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Expansion of the main auroral oval at Jupiter : evidence for Io's control over the Jovian magnetosphere

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In spring 2007, New Horizons' Jupiter fly-by provided a unique opportunity for the largest observation campaign dedicated to the Jovian aurora ever carried out by the Hubble Space Telescope. UV images of the aurora have been acquired on a quasi-daily basis from mid-February to mid-June 2007. Polar projection of the auroral emissions clearly show a continuous long-term expansion of main oval additionally to day by day variations. The main oval moved so much that the Ganymede footprint, which is usually located equatorward of the main emissions, has even been observed inside of it. Simultaneously, the occurrence rate of large equatorward isolated auroral features increased over the season. These emission patches are generally attributed to injections of depleted flux tubes. On 6th June, one of these features exceptionally moved down to the Io footpath. The Io footprint seemed to disappear while the footprint moved through this patch of emission. This disappearance is a unique case among all the UV images of the aurora acquired during the last 12 years.
We suggest that all these changes seen in the Jovian aurora are evidence for a major reconfiguration of the magnetosphere induced by increased volcanic activity on Io. Indeed, New Horizons observed particularly intense activity from the Tvashtar volcano in late February 2007. Moreover, sodium cloud brightening caused by volcanic outbursts have also been seen in late May 2007. According to our interpretation, repeated volcanic outbursts beefed up the plasma torus density and its mass outflow rate. This caused the corotation breakdown boundary to migrate closer to Jupiter. Consequently, the main auroral oval moved equatorward. As heavy flux tubes move outward, sparsely filled ones should be injected into the inner magnetosphere in order to conserve the magnetic flux in this region. This phenomenon could explain the large number of injection signatures observed in May-June 2007. Such a cloud of depleted flux tubes probably disrupted the Io-magnetosphere interaction, leading to an abnormally faint Io footprint.