Pyroclastic density currents – recent advances in understanding and future challenge

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Pyroclastic density currents (PDCs) are dangerous multiphase flows from volcanoes. Research on PDCs research is highly topical for Aotearoa (New Zealand), where all of our active volcanoes are capable of producing PDCs. New Zealand's most lethal eruption (Mount Tarawera in 1886) as well as its most current volcanic disaster (Whakaari in 2019) generated PDCs. Causing approximately one third of volcanic fatalities globally, the development of robust PDC flow and hazard models is a priority in Volcanology and Natural Hazard Science. However, the wide range and complexity of gas-particle feedback mechanisms inside the currents and their hostile nature make quantitative measurements into PDCs and the validation of hazard models challenging. Over the past approximately 15 years, through combining large-scale experiments, field observations, computational and theoretical modelling, major advances have been made in elucidating the enigmatic internal structure of PDCs; in identifying key processes behind their fluid-like motion; in linking newly recognised processes of mesoscale turbulence and energy cascading in large eddies to the PDC behaviour; and in probing the turbulence structure of PDCs to link its characteristics to the origin and perpetuation of the PDC destructiveness. In this presentation, we take a look at recent progress in PDC research and examine how this closes the gaps towards robust hazard modelling. We provide examples of this through the current international PDC model inter-comparison that runs under the umbrella of the International Association of Volcanology and Chemistry of the Earth's Interior. Finally we highlight critical future research challenges and potential pathways to approach them.