Supplementary Materials for "*Characterizing perturbed ionospheric total electron content configurations using the Shannon information content*"

Rezy Pradipta[1] and Bryce Kim[2,3]

[1]Institute for Scientific Research, Boston College, 140 Comm. Ave., Chestnut Hill, MA, 02467, United States
[2]Bozeman High School, 205 North 11th Avenue, Bozeman, MT, 59715, United States
[3]*now at* Rice University, 6100 Main St, Houston, TX, P77005, United States

In this document, we provide several example climatological histograms of VTEC distribution, which are the building blocks for the computation of Shannon information content as described in the main manuscript. These example climatological histograms are for the point coordinate 45°N 120°E, and they were assembled using IGS GIM data from 2011-2016 period. Further, we also provide some additional examples of Shannon information content (SIC) increase during disturbed geomagnetic conditions – along with a set of aggregated SIC histograms to show their full dynamic range.

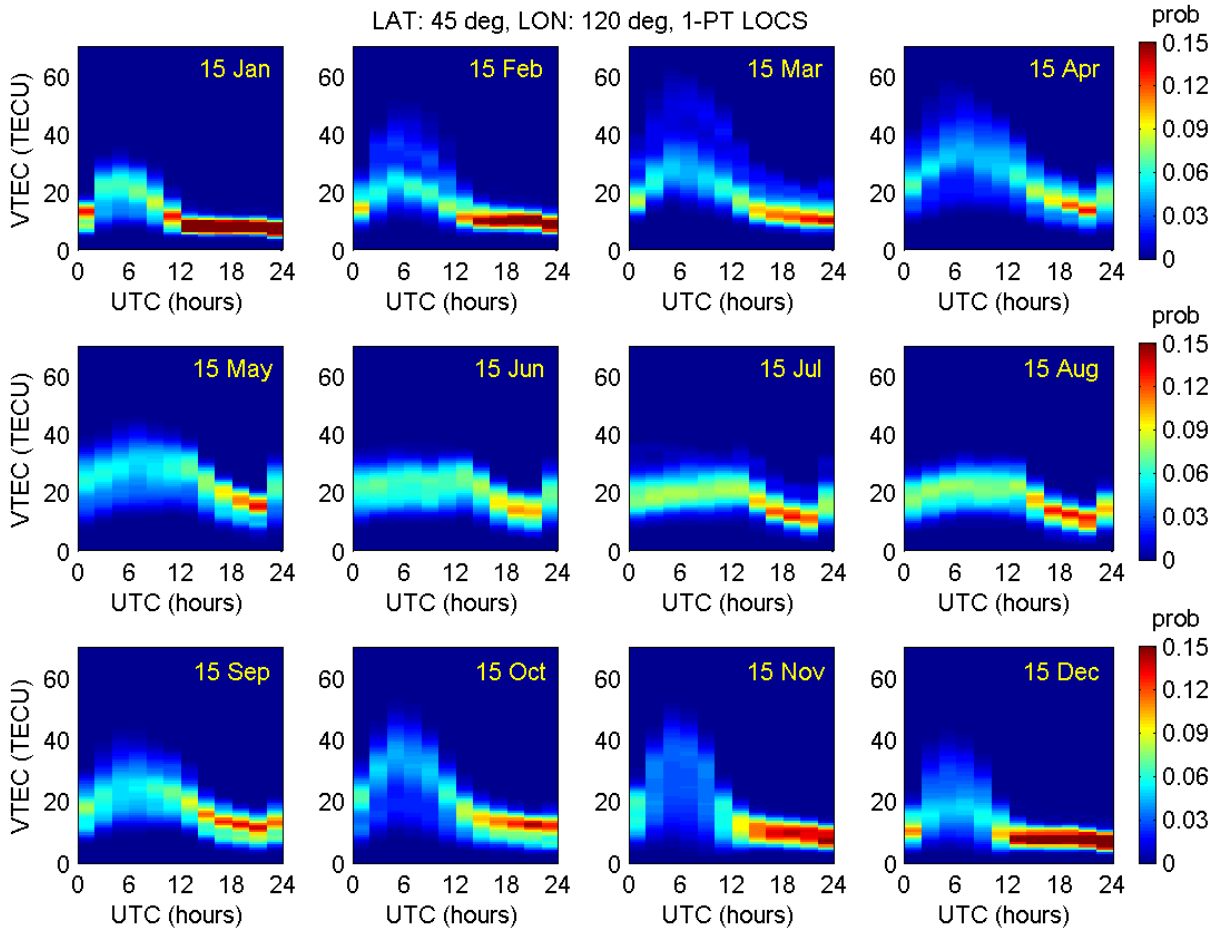

Figure S1. *Climatological probability distribution histograms of VTEC values over 45ºN 120°E as a function of time-of-day (in UTC) for various calendar months based on the IGS GIM TEC data product 2011-2016.*

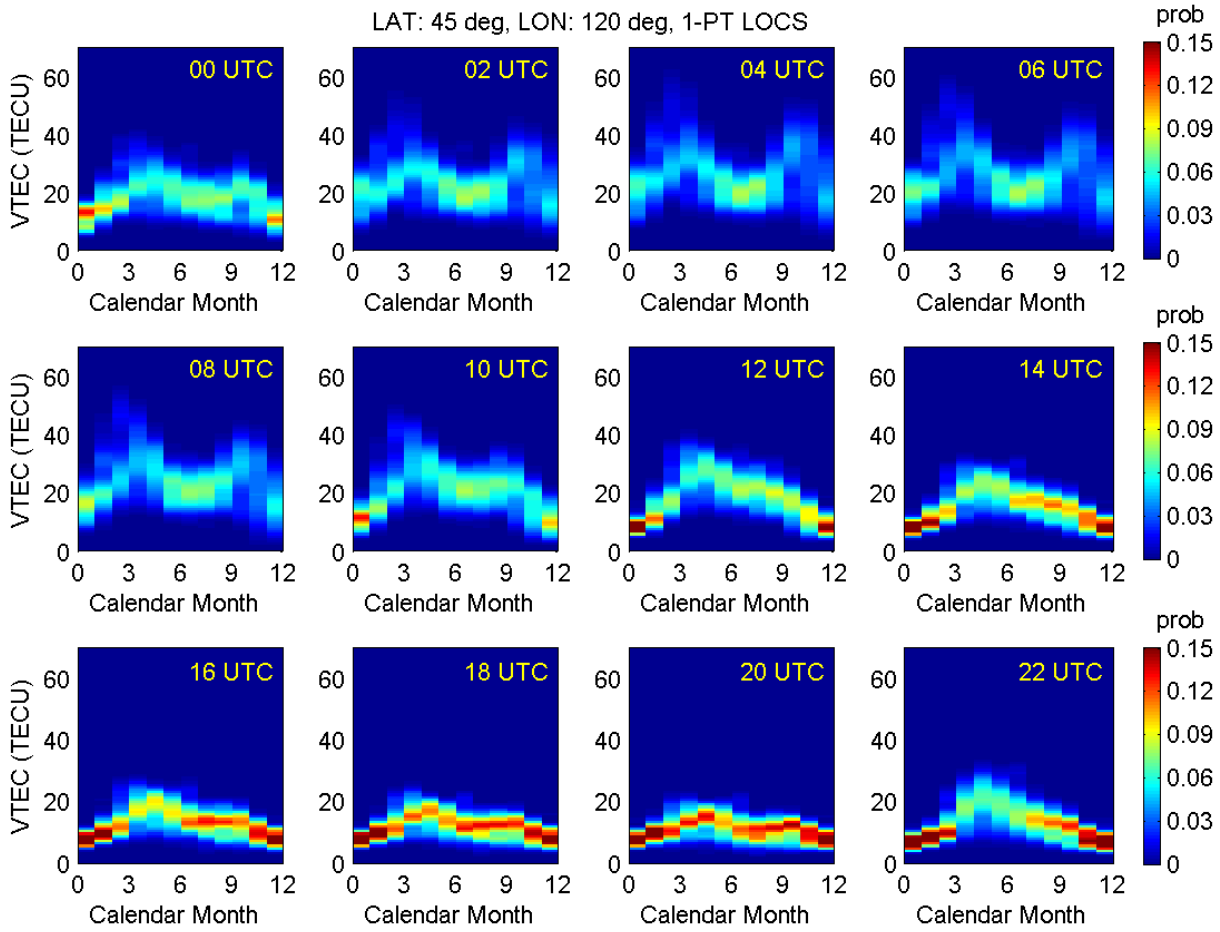

Figure S2. *Climatological probability distribution histograms of VTEC values over 45ºN 120°E as a function of calendar months for various time-of-day (in UTC) based on the IGS GIM TEC data product 2011-2016.*

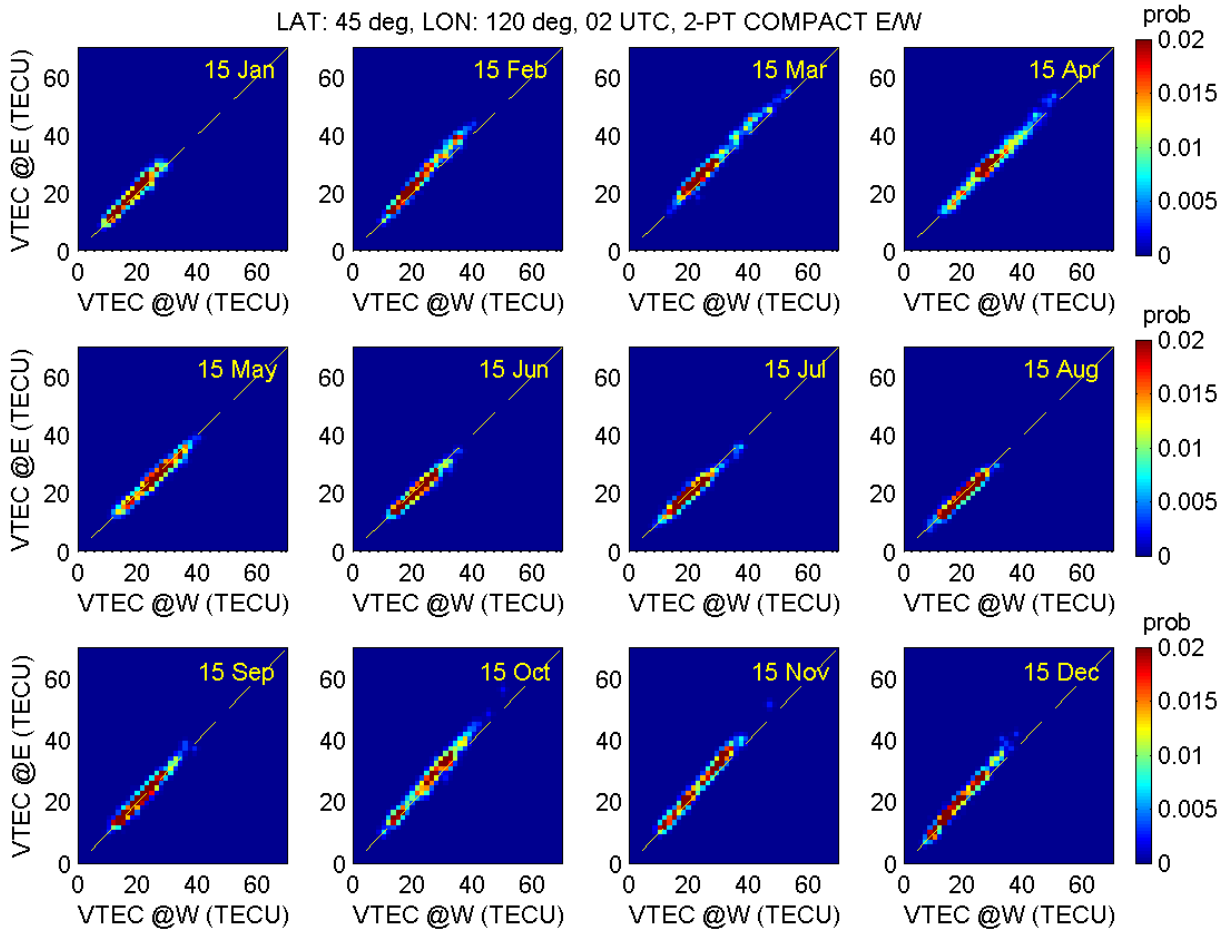

Figure S3. *Bivariate climatological probability distribution histograms of paired VTEC values east-and-west of 45ºN 120°E at 02:00 UTC for various calendar months based on the IGS GIM TEC data product 2011-2016. This is a "compact" case where two nearest neighbor points east-and-west of 45ºN 120°E are used to sample the pair of VTEC values.*

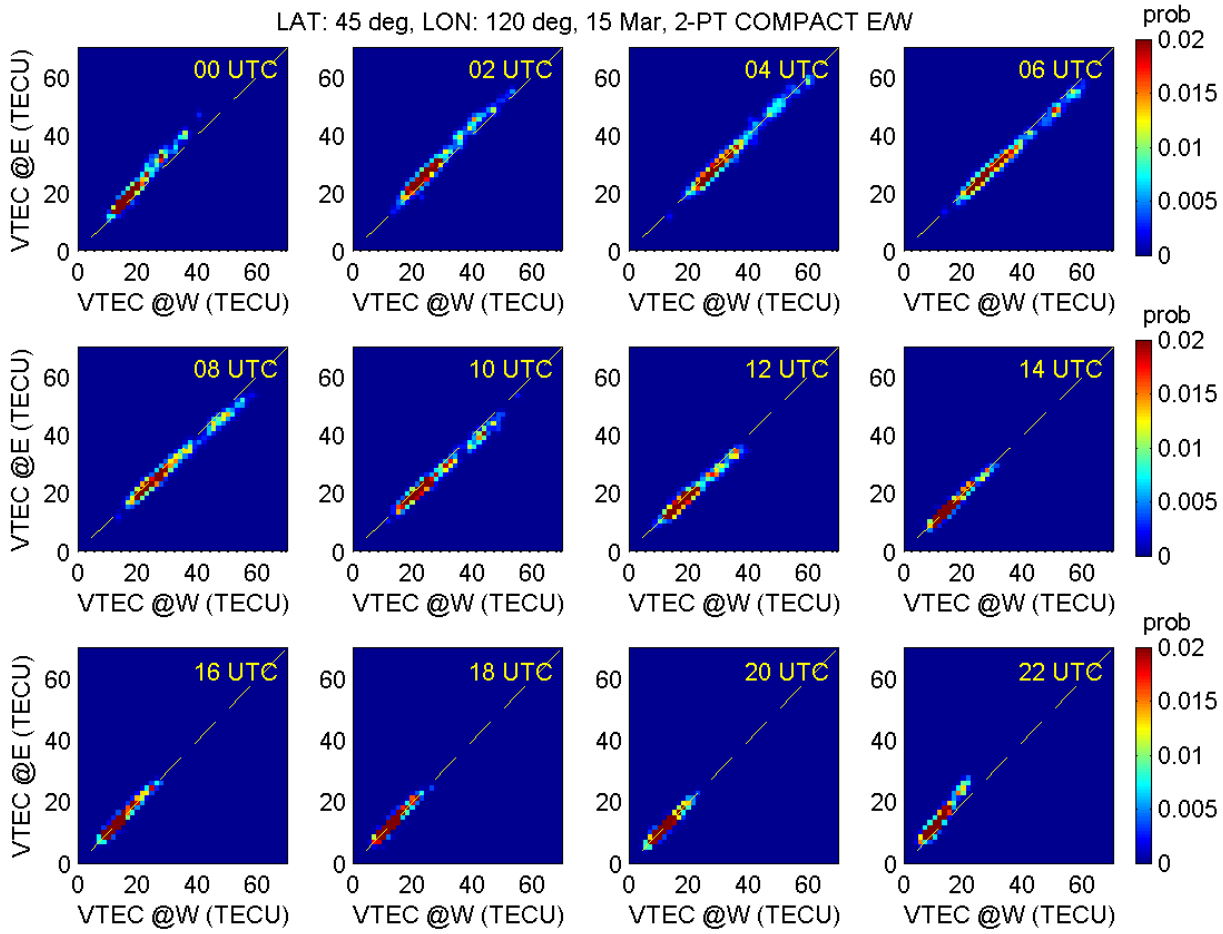

Figure S4. *Bivariate climatological probability distribution histograms of paired VTEC values east-and-west of 45ºN 120°E on 15 March for various time-of-day (in UTC) based on the IGS GIM TEC data product 2011-2016. This is a "compact" case where two nearest neighbor points east-and-west of 45ºN 120°E are used to sample the pair of VTEC values.*

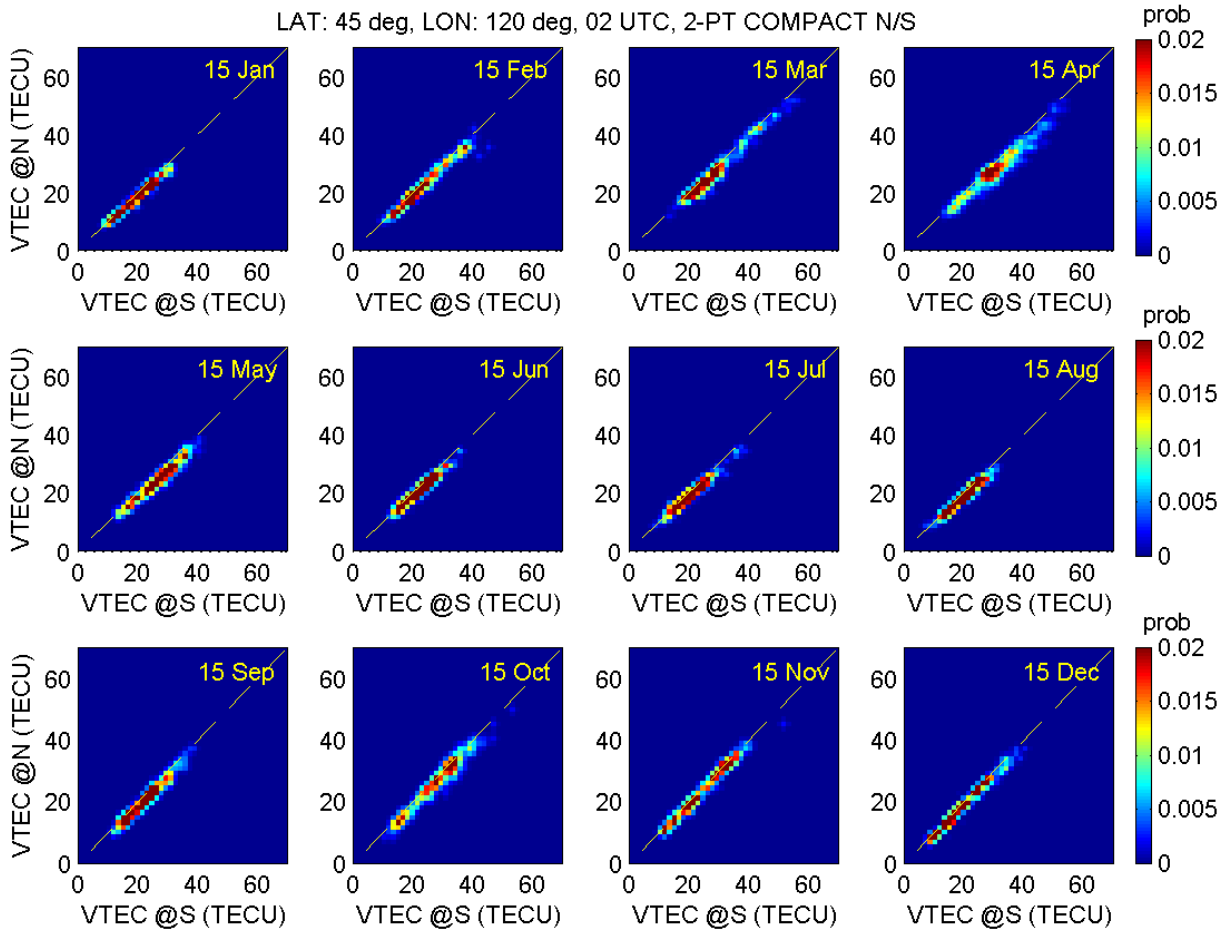

Figure S5. *Bivariate climatological probability distribution histograms of paired VTEC values north-and-south of 45ºN 120°E at 02:00 UTC for various calendar months based on the IGS GIM TEC data product 2011-2016. This is a "compact" case where two nearest neighbor points north-and-south of 45ºN 120°E are used to sample the pair of VTEC values.*

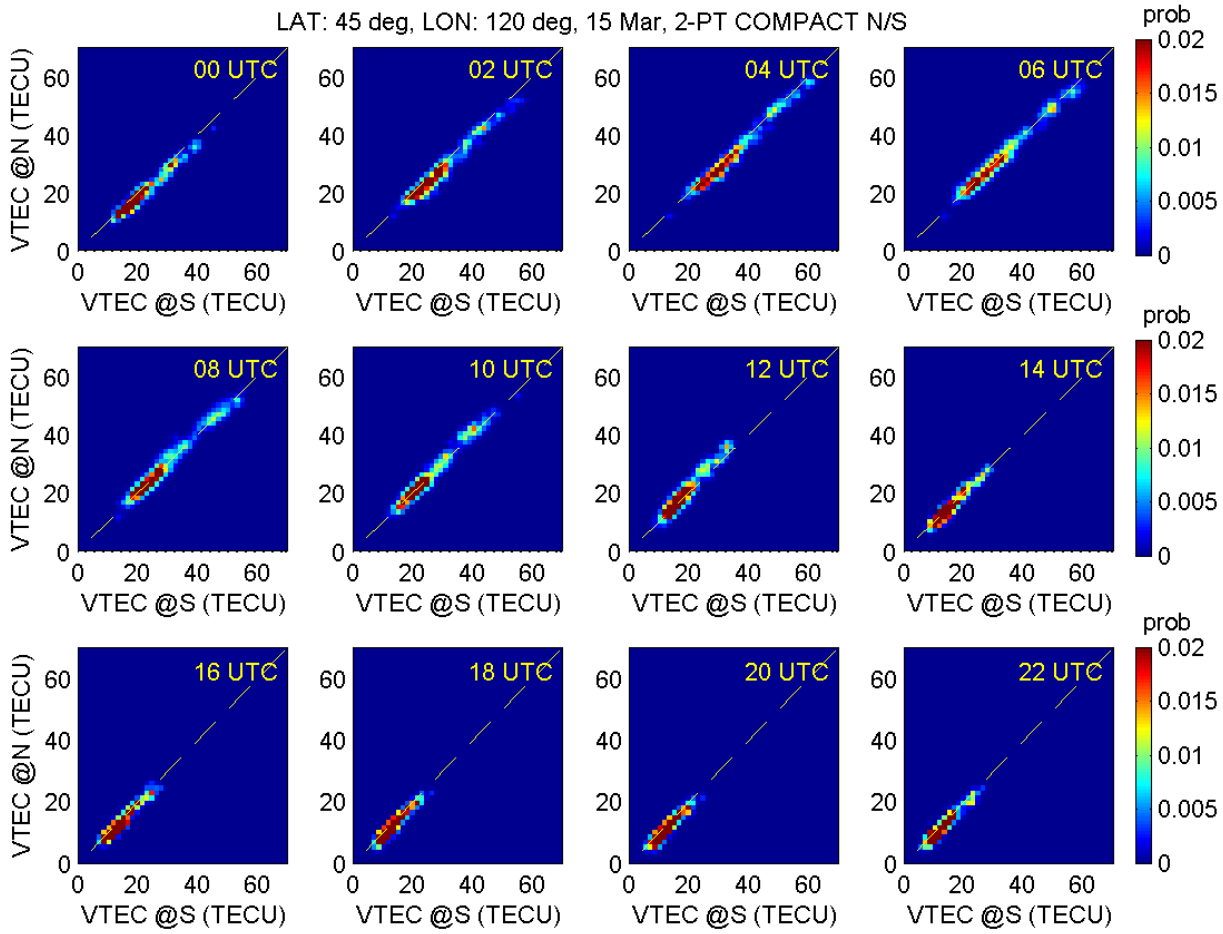

Figure S6. *Bivariate climatological probability distribution histograms of paired VTEC values north-and-south of 45ºN 120°E on 15 March for various time-of-day (in UTC) based on the IGS GIM TEC data product 2011-2016. This is a "compact" case where two nearest neighbor points north-and-south of 45ºN 120°E are used to sample the pair of VTEC values.*

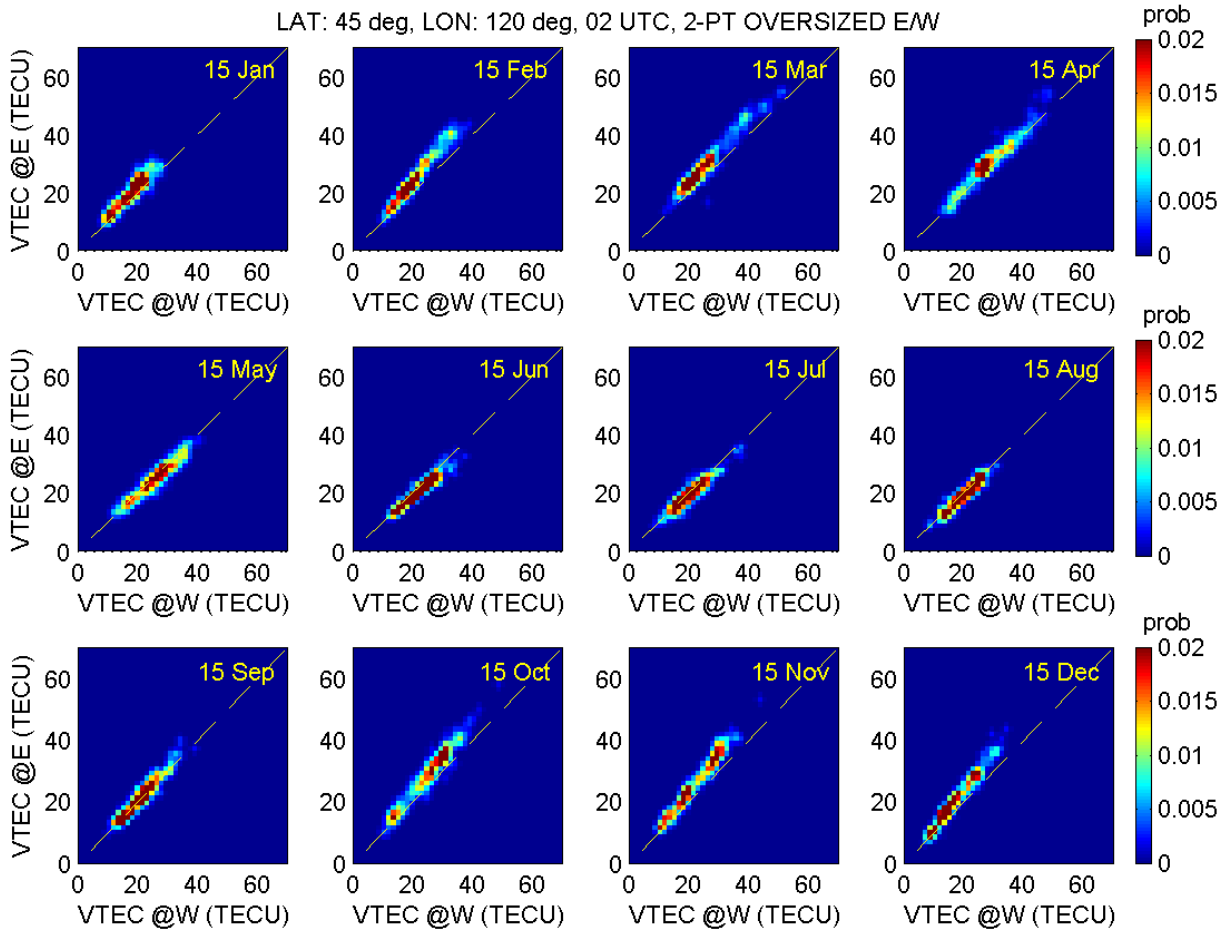

Figure S7. *Bivariate climatological probability distribution histograms of paired VTEC values east-and-west of 45ºN 120°E at 02:00 UTC for various calendar months based on the IGS GIM TEC data product 2011-2016. This is an "oversized" case where two distant neighbor points east-and-west of 45ºN 120°E are used to sample the pair of VTEC values.*

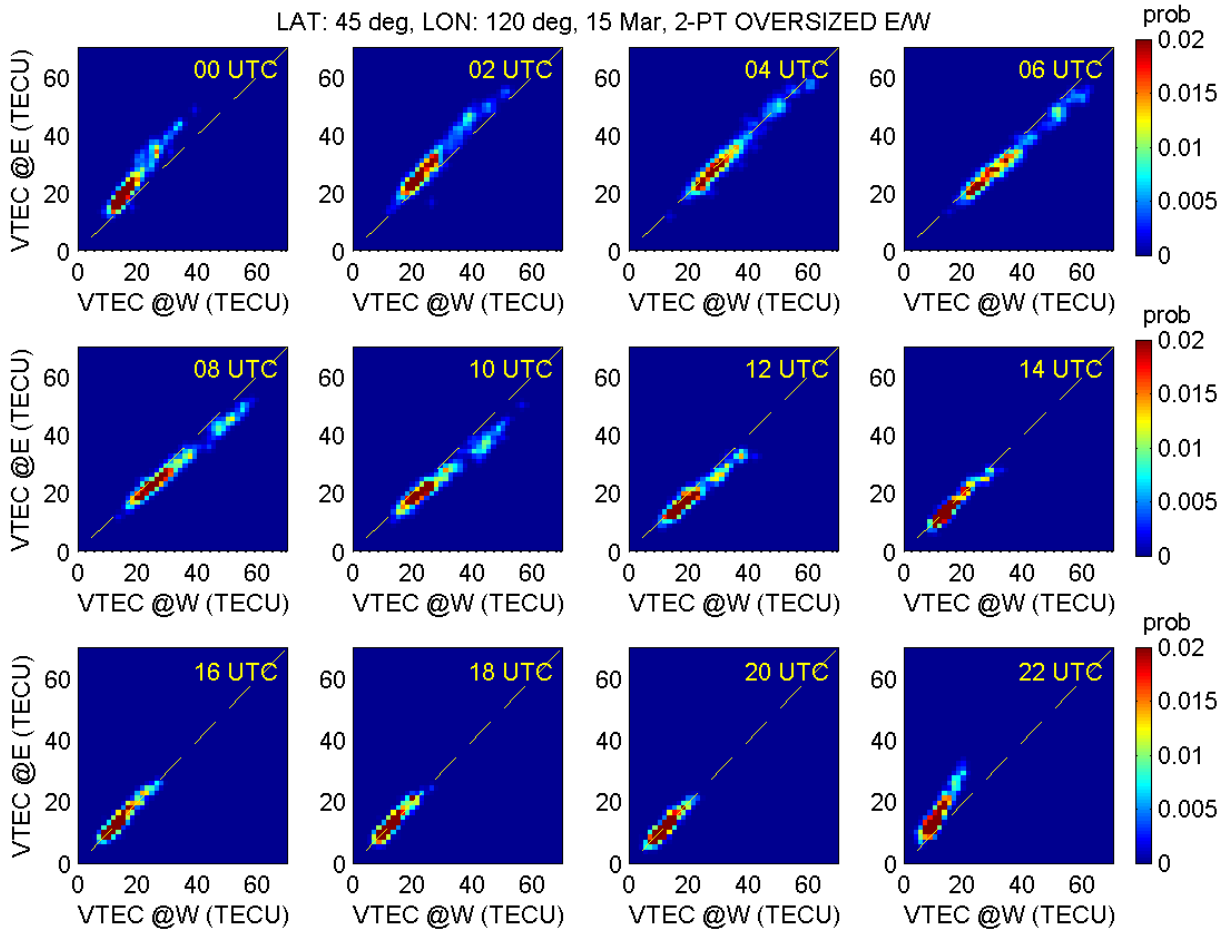

Figure S8. *Bivariate climatological probability distribution histograms of paired VTEC values east-and-west of 45ºN 120°E on 15 March for various time-of-day (in UTC) based on the IGS GIM TEC data product 2011-2016. This is an "oversized" case where two distant neighbor points east-and-west of 45ºN 120°E are used to sample the pair of VTEC values.*

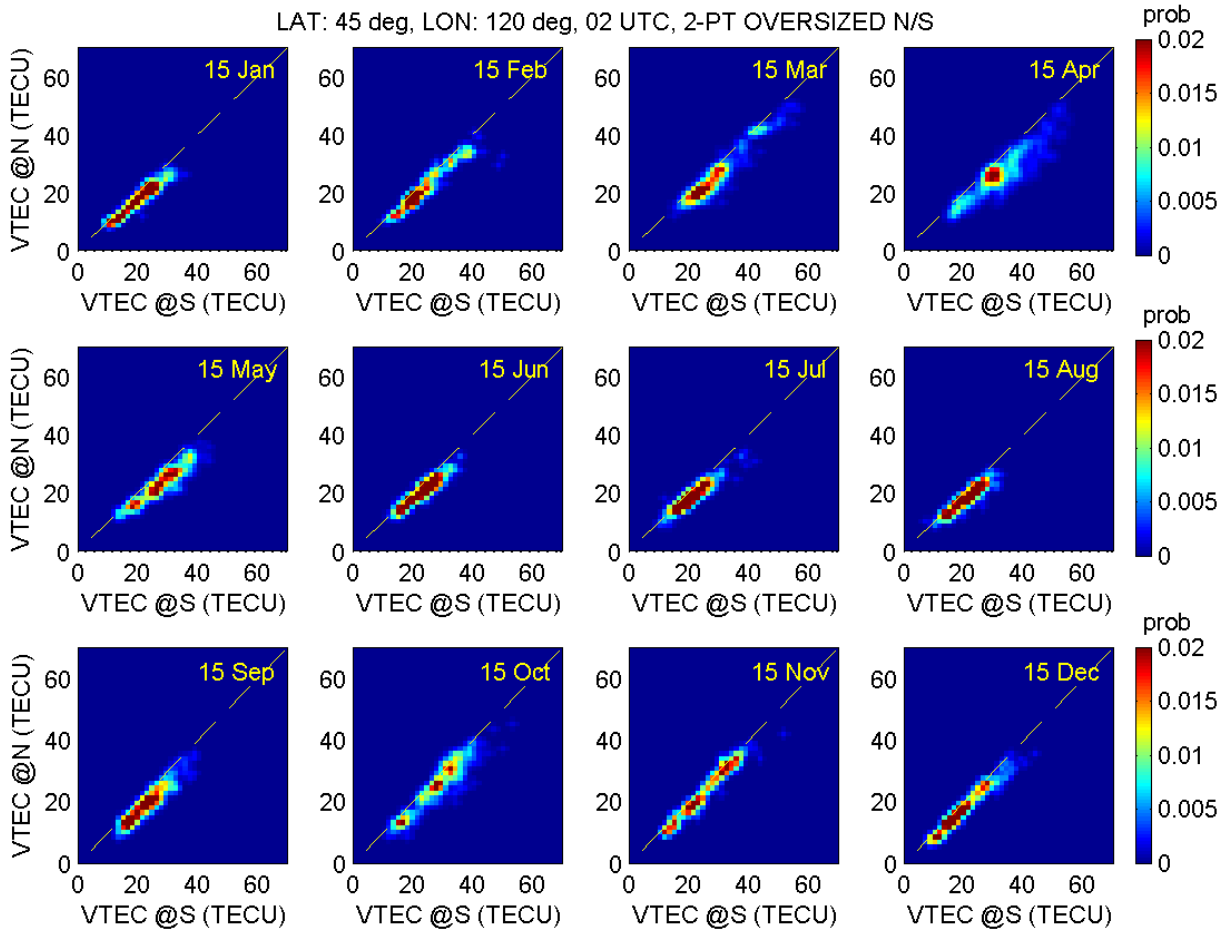

Figure S9. *Bivariate climatological probability distribution histograms of paired VTEC values north-and-south of 45ºN 120°E at 02:00 UTC for various calendar months based on the IGS GIM TEC data product 2011-2016. This is an "oversized" case where two distant neighbor points north-and-south of 45ºN 120°E are used to sample the pair of VTEC values.*

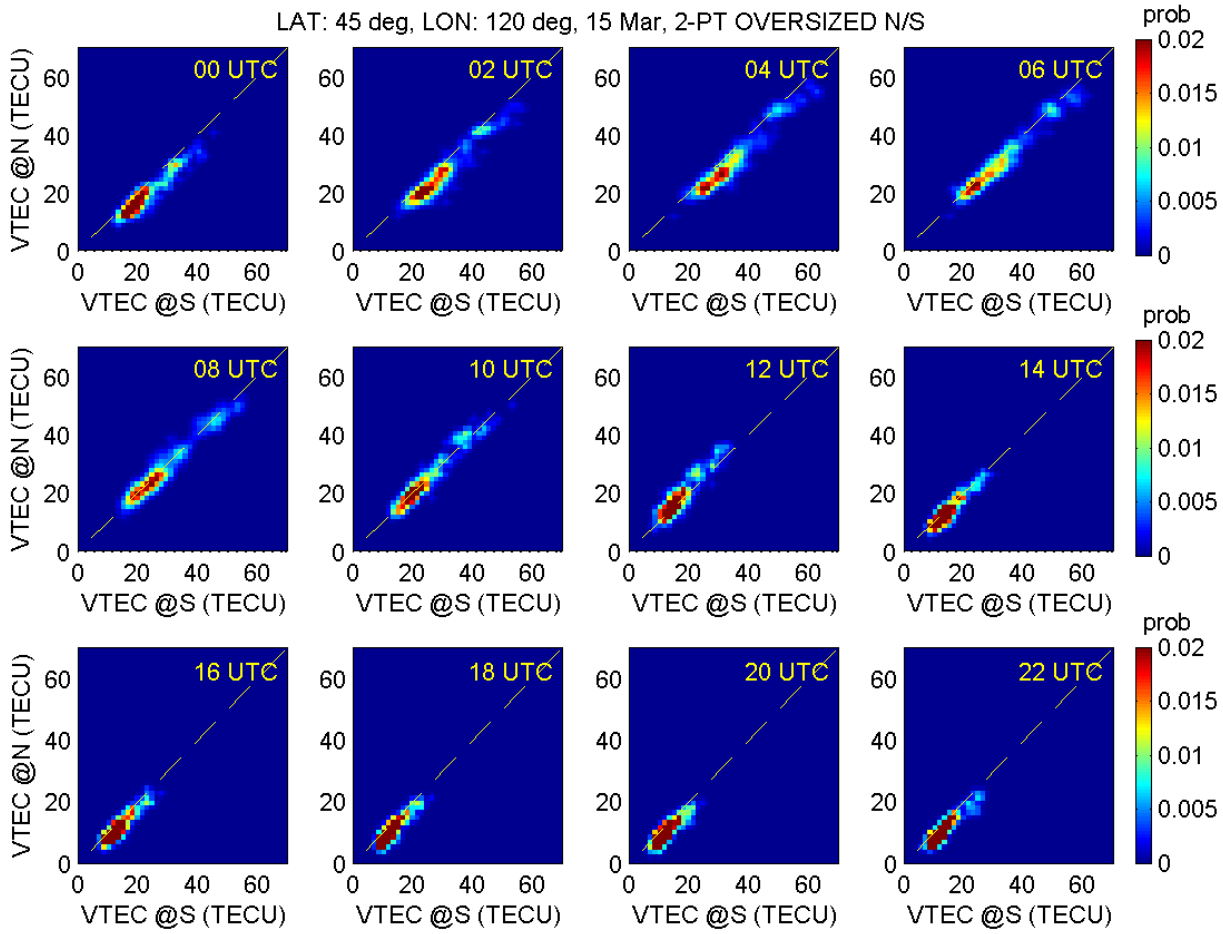

Figure S10. *Bivariate climatological probability distribution histograms of paired VTEC values north-and-south of 45ºN 120°E on 15 March for various time-of-day (in UTC) based on the IGS GIM TEC data product 2011-2016. This is an "oversized" case where two distant neighbor points north-and-south of 45ºN 120°E are used to sample the pair of VTEC values.*

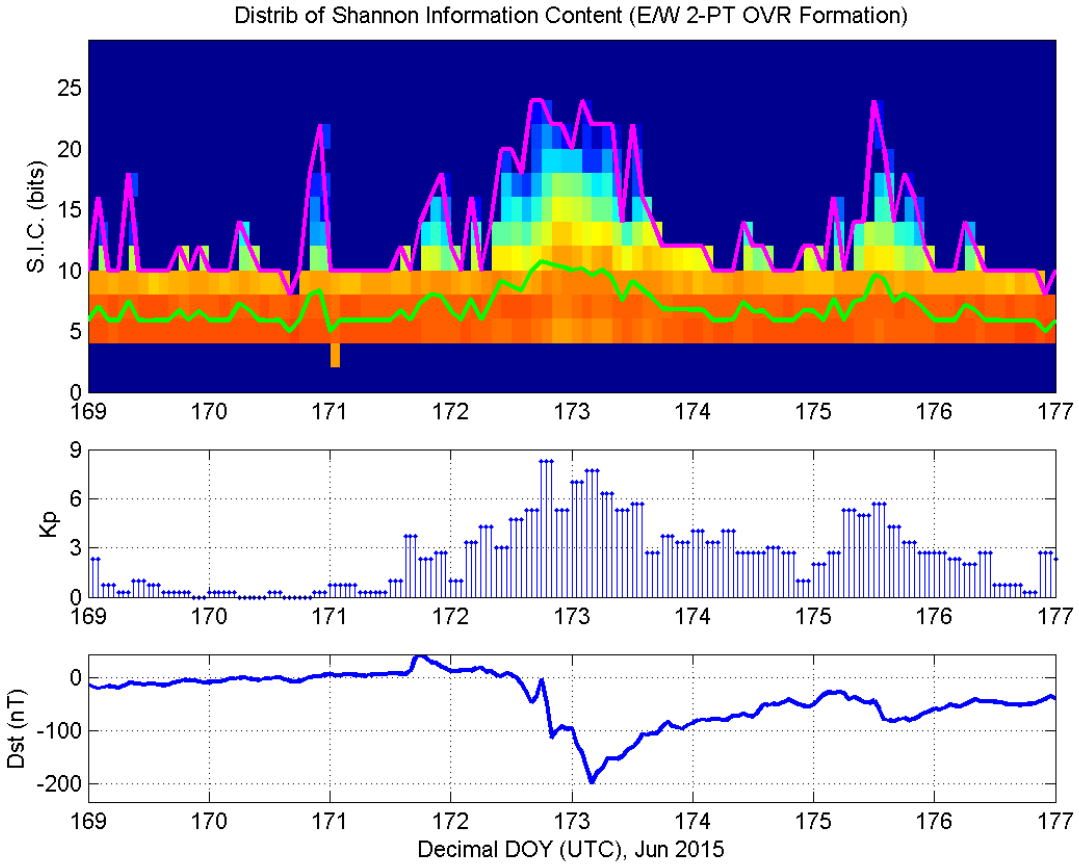

Figure S11. *Example of Shannon information content increase during a disturbed geomagnetic condition that started on 21 June 2011 (day-of-year 172). In response to the geomagnetic storm, the Shannon information content values began to exhibit a significant increase on 22 June 2011 (day-of-year 173).*

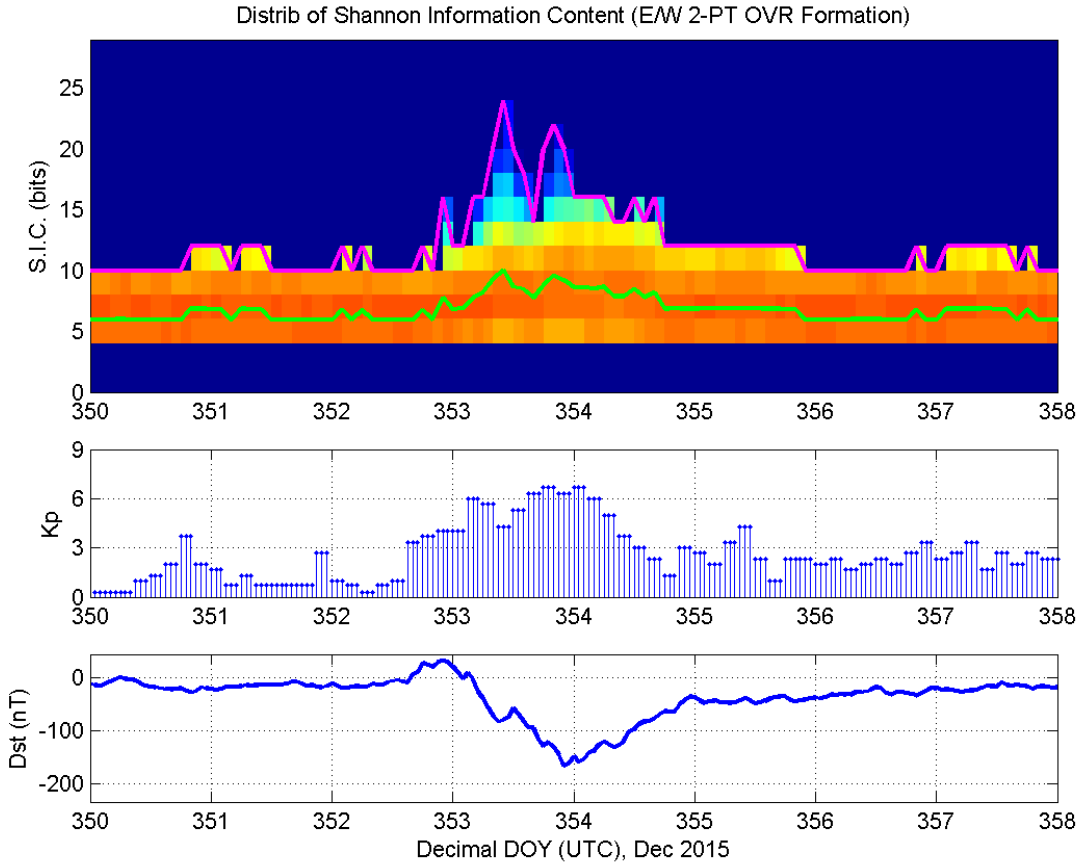

Figure S12. *Example of Shannon information content increase during a disturbed geomagnetic condition that started on 19 December 2011 (day-of-year 353). In response to the geomagnetic storm, the Shannon information content began to exhibit a significant increase on 20 December 2011 (day-of-year 354).*

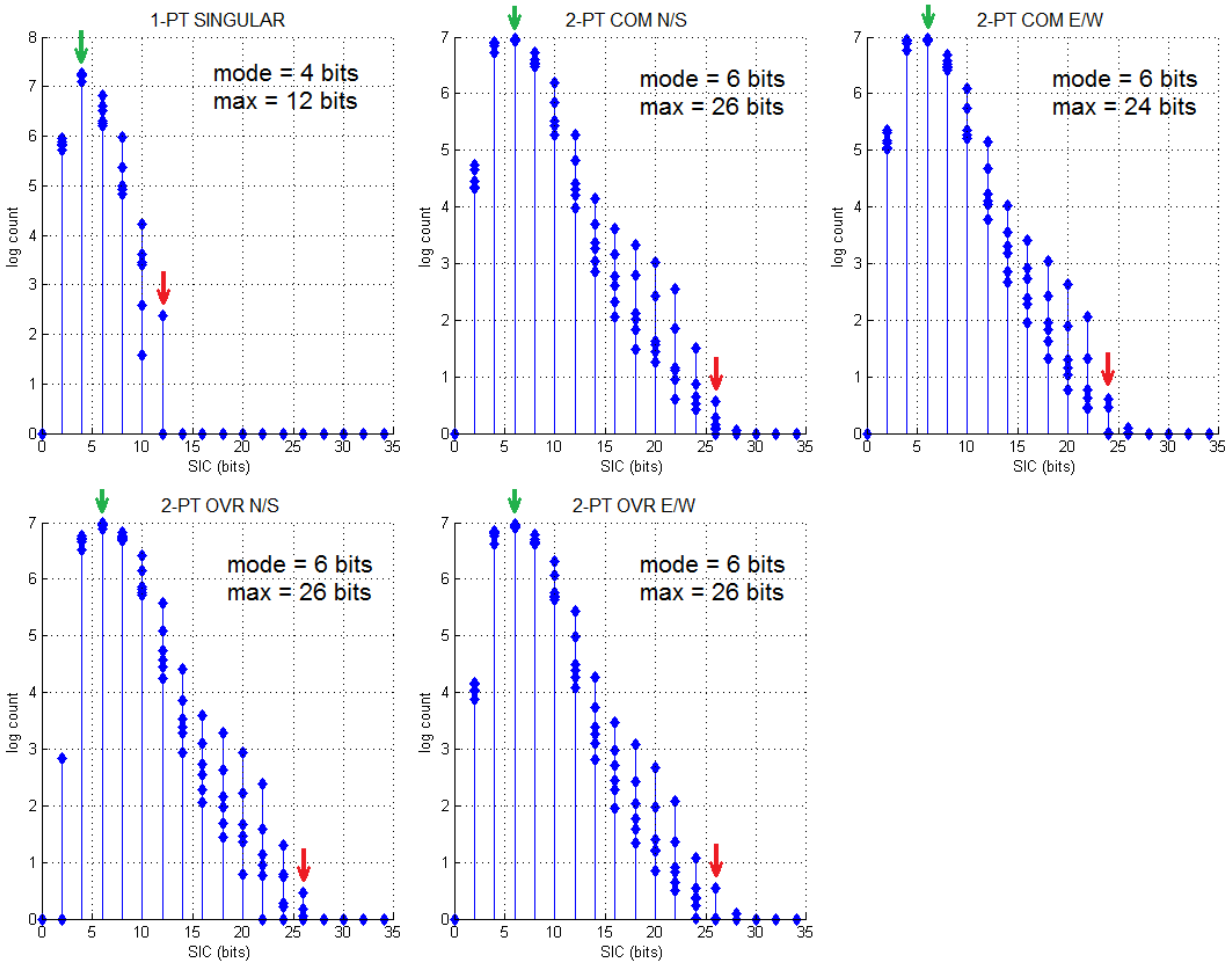

Figure S13. *Aggregated histograms of SIC values during the 2011-2016 period for different point formations. Green arrows mark the mode (bin with the highest count) of the histograms. Red arrows mark the maximum SIC value (last bin with substantial count) in the histograms.*