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# Saturn's Deep Atmospheric Flows in Light of the Cassini Gravity and Magnetic Measurements

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## Abstract

What is the nature of the flow beneath Saturn's clouds? Answering this question has important implications not only for the atmospheric dynamics, but also for the interpretation of the interior density structure, composition, magnetic field and core mass. Using the Cassini gravity measurements we have shown that the observed cloud-level winds extend deep into the interior, decaying around 9,000 km from the cloud-level. The gravity measurements, however, are sensitive to the flow structure at the upper levels but below the region of the major decay the sensitivity is reduced, therefore our ability to decipher the exact structure of the flow at those depths is limited. In addition, these deep flows reach the semi-conducting region where magnetic conductivity might alter the flow due to the flow interaction with the planet's magnetic field, thus restricting its magnitude and shape. A possible solution for this problem might come from our knowledge on the flow-magnetic field interactions and the recently published measurements of Saturn's magnetic field.
Here we present our analysis of Saturn's deep atmospheric flows in light of the Cassini gravity and magnetic Measurements. We use the measurements to constrain the flow in two independent models: a geostrophic balance that relates the flow field to the anomalous gravity field, and a mean-field electrodynamic balance that relates the flow field to the anomalous magnetic field. Using a combined adjoint-based optimization method we calculate the structure of the flow field that can explain best both measurements. We discuss the results and their implications for our understanding of Saturn's atmospheric dynamics and interior structure.