Amateur Satellites
Michael G7VJR

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

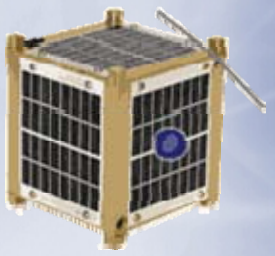
- Many LEO satellites prepared using literally homebrew approaches
- Clean room basements approach commercial standards
- KISS approach
- Avoid specialised parts - beg, borrow, steal!
- Eg. Eagle Sat total cost = $400,000
- Commercial clean room = $1m

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)



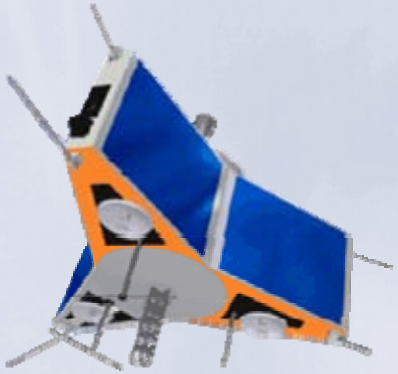
Satellites available

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

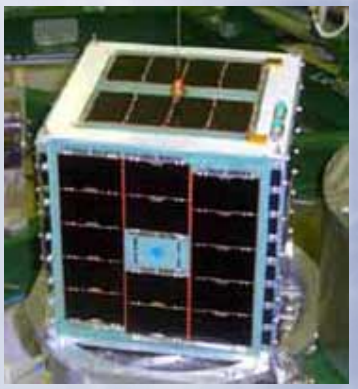
High Earth and Low Earth

- 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

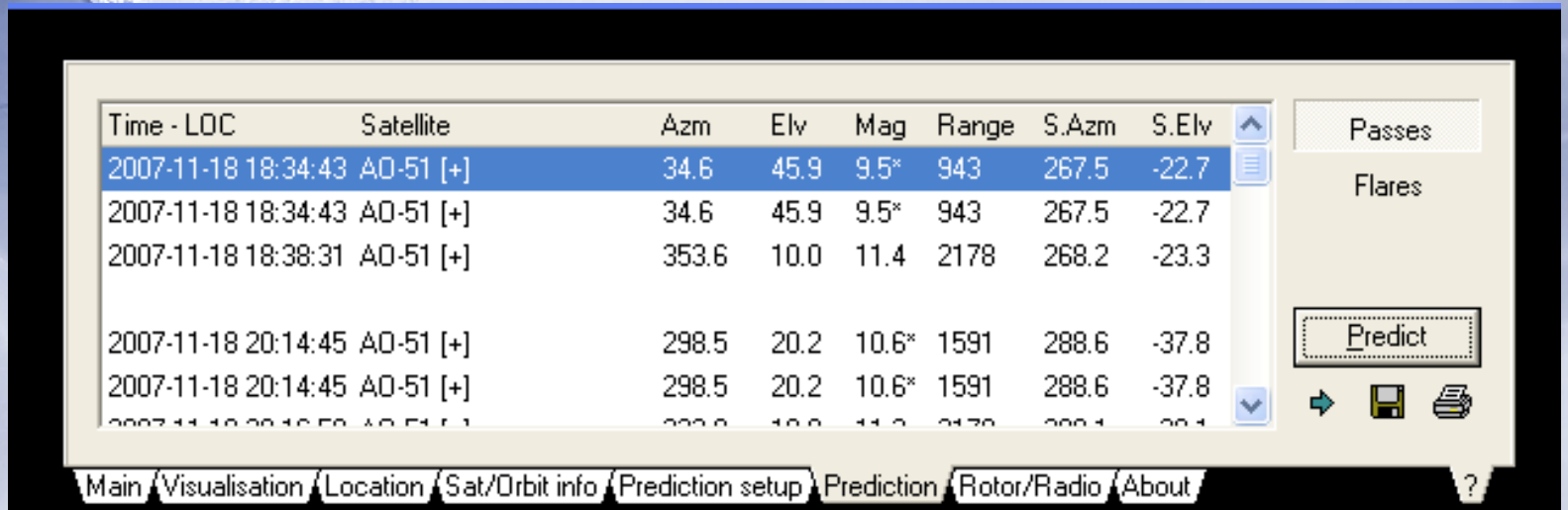
$$f' = \left(\frac{v}{v \pm v_s}\right) f$$

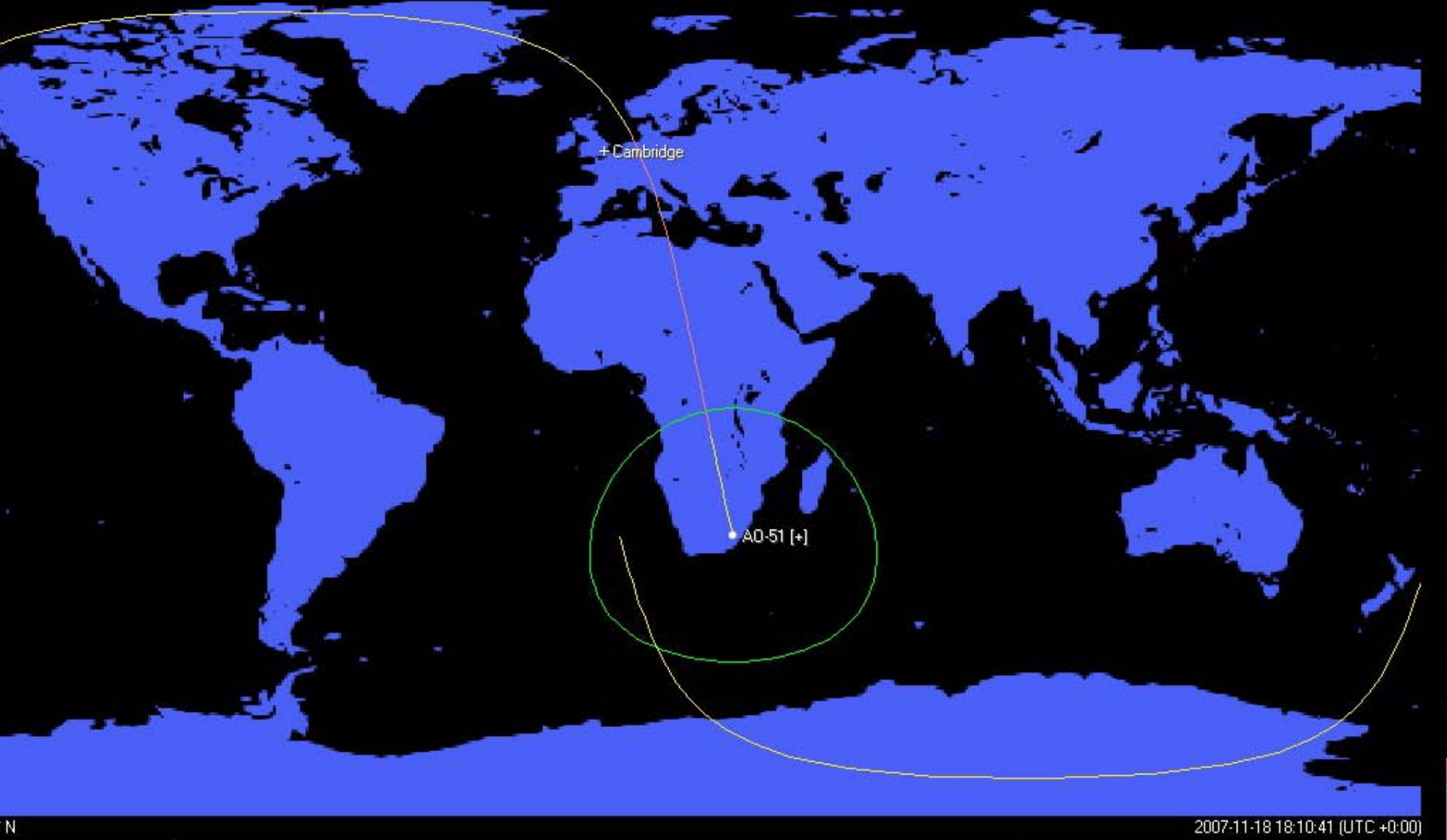
- AO-51 typical velocity: 8,000m/s
- v = approximately c, speed of light
- 145.920MHz uplink: +/- 3.8kHz
- 435.300MHz downlink: +/- 11.6kHz
- Average closing velocity is less than this (eg. vs = 0 when overhead)
- Using FM but uplink signal should be centred within approx 1kHz

Software

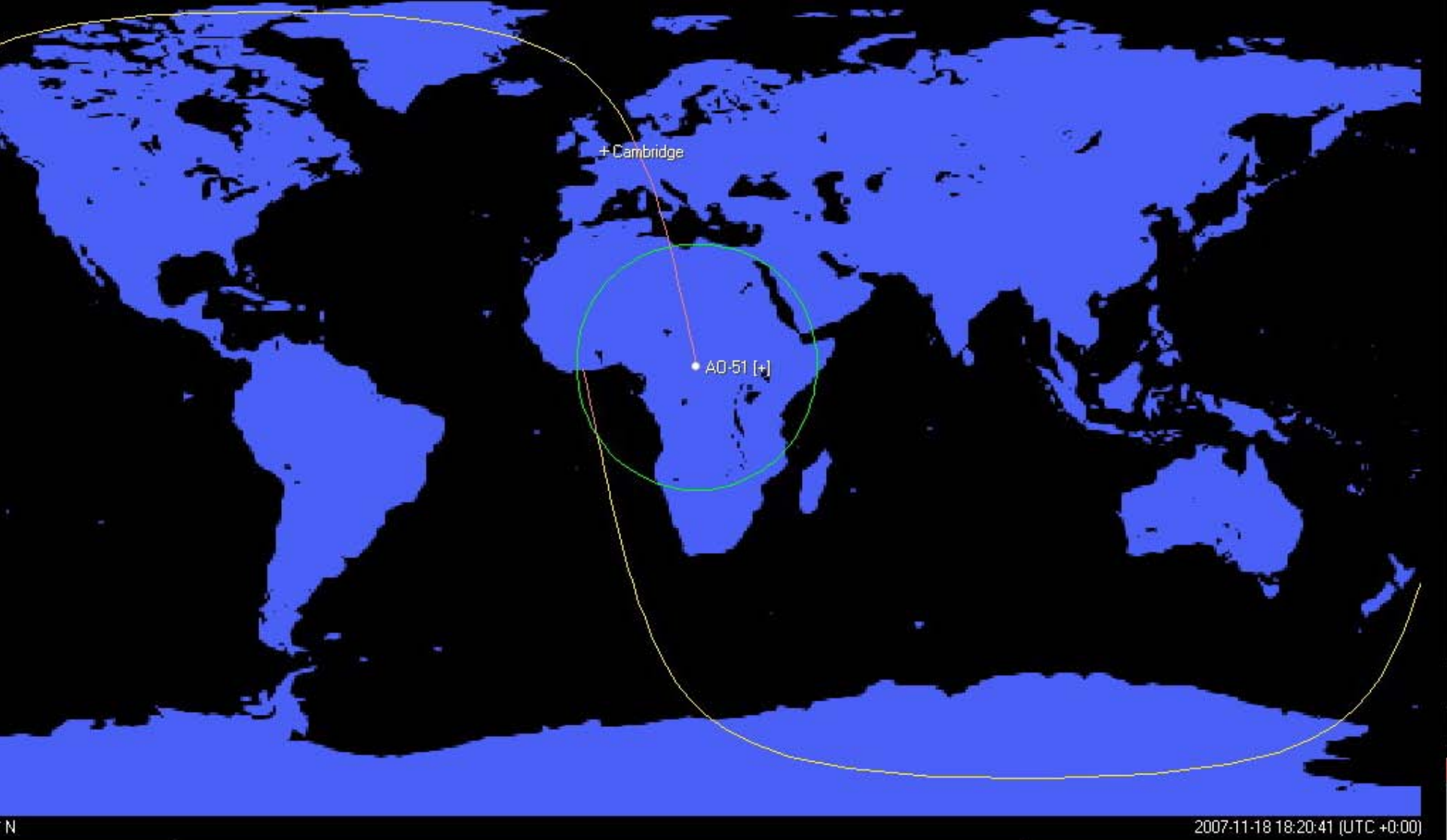
G6UW uses Orbitron

- 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





Mode
Real time
Simulation
2007-11-18 18:10:41
5
minutes
<<< <- -> >>>
Time
Local
UTC
5

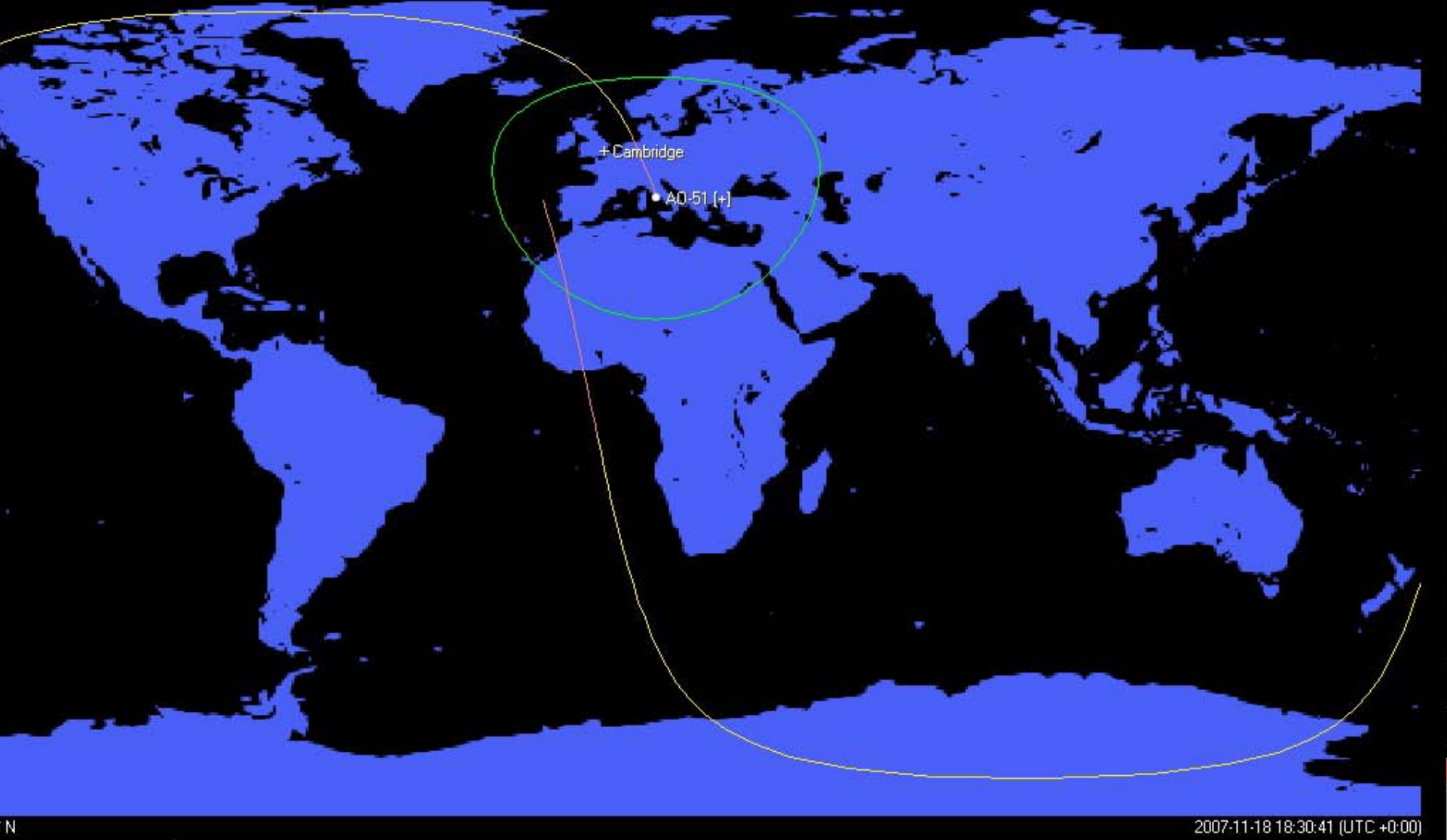


Mode
Real time
Simulation

2007-11-18 18:20:41
5
minutes
<<< <· ·> >>>

Time
Local
UTC

5

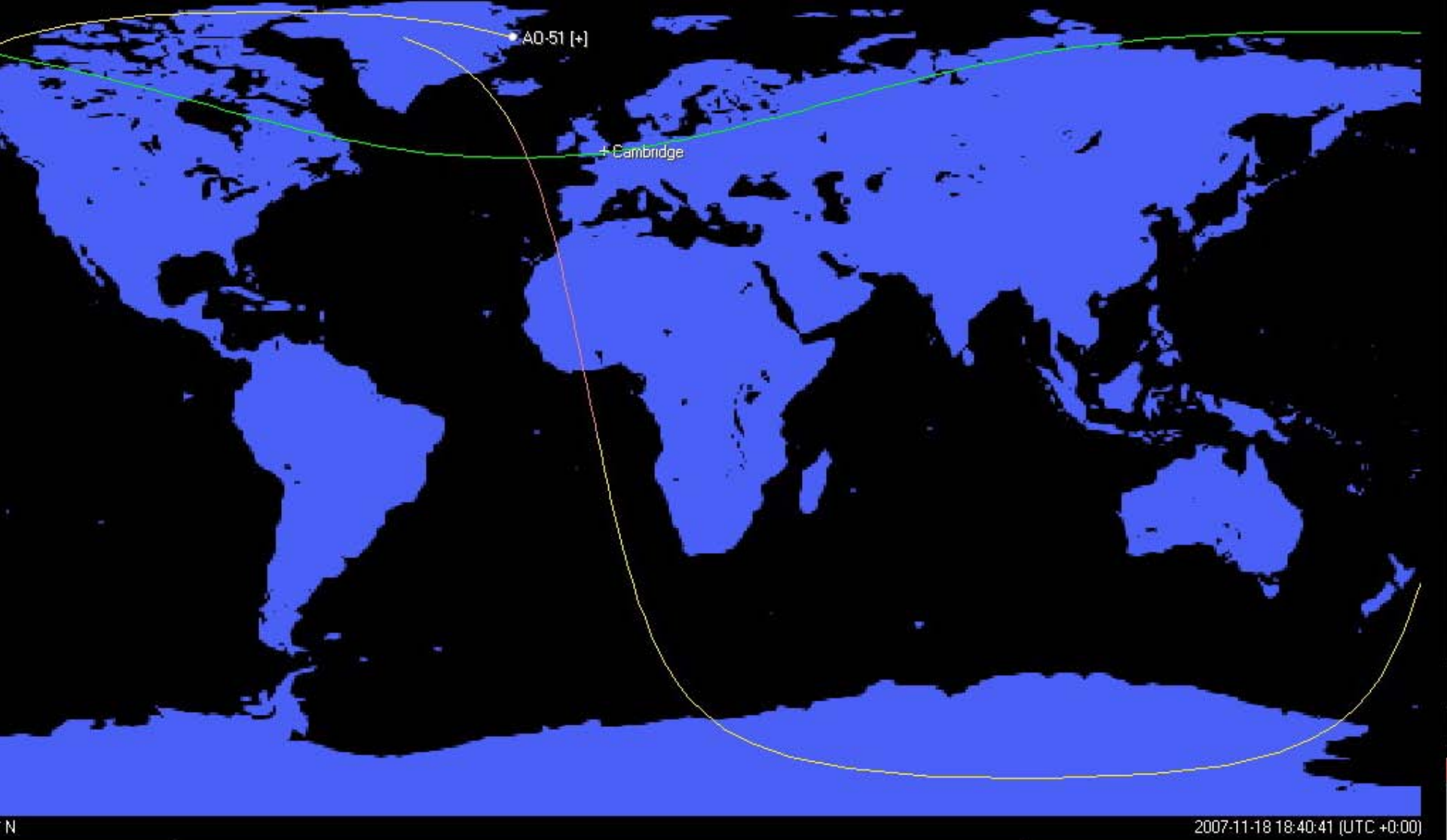


Mode
Real time
Simulation

2007-11-18 18:30:41
5
minutes
<<< <- -> >>>

Time
Local
UTC

5

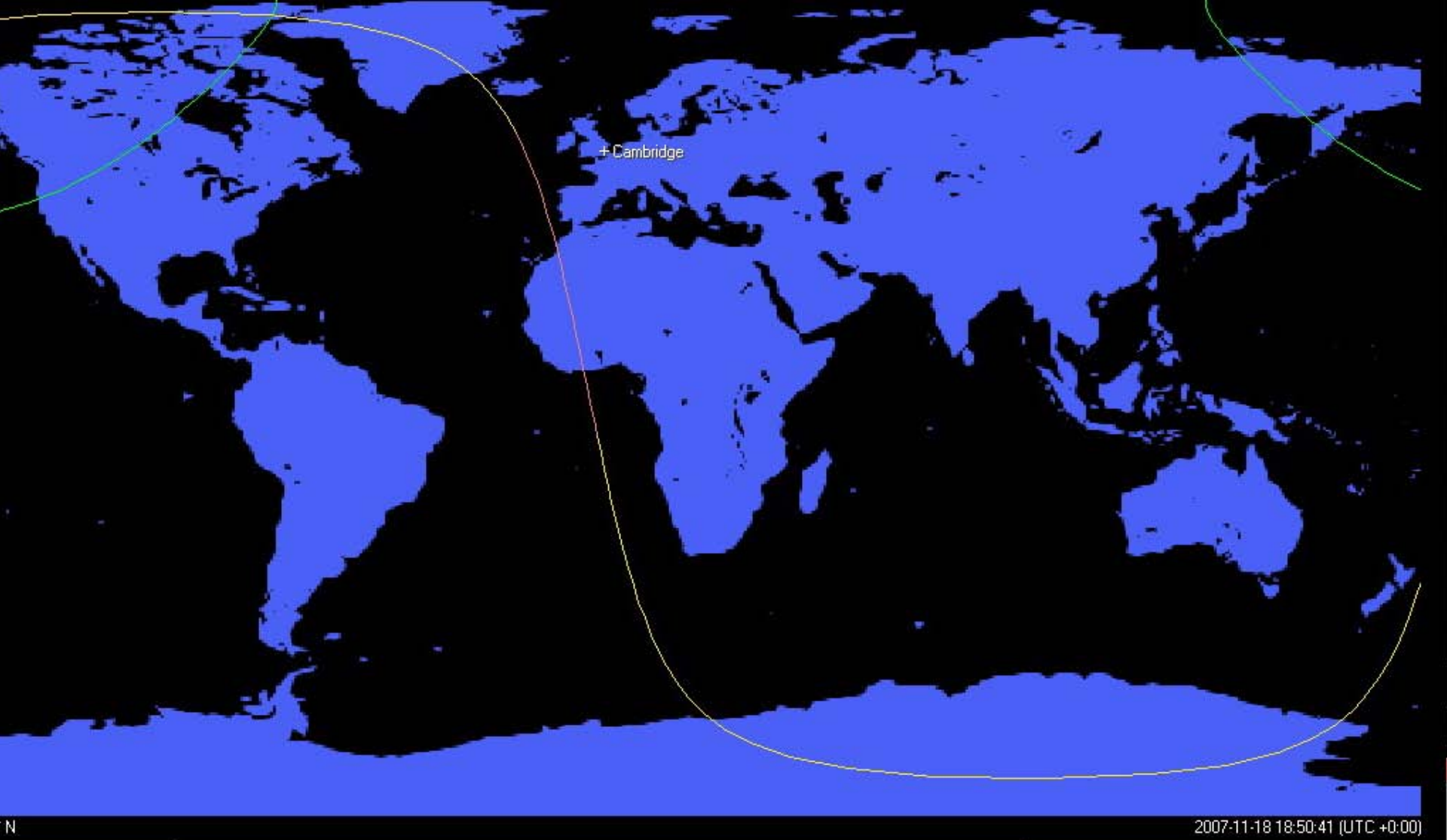


Mode
Real time
Simulation

2007-11-18 18:40:41
5
minutes
<<< <- -> >>>

Time
Local
UTC

5


+ Cambridge
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

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 adust VFO B for doppler offsets - start **up** about 10kHz on 70cm

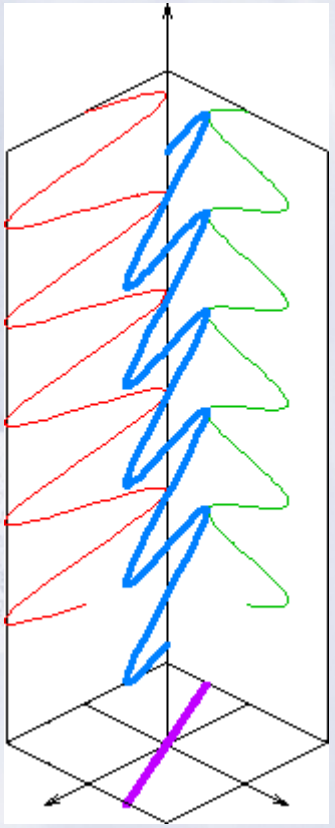
Yaesu FT-847

- Typical starting point:

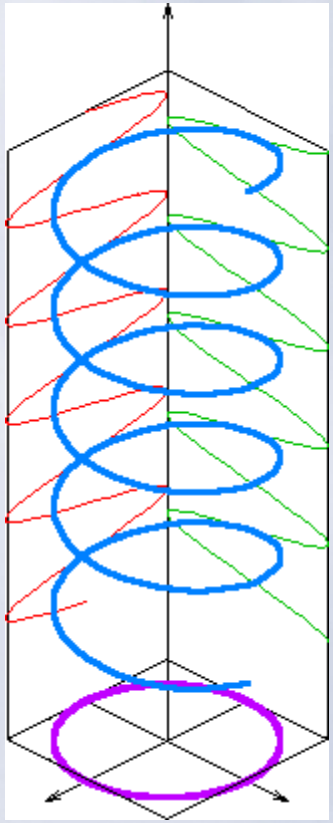
Yaesu FT-847

- 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