



Imperfect coupling between northern and southern ionospheres: asymmetry in TEC anomalies before earthquakes

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The northern ionosphere is coupled to the conjugate southern ionosphere through the highly conducting geomagnetic field lines. The coupling is very strong or “perfect” if the geomagnetic field lines are equipotential (the parallel electric field $E_{\parallel}=0$) and hence the perpendicular electric field (\mathbf{E}_{\perp}) at the conjugate sites of both ionospheres are equal. The coupling is “imperfect” if some of the geomagnetic field lines are non-equipotential ($E_{\parallel} \neq 0$). The field-aligned electric field E_{\parallel} can be associated with electron inertia, pressure gradient and collisions appearing in the form of double layer, kinetic Alfvén waves and finite field-aligned conductivity σ_{\parallel} . We use the Global Ionospheric Maps (GIM) data to examine the conjugate effect of total electron content (TEC) for six significant earthquakes. The anomalous $(\Delta\text{TEC})_{\text{source}}$ in the source ionosphere and $(\Delta\text{TEC})_{\text{conjugate}}$ in the conjugate ionosphere are obtained for 85 events before the six earthquakes. The ΔTEC ratio $\beta = (\Delta\text{TEC})_{\text{conjugate}} / (\Delta\text{TEC})_{\text{source}}$ is calculated for each anomaly. For a “perfect” coupling, $\beta=1$. There are 85 anomalous events before the six significant earthquakes, with 62 events occurring in the daytime (07-18 LT) and 23 events in the nighttime (19-06 LT). The average value of daytime (07-18 LT) TEC variations in the source ionosphere is $|\Delta\text{TEC}|_{\text{source}}=20.13$ TECu, while the average value in the nighttime (19-06 LT) ionosphere is $|\Delta\text{TEC}|_{\text{source}}=14.43$ TECu. The value of ΔTEC ratio β ranges from 0.05 (very weak coupling) to 0.98 (nearly perfect coupling) with an average of 0.52. There are 14 strong coupling cases with $\beta \geq 0.8$, which take place from 11 LT to 19 LT. The daytime (07-18 LT) β average value is 0.57 and the nighttime (19-06 LT) β average is 0.37. The south-north ionosphere coupling is stronger (weaker) in the daytime (nighttime).