Orbit Determination/Comparison and Optical Response of GLONASS Satellites

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The orbits of GLONASS satellites were determined by laser ranging data alone, and were compared with microwave-based precise orbits. The agreement was 20 cm in the radial and 1 m in the along-track component. The optical response from 1 m x 1 m corner cube array was expected to cause an elevation dependent bias for most of laser stations, and we detected such a trend through the orbit determination.

GLONASS satellites have been tracked by the worldwide laser ranging network as well as by the GLONASS-borne microwave-based technique. Owing to the large size of their corner cube reflector arrays, the amount of ranging data is enough to determine their orbits from laser ranging data alone.

Two kinds of calibration is therefore possible for the microwave-based precise orbits; a comparison with laser ranging data and a comparison with the laser-based orbits. The result from the former is well known and is that the precise orbits are 4 or 5 cm higher than the laser ranging observation. We attempted the latter approach and found the differences between the two independent techniques were about 20 cm in the radial and about 1 m in the along-track component.

We found the large size of the array affected the accuracy of measurement to an extent that is dependent on the characteristics of the ranging systems. The offset bias was modelled to be proportional to sin i (i: angle of incidence toward the flat array). Orbital analysis reveals that the effect is significant for multi-photon systems and it makes the measured range on average 22 cm shorter than expected in the absence of the large array, which explains half of the offset of 4 to 5 cm previously discovered between microwave orbits and laser range.