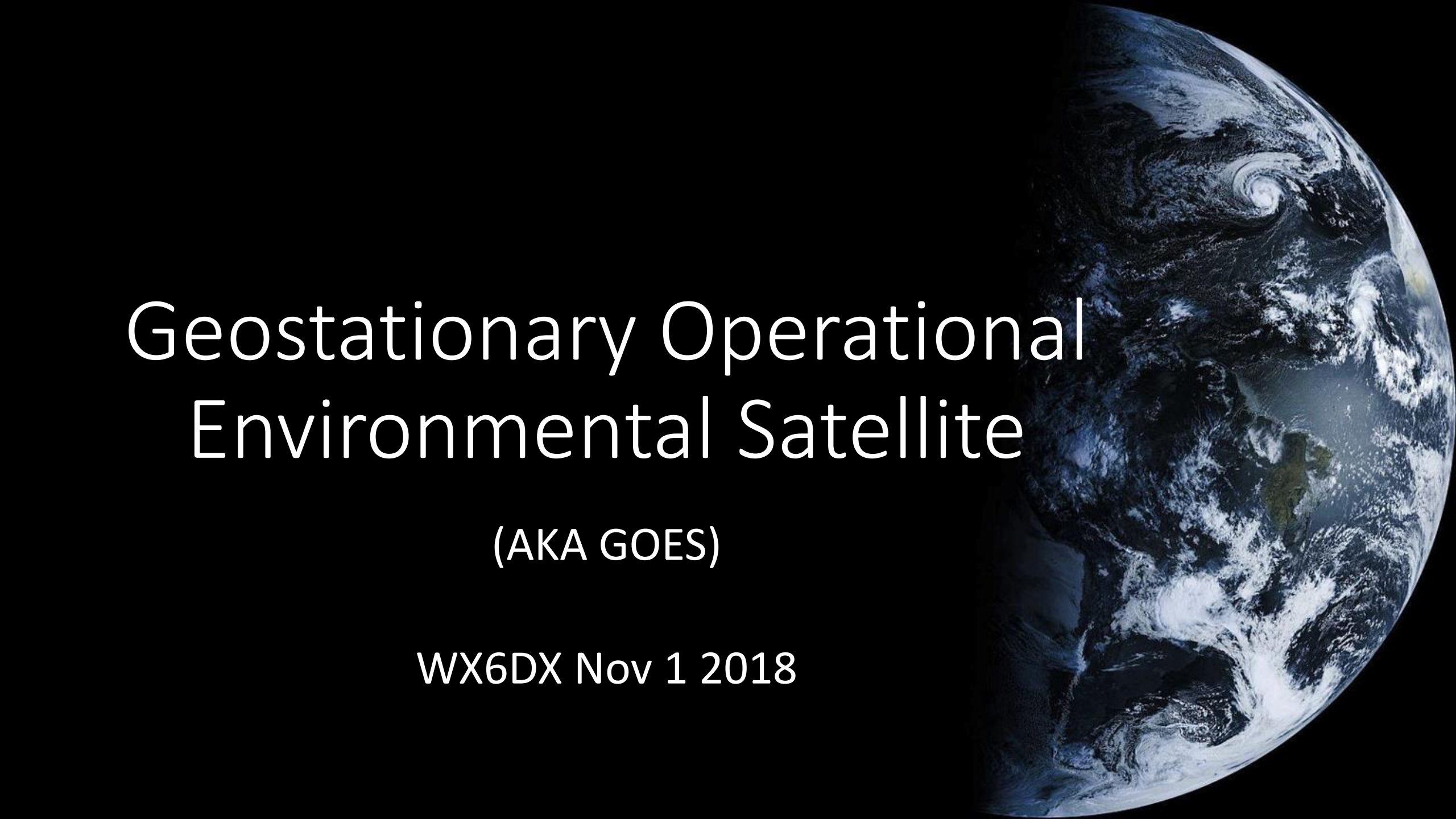
Geostationary Operational Environmental Satellite

(AKA GOES)

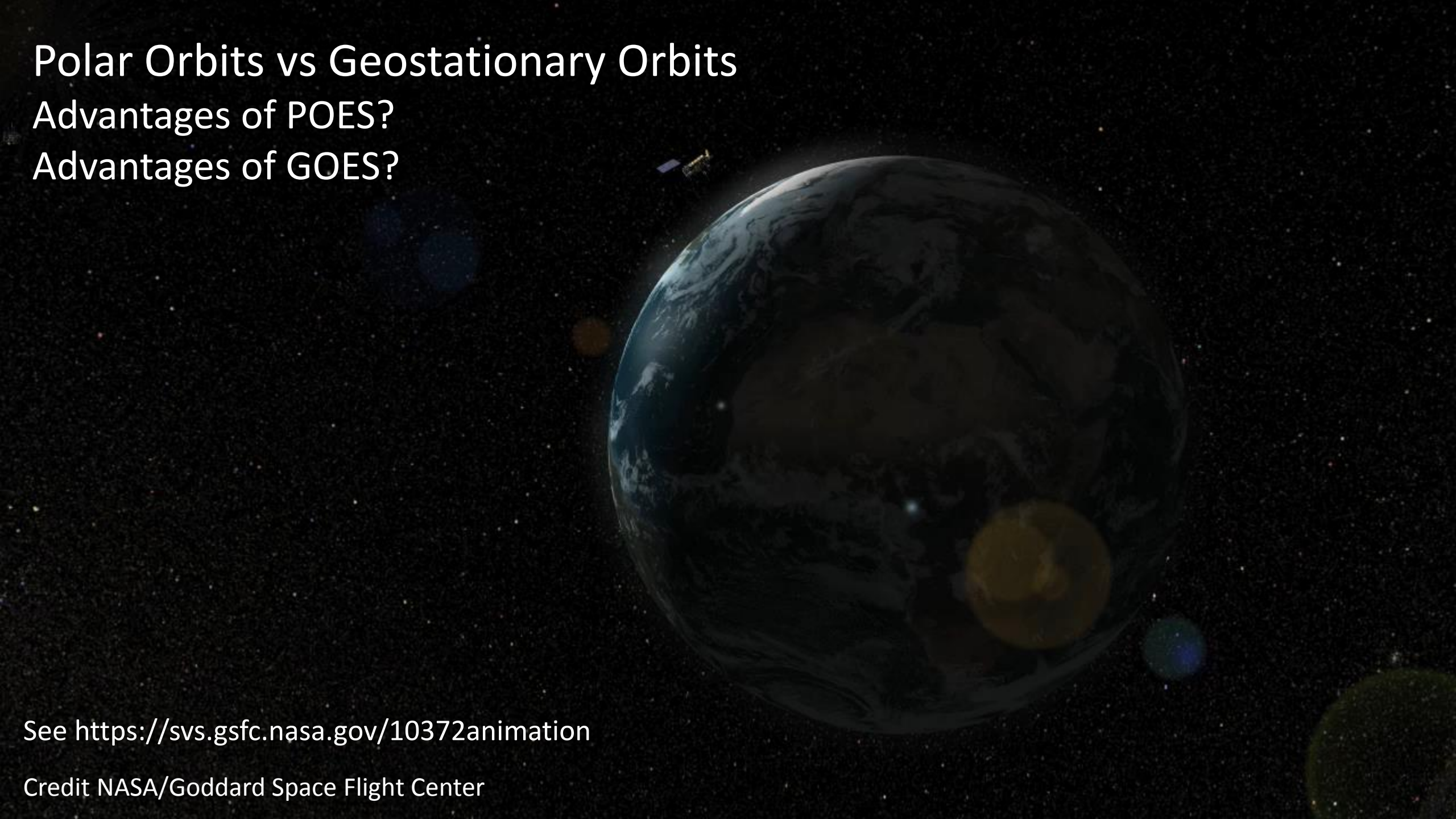
WX6DX Nov 1 2018



Polar Orbits vs Geostationary Orbits

Advantages of POES?

Advantages of GOES?



See https://svs.gsfc.nasa.gov/10372animation

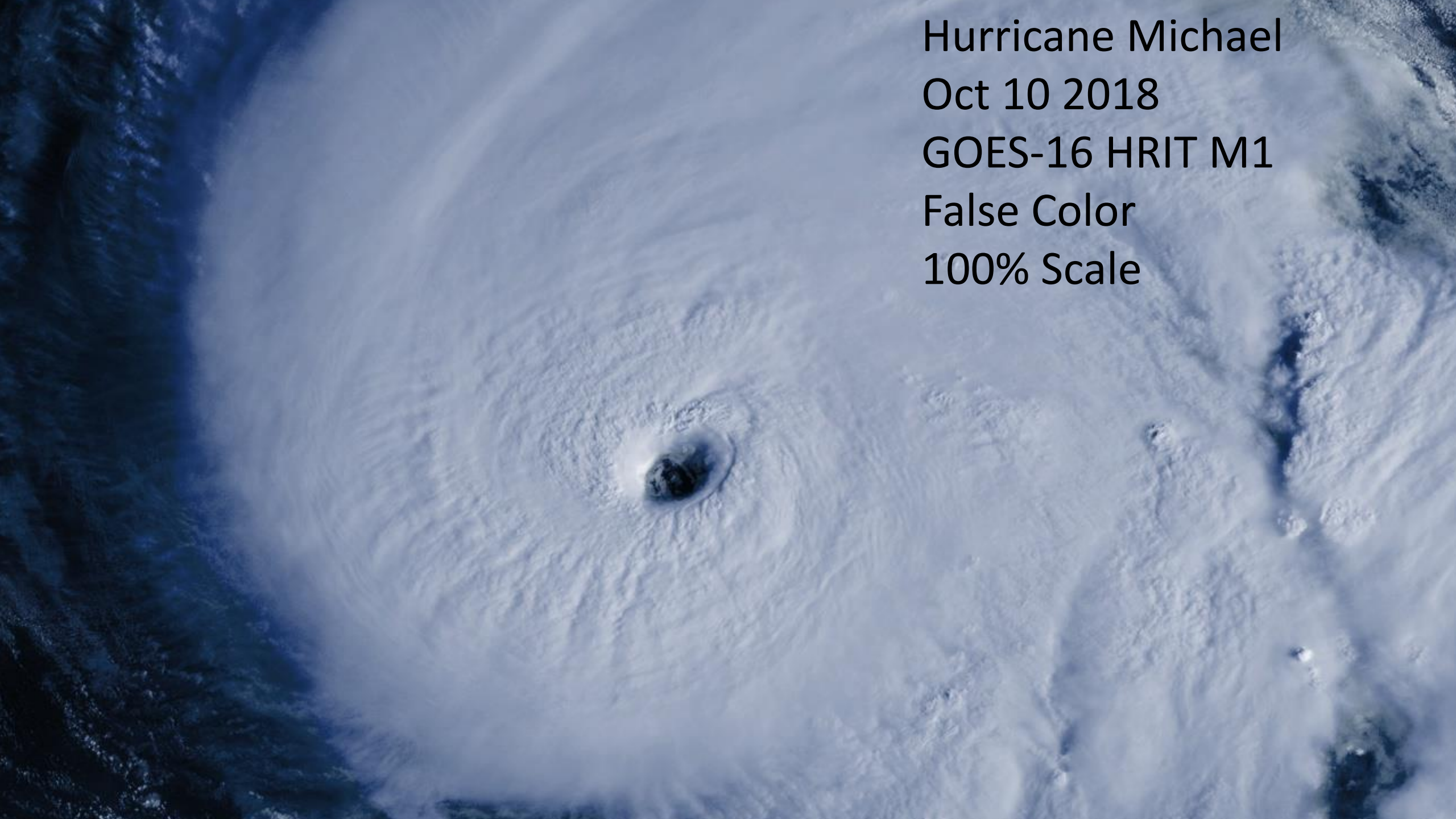
Credit NASA/Goddard Space Flight Center

See separate file for animation

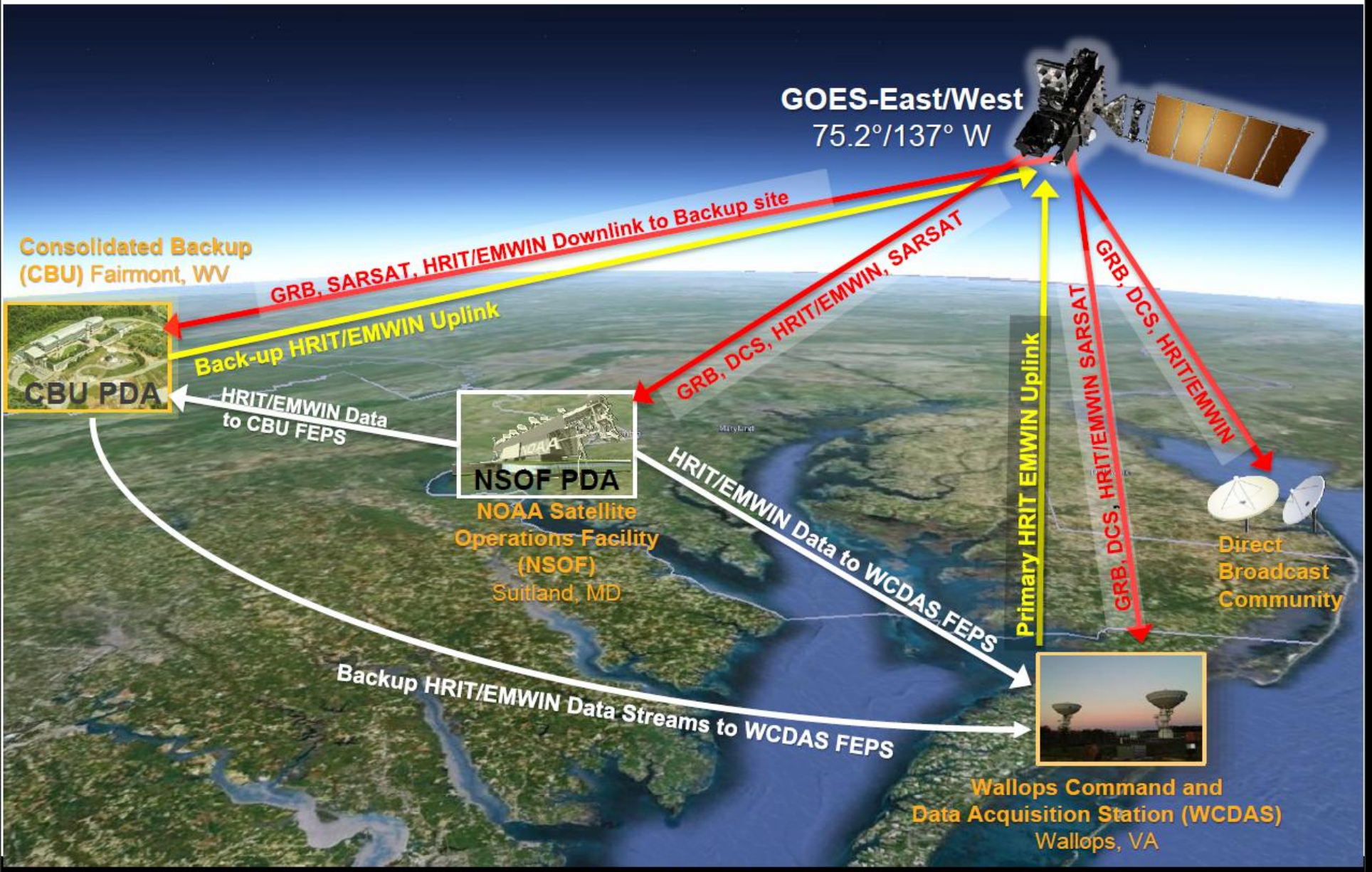
GOES-15
LRIT VIS NH

See separate file for animation

GOES-16
HRIT
False Color
Full Disk


Hurricane Michael
Oct 10 2018
GOES-16 HRIT M1
False Color
100% Scale

GOES HRIT/EMWIN Operations



GRB
GOES Rebroadcast

DCS
Data Collection System (IE Buoys)

HRIT/EMWIN
High Rate Information Transmission / Emergency Managers Weather Information Network

	GOES Variable (GVAR) I.E. GOES 15	GOES Rebroadcast (GRB) I.E. GOES 16 & 17
Full Disk Image	30 Minutes	5 Minutes (Mode 4) 15 min (Mode 3)
Other Modes	Rapid Scan, Super Rapid Scan	3000 km X 5000 km (CONUS: 5 minute) 1000 km X 1000 km (Mesoscale: 30 seconds)
Polarization	Linear	Dual Circular Polarized
Receiver Center Frequency	1685.7 MHz (L-Band)	1686.6 MHz (L-Band)
Data Compression	None	Lossless Compression
Data Rate	2.11 Mbps	31 Mbps
Antenna Coverage	Earth Coverage to 5^0	Earth Coverage to 5^0
Data Sources	Imager (5 bands), Sounder, Magnetometer	ABI (16 bands), GLM, SEISS, EXIS, SUVI, MAG
Space Weather	None	~2 Mbps
Lightning Data	None	~0.5 Mbps

Credit NOAA/NESDIS

GRB
Frequency: 1686.6MHz
Dual Circular Polarization
Data Rate: 15.2Mbps Symbol Rate: 7.82Mbps
Modulation 8PSK
Data Format: DVB-S2

HRIT
Frequency: 1694.1 MHz
Linear Polarization
Data Rate: 400Kbps Symbol Rate: 927ksps
Modulation: BPSK
Error Encoding: Viterbi + Reed Solomon

HRIT/EMWIN

Virtual Channel ID	Group	Product Name
0	Imagery	Admin Text Messages
1	Imagery	Mesoscale (ch. 2, 7, 13)
2	Imagery	Band 2 - Red
6	Imagery	GOES-15
7	Imagery	Band 7 - Shortwave Window
8	Imagery	Band 8
9	Imagery	Band 9 - Mid-Level Trop
13	Imagery	Band 13
14	Imagery	Band 14 - IR
15	Imagery	Band 15
20	EMWIN	Priority
21	EMWIN	Graphics
22	EMWIN	Other
23	Imagery	NWS Products
24	Imagery	NHC Graphics Products
25	Imagery	GOES-R JPG Products
26	Imagery	International Graphics Products
30	DCS	DCS Admin
31	DCS	DCS Data
60	Imagery	Himawari

ABI BANDS QUICK INFORMATION GUIDES

The fact sheets in this section are designed as quick reference guides to provide National Weather Service forecasters with information on each of the GOES-R series Advanced Baseline Imager's 16 spectral bands. These include two visible channels, four near-infrared channels and ten infrared channels. Each fact sheet covers what the band measures and how this is operationally relevant. The fact sheets also include links for more information.

An additional set of operationally-focused ABI band fact sheets is available from our partners at the Cooperative Institute for Meteorological Satellite Studies.

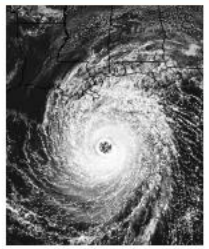
Click on an image in the "ABI Band Fact Sheet" column of the table below to access the information guide for the corresponding ABI band number.

ABI Band Fact Sheet	ABI Band No.	Approx. Central Wavelength (µm)	Band "Nickname"	Band Type
 Updated February 25, 2015	1	0.47	"Blue" Band	Visible
	2	0.64	"Red" Band	Visible

NOAA Satellite and Information Service | GOES-R Program Office

GOES-R ABI Fact Sheet Band 1 ("Blue" visible)

The "need to know" Advanced Baseline Imager reference guide for the NWS forecaster



Above: Simulated image of ABI band 1 for Hurricane Katrina. This image was simulated via a combination of high spatial resolution numerical model runs and advanced "forward" radiative transfer models. (Credit: CIMSS)

In a nutshell

GOES-R ABI Band 1 (0.47 µm central, 0.45 µm to 0.49 µm)

Also Himawari-8/9 AHI Band 1, Suomi NPP VIIRS Band M2

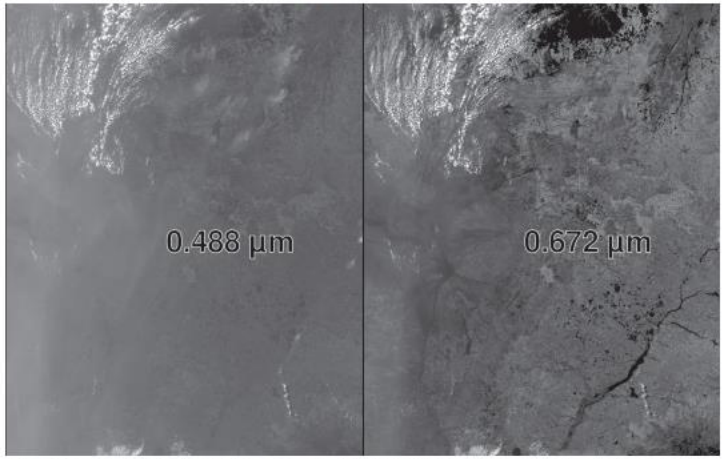
New for GOES-R Series, not available on current GOES

Nickname:
"Blue" visible band

Availability:
Daytime only

Primary purpose:
Aerosols

The 0.47 µm, or "blue" band, one of the two visible bands on the ABI, will provide data for monitoring aerosols. Included on NASA's MODIS and Suomi NPP VIIRS instruments, there are a number of well-established benefits with this band. The geostationary 0.47 µm band will provide nearly continuous daytime observations of dust, haze, smoke and clouds. Measurements of aerosol optical depths (AOD) will help air quality monitoring and tracking. This blue band, combined with a "green" band (which will be simulated from other bands and/or sensors) and a "red" band (0.64 µm), can provide "simulated natural color" imagery of the Earth. Measurements in the blue band may provide estimates of visibility. The 0.47 µm band will also be useful for air pollution studies and improve numerous products that rely on clear-sky radiances (such as land and sea surface products). Other potential uses are related to solar insolation estimates. This band is essential for a natural "true color" RGB. *Source: Schmit et al., 2005 in BAMS and the ABI Weather Event Simulator (WES) Guide by CIMSS.*



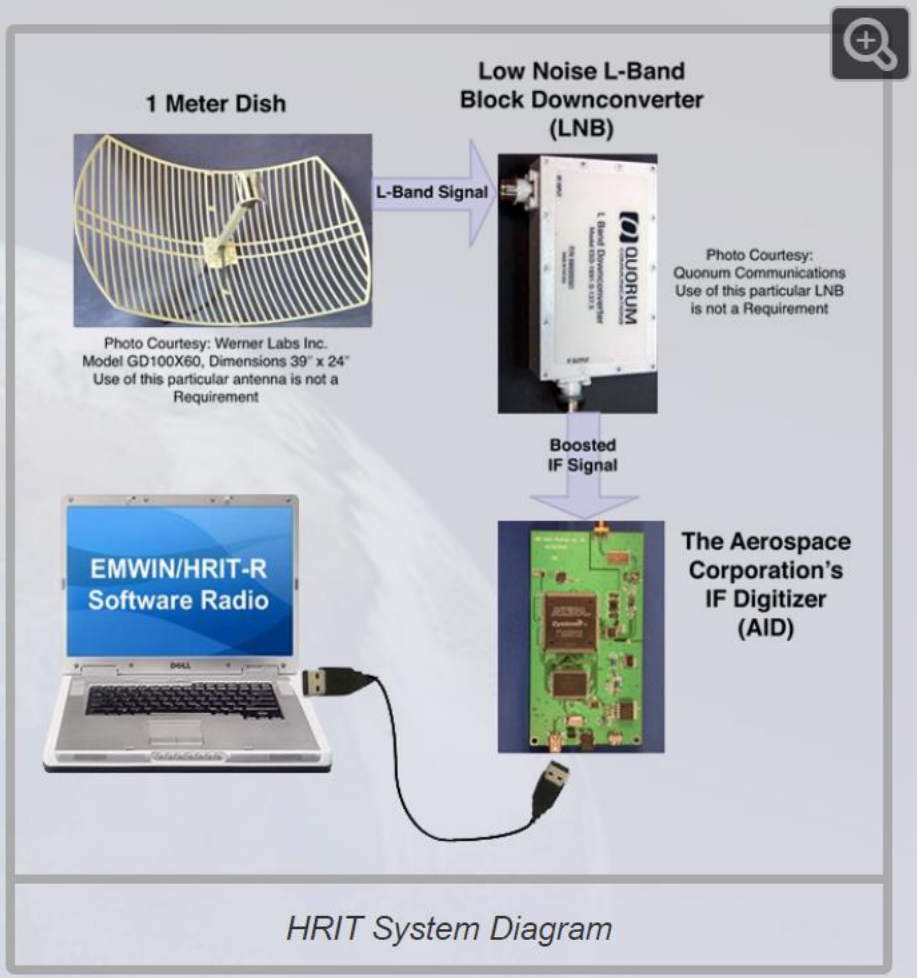
Suomi NPP images of similar blue (left-hand side) and red (right-hand side) visible bands. Note how the smoke is more apparent in the 0.488 µm band. The image is over part of South America (August 23, 2014). Image from SSEC.

Did You Know? There are two baseline scan modes from the ABI. The first is the "flex" mode that consists of a full disk scan every 15 minutes, a continental U.S. (CONUS) image every 5 minutes, and two mesoscale (nominally 1,000 km by 1,000 km) imager

HRIT System Developments Software

USER SYSTEMS: HRIT / EMWIN OVERVIEW

The **Emergency Managers Weather Information Network (EMWIN)** is a direct service that provides users with weather forecasts, warnings, graphics, and other information directly from the National Weather Service (NWS) in near real time. The GOES EMWIN relay service is one of a suite of methods to obtain these data and display the products on the user's personal computer. **The HRIT (High Rate Information Transmission) service** provides broadcast of low-resolution GOES satellite imagery data and selected products to remotely located user HRIT Terminals.

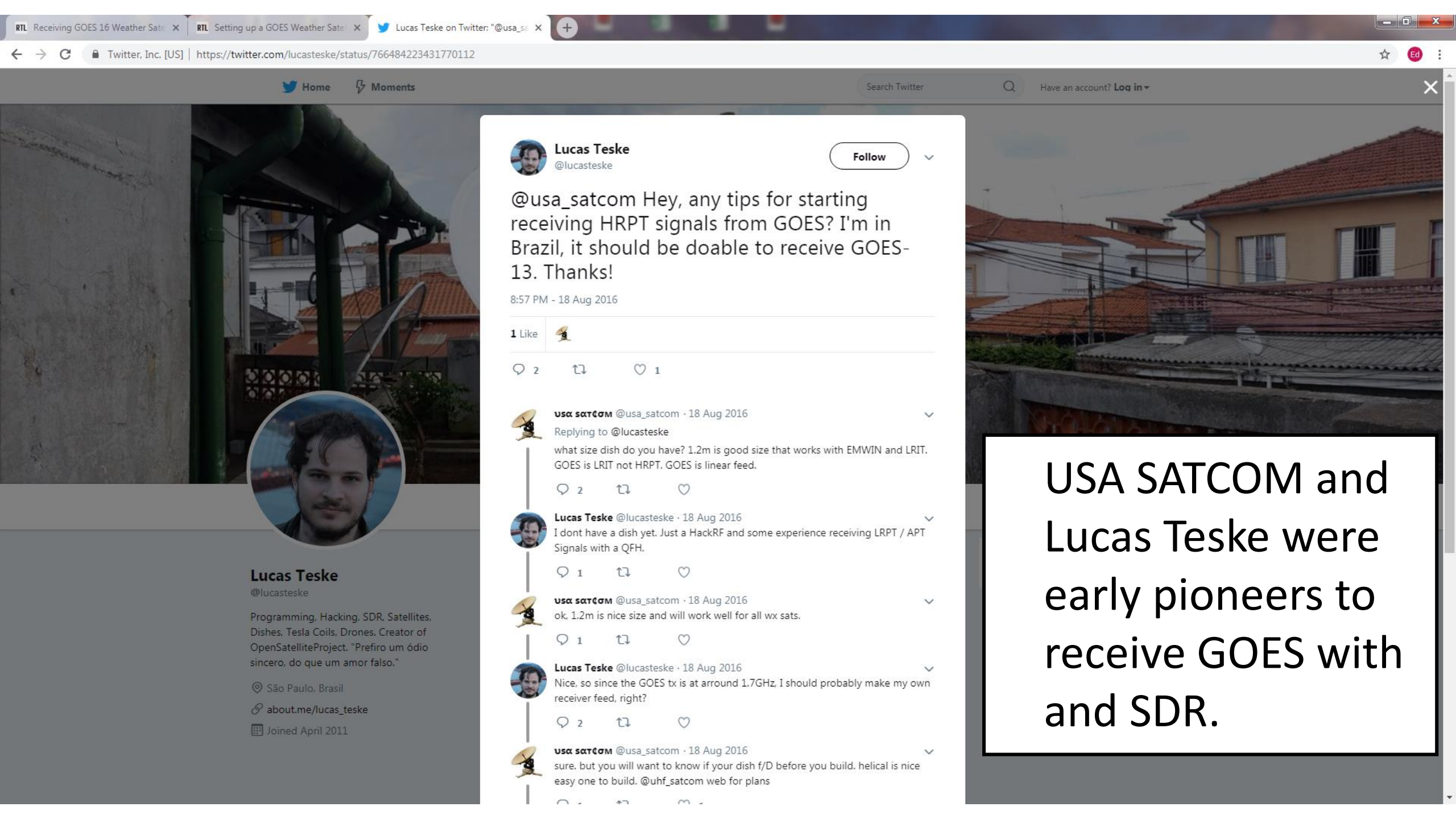


HRIT System Diagram

The GOES-R series will continue the current broadcast services of LRIT (Low Rate
a significantly higher data
o services into a single service
ith the current LRIT service at 128
OES I-M (8-12) series and 19.2
e will be called HRIT/EMWIN—

er hardware as well as a receiver
N) and 1691.0 (LRIT). With
gram) and NESDIS (operator of
ndertook a technology
demonstration program to show that relatively inexpensive receivers designed for the new service could:

NOAA contracted with Aerospace Corporation to develop a system for users early on


Receiving GOES 16 Weather Sate
Setting up a GOES Weather Sate
Lucas Teske on Twitter: "@usa_sa
Twitter, Inc. [US] | https://twitter.com/lucasteske/status/766484223431770112
Home
Moments
Search Twitter
Have an account? Log in
Lucas Teske
@lucasteske
Follow
@usa_satcom Hey, any tips for starting receiving HRPT signals from GOES? I'm in Brazil, it should be doable to receive GOES-13. Thanks!
8:57 PM - 18 Aug 2016
1 Like
2
1
USA SATCOM @usa_satcom · 18 Aug 2016
Replying to @lucasteske
what size dish do you have? 1.2m is good size that works with EMWIN and LRIT. GOES is LRIT not HRPT. GOES is linear feed.
2
Lucas Teske @lucasteske · 18 Aug 2016
I dont have a dish yet. Just a HackRF and some experience receiving LRPT / APT Signals with a QFH.
1
USA SATCOM @usa_satcom · 18 Aug 2016
ok, 1.2m is nice size and will work well for all wx sats.
1
Lucas Teske @lucasteske · 18 Aug 2016
Nice, so since the GOES tx is at arround 1.7GHz, I should probably make my own receiver feed, right?
2
USA SATCOM @usa_satcom · 18 Aug 2016
sure. but you will want to know if your dish f/D before you build. helical is nice easy one to build. @uhf_satcom web for plans
Lucas Teske
@lucasteske
Programming, Hacking, SDR, Satellites, Dishes, Tesla Coils, Drones. Creator of OpenSatelliteProject. "Prefiro um ódio sincero, do que um amor falso."
São Paulo, Brasil
about.me/lucas_teske
Joined April 2011
USA SATCOM and Lucas Teske were early pioneers to receive GOES with and SDR.

RTL Receiving GOES 16 Weather Sate | XRITDecoder

Not secure | www.geo-web.org.uk/XRITDecoder.php

Group for Earth Observation

The Independent Organisation for Weather Satellite and Earth Observation Enthusiasts

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A software solution for decoding and extracting files from GOES LRIT/HRIT streams.

Raydel Abreu Espinet, CM2ESP. January 3rd 2018. (cm2esp at gmail.com)

INTRODUCTION:

This page was last modif

GOES-16, formerly known as GOES-R was launched in Novembe
advantage over the previous generation of NOAA's geostationary
these satellites offer 16 spectral bands for imagery and can cover th
its predecessors.

The change of technology also came with an increase of the data
the old analogue WEFAX was now changed with the HRIT stream
128kbit/s LRIT has.

Luckily for the amateur community and other weather satellite enth
and with the rise and diversification of the SDR technology, no
affordable and competitive prices. Many SDR designers are focuse
download, modify and use wide range of software tools.

In my opinion Raydel was the first to come out with easy to use SDR Windows software and great documentation to get you up and running. Getting good software has been the key!

A minimal LRIT/HRIT receiver

Receiving the LRIT and/or HRIT signal can be done with relatively inexpensive equipment. This guide describes a minimal configuration that I have confirmed to work **at my location**.

Warning

Whether or not this configuration works at your location depends on a large number of factors, such as satellite elevation, local interference, etc. Try it at your own risk.

The bill of materials is as follows:

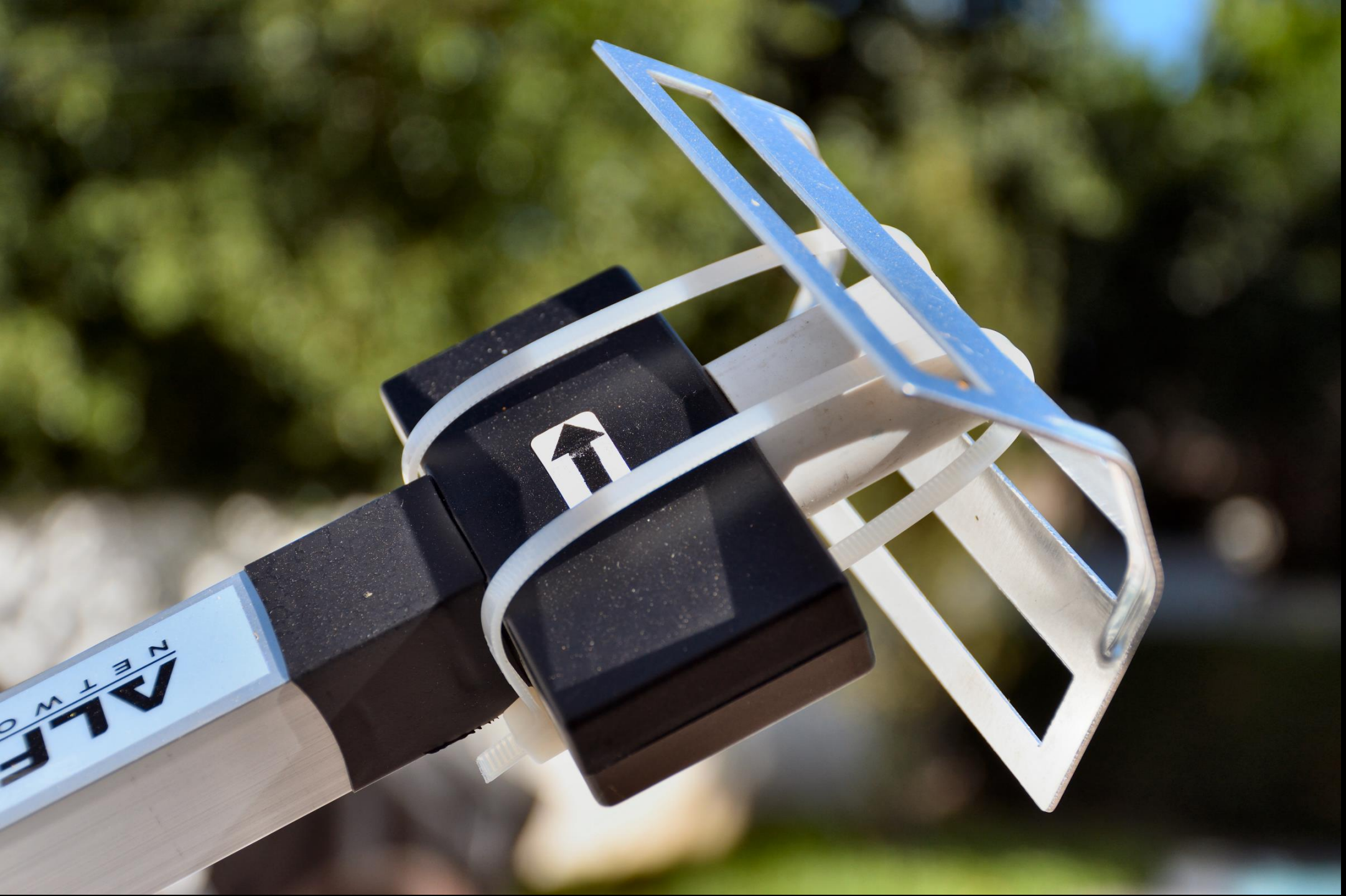
- Raspberry Pi 2 (v1.1+) or higher

Then came Pieter with his Goestools software running on a Raspberry Pi

HRIT System Developments Hardware

Modified 2.4GHz 24dbi grid antenna

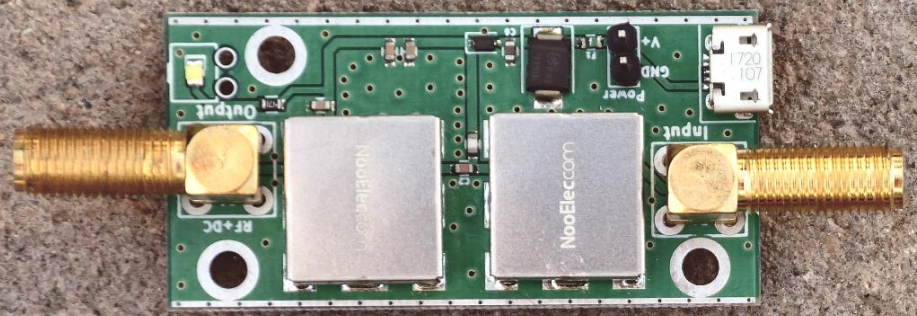
Can buy on Ebay $55 with shipping right now

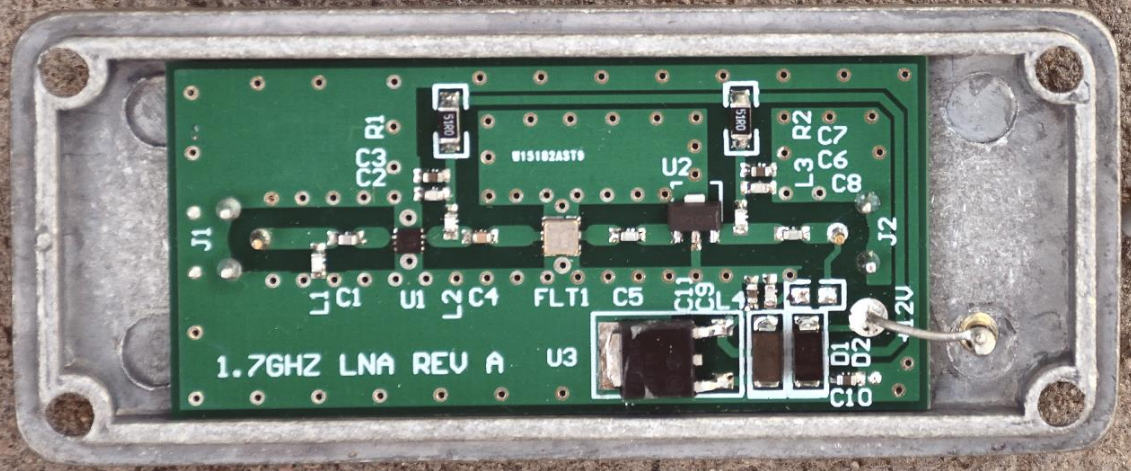


Modified grid antenna Feed with 1” spacer

Nooelec SAWbird
SAW filter + Amp $35

Ebay SPF5189 50M-4G
Amps $5-$11





My 2 Amp + SAW filter design
28db Gain
0.6db NF

Various LNAs and line amplifiers now readily available

Don’t buy cheap SDRs with old tuners that overheat, drift and don’t go to 1700MHz

When you can buy a better one for not much more $24

NooElec NESDR XTR+ RTL-SDR USB Receiver Set w/ TCXO, RTL2832U & Elonics E4000 US

Ultra-Accurate Tuning; eXTended Range SDR, Up To 2.3GHz

Be the first to write a review.

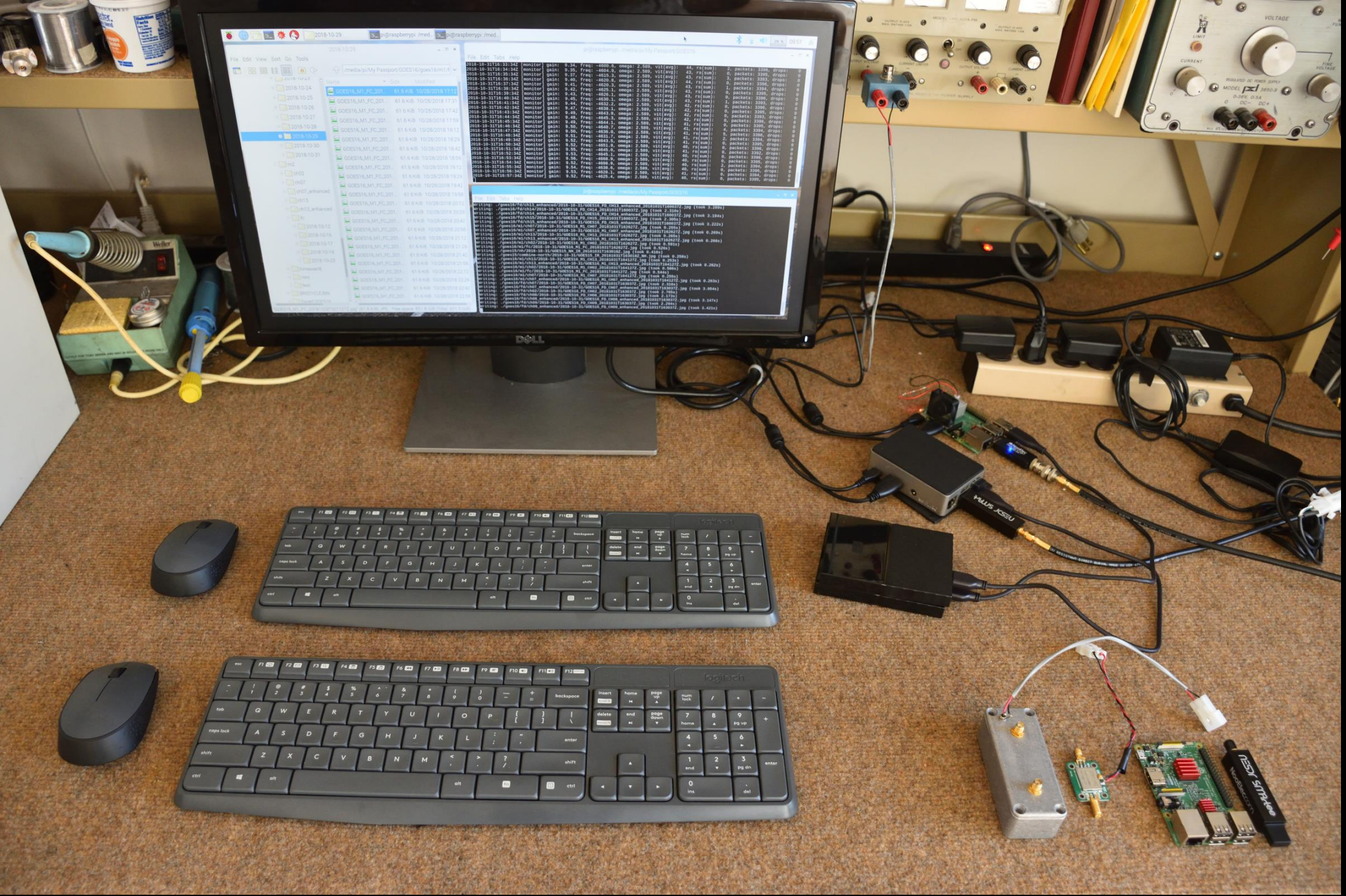
Condition: **New**

Quantity: 1 More than 10 available / 165 sold

Price: **US $34.95**

Buy It Now

Add to cart



My HRIT Station

Both GOES15 GOES16 reception & storage

Enough theory Ed
Let’s see it in action!

My Two Systems of Choice:

Raydel's XRIT Decoder sw to generate LRIT files +
Rob Alblas' XRIT2PIC to display LRIT files
Antenna + LNA + SDR + PC with Windows software

Pieter's Goestools to generate LRIT or JPEG files
Can add outlines, color enhancements and generate false color and cropped images
Antenna + LNA + SDR + Raspberry Pi with Raspian sw

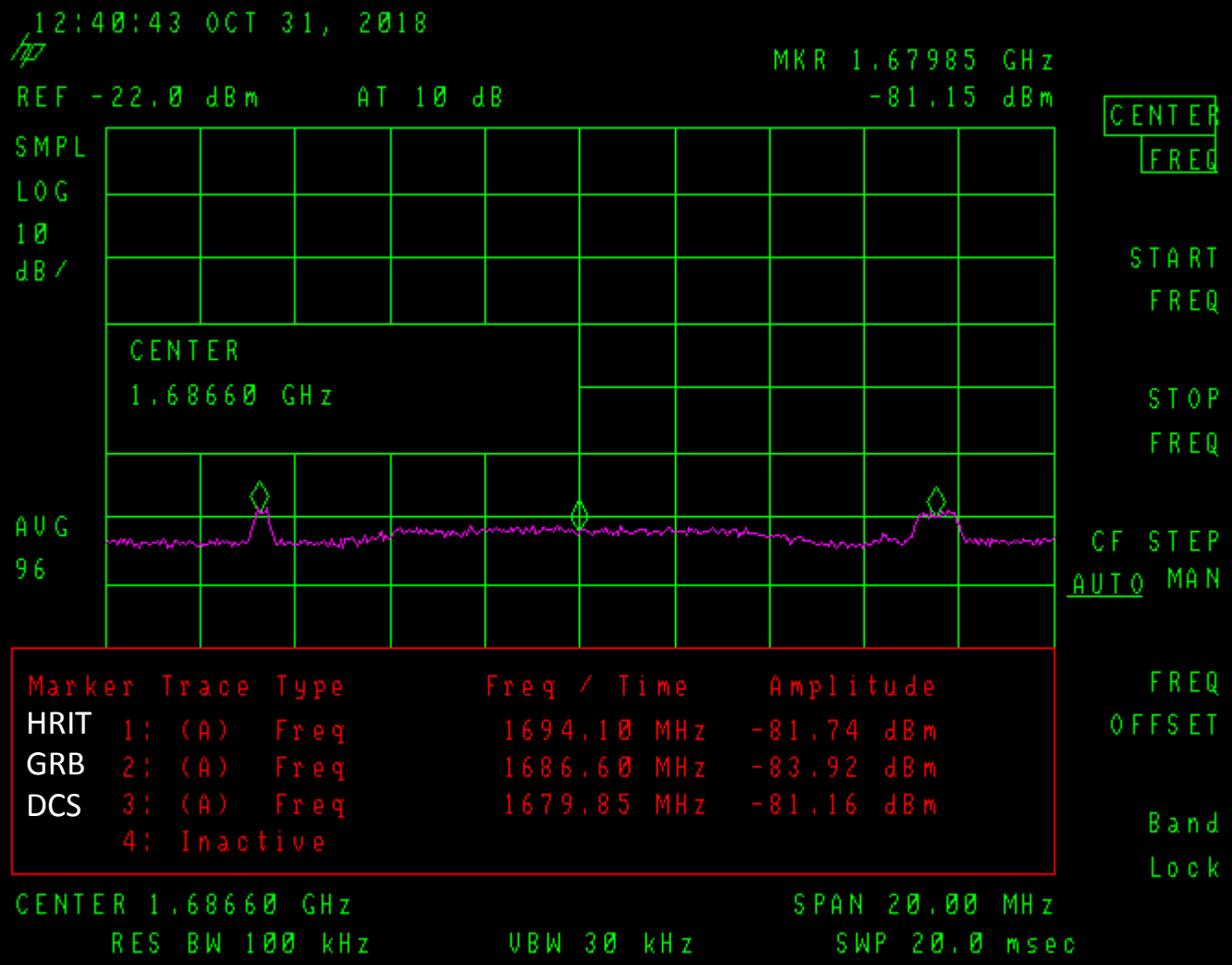
Today’s Demo:

Modified 2.4GHz 24dbi Grid Antenna
My LNA with SAW filter
Mini-Circuits 28db Amp
100’ LMR240
Nooelec Nesdr Smart SDR

1st with PC & Raydel’s SW

Then with Pieter’s Goestools
Rasberry Pi + Rasbian Stretch
USB 1TB hard drive

Spectrum analyzer plot



HRIT
GRB
DCS

First GOES-16 HRIT Reception with Raydel's XRITDecoder SW and Rob's XRIT2PIC SW

SOFTWARE REQUIREMENTS:

Software version was tested to work with the present release. Future versions of the utilities and libraries may or may not work.

- Windows 64 bit version. Tested on Windows 8, but should work as well on 7 and 10.
- Microsoft .Net Framework 4.0[1]
- Visual C++ 2010 Runtime[2]
- Gnuradio 3.7.11 for windows[3]
- Xrit2Pic[4]

See www.geo-web.org.uk/XRITDecoder.php for software links and tutorial

[1] https://www.microsoft.com/en-us/download/details.aspx?id=17718

[2] https://www.microsoft.com/en-US/download/details.aspx?id=5555
https://www.microsoft.com/en-us/download/details.aspx?id=14632
(Both 32bit and 64bit versions are needed)

[3] http://www.gcndevelopment.com/gnuradio/downloads.htm (Use "64-Bit Any CPU" and always latest version)

[4] http://www.alblas.demon.nl/wsat/software/winsoft_msg.html (Use always latest version)

INSTALLATION PROCEDURE:

This page can be downloaded as a .pdf here.

The required XRITDecoder software and files can be downloaded as a .zip folder here.

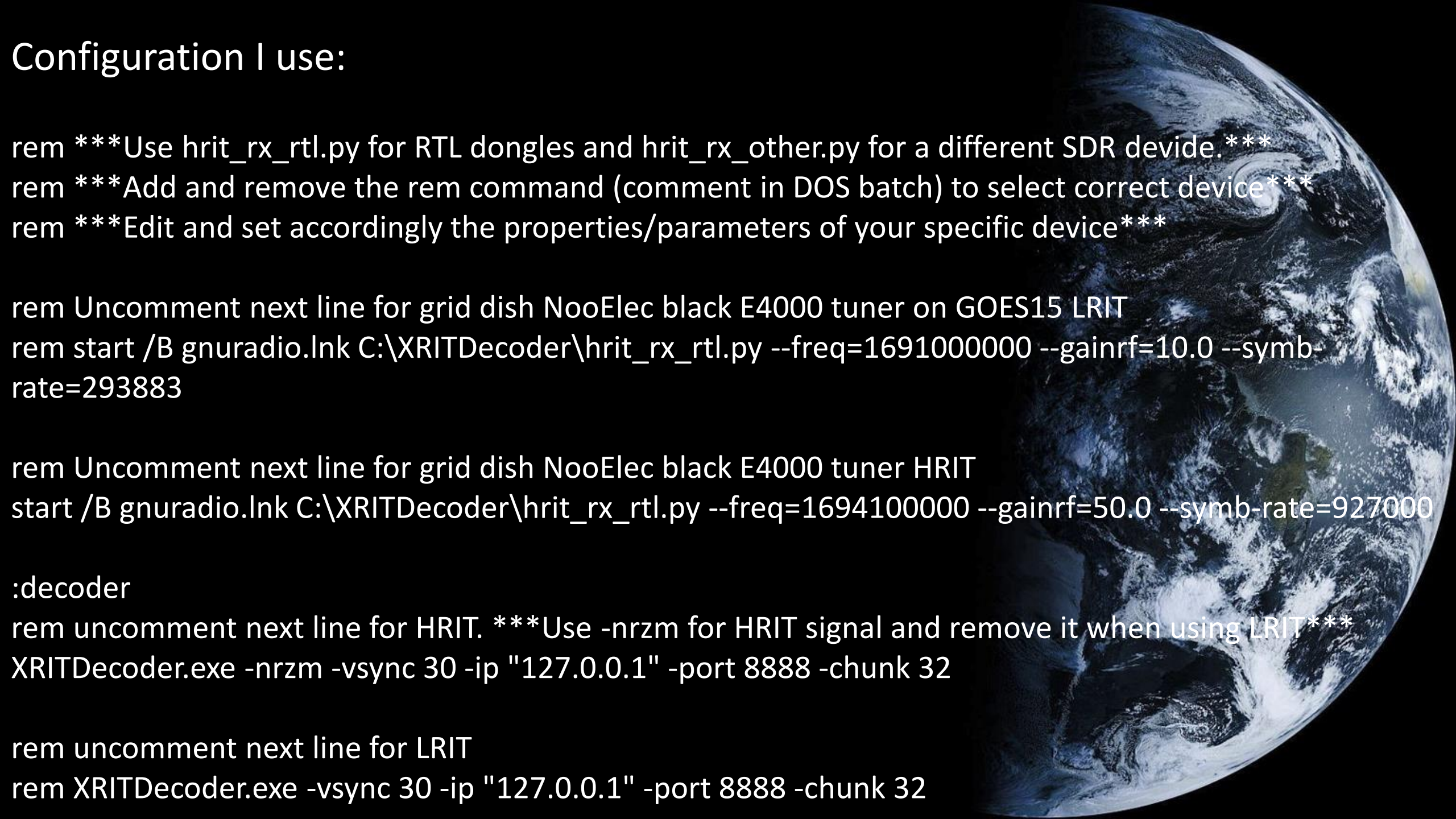
Checked by VirusTotal as virus free. (0/61)

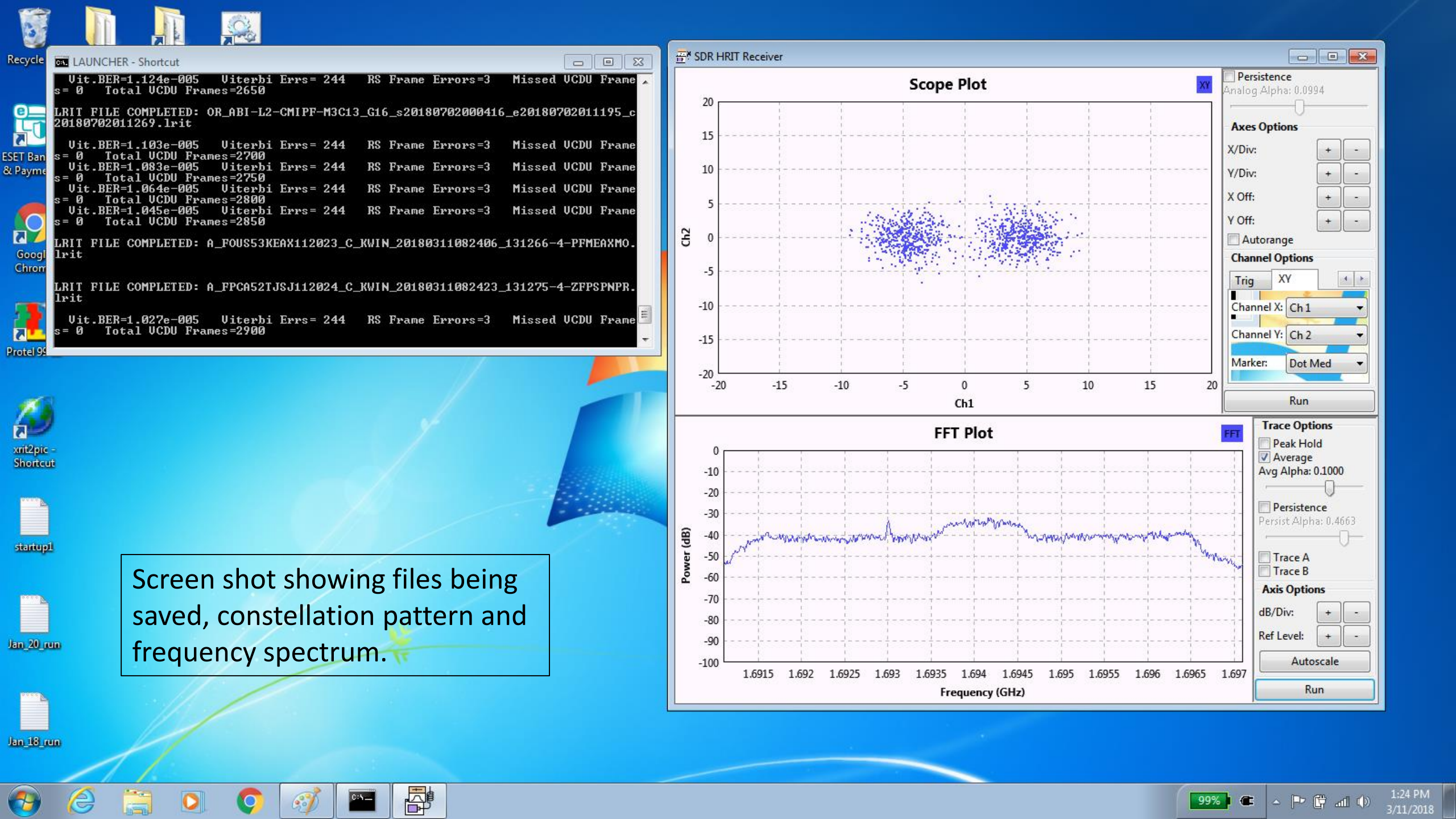
MD5 Checksum, 822519F6D3831C72AF716C46BBC32B86

Top

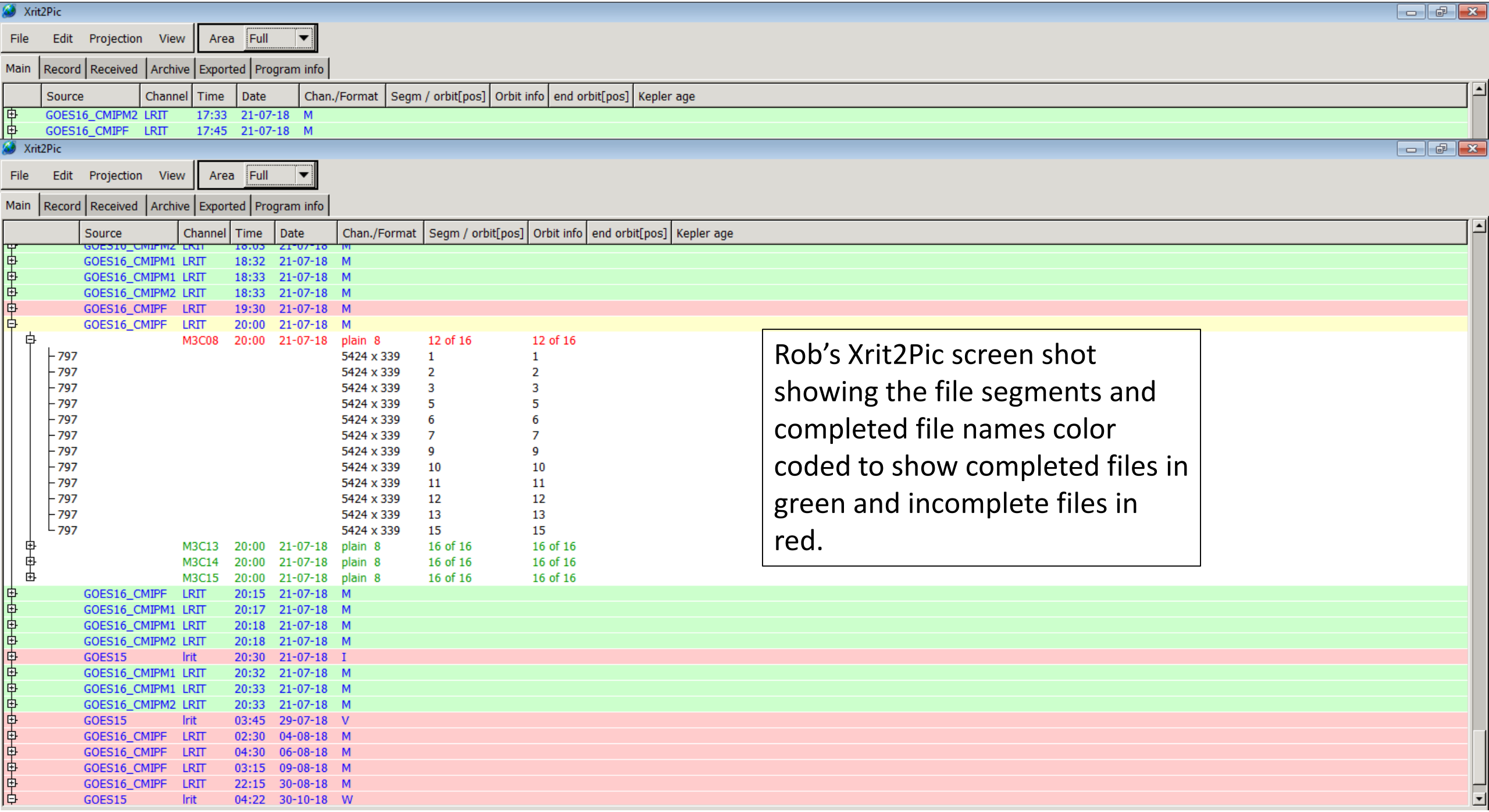
Configuration I use:

```
rem ***Use hrit_rx_rtl.py for RTL dongles and hrit_rx_other.py for a different SDR devide.***
rem ***Add and remove the rem command (comment in DOS batch) to select correct device***
rem ***Edit and set accordingly the properties/parameters of your specific device***

rem Uncomment next line for grid dish NooElec black E4000 tuner on GOES15 LRIT
rem start /B gnuradio.lnk C:\XRITDecoder\hrit_rx_rtl.py --freq=1691000000 --gainrf=10.0 --symb-
rate=293883

rem Uncomment next line for grid dish NooElec black E4000 tuner HRIT
start /B gnuradio.lnk C:\XRITDecoder\hrit_rx_rtl.py --freq=1694100000 --gainrf=50.0 --symb-rate=927000

:decoder
rem uncomment next line for HRIT. ***Use -nrzm for HRIT signal and remove it when using LRIT***
XRITDecoder.exe -nrzm -vsync 30 -ip "127.0.0.1" -port 8888 -chunk 32

rem uncomment next line for LRIT
rem XRITDecoder.exe -vsync 30 -ip "127.0.0.1" -port 8888 -chunk 32
```





Screen shot showing files being saved, constellation pattern and frequency spectrum.



Rob's Xrit2Pic screen shot showing the file segments and completed file names color coded to show completed files in green and incomplete files in red.

Next GOES-16 HRIT Reception with Pieter’s Goestools SW which runs on a Raspberry Pi

FLIRC Aluminum Raspberry Pi Case

Integrated CPU heatsink post to prevent CPU throttling which slows CPU down

Enclosed Raspberry Pi

Building

These instructions should work for both Ubuntu and Raspbian.

Install system dependencies:

```
sudo apt-get install -y \
  build-essential \
  cmake \
  git-core \
  libopencv-dev \
  zlib1g-dev
```

Start at https://pietern.github.io/goestools/guides/minimal_receiver.html for links to the software and tutorial.

If you want to run goesrecv on this machine, you also have to install the development packages of the drivers the SDRs you want to use; `librtlsdr-dev` for an RTL-SDR, `libairspy-dev` for an Airspy.

Now you can build and install goestools:

```
git clone --recursive https://github.com/pietern/goestools
cd goestools
mkdir build
cd build
cmake .. -DCMAKE_INSTALL_PREFIX=/usr/local
make
make install
```

goestools

Search docs

CONTENTS:

Installation

Commands

goesrecv

Options

Configuration

Statistics

Sample configuration

goeslrit

goesproc

Guides

Resources

Options

`-c` , `--config=PATH`	Path to configuration file
`-v` , `--verbose`	Periodically show statistics
`-i` , `--interval=SEC`	Interval for `--verbose`

The site is very detailed showing the commands for both the receive and processing software.

Configuration

The configuration file uses TOML syntax. Look further down for a sample configuration file.

Statistics

There are a few ways to keep an eye on the signal quality and goesrecv performance. You may use more than one method or none at all.

stdout

Specify the `--verbose` option to make goesrecv periodically write stats to stdout. This can be useful if you need immediate feedback about the signal lock and signal quality. The interval can be controlled with the `--interval` option. Also see Options.

Sample configuration

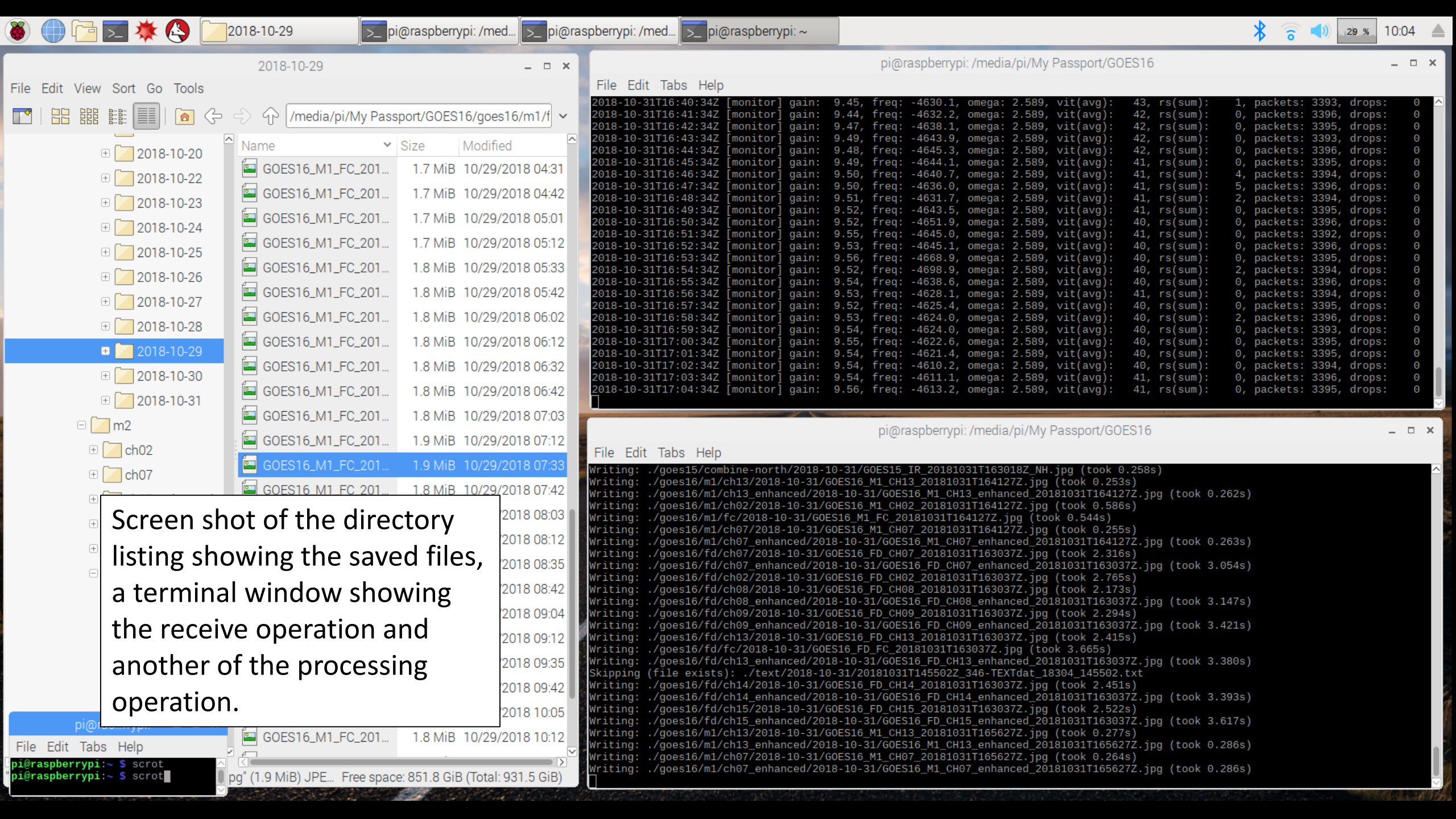
```
[demodulator]
# mode = "lrit"
# mode = "hrit"
source = "airspy"

# The section below configures the sample source to use.
#
# You can leave them commented out to use the default values for the
# demodulator mode you choose ("lrit" or "hrit"). To use and configure
# any of them, uncomment the section below, and change the demodulator
# source field to match the source you want to use.
#

# [airspy]
# frequency = 1694100000
# gain = 18

# [rtlsdr]
# frequency = 1694100000
# gain = 30

# [nanomsg]
# connect = "tcp://1.2.3.4:5005"
# receive_buffer = 2097152
# sample_rate = 2400000

[costas]
max_deviation = 200e3

[clock_recovery.sample_publisher]
bind = "tcp://0.0.0.0:5002"
send_buffer = 2097152

[quantization.soft_bit_publisher]
bind = "tcp://0.0.0.0:5001"
send_buffer = 1048576
```

Here is the configuration of the receive software.

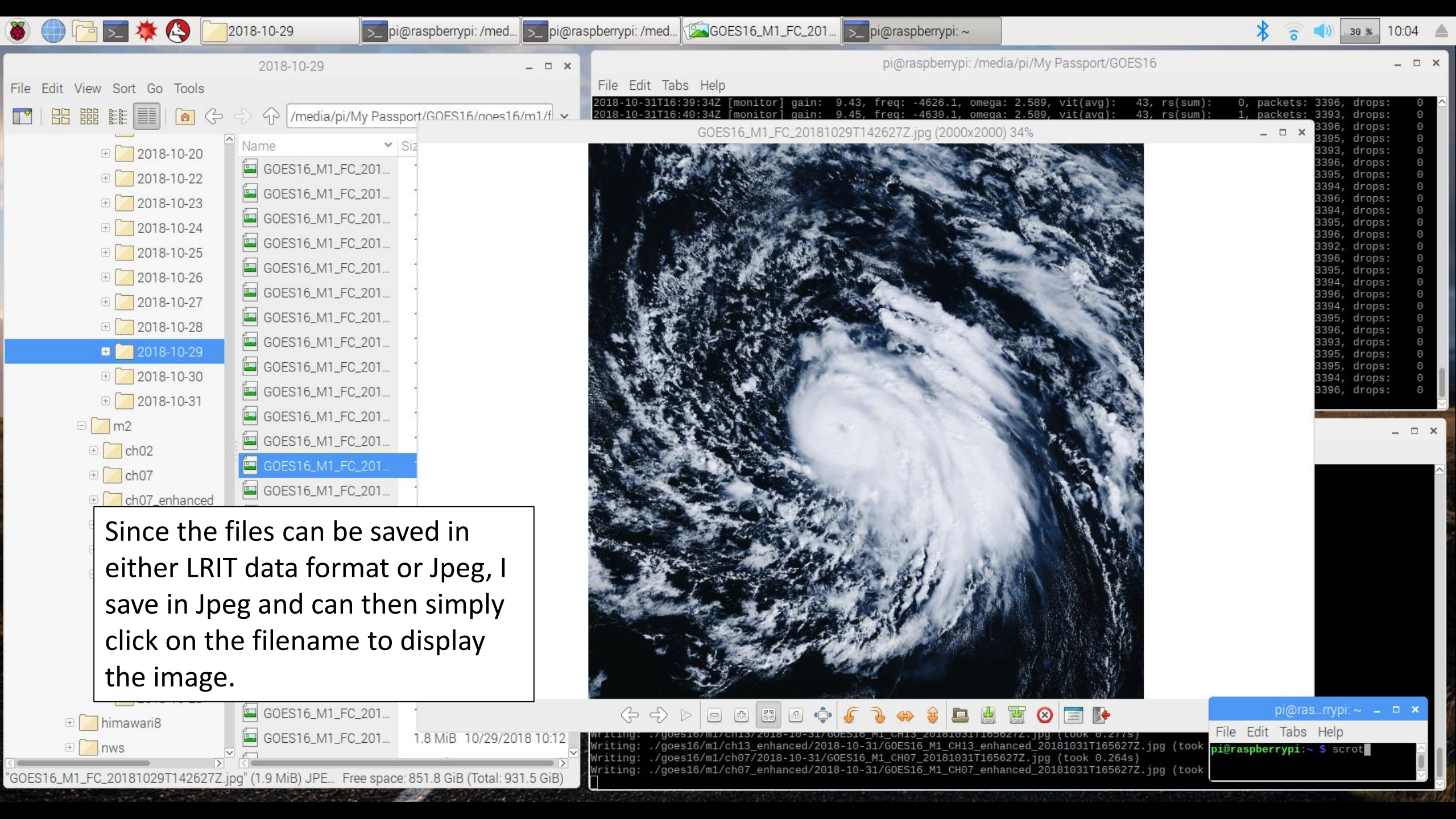
Sample configuration

```
# Example configuration file for goesproc
#
# This tool is designed to run on streaming data (live or recorded)
# and product whatever is listed in this file. A single product can be
# processed multiple times (e.g. with different contrast curves,
# different scale, or different annotations) by listing multiple
# handlers for that same product.
#

# GOES-16 mesoscale region 1 imagery is stored at ./goes16/m1/YYYY-MM-DD
# The pattern specified in {time:XXX} is extrapolated using strftime(3).
# It can be used more than once if needed.
[[handler]]
type = "image"
product = "goes16"
region = "m1"
dir = "./goes16/m1/{time:%Y-%m-%d}"

# GOES-16 full disk originals.
[[handler]]
type = "image"
product = "goes16"
region = "fd"
dir = "./goes16/fd/{time:%Y-%m-%d}"

# GOES-16 full disk, channel 2, with contrast curve applied.
# The section [handler.remap] below applies to this handler.
[[handler]]
type = "image"
product = "goes16"
region = "fd"
channels = [ "ch02" ]
directory = "./goes16/fd/{time:%Y-%m-%d}"
filename = "{filename}_contrast"
```

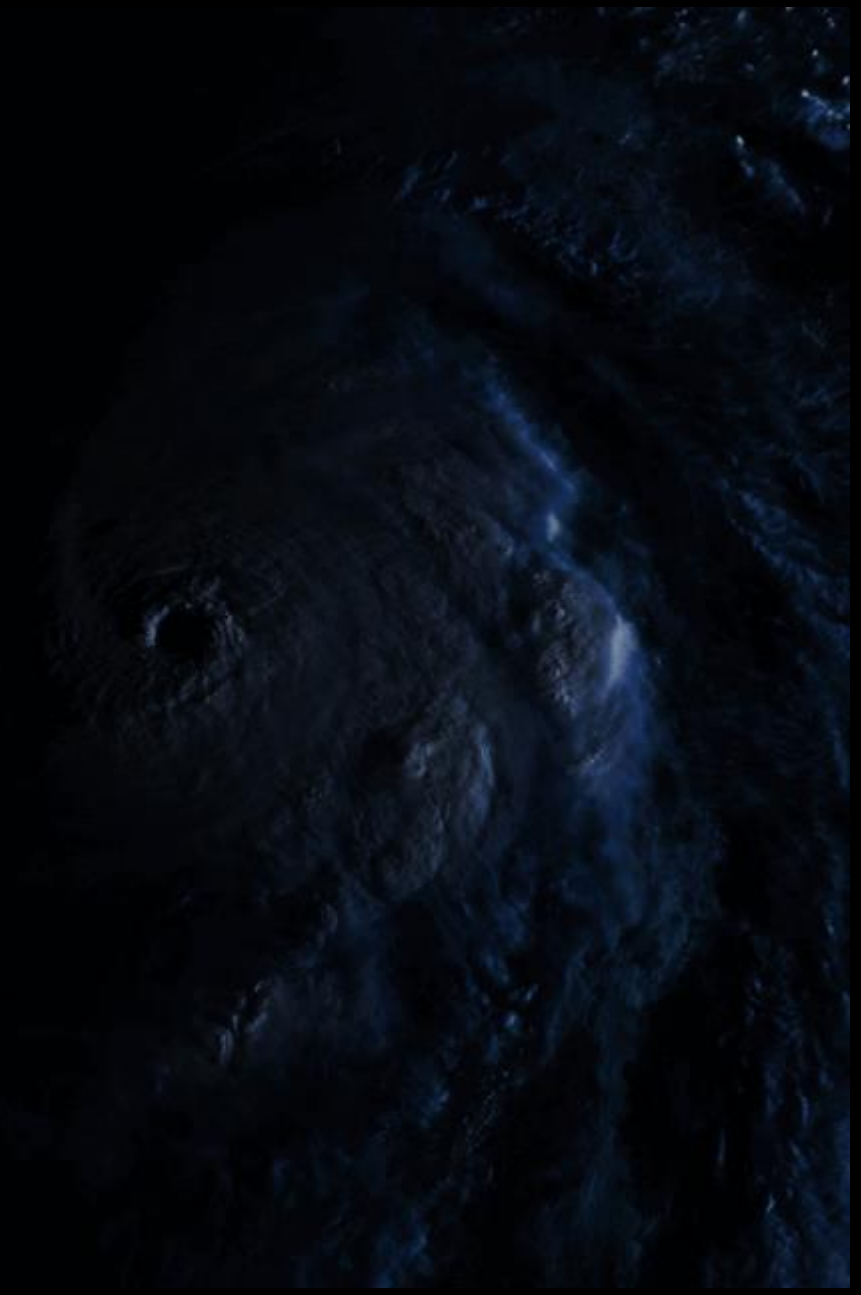
Here is the configuration of the processing software.



Screen shot of the directory listing showing the saved files, a terminal window showing the receive operation and another of the processing operation.

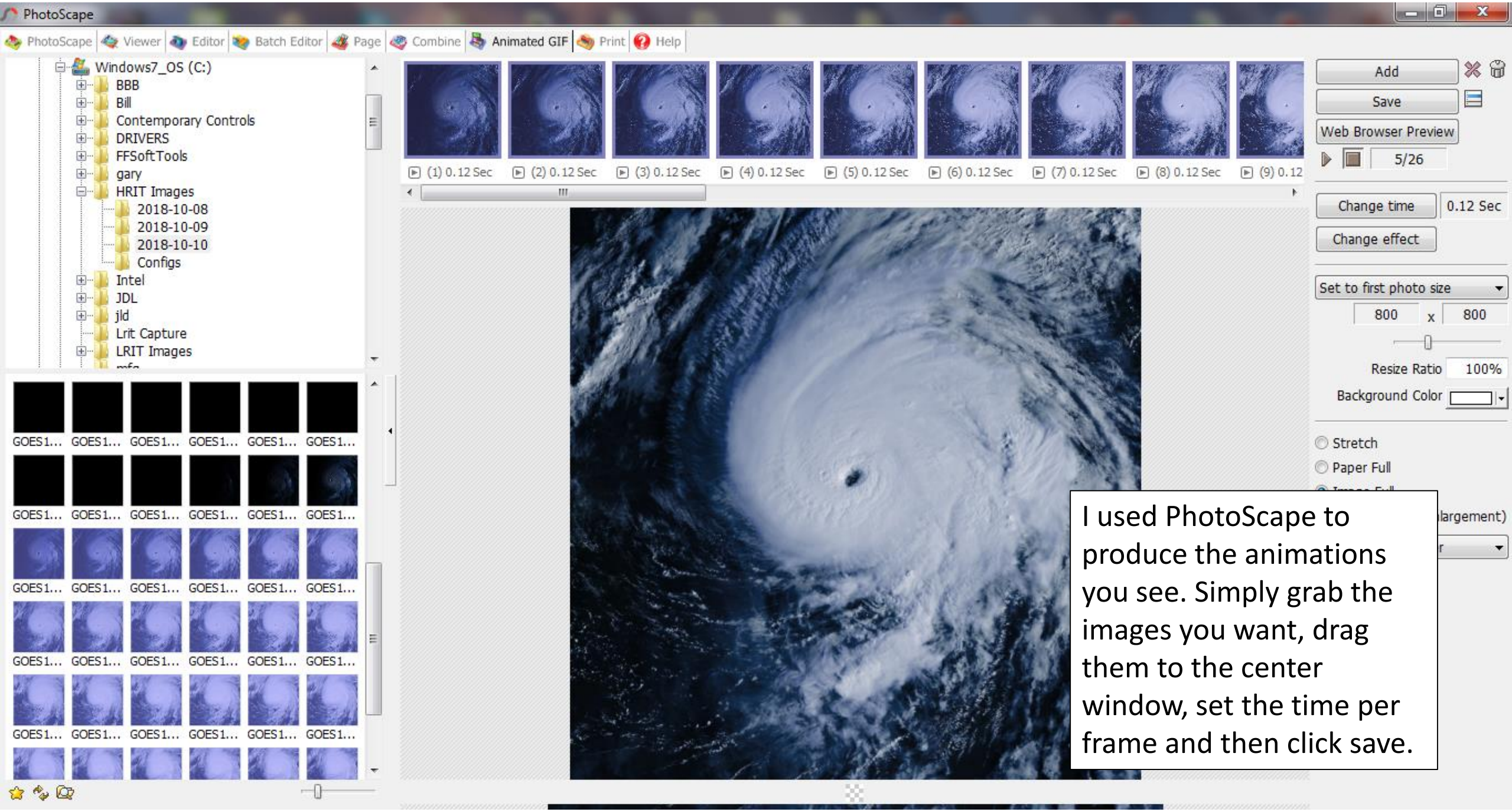

2018-10-29
pi@raspberrypi: /med...
pi@raspberrypi: /med...
GOES16_M1_FC_201...
pi@raspberrypi: ~
30 %
10:04
2018-10-29
File Edit View Sort Go Tools
/media/pi/My Passport/GOES16/goes16/m1/f
2018-10-20
2018-10-22
2018-10-23
2018-10-24
2018-10-25
2018-10-26
2018-10-27
2018-10-28
2018-10-29
2018-10-30
2018-10-31
m2
ch02
ch07
ch07_enhanced
himawari8
nws
Name
GOES16_M1_FC_201...
1.8 MiB 10/29/2018 10:12
"GOES16_M1_FC_20181029T142627Z.jpg" (1.9 MiB) JPE... Free space: 851.8 GiB (Total: 931.5 GiB)
pi@raspberrypi: /media/pi/My Passport/GOES16
File Edit Tabs Help
2018-10-31T16:39:34Z [monitor] gain: 9.43, freq: -4626.1, omega: 2.589, vit(avg): 43, rs(sum): 0, packets: 3396, drops: 0
2018-10-31T16:40:34Z [monitor] gain: 9.45, freq: -4630.1, omega: 2.589, vit(avg): 43, rs(sum): 1, packets: 3393, drops: 0
3396, drops: 0
3395, drops: 0
3393, drops: 0
3396, drops: 0
3395, drops: 0
3394, drops: 0
3396, drops: 0
3394, drops: 0
3395, drops: 0
3396, drops: 0
3392, drops: 0
3396, drops: 0
3395, drops: 0
3394, drops: 0
3396, drops: 0
3394, drops: 0
3395, drops: 0
3396, drops: 0
3393, drops: 0
3395, drops: 0
3395, drops: 0
3394, drops: 0
3396, drops: 0
GOES16_M1_FC_20181029T142627Z.jpg (2000x2000) 34%
Writing: ./goes16/m1/ch13_enhanced/2018-10-31/GOES16_M1_CH13_enhanced_20181031T165627Z.jpg (took
Writing: ./goes16/m1/ch07/2018-10-31/GOES16_M1_CH07_20181031T165627Z.jpg (took 0.264s)
Writing: ./goes16/m1/ch07_enhanced/2018-10-31/GOES16_M1_CH07_enhanced_20181031T165627Z.jpg (took
pi@ras...rrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ scrot
Since the files can be saved in either LRIT data format or Jpeg, I save in Jpeg and can then simply click on the filename to display the image.

See separate file for animation



Hurricane Michael
Oct 10 2018
GOES 16 HRIT M1
False Color

Animation generated using PhotoScape


PhotoScape
PhotoScape
Viewer
Editor
Batch Editor
Page
Combine
Animated GIF
Print
Help
Windows7_OS (C:)
BBB
Bill
Contemporary Controls
DRIVERS
FFSoftTools
gary
HRIT Images
2018-10-08
2018-10-09
2018-10-10
Configs
Intel
JDL
jld
Lrit Capture
LRIT Images
(1) 0.12 Sec
(2) 0.12 Sec
(3) 0.12 Sec
(4) 0.12 Sec
(5) 0.12 Sec
(6) 0.12 Sec
(7) 0.12 Sec
(8) 0.12 Sec
(9) 0.12
Add
Save
Web Browser Preview
5/26
Change time
0.12 Sec
Change effect
Set to first photo size
800
x
800
Resize Ratio
100%
Background Color
Stretch
Paper Full
I used PhotoScape to produce the animations you see. Simply grab the images you want, drag them to the center window, set the time per frame and then click save.

Thanks to NOAA for their satellites and support and Raydel and Pieter for their excellent software which made this possible.