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ORBIT DETERMINATION USING ISON OPTICAL DATA: AN INDEPENDENT ANALYSIS

Abstract

The overall goal is to demonstrate the suitability of the International Scientific Observing Network (ISON) optical tracking data for an orbit determination system and to explore the angular measurement accuracy of the ISON data.

Established in 2001, the international Scientific Optical Network (ISON) now consists of 42 telescopes at 27 observatories in 12 countries around the world that provide right ascension and declination observations for objects in Earth orbit. Observation scheduling and data processing are done at the Keldysh Institute of Applied Mathematics, Russian Academy Sciences (KIAM RAS). ISON is an important source of space situational awareness (SSA) data that could help improve the safety of space operations and support other space sustainability initiatives.

We use the Linux version of the RD GTDS program as our primary orbit determination tool. RD GTDS has been employed in the MIT community since 1978 and has been significantly enhanced including physical models, semi-analytical satellite theories, modern estimation methods, and allowable sensor choices. Most recently, GTDS has been used to fit precise ephemeris data and SLR data.

To estimate the accuracy of the raw measurements we will use (1) the precise orbits of the test satellites, (2) measurements from each instrument observing the test satellites, and (3) precise coordinates for each instrument. In the first test, we interpolate the precise orbit at the observation times. The interpolated state is transformed to an available GTDS input coordinate system. We exercise the GTDS Differential Correction (DC) program to obtain the 'computed' value of the observation and form the 'O-C' by differencing the actual ISON observation and the 'computed' values. This process is repeated over the available ISON data to generate measurement statistics. The process is independent of the GTDS orbit propagator. We also consider a second process. We fit the GTDS orbit propagator to the reference orbit. Using the resulting epoch state vector, we perform a single-iteration DC using the ISON observation data. If the residuals in the fit to the reference orbit are small, the residuals in the DC using the ISON observation data should well represent the observation errors.

The choice of the space objects reflects (1) overall ISON goals, (2) availability of ISON data, and (3) availability of reference orbits. There are two sources of high altitude reference orbits. One is the precise orbits for the GNSS satellites. The other is the ILRS. We anticipate commercial geostationary satellites equipped with GNSS receivers