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MULTIPHASE FLOW MODELLING OF EXPLOSIVE VOLCANIC ERUPTIONS USING AN ADAPTIVE UNSTRUCTURED MESH-BASED APPROACH

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Explosive volcanic eruption events, in which large quantities of hot gas and ash are expelled high into the atmosphere, are one of the most powerful natural hazards. In order to gain a full understanding of the dangers these eruptions pose, their complex multiscale and multiphase nature must be captured to a high degree of accuracy. The application of numerical multiphase flow models often represents the only tenable way of achieving this, and permits the investigation of ash cloud evolution in domains many times larger than the laboratory-scale. However, even the most advanced models of eruption dynamics are restricted by the fixed mesh-based approaches that they generally employ. The research presented herein introduces a compressible multiphase flow model recently implemented within Fluidity, a combined finite element / control volume CFD code, for the study of explosive volcanic eruptions. Fluidity adopts an adaptive unstructured mesh-based approach to discretise the domain and focus numerical resolution only in areas important to the dynamics, while decreasing resolution where it is not needed as a simulation progresses. This allows the accurate but economical representation of the flow dynamics throughout time. The application of the model considers a 7 km $\times$ 7 km domain in which the violent eruption of hot gas and volcanic ash high into the atmosphere is simulated. It is shown by a convergence analysis that Fluidity offers the same solution accuracy for reduced computational cost using an adaptive unstructured mesh, compared to the same simulation performed with a fixed uniform mesh.