Promote AGASC 1.6 for use with OFLS 10.3 and SAUSAGE

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• Seek approval to promote AGASC 1.6 for operational use with OFLS 10.3 and SAUSAGE
• AGASC 1.6 corrects a calibration error in AGASC 1.5. For red stars the predicted magnitudes are up to 0.5 mags too bright
• New version also has improved star magnitude uncertainties which account for stellar spectral variation
• Only the MAG_ACA and MAG_ACA_ERR columns have been updated. All other values are identical and files retain the same length and same number of header blocks.

Presentation:
  – Background
  – Calibration
  – Creation of AGASC 1.6
  – Validation
AGASC 1.5 uses observed V and B-V color to predict star magnitude in the ACA bandpass, which is fairly red

Predicted magnitude can have significant uncertainty because of variations in stellar spectra

AGASC 1.5 was calibrated in May 2001 using 1939 observed Tycho-1 stars to update MAG_ACA and MAG_ACA_ERR

Derived a third order polynomial fit

$$MAG_{ACA} = V + C_0 + C_1 (B-V) + C_2 (B-V)^2 + C_3 (B-V)^3$$
Apparently a good fit, but...
Background

- Early in 2004 it was observed that for red stars (B-V > 0.5) there was an increasing discrepancy between the predicted and observed ACA magnitudes (using 25937 acquisition stars)
Background

- There is no strong magnitude or temporal dependence
The discrepancy between predicted and observed magnitudes was eventually traced to a “accounting” error in program used to generated AGASC 1.5:

- The usual Johnson B-V color is related to the Tycho $B_T - V_T$ color by $B-V = 0.85 \times (B_T - V_T)$
- In the process of generating AGASC 1.5 that correction factor got applied in twice in different places

The star selection and acquisition working group came to a consensus that a fix was needed and that the cleanest legacy solution was to correct the AGASC
Using a substantially larger database of observed stars (~26000 vs. 2000), we generated a new best-fit curve to relate MAG_ACA and Tycho-2 magnitudes $B_T$ and $V_T$.

- Recalibration only applies to stars with Tycho-2 colors (>99.8% of candidate guide/acquisition stars)
- With larger database we could fit over a wider color range
- A spline fit was used instead of a polynomial fit, giving a better fit over the wide range
- MAG_ACA_ERR was recalculated to account for intrinsic uncertainty related to dispersion in stellar spectra
  
  \[ \sigma_{mag_{aca}}^2 = \sigma_v^2 + \sigma_{(b-v)}^2 \left[ \frac{d \text{MAG}_\text{ACA}}{d(B-V)} \right]^2 + \sigma_{aca_{resp}}^2 \]

  - ACA response term calculated so mean MAG_ACA_ERR matches observed RMS in each color bin

  - Details: [http://cxc.harvard.edu/mta/ASPECT/agasclp6cal/](http://cxc.harvard.edu/mta/ASPECT/agasclp6cal/)
Calibration

Spline Fit with Characterized ACA response errors

Observed ACA Mag - Tycho V - Mag

COLOR2
Calibration

AGASC 1.6 MAG_ACA_ERR

AGASC 1.5 MAG_ACA_ERR
Calibration

- Compare deviations (1.5 vs. 1.6) using actual AGASC 1.6
Creation of AGASC 1.6

- The new files for AGASC 1.6 were created using an IDL script
  - Read in each file
  - Update the MAG_ACA and MAG_ACA_ERR columns for stars with Tycho-2 colors
  - Update header comments for version 1.6
- Documentation
  - Added AGASC 1.6 entry to main SOT MP AGASC page and supplied links to Aspect web pages with detailed description of calibration and testing
  - Updated standard COMMENTS.TXT
  - Put all code and auxiliary data files in a single directory with associated documentation
Validation

- Unit level comparison of AGASC 1.5 to 1.6
  [http://cxc.harvard.edu/mta/ASPECT/agasclp6testing/](http://cxc.harvard.edu/mta/ASPECT/agasclp6testing/)

- CXCDS (Aspect pipeline, MP tools, starchcheck, archive)

- Flight ops
  - OFLS 10.3 load product generation
  - SAUSAGE
  - OFLS 10.3 AD&SC

- Working promotion plan containing detailed test results at
  [http://jeeves.cfa.harvard.edu/Murk/Chandra/PromotionPlan](http://jeeves.cfa.harvard.edu/Murk/Chandra/PromotionPlan)
Validation: Unit level

- Unit level comparison of AGASC 1.5 to 1.6
  (http://cxc.harvard.edu/mta/ASPECT/agasclp6testing/)
  - Color vs. Mag scatter plot
  - Color vs. Mag_err scatter plot
  - Mag and Mag_err distributions
  - Detailed comparison of catalogs generated by SAUSAGE
Validation: CXCDS

- **CXCDS Aspect pipeline**
  - Ran aspect pipeline for eight obsids (standard regression test cases) and confirmed no unexpected errors or outputs and only expected changes in guide star output file

- **Mission planning tools**
  - Confirmed correct operation of `mp_sfe`, `mp_get_agasc_id` and `mp_get_agasc`

- **Starcheck**
  - Ran starcheck on three FOT test loads and confirmed no errors or unexpected results

- **SOE file ingest**
  - Ingested SOE file from one FOT test load using beta archive server and confirmed correct ingest
Validation: Flight Ops

• OFLS 10.3 and SAUSAGE
  – AGASC 1.6 installed on SGI/OFLS3 server and NetApp for SAUSAGE access
  – Built three weekly loads and performed full ACA review. (One load specifically chosen to have many red stars)
  – Some differences in selected stars noted, as expected
  – No problems in overall star selection

• OFLS AD&SC testing (W. Davis)
  – Confirmed AGASC 1.6 can be read using W.Davis' PC tool startest
  – Ran AD&SC with 14 attitudes with different star densities
  – Results identical for identified stars and attitude solutions

• Similar testing will be done with the Linux OFLS 11 at which time we will seek FDB approval for promotion on this platform
Promotion

- Once approved actual deployment will include coordinated events, done at a convenient time between load builds
- ClearDDTS actions:
  - Install Release 4 of Star Catalog AGASC 1.6 on OFLS1 in Working State
  - Make Star Catalog AGASC 1.6 Operational (Baseline)
- Change star catalog pointer for SAUSAGE
- New DS patch release to change pointers to AGASC 1.6, which is already installed on DS. Precise coordination not required
- After time of no less than 3 months, remove AGASC 1.5
Conclusion

- AGASC 1.6 will improve reliability of star acquisition and guiding
  - More accurate predicted star magnitudes
  - More realistic assessment of magnitude uncertainties
- Testing shows that there are no radical changes and there will be no impact on the ability to find stars in specific fields
- Important for the legacy of Chandra to have the star catalog correct