PROGRAM OF AES ORBIT DETERMINATION FROM MEASUREMENT DATA OF ASTRONOMICAL STATION ("ORBITA - M")

A.D. Sheptoon, S.Ja. Kolesnik, N.G. Paltsev
Astronomical Observatory, Odessa State University, Odessa 270014 Ukraine

ABSTRACT. A program is developed of determining AES orbits from measurement data of one or several astronomical stations. Its algorithm is rather stable to small errors of measurements and permits to use data with low accuracy for calculations.The use of several transits data enables to increase presision of orbital semi-major axe determination by nearly 10000 times.

Key words: orbital date, ephemeris service

The "Orbita - M" program has been developed in DC AO OSU and designated for AES orbits determination from the data of positional measurements of one or several observing stations. The given program version is a total result of research work carried out within the framework of the theme "Ballistics - 1" jointly with GKB "Yuzhnoye" (Dnepropetrovsk) in 1996 - 1997. It permits to use data both of one and several AES transits in the visibility zone of one or several observing stations. In the given program version the number of stations is restricted to three, with that, up to 40 positional points can be used in case of one transit or up to 10 positional points per transit within four transits. In the given program version, observational data in topocentric azimuthal system of coordinates are used as initial data. The algorithm applied in this program enables to use data for calculations the precision of which is much less than that of data used in classic algorithms for solving similar problems. We succeeded in attaining this with inclusion into the program algorithm a problem of finding minimum functional representing a weighted average sum of standard deviations of calculated satellite positions from the measured ones in the fixation points. To minimize the functional a method of conjugate directions is applied. After estimating steps from all the minimization parameters a conclusion can be drawn that by using data of other transits the precision of orbital semi-major axis determination increases nearly by 10.000 times. The work-program and its capabilities are shown by the control example. As initial data, ephemerides values have been taken of sputnik "Sich-1" coordinates calculated for the period of 55-10 October 1996 for Odessa, Lvov and Uzhgorod from data of NTTS KhMU of 30.09.96 as well as ephemerides coordinate values for the group of sputniks ("Bundles") calculated for the same points according to the NTTS KhMU data of 20.01.97. The station coordinates are kept in a separate file, its contents can be replenished, if necessary, by the user.

The algorithm of calculations was many times checked up with a model, then by the program itself, when calculating AES orbits carried out within the framework of "Ballistics-1" theme, during the preliminary investigational stage according to the program "Global Star" in 1997, and was highly estimated both on the part of observers and of the customer.

Below are given elemental orbits of satellites calculated in the control example. As is seen from the below results, in spite of the fact that coordinates for calculations have been taken with one decimal sigh only, that is not very precise, the obtained elements of the orbit of the above satellites are rather accurate. So, the scatter in semi-major axis determination

for the "Sich-1" satellite from different coordinate sets and versions of calculations for Lvov-Odessa-Uzhgorod, Odessa-Odessa turned out to be not more than 60 m whereas for the group of satellites ("Bundles") not more than 8 m. The inclination scatter for the above satellites proved to be not more than 0.1 degree. Eccentricity deviations because of its smallness turned out to be relatively great - about 0.0025. It should be noted than the deviations of elemental values from the control ones do not exceed the above scatter magnitudes. It testifies to the good reliability of the calculation algorithm used. If more precise coordinates are used in calculations, the precision of elemental AES orbits determination will be essentially higher.

Elements of elliptic AES orbits

"Sich-1" from the data of stations Lvov 06.10.96 and Odessa, 08.10.96.

Date (date - month) and moment of ascending node crossing:
06 - 10 03:51:12.120 UT
$a = 7034.293$ $e = 0.00417$ $\Omega = 98.457$
$i = 82.519$ $w = 73.116$ $dp = -0.0000018$
Drac. period = 97.78566 min.

"Sich-1" from the data of station Odessa, 2 transits, 05.10 and 08.10.96.

Date (date - month) and moment of ascending node crossing:
05 - 10 03:24:26.216 UT
$a = 7034.302$ $e = 0.00389$ $\Omega = 99.323$
$i = 82.446$ $w = 53.257$ $dp = -0.0000014$
Drac. period = 97.78575 min.

"Bundle" from the data of stations Lvov 14.02, Odessa 15.02 and Uzhgorod 16.02.97.

Date (date - month) and moment of ascending node crossing:
14 - 02 16:48:38.745 UT
$a = 7492.267$ $e = 0.00310$ $\Omega = 282.281$
$i = 63.330$ $w = 120.987$ $dp = -0.0000000001$
Drac. period = 107.43989 min.

"Bundle" from the data of stations Odessa 11.02, Lvov 12.02 and Uzhgorod 13.02.97.

Date (date - month) and moment of ascending node crossing: 11 - 02 17:10:58.512 UT
$a = 7492.260$ $e = 0.00308$ $\Omega = 289.813$
$i = 63.366$ $w = 138.671$ $dp = 0.0000000000$
Drac. period = 107.43989 min.