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The method of characteristics breaks down for accelerating frictional materials on inclined surfaces

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The method of characteristics is used to solve hyperbolic partial differential equations describing the velocity and depth evolution of propagating disturbances following catastrophic mass collapse. These widely-used solutions are appropriate for non-frictional and non-accelerating systems, and have recently been expanded to study the dynamics of mass flows. However, if the system is frictional and accelerating, we will show that the method of characteristics breaks down. Since accelerating systems encompass most problems of interest in natural hazards, including dam breaks, landslides, mudflows, debris flows, avalanches, and most large-scale mass movements, other techniques must be employed. These include either analytical techniques, or numerical solutions using high resolution schemes in the conservative form.