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Meteorological conditions leading to volcanic ash cloud bifurcation and a reduction in forecast skill

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Volcanic ash poses an ongoing risk to the safety of airspace worldwide. The accuracy with which we can forecast volcanic ash dispersion however depends on the atmospheric conditions. In certain meteorological situations the position of ash clouds with residence time less than 24 hours only are correctly simulated whereas in other situations the position of ash particles with residence times longer than 72 hours can be accurately simulated. In this study we use meteorological ensemble forecasts as input to a volcanic ash transport and dispersion model to explore the synoptic-scale conditions which control this predictability. Results indicate that when ash particles encounter regions of large horizontal flow separation in the atmosphere their future trajectories are very sensitive to their position at that time. Nearby ash particle trajectories can rapidly diverge causing the ash cloud to bifurcate. This situation generally leads to a decrease in forecast accuracy for deterministic forecasts which do not represent variability in wind fields at the synoptic-scale. This validates the use of meteorological ensemble forecasting to fully encompass ash cloud distributions, particularly if forecasts contain ash particles with residence times greater than 24 hours.