RAYMOND WALSH, Simon Fraser University
A Dynamical Theory for Cloud Edge Motion

Much is known about cloud formation and their behaviour at large scales (tens of kilometers). Considerably less, in atmospheric science, addresses the fluid mechanics dictating smaller scale motions (tens of meters) that determine the shapes of cloud edges. An example of this is the formation of a holepunch cloud. A curious phenomena whereby a growing circular hole in a shallow cloud layer opens up due to a disturbance typically initiated via aircraft. Only recently (2015) has the mechanism for its formation been understood which stands as the motivation for this work.

We present a new model for the edge motion of stable non-precipitating clouds. Our proposed model combines buoyancy driven fluid mechanics and the thermodynamic theory for phase change of water into a self-consistent Boussinesq theory. Further approximation including linearization of the thermodynamics about a cloud forming state and leveraging the low water content of the atmosphere leads to an analytically tractable free boundary model for cloud edge motion. Exact solutions to this model then serve as a theoretical benchmark against which full physics numerical models can be compared. In particular, we present results from the cm1 model (cloud model 1) developed by George Bryan out of the National Center for Atmospheric Research in Boulder Colorado. We finish by presenting an analytically calculated travelling wave solution on the clear/cloud interface for which the dispersion relation is derived and compared.