

We are extremely happy to have the opportunity to reply the comments from a major member of the IGEPN, which is the official institute in charge of monitoring the volcanoes, earthquakes and other tectonic processes in Ecuador. We are really concerned about the low quality of such comments, which arises from personal interests and not from scientific proofs. Saying so, we will reply to every comment of B. Bernard about our manuscript.

### 1) Sampling:

The reviewer mentions that the sampling sites are not located along the main axis of the fallout of the ash plume from the Cotopaxi volcano on 14<sup>th</sup> of August. Even more, he provides a link (<http://www.igepn.edu.ec/cotopaxi/informes-cotopaxi/coto-especiales/coto-e-2015/13327-informe-especial-cotopaxi-21-08-2015/file>) showing a map with an almost perfect drop-shaped distribution of ash deposits. As far as we know this map is quite different from the reality based on two facts. First, the ash deposit distribution shown in our paper is based on satellite images and also field observations, while the “perfect drop-shaped distribution” is based on most likely theoretical predictions, but nobody exactly knows how they get this data. Natural processes are quite complex and computer models hardly predict the distribution of ashes.

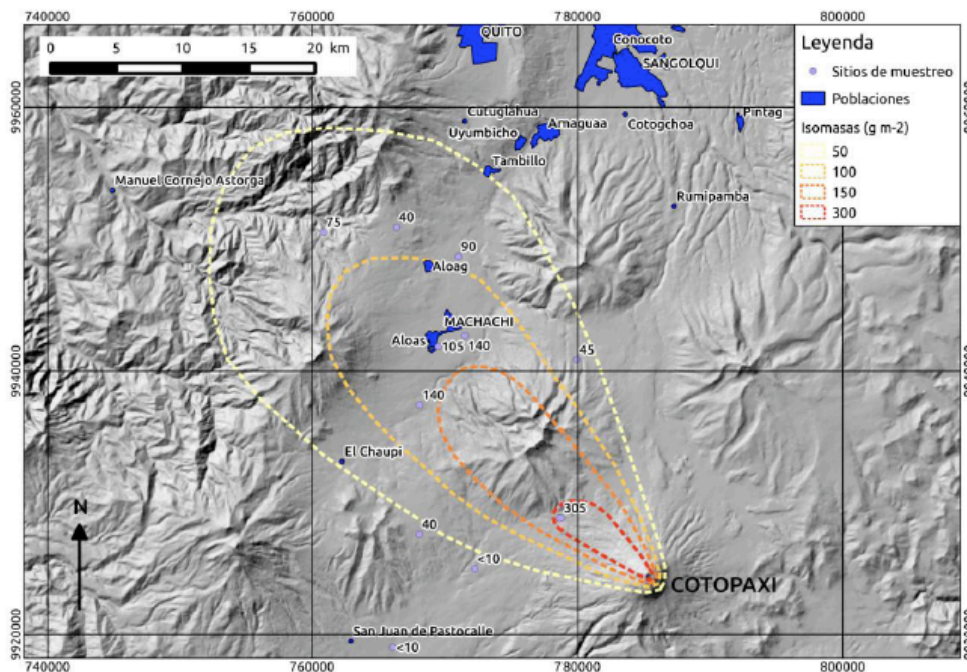
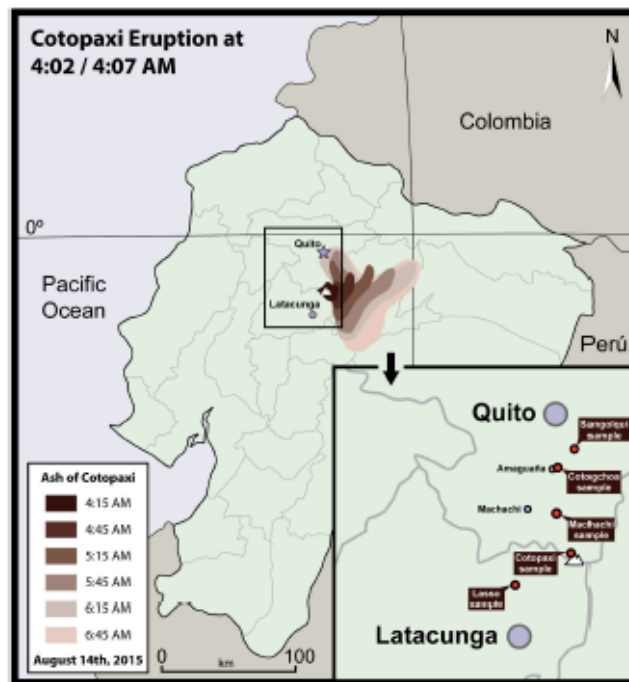


Fig. 1: B. Bernard’s map of perfect ash distribution taken from the link indicated in the text

This map of Fig. 1 shall be compared with Fig. 2 and also with some of the satellite images shown in Fig. 3, which have been taken as base for collecting the volcanic ash samples shown in our work. Secondly in Fig. 2 the ash distribution is exclusively from the very first explosions at 4:02 and 4:07 a.m. and not from all day, when more explosions have occurred with a variety of wind directions. This is indicated in the figure caption of the paper and also there is a further explanation in the main text. In our Fig. 2 we have particularly illustrated even the time distribution of the ash as taken by the satellite images of NOAA (see subtitles).



**Figure 2.** Ash cloud distribution of the 04:02 and 04:07 ECT events of the 14 August reactivation of Cotopaxi volcano. Distribution drawn based on images of the Ecuador Satellite Imagery of the Satellite Services Division of the National Environmental Satellite, Data, and Information Service (NESDIS). Inset in the bottom right shows the sample sites (see text for explanations).

Fig. 2: Our map of the manuscript describing on-time ash distribution based on field observations and satellite images of NOAA (Fig. 3).

Furthermore, in Fig. 4 we have also illustrated the ash fall distributions of other explosions occurred on the same day, so B. Bernard can realize how wrong his arguments are.

In conclusion, the ash distribution map shown on our paper correspond to the first explosions and it is drawn based on satellite measurements while the map shown in the special report provided by the IGEPN is quite different to what really happened on the 14<sup>th</sup> of August 2015 around the Cotopaxi volcano. Our samples have been

collected attending to the main wind directions contrary to the reviewer's comments.

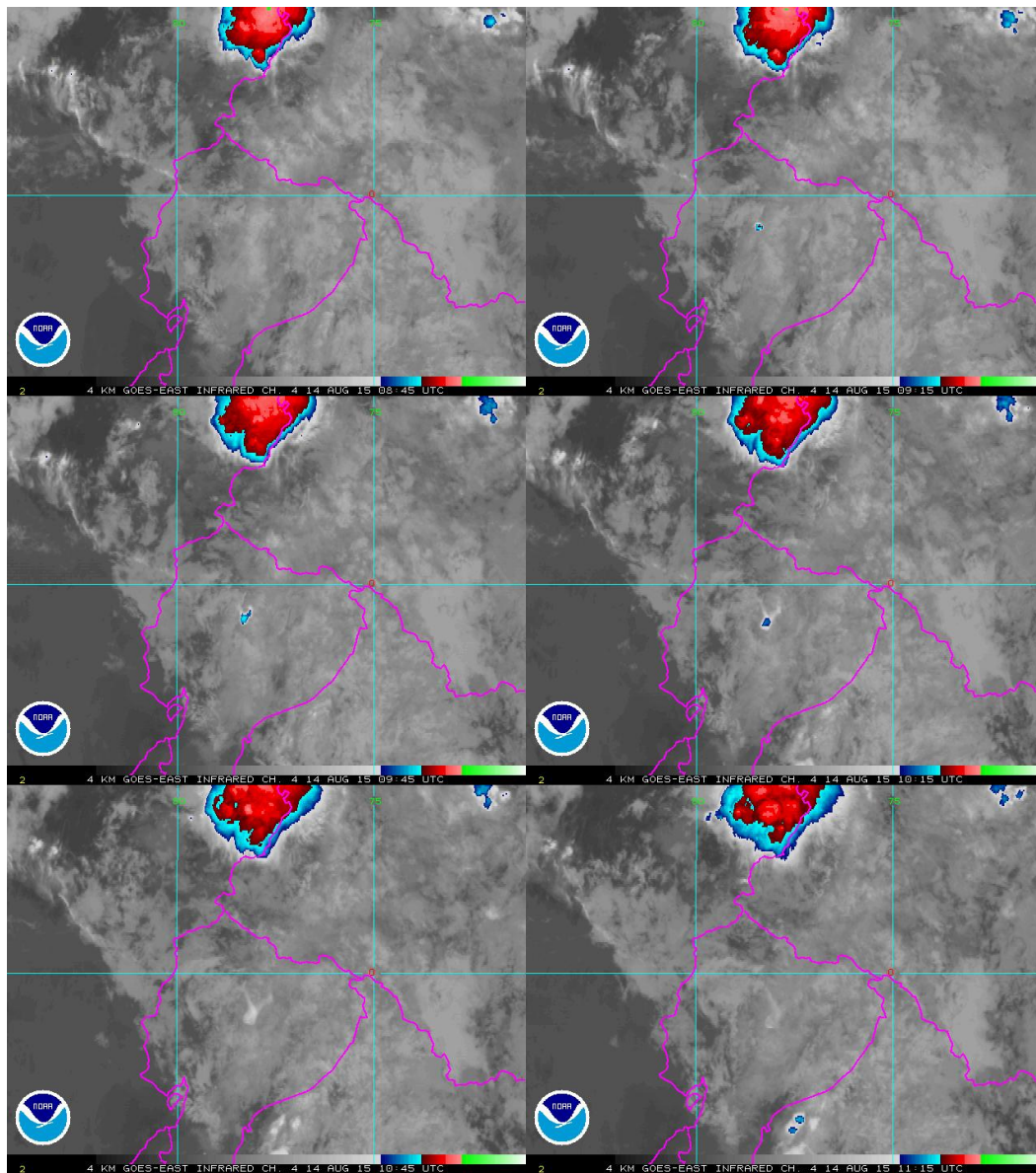


Fig. 3: Satellite images of NOAA of six different times of the morning of the 14<sup>th</sup> of August, which are the base of our Fig. 2 of the manuscript.

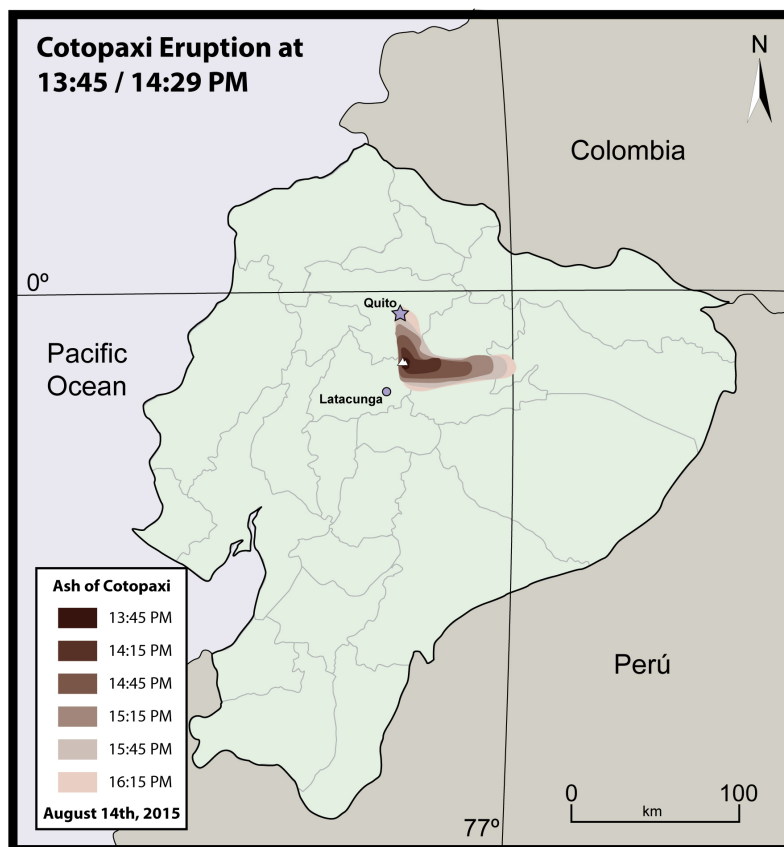
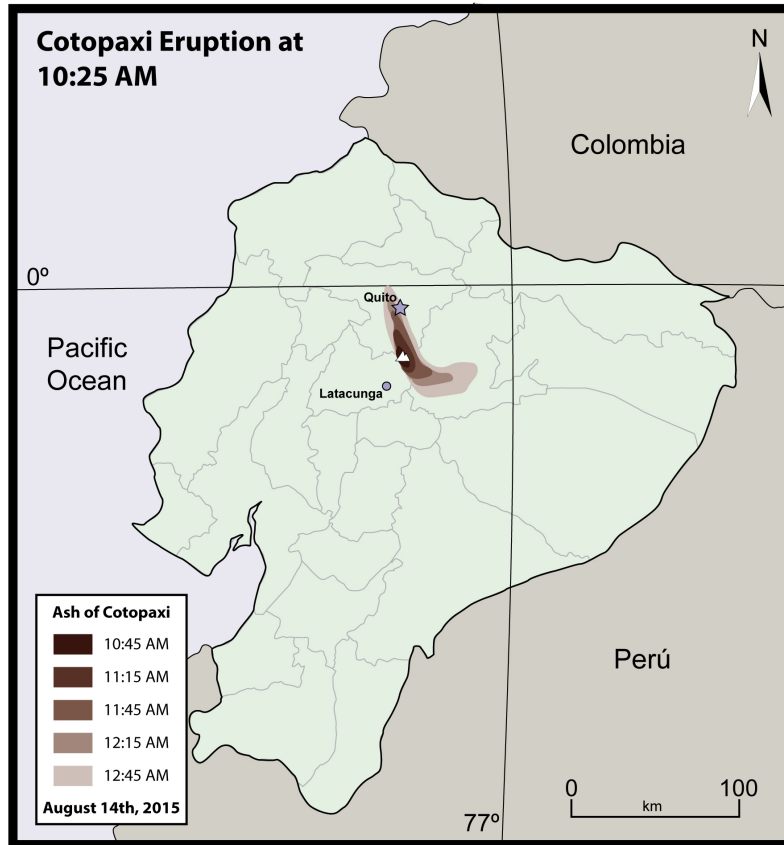


Fig. 4: Ash distributions of later explosions of the 14<sup>th</sup> of August 2015 of the volcano Cotopaxi.

We strongly recommend to B. Bernard to read the files from [www.ssd.noaa.gov](http://www.ssd.noaa.gov) (archives) this is a valuable source for ash-charged wind directions for scientists who work in fundamental issues of volcanology. Also the argument of B. Bernard: “No information is given on the thickness or the load of the deposits corresponding to the samples even though this is basic information”, this information is absolutely worthless in respect to the goals of our manuscript.

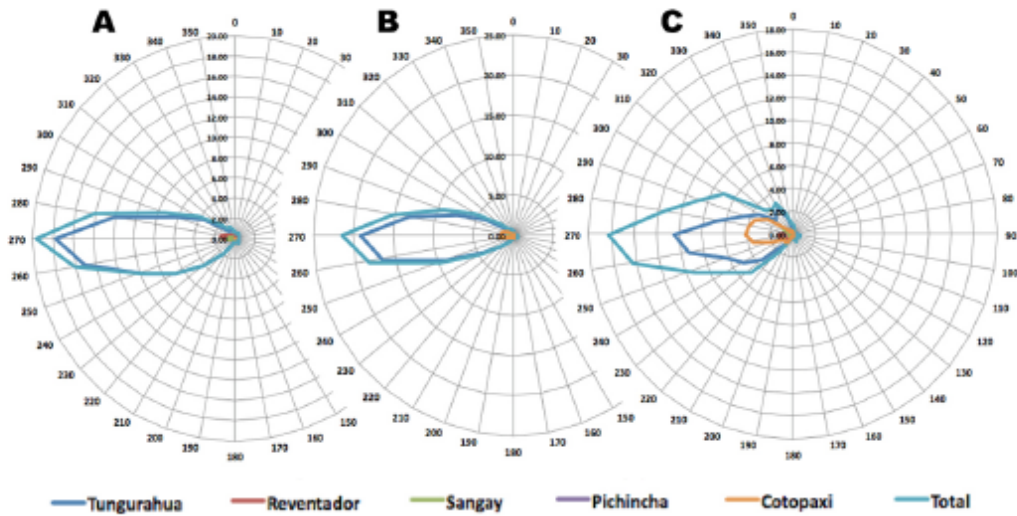
## **2) Main event:**

B. Bernard as member of the IGEPN is responsible for monitoring volcanic and seismic data from Ecuador. The data presented in our paper about other eruptions are coming from published studies and do not need to be explained again. In respect to the events occurred on 14<sup>th</sup> of August, we refer the interested reader to check the news published about the event. It is useful to remember that in the case of lahars generation the nearest city will be hit in 30 minutes. Although the Cotopaxi is being monitored 24 hours a day, seven days a week, the alert given by the IGEPN was spread seven hours after the first explosion. Moreover, on the 15<sup>th</sup> of August, just one day after the reactivation of the Cotopaxi volcano, the IGEPN claimed to have registered the existence of pyroclastic flows and lahars generation, which is an absolutely wrong interpretation of events. It is more than obvious, that B. Bernard tries to defend the activities of the IGEPN, but he fails tremendously, as the facts speak for themselves.

## **3) Wind directions:**

Our data (Fig. 4 of the manuscript) are based on objective measurements. The wind directions at the different seasons or months are currently under review for a new publication (Toulkeridis, T. and Zach, I.: Wind directions of volcanic ash-charged clouds in Ecuador – implications for the public and flight safety, *Geomat. Nat. Hazards Risks*, in press, 2015.). Even more so, we have included in our manuscript the main wind directions of Ecuadorian volcanoes, which have expelled ashes in the past 16 years (1999-2015) based on a data set. A total of 18688 data of the 4672 images were subdivided per month in order to determine the main wind directions for the different seasons in Ecuador. Around 92.70 % of the obtained data belongs to Tungurahua volcano, 3.94 % to El Reventador volcano, 2.70% to Sangay volcano and the remaining 0.66 % to Guagua Pichincha volcano. These data were compared with the data of Cotopaxi volcano. Once again, we are able to prove, that our data are

substantial, transparent and of high interest.



**Figure 4.** Wind directions of ash-charged clouds of five Ecuadorian volcanoes being active between September 1999 until September 2015 plotted in a rose-diagram, demonstrating the data of July, August and September, the time period of the reactivation of Cotopaxi volcano.

#### 4) Hydrothermal origin:

The present study is based on the morphology and chemistry of the sampled ashes from the reactivated Cotopaxi volcano. No juvenile magma has been found in any of the analyzed samples during the several months of volcanic activity. The interpretation of the origin of the ashes sampled in this study is unequivocal and therefore should not be questioned without scientific proofs. Our data and time proved us absolutely correct.

The authors