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Vorticity and energy diagnostics from the 2000 Cassini Jupiter flyby

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Abstract

The Cassini spacecraft flew by Jupiter in December 2000, returning hundreds of images near closest approach [1]. We have been analysing the images spanning four Jupiter rotation periods at closest approach using automated cloud tracking software to obtain horizontal velocity fields. Our method has some advantages over other methods used for this purpose in that it accounts for both cloud deformation and rotation in addition to the standard translation.

We shall present detailed horizontal velocity vectors and related vorticity and energy fields over four Jupiter rotation periods. We also intend to produce derived energy and turbulence diagnostics that will help us to understand the interplay between processes acting on different length scales. It may also be possible to relate these diagnostics to 'zonostrophic' jets and small-scale turbulence studied in the laboratory using the Coriolis rotating tank, work itself motivated by jets in giant planet atmospheres [2]. In the future we intend to combine velocity fields with temperature data to produce fully-3D velocity and potential vorticity fields for Jupiter's troposphere and stratosphere.

The cloud tracking method is based on correlation image velocimetry (CIV) and was originally developed by the Coriolis facility team at LEGI, Université de Grenoble [3], where it is used to extract velocity fields from data obtained in their 13m diameter rotating tank experiment. The method has two stages. First, velocity vectors are calculated using translation only, where the velocity is defined by the highest correlation between two images taken 63 minutes apart of a small pixel patch moving within a larger search box. In the second stage the correlation analysis is repeated, but instead of just translation of the pixel patch, rotation and deformation (shearing, stretching) are taken into account. We use the first stage velocity field as an estimate of the velocity vector and search within a small window around this, including sub-pixel translations, to refine the velocity.

We have also been involved with a collaborative effort comparing methods used for cloud tracking in planetary atmospheres [4], and will summarise the progress of this work as well.

Acknowledgements

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References

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[4] Sayanagi, K.M. and 23 others: Planetary cloud-tracking wind measurements: Validation, Evaluation and Benchmark, AGU Fall Meeting, 13–17 December 2010, San Francisco, CA.