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High latitude observations of magnetotail plasma-sheet plasma in conjunction with a transpolar arc

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Transpolar arcs (TPAs) are auroral features which extend into the polar cap from the night side of the main auroral oval. In their most developed form, TPAs and the main auroral oval resemble a Greek 'theta', hence their alternative name of theta auroras. Observations from low-altitude spacecraft have reported that the plasma distribution above a TPA is similar to that above the main auroral oval, indicating that TPAs exist on closed magnetic field lines embedded within the open polar cap, but very few simultaneous observations have been reported of TPAs and conjugate points further out in the magnetotail. A major candidate mechanism for TPA formation invokes the closure of lobe flux in a twisted magnetotail, where the closed flux is prevented from returning to the dayside as the twist causes the northern and southern hemisphere footprints of the closed field lines to straddle the midnight meridian. In this mechanism, closed flux builds up on the night side, so plasma similar to typical plasma sheet distributions should be observed at high latitudes embedded within the lobe. We present preliminary observations of three cases where the Cluster spacecraft observes plasma-sheet plasma embedded within the lobes, and at much higher latitudes than those at which the plasma sheet is usually observed. The plasma distributions are indicative of closed field lines, and the locations of the spacecraft map to a point on the TPA that is significantly poleward of the main auroral oval. These observations are consistent with TPAs being formed by the proposed reconnection/twisted magnetotail mechanism.