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Stratosphere-Troposphere Exchange Involving the Eyjafjallajökull Volcanic Plume

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During research flights in May 2010 investigating the ash plume emanating from the Eyjafjallajökull eruption, the BAe 146 aircraft, operated by the Facility for Airborne Atmospheric Measurement (FAAM), encountered what appears to be a stratospheric intrusion over the southern North Sea. Very dry, ozone rich air was detected at altitudes down to 6.3 km and was located over a region of dense aerosol. A region of low tropopause height and high Ertel potential vorticity (PV) at the 315 K potential temperature surface is shown in this area in UK Met Office model fields. Airborne lidar measurements of the ash plume show it as being continuous across the tropopause region and this is supported by in situ measurements of sulphur dioxide; evidence of the tropopause fold was also recorded in the thermal infrared by the Airborne Research Interferometer Evaluation System (ARIES) while the Ozone Monitoring Instrument (OMI) onboard the AURA satellite recorded total column ozone in excess of 425 Dobson units (DU) in the region. Throughout the eruption, strong ozone depletion was observed in the volcanic plume which is believed to be the result of homogeneous bromine chemistry.

This eruption was believed to be predominantly tropospheric with a typical plume height at source of around 6 km but we show that a proportion of the plume crosses the tropopause as a result of a mixing event over the North Sea and, further, Met Office models also show a region of low tropopause height and high PV over Iceland suggesting that the proportion of the plume entering the stratosphere could be higher, with the effect of increasing the aerosol and halogen loading in the lowermost stratosphere.