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Comparing solar wind velocity measurements derived from Sun-grazing Comet Lovejoy (C/2011 W3) as observed from multiple locations

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Comets' plasma (type I) tails have been studied as natural probes of the solar wind since the mid-20th century. Local solar wind conditions directly control the morphology and dynamics of a comet's plasma tail. During ideal observing geometries, the orientation and structure of the plasma tail can reveal large-scale and small-scale variations in the local solar wind structure. These variations can be manifested as tail condensations, kinks, and disconnection events.

The technique employed in this study was established by analysing geocentric amateur observations of comets C/2001 Q4 (NEAT) and C/2004 Q2 (Machholz). These amateur images, obtained with modern equipment and sensors, are arguably better in quality than professional images obtained only 2-3 decades ago. Multiple solar wind velocity estimates were derived from each image and the results compared to observed and modelled near-Earth solar wind data.

Our unique analysis technique allows us to determine the latitudinal variations of the solar wind, heliospheric current sheet sector boundaries and the boundaries of transient features as a comet with an observable plasma tail probes the inner heliosphere.

We present solar wind velocity measurements derived from multiple observing locations of comet Lovejoy (C/2011 W3) from the 14th – 19th December 2011 using recent images from the SECCHI and LASCO heliospheric imagers and coronagraphs aboard STEREO A and B, and SOHO. Comet Lovejoy was a very bright sungrazer, which plunged into the solar corona and largely survived its perihelion (1.19 solar radii) on 16th December at 00:17 UT. Lovejoy, an exception amongst sungrazers, displayed a prominent plasma tail pre-perihelion and post-perihelion, as it probed the solar atmosphere. Overlapping observation sessions from the three spacecraft provided the perfect opportunity to use comet Lovejoy as a diagnostic tool to understand solar wind variability close to the Sun.

We plan to compare our observations to results of suitable simulations of plasma conditions in the corona and inner heliosphere during the time of Lovejoy's perihelion passage. The correlation of the solar wind velocity distribution from different observing locations can provide clues towards the morphology and orientation of the plasma tail. We also attempt to determine the non-radial contributions to the measured solar wind velocities via this study.