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Improved atmospheric refraction modeling for Satellite Laser Ranging: Model Validation

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Atmospheric refraction is an important accuracy-limiting factor in the use of satellite laser ranging (SLR) for high-accuracy science applications. In most of these applications, and particularly for the establishment and monitoring of the TRF, of great interest is the stability of its scale and its implied height system. The modeling of atmospheric refraction in the analysis of SLR data comprises the determination of the delay in the zenith direction and subsequent projection to a given elevation angle, using a mapping function. Standard data analyses practices use the 1973 Marini-Murray model for both zenith delay determination and mapping. This model was tailored for a particular wavelength and is not suitable for all the wavelengths used in modern SLR systems. Mendes et al., [2002] pointed out some limitations in that model, namely as regards the modeling of the elevation dependency of the zenith atmospheric delay (the mapping function component of the model). The mapping functions developed by Mendes et al. [2002] represent a significant improvement over the built-in mapping function of the Marini-Murray model and other known mapping functions. Of particular note is the ability of the new mapping functions to be used in combination with any zenith delay model, used to predict the atmospheric zenith delay. Mendes and Pavlis [2002] concluded also that current zenith delay models have errors at the millimeter level, which increase significantly at 0.355 micrometers, reflecting inadequacy in the dispersion formulae incorporated in these models. Recently, a more accurate zenith delay model was developed, applicable to the range of wavelengths used in modern SLR instrumentation (0.355 to 1.064 micrometers), [Mendes and Pavlis, 2004]. Using 3-D ray tracing and globally distributed satellite data from UMBC's AIRS instrument on NASA's AQUA platform, we assess the new zenith delay models and mapping functions. We discuss the effect of using different types of input data to drive those models and the sensitivity of models and functions to changes in the wavelength, and we give some recommendations towards an unification of practices and procedures in SLR data analysis, including sample analysis of SLR tracking data.