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Orbit and attitude determination of the first QZSS satellite

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The Japanese Quasi-Zenith Satellite System (QZSS) is a regional augmentation system for Global Positioning System (GPS) users in Asia and the Pacific. QZSS satellites transmit navigation signals in the L1, L2, and L5 band interoperable with GPS. Furthermore, a SAIF (Submeter-class Augmentation with Integrity Function) signal on the L1 frequency and a LEX (L-band EXperimental) signal at 1278.25 MHz (E6) are transmitted. The first QZSS satellite was launched in September 2010 and started to transmit its standard codes in December 2010.

The Cooperative Network for GIOVE Observation (CONGO) was primarily established for GIOVE signal analysis, orbit, and clock determination. It is a global real-time GNSS tracking network of currently 15 stations jointly operated by Deutsches Zentrum für Luft- und Raumfahrt (DLR, Oberpfaffenhofen, Germany), Bundesamt für Kartographie und Geodäsie (BKG, Frankfurt, Germany), and Deutsches GeoForschungsZentrum (Potsdam, Germany) in cooperation with a number of local station hosts. Four Javad Triumph receivers of the CONGO network were recently upgraded with a prototype firmware providing QZSS tracking capability. These receivers are able to track all QZSS signals except for the LEX signal.

QZSS satellite orbit parameters are computed from the tracking data of these four receivers: With a GPS-only precise point positioning (PPP) solution, station coordinates, troposphere parameters, and receiver clock biases are estimated. These parameters are kept fixed in a consecutive step to solve for QZSS orbit and clock parameters. The quality and consistency of these products and the broadcast orbits will be evaluated by orbit fits, day boundary discontinuities, as well as Satellite Laser Ranging (SLR) residuals. As the L1 and the SAIF signal are simultaneously transmitted via different antennas, the vector between the two antennas can be estimated. The stability of this vector representing the attitude of the satellite as well as the attitude behavior in general will be analyzed.