



Amateur Satellites
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OSCAR communications from G6UW



Overview

- ✧ Background of OSCAR and AMSAT
- ✧ Technical Topics
- ✧ Workable Satellites
- ✧ Using software and Yaesu FT-847
- ✧ Next steps

AMSAT and OSCAR

- ✧ AMSAT Education body formed in 1969
- ✧ A partnership programme in space research
- Development of low cost missions
- Never commercial
- ✧ OSCAR 1 launched in Dec 1961 - four years after Sputnik





OSCAR principles

- ✧ Many LEO satellites prepared using literally homebrew approaches
- ✧ Clean room basements approach commercial standards
- ✧ KISS approach
- ✧ Avoid specialised parts - beg, borrow, steal!
- ✧ Eg. Eagle Sat total cost = \$400,000
- ✧ Commercial clean room = \$1m

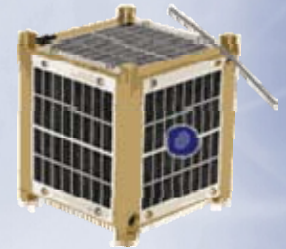


Launch practicalities

- ✧ Amsat is not part of NASA
- ✧ Volunteer-based:
 - Cash donations
 - Expert volunteer staff
 - Secondary user, free payload lifting, eg Ariane Structure for Auxiliary Payloads (ASAP)
 - Strongly supported by space agencies

Typical OSCAR service

- ✧ Traditionally, either band repeaters or digimode mailboxes
- ✧ Since 1961, a total of 94 non-commercial satellites (see <http://www.amsat.org/amsat-new/satellites/history.php>)
- ✧ Now, increasingly software defined
 - Changing schedule of services
 - Radio behaviour reprogrammable
 - 'Cube' or 'Pico' sats (10cm cube)





Satellites available

Satellite	Type	Launch Date	Overall Status
CubeSat OSCAR 56	Beacon/APRS Digipeater	2/21/2006	Operational (*)
VUSat-OSCAR 52	SSB/CW Voice Transponder	5/5/2005	Operational
AMSAT-OSCAR 51	FM Voice Repeater/PacSat	6/28/2004	Operational
Saudi-OSCAR 50	FM Voice Repeater	12/20/2002	Operational
ARISS	APRS, Crew Contact, Repeater	11/20/1998	Operational
Gurwin-OSCAR 32	PacSat	7/10/1998	Operational
Fuji-OSCAR 29	SSB/CW Voice Transponder	8/17/1996	Operational
PCSat2	APRS Digipeater	8/3/2005	Semi-Operational
Navy-OSCAR 44	APRS Digipeater	9/30/2001	Semi-Operational
AMRAD-OSCAR 27	FM Voice Repeater	9/26/1993	Semi-Operational
LUSAT-OSCAR 19	Beacon	1/22/1990	Semi-Operational
UoSat OSCAR 11	Beacon	3/1/1984	Semi-Operational
AMSAT-OSCAR 7	SSB/CW Voice Transponder	11/15/1974	Semi-Operational

High Earth and Low Earth

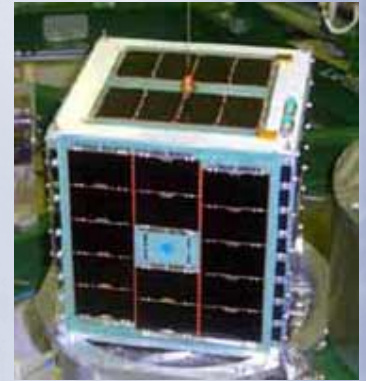
- ❖ LEO satellites: small footprint, limited range, easy to launch, easy to work but fast!
- ❖ HEO satellites: hemisphere footprint, hard to launch, hard to work
- ❖ There are no HEO amateur satellites left (notably AO-40 - explosion, 2000 and AO-13 radiation 'death')
- ❖ AMSAT is focused on two HEO satellites: Eagle Sat and P3P

QuickTime™ and a decompressor are needed to see this picture.



Example Satellite: AO-51

- ✧ LEO AO-51 "Echo" 25cm cube, 11kg
- ✧ June 2004 launch
- ✧ 144MHz, 1.2GHz uplinks
- ✧ 433MHz, 2.4GHz downlinks
- ✧ 18W power in sunlight (7.5W RF, total)
- ✧ Approx 800km orbit, 3000km to horizon
"AOS", 1h 39m orbit (14 passes per day)
- ✧ 70cm/2m repeater is highly accessible (FM immune to doppler)
- ✧ An ideal "first" satellite



LEO Practicalities

- ✧ Receive budget and circular polarisation
- ✧ Doppler Shift
- ✧ Tracking - Keplerian elements: azimuth, elevation
- ✧ Computer control





G6UW Link budget

- ✧ Working in dB relative to 1mW at **3000KM**
- ✧ Satellite power +30dB (1W)
- ✧ Satellite gain +2dB
- ✧ Path loss -155dB
- ✧ Polarisation -0dB (circular polarisation)
- ✧ Ionosphere -1dB
- ✧ 70cm RX Yagi gain: +14dB
- ✧ **Total budget: -110dbM**
- ✧ **FT-847 Signal to Noise and Distortion is conservatively -120dBm for usable signal**

Doppler Shift

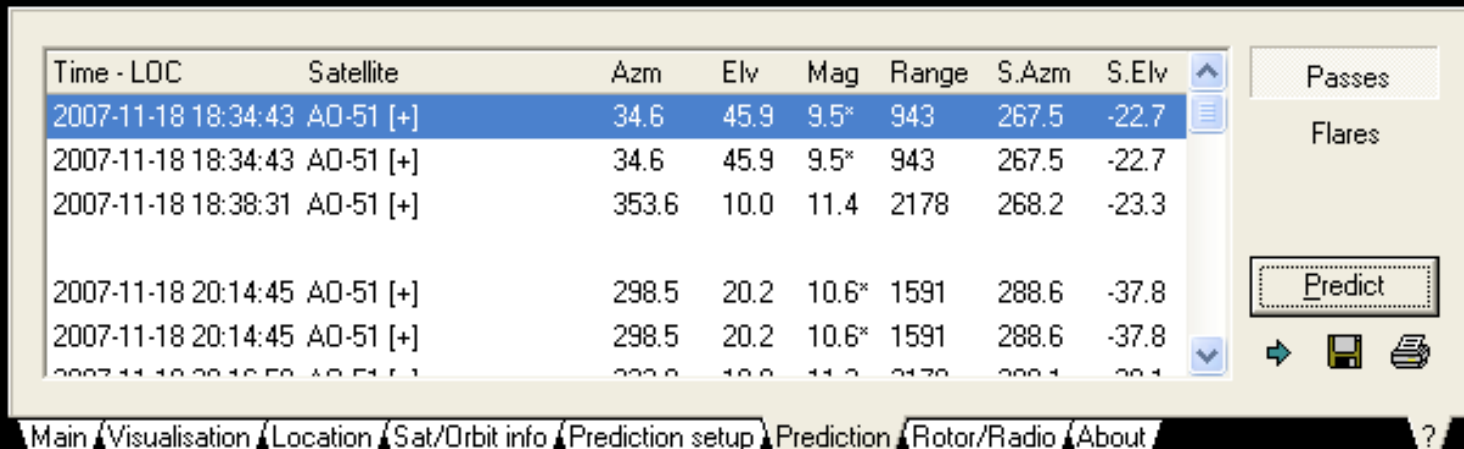
$$f' = \left(\frac{v}{v \pm v_s} \right) f$$

- ✧ AO-51 typical velocity: 8,000m/s
- ✧ v = approximately c , speed of light
- ✧ 145.920MHz uplink: +/- 3.8kHz
- ✧ 435.300MHz downlink: +/- 11.6kHz
- ✧ Average closing velocity is less than this (eg. $v_s = 0$ when overhead)
- ✧ Using FM but uplink signal should be centred within approx 1kHz

Software

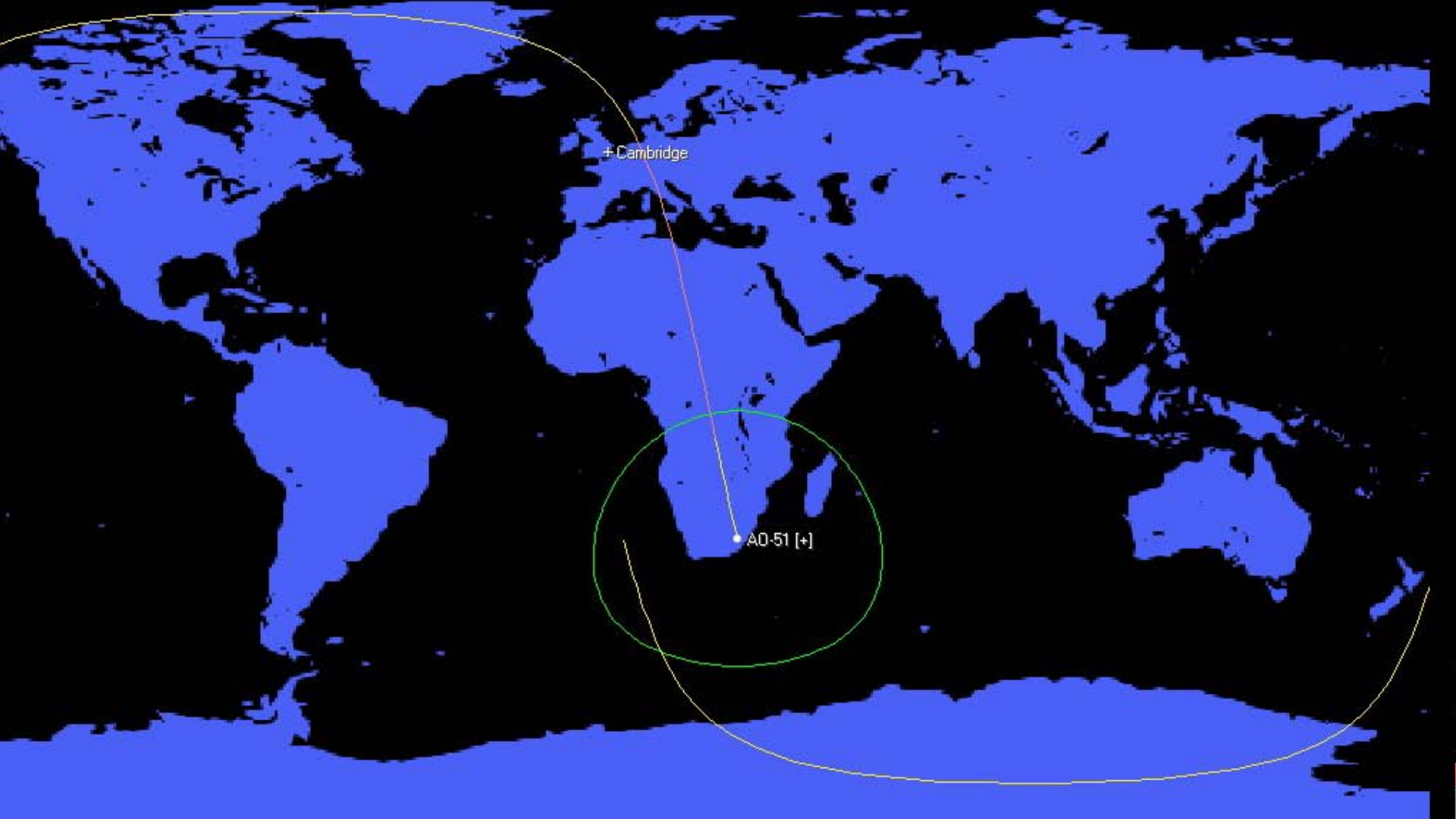
G6UW uses Orbitron

- ✧ Includes rotator and radio control (SPID mode 'A' for auto allows computer control)
- ✧ Update TLE files before use (see <http://www.stoff.pl/tle/tle.zip>)
- ✧ Use 'Prediction' to find next pass then click on pass



The screenshot shows the Orbitron software interface. It features a table with columns for Time - LOC, Satellite, Azm, Elv, Mag, Range, S.Azm, and S.Elv. The table lists several passes for satellite AO-51. To the right of the table is a 'Predict' button and a 'Flares' section. The bottom of the window shows a menu bar with options: Main, Visualisation, Location, Sat/Orbit info, Prediction setup, Prediction, Rotor/Radio, and About.

Time - LOC	Satellite	Azm	Elv	Mag	Range	S.Azm	S.Elv
2007-11-18 18:34:43	AO-51 [+]	34.6	45.9	9.5*	943	267.5	-22.7
2007-11-18 18:34:43	AO-51 [+]	34.6	45.9	9.5*	943	267.5	-22.7
2007-11-18 18:38:31	AO-51 [+]	353.6	10.0	11.4	2178	268.2	-23.3
2007-11-18 20:14:45	AO-51 [+]	298.5	20.2	10.6*	1591	288.6	-37.8
2007-11-18 20:14:45	AO-51 [+]	298.5	20.2	10.6*	1591	288.6	-37.8
2007-11-18 20:18:50	AO-51 [+]	298.5	20.2	11.2	2178	288.6	-37.8



+ Cambridge

AO-51 [+]

2007-11-18 18:10:41 (UTC +0:00)

Mode

Real time

Simulation

2007-11-18 18:10:41

5 minutes

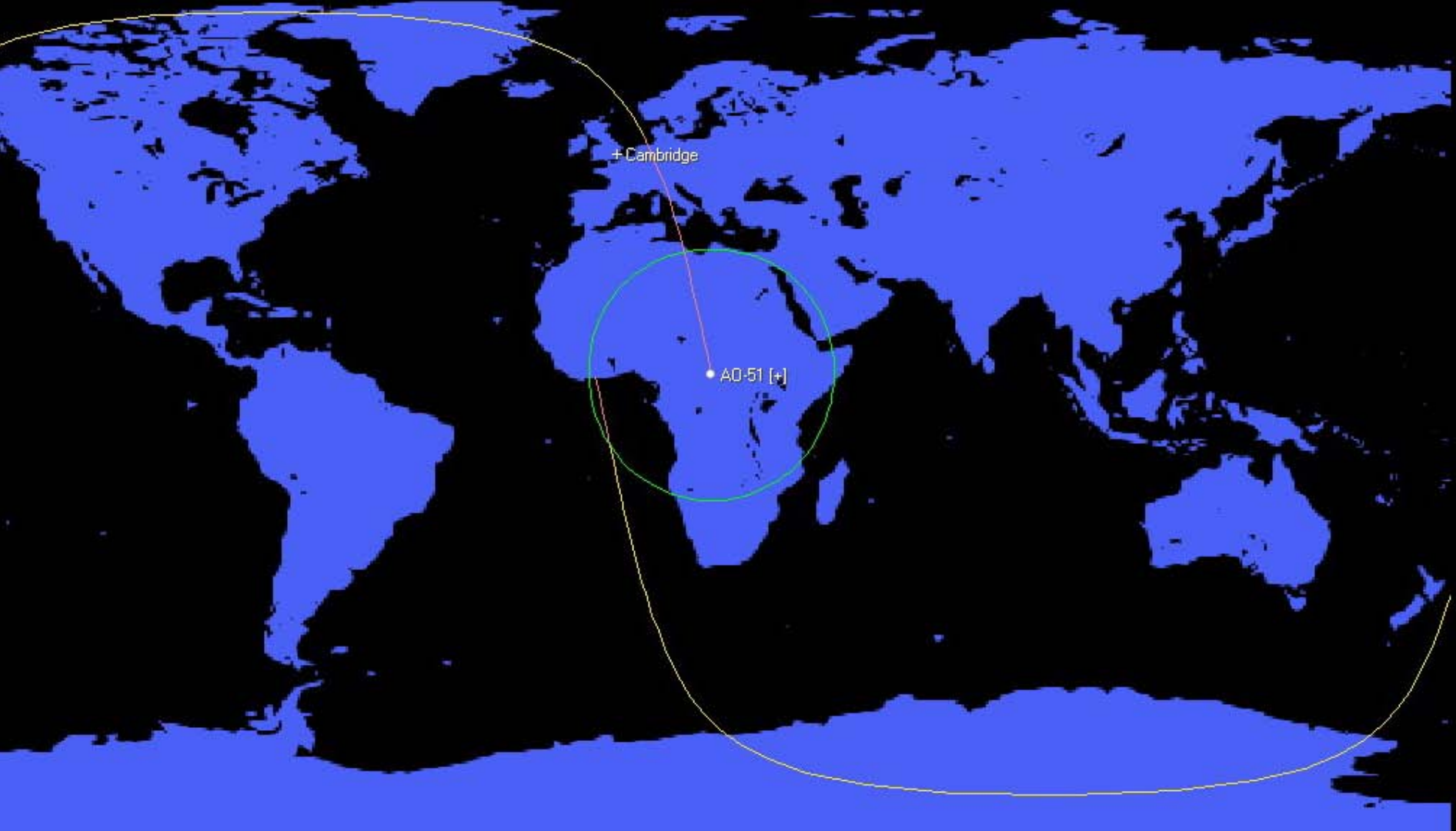
<<< < > >>>

Time

Local

UTC





N

2007-11-18 18:20:41 (UTC +0:00)

Mode

Real time

Simulation

2007-11-18 18:20:41

5 minutes

<<< < > >>>

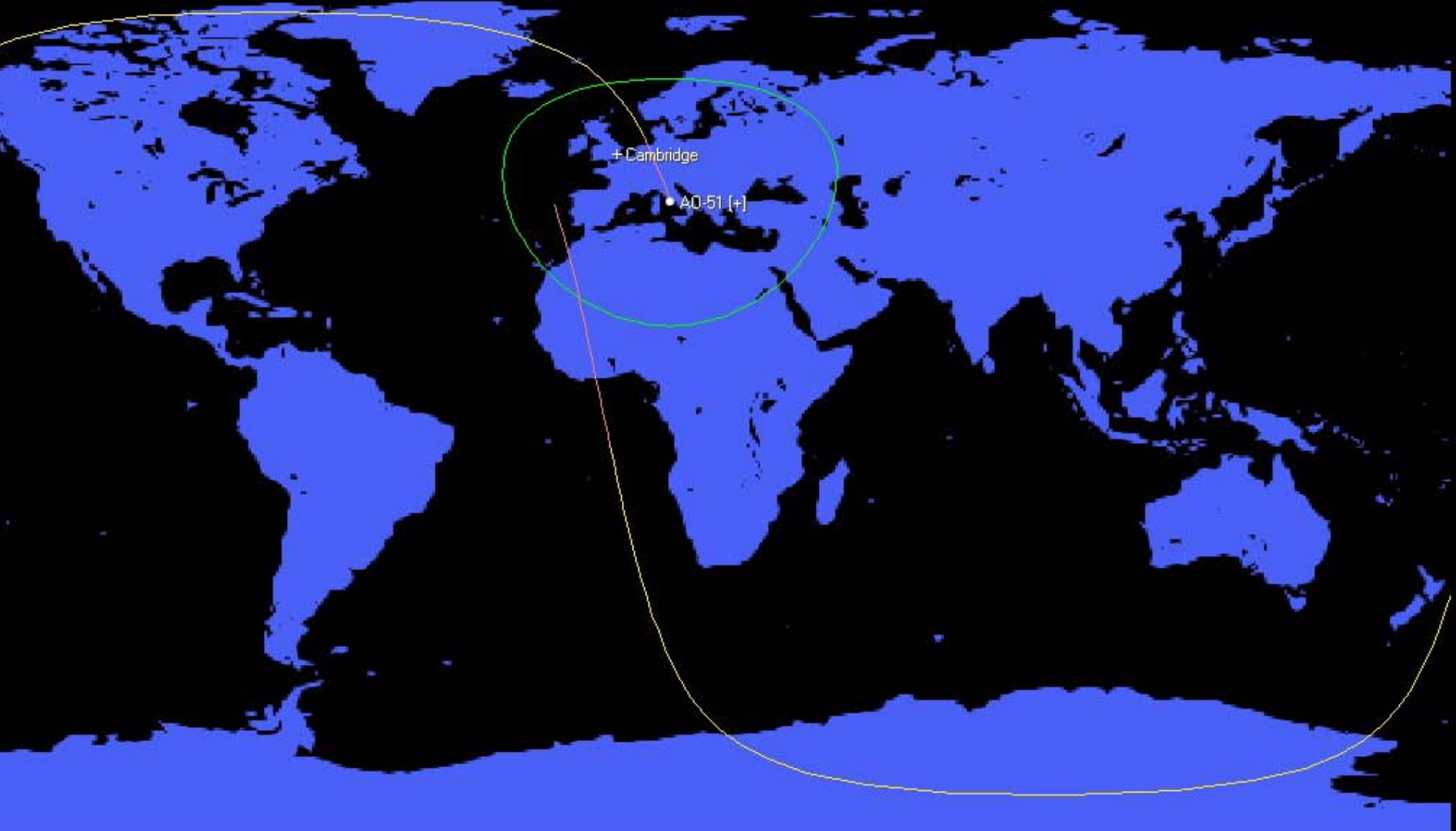
Time

Local

UTC

5

A toolbar containing icons for home, camera, zoom in, zoom out, pan, zoom reset, save, info, simulation start, simulation stop, simulation pause, simulation refresh, a dropdown menu with '5', and a clock icon.



N

2007-11-18 18:30:41 (UTC +0:00)

Mode

Real time

Simulation

2007-11-18 18:30:41

5 minutes

<<< < > >>>

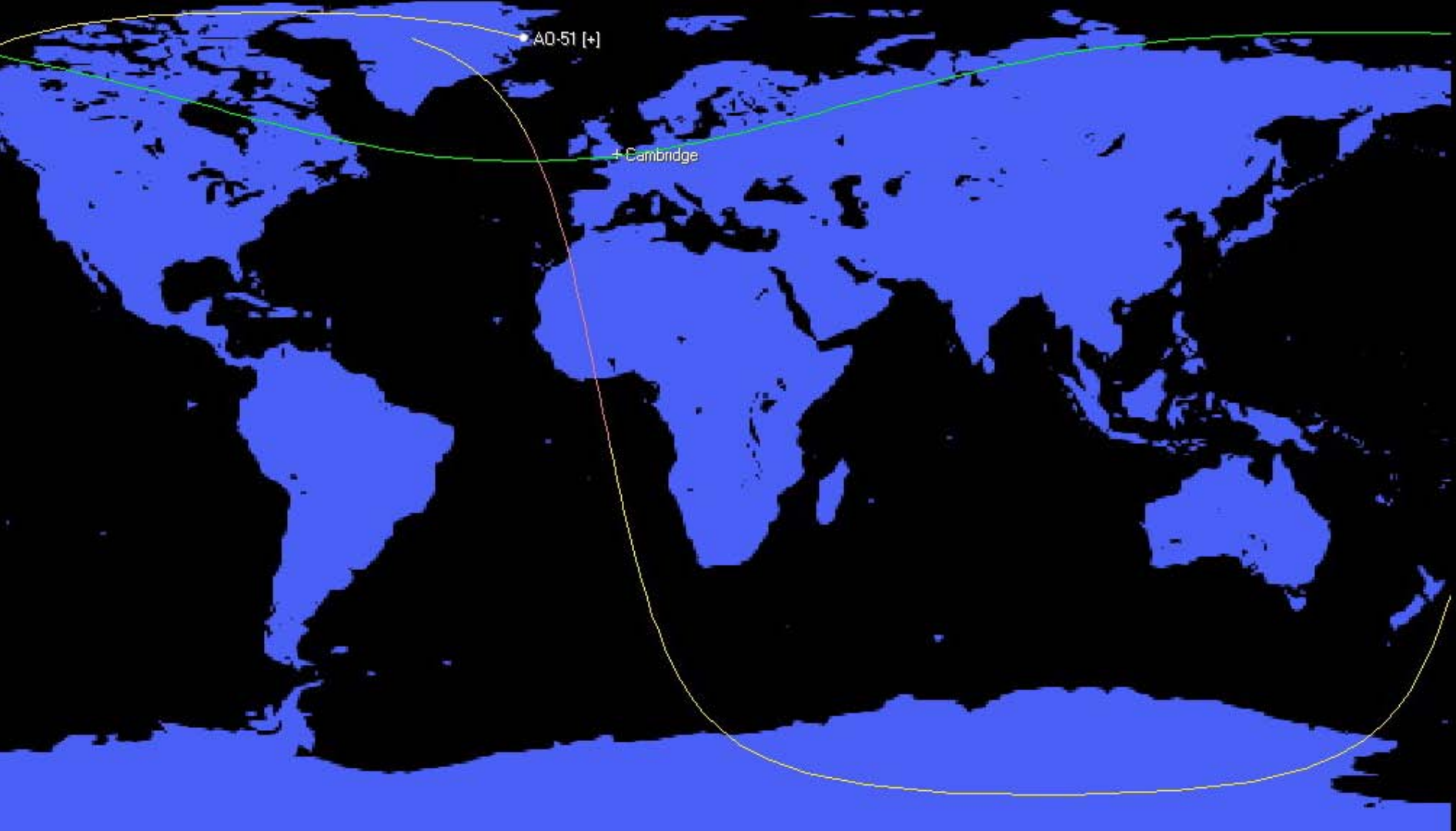
Time

Local

UTC

5

A toolbar containing icons for home, camera, zoom in, zoom out, pan, pan up, pan down, pan left, pan right, info, compass, grid, and a zoom level dropdown set to 5.



N

2007-11-18 18:40:41 (UTC +0:00)

Mode

Real time

Simulation

2007-11-18 18:40:41

5 minutes

<<< < > >>>

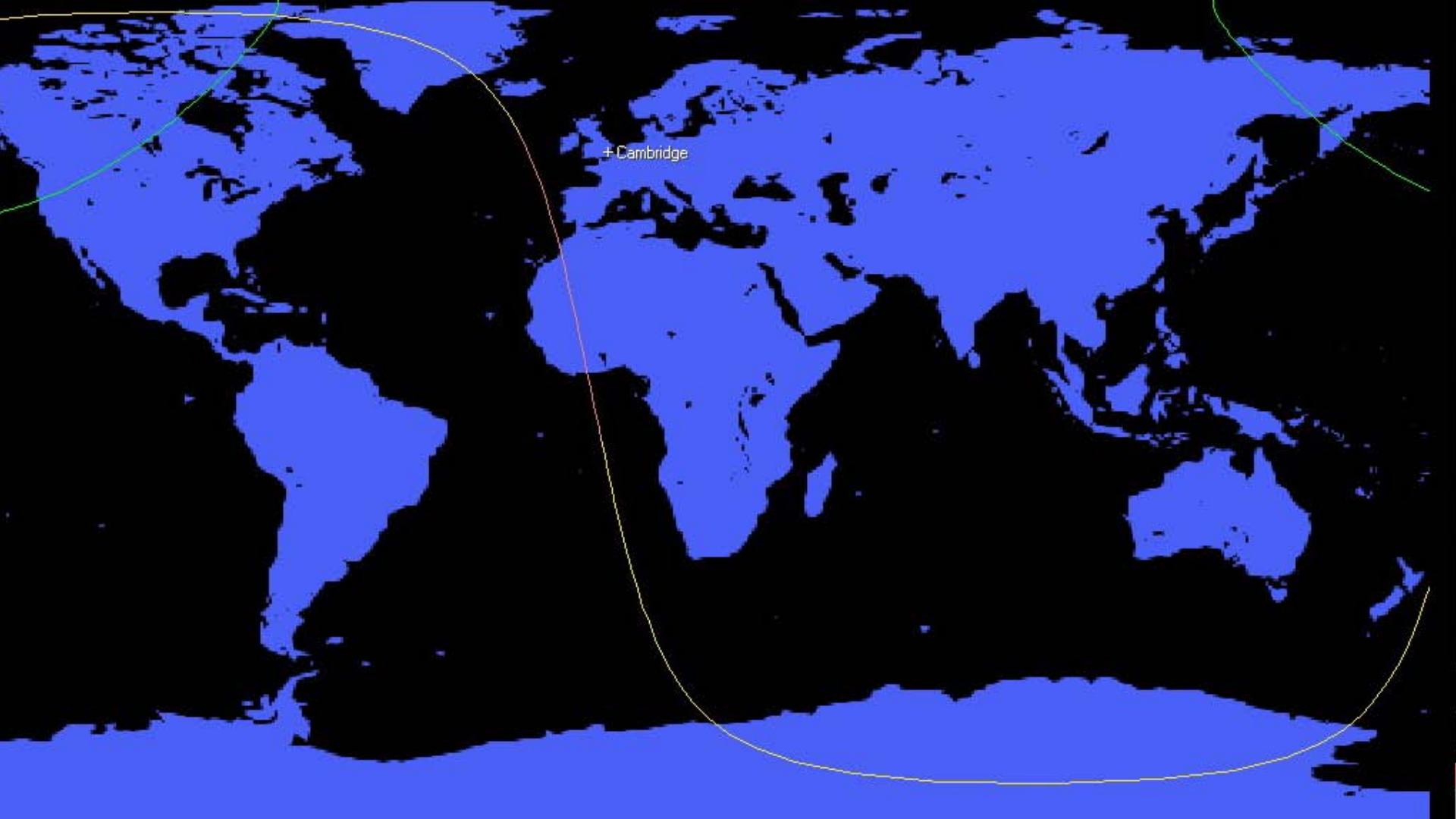
Time

Local

UTC

5

A toolbar containing various icons for map navigation and simulation control, including a red diamond, a camera, a minus sign, a plus sign, a magnifying glass, a folder, a document, an information icon, a globe, a grid, a refresh icon, a close icon, a dropdown menu with '5', and a clock icon.



N

2007-11-18 18:50:41 (UTC +0:00)

Mode

Real time

Simulation

2007-11-18 18:50:41

5 minutes

<<< < > >>>

Time

Local

UTC

5

Navigation icons: Home, Back, Forward, Stop, Refresh, Home, Full Screen, Maximize, Close, Zoom In, Zoom Out, Clock



Yaesu FT-847

- ✧ For AO-51, use manual tuning (Echo is a fixed frequency repeater)
- ✧ First press 'Sat' mode
- ✧ Start by tuning both VFOs:
 - VFO A = TX on 145.920MHz
 - VFO B = RX on 435.300MHz
 - Then press 'Track' to gang VFOs
 - Adjusting VFO A will automatically adjust VFO B for doppler offsets - start **up** about 10kHz on 70cm

Yaesu FT-847

✧ Typical starting point:

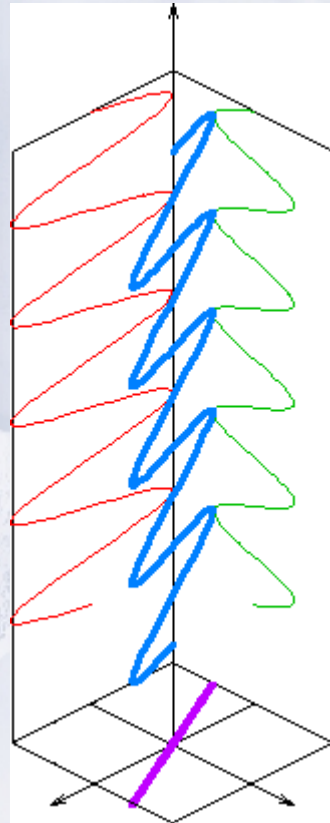


Yaesu FT-847

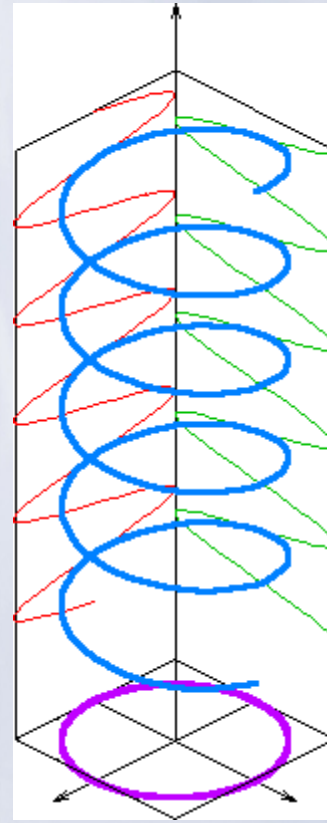
✧ Tuning VFOs



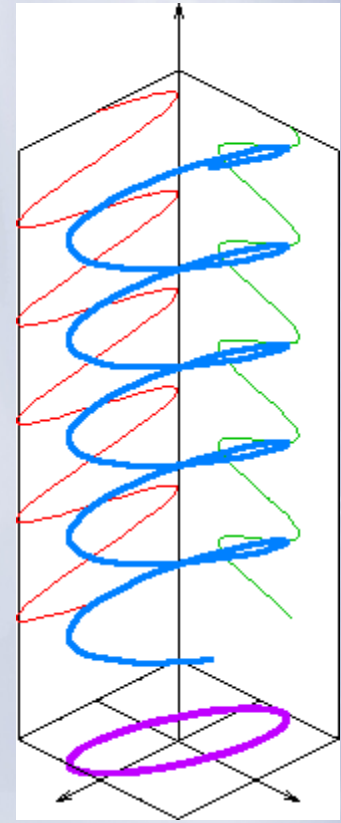
Circular Polarisation



Linear



Circular



Elliptical

Circular Polarisation



Yaesu FT-847

- ✧ Wait for 'AOS' and try calling (set power to 10W)
- ✧ CTCSS access codes are not always enforced
- ✧ If they are used, remember to set TX CTCSS code to 67Hz
- ✧ Typical QSO:

CQ AO-51 from G6UW, G6UW

G6UW from CT1ABC, CT1ABC

CT1ABC from G6UW, you are 5 and 9 in JO02AF

G6UW from CT1ABC, QSL you are 5 and 9 in IN60KD

CT1ABC from G6UW, thank you and 73 from Cambridge University

Record in WinLog - satellite QSL rates are nearly 100%
AO-51 is very busy. Once mastered, try VU-52!

Next Steps

- ✧ Work a satellite with your callsign or G6UW
- ✧ G6UW is equipped with an advanced, above-average station capable of working LEO and HEO satellites on 2m/70cm
- ✧ Total investment and donations > £2,500
- ✧ Pressure on the second tower means this facility must be used more!
- ✧ Project "owner" sought to encourage and expand satellite activity and offer demonstrations to new members, schools.

Thank you

Michael G7VJR