Vertical Mass Flux by the 2010-2011 Great Storm of Saturn

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We present a re-analysis of Cassini Composite Infrared Spectrometer (CIRS) data captured during the 2010-2011 Great Storm of Saturn to calculate the vertical mass flux caused by the storm. The intense cumulus outburst started on December 5, 2010 at 33ºN planetocentric latitude, and the clouds that emanated from the storm engulfed the entire latitude band over the subsequent months. The CIRS observation captured the storm's impact on the tropospheric thermal structure (Achterberg et al. 2014). The change in the thermal structure detected by Achterberg et al. (2014) is caused by the vertical uplifting of mass by the cumulus convection in the storm. We re-analyze the CIRS data processed by Achterberg et al. (2014) to determine the vertical mass flux. Images captured by the Imaging Science Subsystem (ISS) camera showed that active convective phase of the storm lasted until August 2011 (Sayanagi et al. 2013). Our preliminary analysis of CIRS data shows that, by August 2011, between 15ºN and 45ºN latitudes, the storm lifted about 1.65×10^{19} kg of mass to levels above the 700-mbar pressure altitude from levels below.

Analyzing images captured by ISS using the CB2 (750 nm) filter and Cassini Visible and Infrared Mapping Spectrometer (VIMS)'s 5-micron channel reveals that, after August 2011, cumulus activities ceased in the storm's latitudes, and a vast cloudless area grew until it encircled the entire band between 30ºN and 40ºN latitude by January 2012. The cloudless region further grew to the south and reached 20ºN by December 2012. Interestingly, analysis of the CIRS data indicates that the vertical mass flux continued as the clouds cleared after the storm. Our preliminary analysis shows that, between August 2011 and August 2012, 1.9×10^{18} kg more mass was lifted to altitudes above the ~700-mbar level. We hypothesize that the vertical mass flux during the cloud clearing was caused when the tropospheric air parcels became buoyant when they were relieved from the mass loading of the storm clouds.

We note that measuring vertical mass flux caused by a cumulus storm is extremely difficult for storms on Earth because the mass uplifted by the storms is rapidly dispersed and diluted by the storm's environment. In comparison, Saturn's Great Storm of 2010-2011 completely filled the latitude zone between 20°N and 40°N; thus, the storm was essentially contained in a closed box, and allowed us to measure the storm's vertical mass flux.

References:

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