EARTH SCIENCE APPLICATIONS OF SATELLITE LASER RANGING (SLR)

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The use of ground-based precision laser systems to track Earth orbiting satellites has yielded the most precise and unambiguous measurements for precision orbit positioning since the first SLR systems were deployed in the late 1960s. This presentation will provide an overview of the state of SLR technologies, their current applications, and the science products they have made possible. Satellite laser ranging has continually provided an important resource for satellite orbit determination, verification and validation of active remote sensing systems, and for producing science products that are needed to support a wide range of space geodesy and geodynamic investigations.

SLR techniques are being used to both directly provide precision orbits and calibrate precise orbit positioning provided by other tracking systems. And by being a dynamic as opposed to reduced dynamic technique, SLR has contributed significant insight into the intricate force modeling needed to produce cm-level orbit accuracy. Precision orbit determination from SLR has significantly evolved and now requires a high level of sophisticated conservative and non-conservative force modeling which for the most accurate applications, requires a complete description of the satellites' surface structure, composition, spin rate, and thermal properties. SLR provides important and in many cases key independent validation for a variety of orbit applications. For example, SLR is used to complement GPS to validate orbit accuracy, detect maneuvers, and provide a back up, fail safe orbit determination capability which has saved missions due to active tracking system failures.

Important contributions have been obtained by SLR to monitor and better understand long wavelength changes in the Earth's gravity field. This includes both tidal and non-tidal effects. Mass flux within the Earth's system over large spatial scales can be observed through the orbit changes they induce on well tracked SLR satellites. The return of the Earth to isostatic equilibrium since the time of the most recent Ice Age is a major source of nearly secular long wavelength gravity field changes being studied through SLR. As knowledge of the long wavelength gravity field has improved, further improvements have been made in deriving a constraint on the Lens Thirring effect. SLR currently yields a measure of this effect to better than 10% of its expected value as predicted by General Relativity.

SLR contributions to the International Terrestrial Reference Frame (ITRF) are significant. SLR satellite missions continue to contribute to decadal time histories of site motions to help establish the geophysical context for many phenomena, a robust reference frame to report these changes within, and place constraints on the geophysical models themselves. SLR contributions to the ITRF are unique for monitoring the motion of the geocenter with respect to the frame realized by the tracking networks. SLR also provides the longest time series of precision Earth rotation and polar motion parameter monitoring, and invaluable information on the absolute scale of the terrestrial reference frame.