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Decadal Variation in the Earth Dynamic Oblateness, J2, from SLR data

M. Cheng and B. D. Tapley
University of Texas at Austin, Center for Space Research, Austin, United States (cheng@csr.utexas.edu, 1 512 4713570)

Satellite Laser Ranging (SLR) data tracked by the ILRS network have recorded the global nature of long-wavelength mass redistribution occurring within the Earth system for more than three decades. The variations in J2, determined by analysis of SLR data, provide a clear vision of the large-scale mass redistribution within the Earth system. Early analysis of a 28-year time series of monthly SLR estimates of J2 [Cheng and Tapley, 2004] indicated that, in addition to the secular, 18.6 year tidal and seasonal variations, the J2 has undergone significant interannual and decadal variations, which are related to the strong El Niño-Southern Oscillation (ENSO) events during the periods of 1987-1991 and 1996-2002. Recent analysis of SLR data spanning the period from January 1976 to March 2009 suggests that those ENSO related variations are superimposed on a significant decadal fluctuation with a period of $\tilde{9}$.4 years. Two distinct cycles have occurred since 1987. It appears that a new cycle started late in 2006 with steadily increasing values of J2. This increase in J2 is associated with significant mass transport between tropical and extratropical areas and may be related to the recent ice loss in the Greenland and Antarctica ice sheets. This paper presents detail analysis of the variations in J2 from analysis of over 33-years of SLR data. Finally, the SLR results are compared with the J2 variations predicted from atmosphere-ocean-hydrological models.