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How deep is the Great Red Spot? a multimethod analysis using the recent Juno gravity measurements

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Abstract

One of Jupiter's most prominent atmospheric features, the Great Red Spot (GRS), has been observed for more than two centuries, yet little is known about its structure and dynamics below its observed cloud level. While its anticyclonic vortex appearance suggests it might be a shallow weather-layer feature, the very long time span for which it was observed implies it is likely deeply rooted, otherwise it would have been sheared apart by Jupiter's turbulent atmosphere. Determining the GRS depth will shed light not only on the processes governing the GRS, but on the dynamics of Jupiter's atmosphere as a whole. The first Juno flyby over the GRS (PJ7) discovered using microwave radiometer measurements that the GRS is at least a couple hundred kilometers deep. The next flybys over the GRS (PJ18 and PJ21) allow high-precision gravity measurements that can be used to estimate how deep the GRS winds penetrate below the cloud-level.

We present here an analysis of the recent GRS flybys, using a multimethod approach for the gravity analysis and a dynamical model relating the gravity signal to the possible structure of the GRS. The analysis is based on a Slepian function method and the concentrated-masses method. Both approaches, while very different from each other, enable an effective representation of the wind-induced spatially confined gravity signal, and allow an efficient determination of the dept of the GRS. We discuss the results and their implications to our understanding of the GRS dynamics.