Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Zonal jets in thermodynamic shallow water equations with radiative relaxation[1] PAUL DELLAR, EMMA WARNEFORD, University of Oxford — The thermodynamic shallow water equations treat the reduced gravity as an advected scalar. This allows them to support horizontal variations in temperature, as well as the usual variations in depth and horizontal velocity. Originally proposed for lakes and tropical oceans, we have used them to model the atmospheres of gas giant planets. Adding a radiative cooling term to the temperature evolution equation creates a mass- and momentum-conserving shallow water model that produces super-rotating equatorial jets in our numerical simulations, unlike the sub-rotating jets found in standard shallow water simulations on rotating spheres. We also derive a quasigeostropic version of these equations, in which radiative coupling substantially increases the fraction of kinetic energy accounted for by the zonally-averaged flow in forced-dissipative simulations. Finally, we derive further reduced models in the limit of rapid radiative relaxation.

[1]Partially supported by EPSRC ARF grant EP/E054625/1

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Date submitted: 05 Aug 2011 Electronic form version 1.4