MATISSE_calibrators

July 14, 2018

1 Good calibrators from the MSDFCC for MATISSE

```
In [164]: from astropy.io import fits
          from astropy import coordinates as coord
          from astropy import units as u
          from matplotlib import pyplot as plt
          import numpy as np

          %pylab inline
```

```
Populating the interactive namespace from numpy and matplotlib
```

```
In [165]: msdfcc_file="msdfcc-v6.fits"
          hdu=fits.open(msdfcc_file)
          cal_db=hdu[1].data
          print("The catalogue contains {0} calibrators".format(len(cal_db)))
```

```
The catalogue contains 465840 calibrators
```

1.1 Selection criteria for good MATISSE calibrators

1.1.1 Select only true calibrators where fluxes, flux uncertainties and diameters are known

```
In [166]: cal_db = cal_db[(cal_db["CalFlag"]==0) &
                    (cal_db["IRflag"] == 0) &
                    (np.isfinite(cal_db["median_L"])) &
                    (np.isfinite(cal_db["MAD_L"])) &
                    (np.isfinite(cal_db["median_N"])) &
                    (np.isfinite(cal_db["MAD_N"])) &
                    (np.isfinite(cal_db["UDDL_est"]))]

          print("There are {0} true calibrators with known fluxes, flux uncertainties and diamet
```

```
There are 198989 true calibrators with known fluxes, flux uncertainties and diameters
```

1.1.2 Select by flux

```
In [167]: flux_threshold_L_Jy = 1
          flux_threshold_N_Jy = 1

          cal_db = cal_db[(cal_db["median_L"] > flux_threshold_L_Jy) &
                          (cal_db["median_N"] > flux_threshold_N_Jy)]

          print("There remain {0} calibrators that are brighter than {1:5.2f} Jy in L and bright
```

```
There remain 3460 calibrators that are brighter than  1.00 Jy in L and brighter than  1.00 Jy in
```

1.1.3 Select by diameter

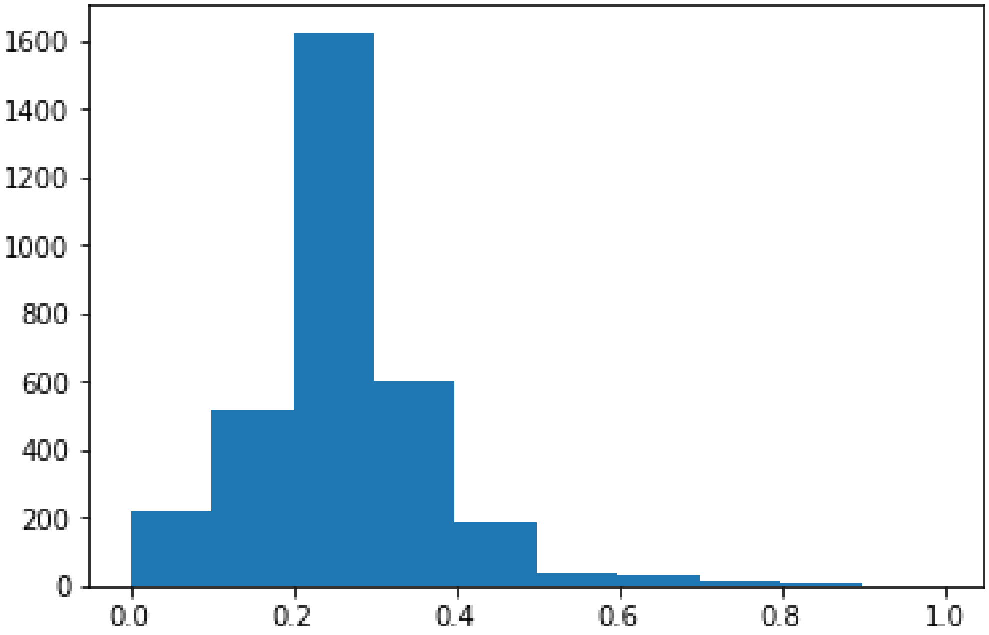
```
In [168]: diameter_threshold_mas = 3

          cal_db = cal_db[cal_db["UDDL_est"] < diameter_threshold_mas]

          print("There remain {0} calibrators that are smaller than {1:5.2f} mas".format(len(cal
```

```
There remain 3228 calibrators that are smaller than  3.00 mas
```

1.1.4 Select by flux uncertainty

```
In [169]: plt.hist(cal_db["MAD_N"]/cal_db["median_N"])
```

```
Out[169]: (array([  2.20000000e+02,   5.20000000e+02,   1.62500000e+03,
                    6.00000000e+02,   1.86000000e+02,   3.50000000e+01,
                    2.70000000e+01,   1.10000000e+01,   3.00000000e+00,
                    1.00000000e+00]),
           array([  5.31833910e-04,   1.00302727e-01,   2.00073621e-01,
                    2.99844514e-01,   3.99615408e-01,   4.99386301e-01,
                    5.99157195e-01,   6.98928088e-01,   7.98698982e-01,
                    8.98469875e-01,   9.98240769e-01]),
           <a list of 10 Patch objects>)
```



```
In [170]: flux_uncertainty_L_threshold = 0.1
          flux_uncertainty_N_threshold = 0.4

          cal_db = cal_db[((cal_db["MAD_L"]/cal_db["median_L"]) < flux_uncertainty_L_threshold)
                          ((cal_db["MAD_N"]/cal_db["median_N"]) < flux_uncertainty_N_threshold)]

          print("There remain {0} calibrators with flux uncertainties in L and N less than {1:.0
```

```
There remain 1266 calibrators with flux uncertainties in L and N less than 10% and 40% respectiv
```

1.1.5 Select by DEC

We only select by declination here since the required coordinate transform takes some time on the full catalogue

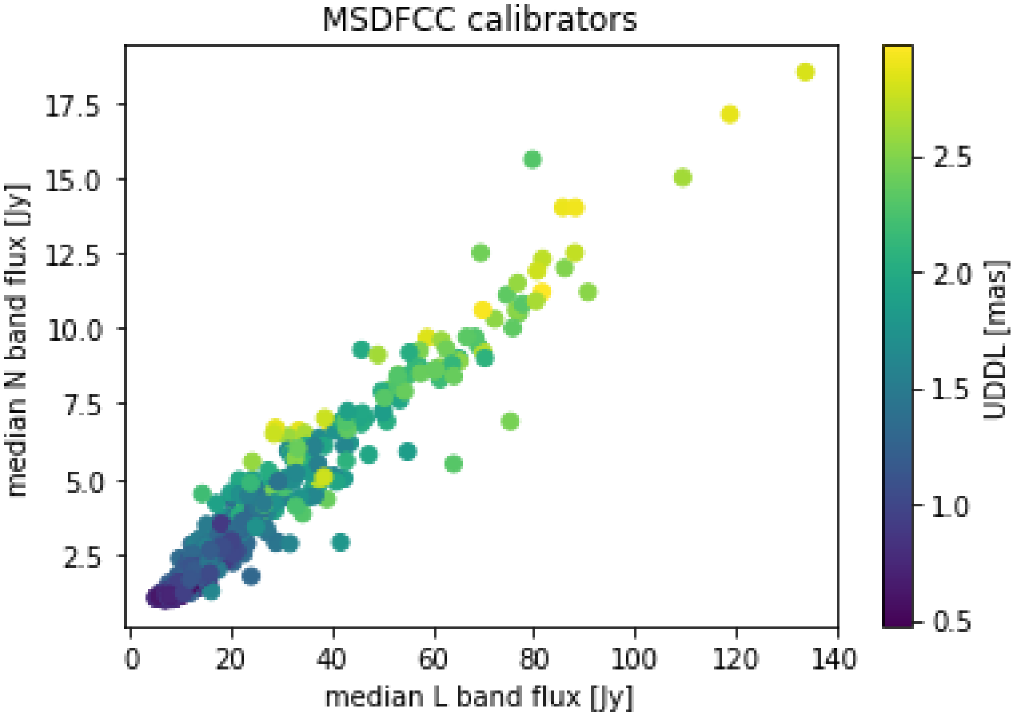
```
In [171]: dec_threshold = 30 * u.deg
          dec = coord.Angle(cal_db["DEJ2000"],unit=u.deg)
          cal_db = cal_db[dec < dec_threshold]

          print("There remain {0} calibrators in the southern hemisphere".format(len(cal_db)))
```

```
There remain 917 calibrators in the southern hemisphere
```

Flux distribution of good calibrators

```
In [172]: plt.scatter(cal_db_plot["median_L"],cal_db_plot["median_N"],c=cal_db_plot["UDDL_est"])
          plt.xlabel("median L band flux [Jy]")
          plt.ylabel("median N band flux [Jy]")
          titlestring="MSDFCC calibrators"
          plt.colorbar(label="UDDL [mas]")
          plt.title(titlestring)
```

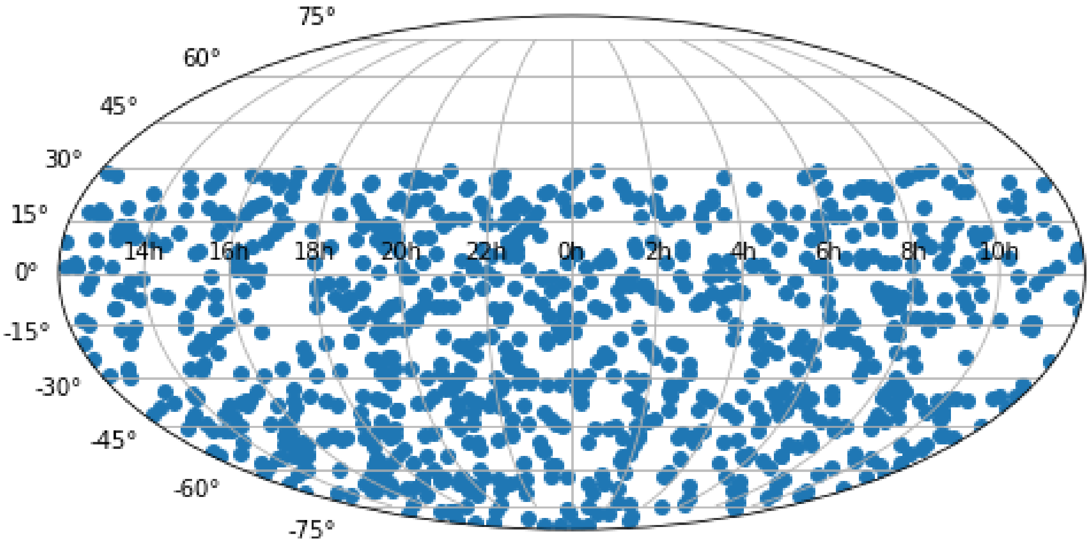
```
Out[172]: <matplotlib.text.Text at 0x10b58f630>
```



Skymap of good calibrators

```
In [173]: ra = coord.Angle(cal_db["RAJ2000"],unit=u.hourangle)
          ra = ra.wrap_at(180*u.degree)
          dec = coord.Angle(cal_db["DEJ2000"],unit=u.deg)
          fig = plt.figure(figsize=(8,6))
          ax = fig.add_subplot(111, projection="mollweide")
          ax.scatter(ra.radian, dec.radian)
          ax.set_xticklabels(['14h','16h','18h','20h','22h','0h','2h','4h','6h','8h','10h'])
          ax.grid(True)
```

```
/usr/local/Cellar/python3/3.6.1/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-pack
  theta = np.arcsin(y / np.sqrt(2))
```



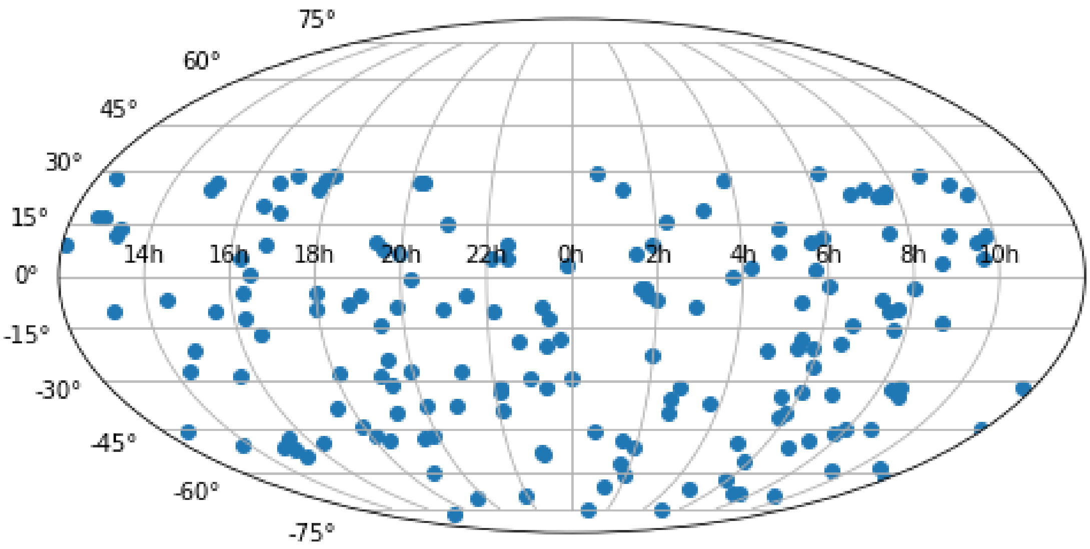
1.2 Hybrid calibrators for MATISSE UT observations

A hybrid calibrator is a calibrator that can be used for both L and N band calibration.

```
In [200]: N_limit_UT=5
          L_limit_UT=1
          cal_db_hybrid_UT = cal_db[(cal_db["median_L"] > L_limit_UT) & (cal_db["median_N"] > N_
          print("There are {0} hybrid calibrators for UT observations".format(len(cal_db_hybrid_
```

```
There are 173 hybrid calibrators for UT observations
```

```
In [201]: import astropy.coordinates as coord
          from astropy import units as u
          ra = coord.Angle(cal_db_hybrid_UT["RAJ2000"],unit=u.hourangle)
          ra = ra.wrap_at(180*u.degree)
          dec = coord.Angle(cal_db_hybrid_UT["DEJ2000"],unit=u.deg)
          fig = plt.figure(figsize=(8,6))
          ax = fig.add_subplot(111, projection="mollweide")
          ax.scatter(ra.radian, dec.radian)
          ax.set_xticklabels(['14h','16h','18h','20h','22h','0h','2h','4h','6h','8h','10h'])
          ax.grid(True)
```



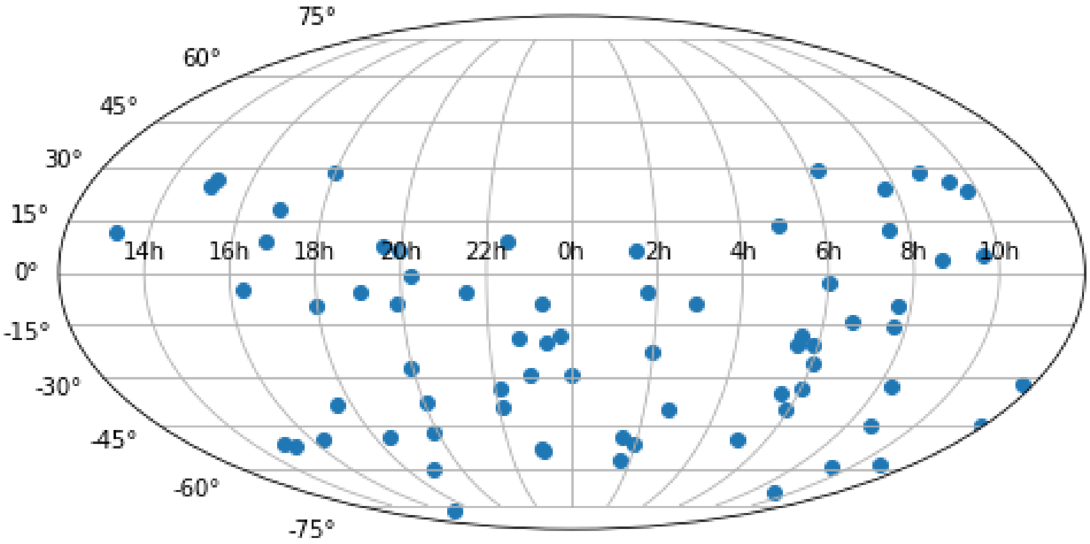
```
In [202]: # show table of UT hybrid calibrators
          from astropy.table import Table
          t=Table([cal_db_hybrid_UT["Name"],
                   cal_db_hybrid_UT["SpType"],
                   cal_db_hybrid_UT["RAJ2000"],
                   cal_db_hybrid_UT["DEJ2000"],
                   cal_db_hybrid_UT["UDDL_est"],
                   cal_db_hybrid_UT["median_L"],
                   cal_db_hybrid_UT["median_N"]],
                  names=["Name","SpType","RAJ2000","DEJ2000","UDDL_est","median_L","median_N"])
          t.show_in_notebook()

Out[202]: <IPython.core.display.HTML object>
```

1.3 Hybrid calibrators for MATISSE AT observations

```
In [207]: N_limit_AT=8
          L_limit_AT=5
          cal_db_hybrid_AT = cal_db[(cal_db["median_L"] > L_limit_AT) & (cal_db["median_N"] > N_
          print("There are {0} hybrid calibrators for AT observations".format(len(cal_db_hybrid_

There are 71 hybrid calibrators for AT observations
```

```
In [208]: ra = coord.Angle(cal_db_hybrid_AT["RAJ2000"],unit=u.hourangle)
          ra = ra.wrap_at(180*u.degree)
          dec = coord.Angle(cal_db_hybrid_AT["DEJ2000"],unit=u.deg)
          fig = plt.figure(figsize=(8,6))
          ax = fig.add_subplot(111, projection="mollweide")
```

```
ax.scatter(ra.radian, dec.radian)
ax.set_xticklabels(['14h','16h','18h','20h','22h','0h','2h','4h','6h','8h','10h'])
ax.grid(True)
```



```
In [209]: # show table of AT hybrid calibrators
          from astropy.table import Table
          t=Table([cal_db_hybrid_AT["Name"],
                   cal_db_hybrid_AT["SpType"],
                   cal_db_hybrid_AT["RAJ2000"],
                   cal_db_hybrid_AT["DEJ2000"],
                   cal_db_hybrid_AT["UDDL_est"],
                   cal_db_hybrid_AT["median_L"],
                   cal_db_hybrid_AT["median_N"]],
                  names=["Name","SpType","RAJ2000","DEJ2000","UDDL_est","median_L","median_N"])
          t.show_in_notebook()

Out[209]: <IPython.core.display.HTML object>
```