

## ***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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This paper is among the first to examine formulations for resuspension of volcanic ash that can be incorporated into a volcanic ash dispersion model, and tests three formulations using the Fall3d model, comparing results with measurements during an ash resuspension event in Argentina on October 14–18, 2011. The results report a significant advance in the capability of modeling ash-cloud movement because ash clouds represent a significant hazard to aircraft and almost no tephra transport models currently are capable of calculating ash resuspension. Ash resuspension events have closed airports and caused flights to be redirected in South America in 2011, in Ice-

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land in 2010–2011, and periodically in the Cook Inlet region of Alaska as ash from the 100-year-old Katmai eruption is suspended by wind from the Valley of Ten Thousand Smokes.

With some exceptions noted below, the formulations are clearly presented, the input provided to the model are clear, there are good observational data with which to compare results, and the interpretations are well justified. The illustrations are clear except for small text or labels in some figures which are noted below.

One conclusion I find appealing is that the simplest of the three formulations seems to work as well or better than the two more complicated ones, at least for the event simulated. I agree with the authors concluding point (lines 698–702) that more elaborate formulations require more parameters whose value are uncertain. Hence simplicity is an advantage in this case.

My main suggestions are as follows:

–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.  $|\text{mean}(u'v')|$ ), 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. How small must the vertical spacing be in the WRF model to accurately calculate  $u^*$ , and model inputs might influence it?

–The concept of horizontal saltation flux (lines 258–259) could be explained more clearly. From the units ( $\text{kg m}^{-1} \text{s}^{-1}$ ) 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?

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Below are many additional minor edits, some of which duplicate the comments made above. Overall I think that the paper is worthy of publication with minor revision. I look forward to seeing the paper in print.

Larry Mastin

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).

Line 48: change "adequate" to "of favorable" or something similar

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.

Line 101: change "constrains" to "constraints"

Line 103: change "once calibrated" to "after calibrating".

Line 133: change "trough" to "through"

Section 3.1: For us modelers who don't use friction velocity it would be valuable to define it before discussing it.

Line 171: remove "of" from "requires of data on . . ."

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?

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  $Re=1331d^{1.56}$ ?

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What is the physical meaning of such a Reynolds number?

Line 213: ". . . considering spherical particles with a cohesion force proportional to particle size." Should this say "inversely proportional to particle size"? 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/m<sup>3</sup>,  $\rho_b=1,500$  kg/m<sup>3</sup>, and  $w=20\%$ . Then  $w_g=20\%*1,000/1,500=13.2\%$ . This number has no physical meaning to me.

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?

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.

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  $u^*$ .

Line 257: Horizontal saltation flux is given in units of kg m<sup>-1</sup> s<sup>-1</sup>. 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?

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)?

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Line 289: add “one” after “allows”.

Line 300: change “aggregates” to “aggregate”.

Lines 325, 329 and 334: change “consists on” to “consists of”

Line 350: change “sparse” to “sparsely distributed”

Lines 365-366: “e.g. the famous Route 40 linking Bariloche city with the Neuquén province”. Perhaps refer to Fig. 2 here.

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 area of Buenos Aires?

Line 389: delete “only”

Line 392: add “in the” before “afternoon”. (or reword to say “until the afternoon of Monday the 17th”)

Line 426: should “WRF-ARF” be “WRF-ARW” as on line 403?

Line 451: change “an horizontal” to “a horizontal”

Line 471: change “solved” to “resolved”.

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?

Line 500: change “fixing” to “fix”

Line 502: add “they” before “influence”

Line 507: change “parametrized” to “parameterized”

Line 542: change “allows discriminating” to “allows for discrimination”

Line 546: Delete “Additionally” (it’s redundant with “also”)

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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).

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”

Line 613: change “particulate” to “particulates”

Line 620: change “estimate to contribution” to “estimate the contribution”

Line 657: change “contributing with” to “contributing to”

Figure 1 legend: should “SH” be “SL”, for Shao and Lu?

Figure 2: On this map, Buenos Aires is labeled “Capital Federal (CABA)”. It would be valuable to also label it “Buenos Aires”.

Figure 3 caption: change “kg/m<sup>3</sup>” to “kg/m<sup>2</sup>”. And change “Circles show the location” to “Circles show the locations”.

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? At M1 and M2 I can see one clear peak but it’s not as easy to pick out a second peak that might have caused resuspension.

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.

Figure 10 caption, end: change “dashed line” to “dashed lines”

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