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Influence of the observational noise and the parameters of spacecraft dynamical model on the Phobos mass estimations: Viking 1 and MEX flybys

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The mass of Phobos (GM more precisely) estimated by different authors based on diverse data-sets and methods, varies more than $1-\sigma$ error. The most complete list of GM values is presented in the work of R. Jacobson and includes the estimations in the interval $[5.87-8.5]*10^5[m^3/sec^2]$. Furthermore, even the comparison of the estimations coming from the same estimation procedure applied to the consecutive flybys of the same spacecraft shows big variations in GMs. The indicated behavior is very pronounced in the GM estimations stemming from the Viking 1 flybys in February 1977 (as well as from MEX flybys, though in a slightly smaller degree) and in this work we made an attempt to figure out its roots.

The GM estimations are very sensitive to the Phobos ephemeris, accuracy of a spacecraft orbit (particularly, how well we can model non-gravitational forces acting on a spacecraft), radio-tracking measurements quality (noise and coverage), geometry (i.e. relative position between a spacecraft, Phobos and an Earth's tracking station) and distance of flyby. Inaccuracies in all those elements will result in the errors of GM. Thus, in the present work we tested the impact of most of those factors by means of simulations as well as by changing certain parameters of the spacecraft dynamical model while fitting real observations.

Neither distances of flybys nor a priori ephemerides show clear correlation with the GM_{Phobos} estimations and their formal errors. In the same time, analysis of the post-fit Doppler residuals revealed that our observations are not very sensitive to the the errors in GM_{Phobos}. In other words, changes of the spacecraft velocities due to $\Delta GM_{Phobos} = 10^5[m^3/sec^2]$ are at the level of 0.06 mm/sec in case of Viking 1 flybys. Decreasing in the value of the noise of observations diminish the GM formal errors and bringing the values of GM themselves closer to one another. Thus, we could conclude that the noise of real Viking 1 measurements is bigger than the sensitivity of those observations to the GM variations.

The similar studies of radio-science data acquired during MEX flybys in 2006, 2008 and 2010 will be presented as well.