

Promote AGASC 1.8 for operational use

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AGASC 1.8

We seek approval to promote AGASC 1.8 for operational use.

Almost 9 million stars are updated in AGASC1.8.

The update was done by matching AGASC stars in the Gaia DR3 catalog. Gaia is a European Space Agency mission providing high-precision astrometry and multi-band photometry of more than 1000 million stars in the Milky Way.

AGASC 1.8 includes the following updated information:

- A precise estimate of ACA magnitude derived from Gaia photometry.
- Precise positions and proper motions (and their uncertainties).

Background

As temperatures increase, single stars can have higher impact on difficult catalogs. Catalog issues are a source of risk not included in catalog evaluation metrics:

- A star that is fainter than expected might not be acquired
(> 130 known cases)
- A star that is brighter than expected will be rejected by the OBC if the magnitude is brighter than 5.2.
(at least 4 cases)
- A star 5+ arcsec from the expected location will be rejected by the OBC
(at least two cases since May 2017)
- A spoiler that is brighter than expected can affect the attitude determination.

AGASC-Gaia DR3 Cross-Match

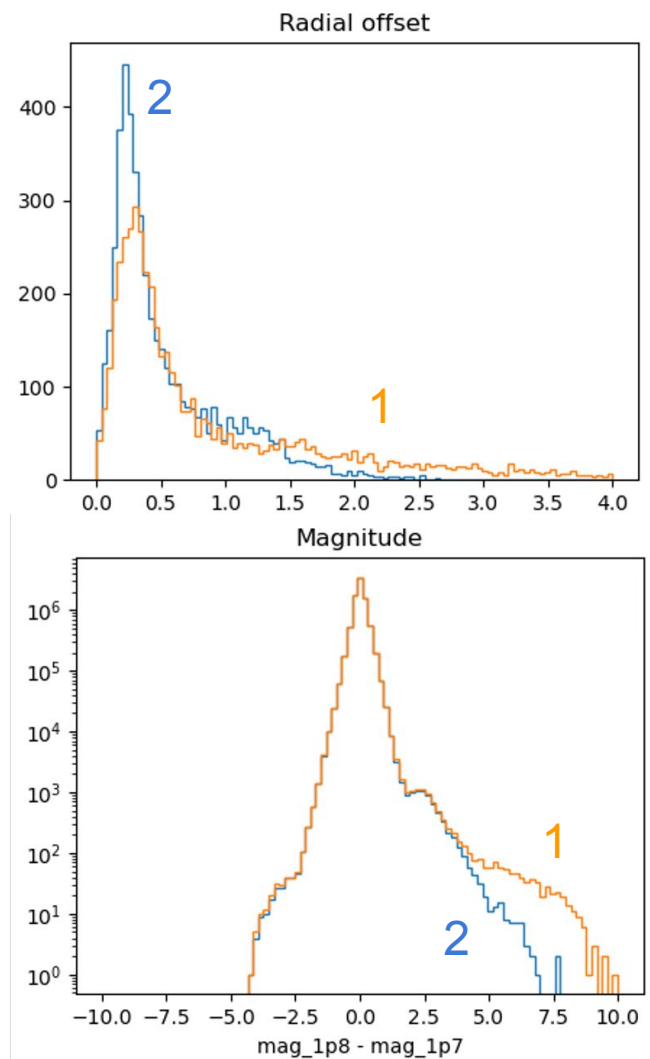
Two independent cross-matching algorithms were used to match ~9 million stars:

1. Tycho2 and GSC2.3 position-based cross-matches published as part of Gaia DR3.
2. Our own position- and magnitude-based cross-match.

The two methods agree in 99.96% of cases.

Most of the discrepancies are understood as defects in how proper motion and magnitude are treated in the published cross-matches.

Outlier analysis was done on multiple conditions and hundreds of matches were inspected.



Magnitude Estimates

Analytical model used to predict the ACA observed magnitude from the Gaia blue, green, and red magnitudes.

Plot shows distribution of observed - catalog mags.

1-99% confidence region:

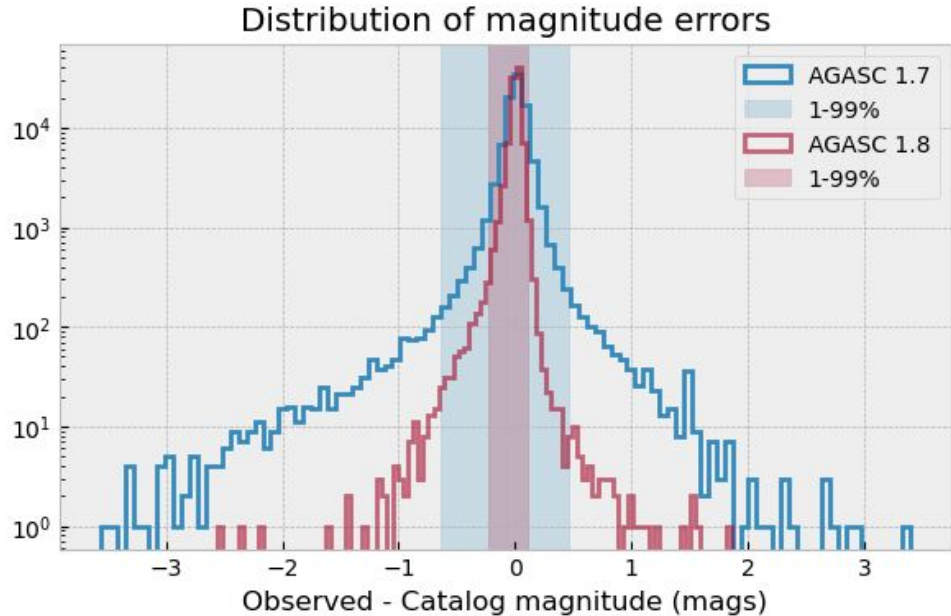
AGASC-1.7: 1.1 mag

AGASC 1.8: 0.3 mag

of Errors > +/- 1 mag

AGASC-1.7: 682 stars

AGASC-1.8: 26 stars



AGASC Catalog Update

The following fields are updated for 8903379 stars:

- **MAG, MAG_ERR, MAG_BAND, MAG_CATID.** Magnitude.
- **MAG_ACA, MAG_ACA_ERR.** ACA magnitude.
- **COLOR1, COLOR2, COLOR1_ERR, COLOR2_ERR, C1_CATID, C2_CATID.** Color.
- **RA, DEC, EPOCH, POS_CATID, POS_ERR.** Position.
- **PM_RA, PM_DEC, PM_CATID.** Proper motion.
- **VAR, VAR_CATID.** Variable flag.

These are updated for all stars:

- **XREF_ID1, XREF_ID5.** The Gaia counterpart ID.
- **ASPQ1, ASPQ2.** Spoiler star codes.
- **RSV4.** GSC1.1 star number (was XREF_ID1).

One duplicate record was removed (AGASC ID 154534513)

AGASC IDs remain unchanged

Star Working Group Review

SS&AWG held a detailed technical review meeting on 2024-June-18.

AGASC 1.8 algorithms, content, testing and validation were **reviewed and approved** by SS&AWG.

In the next few slides we present the validation and testing highlights for the FDB.

Validation and testing

Updated files are compatible with tools and as-expected

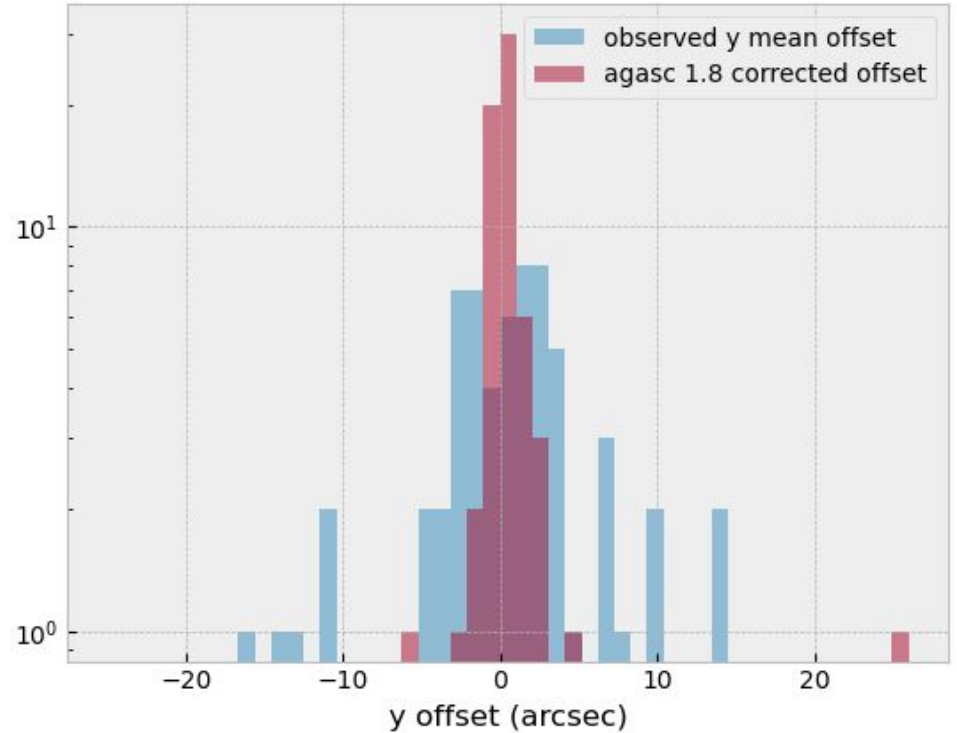
- Team independently verified values and types in the three new files for operations
- Integration tests in ska3 confirms compatibility with Python tools
 - agasc, proseco, sparkles, kadi, starcheck packages depend directly on the AGASC
 - Starcheck release (> 14.10) required to use 1.8 proseco AGASC by default - promotion planned with ska3-flight 2024.7 with AGASC 1.8
 - proseco and agasc packages required updates to regression-style tests configured with AGASC 1.7
- FOT has run integration testing that verifies compatibility with no issues in star selection

Validation and testing

Vast majority of star position changes (1.7 \Rightarrow 1.8) less than 1 arcsec.

For observed stars with position change over 2 arcsec, AGASC 1.8 positions match observed data better than AGASC 1.7.

One large outlier (26 arcsec) was a tracked hot pixel.



Validation and testing

AGASC 1.8 for ground use in CXCDS pipeline:

- FITS files in /data/agasc1p8 area are as-expected
- MP tools (mp_get_agascid, mp_get_agasc_cone) work.
- SOT Aspect spot checked pipeline on 3 observations
 - 1 with guide star with large (5 arcsec) position change
 - 1 with star with moderate (1.5 arcsec) position change
 - 1 using the FITS file with a removed entry in 1.8
- DS ran functional and integration tests to be documented in DS ECR

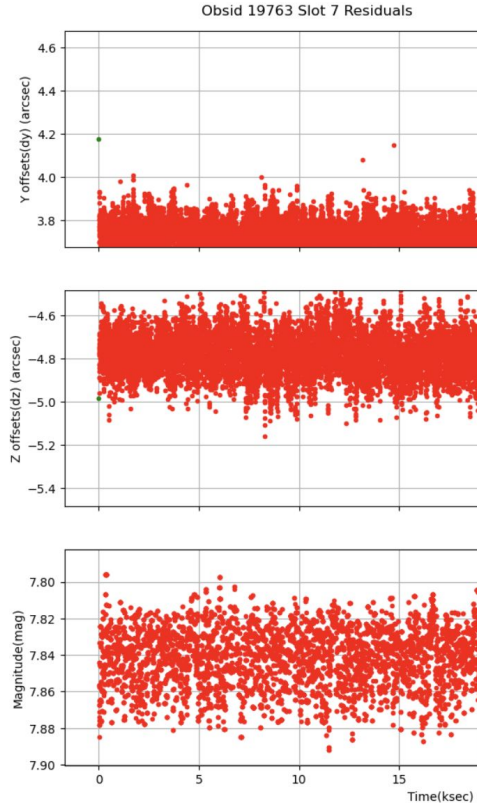
Validation and testing

FITS files as-expected and work with aspect pipeline.

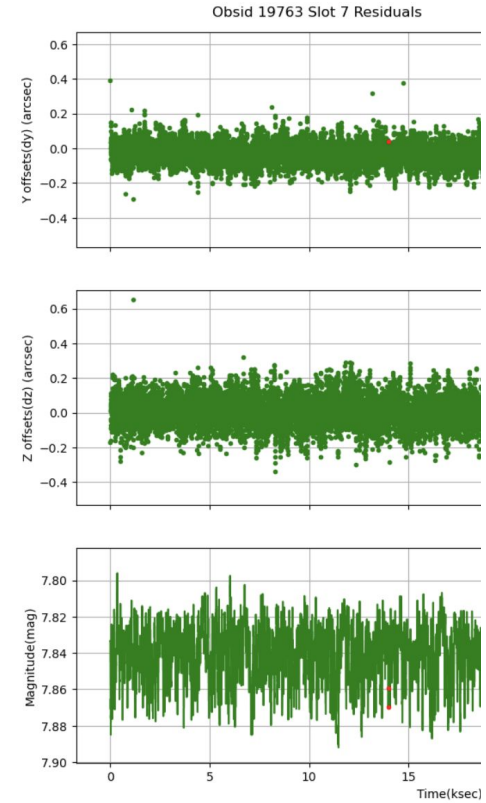
Example shows aspect pipeline residuals for obsid 19763

Red plotted centroids not used by Kalman filter - too far from catalog star position

With 1.7 star positions



With 1.8 star positions



AGASC 1.8 Promotion: Flight Operations

(Star selection in FOT Matlab Tools and Star catalog evaluation during ACA load review)

Promotion is planned so JUL2924 loads are built with AGASC 1.8.

The following files will be placed in `/proj/sot/ska/data/agasc` upon approval (after JUL2224 loads approved):

- `agasc1p8.h5`
- `miniagasc_1p8.h5`
- `proseco_agasc_1p8.h5`

MATLAB promotion:

- The MATLAB Tools **already** allow users to manually select the new agasc 1.8 file (`proseco_agasc_1p8.h5`). The default will remain AGASC 1.7 file until promotion is completed.
- The FOT Mission Planner building the JUL2924 loads will be able to select the AGASC 1.8 file in anticipation of the approval for this schedule.
- After approval of the AGASC 1.8 update, the default will be updated to use AGASC 1.8 and allow access to the other 1.8 files.

AGASC 1.8 Promotion: CXADS operations

The ground aspect pipeline depends on the 9537 files of the AGASC 1.8.

These have been installed in advance for testing in `/data/agasc1p8`.

The CXADS AGASC 1.8 will be promoted in DS 10.12.7 via environment variable changes that make `/data/agasc1p8` the flight AGASC in support of JUL2924 loads.

AGASC 1.8 Backout Plan

Flight operations

The AGASC 1.7 files will **not** be removed from the end user's machines on promotion.

The MATLAB tools will allow users to manually select the AGASC 1.7 files as needed, and the tools can be reverted to default to AGASC 1.7.

AGASC 1.8 files would be removed from `/proj/sot/ska/data/agasc`.

CXCDS aspect pipeline

Revert pipeline to use `/data/agasc1p7` following process in ECR.

Recommendation

We are recommending approval of AGASC 1.8 for operational use.