NOAA Satellite Reception under Windows 10 with a Software Defined Radio

1. Introduction

One of the first things I wanted to try with my new RTL-SDR USB dongle was to receive weather satellite maps. It turned out to be fairly easy to set up a "software defined radio" (SDR) and an imaging program and then manually tune to the appropriate satellite frequency and receive a map, but it quickly became apparent that the real solution would be to automatically tune to the various satellites as they came overhead … and that's where things got interesting. This article is a summary of the many steps involved in setting this up.

The National Oceanic and Atmospheric Administration (NOAA) operate a number of satellites that send back images of the earth. Currently there are three operational NOAA satellites transmitting in the 137 MHz band and these are the ones I will focus on for the purposes of this article:

NOAA 15 137.620 MHz
NOAA 18 137.9125 MHz
NOAA 19 137.100 MHz

There are numerous articles on the internet that give procedures for setting up SDR and imaging software, but I found that none of them were completely clear. As a result, it took me many attempts to get a successful receiver setup working.   Since no one software module will do it all, there are three main software modules required:

SDRSharp   - This is the Sofware Defined Radio component, available free from Airspy at: https://airspy.com/download/ The software has the ability to run "plug-ins".   More on the plugins below.

WXtoIMG – free, but no longer supported software for converting satellite signals to images. Download from: https://wxtoimgrestored.xyz/downloads/   This is a superb piece of software and it is very unfortunate that the author, Kevin Schuchmann decided not continue development. It has built-in interfaces for a long list of commercial receivers, but unfortunately, not for SDR. So, even though it has a scheduler that will turn on the imaging software when it determines that an appropriate satellite is in range, it can't communicate that to the SDRSharp radio software. So, a third module is required to set the radio to the appropriate frequency at the correct time.

Orbitron – another free and excellent software package that can track the NOAA (and virtually every other) satellites and notify the SDRSharp receiver when one is in range.   Download: http://www.stoff.pl/

Four additional pieces of software are required in order to get everything to work together:

RTL-SDR USB Device Driver: Zadig installs the required driver in Windows 10 to support the RTL-SDR dongle.   Download zadig-2.5.exe from https://zadig.akeo.ie/

VB-Audio Virtual Cable – The WXtoIMG software was originally designed to accept the audio output from a commercial receiver. The SDRSharp receiver normally expects to send the audio signal to the Windows primary audio device. This software provides a virtual connection between the two and still allows you to monitor the signal through the Windows 10 speakers. Download VBCABLE_Driver_Pack43.zip from: https://vb-audio.com/Cable/

DDE Tracking and Scheduler Plugin: In order to automatically tune the SDRSharp receiver to the proper satellite frequency, Orbitron must send information to SDRSharp. It does so via this plugin, which can be downloaded here: http://www.rtl-sdr.ru/page/komplekt-plaginov-dlja-priema-sputnikov

When Orbitron determines that a selected satellite is in position, it sends an "Acquisition of Signal" (AOS) message to the plugin with the satellite name. The plugin then issues commands to SDRSharp via the DDE plugin to set it to the correct frequency and bandwidth. When the satellite drops below the reception horizon, Orbitron will send a "Loss of Signal" (LOS) command which the plugin uses to trigger additional actions.

NTP Clock Synchronization: in order to make sure Orbitron and WXtoIMG are using the same clock, it is recommended that you install a National Time Protocol package that will keep Windows and all software synchronized. Download ntp-4.2.8p15-win32-setup.exe from: https://www.meinbergglobal.com/english/sw/ntp.htm

NOAA Satellite Map Receiver Block Diagram
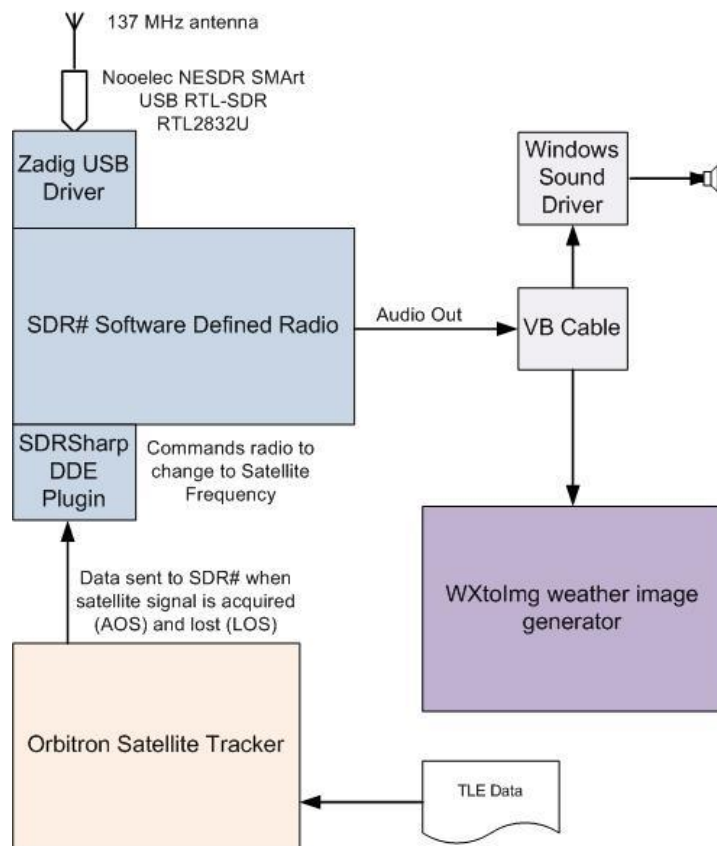
2. **Installing Zadig**

- Run zadig-2.5.exe
- Click on "Install WCID Driver"
- Installation may take a minute or two
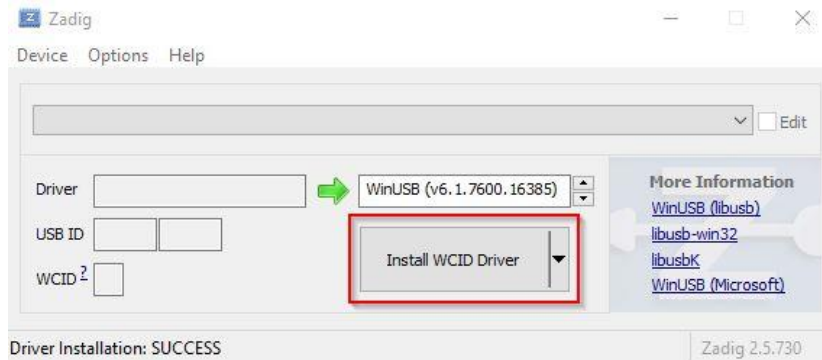
3. **Installing Date & Time Sync**

- Run ntp-4.2.8p15-win32-setup.exe
- Agree to terms
- Use default installation folder
- Accept default components
- Create initial configuration file and select Worldwide servers with fast initial sync
- Accept final defaults
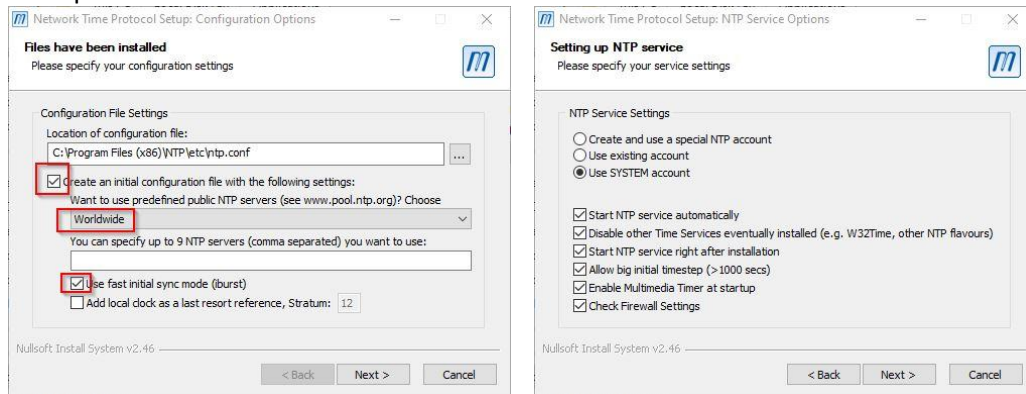
4. **Installing VB-Audio Virtual Cable**

- Extract all files to a temporary folder
- Run Setup Program in administrator mode
- Reboot after installation
- Open Control Panel -> Sound -> Recording
- Double-click to open Cable Output
- Click on Listen tab and check the "Listen to this device" box
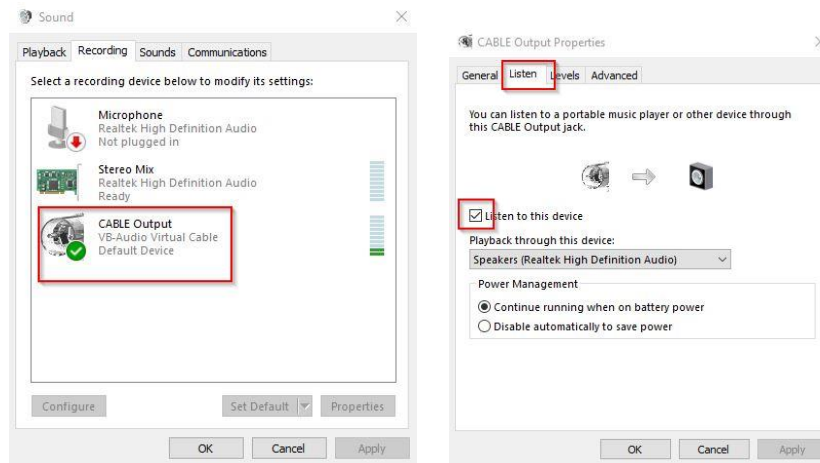
5. **Installing SDR# and Plugins**

- SDRSharp for Windows does not install like other windows applications. Instead, unzip all files to a folder and create a shortcut on the desktop to SDRSharp.exe.
- For ease of access, use a top-level folder on Drive C, eg: C:\SDRSharp
- Create a shortcut to SDRSharp.exe on the desktop.
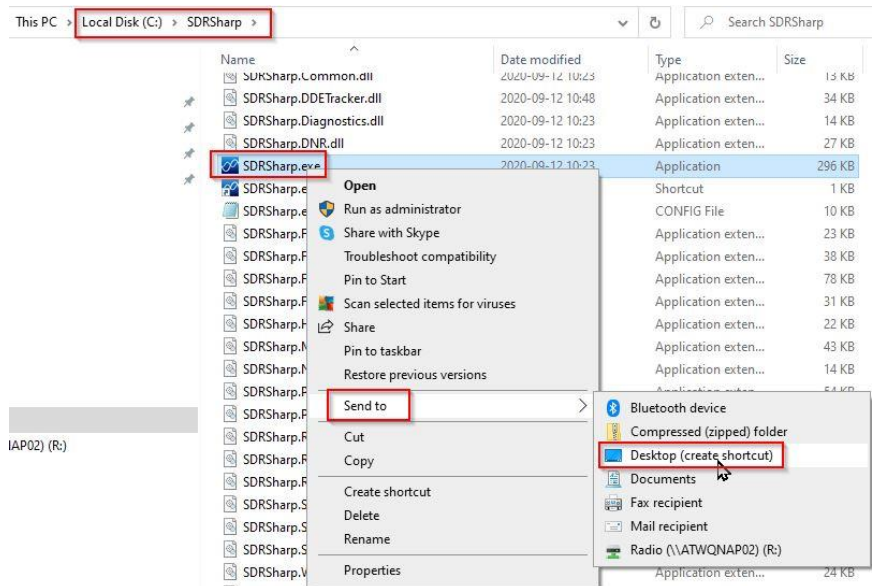
- **Remove unwanted plugins**: SDRSharp comes with many plugins. Depending on what you want to do, it may be more convenient to eliminate as many as possible to make the main screen easier to manage. In this example, I keep only the Zoom FFT, Band Plan and Frequency Manager.

    - Open plugins.xml with notepad
    - Remove all "add key" entries except the ones you want to keep. My final result looks like this:
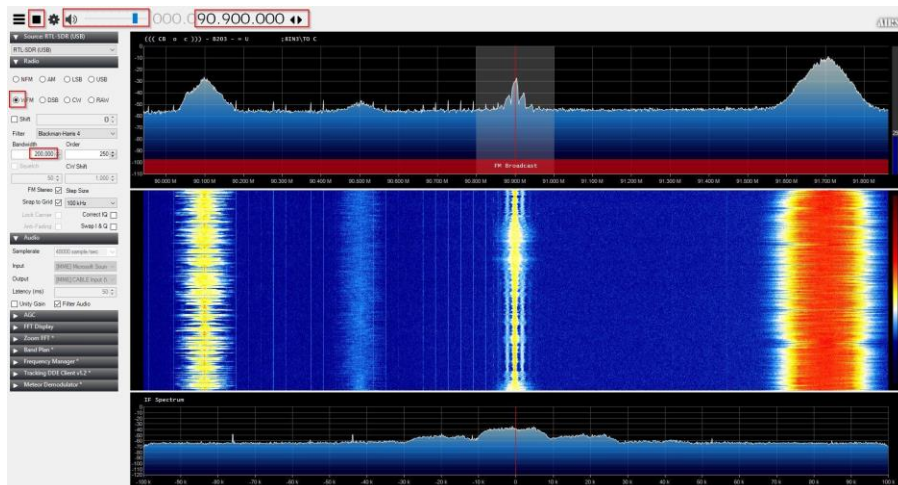
```
le  Edit  Format  View  Help
?xml version="1.0" encoding="utf-8" ?>
sharpPlugins>
 <add key="Zoom FFT" value="SDRSharp.ZoomFFT.ZoomFFTPlugin,SDRSharp.ZoomFFT" />
 <add key="Band Plan" value="SDRSharp.BandPlan.BandPlanPlugin,SDRSharp.BandPlan" />
 <add key="Frequency Manager" value="SDRSharp.FrequencyManager.FrequencyManagerPlugin,SDRSharp.FrequencyManager" />
/sharpPlugins>
```

- Make sure the RTL-SDR Sharp USB receiver is plugged into a USB port and connected to an antenna.
- Start SDRSharp
- Select the RTL-SDR (USB) device
- Select the VB-Cable audio device
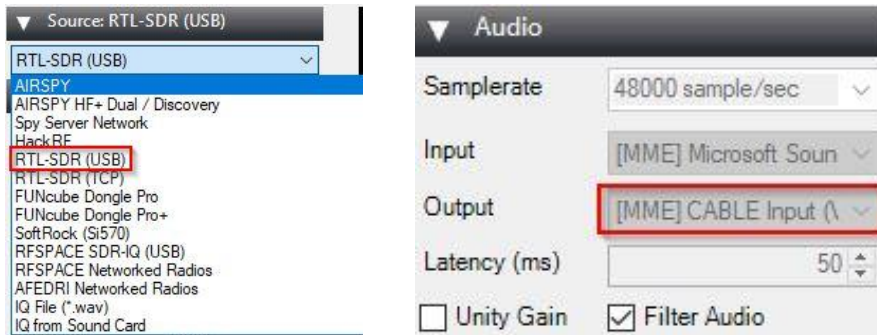
- Click on the play button to start the radio and tune to a local FM broadcast station with a bandwidth of 200,000 to confirm that the radio is working. The SDRSharp volume will need to be at about 75% in order to send an adequate signal to WXtoIMG. Adjust the Windows volume to a suitable level.
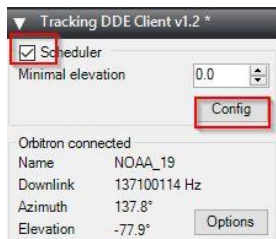
6. **Install DDE Tracking and Scheduler Plugin**
   - Open the DDETracker.zip folder and copy all .dll and .exe files to C:\SDRSharp
   - Open MagicLine.txt and copy the single line of text to c:\SDRSharp\plugins.xml
   - Plugins.xml will now look like this:

   - Restart SDRSharp
   - Program the actions that SDRSharp will take on notification of AOS: Open the DDE plugin panel, enable the scheduler and select config:

   - For each satellite to be received, program the actions for AOS and LOS. The actions after LOS are not critical but, in my case, I chose to return to CBC Radio in my area; this helps me to know that the program is running as it has a tendency to freeze after running for a day or two.
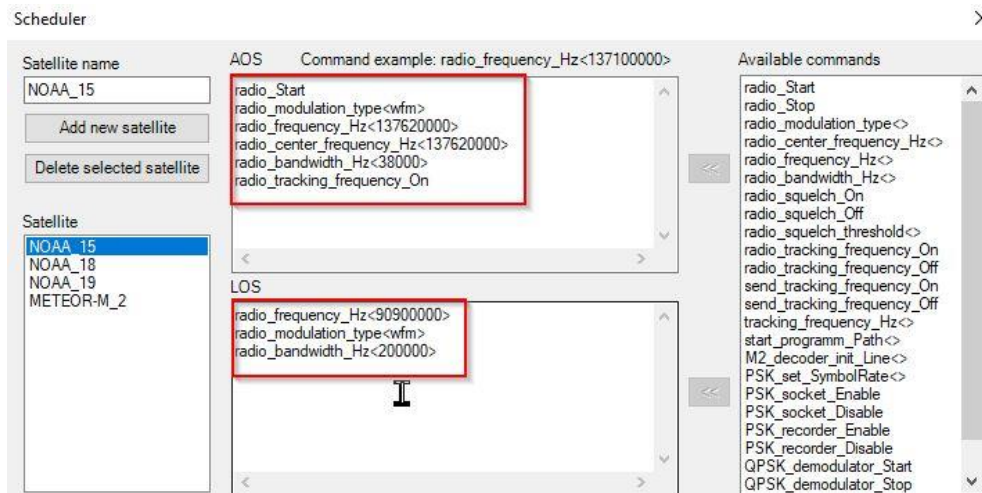
   - The current satellite frequencies (Sep 2020) are:
     - NOAA 15 137.620
     - NOAA 18 137.9125
     - NOAA 19 137.100

7. Installing Orbitron

- Orbirton installs in the standard Windows fashion, but change the installation folder to C:\SDRSharp\Orbitron. The reason for this is, if it installs in the usual C:\Program Files (X86) folder it will require administrative privileges to edit the configuration and TLE files.
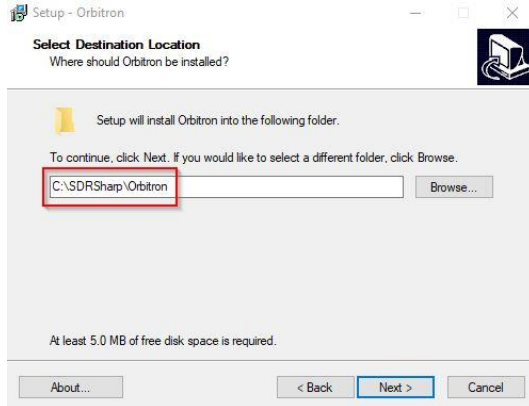
- Open c:\SDRSharp\Orbitron\config\ setup.cfg in Notepad and add the following lines at the end of the file:
    [Drivers]
    SDRSharp=C:\SDRSharp\SDRSharpDriverDDE.exe

- Open c:\SDRSharp\Orbitron\TLE\weather.txt and make sure the following lines appear in the list. Note that the actual data may be different and that is ok. But if there is no entry for a satellite, add the appropriate 3 lines to the file. This step is included because my installation of Orbitron did not include NOAA 19

    NOAA 15
    1 25338U 98030A   20257.91459965 .00000028 00000-0 30436-4 0 9995
    2 25338 98.7127 282.4945 0010513 11.9937 348.1491 14.25989254161581
    NOAA 18
    1 28654U 05018A   20257.91836184 .00000055 00000-0 54307-4 0 9998
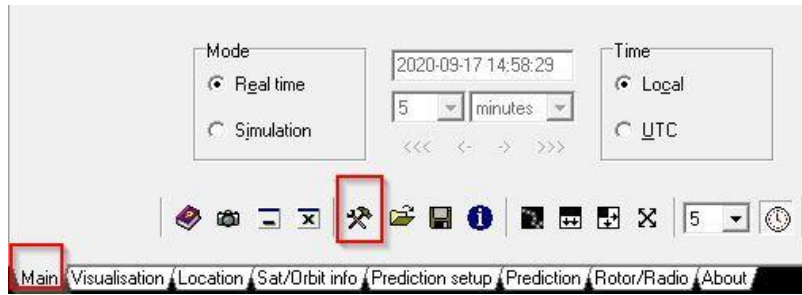   2 28654 99.0356 315.1381 0013833 345.9765 14.1020 14.12538864789406
    NOAA 19
    1 33591U 09005A   20257.92853763 .00000022 00000-0 37270-4 0 9991
    2 33591 99.1971 265.5823 0013890 183.9297 176.1766 14.12431260597627
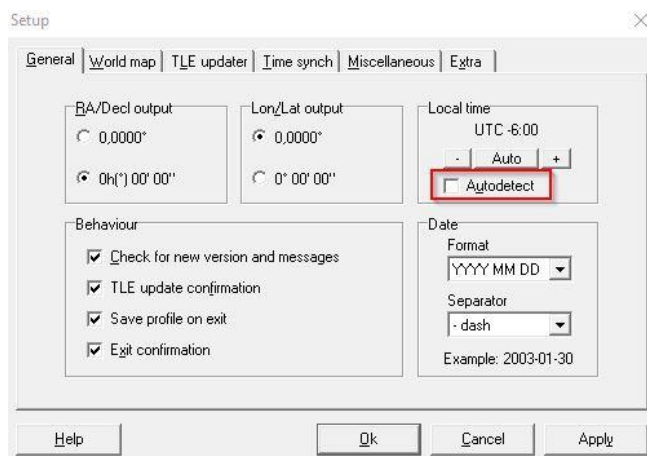
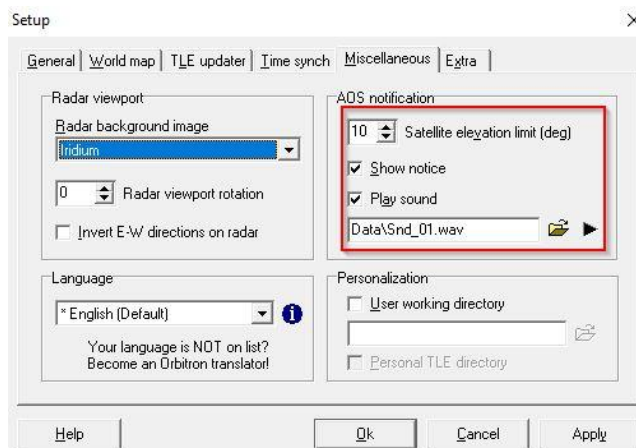- Set up your location. Choose from pre-sets or program your own.
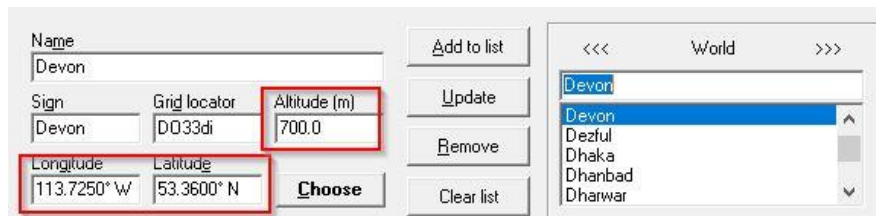
- On the Main tab, select the tool icon

- On the General Tab, turn off autodetect under Local Time and specify the time difference to UTC
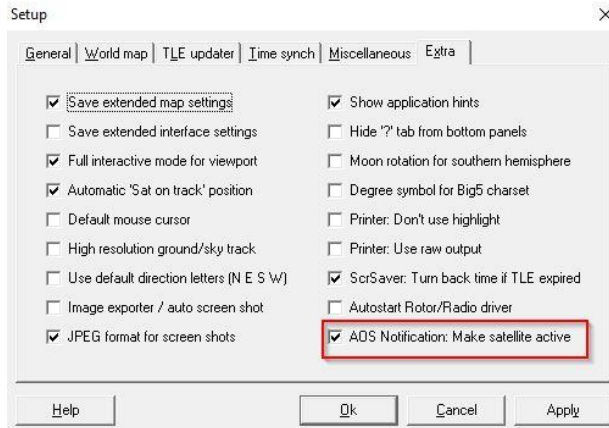

- On the Miscellaneous tab, specify the minimum satellite elevation. I also chose to keep the notifications enabled
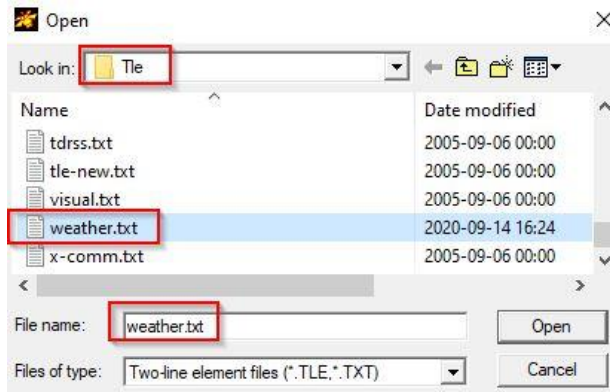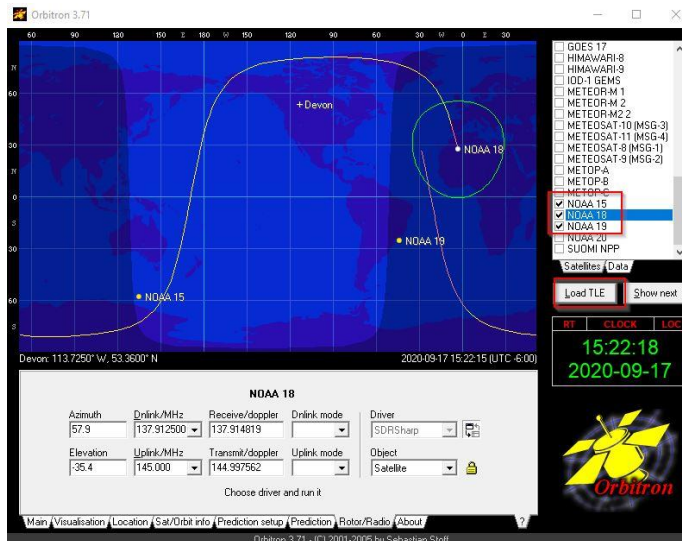
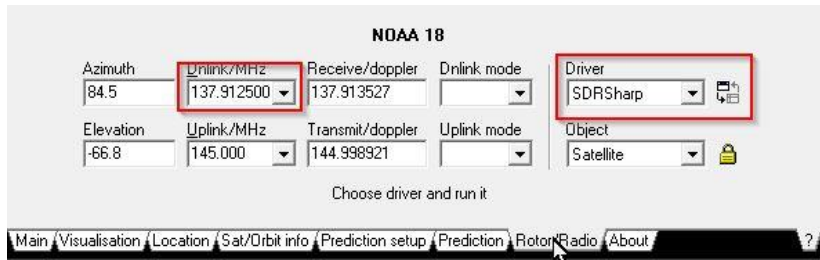- On the Extra tab, enable AOS Notification

- Close the setup window.
- Click on the "Load TLE" button on the right panel. Select Weather.txt ast the source.

- Select each satellite in the right panel.

- As you select each one, set the downlink frequency under the Rotor/Radio tab.

- The current satellite frequencies (Sep 2020) are:
  - NOAA 15 137.620
  - NOAA 18 137.9125
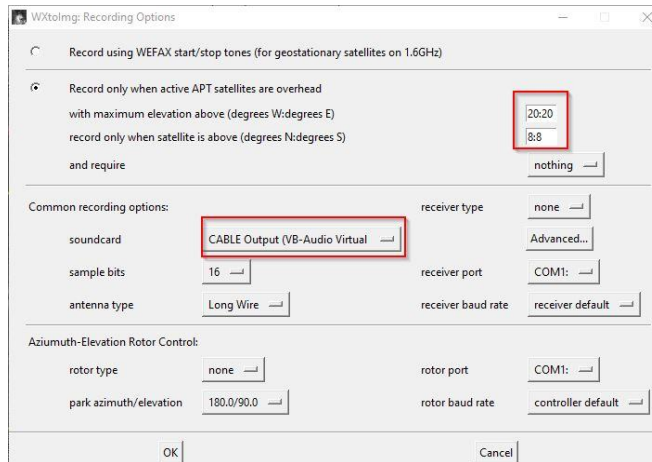 - NOAA 19 137.100

8. **Install WXtoImg**

- Run wxinst21011.exe and select default installation options
- Start WXtoIMG
- Select the satellites to track under Options -> Active APT Satellites
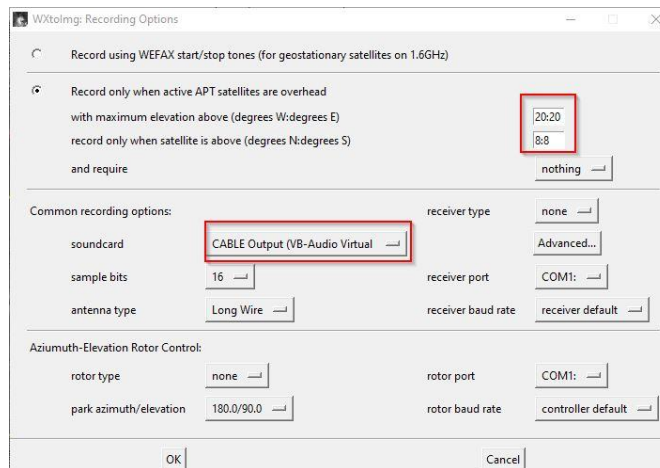- Set location under Options -> Ground Station Location
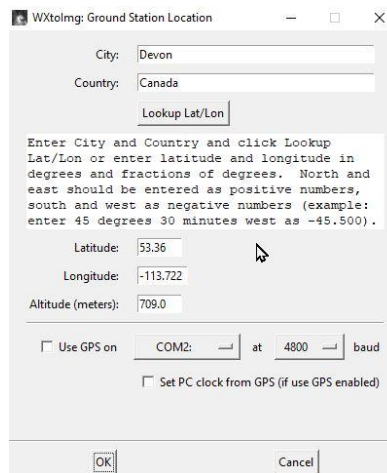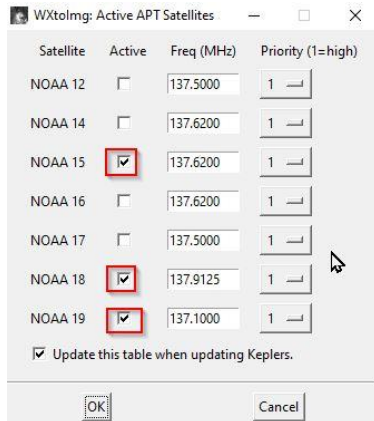
- Set LTE data source under Options -> Internet Options
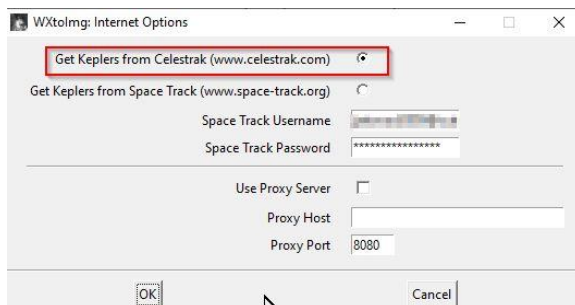
- Set the audio source and elevation options

- Set the program to automatically record when satellites are in range

9. Conclusion

There are many options available in all of these programs. The settings shown in this document work – Orbitron tracks the satellites and notifies SDRSharp when it is time to tune to them. WXtoIMG also tracks the satellites and starts recording when they are in view.

There are numerous articles on the internet that deal with the construction of a 137 MHz antenna. For test purposes, I use a ¼ wave VHF band vertical but a purpose-built antenna will guarantee much better reception, even at low angles.

It is quite possible that some of the settings are not required. It is also quite possible that there are other settings that I missed. Your feedback is welcome at john_first@live.com