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A laboratory analogue of the Madden-Julian oscillation (MJO) ?

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The Madden-Julian oscillation (MJO) (Madden and Julian, 1971; 1972) is the main intraseasonal atmospheric fluctuation in the equatorial troposphere affecting weather in large parts of the world (Zhang, 2005). Despite substantial scientific efforts in recent decades reliable forecasting and understanding the mechanisms of the MJO remain key-challenges in atmospheric science. Diabatic processes associated with tropical convection and two-way atmosphere-ocean interaction are generally believed to be crucial in explaining the MJO (ECMWF, 2004). Here we attempt to demonstrate, analytically and using a hierarchy of models from laboratory scale to global circulation models (GCM), that MJO-like phenomena may be a solution of the nonlinear shallow-water theory given the right balance between nonlinearity and Rossby wave dispersion. The propagation direction and speed as well as the maintenance of the emerging solitary structure is determined by an external forcing, which may arise from internal tropical heating or mechanically enforced from the extratropics. Contrary to common believe, MJO-like structures may therefore be explained as a natural mode arising from dry, non-linear atmospheric dynamics under either diabatic or adiabatic forcing. In fact, the dynamical mechanism may be shown in a laboratory analogue just as the Plumb-McEwan experiment for the quasi-biennial oscillation (QBO) (Plumb and McEwan, 1978; Wedi and Smolarkiewicz, 2005).