A motion analogous to double-diffusive convection in volcanic ash clouds

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I will talk about the dynamics of a volcanic ash cloud, which sometimes induces a motion similar to double-diffusive convection. A volcanic ash cloud consists of a solid-gas mixture that suspends numerous hot pyroclasts (fragmented solids particles of lava rocks generated during explosive volcanic eruptions). The typical temperature of an ash cloud is higher than 1000K and the mass fraction of pyroclasts is larger than 90 wt% immediately after the discharge from a volcanic vent. Intense volcanic explosions tear magma into subcentimeter fragments, and thus, we can assume that the pyroclasts homogeneously distribute in the surrounding turbulent gas-phase at the early stage of the eruption. Accordingly, the density of the gas-particle mixture can be expressed as a function of the temperature and concentration of suspended pyroclasts. This property causes a motion analogous to double-diffusive convection in volcanic ash clouds because the property is similar to that of seawater, of which density can be expressed as a function of the temperature and salinity. Owing to the high concentration of suspended pyroclasts, the density of an ash cloud is larger than the ambient air density at the initial stage of the eruption. However, the ash cloud becomes less dense than the ambient air as time progresses because the vigorous turbulence mixes the ash clouds with the ambient air and the mixed air is significantly heated and expanded to reduce the density of the ash clouds below the ambient density. As a result, convection occurs. I will discuss the difference between the convection in the ash cloud and the double-diffusive convection observed in the ocean interior. In particular, I will point out that the temperature of an ash cloud, which is typically higher than 1000K, plays an essential role in the occurrence of the convection. I will also demonstrate numerical simulations that exhibit a well-known behavior of pyroclastic surges caused by the above-mentioned convection.