Example of how to process a CYGNSS raw IF data collection
Scott Gleason, Sept, 2017.

60 second FM8 Raw IF data collection over Hurricane Harvey Example

Input Files:

Finding files. Day of data collection was August 25 2017, convert to day number (237), this web site works (http://mistupid.com/calendar/dayofyear.htm). Raw IF and meta data files are found on UM SFTP in from UM SFTP, /data/cygnss/rawif/2017/day of year.

metadata file: cyg08_raw_if_20170825_141629_meta.bin
(from UM SFTP, /data/cygnss/rawif/2017/237/)

raw IF data file: cyg08_raw_if_20170825_141629_data.bin
(from UM SFTP, /data/cygnss/rawif/2017/237/)

Separately, download the Level 1 netcdf file for this FM and day from the PO-DAAC

level 1 netcdf file: cyg08.ddmi.s20170825-000000-e20170825-235959.l1.power-brcs.a10.d11.nc
(from PO-DAAC)

Step 1:

The script Plot_rawIF_Tracks.m which calls process_rawIF_metadata.m and Load_CYGNSS_netCDF_Level1.m will extract the necessary meta data from the Level 1 netcdf file. Set the path of the level 1 netcdf file in Plot_rawIF_Tracks.m and run.

The octave script process_rawIF_metadata.m will parse the binary metadata file for key parameters (it does not parse everything). Set the path and file name of the _meta.bin file and run this script, you get,

satIDhex = 49
gpsweek = 1963
gpssecs = 483407
Channel 1,2,3, I Only ... default for most collections

The GPS seconds start time is then used to find the raw IF interval in the Level 1 netcdf file and pull out the necessary meta data: PRNs, antennas, Dopplers for the 4 satellites being tracked by the instrument over the 60 collection interval. Finding other reflections not tracked by the DMR I discuss how to do later.

It will output 3 plots with SP tracks, PRNs and antenna info for the 4 "best" specular points. Results shown below,
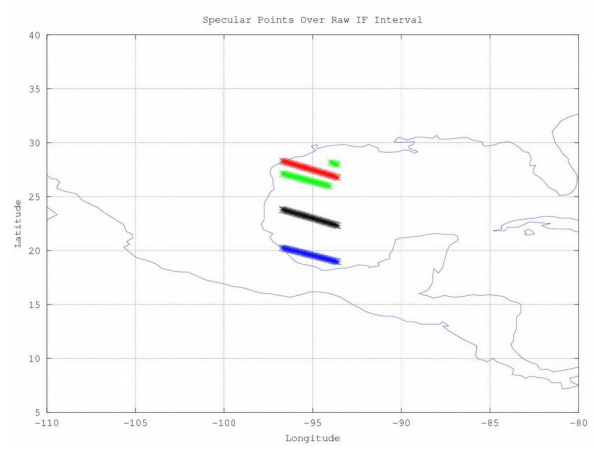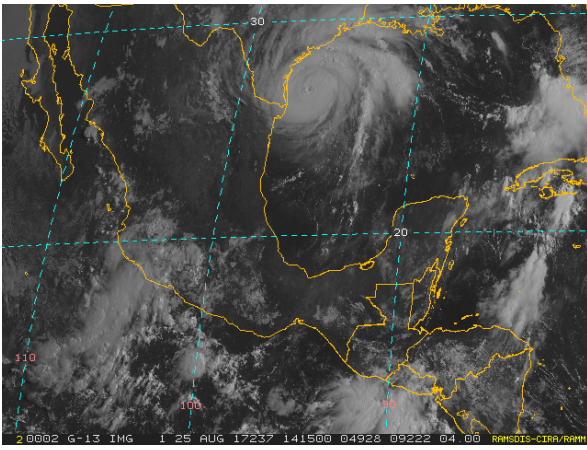
Figure 1, (left) RAMSDIS Online Archive Image of Harvey at time of collection. (right) Specular point tracks over collection duration (from script).
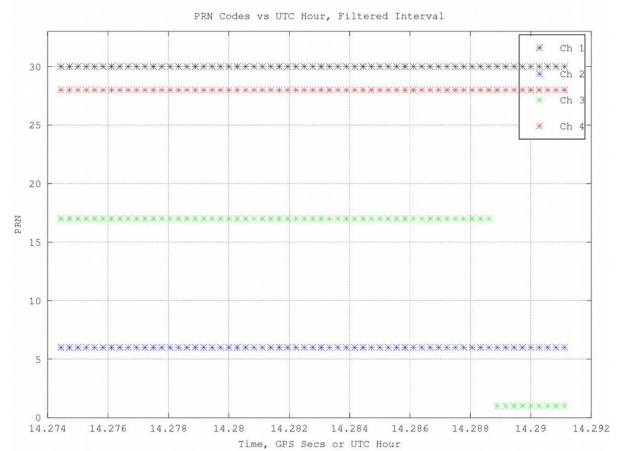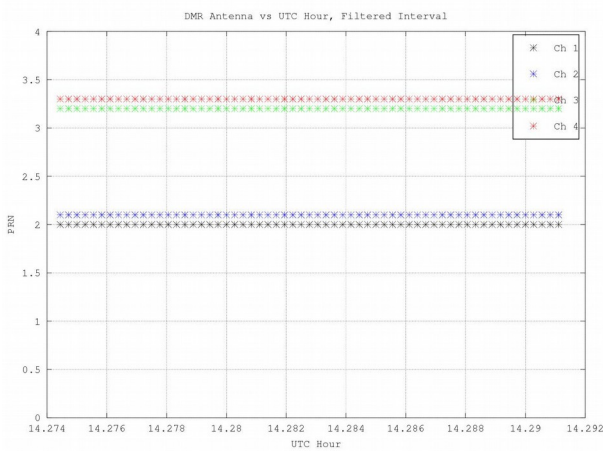

Figure 2, (left) Channel antenna allocations. (right) Channel PRN allocations.

Step 3:

Collect information from from output of Plot_rawIF_Tracks.m for configuration of the DDM Processor. The outputs from the Step 2 above should look like,

PRN1 = 30
ANT1 = 2
start_dopp1 = 9107.37597656250
dopp_rate1 = -33.2125081380208
SP_mean_gain1 = 9.24045775366611
PRN2 = 6
ANT2 = 2
start_dopp2 = 10319.1630859375
dopp_rate2 = -25.2823242187500
SP_mean_gain2 = 8.51110523255145
PRN3 = 17
ANT3 = 3
start_dopp3 = -13514.3154296875
dopp_rate3 = 334.490185546875
SP_mean_gain3 = 1.30710178393810
PRN4 = 28
ANT4 = 3
start_dopp4 = 1489.82556152344

dopp_rate4 = -27.4664708455404
SP_mean_gain4 = 14.6910507952581

Step 4:

Process individual DDMs

      1) Run CYGNSS DDM Processor
      2) Advanced Signal Search Tab → Do nothing (leave as is)
      3) Time Series Processing Tab → Set range of second to process. For example Start=1,
      End=1, Step=1 for a single DDM at second 1 of data set
      4) Per DDM Processing Tab → configure entries based on info above:
      - Use default configuration file
      - PRN = 28
      - Start Doppler = -1500 (about 3000 before center)
      - End Doppler = 4500 (about 3000 after center)
      - Doppler step = 200 (finer than on-board DDM processing)
      - non-coherent Integration = 1000 (default)
      - Number of channels logged = 3 (default)
      - Channel to process = Nadir 2 (i.e. antenna 3 from list above)
      - Delay spacing = 1/8 chip (finer than on-board DDM processing)
      5) Hit "GO"

      Takes a few 10s of seconds to run

Output file generated in program "root" directory:
build-CYGNSS_DDM_Processor-Desktop-Debug/Processed_DDMs.bin (~2M size)

Plot output using Octave/Matlab script: plot_FFT_DDMs_binary1.m

In this script a) set path and file name at beginning of script, b) set flags for full DDMs (all delays) and/or delay waveforms if desired and c) change the size of the cropped full DDM delay to plot with the variables buffer_delay_size and buffer_dopp_size. When you run this script the output should look like:
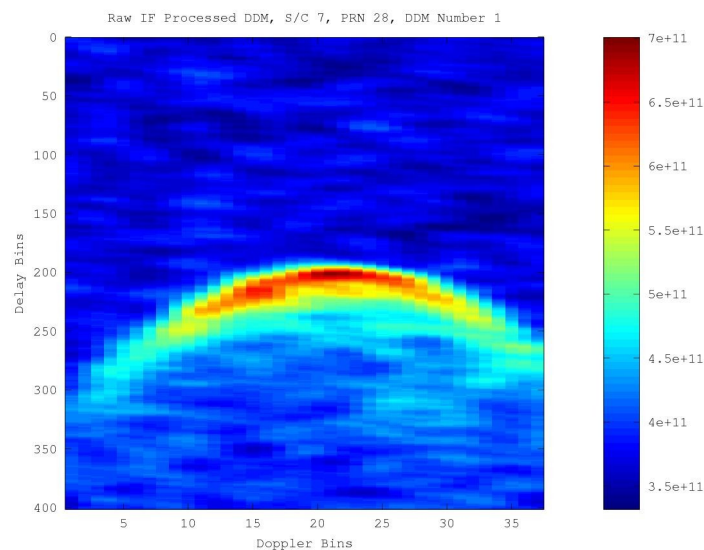

Figure 3, FM8, PRN28 DDM, Second 1. Output of plot_FFT_DDMs_binary1.m

Or

Process multi-second sequence by commenting in "^" the following line in the configuration file,
^D 28 3 5000 200 1500 -27 0

The run DDM Processor as follows:

      1) Run CYGNSS DDM Processor
      2) Advanced Signal Search Tab → Check Use "PRNs/Dopplers in File"
      3) Time Series Processing Tab → Set range of second to process. For example Start=0,
      End=5, Step=1 to process the first 5 seconds
      4) Per DDM Processing Tab → configure entries based on info above:
      - Use default configuration file
      - PRN = Set in configuration file
      - Start Doppler = Set in configuration file
      - End Doppler = Set in configuration file
      - Doppler step = Set in configuration file
      - non-coherent Integration = 1000 (default)
      - Number of channels logged = 3 (default)
      - Channel to process = Set in configuration file
      - Delay spacing = 1/4 chip (default)
      5) Hit "GO"

      Takes a couple minutes to run

Step 5:

Finding all possible satellites in view (i.e. reflections not tracked by DMR channel)

Step 6:

Use DDM Processor to perform all PRN search using short duration of data, with large Doppler search range to detect all zenith direct signals in-view. There will be reflected signals in the data for all of these signals, but at lower (possible undetectable) antenna gain. For the raw IF data set above the following direct signals were found with a quick search (there could be more):

PRN 1, Doppler 10000, SNR 6.7627
PRN 6, Doppler 12000, 8.1779
PRN 7, Doppler 24000, 10.042
PRN 17, Doppler -17000, 10.136
PRN 19, Doppler -20000, 11.287
PRN 28, Doppler 2000, 7.5641
PRN 30, Doppler 11000, 11.048

In addition to the 4 DMR channels, there is also PRN 7 and 19 (as well as not tracked track portions for 17 and 1 on channel 3),

Step 7:

Process multi-second sequence by commenting in "^" the following line in the configuration file,
^D 1 3 5000 500 6500 0 0

The run DDM Processor as follows:

1) Run CYGNSS DDM Processor
2) Advanced Signal Search Tab → Check Use "PRNs/Dopplers in File"
3) Time Series Processing Tab → Set range of second to process. For example Start=30, End=30, Step=1 to process only second 30
4) Per DDM Processing Tab → configure entries based on info above:
- Use default configuration file
- PRN = Set in configuration file
- Start Doppler = Set in configuration file
- End Doppler = Set in configuration file
- Doppler step = Set in configuration file
- non-coherent Integration = 2000 (increase to improve SNR)
- Number of channels logged = 3 (default)
- Channel to process = Set in configuration file
- Delay spacing = 1/4 chip (default)
5) Hit "GO"

Takes about a minute to run

Plot output using Octave/Matlab script: plot_FFT_DDMs_binary1.m, which should look like this,
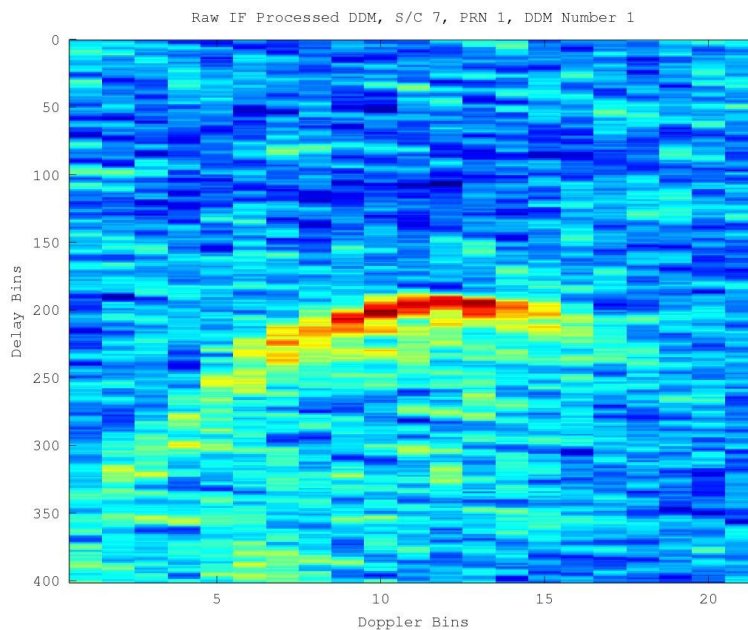

Figure 4, FM8, PRN1 DDM, Second 30, 2000ms. Output of plot_FFT_DDMs_binary1.m