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What Makes Precipitating Atmospheric Convection Different?[1]

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The word "convection" refers to the upward and downward motions induced by the buoyant release of gravitational potential energy in an unstably stratified fluid. Convection occurs in many contexts, including oceans, planetary atmospheres, stars, and in laboratory and industrial processes. Convection in the earth's atmosphere can be subdivided into three types; that with no condensed water, that with condensed water but no precipitation, and that with precipitation. The first two categories have similar characteristics and are both similar in character to many other forms of convection, e.g., in the atmospheres of stars. Convection with precipitation differs in a fundamental way from other convection because of the fallout of condensed water substance from ascending parcels in the form of rain, hail, and snow. The net effect of this fallout is that the narrow convective updrafts are heated rapidly via the release of latent heat, whereas much of the descending air subsides only slowly over a vast area under the influence of thermal radiative cooling. Other descending parcels have their descent hastened by the evaporative cooling of precipitation falling through them. A final complication comes from the processes responsible for the formation of precipitation from the tiny droplets produced by condensation in updrafts. Rain and snow formation depend heavily not only on the kinematics of updraft motion, but also on the population of atmospheric aerosols. The representation of precipitating atmospheric convection in large-scale numerical models of the atmosphere is one of the greatest unsolved problems facing weather and climate prediction.

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