DynAstVO: the Europlanet database of Near-Earth asteroid orbits

J. Desmars[1,3], W. Thuillot[1], D. Hestroffer[1], P. David[1], P. Le Sidaner[2], S. Erard[3]

1. IMCCE, Observatoire de Paris, PSL Research University, Paris, France
2. DIO, Observatoire de Paris, PSL Research University, Paris, France
3. LESIA, Observatoire de Paris, PSL Research University, Paris, France

Abstract

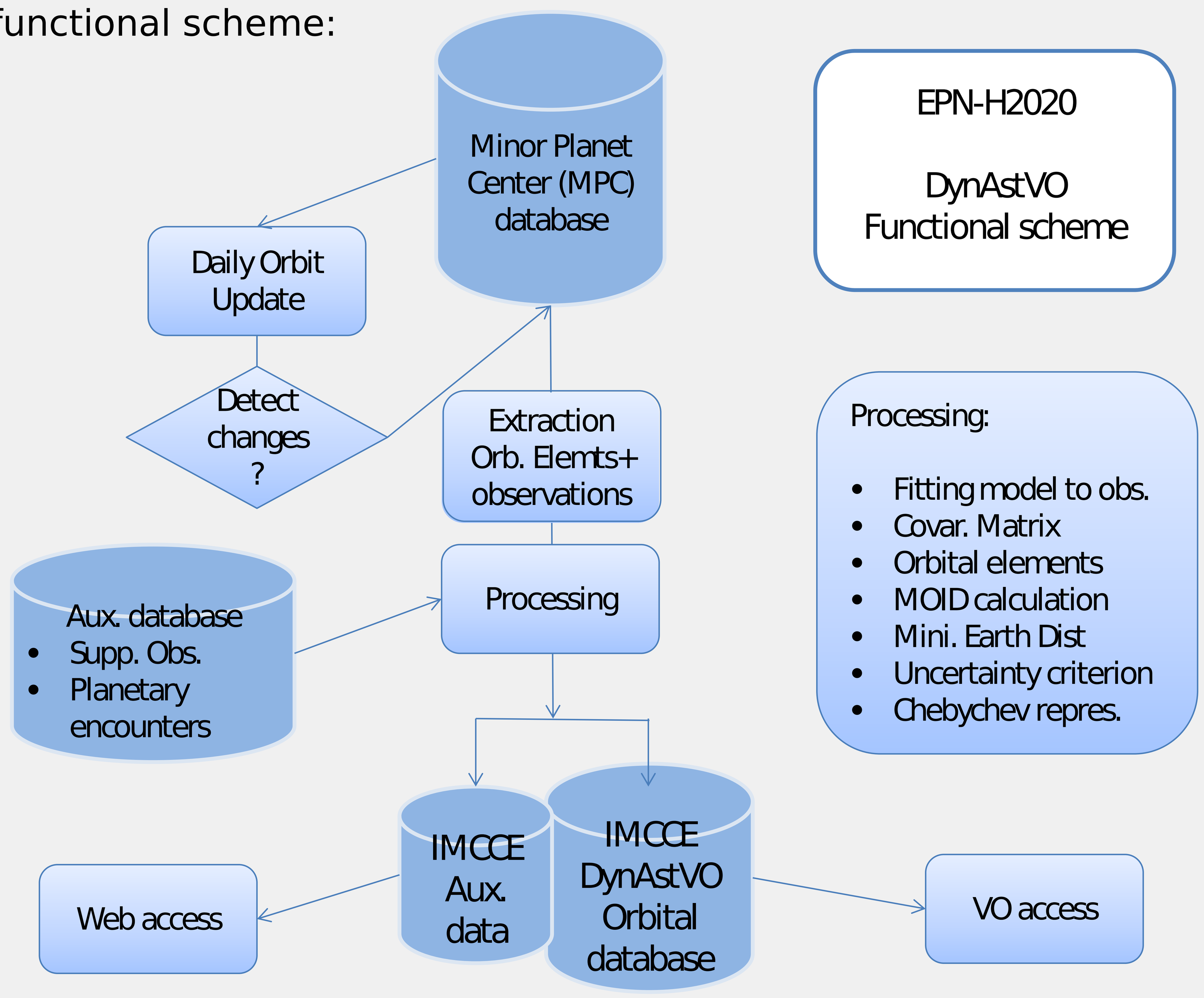
DynAstVO is a new orbital database dedicated to Near Earth Asteroid orbits, developed within the Europlanet 2020 RI framework. It provides parameters of asteroid orbits: orbital elements, observational information, minimum distance with Earth and planets, ephemeris and in particular, orbit uncertainty and associated covariance matrix.
This database is updated daily on the basis of the Minor Planet Electronic Circulars. Orbit determination and improvement are computed as soon as new observations are available or an object is discovered. This database conforms to EPN-TAP environment (Erard et al. 2014) and is accessible through VO protocols or classical web access. Auxiliary data such as SPICE kernels for their ephemerides are provided. Finally, we present a comparison with other classical databases such as Astorb or MPCORB, NEODyS and JPL Horizons.

Introduction & Context

DynAstVO is a new orbital database dedicated to Near-Earth Asteroids. It presents an independent service for orbits and ephemerides of NEAs. The database also provides information about the orbital uncertainty (covariance matrix) enabling to validate the orbit and to deal with risk assessment in addition to other services (ASTORB, MPCORB, NEODyS and JPL HORIZONS).
The database is updated daily in respect to MPECs, accessible through VO protocols and conforms to EPN-TAP environment.

Processing of DynAstVO

The Minor Planet Center publishes daily MPECs that provide new discovered asteroids and new observations. On the basis of MPECs, DynAstVO proceeds to update or create orbit through the following functional scheme:



DynAstVO is finally built into the EPN-TAP environment (Erard et al., 2014) and accessible through VO protocols or a web access.

Parameters of DynAstVO

For each asteroid, DynAstVO provides:

- name, number and designations
- orbital elements and the state vector at the epoch corresponding approximatively to the middle of the observational period
- number of observations and radar measurements, dates of first and last observations used for the orbit determination
- magnitude parameters (H and G slop)
- covariance matrix and Sky-Plane uncertainty (uncertainty in the position at epoch)
- Earth-MOID (minimum orbital intersection distance)
- ephemeris in Spice Kernel format (bsp file) for 1980-2030 period

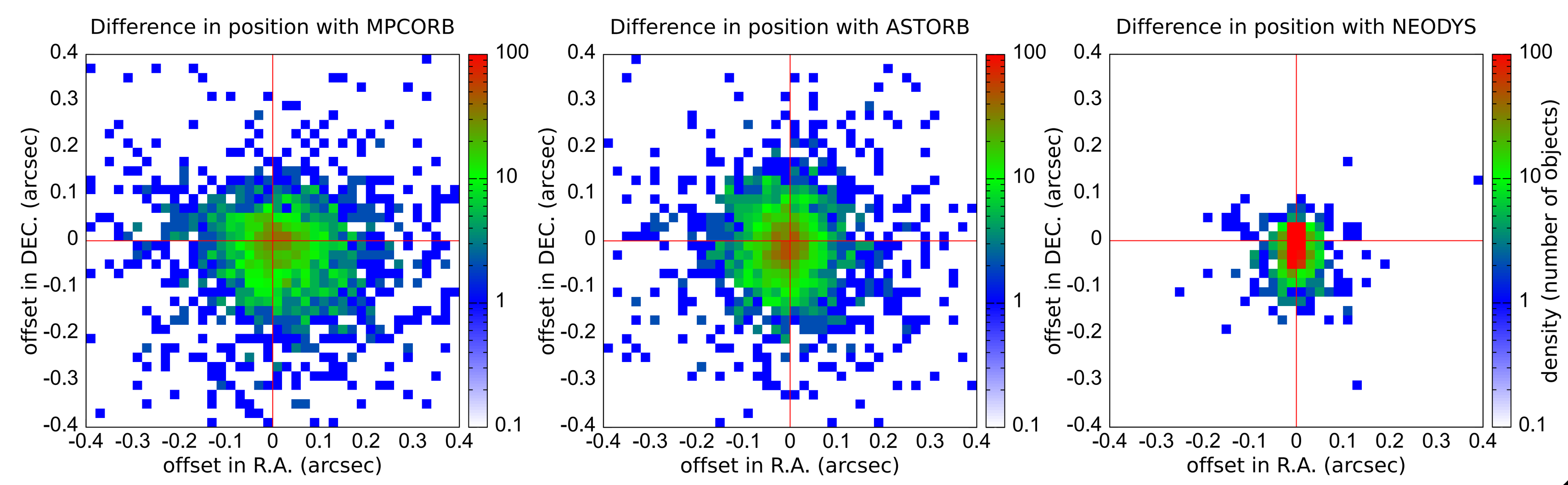
An additional table also provides the orbital elements and the state vector at a current epoch, identical for all asteroids.
Dates, minimum distances (and their uncertainties) of close approaches with Mercury, Venus, Earth, Moon and Mars are presented.

Dynamical model and observations

The orbit determination process comes from Desmars (2015) and consists in an integration of equations of motion and variational equations. Orbital elements are determined by a Levenberg-Marquadt algorithm. The dynamical model takes into account the gravitational perturbations of the Sun, the eight planets, the Moon and Pluto (positions are from INPOP13c (Fienga et al. 2014)), the gravitational perturbations of the four main asteroids (Ceres, Pallas, Vesta and Hygiea), the corrections of relativistic effects of the Sun, the flatness of Sun $J_{2\odot}$ and the flatness of the Earth $J_{2\oplus}$.
Corrections from bias in stellar catalogues are applied and the weighting scheme presented in Farnocchia et al. (2015) is used.
Observations and radar measurements come from the Minor Planet Center database.

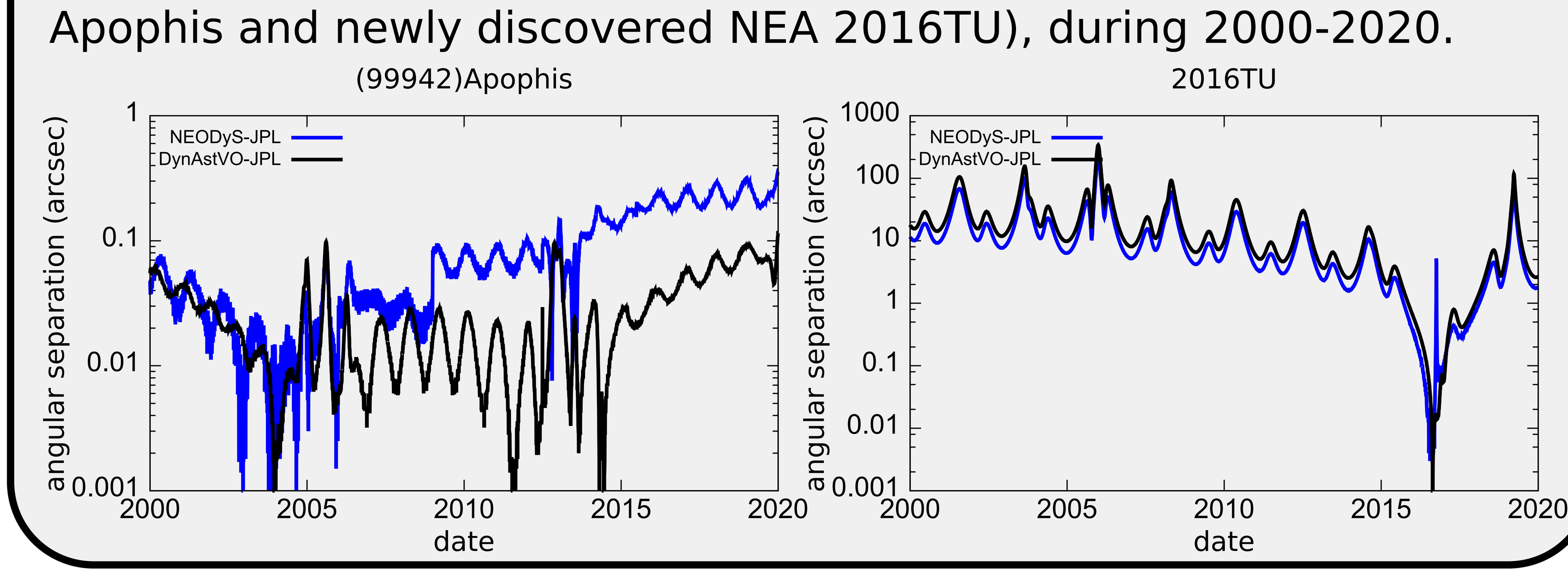
Comparison with other databases

We compare DynAstVO with MPCORB, ASTORB, and NEODyS by computing the apparent position from geocentre at reference epoch. Figures show the difference in position for 2238 numbered NEAs in right ascension and declination. Small differences can be explained by different processes of propagation (as epoch is 2016.11.08 for ASTORB and 2016.07.31 for MPCORB and NEODyS).



Comparision with ephemerides

We present comparisons between ephemerides provided by DynAstVO and two other ephemerides service providers (ASTDyS/NEODyS and JPL HORIZONS) for two characteristic objects (99942 Apophis and newly discovered NEA 2016TU), during 2000-2020.



Conclusion and prospectives

DynAstVO provides the orbits, ephemerides, close approaches of NEAs (16 346 objects on 13 September 2017).
In the future, we plan to develop the database by including MOID data, impact probabilities, and post-mitigation tools (Eggl et al. 2015) and to extend the database to all minor planets.

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Contact: Josselin Desmars - *email*: josselin.desmars@obspm.fr
DynAstVO database : http://vespa.obspm.fr

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