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GCM studies of Jovian turbulence and jet stability

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We have investigated the hydrodynamic stability of observed subtropical jets in Jupiter's Northern and Southern hemisphere as an initial value problem by use of the Oxford Planetary Unified model System (OPUS). Using an extended form of the Hydrodynamic Primitive Equations, OPUS is capable of including 30 vertical levels from 0.1 bar to 10 bar. The model was initiated with temperature and balanced thermal wind profiles recently obtained by Cassini's Composite InfraRed Spectrometer (CIRS) during the Jupiter fly-by in 2000. The initial profiles extend down to an atmospheric depth of approximately 0.5 bar and thus significantly reduce the domain over which arbitrary assumptions have to be made in comparison to previous studies with OPUS (Yamazaki et al., 2004).

A sensitivity study was conducted examining the effects of different approaches to maintaining the zonally-symmetric pattern of of zonal velocity on the atmospheric configurations obtained. Applying momentum forcing in the model, which is smoothly distributed with height, we obtained a reasonably realistic representation of turbulent motion in Jupiter's Southern hemisphere, including the formation of isolated, slowly drifting vortices in the Great Red Spot band. The vortices were comparable to the Great Red Spot in size and in vertical structure at least near the tropopause. In addition multiple short-lived smaller eddies developed at the latitudes of Jupiter's White Ovals. Although instabilities occurred in the Northern hemisphere jets, our model did not generated anticyclones at these latitude as consistent with observations, although the dynamical reasons for this are not yet clear.

Further results will be presented on the response of atmospheric flow fields to different combinations of thermal and momentum forcing. We will thereby focus on the development of meridional circulations in Jupiter's atmosphere as a result of different forcing scenarios. A simple Jovian cloud scheme has been added to OPUS and will be used to illustrate the obtained circulations through the advection of ammonia ice

clouds. It is envisioned that diagnostics from the cloud scheme will be well suited for comparison with observed cloud motion on Jupiter and thus provide a useful means of verification for the modeled atmospheric states.