

## ***Interactive comment on “Impacts of the 2014–2015 Holuhraun eruption on the UK atmosphere” by Marsailidh M. Twigg et al.***

### **Anonymous Referee #1**

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Impacts of the 2014-2015 Holuhraun eruption on the UK atmosphere By Twigg et al.

General:

This paper explores gas and particle phase composition and regional perturbations during an effusive volcanic event. The data presented are interesting and certainly worth publishing; however, I have several major comments with respect to interpretation of the data that should be addressed before publication.

Major Comments:

The major comment I have is with respect to the simultaneous observation of newly formed particles and HCl. The authors imply that SO<sub>2</sub> in the plume is responsible for both new particle formation and the heterogeneous displacement of chloride from sea

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salt particles resulting in the formation of gaseous HCl. This finding is quite surprising considering that chloride displacement by H<sub>2</sub>SO<sub>4</sub> should substantially deplete the concentrations of H<sub>2</sub>SO<sub>4</sub> required to nucleate and grow new particles in the atmosphere. Figures 5 and 6 imply that heterogeneous uptake of H<sub>2</sub>SO<sub>4</sub> and new particle formation by H<sub>2</sub>SO<sub>4</sub> are occurring at the exact same time at the same site. Additional evidence is required to support this claim. Specifically, the authors should show that there is enough H<sub>2</sub>SO<sub>4</sub> to support heterogeneous uptake, nucleation, and particle growth during this time period.

Specific Comments: Abstract: 1. The authors should clearly highlight that they are presenting data on effusive volcanic activity, which has been under-explored. This would further highlight the significance of their work.

2. Lines 25-27, only a few days in September are explored in depth. The authors should revise their statement that 4 months were studied and state that a large atmospheric perturbation occurring during a few days in Sept attributed to effusive volcanic activity is their main focus.

3. The authors should provide a sentence highlighting their lines of evidence that the perturbation was due to volcanic activity.

4. The authors should mention what the aerosol acidity was. This can be calculated using the data they have on hand and the ISORROPIA-II model.

Introduction

1. A more detailed discussion of explosive vs effusive volcanic activity would be helpful as well as a synopsis of previous finds relevant to tropospheric chemistry. This would help give context to the authors' findings.

2. The authors should comment on any findings relevant to halogen chemistry and volcanic activity if they are going to comment on HCl concentrations and their formation during a volcanic event.

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## Methods

1. If the SMPS had that much of a sizing offset, can any comment really be made regarding nucleation?
2. What temperature and RH conditions were used to run ISORROPIA-II?

## Results

### 3.1 Identification of the volcanic plume

1. HYSPLIT back trajectories would help eliminate the possibility that other sources of aerosol are influencing the observations.

#### 3.2.1 Formation of sulfate aerosols

2. The authors seem to imply that nucleation is occurring in the boundary layer at the same time as acid displacement. Further evidence is needed to support this. Can the authors prove that nucleation isn't occurring instead in the free troposphere where low particle surface area would favor this process?

#### 3.2.2. Modification of the chemical composition within the plume

3. What does the temporal and spatial variability of aerosol Cl tell you? Do you see Na and Cl in proportions similar to sea salt near site that become more acidic with more SO<sub>4</sub> in the aerosol as you move away from the plume?
4. Figure 7 is very hard to read and interpret. Why do none of the data fall on the 1:1 line?

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