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The origin of secondary mass maxima in tephra fall deposits

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Some tephra fallout deposits show a distal increase of mass and thickness, hereafter referred to as Areas of Secondary Mass Maximum (ASMM). To assess the volcanic ash transport and sedimentation processes that cause such depositional variations, we focus on the August and September Mount Spurr eruptions, Alaska, which produced fallout deposits with conspicuous ASMMs beyond ~150 km from vent. We compare the crosswind and downwind variations of mass and grainsize within the two fallout deposits, and show that the increase of sedimentation at the ASMM does not result from preferential settling of fine (<100 µm) ash relative to coarser grainsizes, as has been suggested. Finer ash reached the ground much closer to the vent than the theory predicts, as observed in many other fallout deposits. However, the mechanism leading to enhanced settling at ASMMs affected the sedimentation of both fine ash and coarser particles. Measurement of the particle fall velocities in a sample from the August deposit shows that the texture and morphology of the particles has only a minor effect on settling within the ASMM. But we find a clear link between the ASMM and the topography: in both deposits, the mass local minimum occurs on the windward flank of a 2 km-high mountain range, while the local maximum (i.e. the ASMM) appears on the leeward flank. We suggest that wind patterns in the boundary layer, affected by the topography, led to the formation of ASMMs.