1.1_ATLAS

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of ATLAS/VST data

ATLAS/VST catalogue: the catalogue comes from `dmu0_ATLAS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (2")
- The Petrosian magnitude to be used as total magnitude (no "auto" magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-20 13:37:11.198747
```

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
Out[6]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

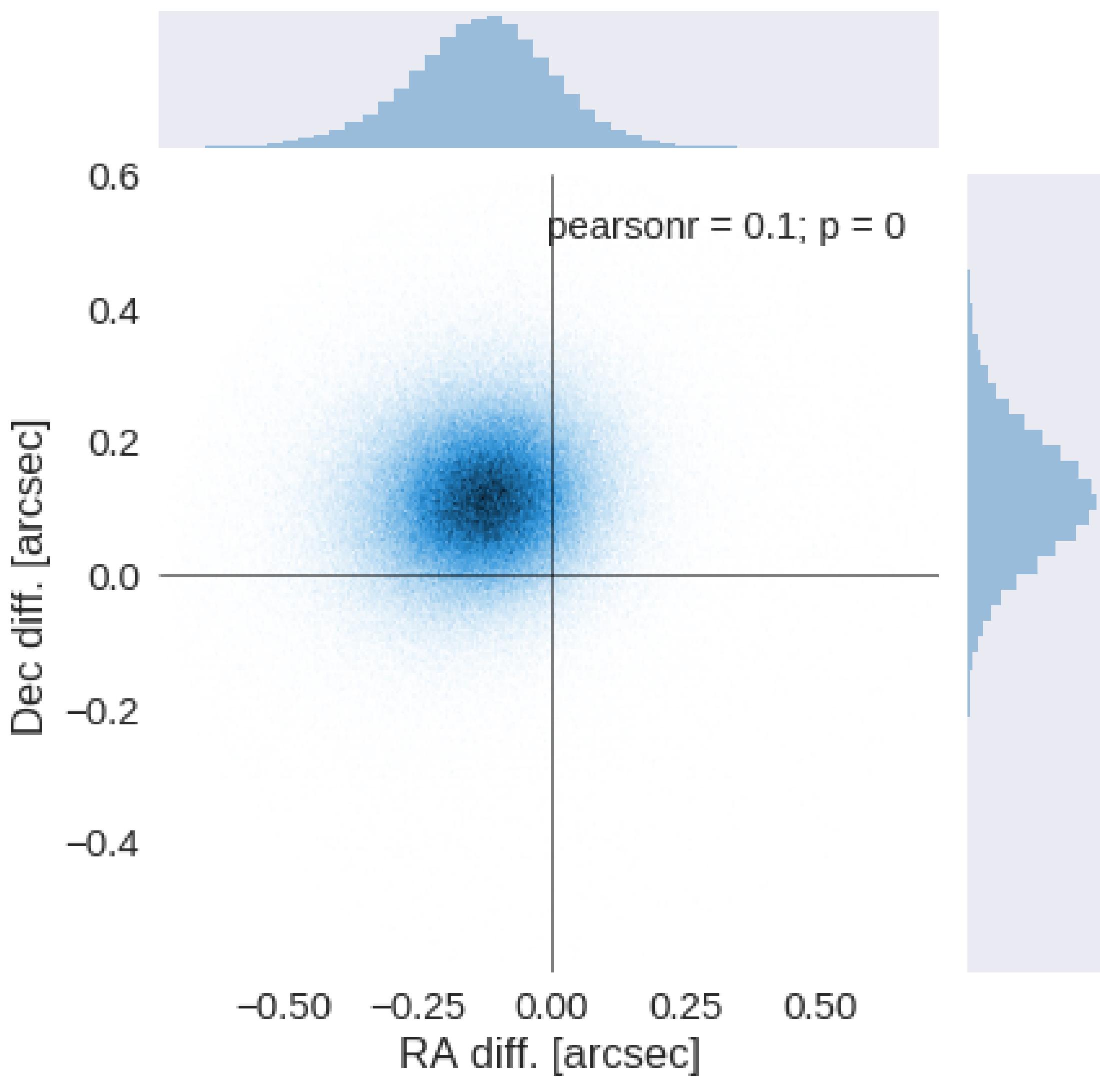
We remove duplicated objects from the input catalogues.

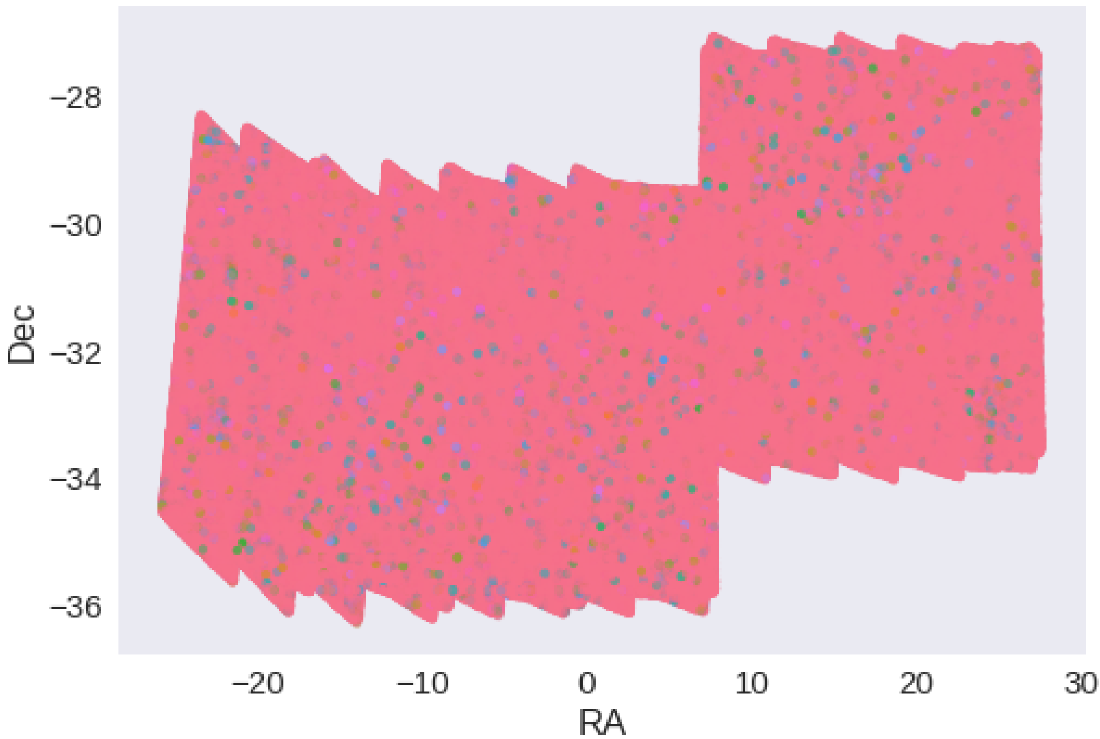
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 7937203 sources.
The cleaned catalogue has 7562634 sources (374569 removed).
The cleaned catalogue has 362887 sources flagged as having been cleaned
```

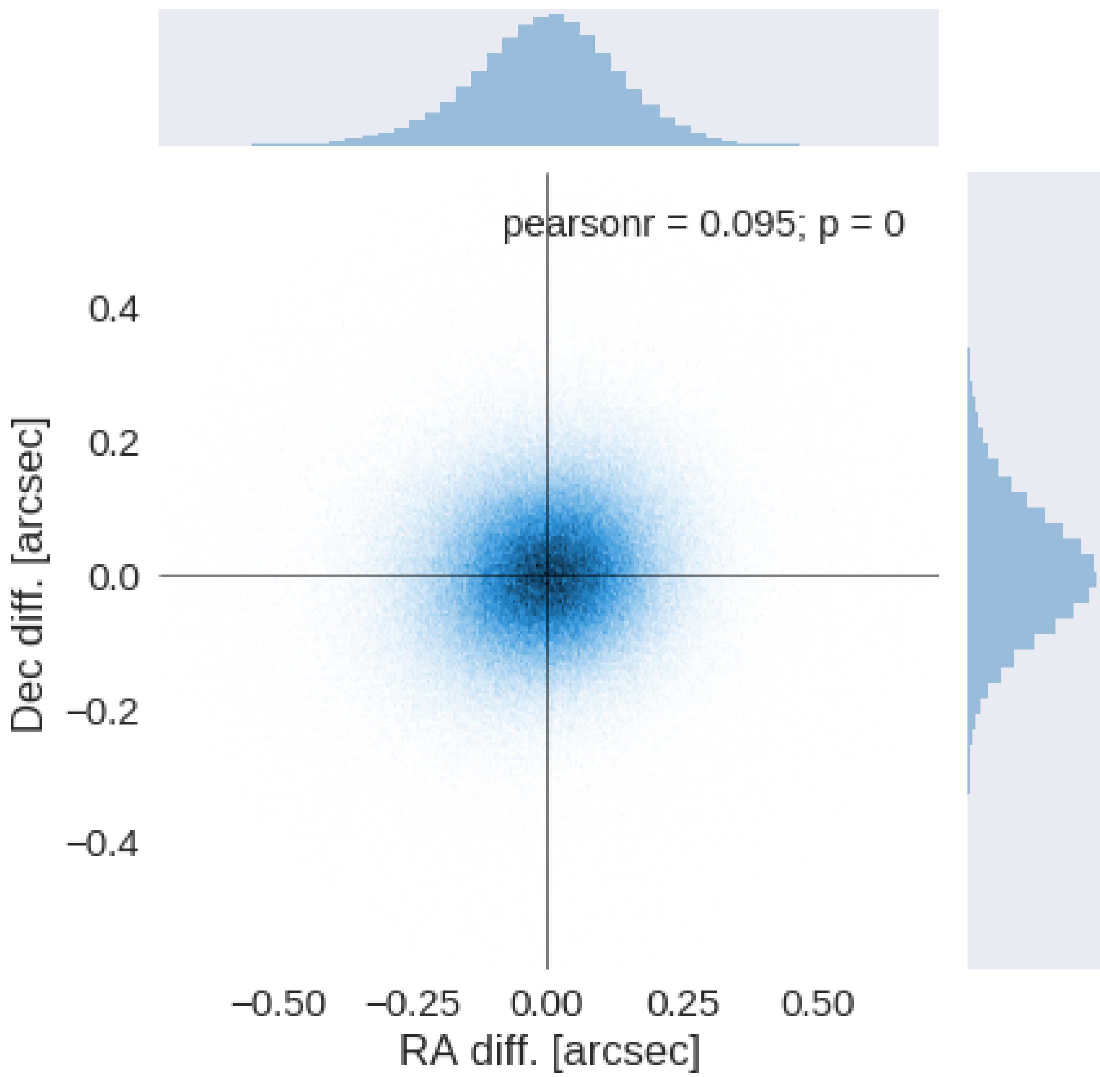
1.4 III - Astrometry correction

We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

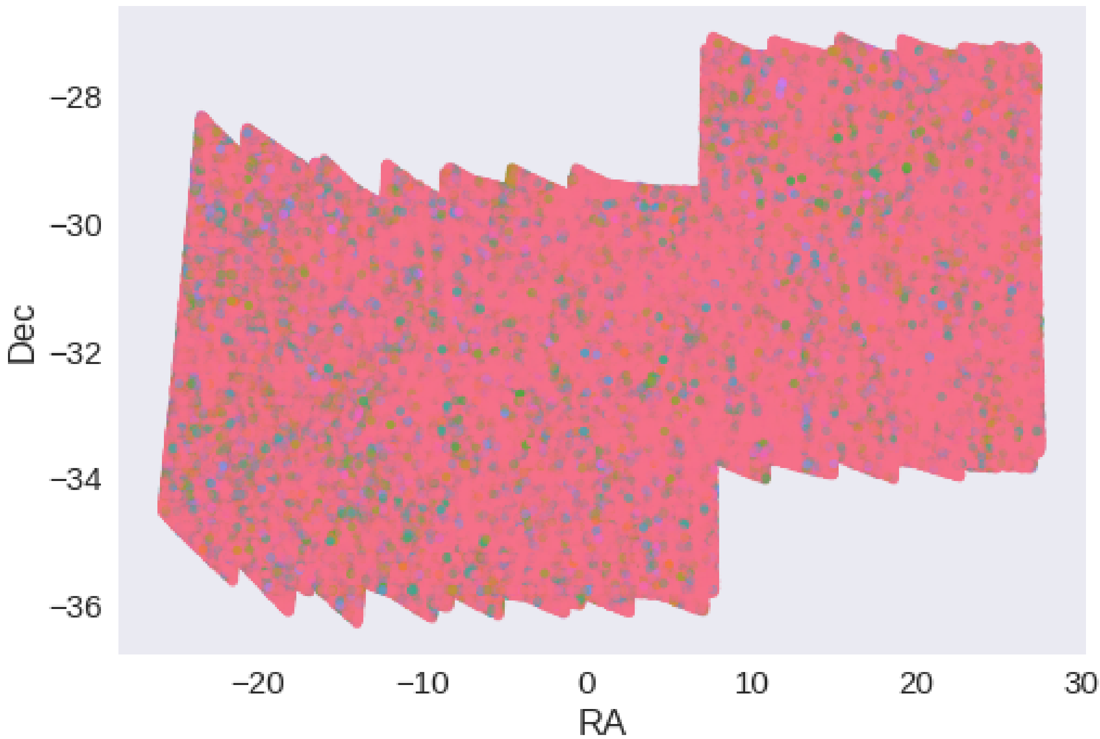





```
RA correction: 0.12983922202352005 arcsec
Dec correction: -0.11415334424285106 arcsec
```



pearsonr = 0.095; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
754069 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.2_KIDS

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of KIDS/VST data

Kilo Degree Survey/VLT Survey Telescope catalogue: the catalogue comes from `dmu0_KIDS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (10 pixels = 2")
- The Petrosian magnitude to be used as total magnitude (no "auto" magnitude is provided).

We take 2014 as the observation year from a typical image header.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-19 22:56:56.995874
```

1.2 I - Column selection

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero enc
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value enco
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: invalid value enco
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

```
Out[6]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

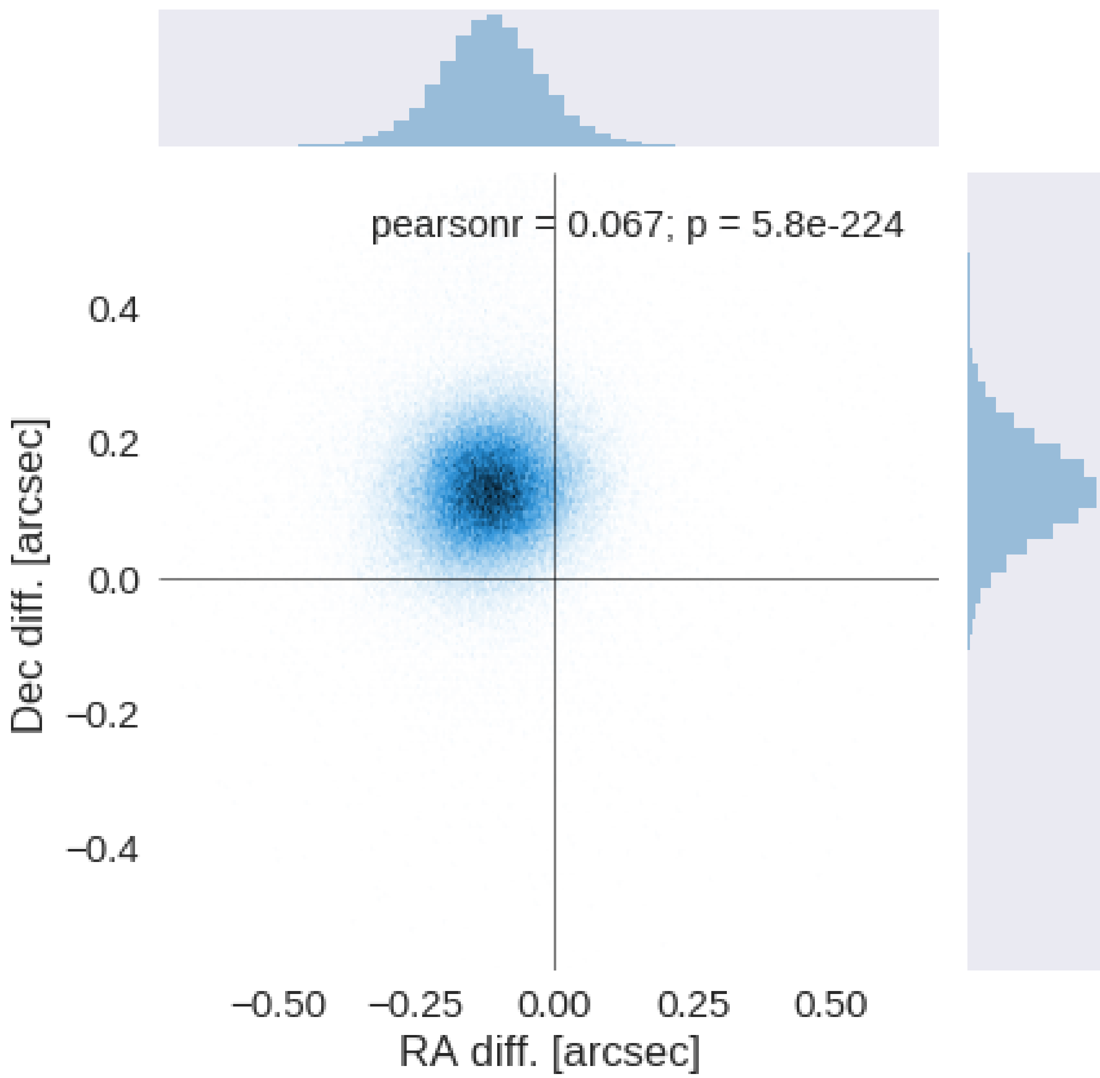
We remove duplicated objects from the input catalogues.

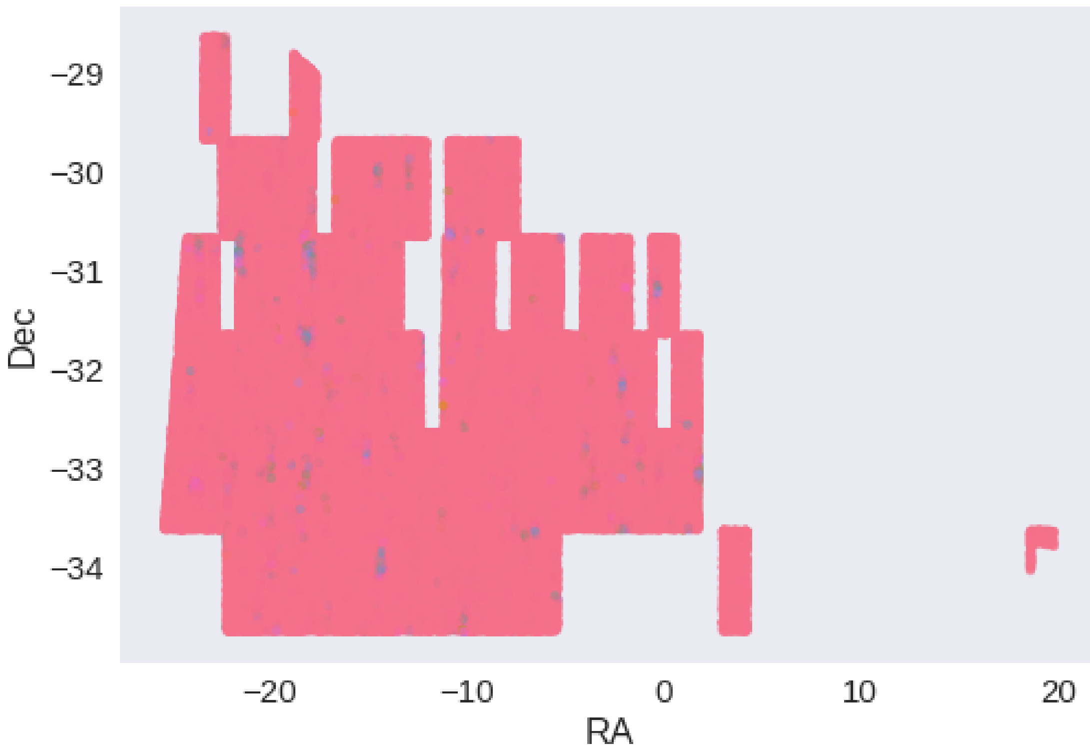
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 9667089 sources.
The cleaned catalogue has 9666966 sources (123 removed).
The cleaned catalogue has 123 sources flagged as having been cleaned
```

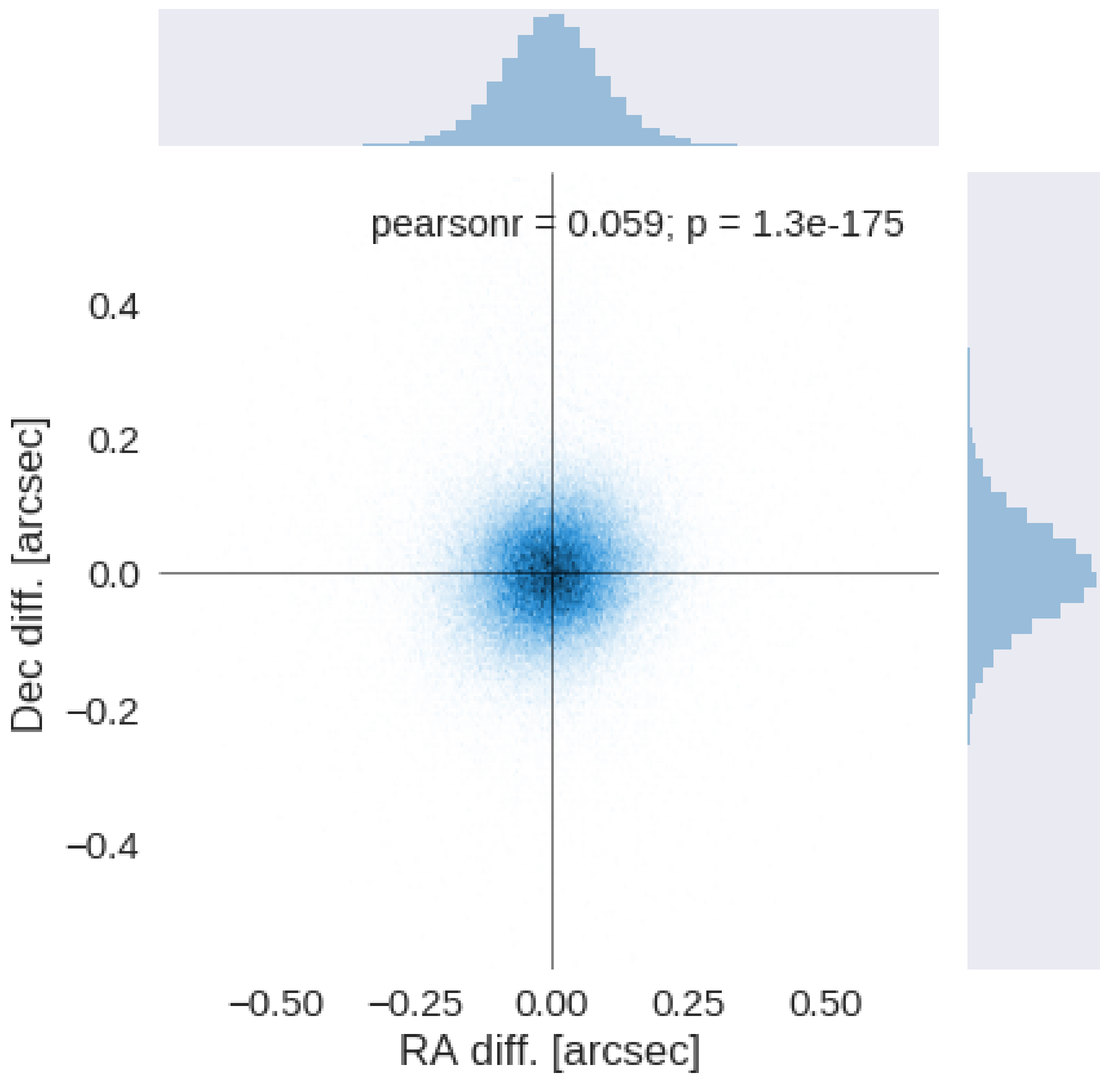
1.4 III - Astrometry correction

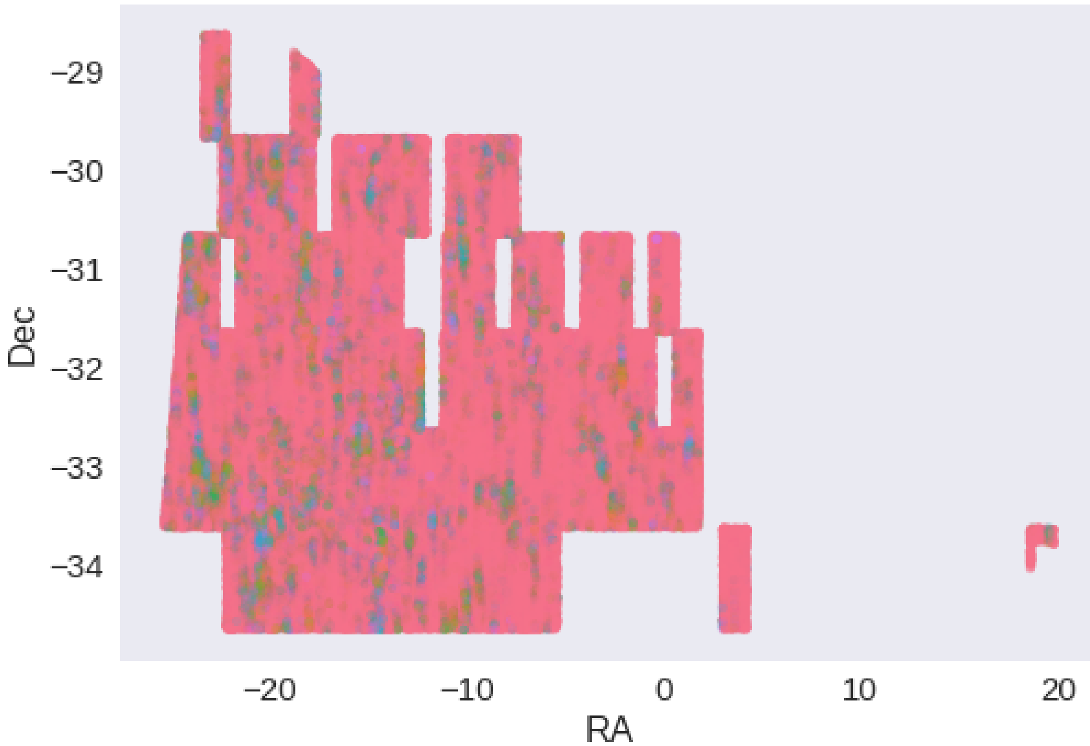
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.11440588580171607 arcsec
Dec correction: -0.12961663829287318 arcsec
```


pearsonr = 0.059; p = 1.3e-175
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
240146 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_PanSTARRS-3SS

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of Pan-STARRS1 - 3pi Steradian Survey (3SS) data

This catalogue comes from `dmu0_PanSTARRS1-3SS`.

In the catalogue, we keep:

- The `uniquePspsSTid` as unique object identifier;
- The r-band position which is given for all the sources;
- The grizy `<band>FApMag` aperture magnitude (see below);
- The grizy `<band>FKronMag` as total magnitude.

The Pan-STARRS1-3SS catalogue provides for each band an aperture magnitude defined as "In PS1, an 'optimal' aperture radius is determined based on the local PSF. The wings of the same analytic PSF are then used to extrapolate the flux measured inside this aperture to a 'total' flux."

The observations used for the catalogue where done between 2010 and 2015 (ref).

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-19 23:13:40.115528
```

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
Out[6]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

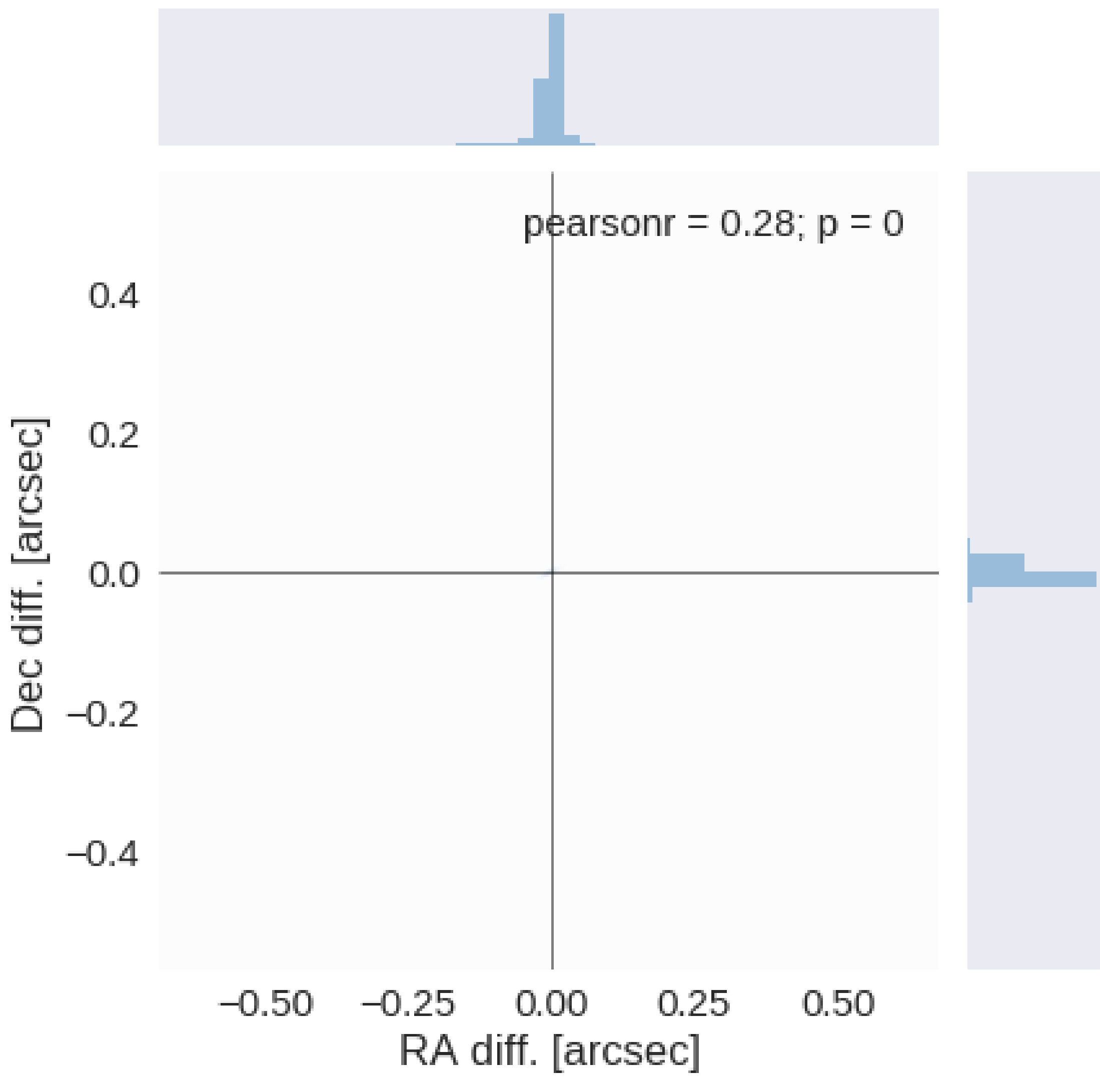
We remove duplicated objects from the input catalogues.

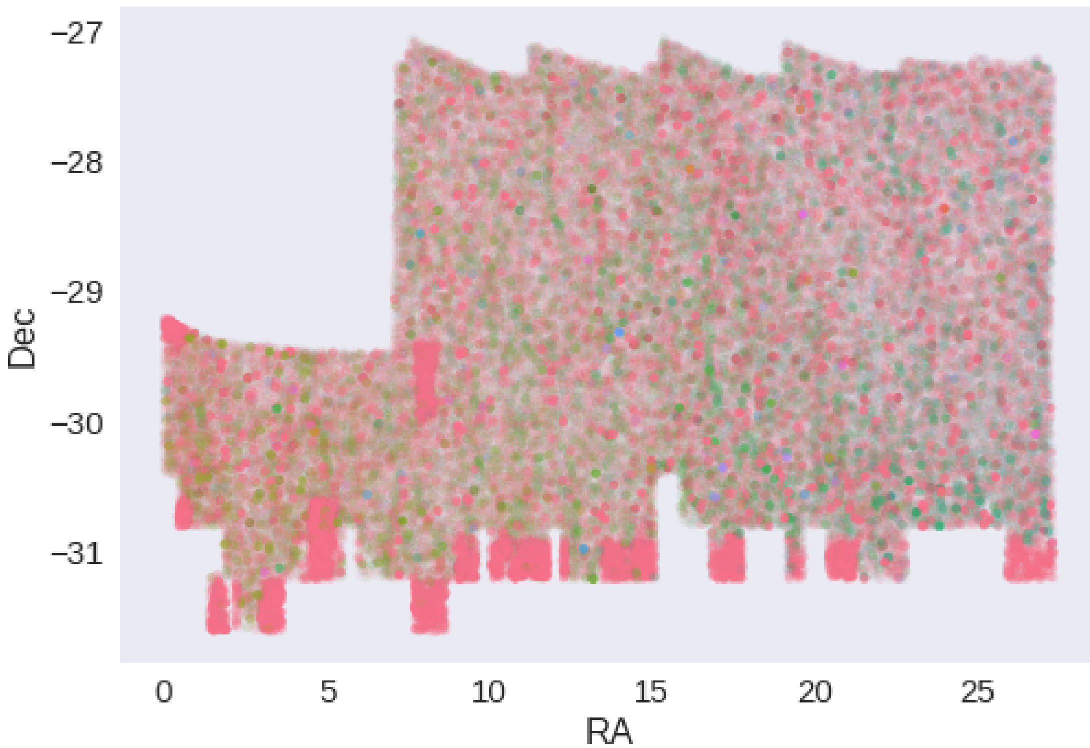
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 1176484 sources.
The cleaned catalogue has 1175819 sources (665 removed).
The cleaned catalogue has 665 sources flagged as having been cleaned
```

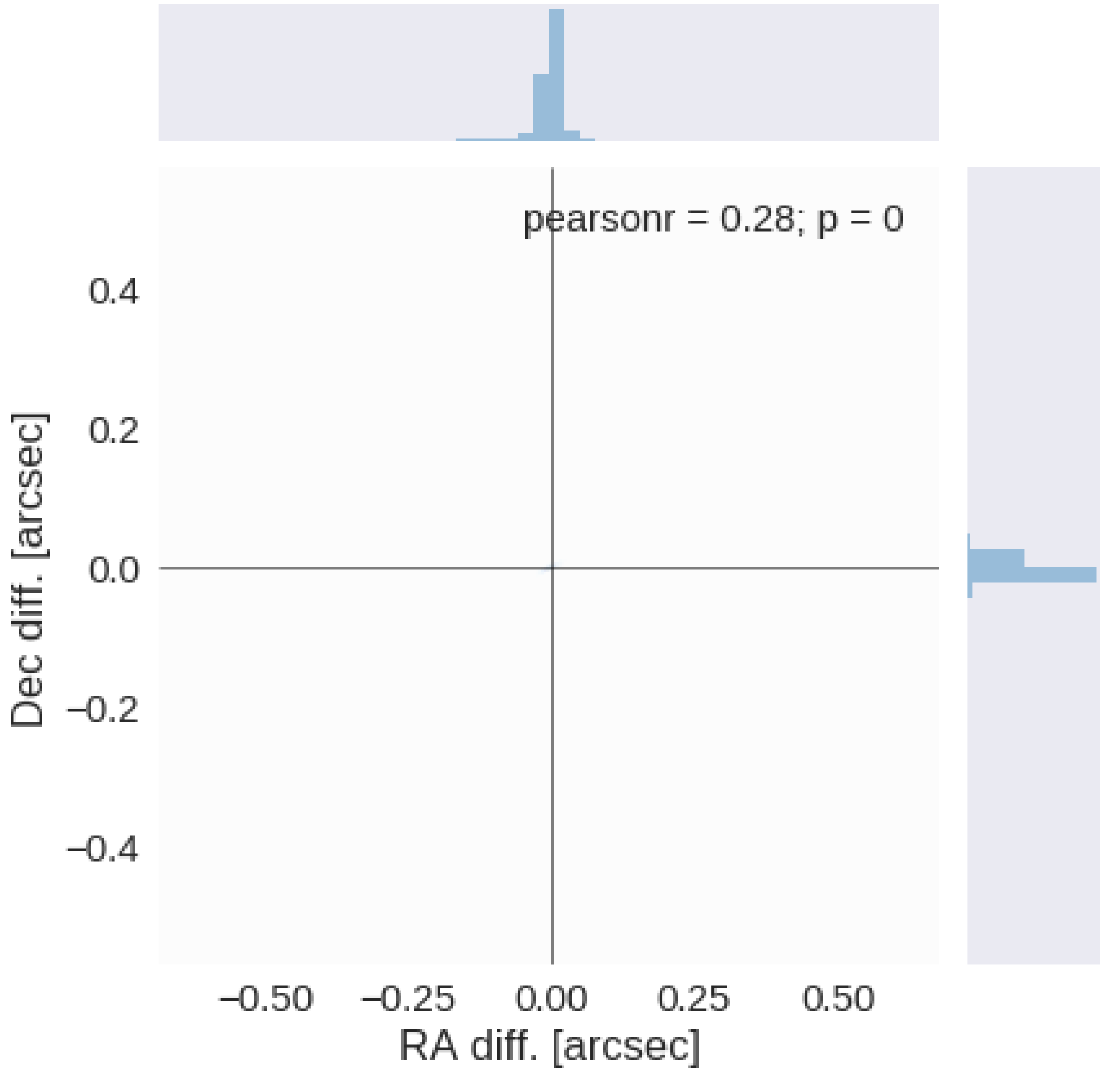
1.4 III - Astrometry correction

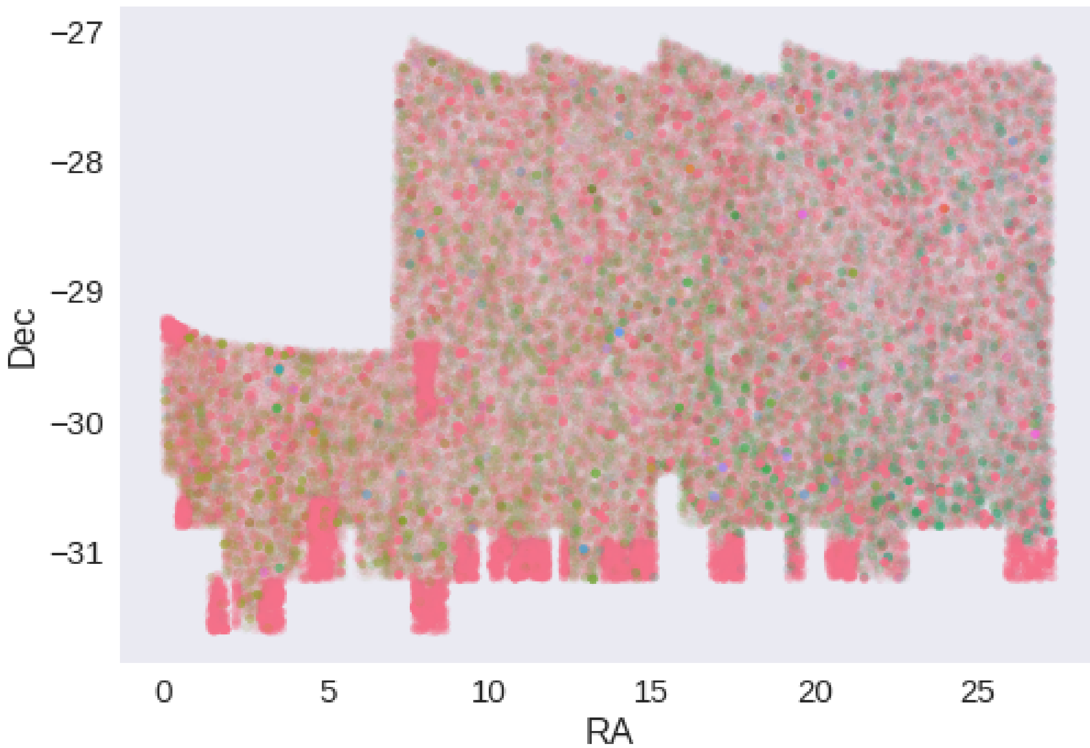
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 5.458857685880503e-05 arcsec
Dec correction: -0.0004657485661141436 arcsec
```


pearsonr = 0.28; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
176621 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_VISTA-VIKING

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of VIKING data

VISTA telescope/VIKING catalogue: the catalogue comes from `dmu0_VIKING`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band.
- The kron magnitude to be used as total magnitude (no "auto" magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-20 12:21:10.295565
```

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
Out[7]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

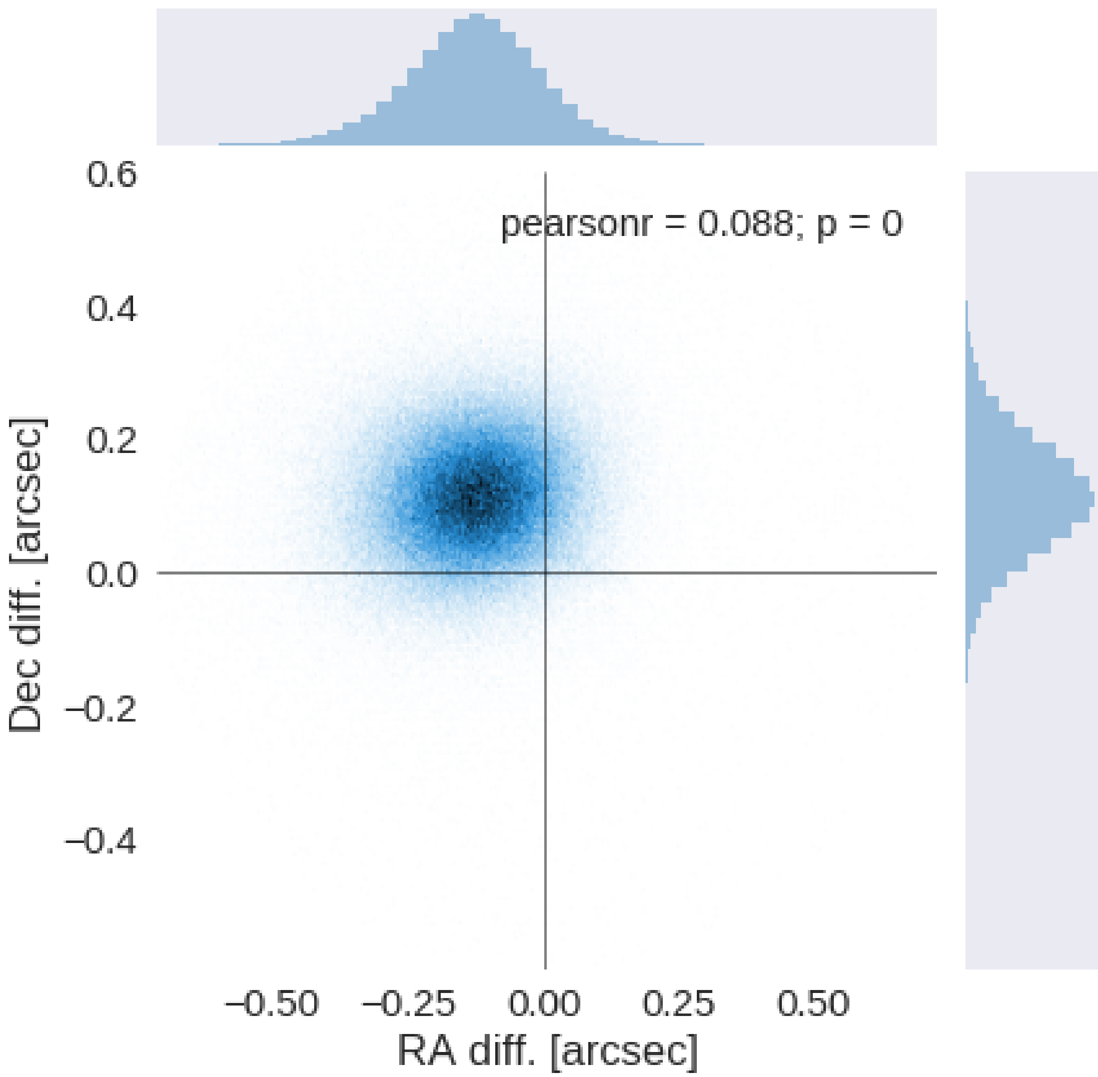
We remove duplicated objects from the input catalogues.

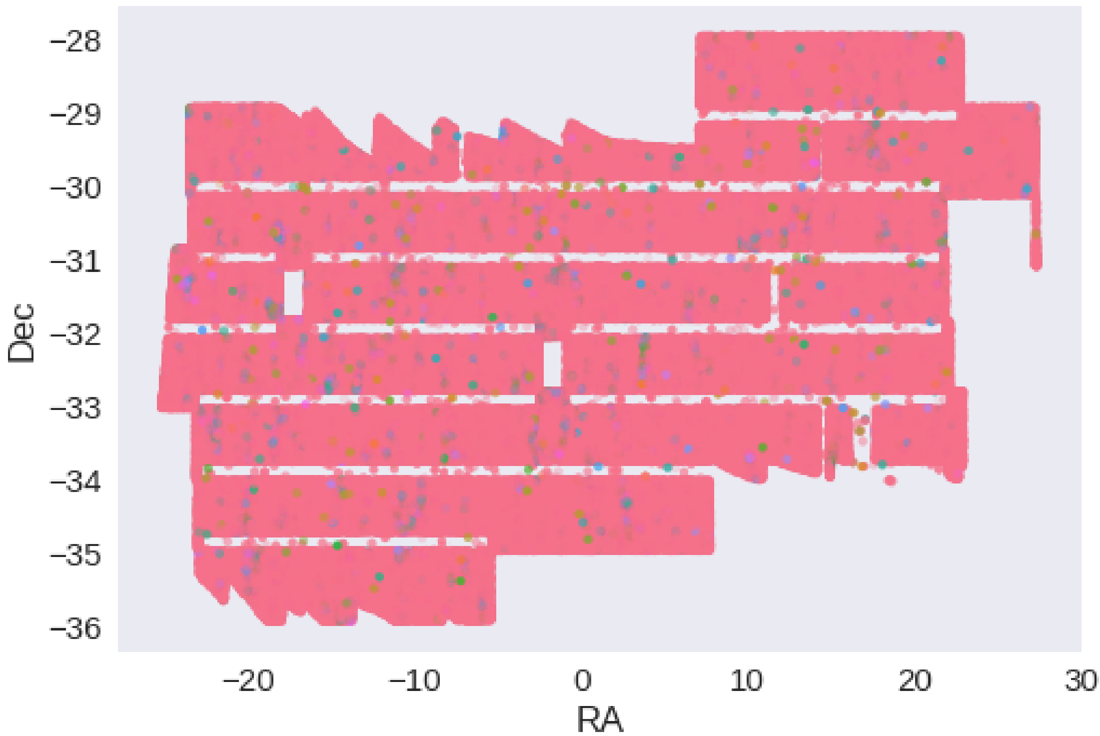
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 12380676 sources.
The cleaned catalogue has 12350404 sources (30272 removed).
The cleaned catalogue has 30050 sources flagged as having been cleaned
```

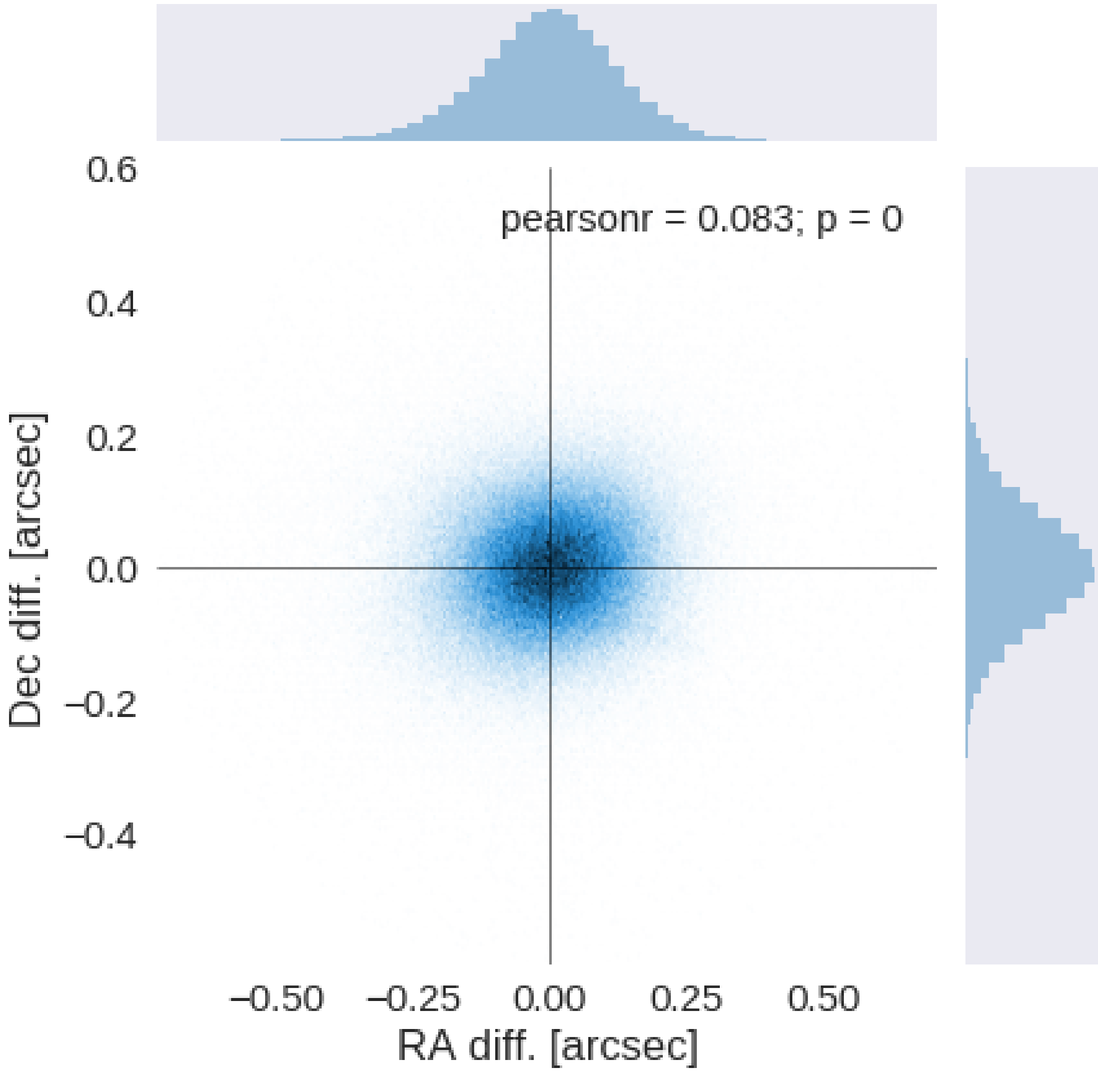
1.4 III - Astrometry correction

We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

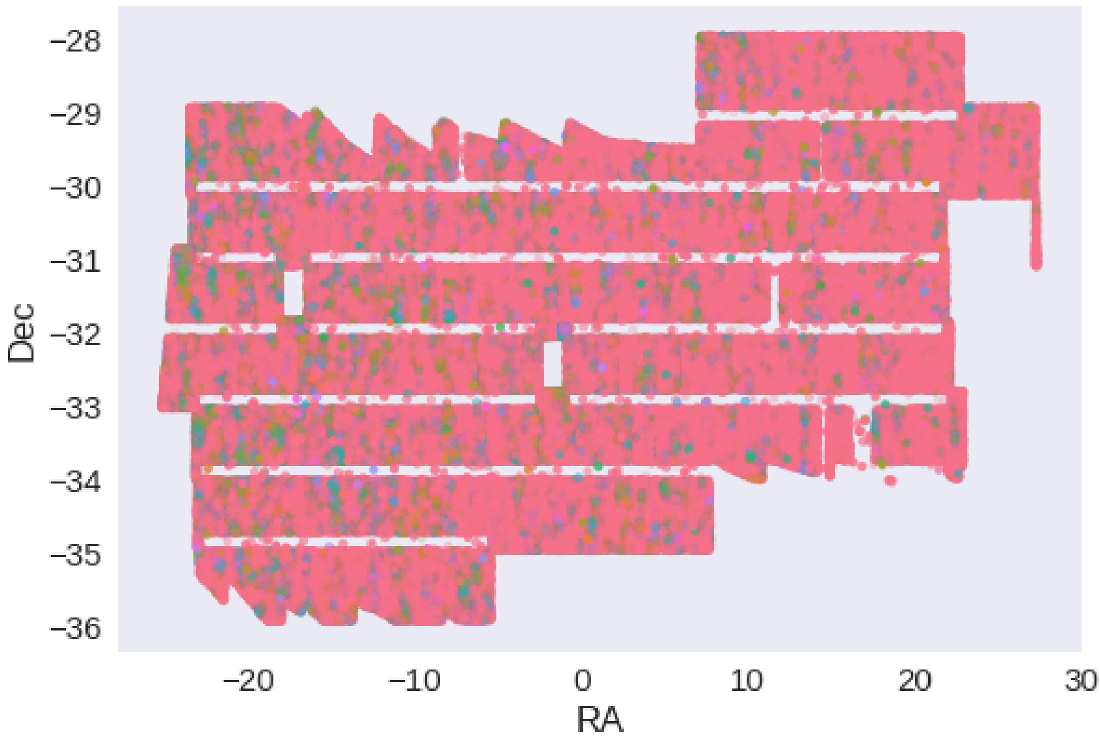





```
RA correction: 0.12487526277027428 arcsec
Dec correction: -0.11282892556891966 arcsec
```



pearsonr = 0.083; p = 0
0.6
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
468817 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.5_DES

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of DES data

Blanco DES catalogue: the catalogue comes from `dmu0_DES`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The G band stellarity;
- The magnitude for each band.
- The auto/kron magnitudes/fluxes to be used as total magnitude.
- The aperture magnitudes, which are used to compute a corrected 2 arcsec aperture magnitude.

We don't know when the maps have been observed. We will take the final observation date as 2017.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-21 17:43:55.277747
```

1.2 1 - Aperture correction

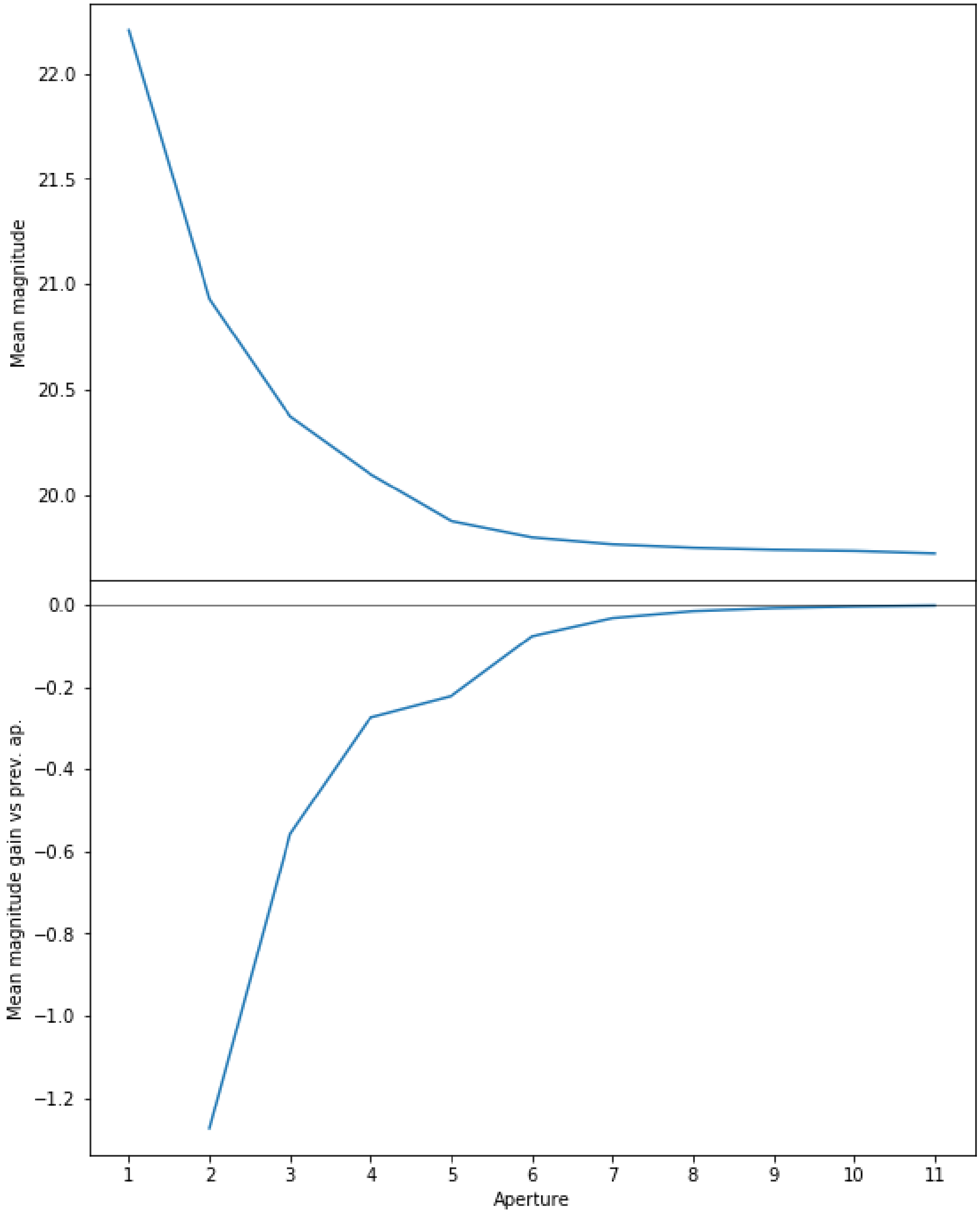
To compute aperture correction we need to dertermine two parametres: the target aperture and the range of magnitudes for the stars that will be used to compute the correction.

Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures:

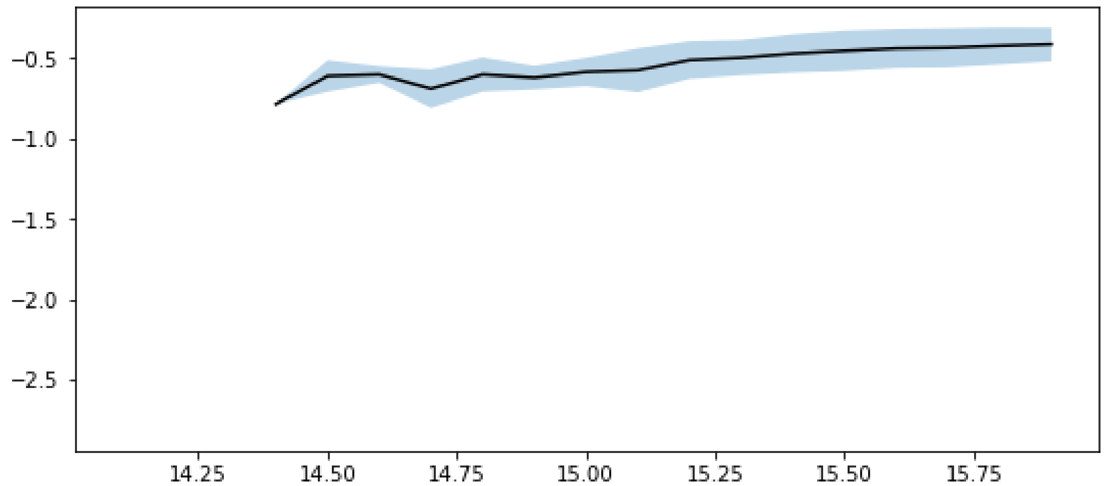
The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude. The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course). As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

Magnitude range: To know what limits in aperture to use when doing the aperture correction, we plot for each magnitude bin the correction that is computed and its RMS. We should then use the wide limits (to use more stars) where the correction is stable and with few dispersion.

1.2.1 I.a - g band



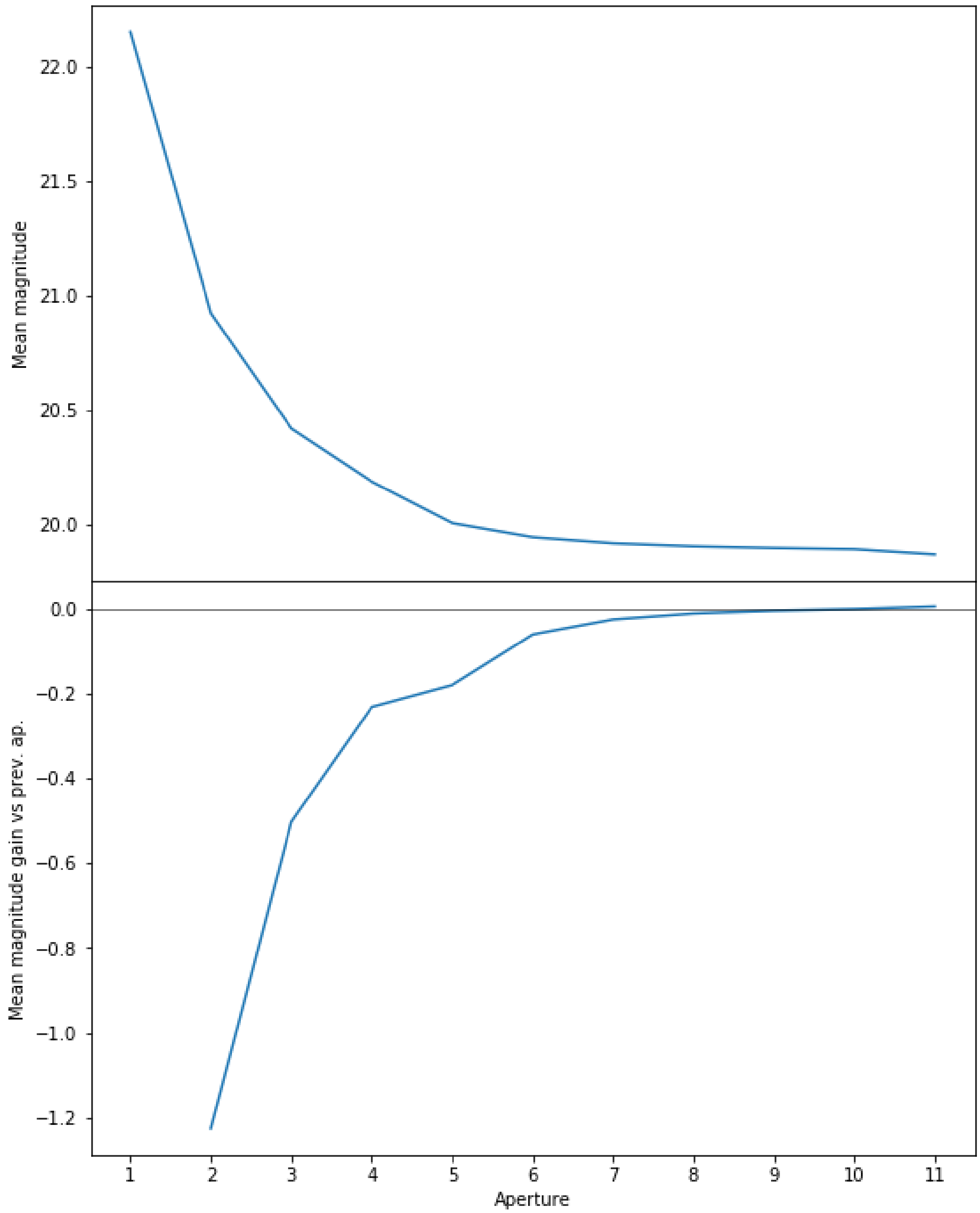
We will use aperture 10 as target.



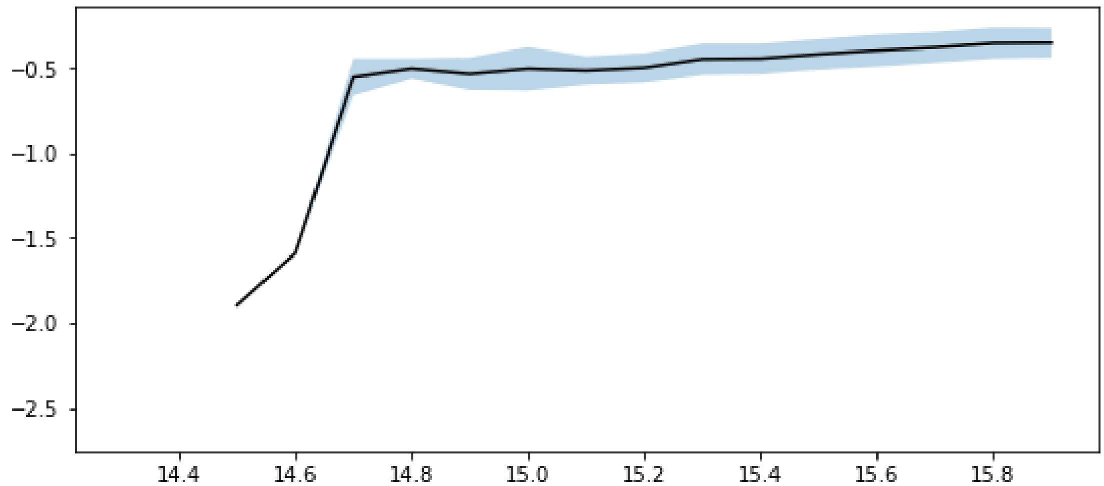
We will use magnitudes between 15.0 and 16.0

```
Aperture correction for g band:
Correction: -0.43956947326660156
Number of source used: 8336
RMS: 0.12080908091581184
```

1.2.2 I.b - r band



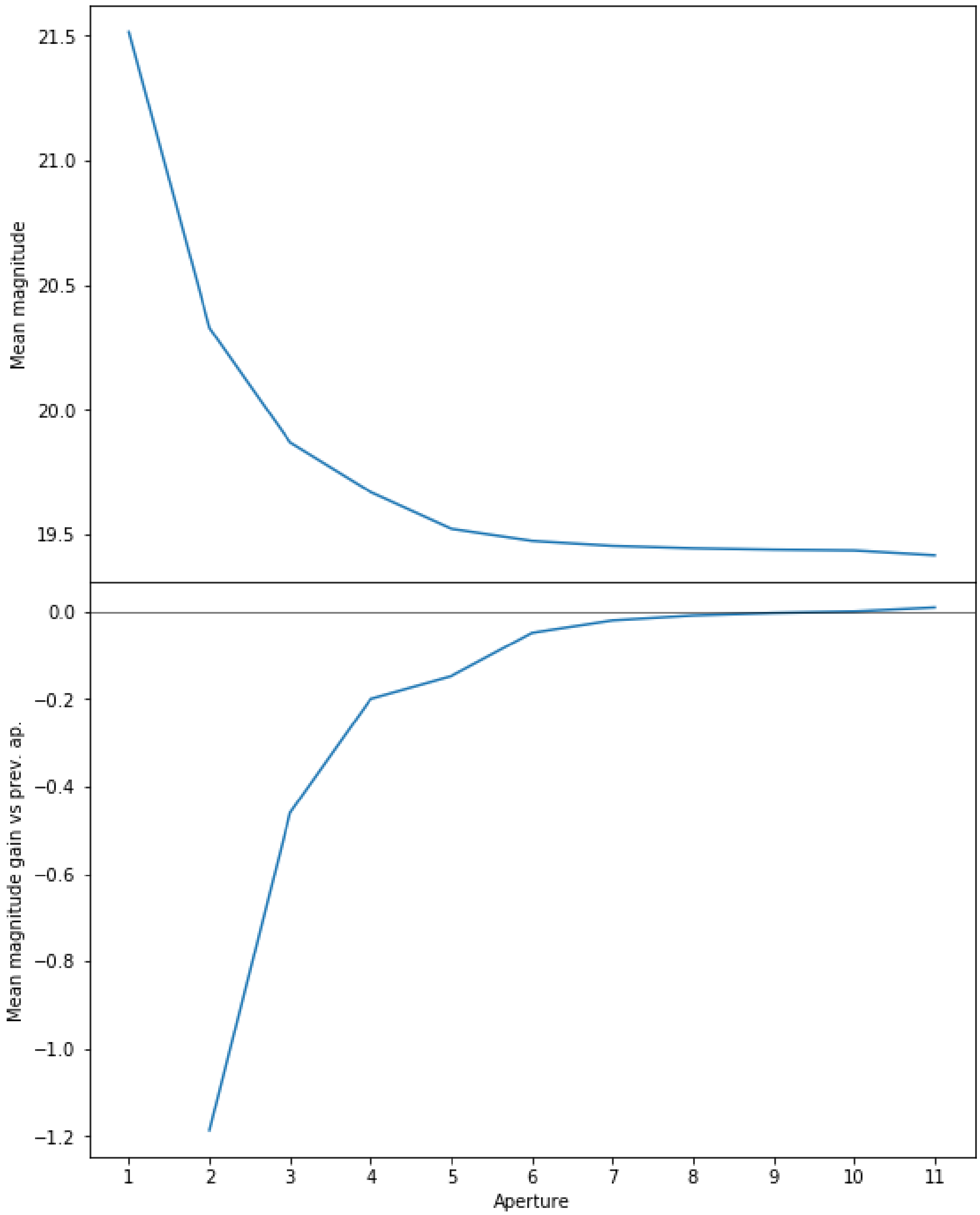
We will use aperture 10 as target.



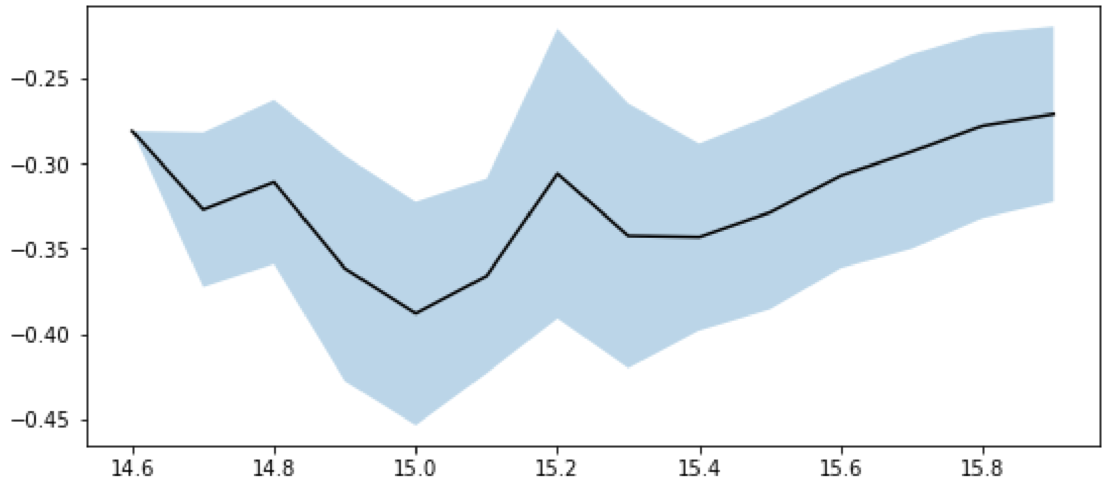
We use magnitudes between 15.0 and 16.0.

```
Aperture correction for r band:
Correction: -0.37449073791503906
Number of source used: 5338
RMS: 0.09751122649201878
```

1.2.3 I.b - i band



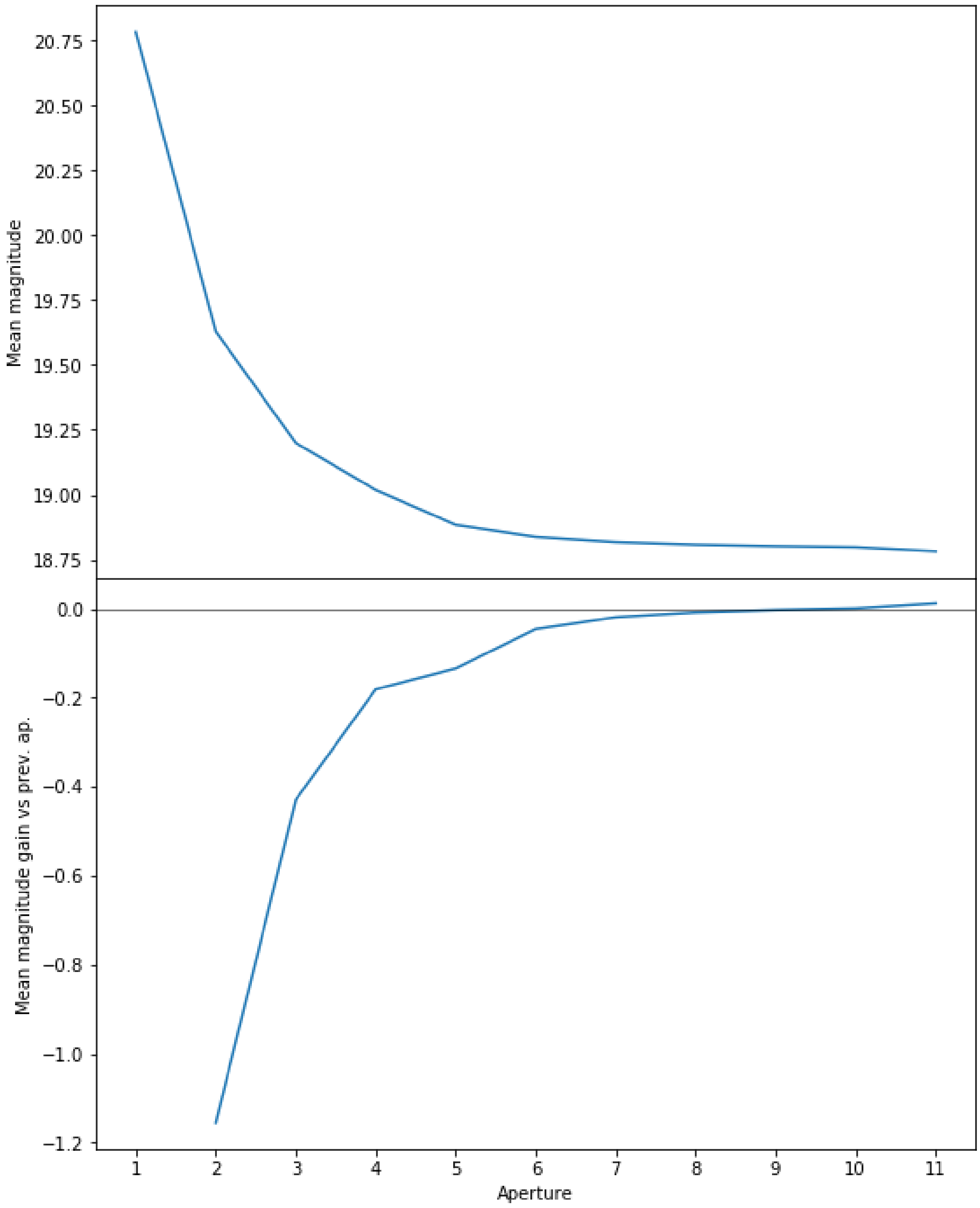
We will use aperture 10 as target.



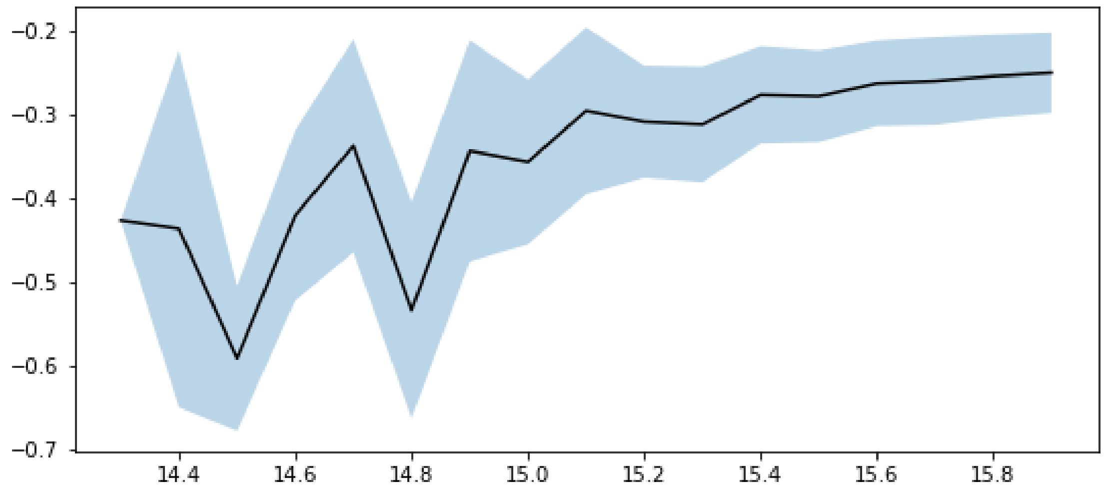
We use magnitudes between 15.0 and 16.0.

```
Aperture correction for i band:
Correction: -0.2837257385253906
Number of source used: 4319
RMS: 0.058088824540272574
```

1.2.4 I.b - z band



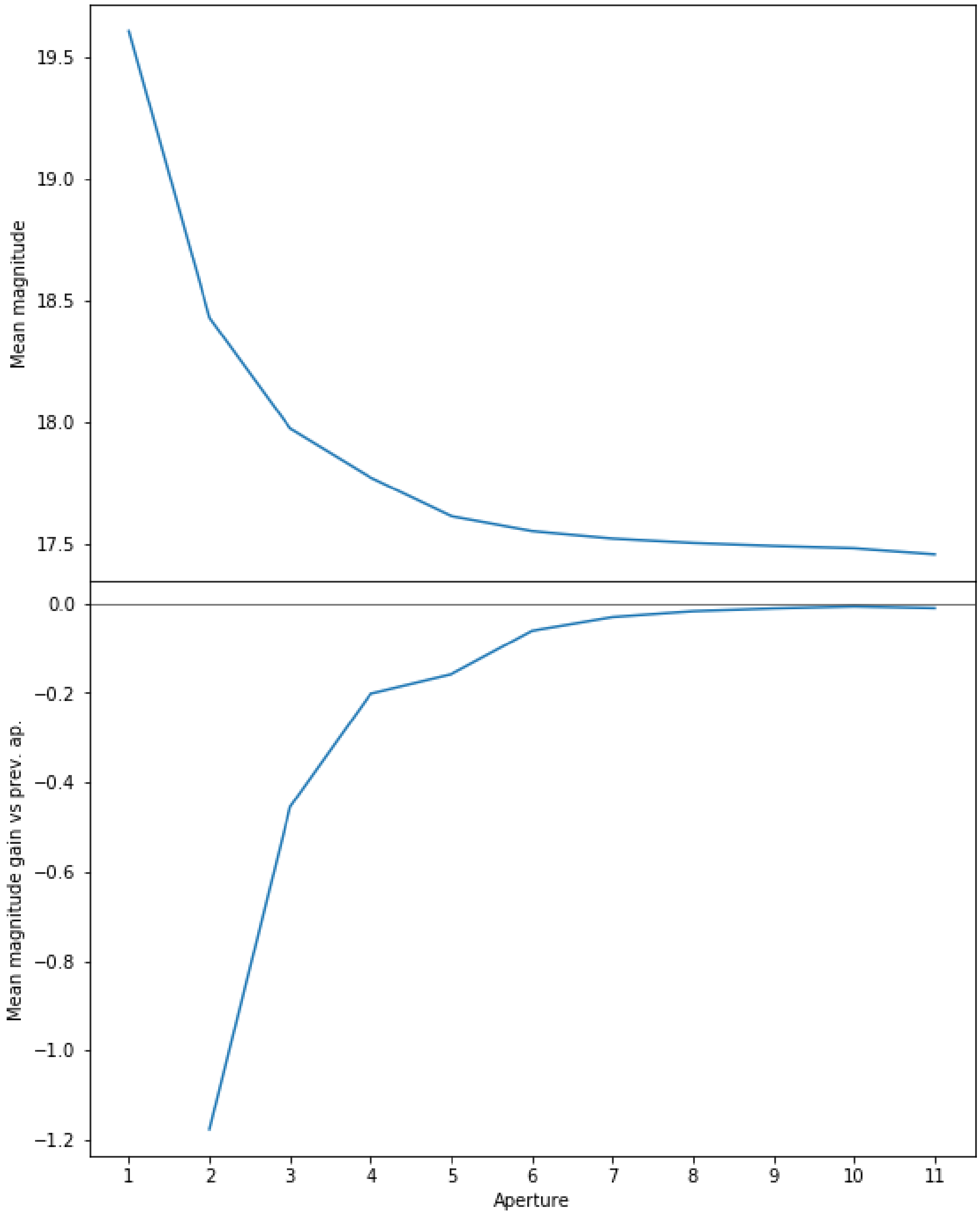
We will use aperture 57 as target.



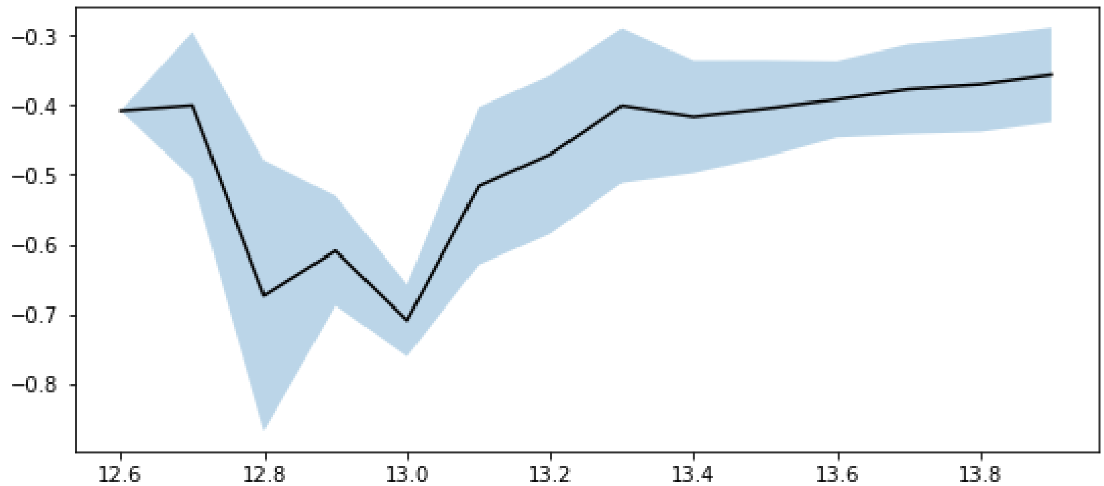
We use magnitudes between 15.0 and 16.0.

```
Aperture correction for z band:
Correction: -0.2564411163330078
Number of source used: 8152
RMS: 0.051805109263165755
```

1.2.5 I.b - y band



We will use aperture 10 as target.



We use magnitudes between 15.0 and 16.0.

```
Aperture correction for y band:
Correction: -0.2907543182373047
Number of source used: 11219
RMS: 0.043677835648857084
```

1.3 2 - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
Out[24]: <IPython.core.display.HTML object>
```

1.4 II - Removal of duplicated sources

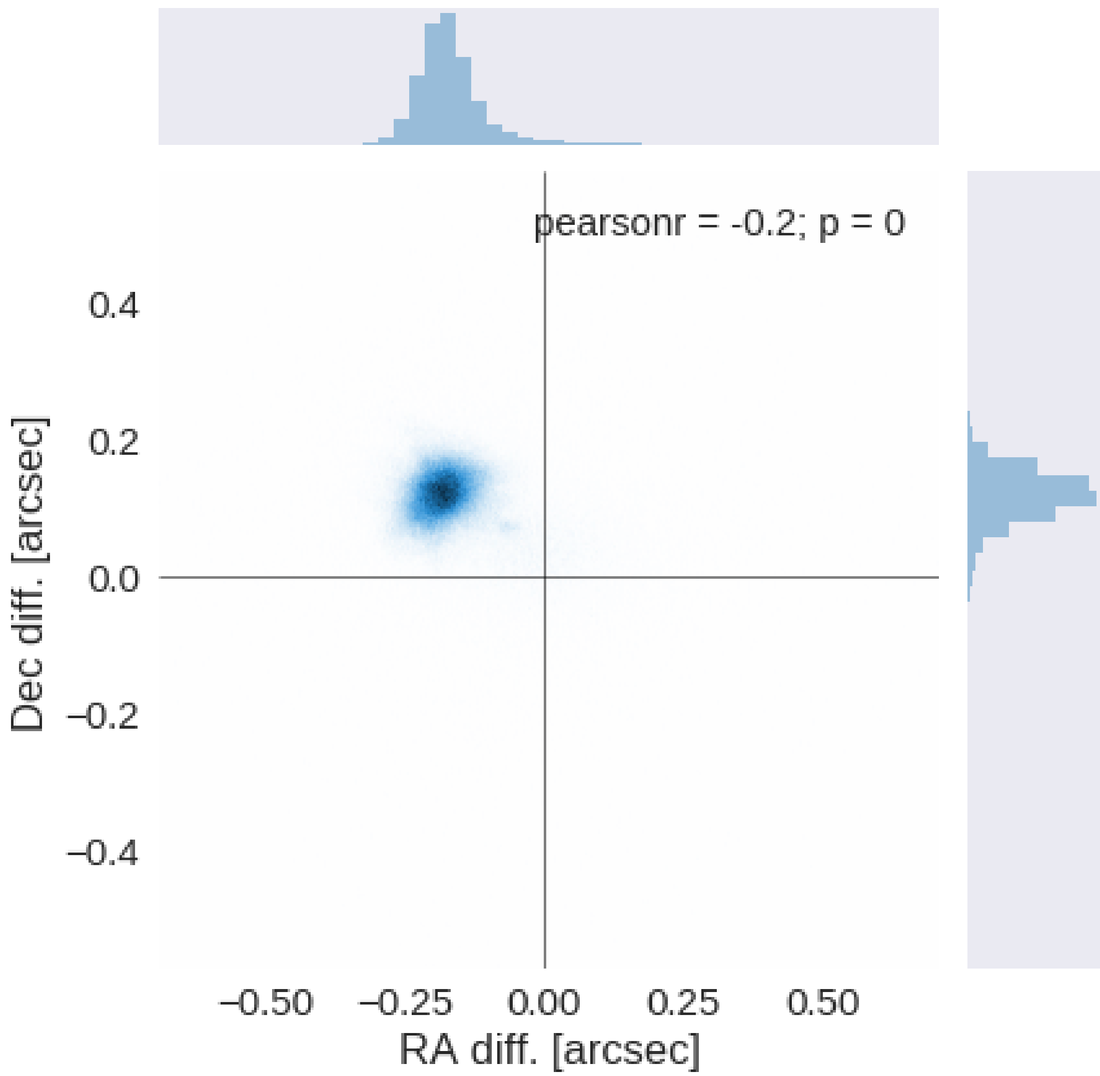
We remove duplicated objects from the input catalogues.

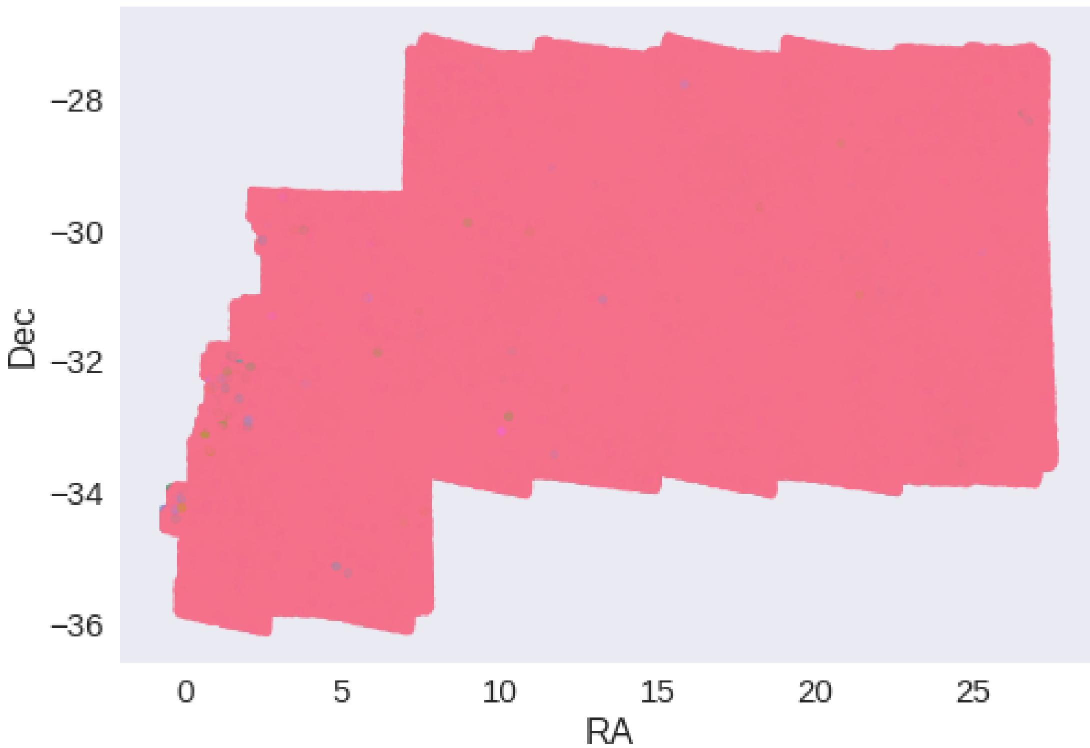
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 10611105 sources.
The cleaned catalogue has 10610962 sources (143 removed).
The cleaned catalogue has 143 sources flagged as having been cleaned
```

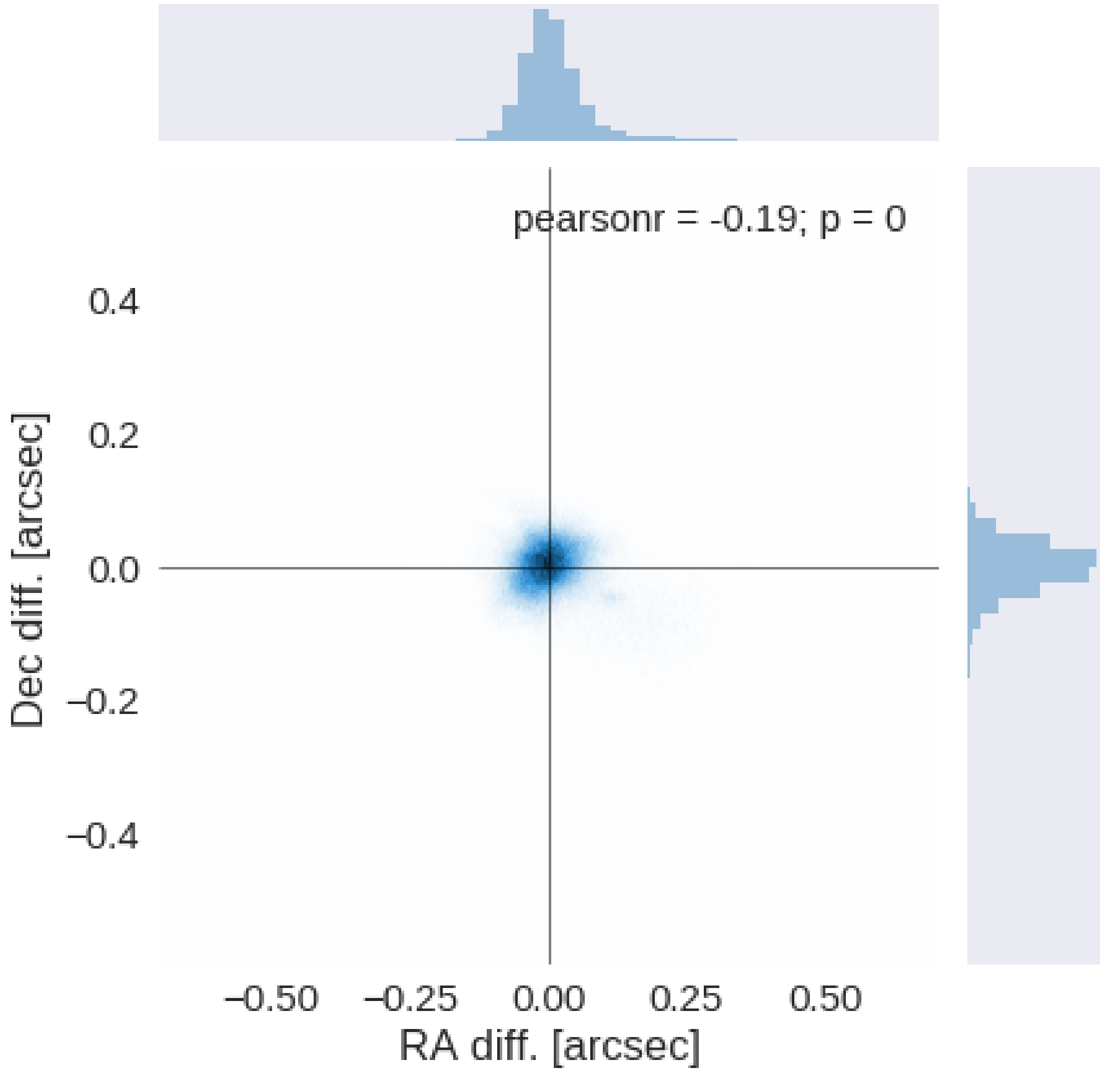
1.5 III - Astrometry correction

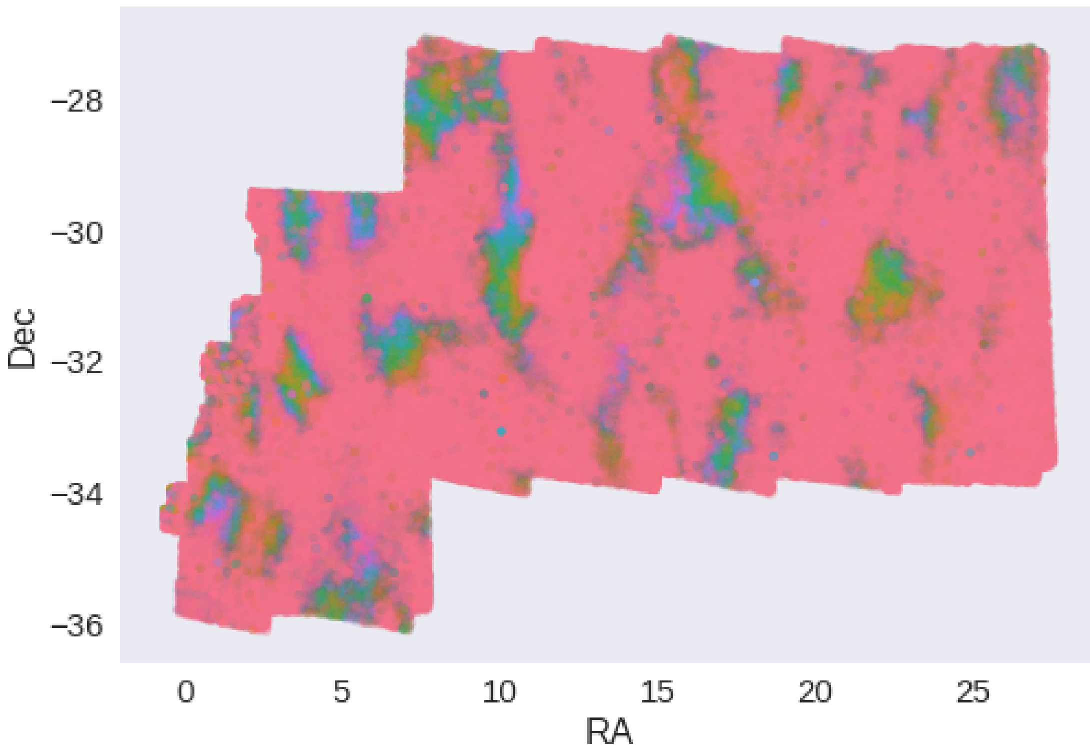
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.1809856744952043 arcsec
Dec correction: -0.11979971748701246 arcsec
```


pearsonr = -0.19; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.6 IV - Flagging Gaia objects

```
350801 sources flagged.
```

1.7 V - Flagging objects near bright stars

2 VI - Saving to disk

2.1_Omegacam_merge

March 8, 2018

1 HATLAS-SGP master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

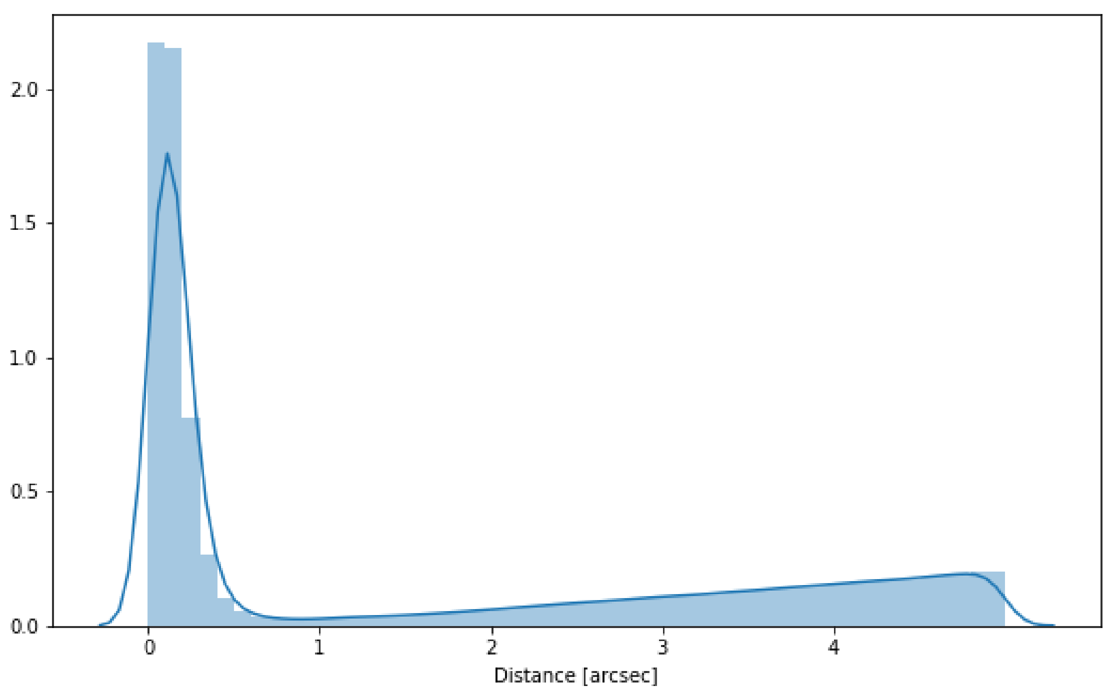
```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-21 21:17:54.577861
```

1.1 I - Reading the prepared pristine catalogues

1.2 II - Merging tables

1.2.1 ATLAS

1.2.2 Add KIDS



1.3 Cleaning

1.4 VI - Choosing between multiple values for the same filter

1.4.1 ATLAS and KIDS

The ATLAS and KIDS surveys are both on the VLT Survey Telescope (VST). KIDS is significantly deeper so we take KIDS fluxes if available.

Survey	Bands observed
ATLAS	u, ul, griz
KIDS	ugri

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
```

```
Out[13]: <IPython.core.display.HTML object>
```

1.5 X - Saving the catalogue

```
Missing columns: {'atlas_flag_cleaned', 'omegacam_intid', 'atlas_flag_gaia', 'kids_id', 'kids_fl
```

2.2_Merging

March 8, 2018

1 HATLAS-SGP master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-21 22:15:12.935653
```

1.1 I - Reading the prepared pristine catalogues

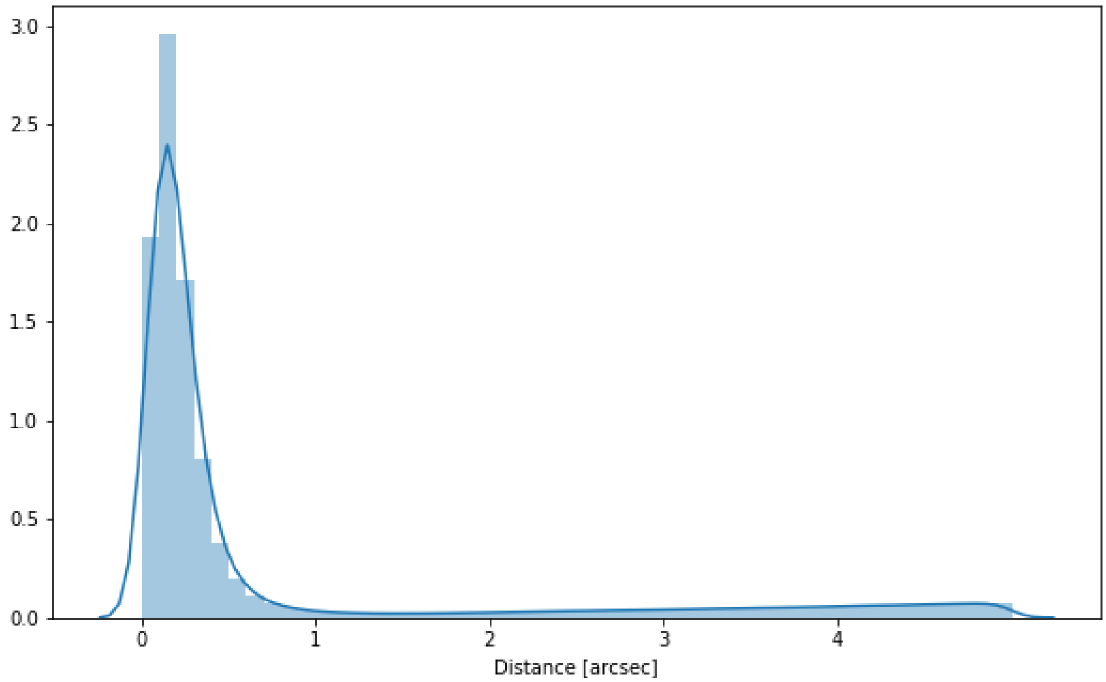
1.2 II - Merging tables

We first merge the optical catalogues and then add the infrared ones: CFHTLenS, CFHTLS, DECaLS, HSC, KIDS, PanSTARRS, UKIDSS-LAS, VISTA-VHS, and VISTA-VIKING.

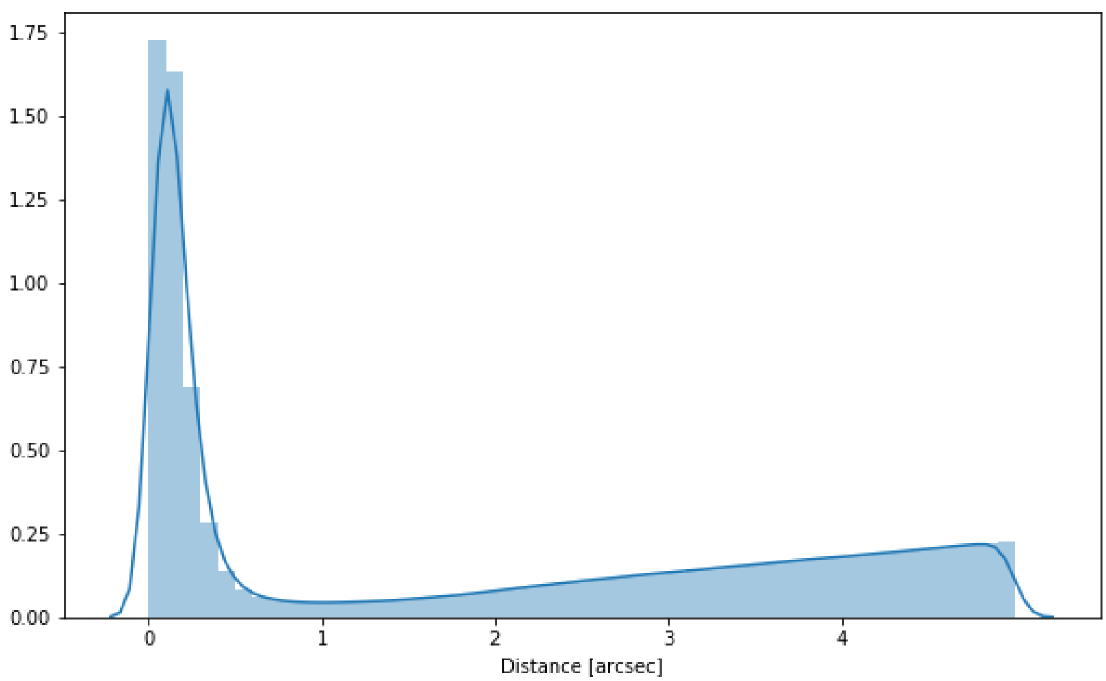
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 Omegacam (ATLAS and KIDS)

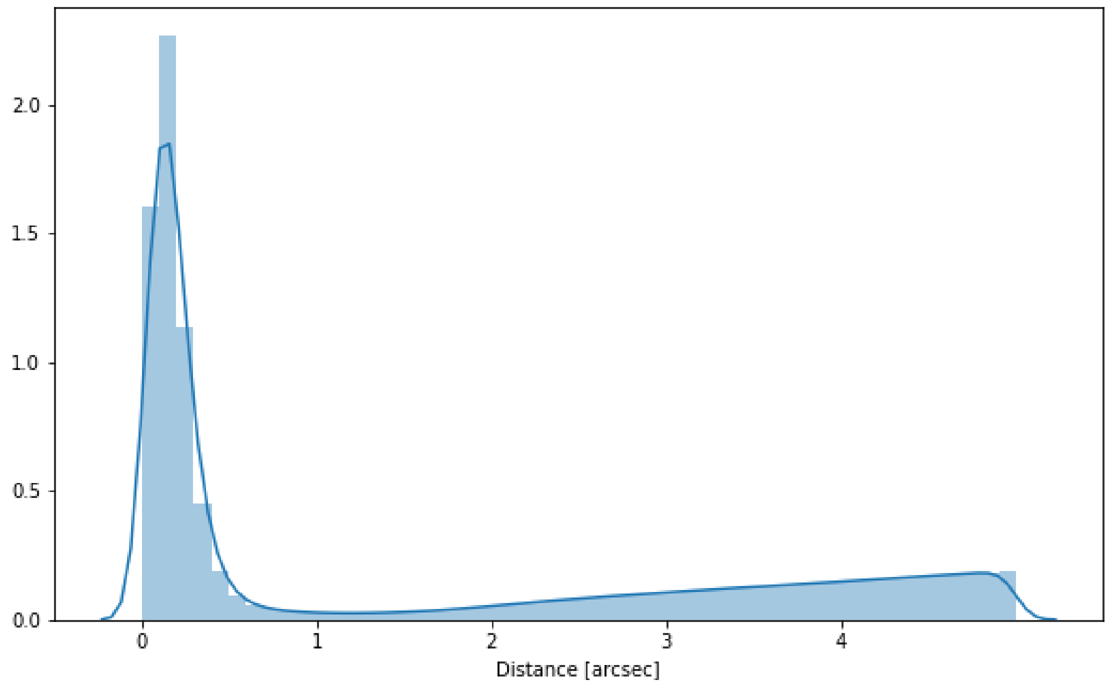
1.2.2 Add PanSTARRS



1.2.3 Add VIKING



1.2.4 Add DES



1.2.5 Cleaning

When we merge the catalogues, astropy masks the non-existent values (e.g. when a row comes only from a catalogue and has no counterparts in the other, the columns from the latest are masked for that row). We indicate to use NaN for masked values for floats columns, False for flag columns and -1 for ID columns.

```
Out[13]: <IPython.core.display.HTML object>
```

1.3 III - Merging flags and stellarity

Each pristine catalogue contains a flag indicating if the source was associated to a another nearby source that was removed during the cleaning process. We merge these flags in a single one.

Each pristine catalogue contains a flag indicating the probability of a source being a Gaia object (0: not a Gaia object, 1: possibly, 2: probably, 3: definitely). We merge these flags taking the highest value.

Each prisitine catalogue may contain one or several stellarity columns indicating the probability (0 to 1) of each source being a star. We merge these columns taking the highest value.

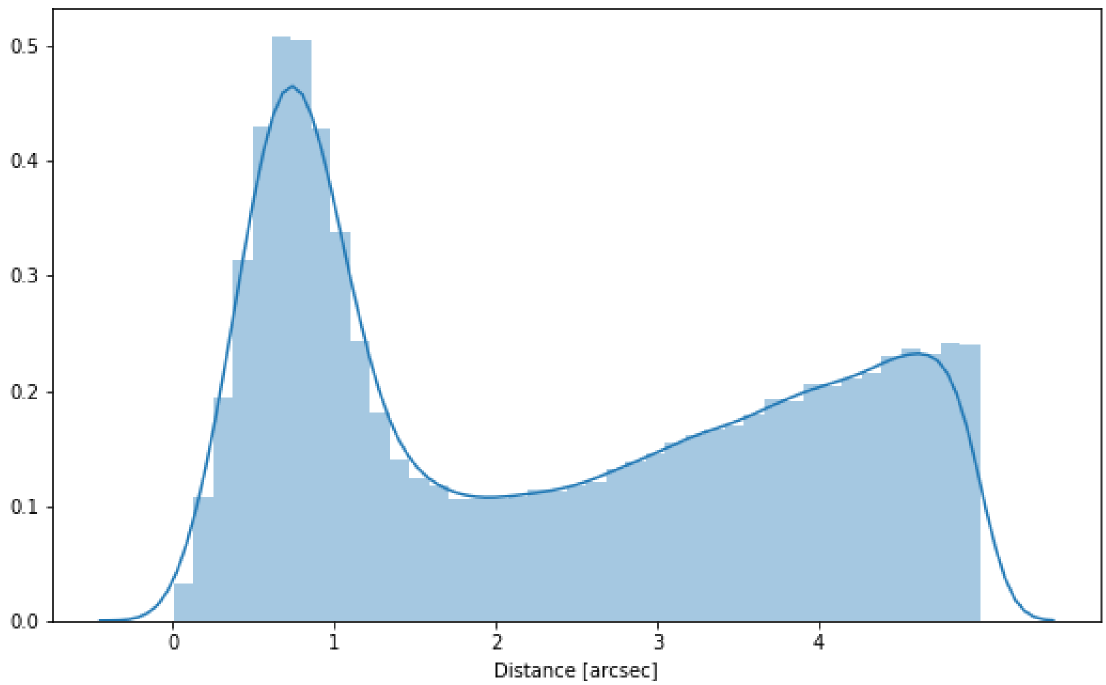
```
atlas_stellarity, kids_stellarity, viking_stellarity, des_stellarity
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 V.b - Add Specz



1.7 VII.a Wavelength domain coverage

We add a binary `flag_optnir_obs` indicating that a source was observed in a given wavelength domain:

- 1 for observation in optical;
- 2 for observation in near-infrared;
- 4 for observation in mid-infrared (IRAC).

It's an integer binary flag, so a source observed both in optical and near-infrared by not in mid-infrared would have this flag at 1 + 2 = 3.

Note 1: The observation flag is based on the creation of multi-order coverage maps from the catalogues, this may not be accurate, especially on the edges of the coverage.

Note 2: Being on the observation coverage does not mean having fluxes in that wavelength domain. For sources observed in one domain but having no flux in it, one must take into consideration de different depths in the catalogue we are using.

1.8 VII.b Wavelength domain detection

We add a binary flag_optnir_det indicating that a source was detected in a given wavelength domain:

- 1 for detection in optical;
- 2 for detection in near-infrared;
- 4 for detection in mid-infrared (IRAC).

It's an integer binary flag, so a source detected both in optical and near-infrared by not in mid-infrared would have this flag at 1 + 2 = 3.

Note 1: We use the total flux columns to know if the source has flux, in some catalogues, we may have aperture flux and no total flux.

To get rid of artefacts (chip edges, star flares, etc.) we consider that a source is detected in one wavelength domain when it has a flux value in **at least two bands**. That means that good sources will be excluded from this flag when they are on the coverage of only one band.

This now takes place in the fonal stage when photometry is folded in

1.9 VIII - Cross-identification table

We are producing a table associating to each HELP identifier, the identifiers of the sources in the pristine catalogue. This can be used to easily get additional information from them.

```
['omegacam_intid', 'atlas_id', 'kids_id', 'ps1_id', 'viking_id', 'des_id', 'help_id', 'specz_id'
```

1.10 IX - Adding HEALPix index

We are adding a column with a HEALPix index at order 13 associated with each source.

1.11 X - Saving the catalogue

```
Missing columns: {'specz_id', 'omegacam_intid', 'zspec_association_flag', 'viking_id', 'omegacam
```

1.12 XI - Folding in photometry

On HATLAS-SGP there is too much data to load all in to memory at once so we perform the cross matching without photometry columns. Only now do we fold in the photometry data by first cutting the catalogue up in to manageable sizes.

```
298
```

1.13 How to generate final catalogueű

After this notebook has been run there will be a set of sub catalogues in data/tiles/

These need to be stacked using stilts:

For many purposes this file may be too large. In order to run checks and diagnostics we typically take a subset using something like:

3_Checks_and_diagnostics

March 8, 2018

1 HATLAS-SGP master catalogue

1.1 Checks and diagnostics

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-22 12:08:23.247050
```

```
Using masterlist ./data/master_catalogue_sgp_20180221.fits
```

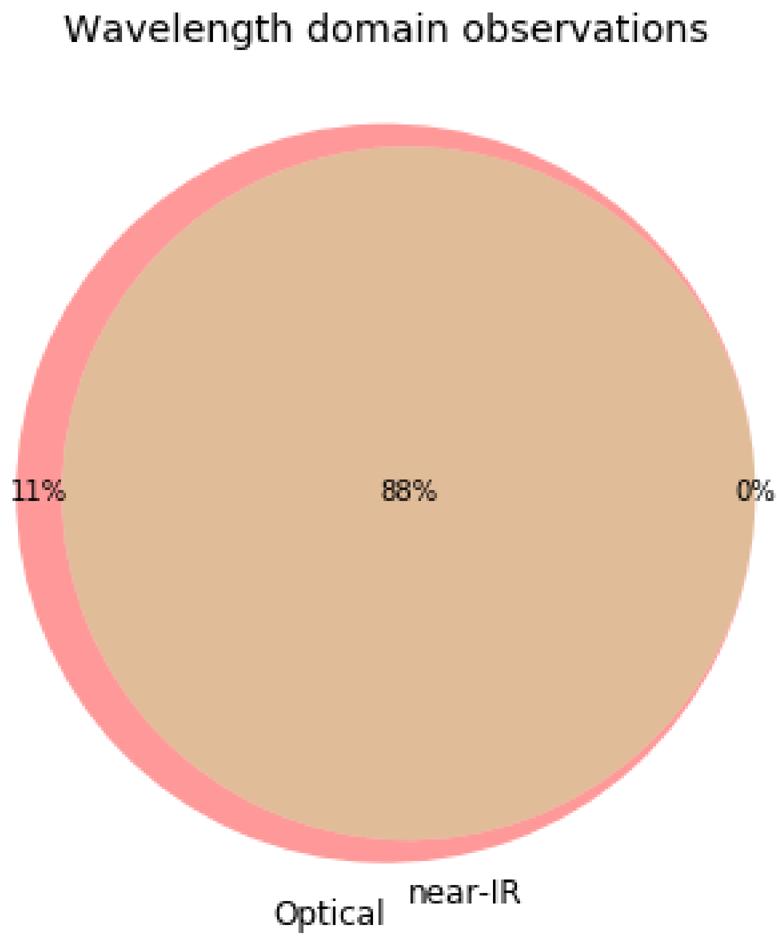
1.2 0 - Quick checks

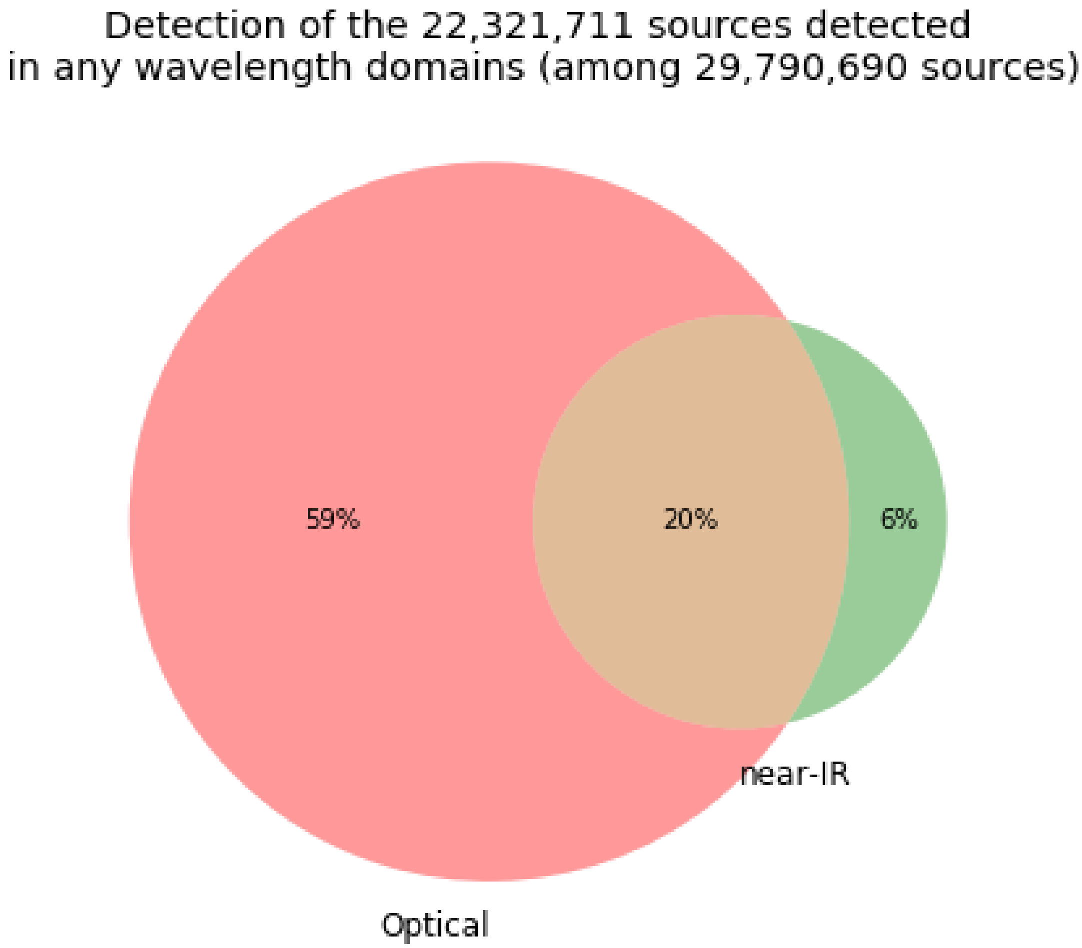
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
```

```
Table shows only problematic columns.
```

```
Out[4]: <IPython.core.display.HTML object>
```

1.3 I - Summary of wavelength domains



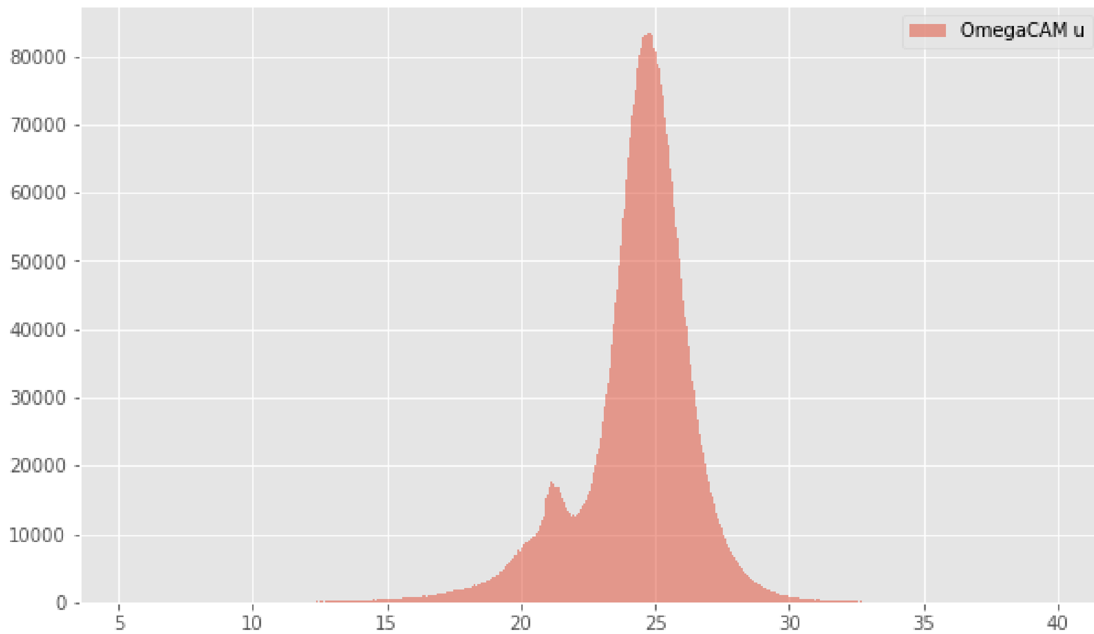


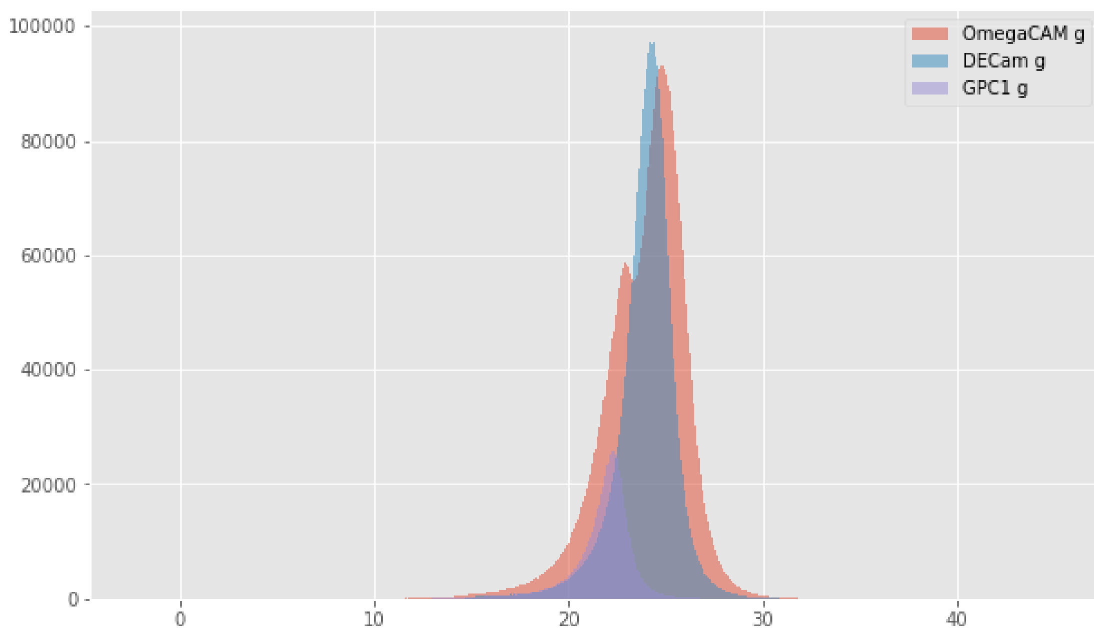
1.4 II - Comparing magnitudes in similar filters

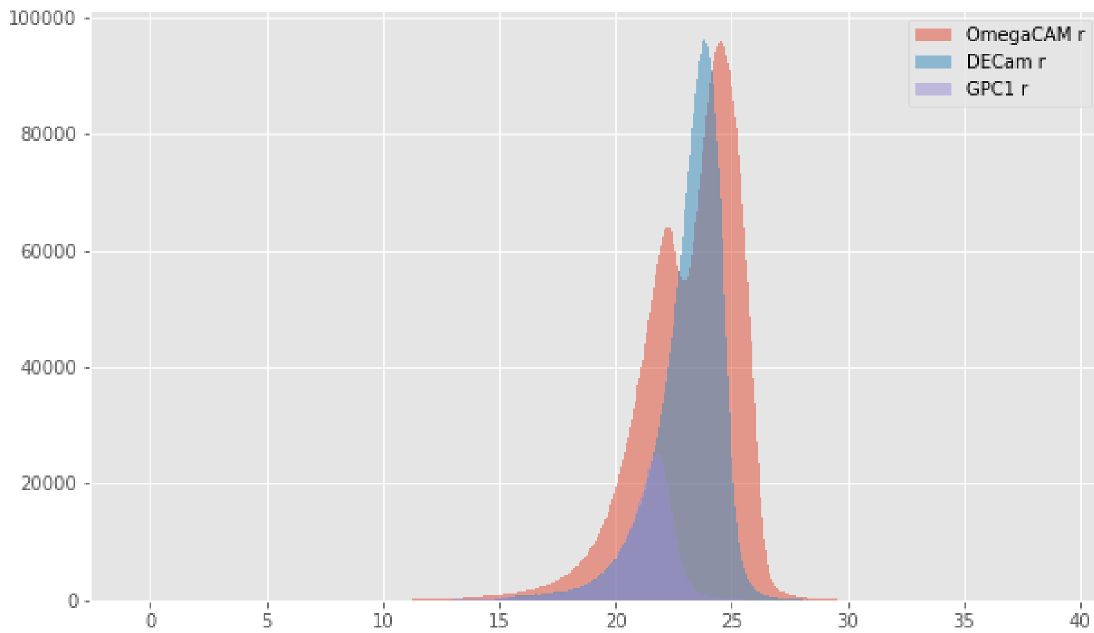
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

1.4.1 II.a - Comparing depths

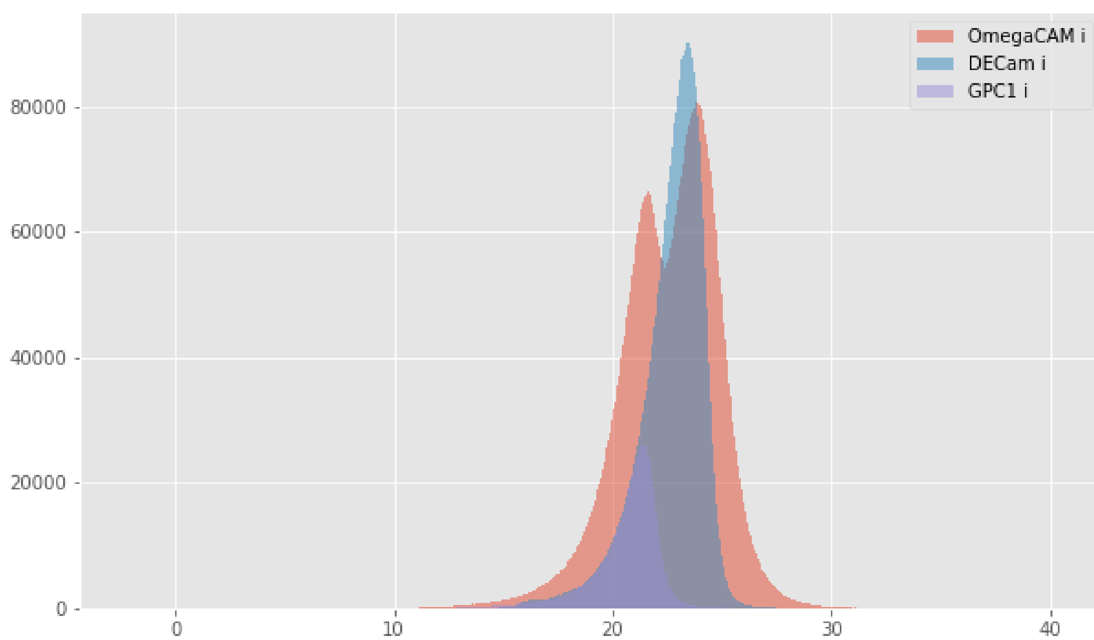
We compare the histograms of the total aperture magnitudes of similar bands.


OmegaCAM u
80000
70000
60000
50000
40000
30000
20000
10000
0
5
10
15
20
25
30
35
40

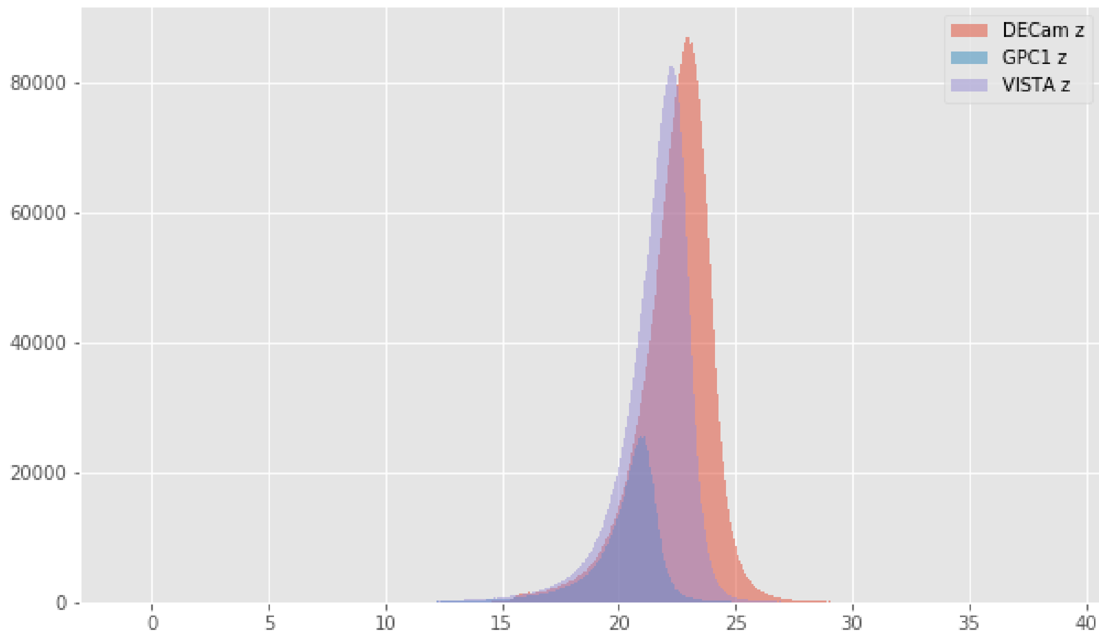

OmegaCAM g
DECam g
GPC1 g
100000
80000
60000
40000
20000
0
0
10
20
30
40

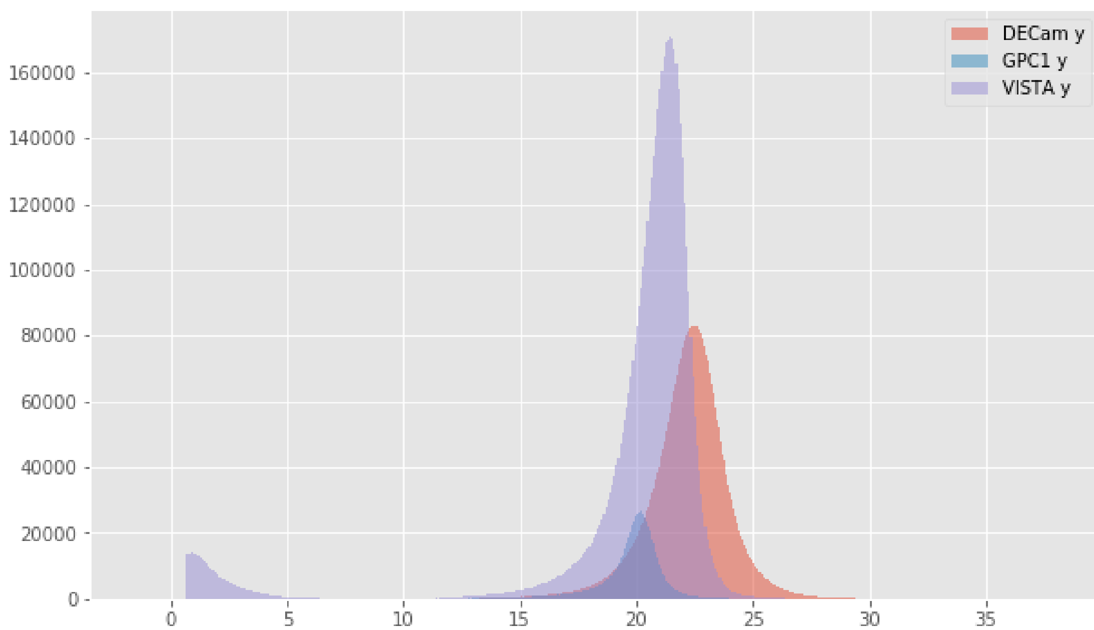


OmegaCAM r
DECam r
GPC1 r
100000
80000
60000
40000
20000
0
0
5
10
15
20
25
30
35
40



OmegaCAM i
DECam i
GPC1 i
80000
60000
40000
20000
0
0
10
20
30
40

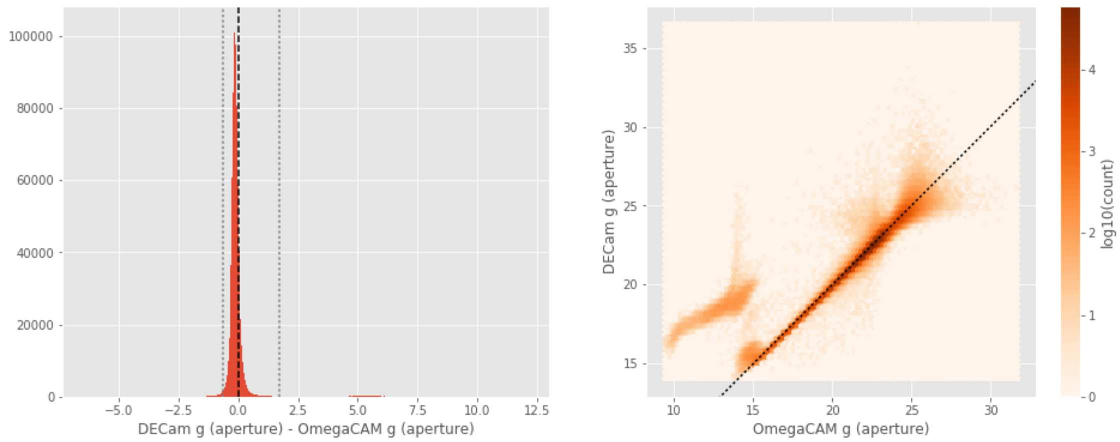




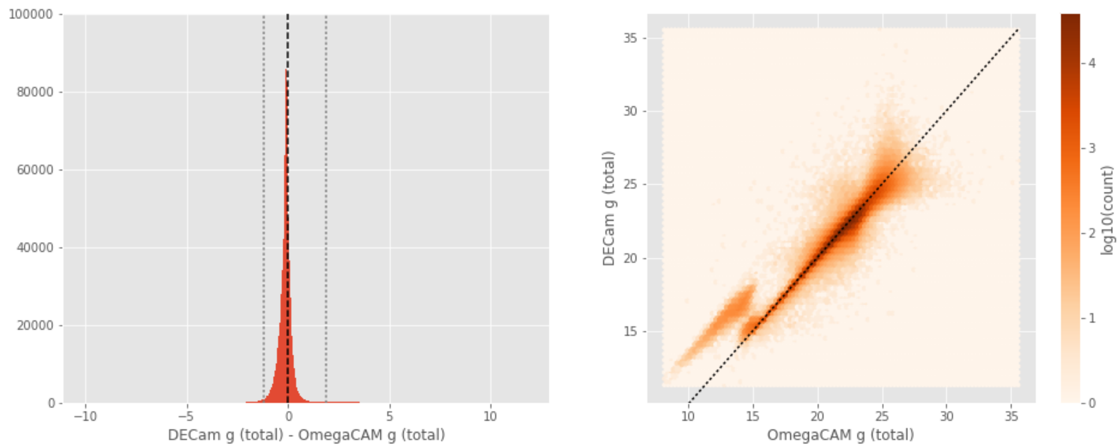
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

```
DECam g (aperture) - OmegaCAM g (aperture):
- Median: -0.13
- Median Absolute Deviation: 0.09
- 1% percentile: -0.6474657525146481
- 99% percentile: 1.7280513825341686
```

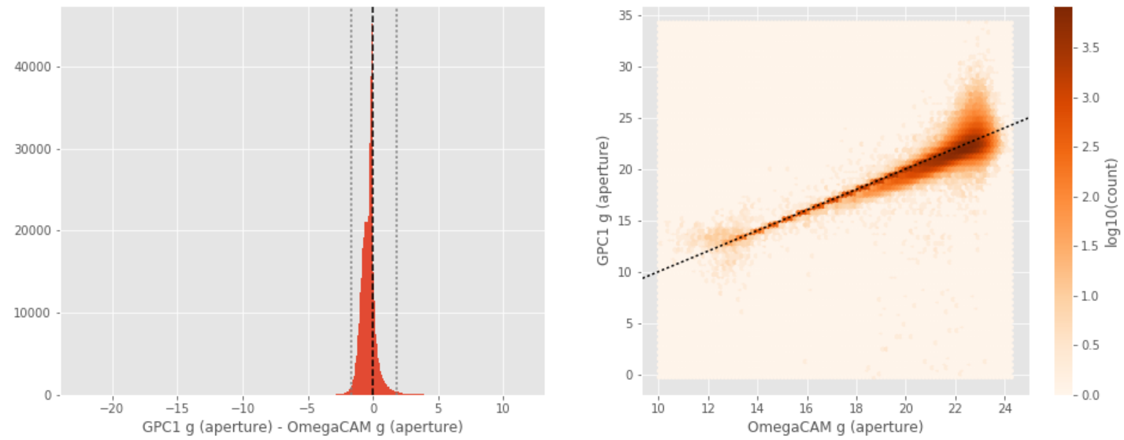



```
DECam g (total) - OmegaCAM g (total):
- Median: -0.09
- Median Absolute Deviation: 0.14
- 1% percentile: -1.1961334181604002
- 99% percentile: 1.911162154801013
```

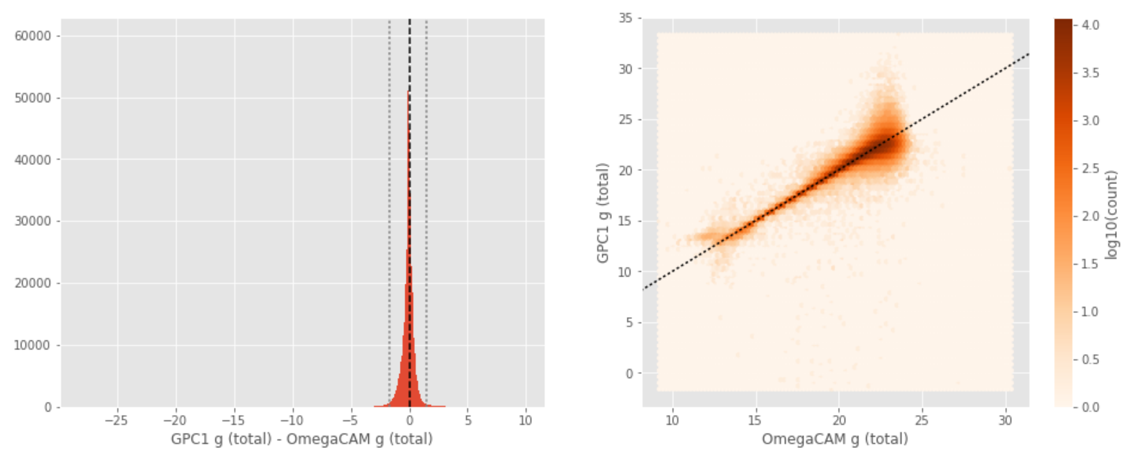



```
GPC1 g (aperture) - OmegaCAM g (aperture):
- Median: -0.31
```

- Median Absolute Deviation: 0.30
- 1% percentile: -1.6985355429382323
- 99% percentile: 1.8626549105468695

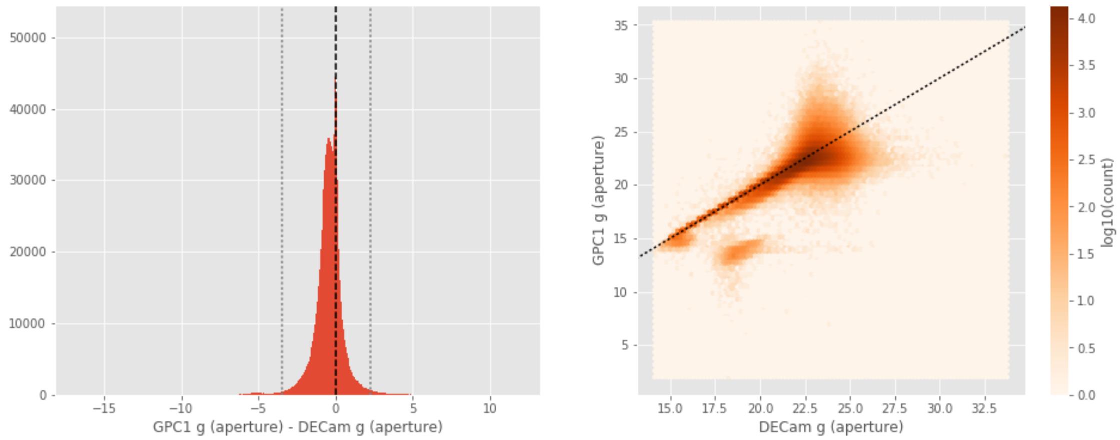


GPC1 g (total) - OmegaCAM g (total):
- Median: -0.05
- Median Absolute Deviation: 0.21
- 1% percentile: -1.6923736712036148
- 99% percentile: 1.458908375190431

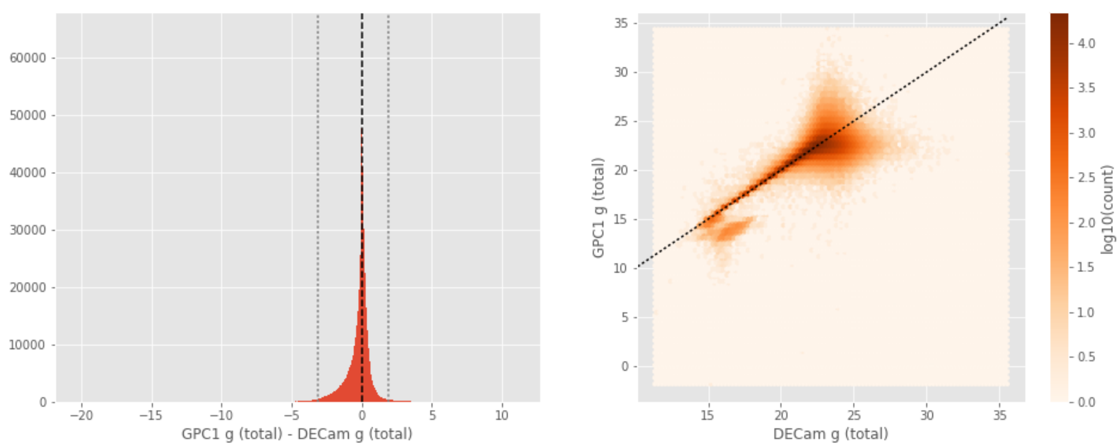


GPC1 g (aperture) - DECam g (aperture):
- Median: -0.34
- Median Absolute Deviation: 0.42
- 1% percentile: -3.4275997161865233

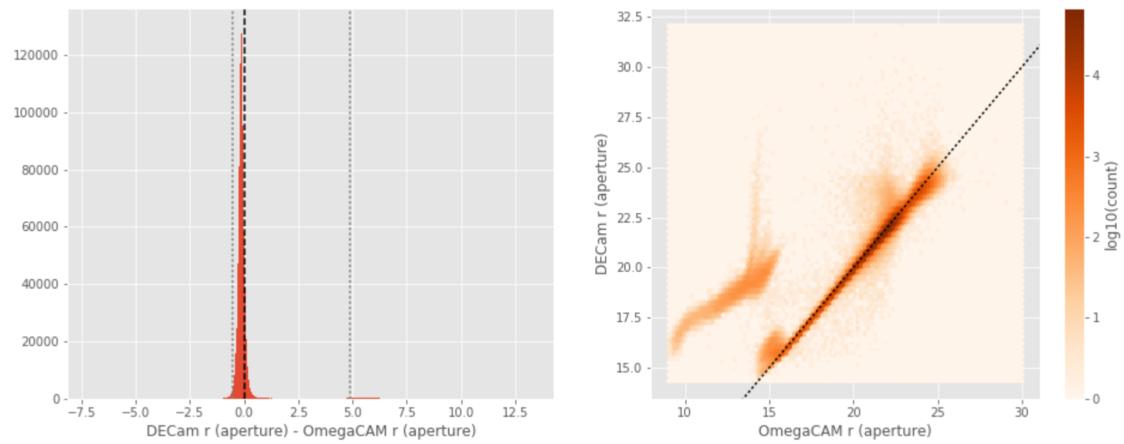
- 99% percentile: 2.2799744033813365



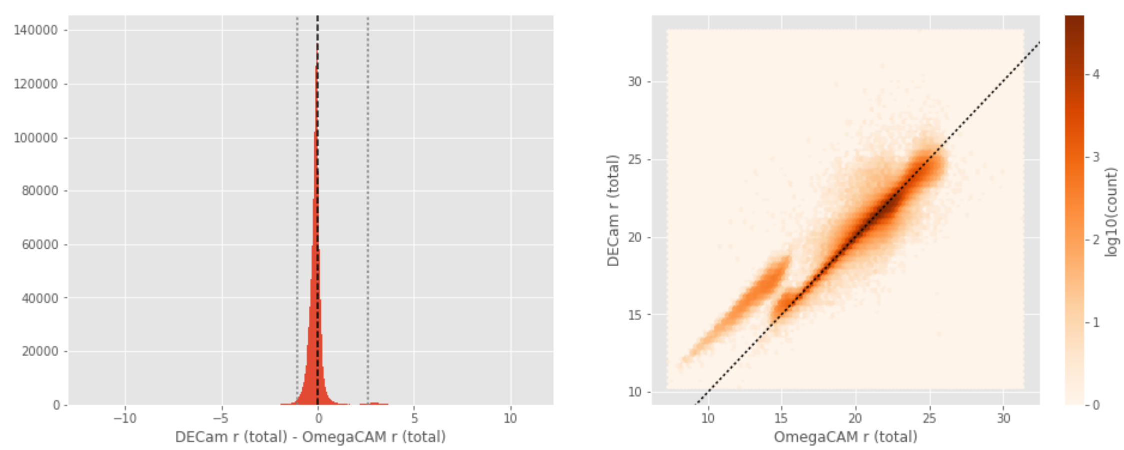
GPC1 g (total) - DECam g (total):
- Median: -0.01
- Median Absolute Deviation: 0.27
- 1% percentile: -3.1576532745361328
- 99% percentile: 1.866502609252933



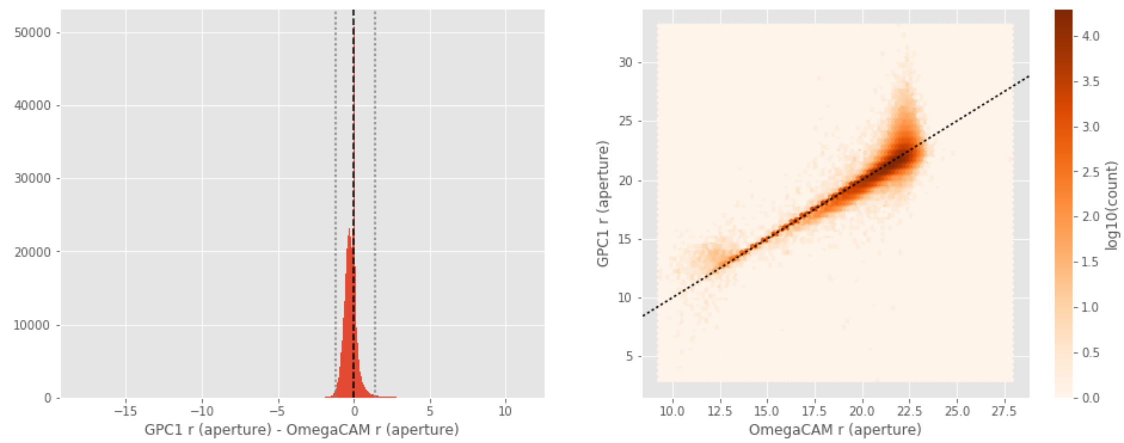
DECam r (aperture) - OmegaCAM r (aperture):
- Median: -0.13
- Median Absolute Deviation: 0.08
- 1% percentile: -0.5350769778564463
- 99% percentile: 4.866558053847657



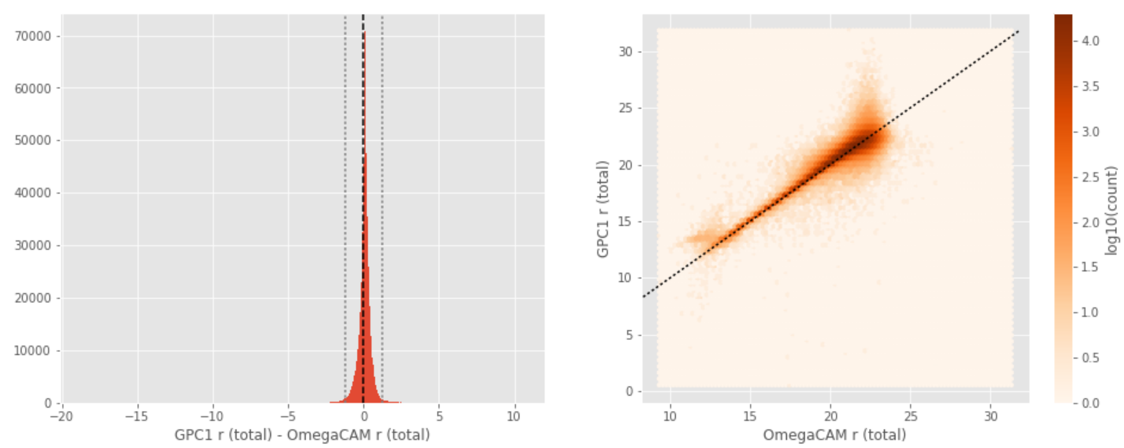

```
DECam r (total) - OmegaCAM r (total):
- Median: -0.11
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0471889911657721
- 99% percentile: 2.6142222210803214
```



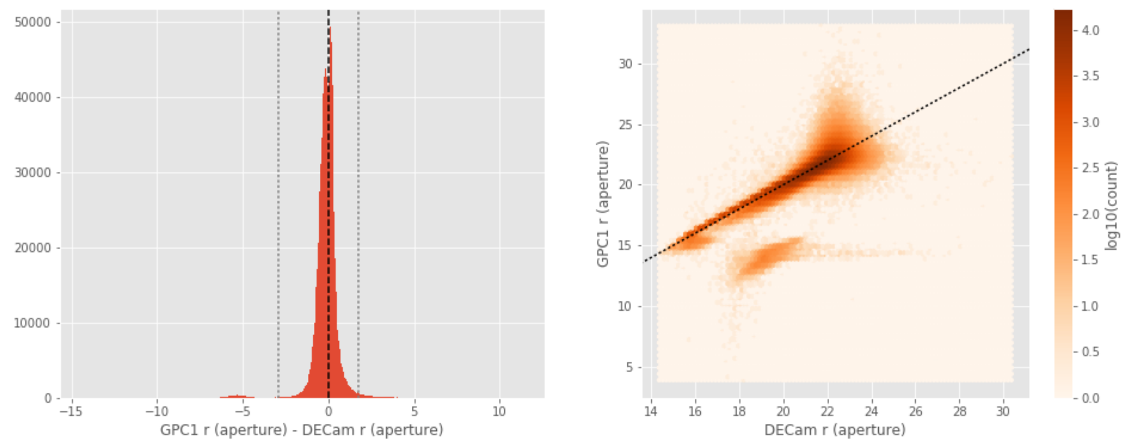

```
GPC1 r (aperture) - OmegaCAM r (aperture):
- Median: -0.19
- Median Absolute Deviation: 0.24
- 1% percentile: -1.1908159821044926
- 99% percentile: 1.3593329190185526
```



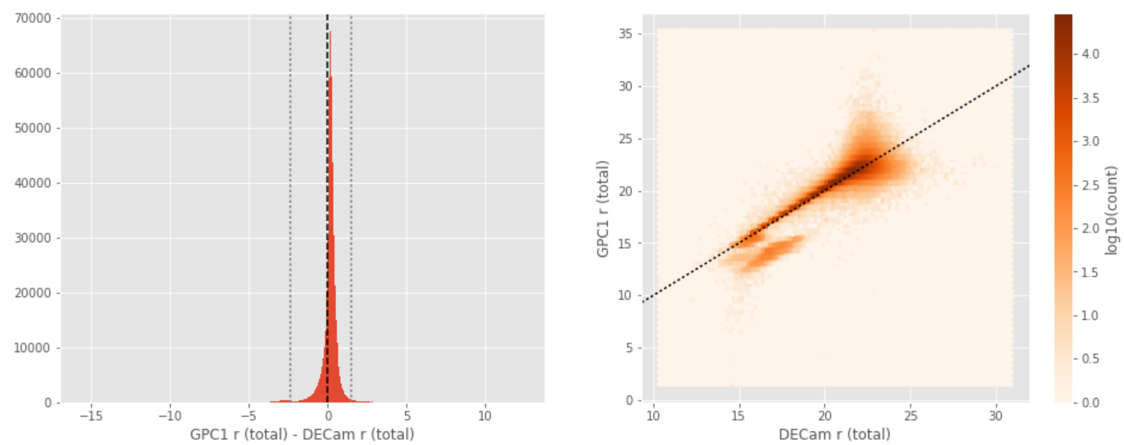
GPC1 r (total) - OmegaCAM r (total):
- Median: 0.09
- Median Absolute Deviation: 0.17
- 1% percentile: -1.208804918706055
- 99% percentile: 1.2806788397802757



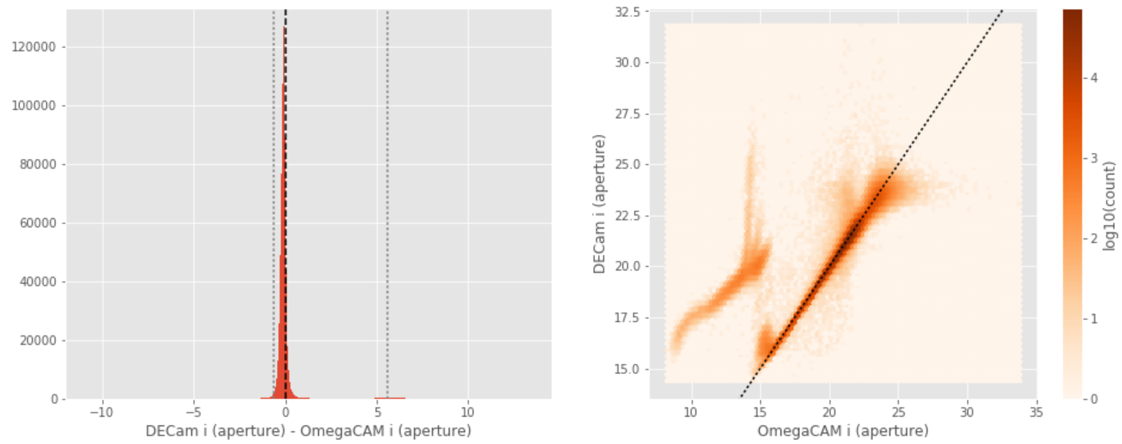
GPC1 r (aperture) - DECam r (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.29
- 1% percentile: -2.9000253677368164
- 99% percentile: 1.7319810867309582



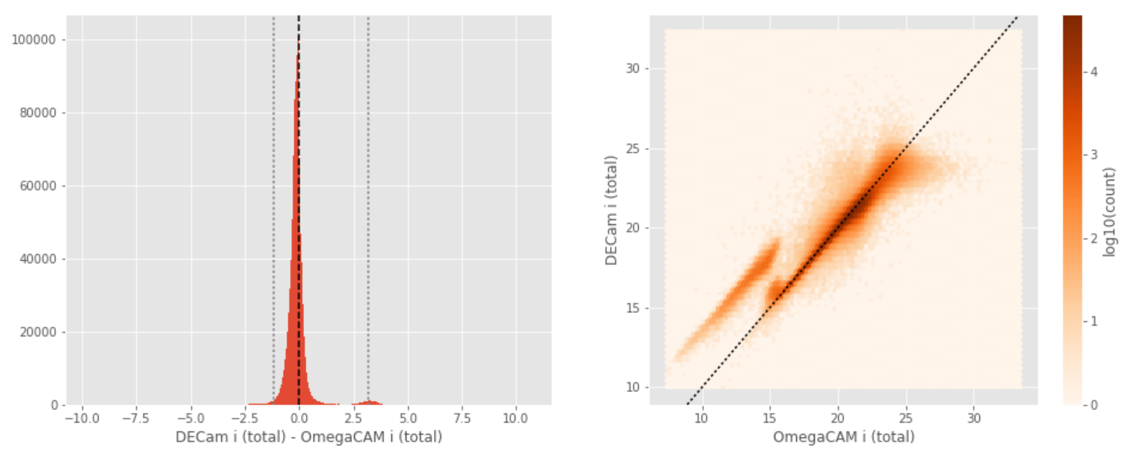
GPC1 r (total) - DECam r (total):
- Median: 0.18
- Median Absolute Deviation: 0.16
- 1% percentile: -2.408263292312622
- 99% percentile: 1.4619639968872113



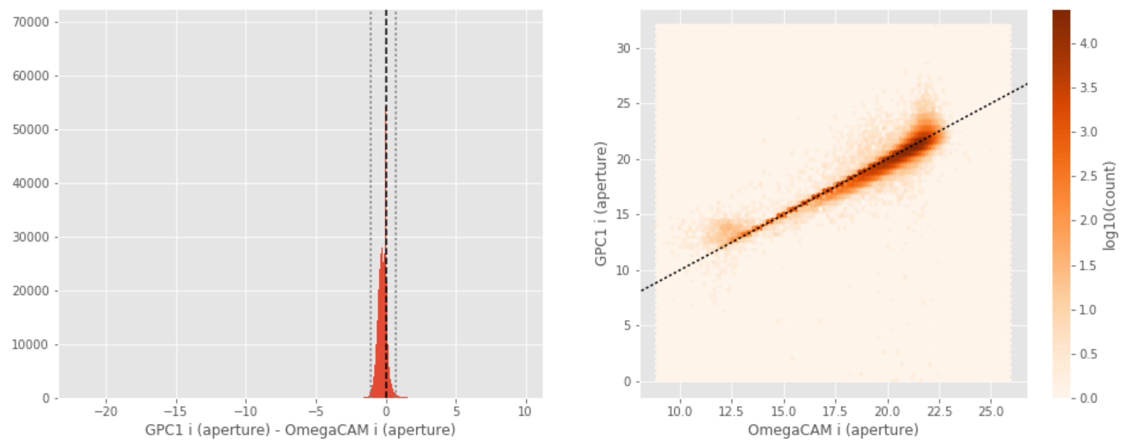
DECam i (aperture) - OmegaCAM i (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.09
- 1% percentile: -0.6352793884277345
- 99% percentile: 5.6036114701904385



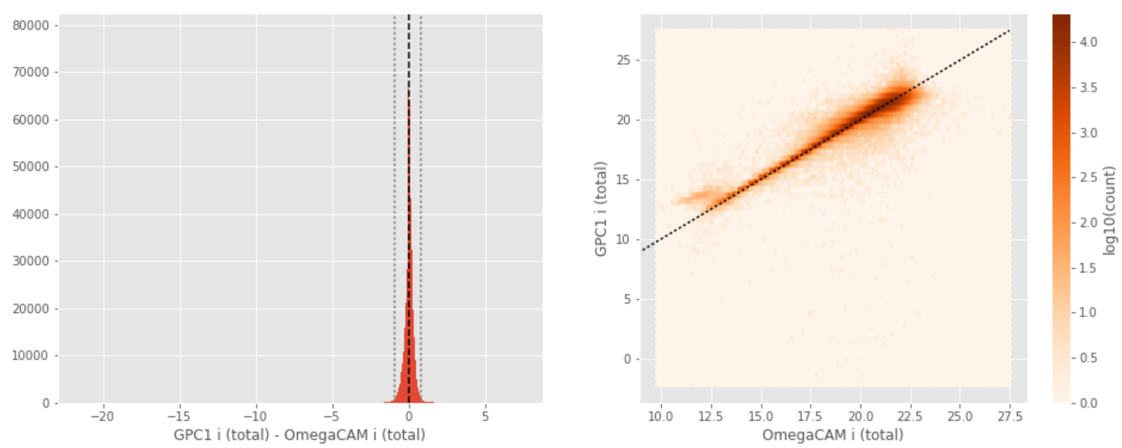
DECam i (total) - OmegaCAM i (total):
- Median: -0.13
- Median Absolute Deviation: 0.15
- 1% percentile: -1.1535859961669928
- 99% percentile: 3.1698317788012687



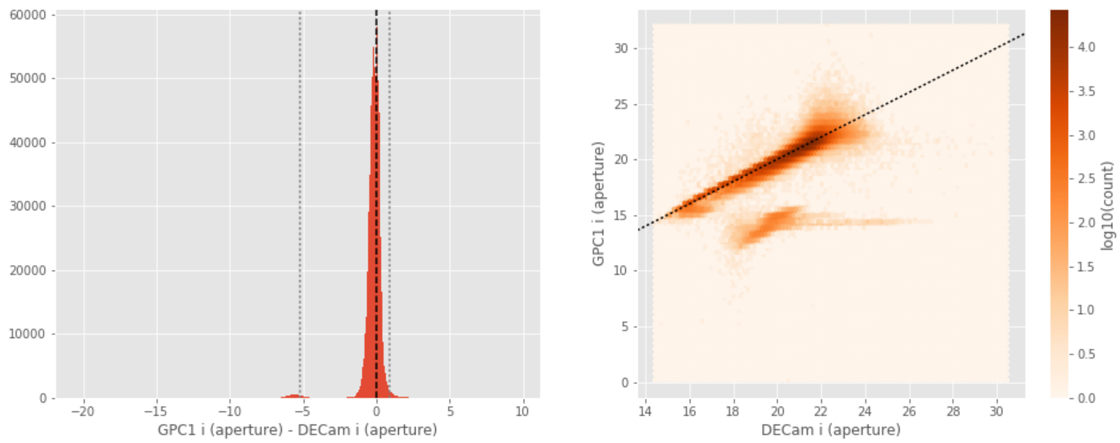
GPC1 i (aperture) - OmegaCAM i (aperture):
- Median: -0.19
- Median Absolute Deviation: 0.20
- 1% percentile: -1.0411629385571295
- 99% percentile: 0.684708058386228



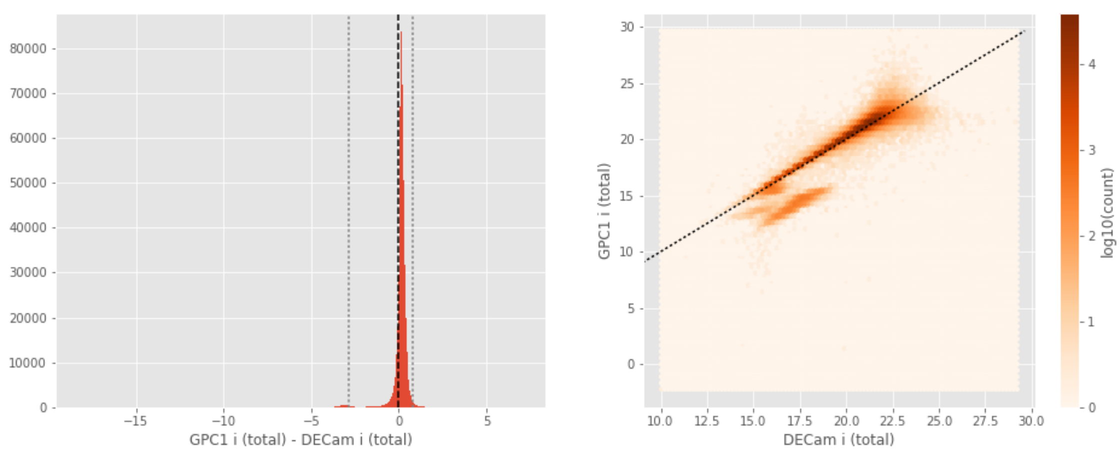
GPC1 i (total) - OmegaCAM i (total):
- Median: 0.06
- Median Absolute Deviation: 0.14
- 1% percentile: -0.8757926416992193
- 99% percentile: 0.8245664915612798



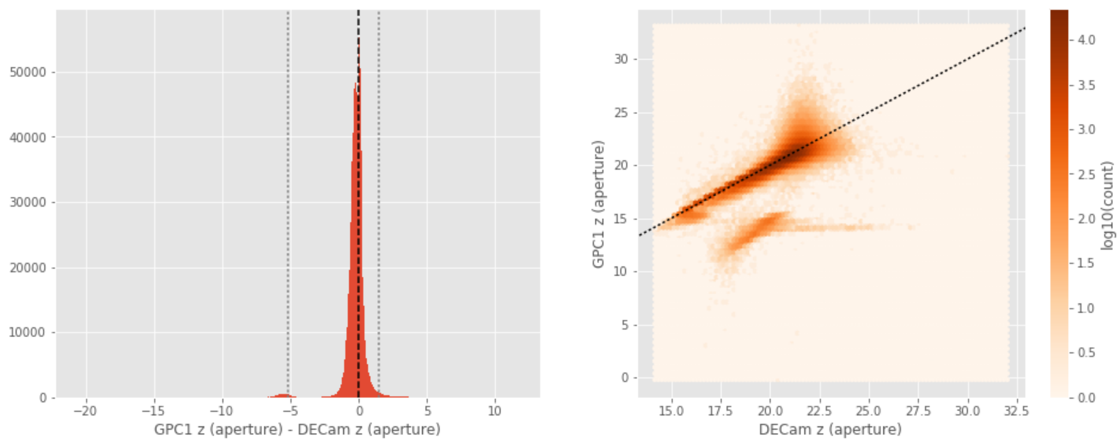
GPC1 i (aperture) - DECam i (aperture):
- Median: -0.12
- Median Absolute Deviation: 0.24
- 1% percentile: -5.175756340026855
- 99% percentile: 0.8781820678710961



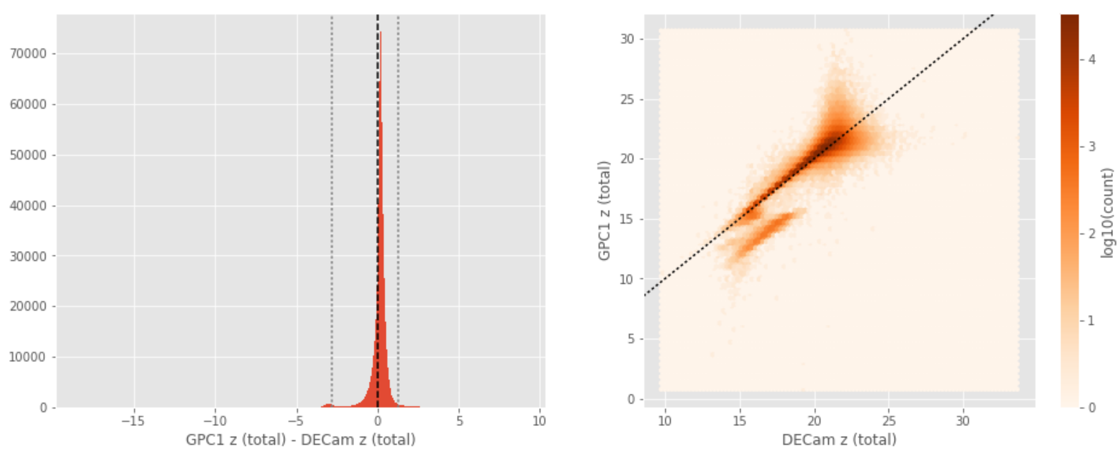
GPC1 i (total) - DECam i (total):
- Median: 0.17
- Median Absolute Deviation: 0.10
- 1% percentile: -2.857390022277832
- 99% percentile: 0.7871204376220695



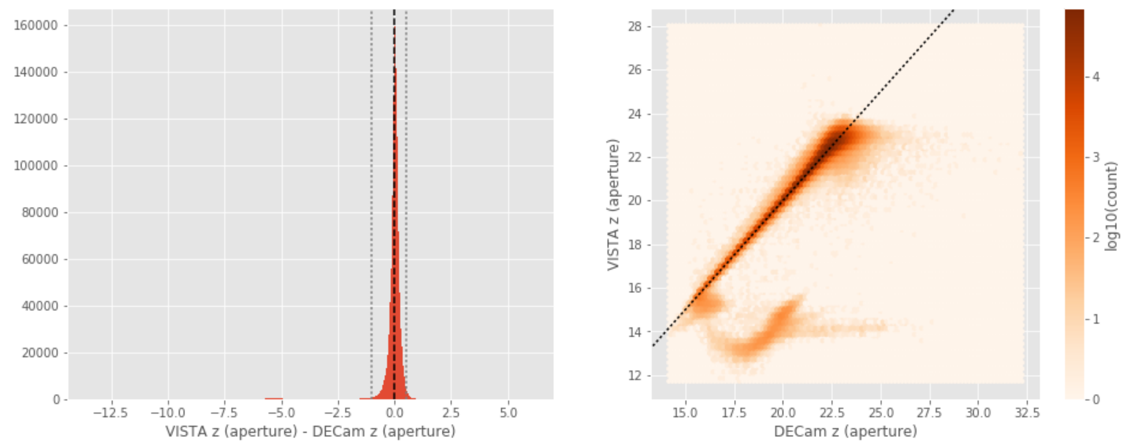
GPC1 z (aperture) - DECam z (aperture):
- Median: -0.15
- Median Absolute Deviation: 0.27
- 1% percentile: -5.1973347663879395
- 99% percentile: 1.5240682601928692



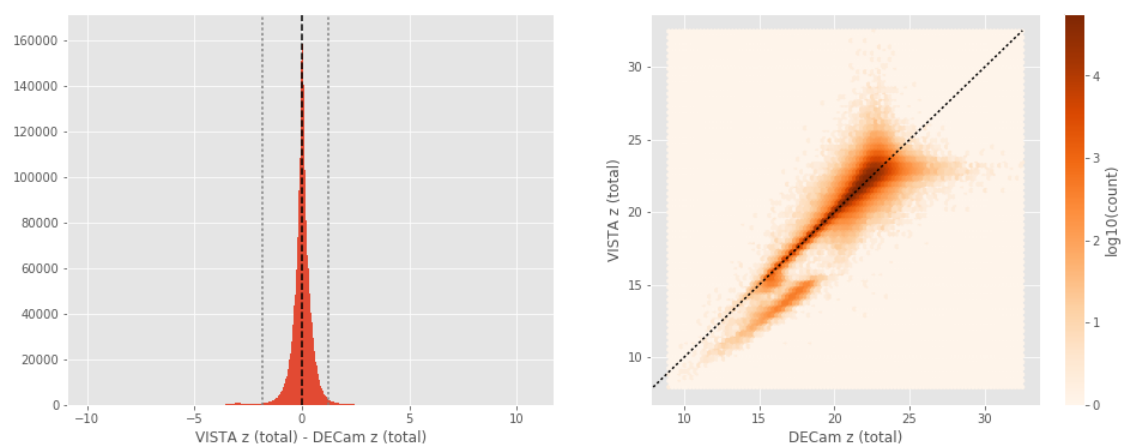
GPC1 z (total) - DECam z (total):
- Median: 0.17
- Median Absolute Deviation: 0.14
- 1% percentile: -2.8264899253845215
- 99% percentile: 1.3064206695556635



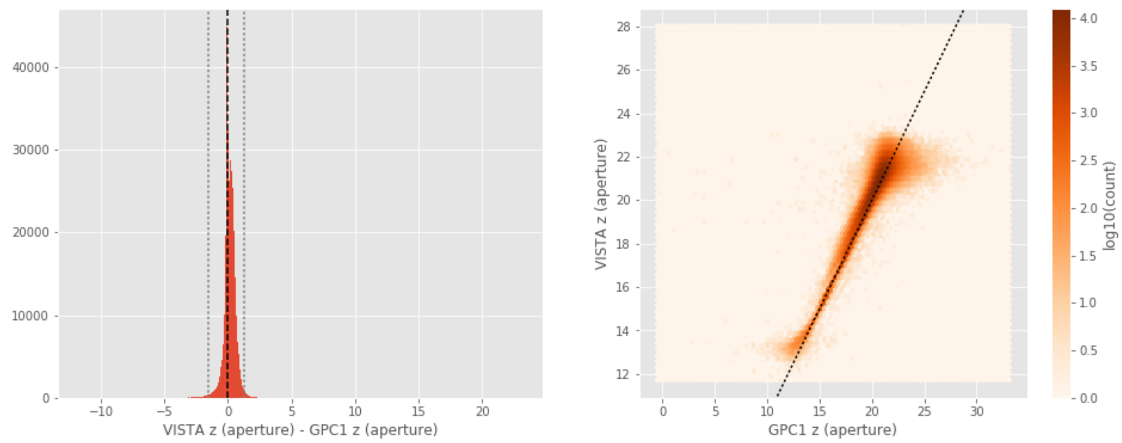
VISTA z (aperture) - DECam z (aperture):
- Median: 0.02
- Median Absolute Deviation: 0.10
- 1% percentile: -1.0295980072021484
- 99% percentile: 0.5161357307434082



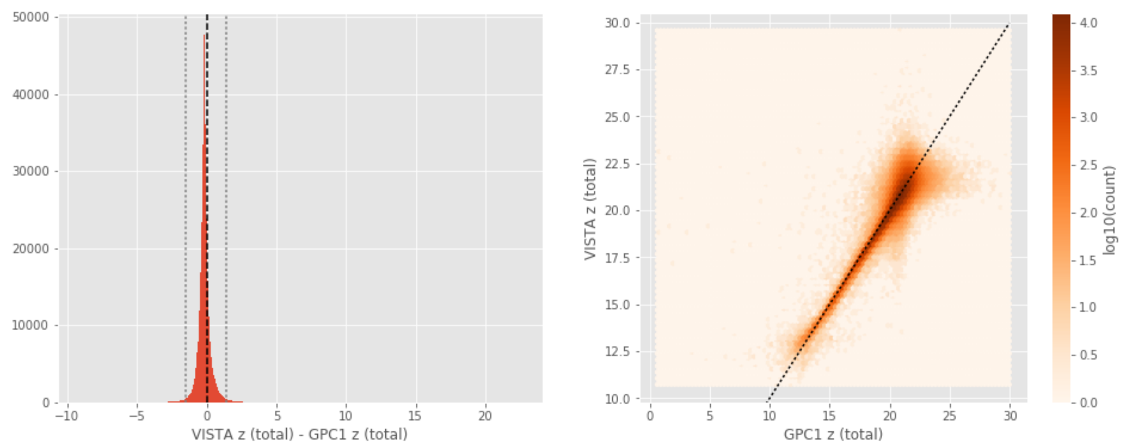

```
VISTA z (total) - DECam z (total):
- Median: 0.02
- Median Absolute Deviation: 0.20
- 1% percentile: -1.8286405181884766
- 99% percentile: 1.2542409133911105
```



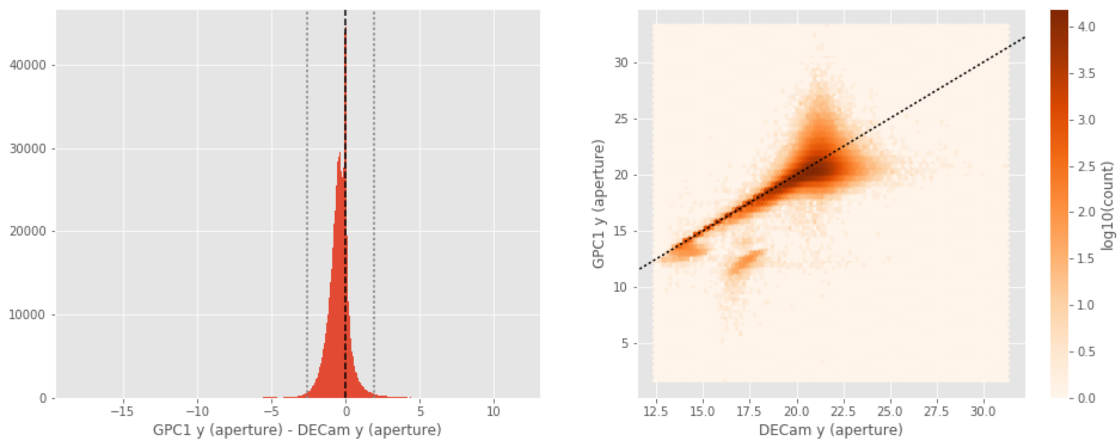

```
VISTA z (aperture) - GPC1 z (aperture):
- Median: 0.14
- Median Absolute Deviation: 0.24
- 1% percentile: -1.5340843200683594
- 99% percentile: 1.2795259094238238
```



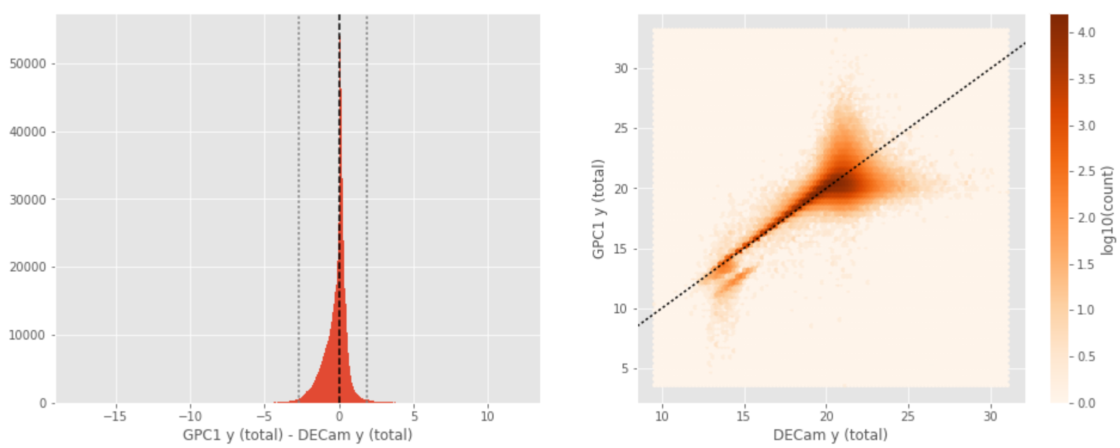
VISTA z (total) - GPC1 z (total):
- Median: -0.17
- Median Absolute Deviation: 0.18
- 1% percentile: -1.5516764831542968
- 99% percentile: 1.3785708236694343



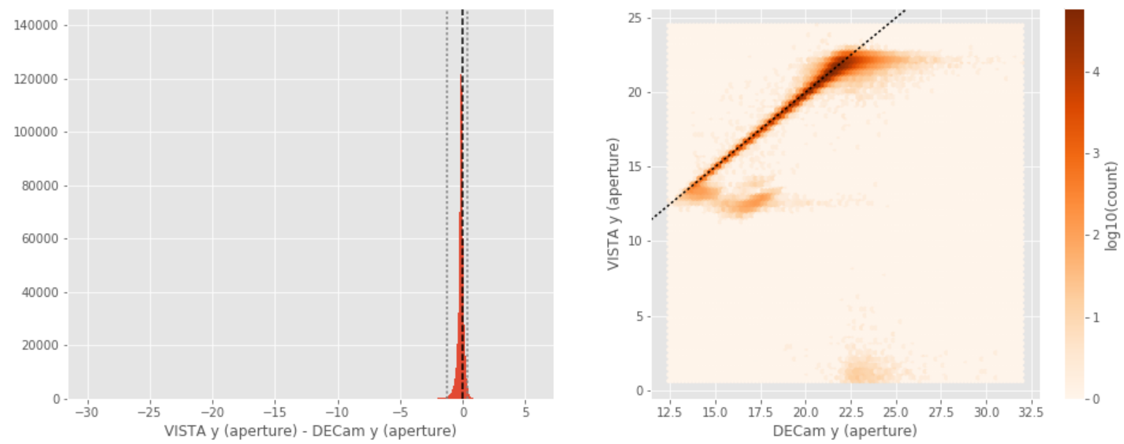
GPC1 y (aperture) - DECam y (aperture):
- Median: -0.39
- Median Absolute Deviation: 0.38
- 1% percentile: -2.618603858947754
- 99% percentile: 1.9402295494079576



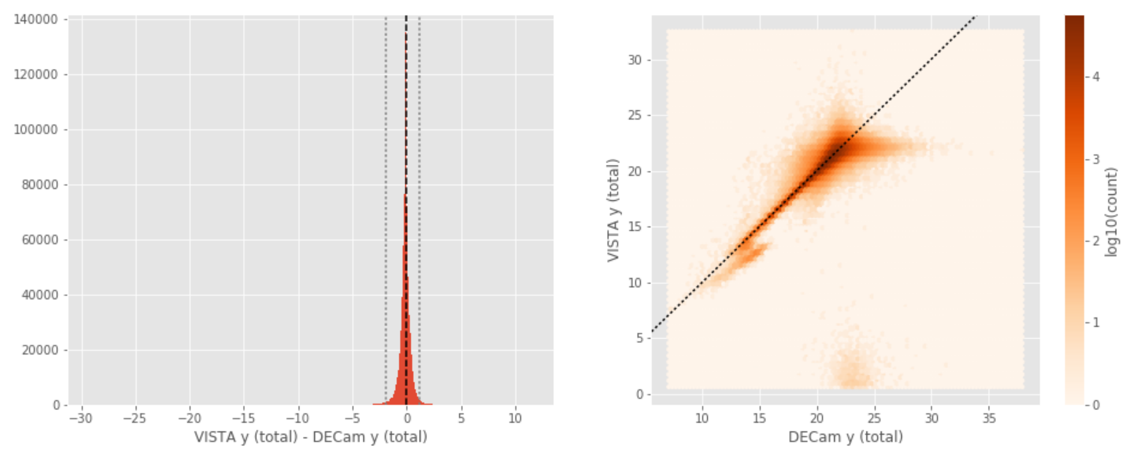
GPC1 y (total) - DECam y (total):
- Median: 0.01
- Median Absolute Deviation: 0.32
- 1% percentile: -2.71594123840332
- 99% percentile: 1.8680044174194355



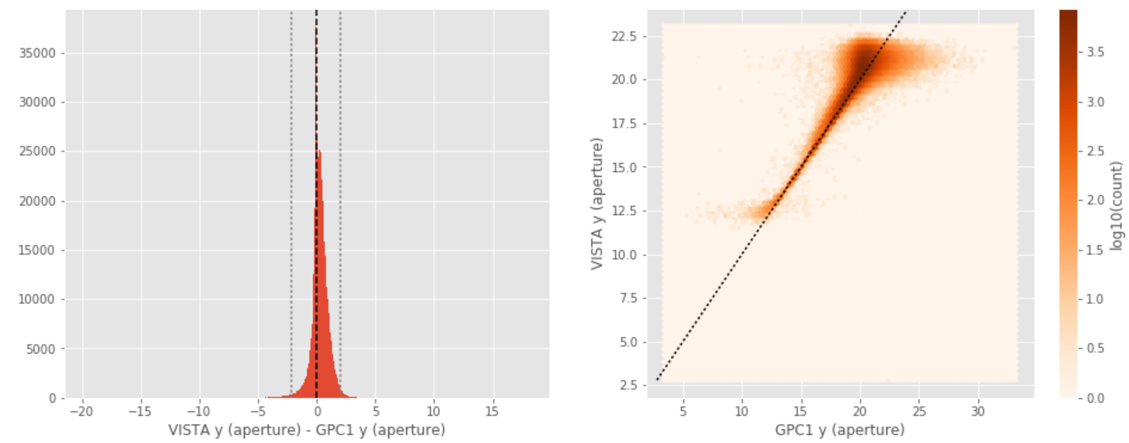
VISTA y (aperture) - DECam y (aperture):
- Median: -0.13
- Median Absolute Deviation: 0.11
- 1% percentile: -1.256957778930664
- 99% percentile: 0.41260734558105483



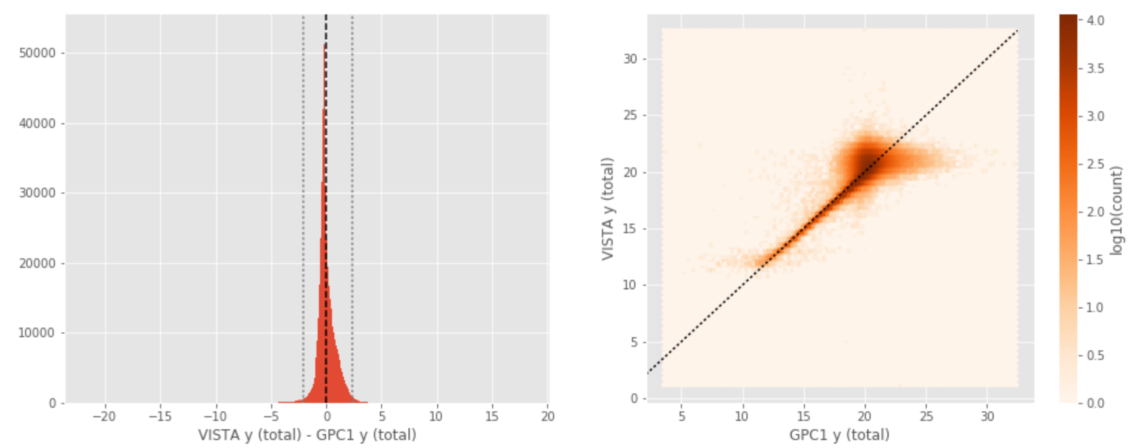
VISTA y (total) - DECam y (total):
- Median: -0.12
- Median Absolute Deviation: 0.20
- 1% percentile: -1.913156509399414
- 99% percentile: 1.2057640457153322



VISTA y (aperture) - GPC1 y (aperture):
- Median: 0.23
- Median Absolute Deviation: 0.35
- 1% percentile: -2.10777437210083
- 99% percentile: 2.065537281036377




```
VISTA y (total) - GPC1 y (total):
- Median: -0.13
- Median Absolute Deviation: 0.33
- 1% percentile: -2.086603355407715
- 99% percentile: 2.3443342590332037
```



1.5 III - Comparing magnitudes to reference bands

Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

1.5.1 III.b - Comparing J and K bands to 2MASS

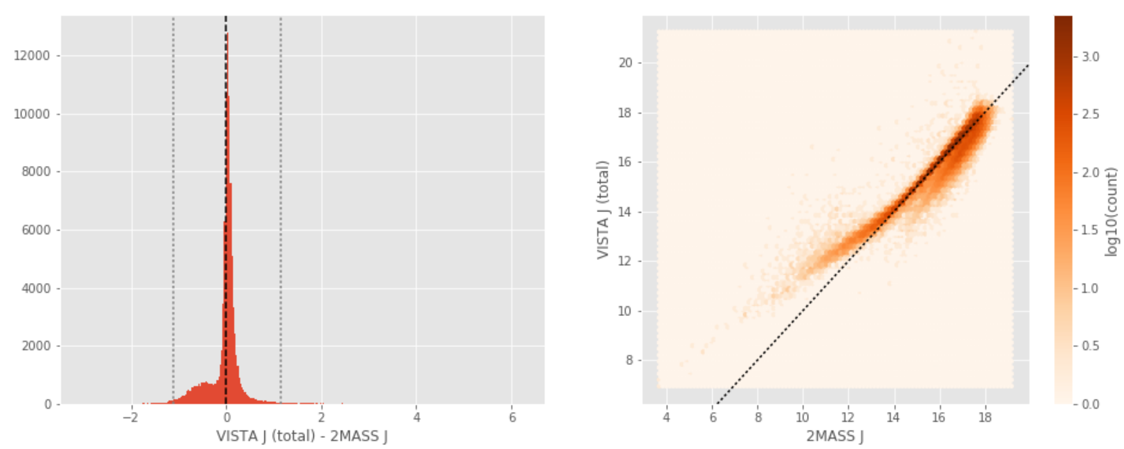
The catalogue is cross-matched to 2MASS-PSC withing 0.2 arcsecond. We compare the VISTA total J and K magnitudes to those from 2MASS.

The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

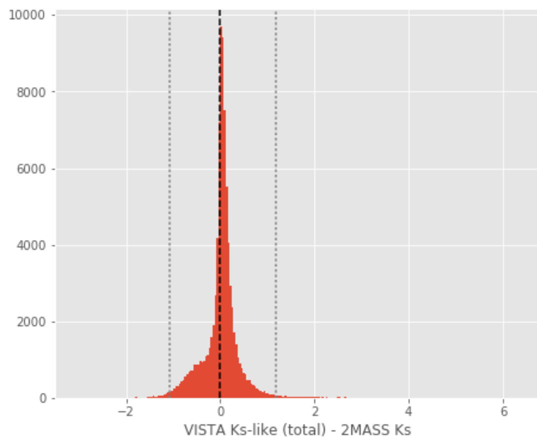
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

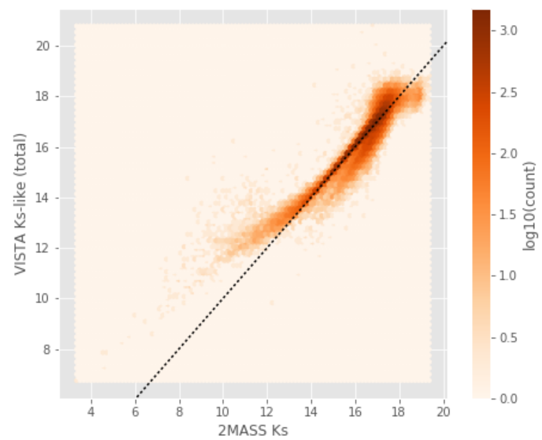
In addition, VISTA uses a Ks band.

```
VISTA J (total) - 2MASS J:
- Median: 0.03
- Median Absolute Deviation: 0.07
- 1% percentile: -1.1194814927579704
- 99% percentile: 1.150870347451982
```



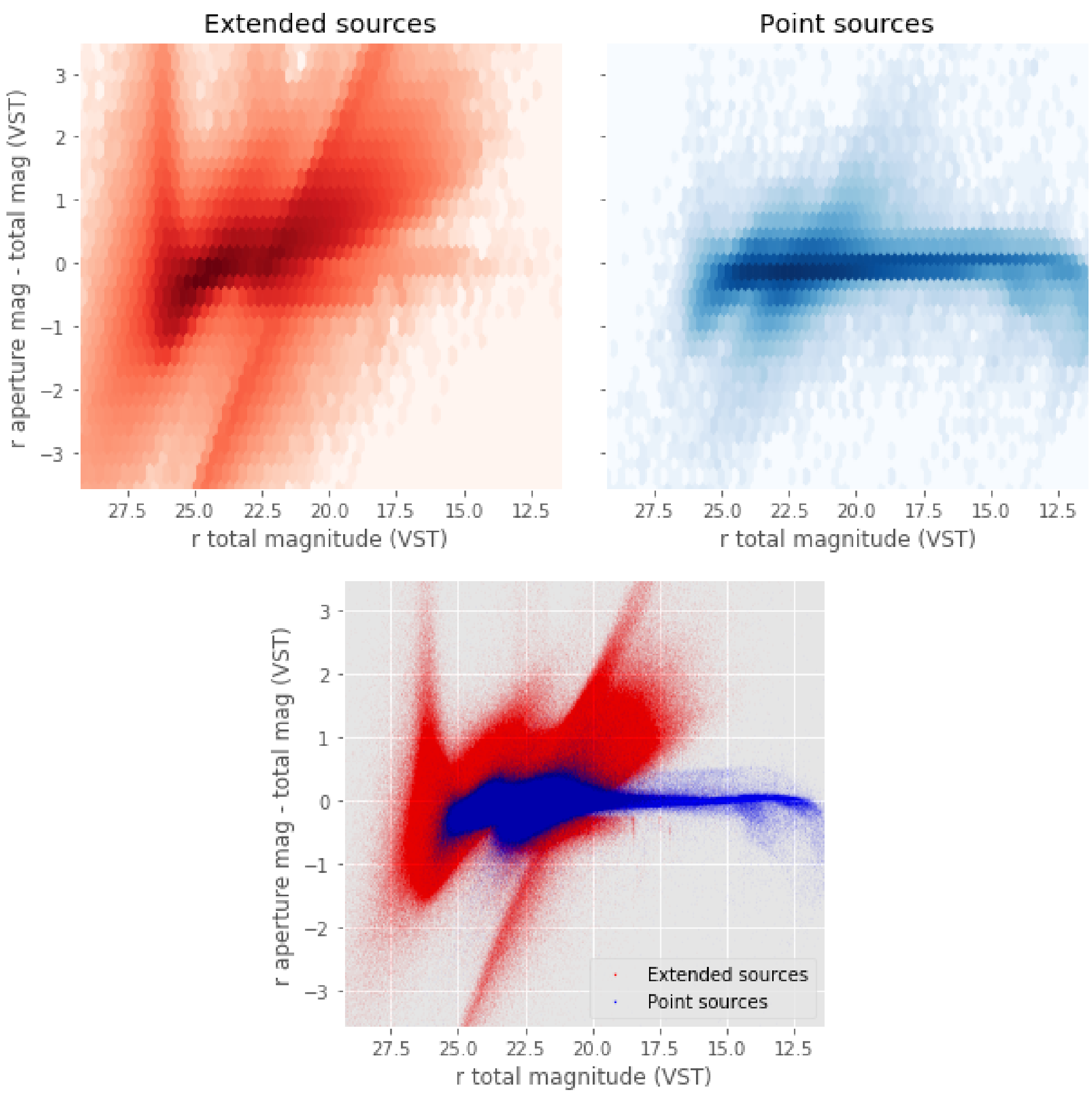

```
VISTA Ks-like (total) - 2MASS Ks:
- Median: 0.04
- Median Absolute Deviation: 0.12
- 1% percentile: -1.0640412553270873
- 99% percentile: 1.1824742867413949
```



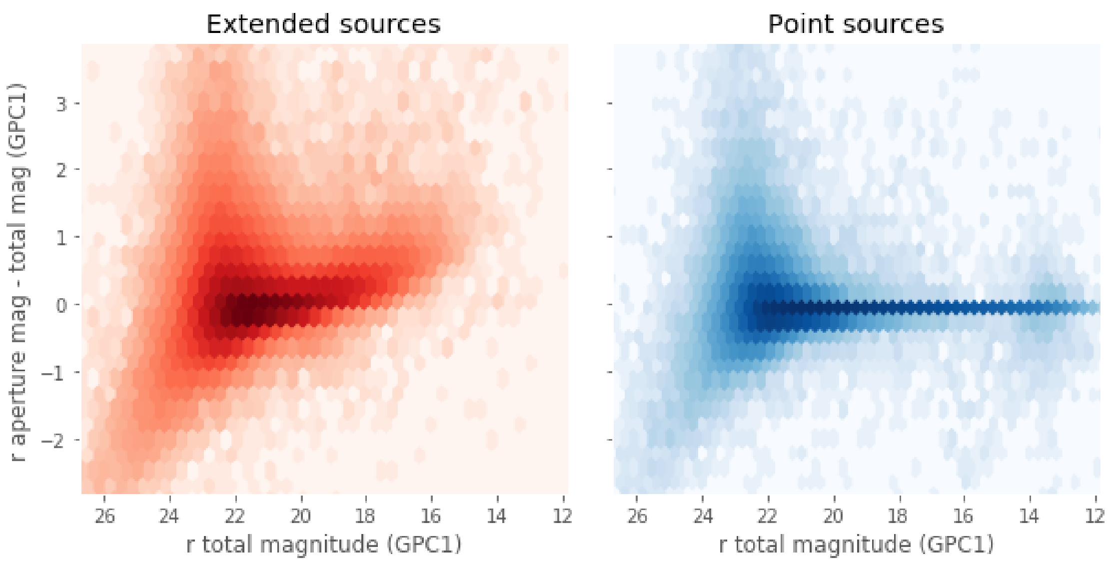


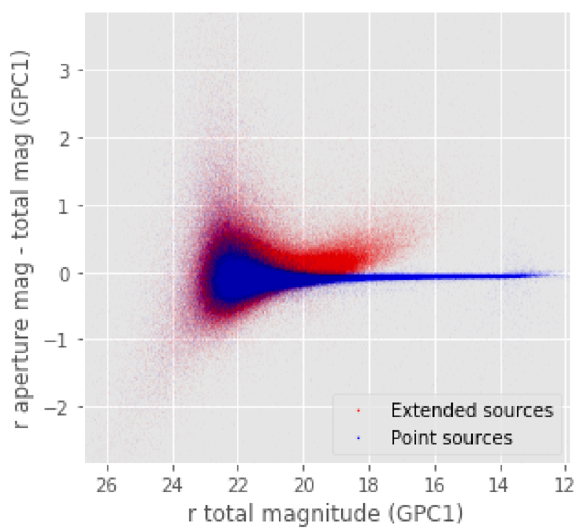
1.6 IV - Comparing aperture magnitudes to total ones.

```
Number of source used: 12930467 / 29790690 (43.40%)
```



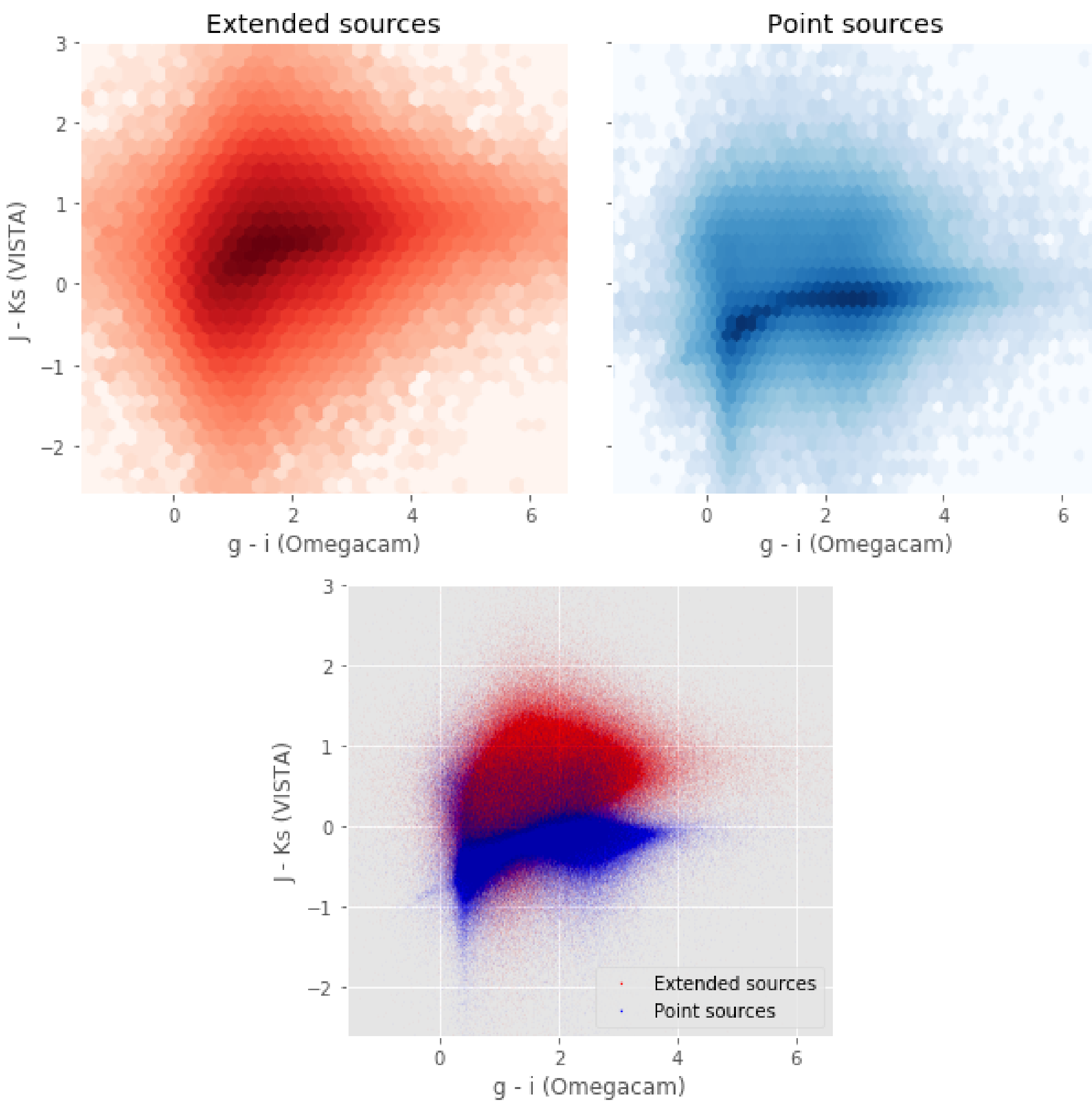
Number of source used: 994579 / 29790690 (3.34%)



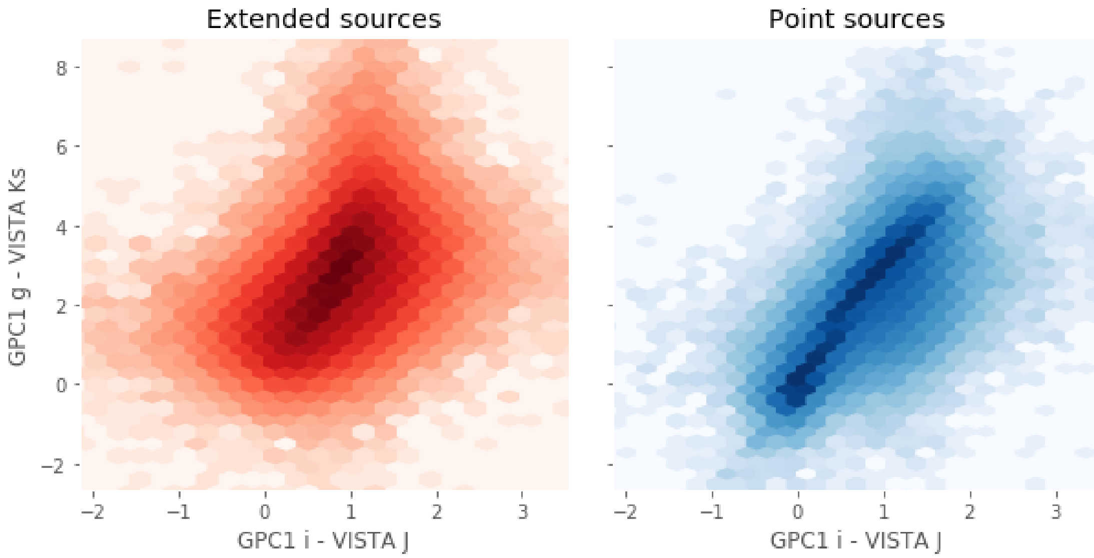


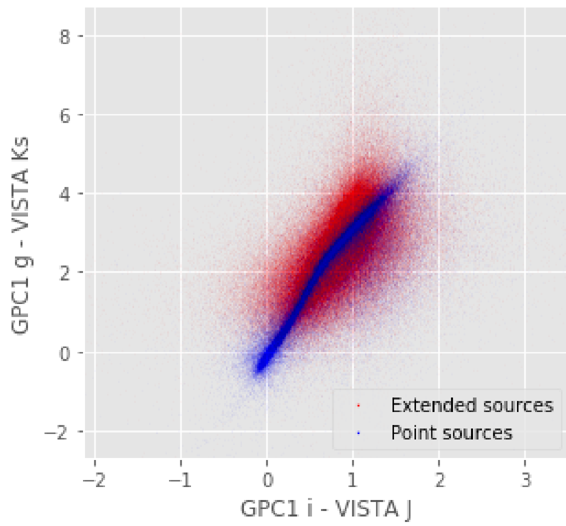
1.7 V - Color-color and magnitude-color plots

```
Number of source used: 1863979 / 29790690 (6.26%)
```

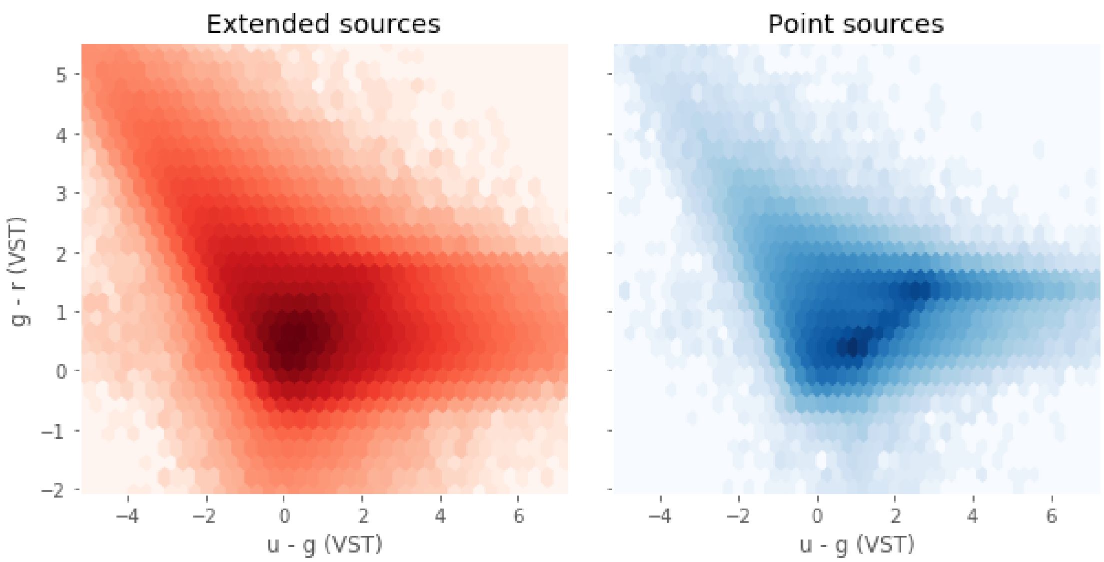


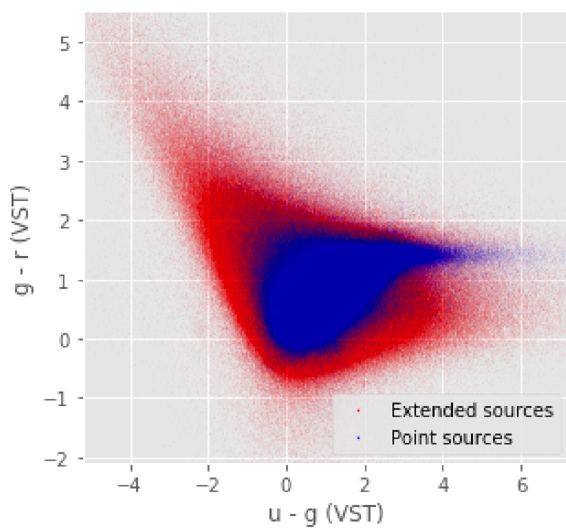

```
Number of source used: 376927 / 29790690 (1.27%)
```



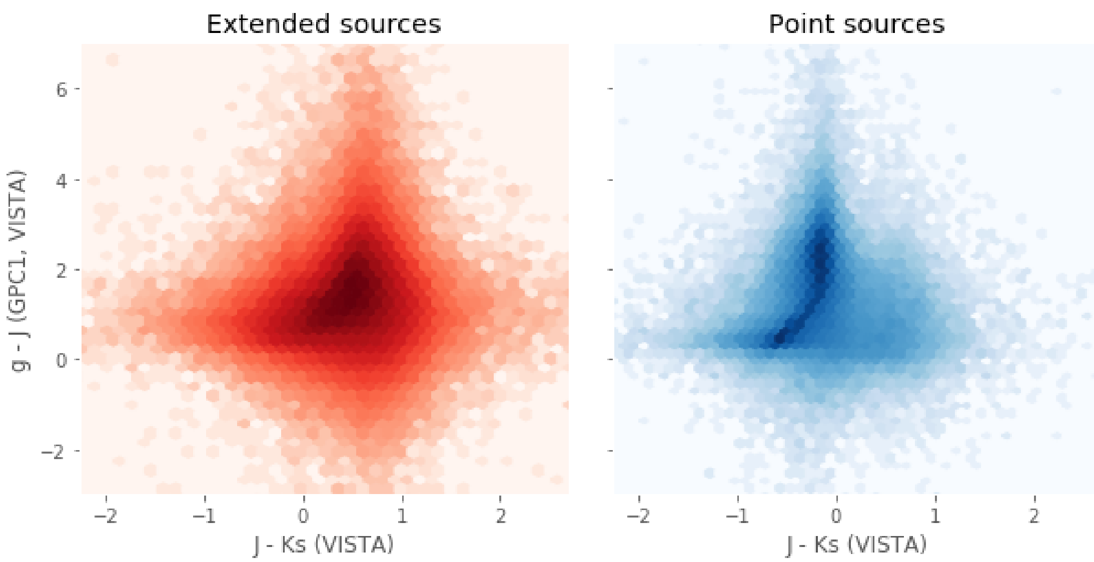


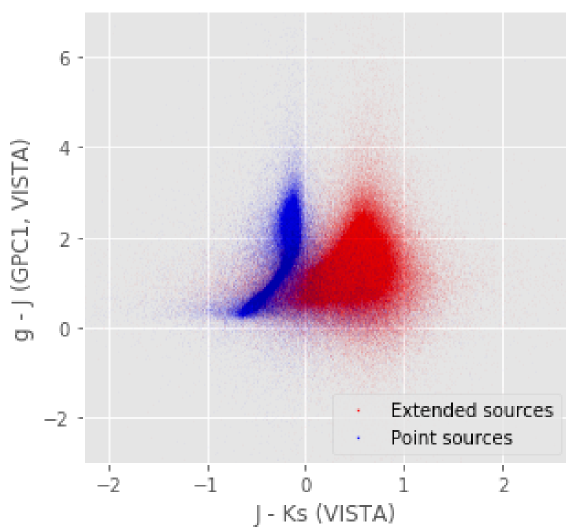
Number of source used: 6640916 / 29790690 (22.29%)



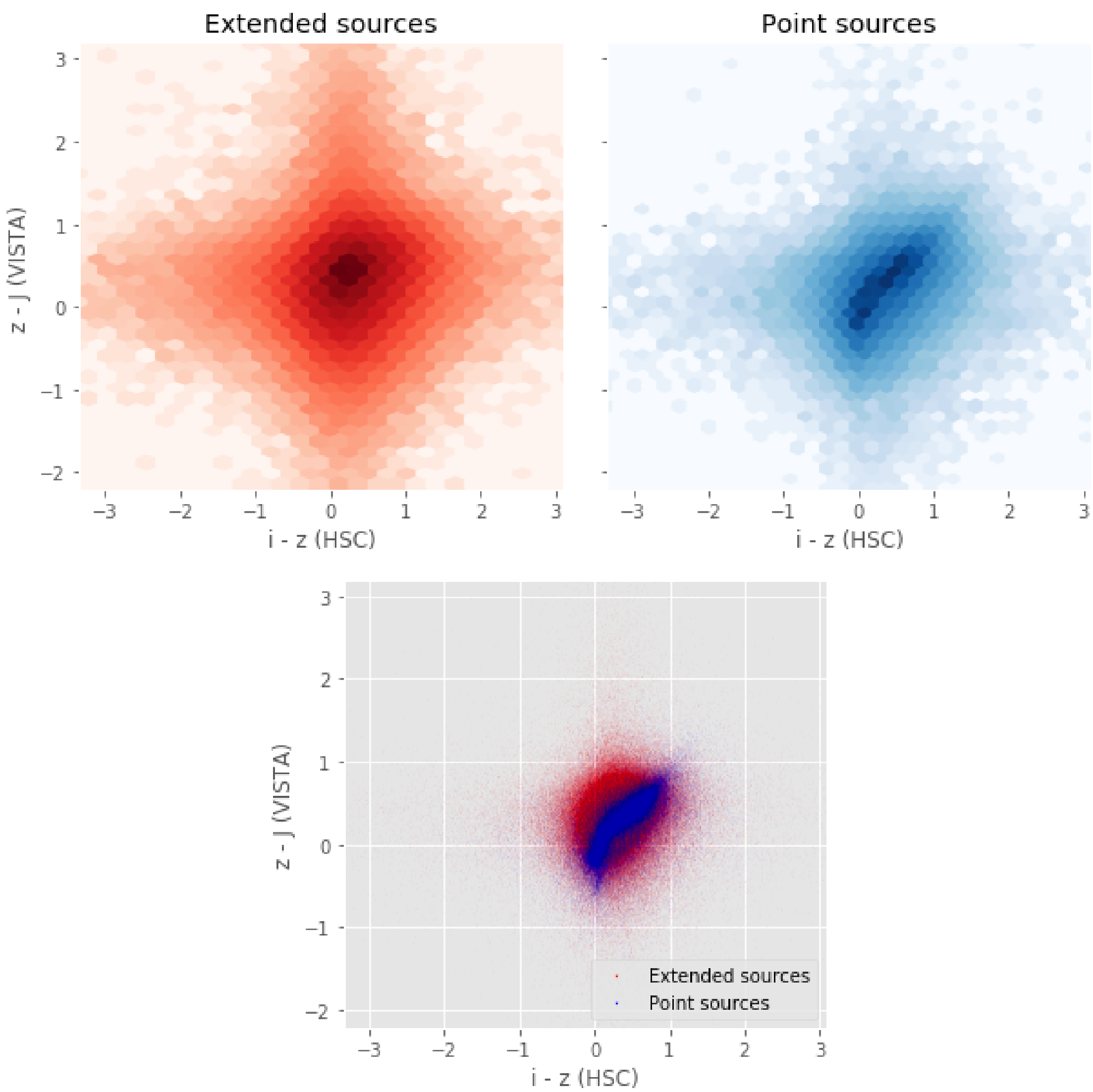



```
Number of source used: 376927 / 29790690 (1.27%)
```






```
Number of source used: 520388 / 29790690 (1.75%)
```


Extended sources
Point sources
z - J (VISTA)
i - z (HSC)
Extended sources
Point sources
z - J (VISTA)
i - z (HSC)

4_Selection_function

March 8, 2018

1 SGP Selection Functions

1.1 Depth maps and selection functions

The simplest selection function available is the field MOC which specifies the area for which there is Herschel data. Each pristine catalogue also has a MOC defining the area for which that data is available.

The next stage is to provide mean flux standard deviations which act as a proxy for the catalogue's 5σ depth

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-27 23:21:53.341804
```

```
Depth maps produced using: master_catalogue_sgp_20180221.fits
```

1.2 I - Group masterlist objects by healpix cell and calculate depths

We add a column to the masterlist catalogue for the target order healpix cell per object.

1.3 II Create a table of all Order=13 healpix cells in the field and populate it

We create a table with every order=13 healpix cell in the field MOC. We then calculate the healpix cell at lower order that the order=13 cell is in. We then fill in the depth at every order=13 cell as calculated for the lower order cell that that the order=13 cell is inside.

```
Out[9]: <IPython.core.display.HTML object>
```

```
Out[11]: <IPython.core.display.HTML object>
```

```
Out[12]: <IPython.core.display.HTML object>
```

1.4 III - Save the depth map table

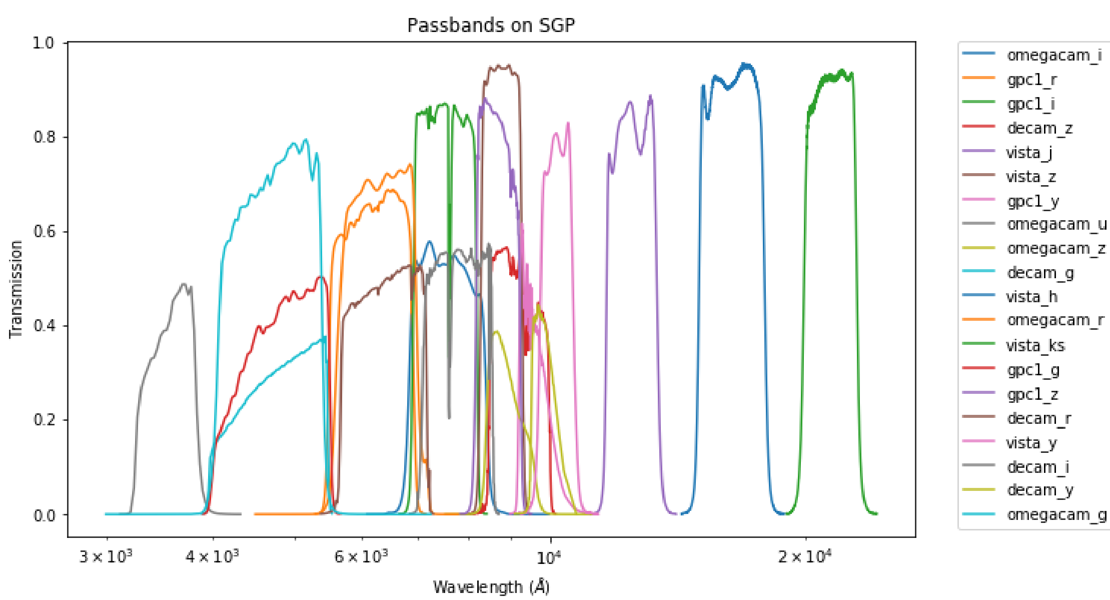
1.5 IV - Overview plots

1.5.1 IV.a - Filters

First we simply plot all the filters available on this field to give an overview of coverage.

```
Out[14]: {'decam_g',
          'decam_i',
          'decam_r',
          'decam_y',
          'decam_z',
          'gpc1_g',
          'gpc1_i',
          'gpc1_r',
          'gpc1_y',
          'gpc1_z',
          'omegacam_g',
          'omegacam_i',
          'omegacam_r',
          'omegacam_u',
          'omegacam_z',
          'vista_h',
          'vista_j',
          'vista_ks',
          'vista_y',
          'vista_z'}
```

```
Out[15]: <matplotlib.text.Text at 0x7ef1e73afe48>
```



1.5.2 IV.a - Depth overview

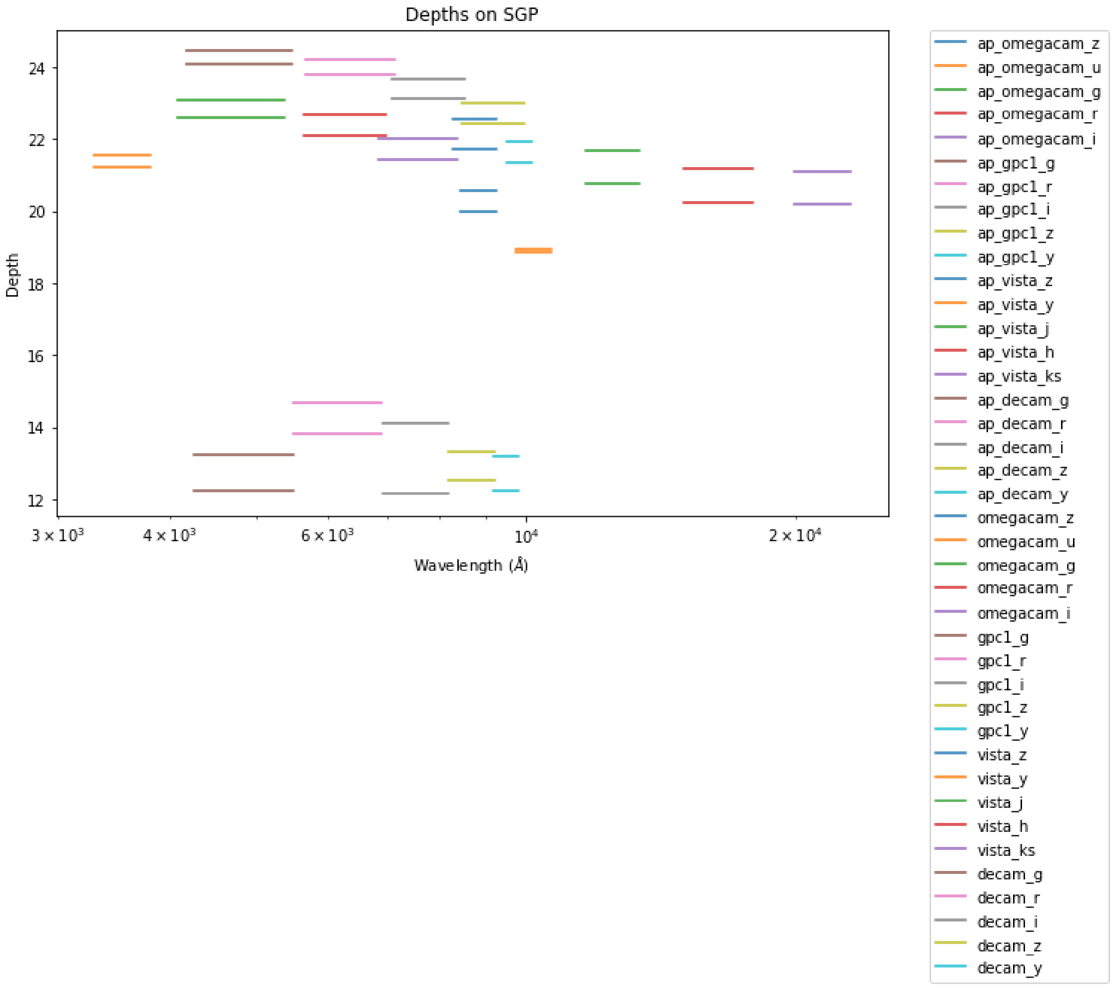
Then we plot the mean depths available across the area a given band is available

```
omegacam_z: mean flux error: 4.349520561238577, 3sigma in AB mag (Aperture): 21.111093392701484
omegacam_u: mean flux error: 1.7349305835913886, 3sigma in AB mag (Aperture): 22.10899160596907
omegacam_g: mean flux error: 0.41757597627000614, 3sigma in AB mag (Aperture): 23.6553581003410
omegacam_r: mean flux error: 0.6100505525239287, 3sigma in AB mag (Aperture): 23.24378230119641
omegacam_i: mean flux error: 1.127856898593322, 3sigma in AB mag (Aperture): 22.576561862517273
gpc1_g: mean flux error: 3641.0688062718277, 3sigma in AB mag (Aperture): 13.804124648218476
gpc1_r: mean flux error: 972.4935034507495, 3sigma in AB mag (Aperture): 15.237480091226828
gpc1_i: mean flux error: 1636.8550682330665, 3sigma in AB mag (Aperture): 14.672171294562759
gpc1_z: mean flux error: 3380.70858859225, 3sigma in AB mag (Aperture): 13.884677520892119
gpc1_y: mean flux error: 3746.128481105709, 3sigma in AB mag (Aperture): 13.773240192429832
vista_z: mean flux error: 0.6899601992278437, 3sigma in AB mag (Aperture): 23.110136765902148
vista_y: mean flux error: 19.097637615963123, 3sigma in AB mag (Aperture): 19.504747742699998
vista_j: mean flux error: 1.5704448656921801, 3sigma in AB mag (Aperture): 22.217140128120285
vista_h: mean flux error: 2.4787085432986435, 3sigma in AB mag (Aperture): 21.721633204085443
vista_ks: mean flux error: 2.635456031105936, 3sigma in AB mag (Aperture): 21.655057425660765
decam_g: mean flux error: 0.12171895805602276, 3sigma in AB mag (Aperture): 24.99380129811255
decam_r: mean flux error: 0.14943357337220306, 3sigma in AB mag (Aperture): 24.771076408789007
decam_i: mean flux error: 0.24646520305746436, 3sigma in AB mag (Aperture): 24.22780783192507
decam_z: mean flux error: 0.45826140827634776, 3sigma in AB mag (Aperture): 23.554413649710987
decam_y: mean flux error: 1.2483417594555521, 3sigma in AB mag (Aperture): 22.466363116327777
omegacam_z: mean flux error: 7.4472286739027425, 3sigma in AB mag (Total): 20.527210139566854
omegacam_u: mean flux error: 2.3231158820249225, 3sigma in AB mag (Total): 21.792019678488522
omegacam_g: mean flux error: 0.6566397000426001, 3sigma in AB mag (Total): 23.163879022273058
omegacam_r: mean flux error: 1.058529214057248, 3sigma in AB mag (Total): 22.64543974196325
omegacam_i: mean flux error: 1.9571956200260976, 3sigma in AB mag (Total): 21.978111275228464
gpc1_g: mean flux error: 9345.197016510885, 3sigma in AB mag (Total): 12.780725709057755
gpc1_r: mean flux error: 2145.3321098092492, 3sigma in AB mag (Total): 14.378460530648546
gpc1_i: mean flux error: 9856.371371111956, 3sigma in AB mag (Total): 12.722904216707455
gpc1_z: mean flux error: 7104.5971034400045, 3sigma in AB mag (Total): 13.078348227110759
gpc1_y: mean flux error: 9117.943363138795, 3sigma in AB mag (Total): 12.80745463765549
vista_z: mean flux error: 1.4982477688633682, 3sigma in AB mag (Total): 22.268237764117593
vista_y: mean flux error: 20.340943701052172, 3sigma in AB mag (Total): 19.436269118743347
vista_j: mean flux error: 3.505853156549205, 3sigma in AB mag (Total): 21.34521255916004
vista_h: mean flux error: 5.748748543561027, 3sigma in AB mag (Total): 20.808263581815616
vista_ks: mean flux error: 6.184235698222347, 3sigma in AB mag (Total): 20.728981779745233
decam_g: mean flux error: 0.17151027385645418, 3sigma in AB mag (Total): 24.621471512231643
decam_r: mean flux error: 0.22345347461905343, 3sigma in AB mag (Total): 24.3342290827814
decam_i: mean flux error: 0.405747680266469, 3sigma in AB mag (Total): 23.68655674928943
decam_z: mean flux error: 0.7824048607703645, 3sigma in AB mag (Total): 22.97361801348361
decam_y: mean flux error: 2.0925635319007347, 3sigma in AB mag (Total): 21.905500232218536


ap_omegacam_z (8433.9004, 9274.5996, 840.69922)
ap_omegacam_u (3296.7, 3807.8999, 511.19995)
ap_omegacam_g (4077.8999, 5369.7002, 1291.8003)
```

```
ap_omegacam_r (5640.7002, 6962.7998, 1322.0996)
ap_omegacam_i (6841.5, 8373.7998, 1532.2998)
ap_gpc1_g (4260.0, 5500.0, 1240.0)
ap_gpc1_r (5500.0, 6900.0, 1400.0)
ap_gpc1_i (6910.0, 8190.0, 1280.0)
ap_gpc1_z (8190.0, 9210.0, 1020.0)
ap_gpc1_y (9200.0, 9820.0, 620.0)
ap_vista_z (8300.0, 9260.0, 960.0)
ap_vista_y (9740.0, 10660.0, 920.0)
ap_vista_j (11670.0, 13380.0, 1710.0)
ap_vista_h (15000.0, 17900.0, 2900.0)
ap_vista_ks (19930.0, 23010.0, 3080.0)
ap_decam_g (4180.0, 5470.0, 1290.0)
ap_decam_r (5680.0, 7150.0, 1470.0)
ap_decam_i (7090.0, 8560.0, 1470.0)
ap_decam_z (8490.0, 9960.0, 1470.0)
ap_decam_y (9510.0, 10170.0, 660.0)
omegacam_z (8433.9004, 9274.5996, 840.69922)
omegacam_u (3296.7, 3807.8999, 511.19995)
omegacam_g (4077.8999, 5369.7002, 1291.8003)
omegacam_r (5640.7002, 6962.7998, 1322.0996)
omegacam_i (6841.5, 8373.7998, 1532.2998)
gpc1_g (4260.0, 5500.0, 1240.0)
gpc1_r (5500.0, 6900.0, 1400.0)
gpc1_i (6910.0, 8190.0, 1280.0)
gpc1_z (8190.0, 9210.0, 1020.0)
gpc1_y (9200.0, 9820.0, 620.0)
vista_z (8300.0, 9260.0, 960.0)
vista_y (9740.0, 10660.0, 920.0)
vista_j (11670.0, 13380.0, 1710.0)
vista_h (15000.0, 17900.0, 2900.0)
vista_ks (19930.0, 23010.0, 3080.0)
decam_g (4180.0, 5470.0, 1290.0)
decam_r (5680.0, 7150.0, 1470.0)
decam_i (7090.0, 8560.0, 1470.0)
decam_z (8490.0, 9960.0, 1470.0)
decam_y (9510.0, 10170.0, 660.0)
```

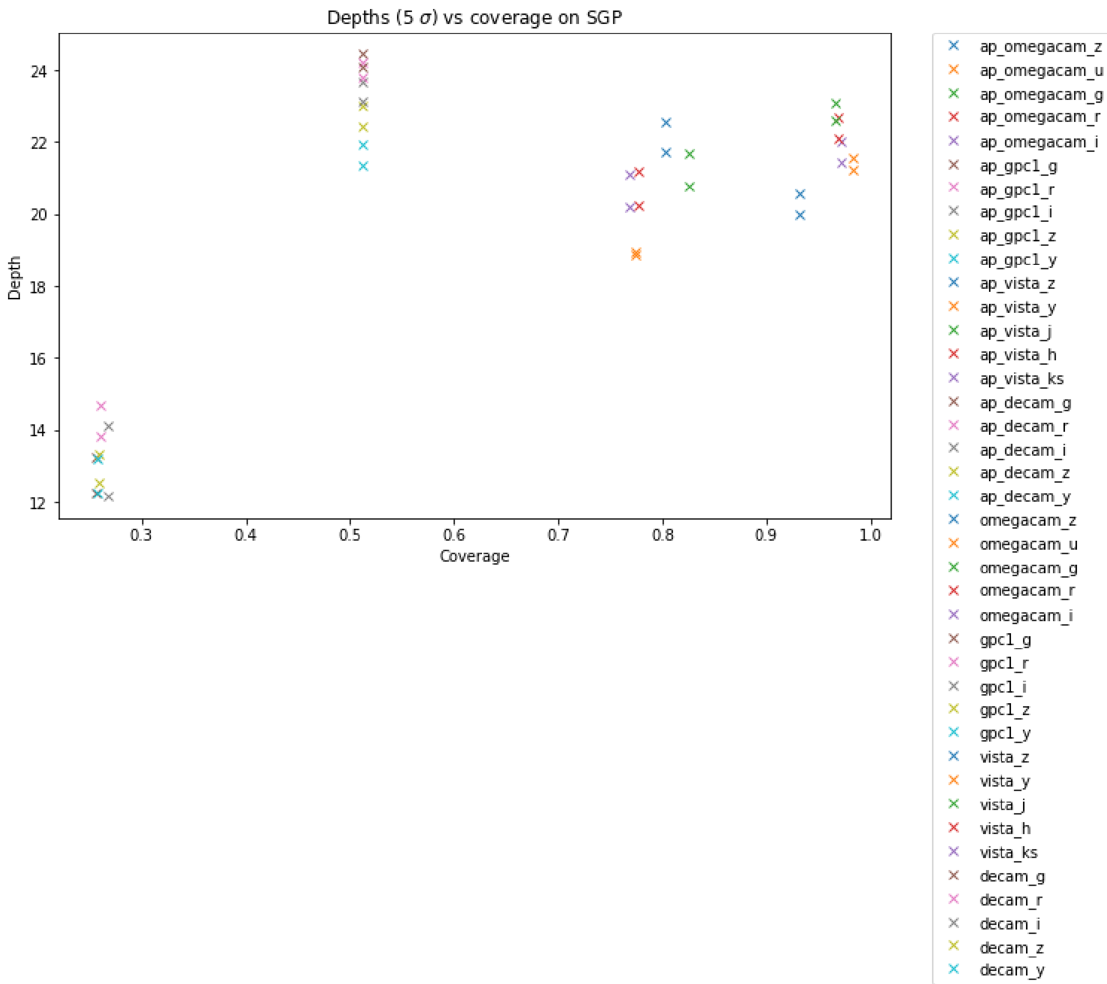
```
Out[20]: <matplotlib.text.Text at 0x7ef1e6f52f60>
```



1.5.3 IV.c - Depth vs coverage comparison

How best to do this? Colour/intensity plot over area? Percentage coverage vs mean depth?

```
Out[21]: <matplotlib.text.Text at 0x7ef1e6f904e0>
```


Depths (5 σ) vs coverage on SGP
Depth
Coverage
24
22
20
18
16
14
12
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
ap_omegacam_z
ap_omegacam_u
ap_omegacam_g
ap_omegacam_r
ap_omegacam_i
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_vista_z
ap_vista_y
ap_vista_j
ap_vista_h
ap_vista_ks
ap_decam_g
ap_decam_r
ap_decam_i
ap_decam_z
ap_decam_y
omegacam_z
omegacam_u
omegacam_g
omegacam_r
omegacam_i
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
vista_z
vista_y
vista_j
vista_h
vista_ks
decam_g
decam_r
decam_i
decam_z
decam_y