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Mars precession rate and moment of inertia from InSight/RISE measurements

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The InSight mission successfully landed on November 26th, 2018 on the surface of Mars. Designed to study the interior structure of Mars, the mission payload consists of a seismometer, a heat flow probe and a radio-science experiment. The latter is an X-band coherent transponder called RISE for Rotation and Interior Structure Experiment [Folkner et al., 2018]. RISE main objective is to provide constraints on the deep interior of Mars, especially the liquid core, through precise tracking of the changes in Mars orientation. The gravitational torque exerted by the Sun on the equatorial bulge of the rotating Mars causes a precession of the axis of rotation in space. The spin axis completes one rotation about the normal to the orbit plane in about 171,000 years, corresponding to a precession rate of about 7.6 arcsecond/year. Variations in the torque due to the relative positions between Mars and the Sun lead to additional periodic time variations of the rotation axis, the nutations that will be the subject of a future study.

The precession rate has already been measured with a very high accuracy of 2.1 mas/year (0.28%) based on historical landers and orbiters tracking [Konopliv et al., 2016], leaving little space for improvement. Nevertheless, because the precession rate is inversely proportional to the polar moment of inertia, which is a key parameter to constrain interior models, we use radio tracking data recently acquired by RISE, combined with historical data from Martian landed missions, to confirm/refine the current value of the precession rate of Mars spin pole and update Mars moment of inertia.

Although challenging, it is worth to mention that the unequaled level of accuracy of RISE data, together with the coverage of the combined data set spanning over 43 years, offers non-negligible opportunities for improvement.

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