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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Modeling volcanic ash resuspension – application to the 14–18 October 2011 outbreak episode in Central Patagonia, Argentina" *by* A. Folch et al.

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We appreciate the positive and constructive review by L.Mastin. Below we detail how the comments/suggestions have been addressed during the revision:

General comments At the beginning of Section 3.1, the authors should provide a clear definition of friction velocity u*. When I looked it up by a Google search it appears to be the mean absolute value of the product of turbulent velocity fluctuations in two dimensions (i.e. |mean(u'v'|), which made me wonder whether and how the WRF-ARW model determines these turbulent velocity fluctuations and the degree to which they

are scale dependent. We have included the following sentence "The friction velocity is a reference velocity used in surface boundary layer theory to scale the shear stress of a fluid, assumed proportional to the square of the mean velocity" to explain the meaning of u*. Regarding WRF-ARW, u* is computed using a first-order local closure to evaluate turbulent fluxes. In WRF, the surface layer schemes (several options available) calculate friction velocities and exchange coefficients that enable the calculation of surface heat and moisture fluxes by the land-surface models. These fluxes provide a lower boundary condition for the vertical transport done in the PBL schemes. In our opinion, details on this are beyond the scope of this paper.

How small must the vertical spacing be in the WRF model to accurately calculate u*, and model inputs might influence it? Typically, u* is computed after evaluation the shear stress at the first vertical layer. Because this involves spatial derivatives of velocity, it is clear that model discretization can affect the results to some extent. We agree that this is something that should be investigated in more detail in future studies.

The concept of horizontal saltation flux (lines 258-259) could be explained more clearly. From the units (kg m-1 s-1) it appears that saltation flux does not change with downwind position so long as the parameters used to calculate it don't change. However at the leading edge when wind first encounters a tephra deposit, I would expect saltation flux to increase with downwind position, eventually perhaps reaching a steady state. Over what distance might this occur? Is it small compared to the horizontal nodal spacing of the model? At a given point, the horizontal flux is the integration, along the vertical, of the stream-wise flux. It can change from point to point when u* and/or u*t vary horizontally (i.e. it is a variable that depends on x,y and time but not on z). Obviously in Fall3d, this is only calculated where the deposit exists so that flux is zero elsewhere.

Minor Edits

Line 39: change "affectation of ground transportation systems and disruption of airports" to something like "disruption of ground transportation systems and traffic at airports." (affectation is not the appropriate word here). Done Line 48: change "adequate" to "of favorable" or something similar Done Line 98-99, change "uncertainties exist regarding source strength for different reasons" to uncertainties exist in both source strength parameters and formulation", or something similar. Done Line 101: change "constrains" to "constraints" ok Line 103: change "once calibrated" to "after calibrating". ok Line 133: change "trough" to "through" Ok Section 3.1: For us modelers who don't use friction velocity it would be valuable to define it before discussing it. See general comment Line 171: remove "of" from "requires of data on . . ." ok Line 174: add "The" before "simplest dust emission schemes". Also, in the paragraph that starts on this line, I'm a little confused about how the issue of soil moisture is accounted for. There must be an assumed decrease in soil moisture with time after the end of a rainfall event. Is this considered in this "simplest" dust emission scheme? Ok The effect of soil moisture on threshold friction velocity if given by (4). In general, w is given by a NWP model, and so changes with time. However, as pointed out in the text, one problem is that NWP models do not consider the existence of ash fallout, which alters the properties of the original soil. . . Line 206: This formula for friction velocity is confusing. If Re is the Reynolds number for flow with regard to particles, why is it calculated using the formula Re=1331dËĘ1.56? What is the physical meaning of such a Reynolds number? We do not know the details. Marticorena and Bergametti (1995) only give this experimental fit, base don lab data by Iversen and White (1982). Line 213: " . . considering spherical particles with a cohesion force proportional to particle size." Should this say "inversely proportional to particle size"? No, cohesion is proportional to size, see eq (20) in Shao and Lu (2000). Line 223: I'm confused about the meaning of w', the "maximum amount of absorbed water." Is there a more specific definition? Line 225: add "dry" before "soil". Also, I'm a bit confused about possible values of w_g and how they might compare with w and w'. A typical value of w' is 10%, and w is the weight percent of water in a soil. But w_g=w*rho_w/rho_b. Let's say that rho_w=1,000 kg/m3, rho_b=1,500 kg/m3, and w=20%. Then w_g=20%*1,000/1,500=13.2%. This number has no physical meaning to me. The meaning of w' and w_g have been better explained in the text. Line 227:

how is w defined? Why would w, the soil moisture content, typically be greater than w', the maximum amount of absorbed water, as given in the caption to Fig. 1? This is now better defined. One can have w>w' is the soil is saturated. Lines 191 and 238-248: what is the scale of the surface roughness that affects the friction velocity? If it's meters or more, the source roughness may not be significantly modified by the tephra deposit unless it's many meters thick. The roughness length is a parameter equivalent to the height at which the wind speed theoretically becomes zero. It ranges from 0.003m for water to around 1.0m for forests. Line 257: how is u* defined? (I couldn't find a definition). In eq. 7 (line 275), when u*>u_*t, I would expect F_v to be proportional (u*-u_*t) rather than simply proportional to u*. Fort he definition of u* see the general comments above. In eq (7), the experimental fit coefficient depends on u* only. Obviously some dependency such as (u*-u*t)ˆ4 could be considered changing the coefficient 10-5 to some other value. Line 257: Horizontal saltation flux is given in units of kg m-1 s-1. This seems to imply that, for a given F_H, the mass flux (kg/s) of particles saltating along the ground surface does not change with downwind position. Is this true? Yes Line 288: you note "An important limitation of (7) is that the vertical flux does not depend on particle size or soil moisture". But (7) gives F_v as a function of u_*t, which, according to (1), does depend on particle size and moisture. Or are we to ignore (1) when employing (7)? Yes, eq (7) ignores (1) and assumes a constant threshold friction velocity as stated in the text. Line 289: add "one" after "allows" ok Line 300: change "aggregates" to "aggregate". ok Lines 325, 329 and 334: change "consists on" to "consists of" ok Line 350: change "sparse" to "sparsely distributed" Ok Lines 365-366: "e.g. the famous Route 40 linking Bariloche city with the Neuquén province". Perhaps refer to Fig. 2 here. Ok, Figure cited Lines 373-374: is the Ciudad Autonoma de Buenos Aires (CABA) different from the city of Buenos Aires that we all know? Would it be clearer to say the metropolitan área of Buenos Aires? ok Line 389: delete "only" Sentence changed Line 392: add "in the" before "afternoon". (or reword to say "until the afternoon of Monday the 17th") ok Line 426: should "WRF-ARF" be "WRF-ARW" as on line 403? corrected Line 451: change "an horizontal" to "a horizontal" ok Line 471: change "solved" to "resolved". ok Line 483: what is the basis for the moisture correction to calculating u_*t? Are you using a soil moisture calculated by the WRF-ARW model as a function of time? Yes, but only for schemes (2) and (3) Line 500: change "fixing" to "fix" ok Line 502: add "they" before "influence" ok Line 507: change "parametrized" to "parameterized" ok Line 542: change "allows discriminating" to "allows for discrimination" ok Line 546: Delete "Additionally" (it's redundant with "also") Ok Line 562: change "show" to "shows". Also are the boundaries of Patagonia shown on any of these maps? (you refer to northern Patagonia on this line). ok Line 563: when noting the "little triangle observed in the deposit region", it would be clearer to say "the little Volcanic Ash Graphic triangle near the CCVC vent in Figure 7d and 7e" done Line 620: change "estimate to contribution" to "estimate the contribution" ok Line 657: change "contributing with" to "contributing to" Ok Figure 1 legend: should "SH" be "SL", for Shao and Lu? Legend changed, only the first author left for simplicity Figure 2: On this map, Buenos Aires is labeled "Capital Federal (CABA)". It would be valuable to also label it "Buenos Aires". The meaning of CABA is now explicit in the text. Figure 3 caption: change "kg/m3" to "kg/m2". And change "Circles show the location" to "Circles show the locations". Units of deposit load are kg/m2. Text changed. Figure 4: is there any way to make the labels larger and easier to read? Also, could you label the peaks in wind speed that are responsible for the resuspension events? Marked now in Fig 5Âł Figure 5a: are there any dates on the y axis of this plot? I see only times but the labels are so small and faint it's hard to tell. Labels corrected Figure 10 caption, end: change "dashed line" to "dashed lines" ok

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