Astrometric Data Sources For Space Surveillance and Space Control

Sean E. Urban
U.S. Naval Observatory
Error Budget

- How much devoted to *a priori* data?
- Systems moving toward higher accuracies
  - *a priori* data accuracies become important
  - Should utilize best data
  - Best changes: allow for updates
- Factors of 100 *for same star* not uncommon
Major Astrometric Catalogs
Major Astrometric Catalogs
FK5 – Old Standard

- Number of stars: 4652
- Mag. Range: 0 to 9 (sparse beyond 6)
- Accuracies (2000)
  - Pos = 100 mas; P.M = 2 mas/yr
- Transit circle data – long epoch span
- Obsolete by Hipparcos
Obsolete FK5-based Catalogs

IRS – International Reference Stars
ACRS – Astrographic Cat. Reference Stars
PPM – Positions and Proper Motions
SAO – All incarnations
Major Astrometric Catalogs
Major Astrometric Catalogs
Hipparcos – New Standard

- Number of stars: 118,000
- Accuracies (2000)
  - Positions: 10 mas
  - Proper motions: 1-2 mas
- HIP satellite observations
- Not obsolete
Hipparcos, continued

- Complete to $V=7.3$
- Stars as faint as 12$^{th}$
- For high precision work, must be aware of flagged data
Major Astrometric Catalogs
Major Astrometric Catalogs

![Graph showing Major Astrometric Catalogs](image)

- IRS
- FK5
- Tycho-2
- HIPPARCOS
- GSC
- A2.0
- UCAC

Position error (mas) epoch 2000 vs. stars/square degree.
ACT Reference Catalog

- Number of stars: 998,758
- Mag. Range: 4\textsuperscript{th} to 11\textsuperscript{th}
- Accuracies (2000)
  - Pos = 40 mas; P.M. = 3 mas/yr
- Tycho (on HIP) and AC
- Obsolete by Tycho-2
Major Astrometric Catalogs
Major Astrometric Catalogs
• Number of stars: 2.54 million
• Mag. Range 0 to 12th
• Accuracies (2000)
  – Pos = 40 mas; P.M. = 1 to 3 mas/yr
• Tycho + TC + Astrographs + AC
• Not obsolete
• Disks available through me
Major Astrometric Catalogs

The diagram illustrates the relationship between position error (mas) with epoch 2000, and the number of stars per square degree for various astrometric catalogs. The catalogs include FK5, IRS, Tycho-2, ACT, GSC, UCAC, and A2.0, each represented by a different symbol and error bar. The y-axis represents position error in milliarcseconds (mas), while the x-axis represents the number of stars per square degree. The catalogs are compared in terms of their precision, with UCAC showing the highest number of stars per square degree and the lowest position error for a given number of stars.
Major Astrometric Catalogs
UCAC1

- Preliminary release March 2000
- Southern hemisphere coverage only
- Mag. Range 8<sup>th</sup> to 16<sup>th</sup>
- Accuracies (2000)
  - Pos. 20 to 70 mas; P.M. 2 to 12 mas/yr
- Observing continuing
Major Astrometric Catalogs
Major Astrometric Catalogs
Guide Star Catalog 1.2

- Number of stars: 19 million
- Mag. Range 6 to 15\textsuperscript{th}
- Accuracies 500 mas?
- Single epoch only, no proper motions
- Recommend using USNO A2.0
Major Astrometric Catalogs
Major Astrometric Catalogs
USNO A2.0

- Number of stars: 526 million
- Mag. range: 10 to 20?
- Accuracies 250 mas?
- Single epoch only, no proper motions
- To be replaced with B series (late 2002)
Catalog Summary

- Use Hipparcos, if possible
- Tycho-2 next
- UCAC1 can be used in south
- A2 if requiring very faint or very dense stars
- FK5, IRS, ACRS, PMM, ACT, and GSC are not recommended
Final Thoughts

• Understand not all catalogs created equal
• Use the best sources of *a priori* data
• If possible, allow for updates
Recommended Catalogs

- IRS
- GSC
- A2.0
- FK5
- Tycho-2
- ACT
- UCAC (16m, 14m, 12.5m)
- HIPPARCOS

Stars per square degree vs. position error (mas) epoch 2000
Recommended Catalogs

- IRS
- FK5
- Tycho-2
- HIPPARCOS
- GSC
- A2.0
- UCAC, 1.6m
- UCAC, 1.4m
- ACT

Position error (mas), epoch 2000 vs. stars/square degree.