

Supporting information for:

In-plume and out-of-plume analysis of aerosol-cloud interactions derived from the 2014-15 Holuhraun volcanic eruption

5 Animation S1: Total column amount of SO₂ (DU) in the OMPS SO₂ plume mask for days retrieved in September 2014. The SO₂ plume mask is obtained using OMPS PCA L2 v2.0 product. A mask is created where the total amount of SO₂ is greater than 1 DU, and then a 3 x 3 median filter is applied to the mask to reduce noise. The grey box shows the bounding box region surrounding the plume mask. Our in-plume vs out-of-plume analysis is conducted within this bounding box. The red star shows location of the eruption site.

10 Animation S2: Total column amount of SO₂ (DU) in the UKESM1-A Holuhraun simulation in September 2014. A mask is created where the total amount of SO₂ is greater than 1 DU. No median filter is applied. The grey box shows the bounding box region surrounding the plume mask. Our in-plume vs out-of-plume analysis is conducted within this bounding box. The red star shows location of the eruption site.

15 Animation S3: Plume analysis of the change in observed liquid cloud droplet number concentration (cm⁻³) inside vs outside the Holuhraun SO₂ eruption plume. The top subfigure shows daily liquid N_d concentrations as observed from MODIS AQUA and constrained by cloud top heights between 1 – 5 km. The plume mask derived from OMPS SO₂ and bounding box is overlayed. The bottom figure shows a histogram of liquid N_d inside (blue) and outside (orange).

20 Animation S4: Plume analysis of the change in observed liquid cloud droplet effective radius (μm) inside vs outside the Holuhraun SO₂ eruption plume. The top subfigure shows daily liquid r_{eff} as observed from MODIS AQUA and constrained by cloud top heights between 1 – 5 km. The plume mask derived from OMPS SO₂ and bounding box is overlayed. The bottom figure shows a histogram of liquid r_{eff} inside (blue) and outside (orange).

25 Animation S5: Plume analysis of the change in observed liquid water path (g m⁻²) inside vs outside the Holuhraun SO₂ eruption plume. The top subfigure shows daily LWP concentrations as observed from MODIS AQUA and constrained by cloud top heights between 1 – 5 km. The plume mask derived from OMPS SO₂ and bounding box is overlayed. The bottom figure shows a histogram of LWP inside (blue) and outside (orange).

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MODIS AQUA liquid cloud properties with cloud top heights 1 - 5 km
overlayed by plume mask bounding region

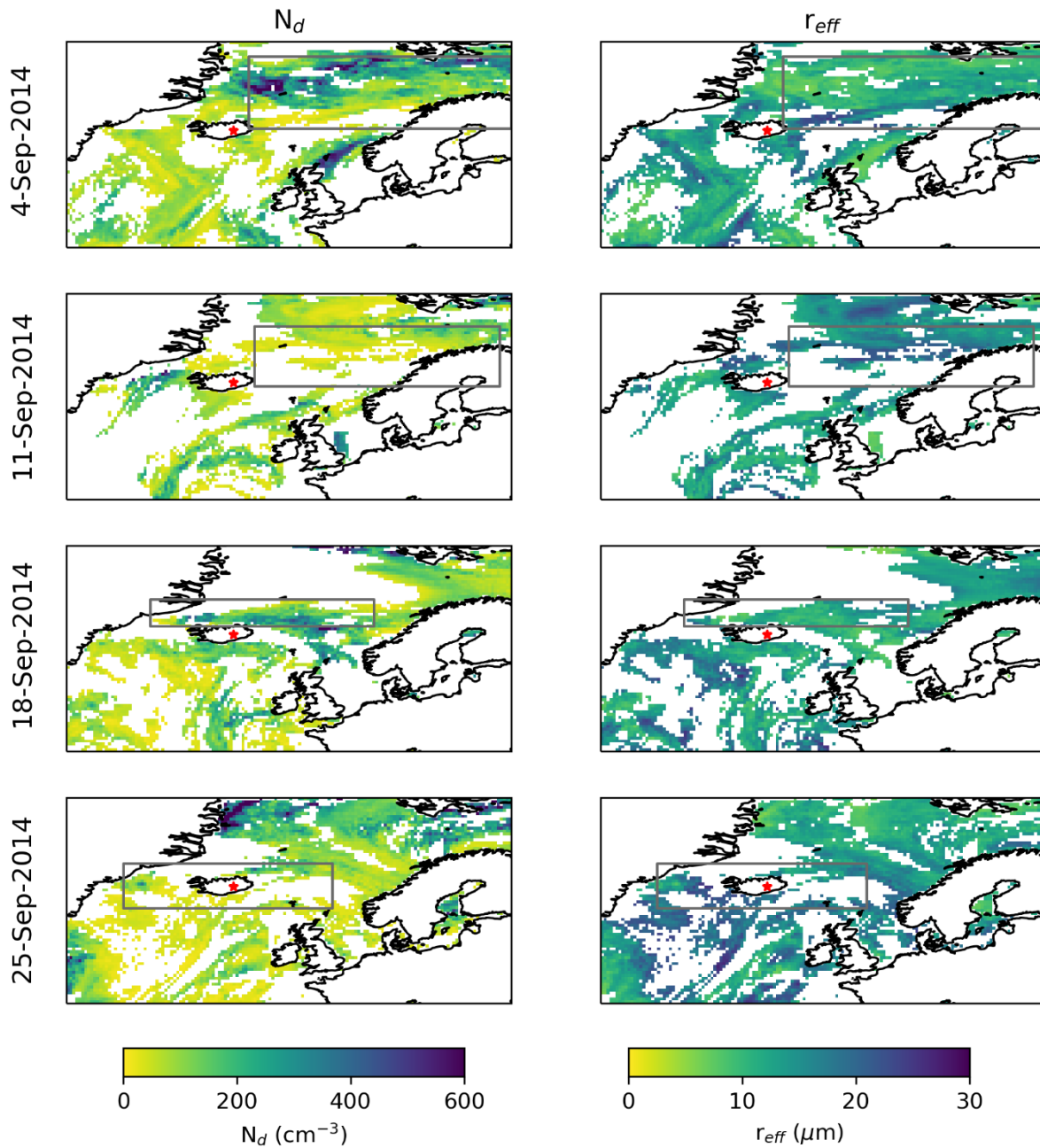


Figure S1: Map of MODIS AQUA liquid cloud droplet number concentration (left column) and effective radius (right column) constrained by cloud top heights between 1 – 5 km for the midweek days in September 2014. The plume mask bounding box derived from OMPS SO₂ is overlayed.

MODIS AQUA LWP with cloud top heights 1 - 5 km

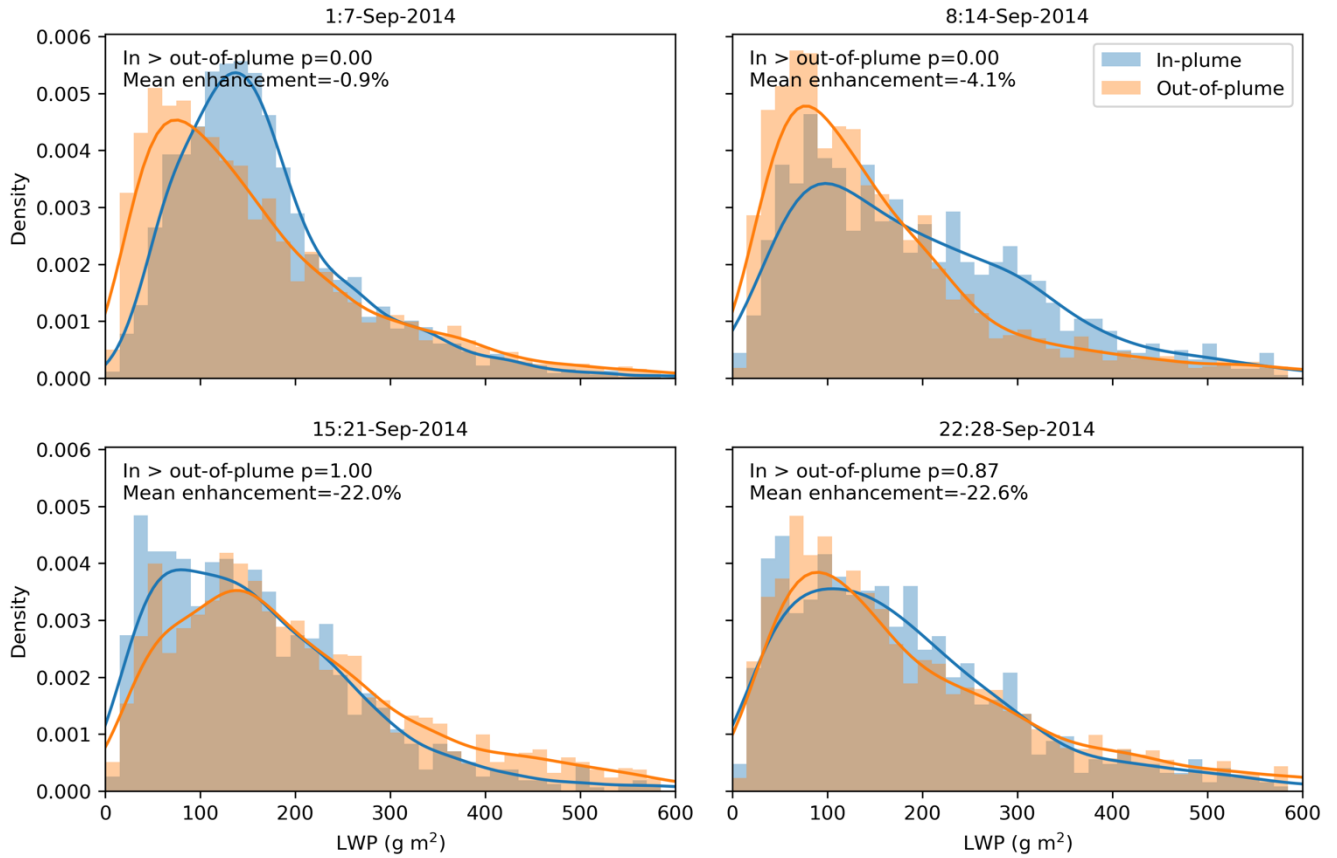
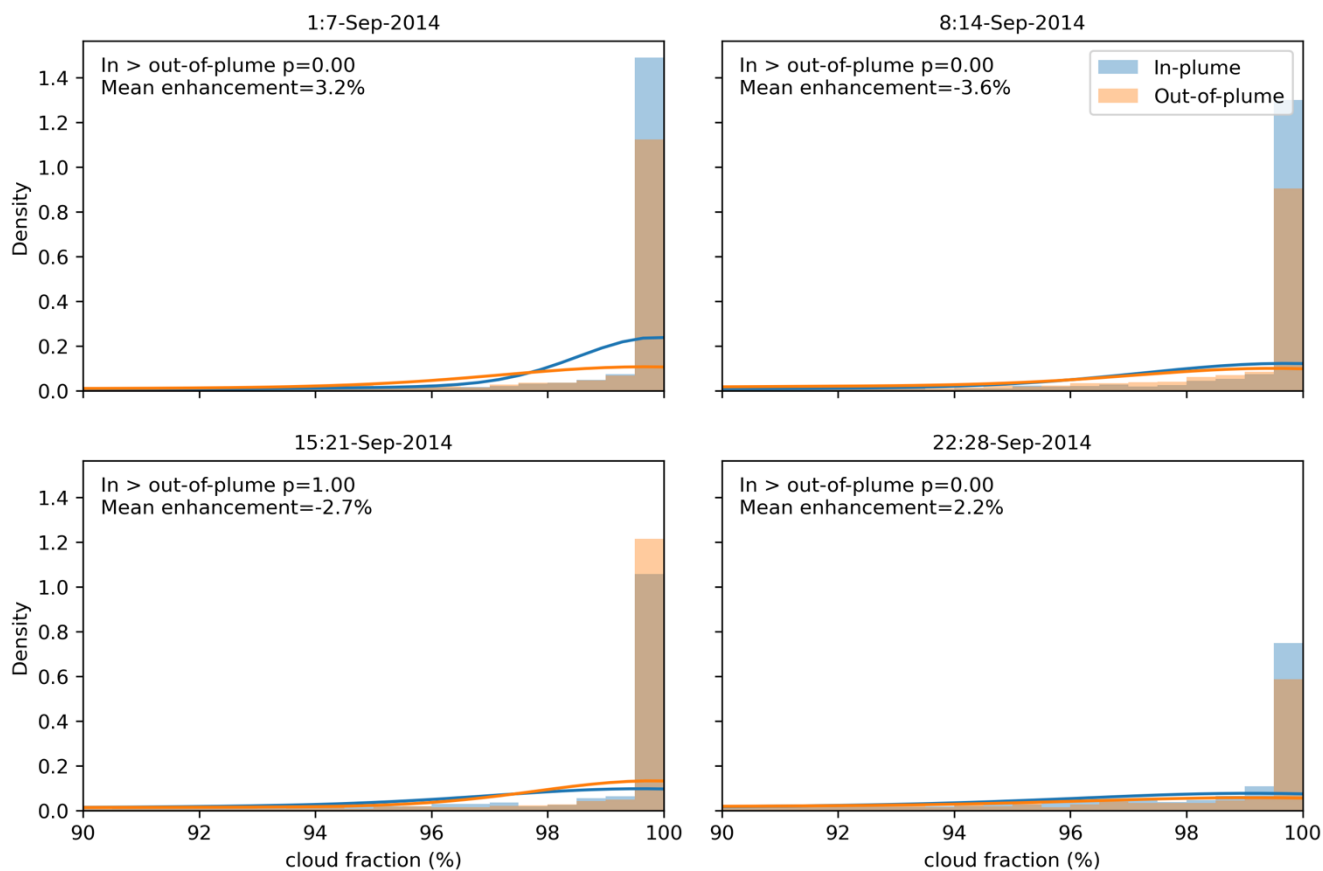
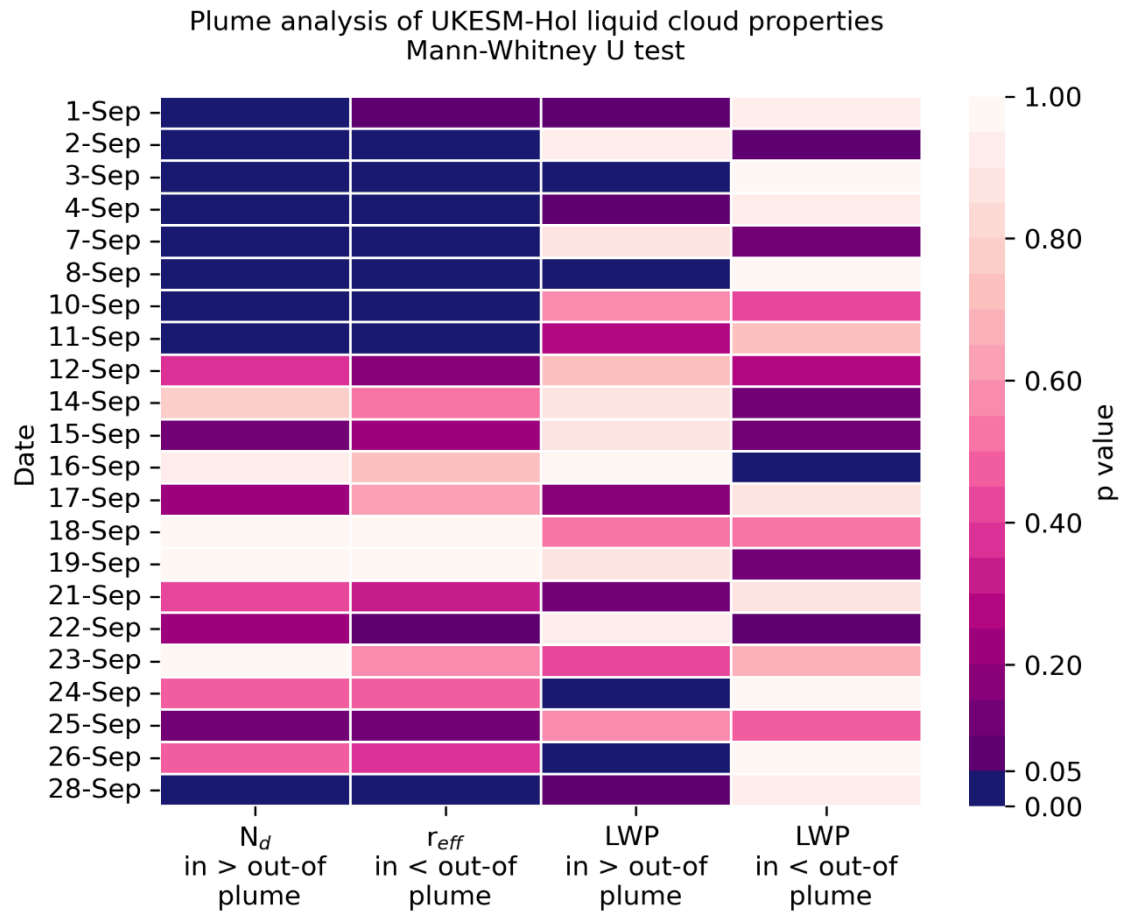


Figure S2: Histogram of MODIS AQUA liquid water path (g m^{-2}) inside (blue) and outside (orange) the plume mask aggregated by week following the Holuhraun eruption. Only marine cloud properties with cloud top heights between 1-5 km are evaluated. The Mann-Whitney U test is used to calculate if the in-plume LWP is statistically greater than outside of the plume. The p value and mean in-plume enhancement is displayed for each week.

MODIS AQUA liquid cloud fraction with cloud top heights 1 - 5 km



50 **Figure S3: Histogram of MODIS AQUA liquid cloud fraction (%) inside (blue) and outside (orange) the plume mask aggregated by week following the Holuhraun eruption. Only marine cloud properties with cloud top heights between 1-5 km are evaluated. The Mann-Whitney U test is used to calculate if the in-plume liquid cloud fraction is statistically greater than outside of the plume. The p value and mean in-plume enhancement is displayed for each week.**



60 Figure S4: Statistical significance changes in cloud properties from the UKESM1-Hol simulations inside vs outside of the OMPS SO₂ plume mask regridded to UKESM1-A resolution. Significance is evaluated using the Mann-Whitney U test. For liquid cloud droplet number and effective radius, significance is evaluated for the direction of an expected increase in N_d and decrease in r_{eff} inside the plume. LWP is evaluated in both directions. The colour bar displays the p value, with dark blue indicating a statistically significant perturbation to cloud properties inside the plume for that day.

UKESM liquid N_d

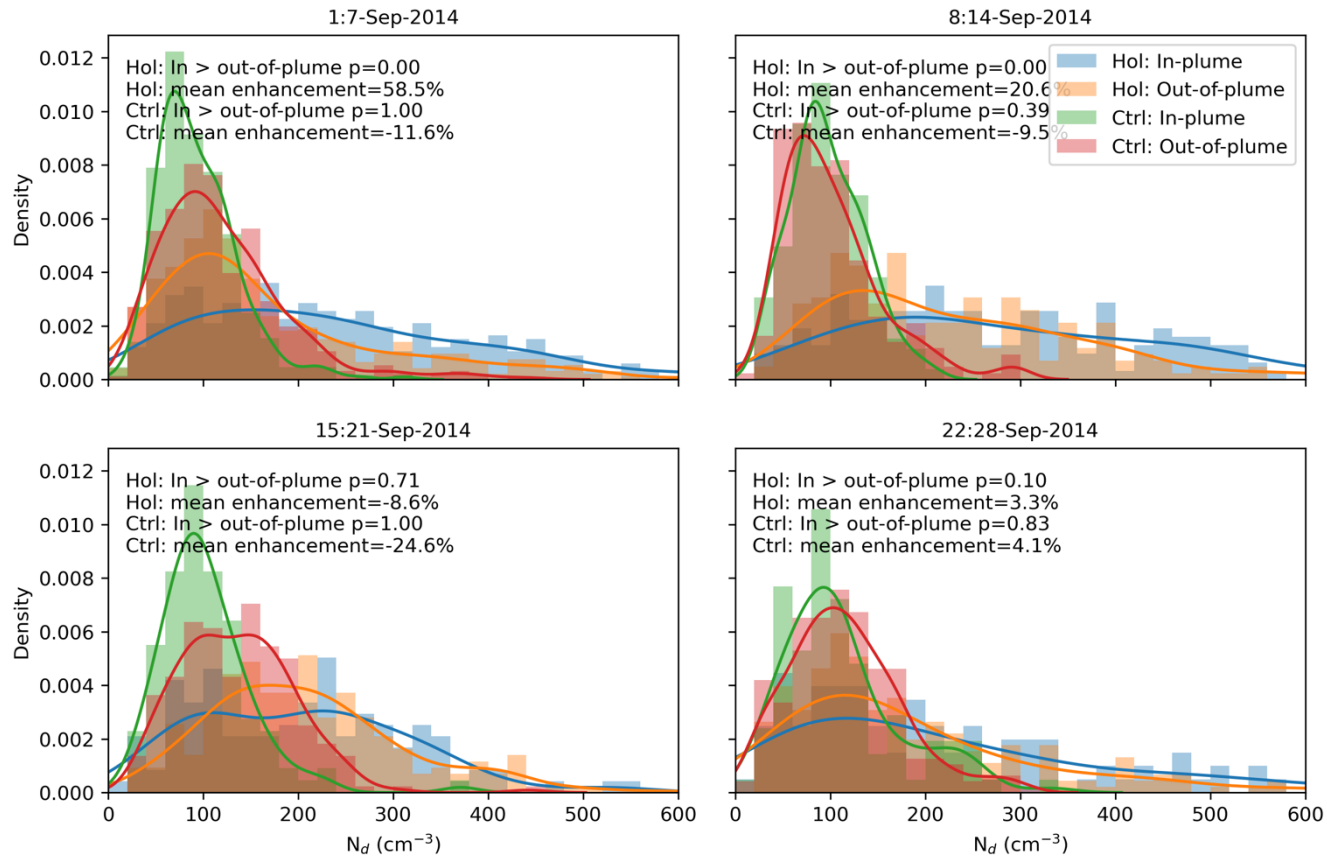


Figure S5: Histogram of liquid cloud droplet number concentration (cm^{-3}) inside and outside the plume mask aggregated by week following the Holuhraun eruption for UKESM1-A simulations at 12 pm. The simulations with the volcanic eruption are shown in blue and orange, and the control simulations are shown in green and red. OMPS has been regridded to UKESM1 resolution prior to calculating the plume mask. Only marine clouds are retained. The Mann-Whitney U test is used to calculate if the in-plume N_d is statistically greater inside the plume than outside of the plume. The p value and mean in-plume enhancement is displayed for each week for the eruption and control simulations.