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Physical characterization of resuspended volcanic ash: the case of the 2011-2012 Cordón Caulle eruption (Chile)

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Primary tephra fallout represents one of the most widespread volcanic hazard in terms of spatial and temporal scales. Several studies during the last couple of decades have provided new insights into our understanding of tephra fallout deposits. Less attention has been dedicated to the characterization of wind resuspension of ash as a secondary but often syn-eruptive volcanic hazard. Resuspension of volcanic particles is a global concern since it is not only confined to the source area (i.e. primary tephra deposit) but it can impact large areas up to several hundred kilometres far from the source. In addition, ash resuspension can occur years, decades and even centuries after the eruption driving significant impact on large areas over extended periods of time and/or exacerbating the consequences of primary hazards and pre-existing conditions (e.g. droughts). Better understanding of this phenomenon, frequency of events as well as the type, size and shape of particles remobilized by the wind is therefore necessary in order to i) improve our preparedness and mitigation measures for volcanic ash impacts in the long-term; and ii) constrain accurate inputs for numerical models and consequently improve the forecasting of resuspension events. We have conducted a detailed physical characterization of ash resuspension associated with the 2011 eruption of Cordón Caulle volcano (Chile) based both on post-deposition field observations and on a systematic syn-deposition collection of airborne material through dedicated samplers at different heights above the soil surface. The 2011 Cordón Caulle eruption produced plumes of 3-14 km generating about 1 km3 of tephra deposited during several months (up to December 2012), but mostly during the first few days. Tephra was deposited towards the Argentinian Andes and Patagonia due to the prevailing westerly winds. The finest and upper layer of this deposit has been remobilized since 2011 and it continues even up to today. Grain size analysis shows that wind is capable to remobilize particles of a very specific range from 1 to 500 μm, with a median of 63 to 90 μm, associated with particle saltation. However, dust devils charged with finer particles (<70 μm) and creeping of larger particles (> 500 μm) have been also observed in the area of Ingeniero Jacobacci in the Patagonian steppe. Our analysis also shows how grainsize sorting is correlated with collection height, with the highest samples (1.50 m from surface) being better sorted than the lowest samples (0.15 m from surface). Frequency of resuspension events and mass flux are mostly controlled by the amount of available ash on the surface with syn-eruptive tephra fallout. However, specific meteorological conditions, such as winds and soil moisture, become dominant with time. The chronological evolution of mass flux shows that resuspension events were more frequent during the austral spring and summer when prevailing winds are stronger (10 – 18 km h^{-1}), gusts reach 90 km h^{-1} and precipitations are low. Even though resuspension events still occur today, a turning point was represented by the strong precipitations of April 2014, which was correlated with a strong decrease in mass flux.