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Refraction modeling in SLR by ray tracing through meteorological data

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Atmospheric refraction is an important accuracy-limiting factor in the use of all space-based geodetic techniques, and suffers from limitations in current refraction models. The current modeling in the analysis of Satellite Laser Ranging (SLR) data comprises the prediction of the atmospheric delay in the zenith direction from surface conditions and projection to the observation's elevation angle, using a mapping function. A new zenith delay model of sub-millimeter accuracy [Mendes and Pavlis, 2004] and a new mapping function of sub-centimeter accuracy [Mendes and Pavlis, 2002] were recently developed, applicable to the wavelengths used in modern SLR instrumentation. Using 2-D ray tracing and globally distributed data from the Atmospheric Infrared Sounder (AIRS), the European Center for Medium Weather Forecasting (ECMWF) and the National Center for Environmental Prediction (NCEP), we validated the new zenith delay model and mapping functions. These however are still far from the desired sub-millimeter accuracy goal for future SLR analysis standards. To further improve the atmospheric delay models, we now look at the effects of horizontal refractivity gradients on SLR data collected at core SLR sites around the globe. We discuss the effects of using different types of input data for the ray tracing (AIRS, ECMWF and NCEP), and the effects of seasonal and diurnal changes, latitudinal dependence, topography and large bodies of water on the delay due to horizontal gradients. We also present a complete analysis on the effects of using ray tracing to compute the total atmospheric delay, including horizontal gradients on a set of SLR data (2004 to 2006) from two geodetic satellites, LAGEOS 1 and 2 and for 10 of the most significant SLR sites around the globe. We also discuss plans for incorporating in the weekly SLR analysis these new corrections in a near-real time operational mode for increased spatiotemporal resolution and improved SLR products.