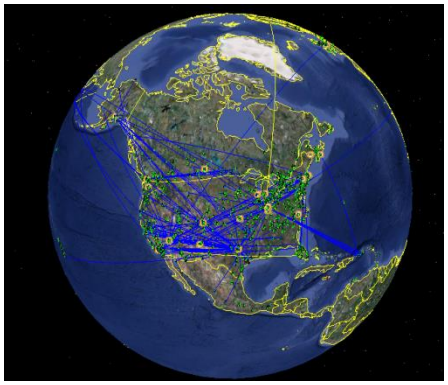


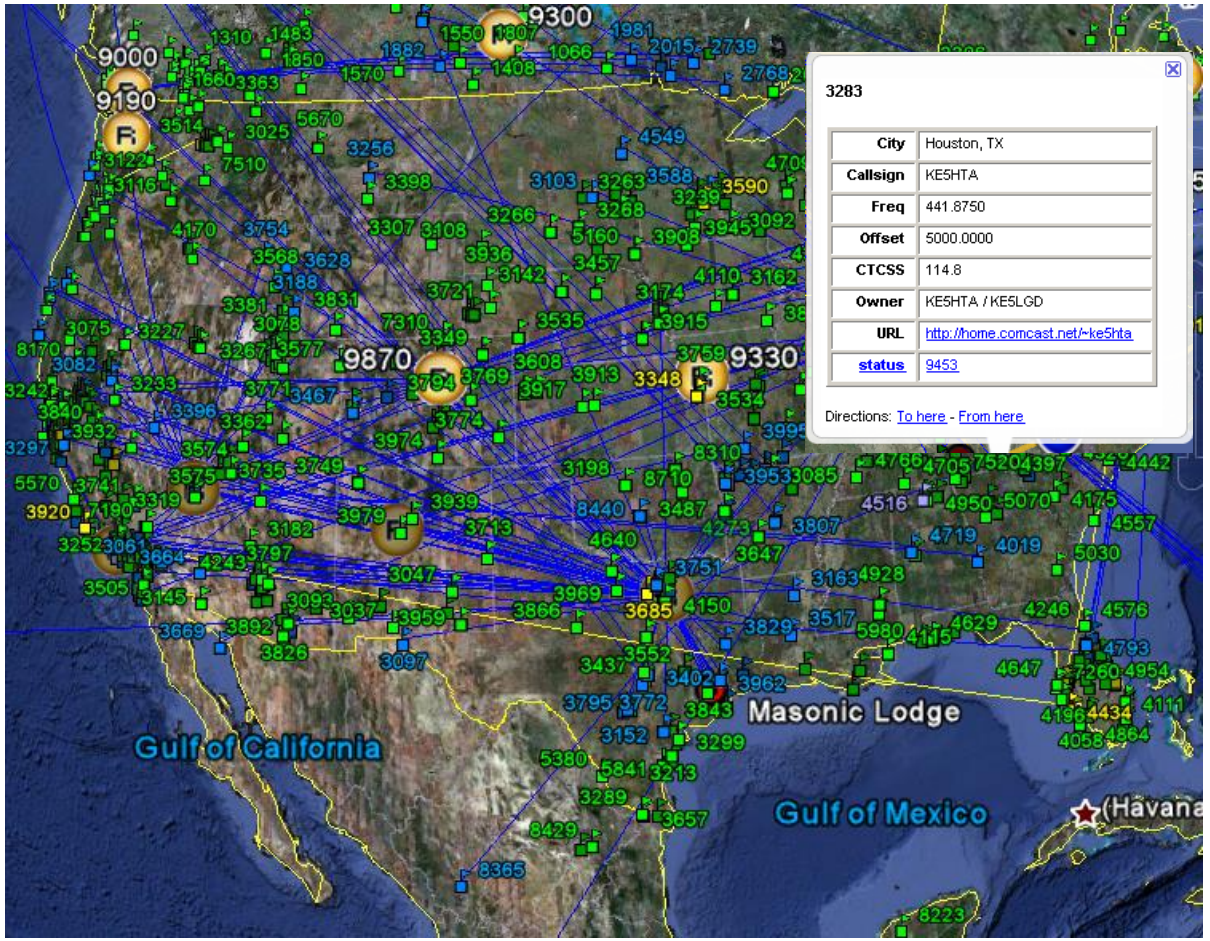
Internet Radio Linking and Repeater Maps Signal Coverage

IRLP Mapping

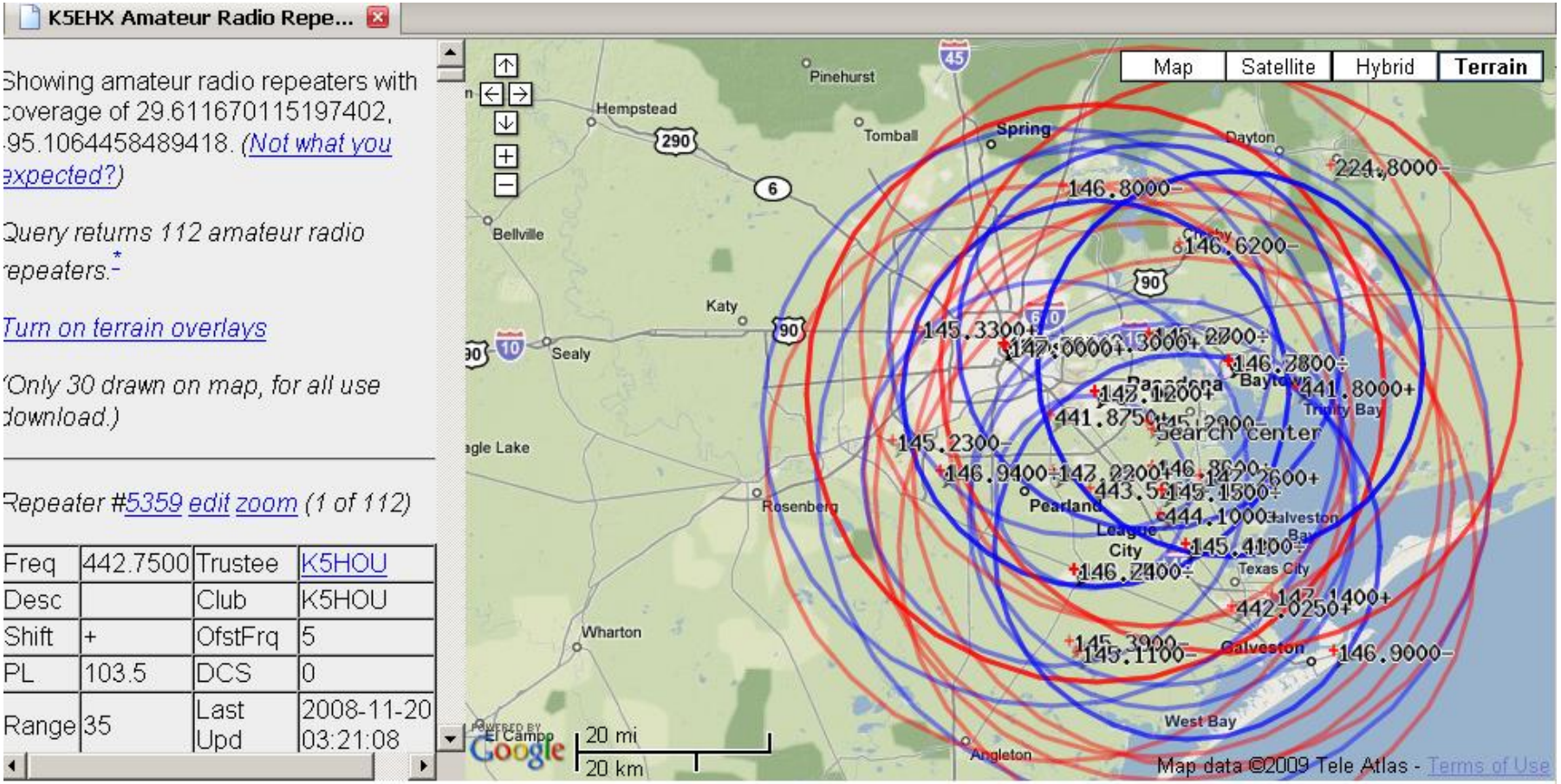
IRLP maps show the locations of internet linked repeaters and their connections across the world.

- Mapping of real time IRLP nodes projected with great circle connections using Google Earth.
- Links. Pop-up link points to active, inactive and idle nodes.



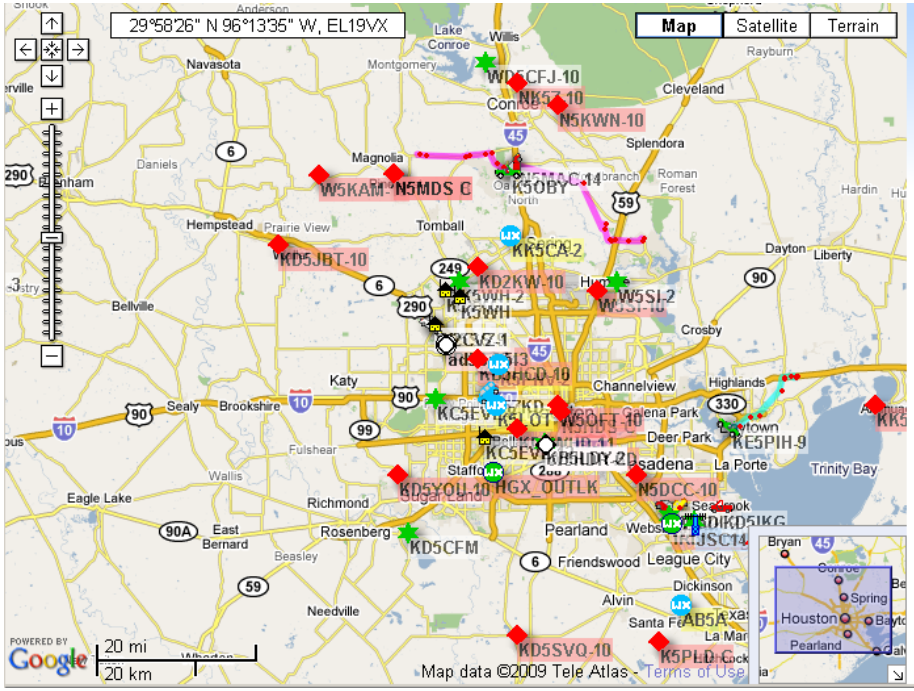


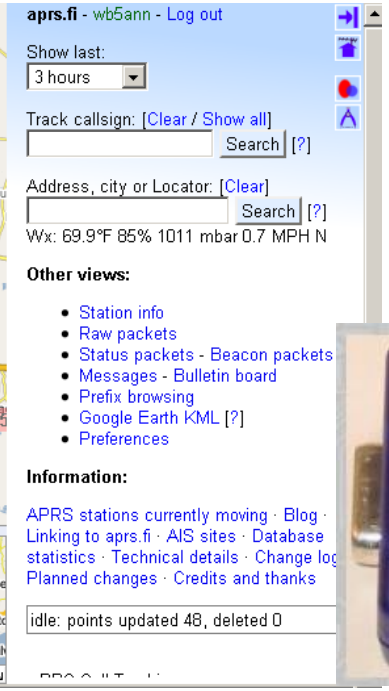
Repeater Maps

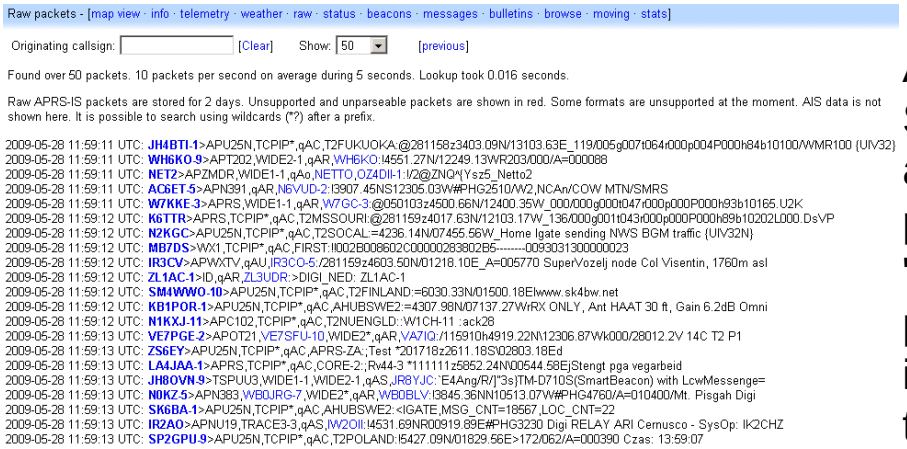


Online repeater mapping from K5EHX with 30 mile range rings. There are a large amount of online maps now that give real time status and location of active repeaters in the US.

APRS Mapping







Raw packets - [map view · info · telemetry · weather · raw · status · beacons · messages · bulletins · browse · moving · stats]

Originating callsign: [Clear] Show: 50 [previous]

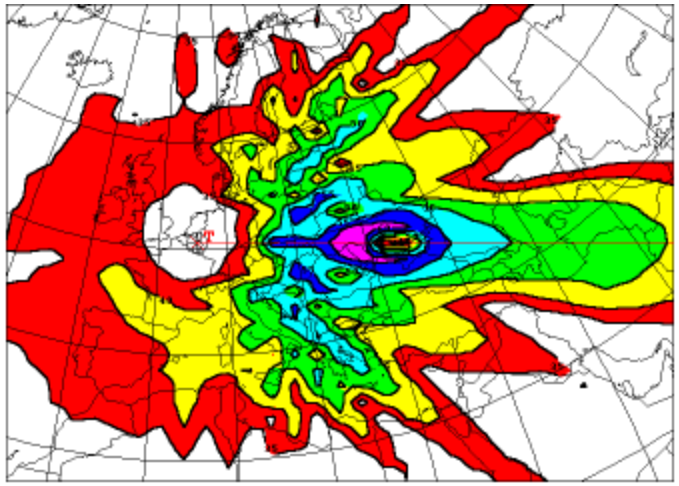
Found over 50 packets. 10 packets per second on average during 5 seconds. Lookup took 0.016 seconds.

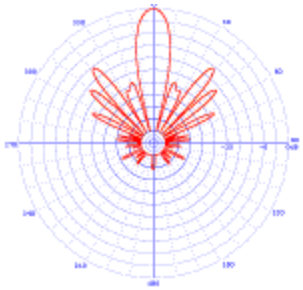
Raw APRS-IS packets are stored for 2 days. Unsupported and unparseable packets are shown in red. Some formats are unsupported at the moment. AIS data is not shown here. It is possible to search using wildcards (*?) after a prefix.

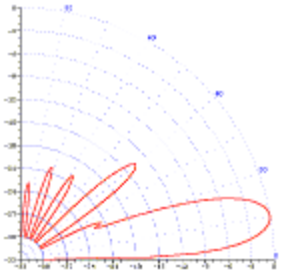
2009-05-28 11:59:11 UTC: JH4BTI-1>APU25N,TCPIP*,qAC,T2FUKUOKA:@281158z3403.09N/13103.63E_119/005g007t064r000p004P000h84b10100/WMR100 {UIV32}
2009-05-28 11:59:11 UTC: WH6KO-9>APT202,WIDE2-1,qAR,WH6KO:!4551.27N/12249.13WR203/000/A=000088
2009-05-28 11:59:11 UTC: NET2>APZMDR,WIDE1-1,qAo,NETTO,OZ4DII-1:!/2@ZNQ^[Ysz5_Netto2
2009-05-28 11:59:11 UTC: AC6ET-5>APN391,qAR,N6VUD-2:!3907.45NS12305.03W#PHG2510/W2,NCAn/COW MTN/SMRS
2009-05-28 11:59:11 UTC: W7KKE-3>APRS,WIDE1-1,qAR,W7GC-3:@050103z4500.66N/12400.35W_000/000g000t047r000p000P000h93b10165.U2K
2009-05-28 11:59:12 UTC: K6TTR>APRS,TCPIP*,qAC,T2MSSOURI:@281159z4017.63N/12103.17W_136/000g001t043r000p000P000h89b10202.L000.DsVP
2009-05-28 11:59:12 UTC: N2KGC>APU25N,TCPIP*,qAC,T2SOCAL:=4236.14N/07455.56W_Home Igate sending NWS BGM traffic {UIV32N}
2009-05-28 11:59:12 UTC: MB7DS>WX1,TCPIP*,qAC,FIRST:II002B008602C00000283802B5--------009303130000023
2009-05-28 11:59:12 UTC: IR3CV>APWXTV,qAU,IR3CO-5:/281159z4603.50N/01218.10E_A=005770 SuperVozelj node Col Visentin, 1760m asl
2009-05-28 11:59:12 UTC: ZL1AC-1>ID,qAR,ZL3UDR:>DIGI_NED: ZL1AC-1
2009-05-28 11:59:12 UTC: SM4WWO-10>APU25N,TCPIP*,qAC,T2FINLAND:=6030.33N/01500.18Elwww.sk4bw.net
2009-05-28 11:59:12 UTC: KB1POR-1>APU25N,TCPIP*,qAC,AHUBSWE2:=4307.98N/07137.27WrRX ONLY, Ant HAAT 30 ft, Gain 6.2dB Omni
2009-05-28 11:59:12 UTC: N1KXJ-11>APC102,TCPIP*,qAC,T2NUENGLD::W1CH-11 :ack28
2009-05-28 11:59:13 UTC: VE7PGE-2>APOT21,VE7SFU-10,WIDE2*,qAR,VA7IQ:/115910h4919.22N\12306.87Wk000/28012.2V 14C T2 P1
2009-05-28 11:59:13 UTC: ZS6EY>APU25N,TCPIP*,qAC,APRS-ZA:;Test *201718z2611.18S\02803.18Ed
2009-05-28 11:59:13 UTC: LA4JAA-1>APRS,TCPIP*,qAC,CORE-2:;Rv44-3 *111111z5852.24N\00544.58EjStengt pga vegarbeid
2009-05-28 11:59:13 UTC: JH8OVN-9>TSPUU3,WIDE1-1,WIDE2-1,qAS,JR8YJC:`E4Ang/R/]"3s}TM-D710S(SmartBeacon) with LcwMessenge=
2009-05-28 11:59:13 UTC: N0KZ-5>APN383,WB0JRG-7,WIDE2*,qAR,WB0BLV:!3845.36NN10513.07W#PHG4760/A=010400/Mt. Pisgah Digi
2009-05-28 11:59:13 UTC: SK6BA-1>APU25N,TCPIP*,qAC,AHUBSWE2:<IGATE,MSG_CNT=18567,LOC_CNT=22
2009-05-28 11:59:13 UTC: IR2AO>APNU19,TRACE3-3,qAS,IW2OII:!4531.69NR00919.89E#PHG3230 Digi RELAY ARI Cernusco - SysOp: IK2CHZ
2009-05-28 11:59:13 UTC: SP2GPU-9>APU25N,TCPIP*,qAC,T2POLAND:!5427.09N/01829.56E>172/062/A=000390 Czas: 13:59:07

APRS or Automated Packet Reporting System works with a GPS, a small TNC and a radio running on 144.39 mHz. The position is reported to the system with "raw packets" (left) which is translated to position, direction and speed. Other information including weather also is transmitted.

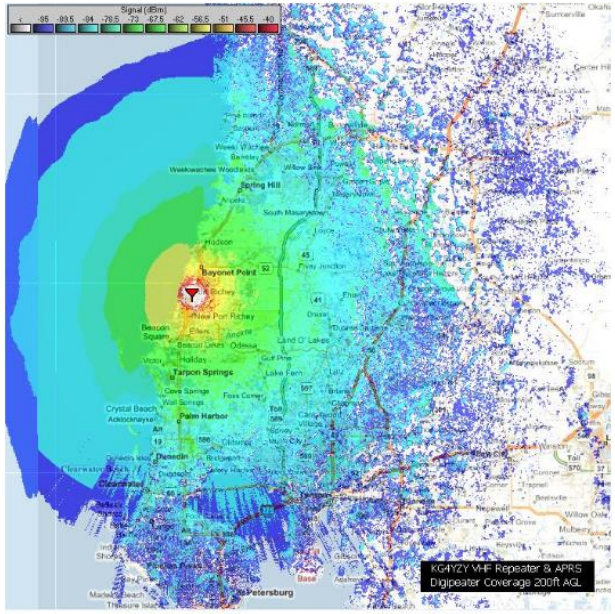
Signal Coverage Maps







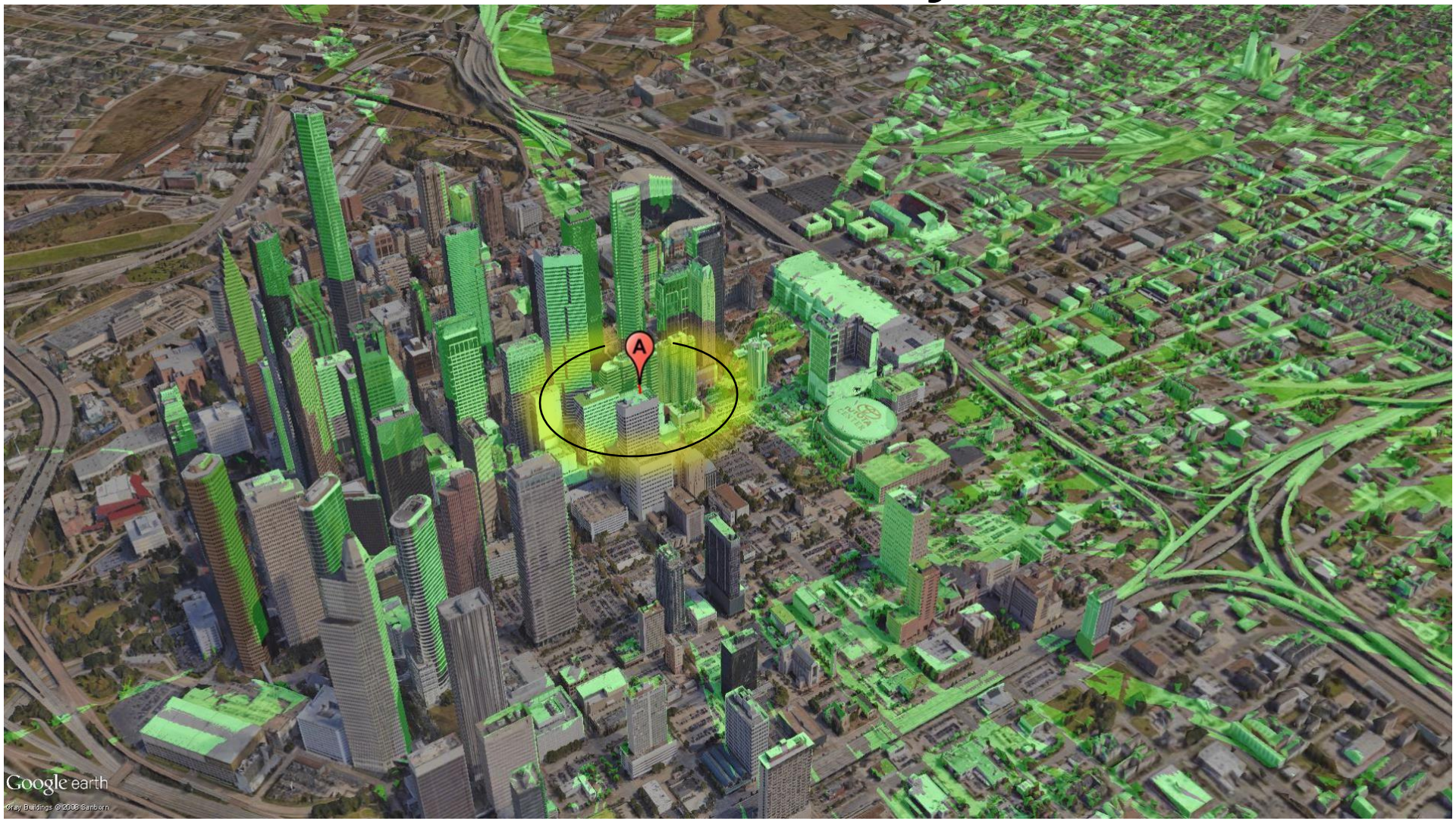
HF model coverage for rhombic antenna.



VHF model power distribution for a hand-held radio taking into account terrain. A digital topo map is used and line of sight prediction software calculates the range and power.

Whats Hot

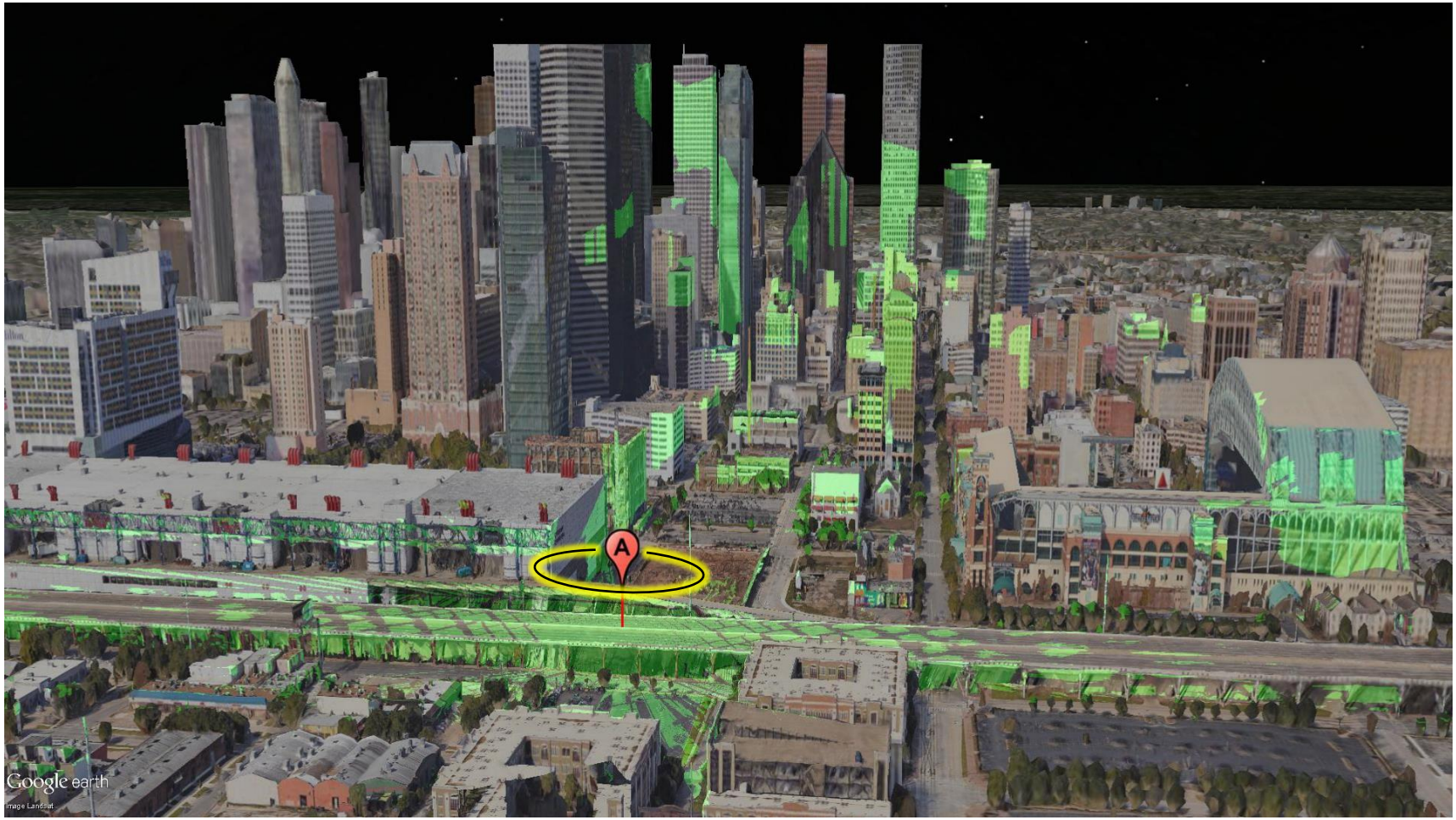
Viewshed Analysis



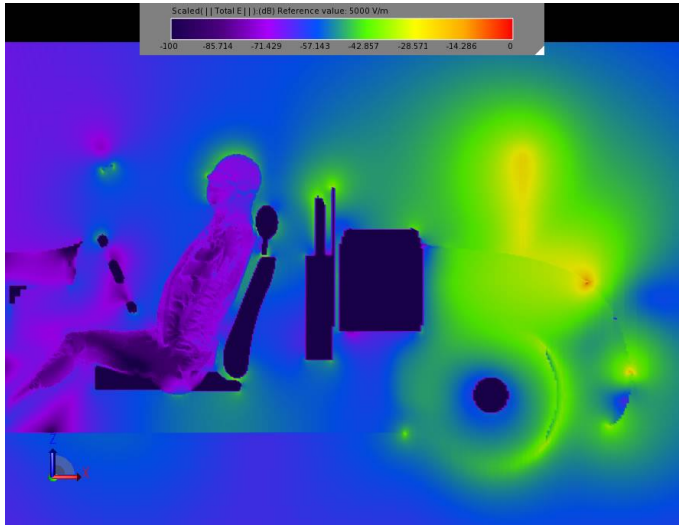
Viewshed shows the visible line of sight path from a location. Slightly different than signal coverage – New feature in Google Earth.

Viewshed Analysis

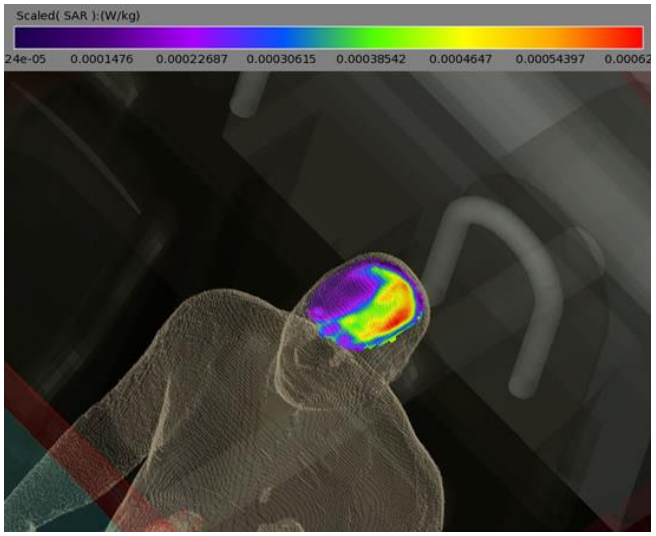
Mobile operating on US59 East of Downtown before Convention Center



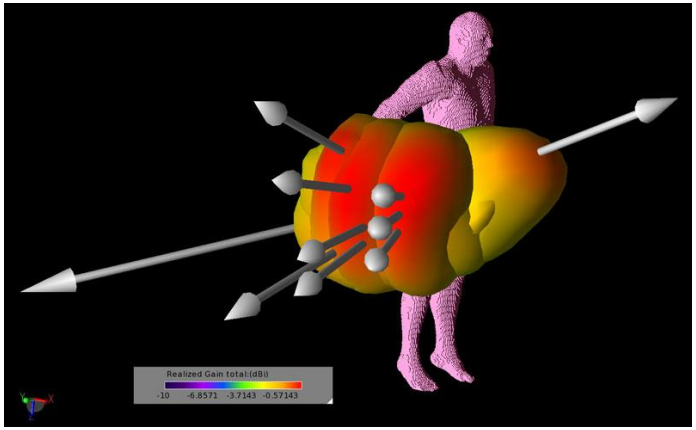
Modeling Maps



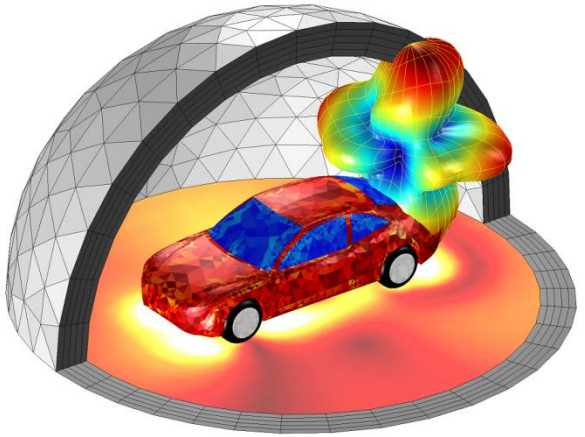
VHF EM Effect in Vehicle



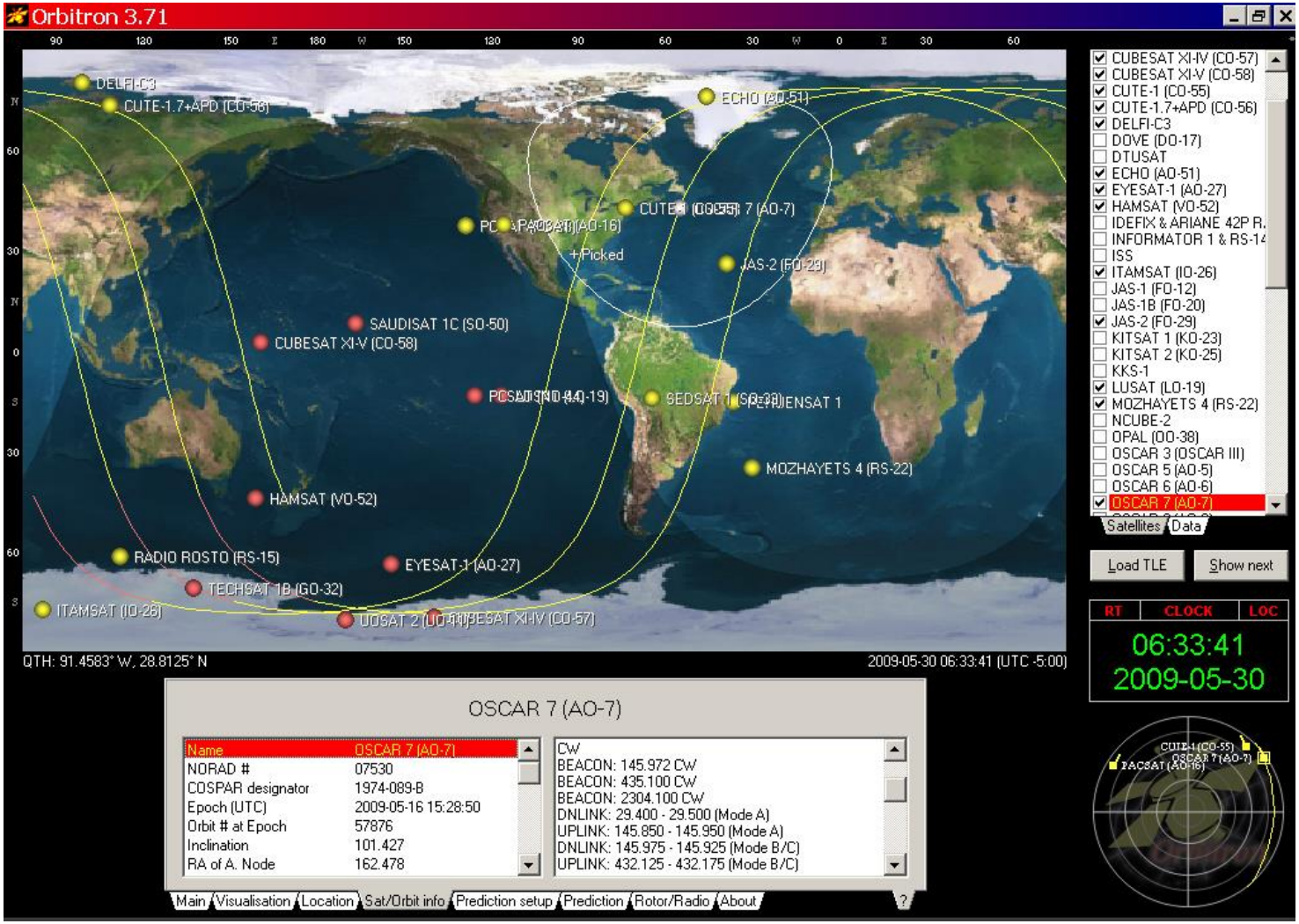
Simulated SAR Exposure



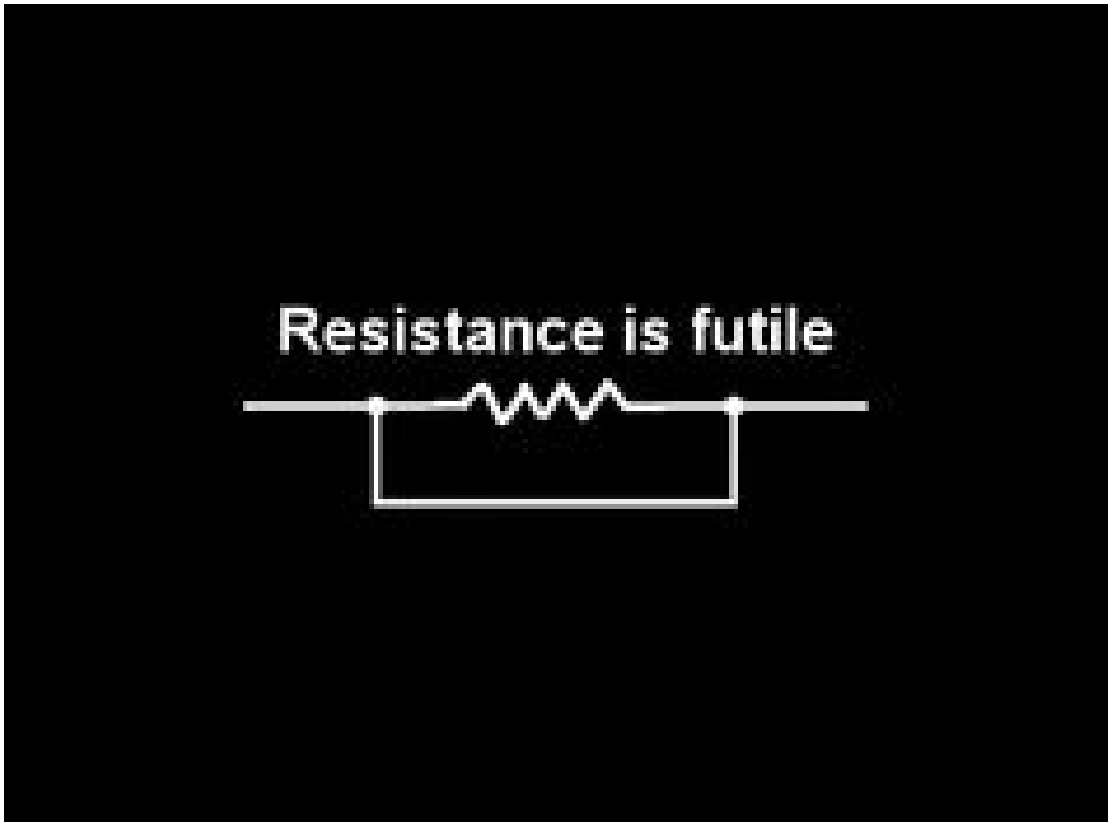
Cell Phone Exposure



Satellite Coverage and Prediction



Summary – A Map is a diagrammatic representation of features in 2 dimensions.



Ham Radio Operator

What My Friends Think I Do

What My Wife Thinks I Do

What Society Thinks I Do

What My Kids Think I Do

What I Think I Do

What I Actually Do

hamhijinks.com