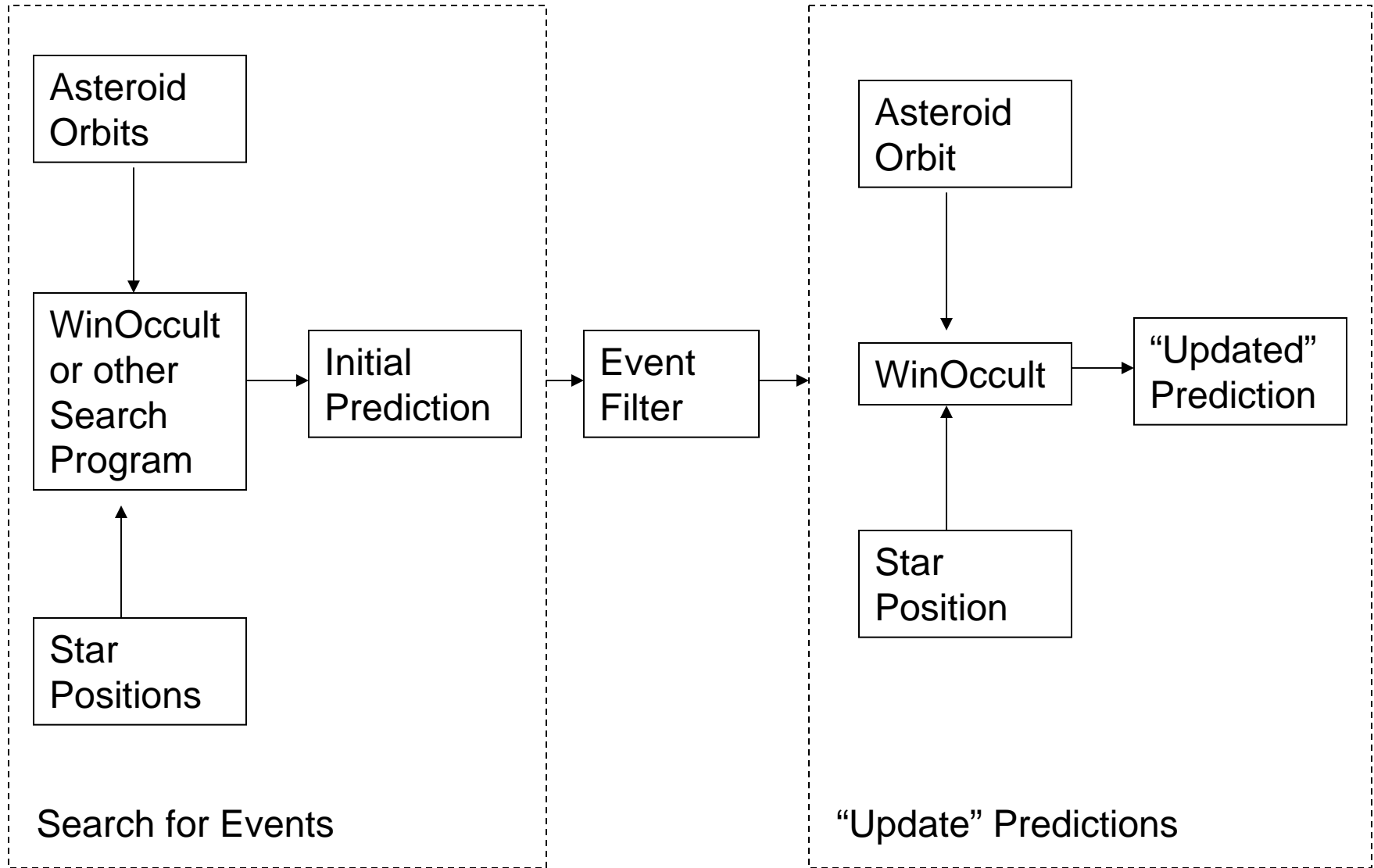


Asteroid Occultation Prediction Process

Steve Preston

Asteroid Occultation Prediction Process Overview



Searchers

- **Edwin Goffin**

- Asteroids: 40km or larger diameter plus some distant objects.
- Orbits: computed by Goffin & MPCORB
- Star Catalog: Compiled catalog primarily based on Tycho2 + TAC plus additional positional info from FK6, Hipparcos, UCAC2 and other source catalogs. Magnitude limit of about 12.
- Timing: 2007 events posted by Apr 2006
- Coverage: Worldwide

Searchers

- **Scott Donnell / Derek Breit**

- Asteroids: 10km or larger
- Orbits: Recent astorb.dat
- Star Catalog: WinOccult Tycho2 (Tycho2 + Hipparcos + UCAC2). Mag limit of about 12.
- Coverage: Worldwide
- Timing: Two search modes
 - Best Events: full year window - six months in advance with bright stars.
 - Deep search: 3 month window - two months in advance.

Searchers

- **Takashi Setoguchi**
 - Asteroids: probably 15km or larger
 - Orbits: Computed by Setoguchi
 - Star Catalog: Tycho2 + Hip + UCAC2
 - Uses his own search program
 - Timing: One month search window one month in advance.
 - Coverage: Japan

Searchers

- **Denis Denissenko**

- Asteroids: probably 15km minimum
- Orbits: from astorb.dat
- Star Catalog: Occult Tycho2 plus UCAC2 stars down to mag 13
- Searches far into the future for spectacular events
- Searches several months out for interesting events over Russia and other parts of the world.

Searchers

- **Andrey Plekhanov**

- Use LinOccult (written by Andrey)
- Asteroids: $e > 0.95$
- Orbits: from astorb.dat & orbfite
- Star Catalog: Tycho2, Hipparcos, UCAC2 ?
- Provides list of events for given location – on request.

Event Filtering

- Goffin
 - Include all of the events from Goffin's list.
 - Compute updates for all events except many of the TNO events and events with un-numbered asteroids.
- Donnell / Breit
 - Include all events with meet "Dunham's criteria"
 - Derek reviews all events to remove events that don't pass over land.

Dunham's Criteria

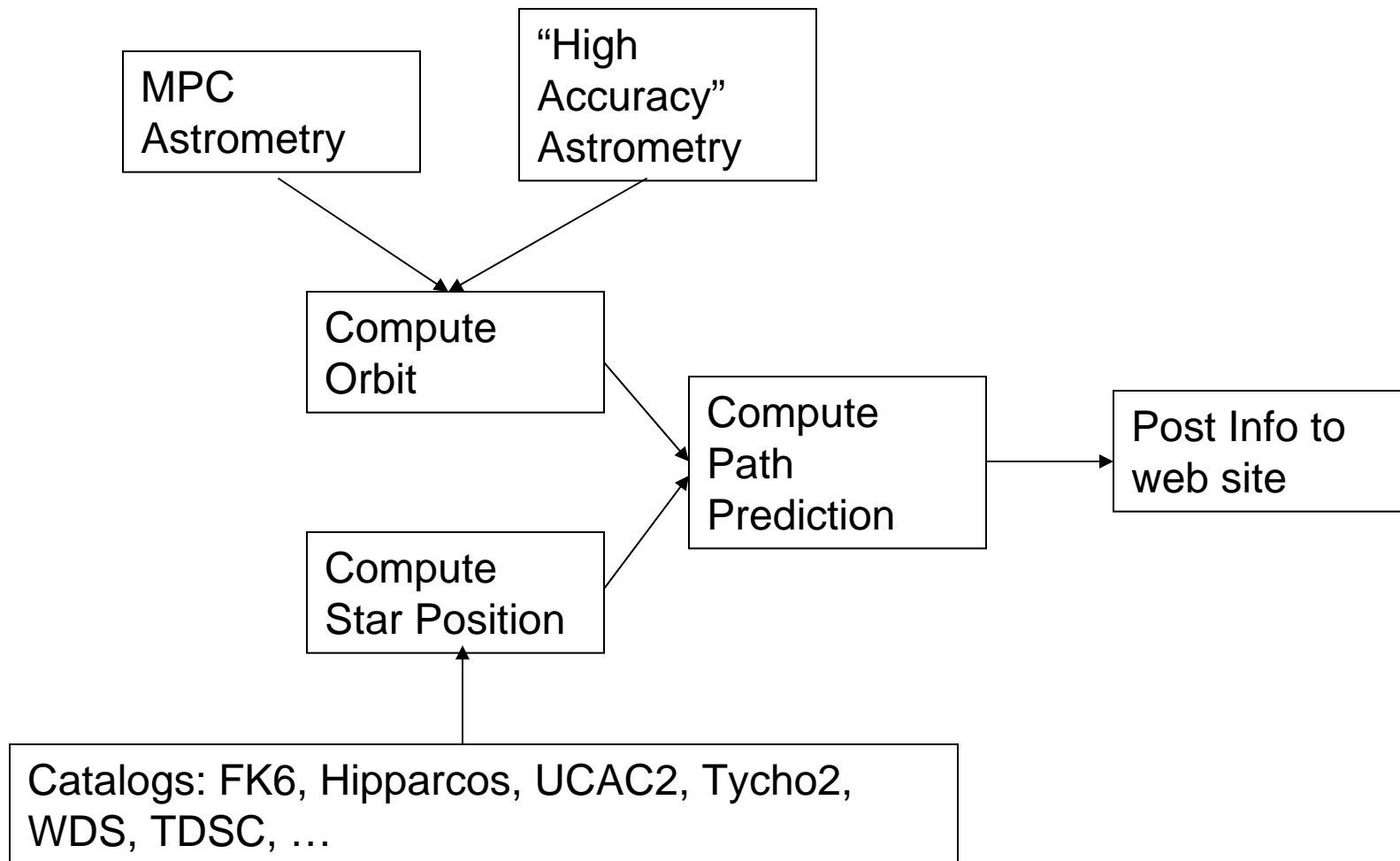
Star Magnitude Lower Limit	Star Magnitude Upper Limit	Asteroid Minimum Subtended Angle (mas)	Minimum Duration (sec)	Minimum Magnitude Drop	Non-FASTT Asteroids?
None	6.5	None ¹	0.33	0.1	Yes
6.5	8.5	10 ¹	0.33	0.1	No ²
8.5	9.5	10 ¹	0.5	0.1	No ²
9.5	10.5	20 ¹	0.5	0.1	No ²
10.5	11.5	20 ¹	1.0	0.1	No ²
11.5	12.5	40 ¹	1.0	0.1	No ²

1. No minimum subtended angle when asteroid diameter greater than 200 km.
2. The following asteroids are not filtered out: 2060 Chiron, 3200 Phaethon, 4015 Wilson Harrington and 5145 Pholus.

Update Timeframe

- First updates of Goffin's events posted soon after Goffin's list is published.
- First updates of events from other searches soon after the events are added to my list.
- Subsequent updates approximately one month and one week prior to the event

Update Process



Computing Orbits

- Astrometry
 - All MPC data after 1900
 - All FASTT data (via email one month and 7 to 10 days before the event)
 - All other “High Accuracy” astrometry: Bill Owen/TMO, Gordon Garradd, Robert McNaught/Siding Springs, Manek/Ondrejov, Behrend/Geneva, Sposetti/Gnosca, Behrend/La Silla

Computing Orbits

- Orbit fits computed with OrbFit software
 - freeware from <http://newton.dm.unipi.it/orbfit/>
 - Newest version is Unix only but source code is available for port to Windows
 - Supports weighting of astrometry via apriori RMS estimates
 - Computes a positional uncertainty statistic
 - Can include additional asteroids as potential perturbers
 - Uses JPL 405 ephemeris

Computing Orbits

- Orbit Fit Computation
 - Let Orbitfit assign a default weight to all “normal” data (typically 1” apriori RMS for recent observations).
 - Assign 0.12” to 0.35” apriori RMS to all “high accuracy” data.
 - Include perturbations from all planets and the moon
 - Include 13 larger asteroids as potential perturbers
 - Compute orbital elements for approximate central time of event
 - Compute positional uncertainty for approximate central time of event

Computing Star Position

- “Research” star positional info
 - Gather data from available catalogs
 - Look for problem areas: double stars, lack of proper motion estimate, unusually high uncertainties.
 - Use UCAC2 position whenever available – even dimmer Hipparcos stars
 - Double stars: look for existing orbit data or use individual positions from Hip or TDSC when available.
- Compute Star Position and uncertainty at time of event
 - Proper motion, parallax, radial velocity

Compute Path Prediction

- WinOccult for path prediction
 - Input asteroid orbit in “user elements” file
 - Input star position as “one-off” star catalog position
 - Compute global view of path
 - Compute individual maps for areas with known observers
 - Compute lat/long path info

Generate Prediction Output

- Event / Path Summary File
- Event HTML file for web
- Star Charts (via Guide)
- Path Maps (via WinOccult)

Post Info to Web

- Generate summary tables for future and past events
- Upload individual event files to web
- Upload summary tables to web

Issues

- Double stars are troublesome
 - Large positional uncertainty in most cases
 - Orbits rarely available
- Asteroid Satellites
- RMS/Weighting methodology
- Many cases of 2 sigma path shifts – too many?

Future Work

- Research accuracy of current prediction methodology
- Orbit fit improvements
 - Add radar data & other positional sources
 - Close approaches
- Post predictions for TNOs and other un-numbered asteroids
- New features tbd for asteroidoccultation.com website
 - Location based search
 - Personalized event info
 - “monitored” events
 - Flag asteroids with satellites