We present results from a comprehensive statistical analysis of ground magnetic field data to reveal the characteristics of the conjugacy or non-conjugacy of the ionospheric electrojet system. Our current understanding of the auroral electrojet system as well as modeling efforts and calculations of key parameters are almost solely based on northern hemisphere observations. The inherent assumption is that there are no significant differences between measurements made at conjugate points in the two hemispheres. In this paper we show that this assumption is often violated and show that intense and long duration non-conjugate events are common. We have characterized differences and similarities of the auroral electrojet system in the two hemispheres and determined the dependence on solar zenith angle, location (magnetic local time and magnetic latitude) and IMF conditions. To determine cause and effect we have tested four published hypothesis claiming to explain non-conjugacy. More than 100 conjugate events and non-conjugate events have been identified. We find that conjugate/non-conjugate events tend to occur in the post-midnight/pre-midnight region and that the solar induced conductivity plays a key role.