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Observing the precession of Mars from orbit

D. E. Smith (1), M. T. Zuber (2)

(1) NASA Goddard Space Flight Center, Greenbelt, MD (dsmith@tharsis.gsfc.nasa.gov/301-614-6013), (2) Massachusetts Institute of Technology, Cambridge, MA (zuber@mit.edu)

Nearly eight years of tracking of MGS have been analyzed in a joint solution for the masses of the seasonal icecaps and the precession of Mars' pole of rotation. Nearly 500 orbital arcs of approximately 5-days in length were analyzed. The seasonal icecaps were modeled as cylindrical cones based upon TES thermal and MOLA altimeter data, and a loosely constrained a priori atmospheric mass model. A constraint was applied to maintain the total volatile mass as constant. The masses of the seasonal caps and the Mars atmosphere, were estimated every 5 days along with the right ascension and declination of the rotation pole, the second degree and order gravity coefficients and other parameters including the mass of Phobos, the larger of the two natural satellites of Mars, and the second degree Love Number, k2. The gravity field used in the analysis was the mgm104c model and all calculations were performed in the IAU2000 reference system. The rate of precession was estimated to be -7452ś90 milliarcseconds/year over the 8-year dataspan, approximately 1.6% numerically smaller than the previous value and approximately equal to the sum of sigmas of the two estimates. The recovered values of the right ascension of the pole were linear with a possible very small quasi-periodic departure from a straight line. The sigma of the slope in right ascension with time was approximately 0.4% of the observed slope. The estimates of the declination showed an expected linear trend but also significant systematic departures from linearity that corresponded with times when the tracking geometry as seen from Earth was edge-on, making the measurement of declination difficult and much weaker than at other times. The declination also suggested other possible periodic departures from the near-linear trend that might be an indication that there are shorter period variations not presently modeled in the precession. The sigma

of the slope in declination is the dominant contributor to the standard deviation of the precession rate.