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Statistical analysis of the runout distance of pyroclastic density currents and implications for emplacement mechanisms

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Pyroclastic density currents (PDCs) are hot mixtures of gas and particles generated by volcanic eruptions. They propagate on the ground at high velocity and can travel distances that are commonly of several tens of kilometers. Understanding the factors that control the long runout distance of PDCs is important for hazard assessment. In this context, we collected data on PDCs in more than 200 publications to create a database. Through statistical analysis of the data, we show that the runout distance of PDCs correlates with the mass eruption rate. A model selection procedure further shows that it is possible to determine two well-defined power law relationships, respectively for fully dilute turbulent currents and for currents with a concentrated base. For dilute currents, the runout distance scales with the ratio of the eruption rate over the particles settling velocity to the power 0.5, in agreement with theory. Runout distances of some concentrated currents are longer than 300 km and outside predictions intervals, and in this regard we argue that these extreme travel distances were reached because the currents were confined in large paleovalleys. We conclude that statistical analysis can help to better understand the mechanisms of complex natural phenomena such as pyroclastic density currents.

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