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Quantifying Differences in Methodologies for Forecasting Tephra Fallout

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Tephra is the most far-reaching of volcanic hazards and therefore poses a significant threat to human populations even at distances on the order of 100km. Tephra fallout models are commonly used to determine the accumulation of ejected material across a region given an eruptive scenario, enabling scientists to make the type of reliable forecasts crucial to hazards assessment. A subset of these fallout models, advection-diffusion models, describe the solution to the transport, diffusion, and sedimentation equations to calculate the mass loading of tephra on the ground relative to a particle release source. Advection-diffusion models are well-suited for civil protection purposes, such as planning mitigation measures. For this reason, they are most often employed in long-term forecasting of volcanic hazards. There are four primary methodologies utilized in long-term tephra forecasting: (1) Worst Case Scenario: eruption parameters and wind field believed to be the worst possible case executed by the model (2) Most Likely Scenario: the most likely eruption parameters and wind field are utilized and the model is run for this single case; (3) Minimally Probabilistic: either the most likely or worst case scenario is utilized and the wind field is varied such that the full range of possible wind fields is sampled from local atmospheric data; (4) Fully Probabilistic: eruption parameters vary based on a set of probability density functions while the wind field is also varied such that the full range of possible wind fields is sampled. While each of these methodologies has merit, each also has drawbacks. The Tephra2 numerical models is here employed to quantify the differences in the resulting hazard maps given each of these techniques. By determining the degree to which the choice of methodology impacts the actual hazard map, this work provides valuable information regarding the applicability of each methodology to tephra forecasting generally.