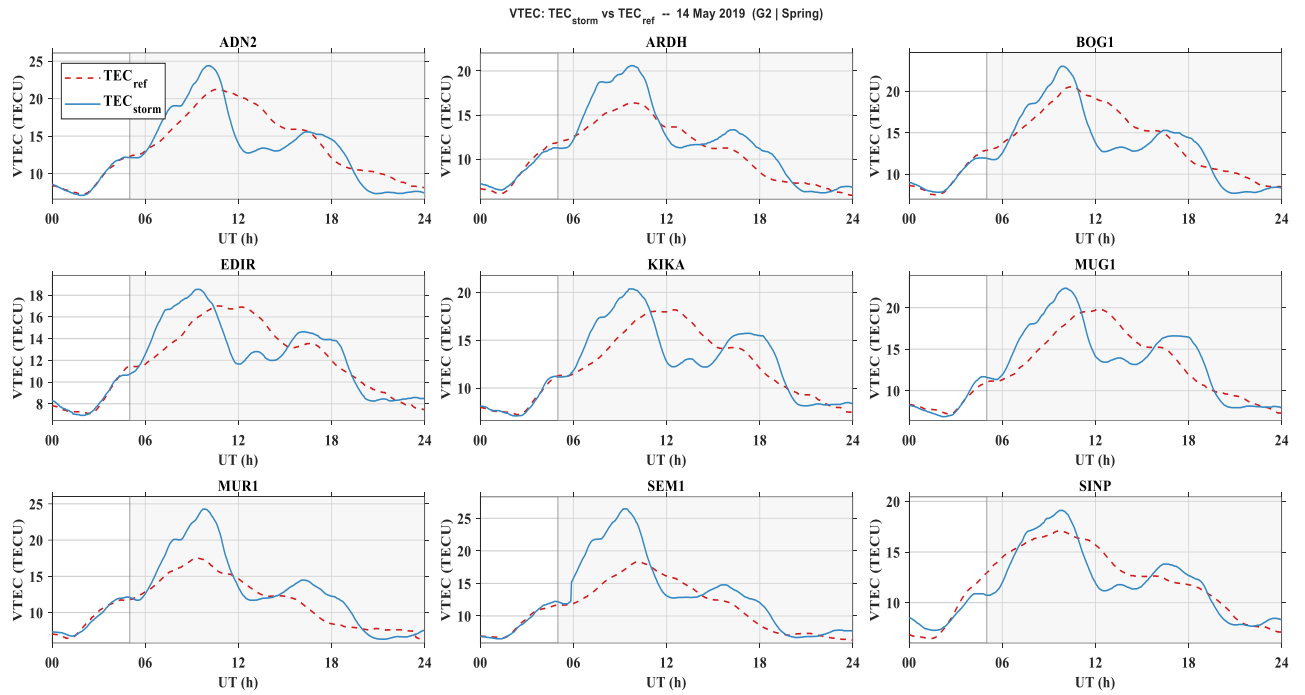
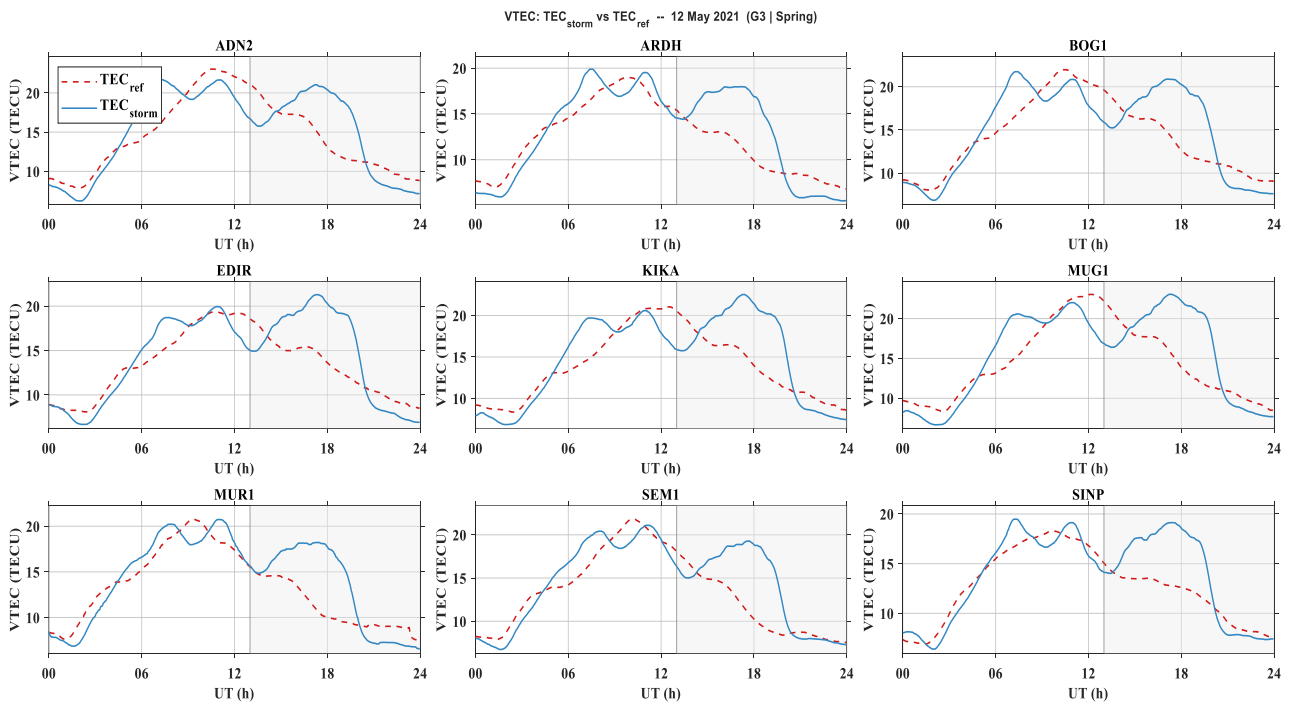


## SUPPLEMENTARY FILE TO:

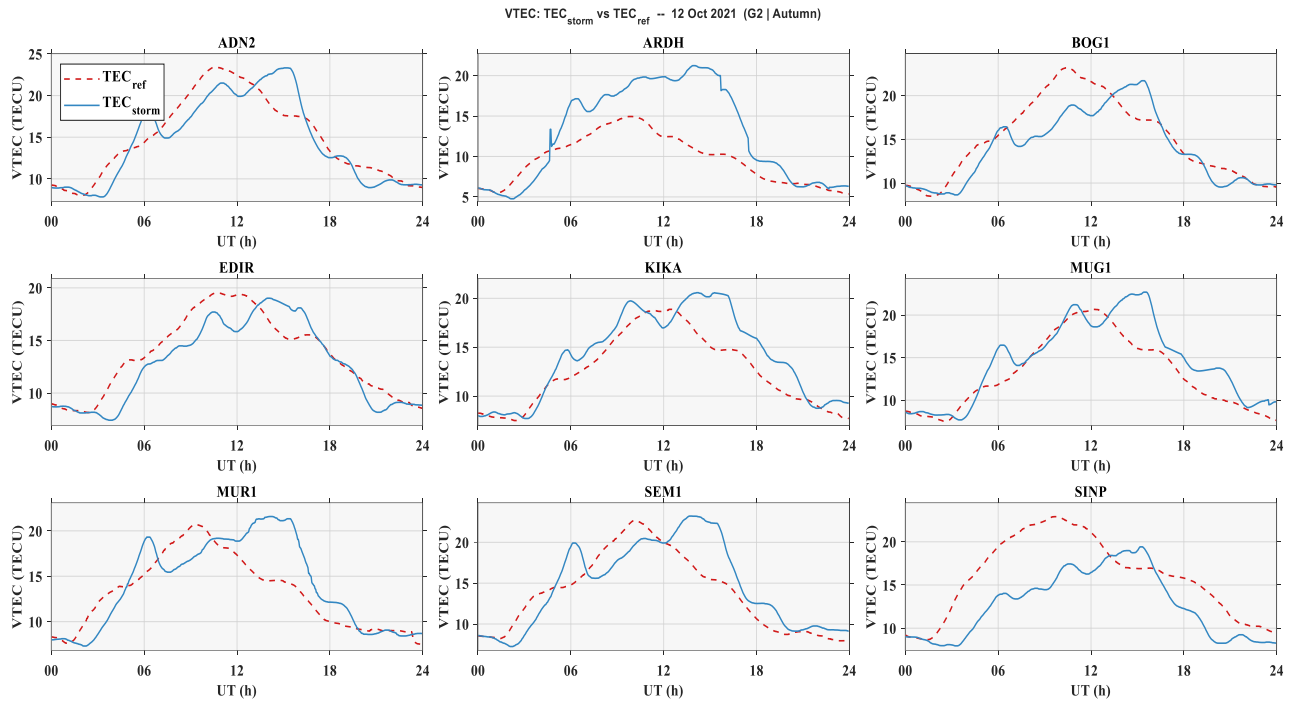
Karatay, S., Arikan, F., & Arikan, O. (2026). Characterization of positive and negative ionospheric storm phases using TNPNGN-Active TEC estimates spanning Solar Cycles 24 and 25 (2019-2023). *Journal of Advanced Applied Sciences*, 5(1), 8-23. <https://doi.org/10.61326/jaasci.v5i1.481>



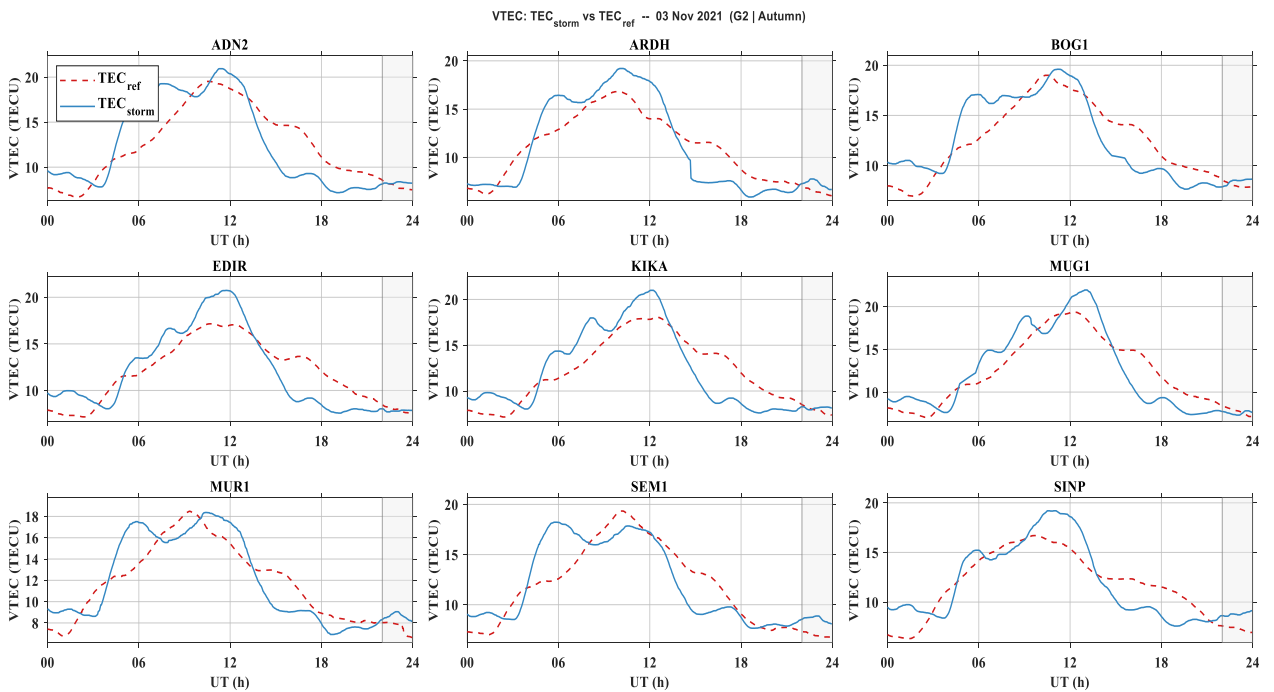
**Figure S1.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 14 May 2019 geomagnetic storm (G2,  $Kp_{max} = 6.3$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



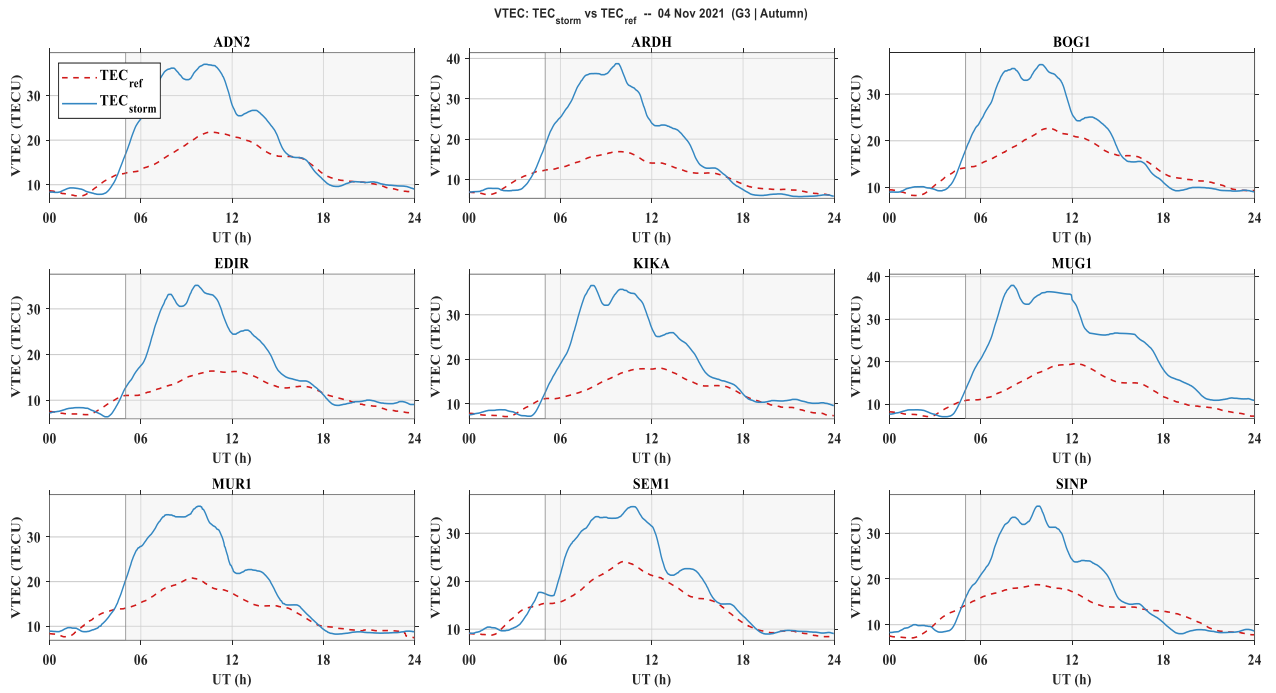
**Figure S2.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 12 May 2021 geomagnetic storm (G3,  $Kp_{max} = 6.6$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



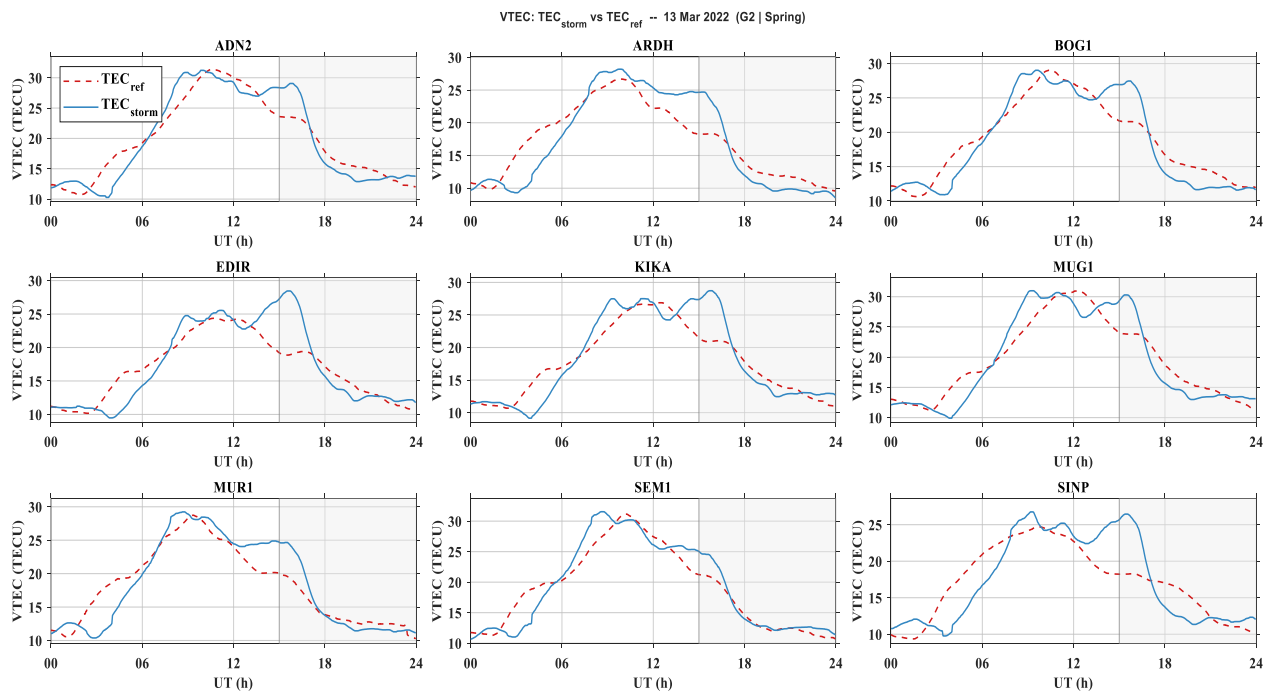
**Figure S3.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 12 October 2021 geomagnetic storm (G2,  $Kp_{max} = 6.3$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



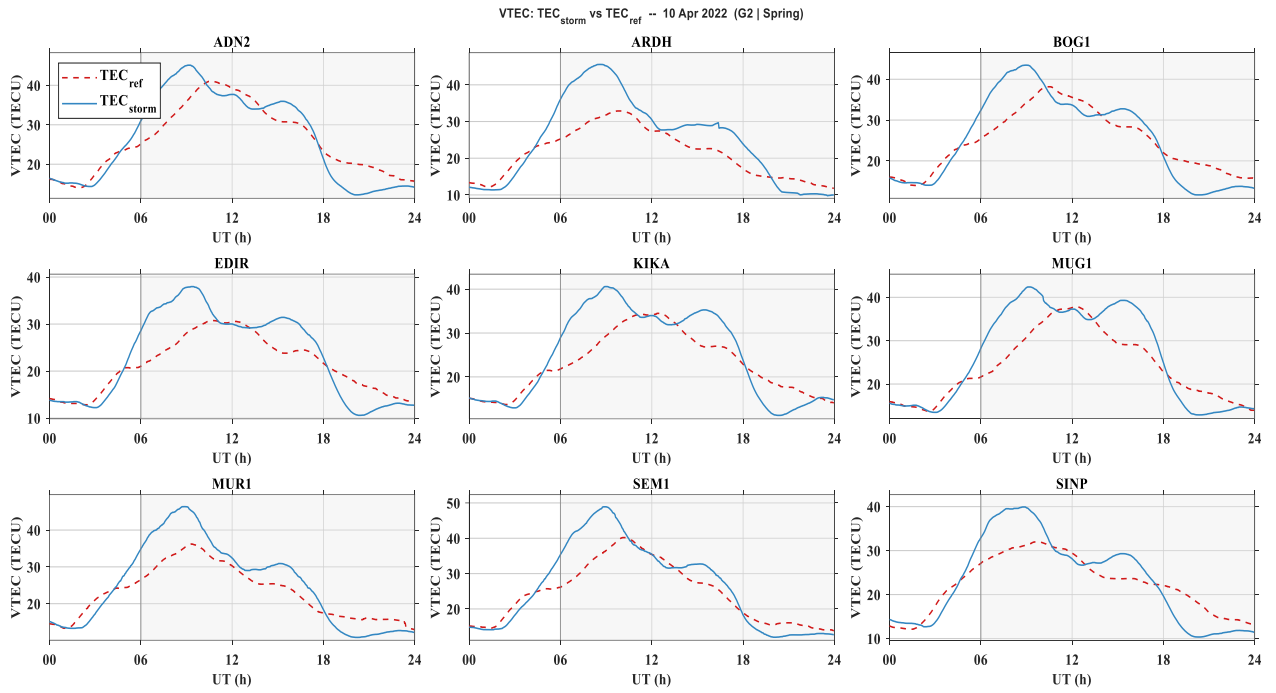
**Figure S4.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 03 November 2021 geomagnetic storm (G2,  $Kp_{max} = 6.3$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



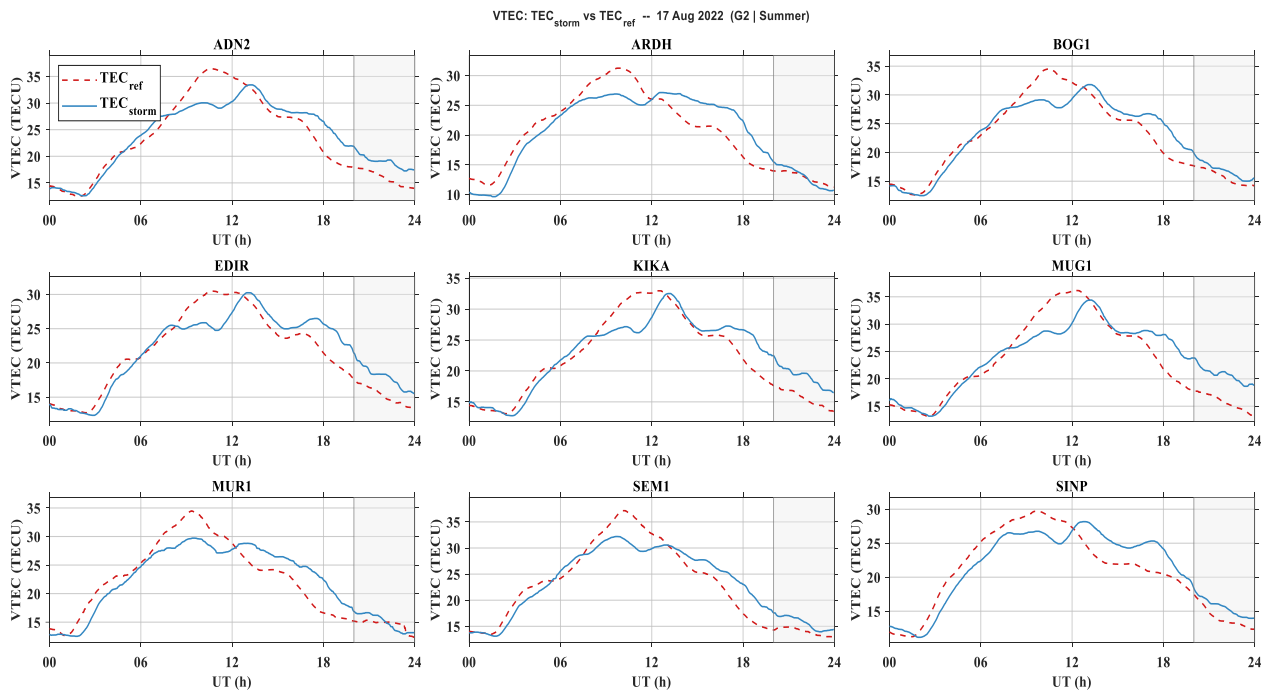
**Figure S5.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 04 November 2021 geomagnetic storm (G3,  $Kp_{max} = 7.6$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



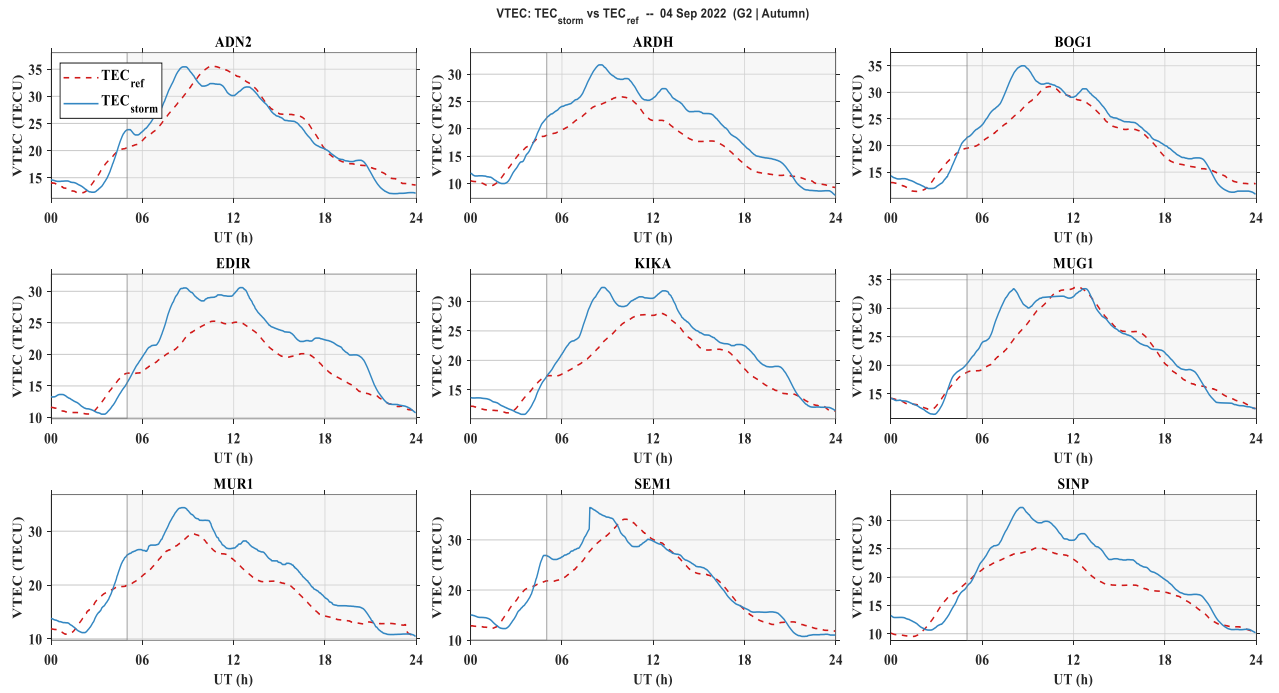
**Figure S6.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 13 March 2022 geomagnetic storm (G2,  $Kp_{max} = 6.3$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



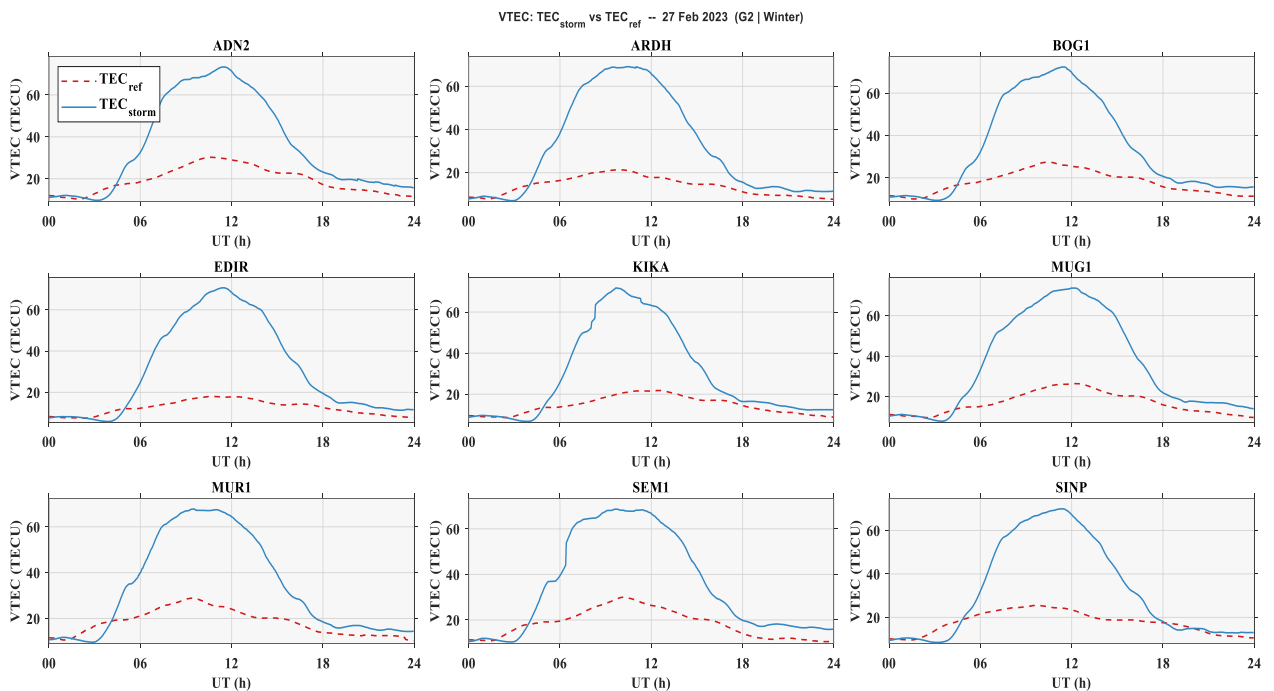
**Figure S7.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 10 April 2022 geomagnetic storm (G2,  $Kp_{max} = 6.6$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



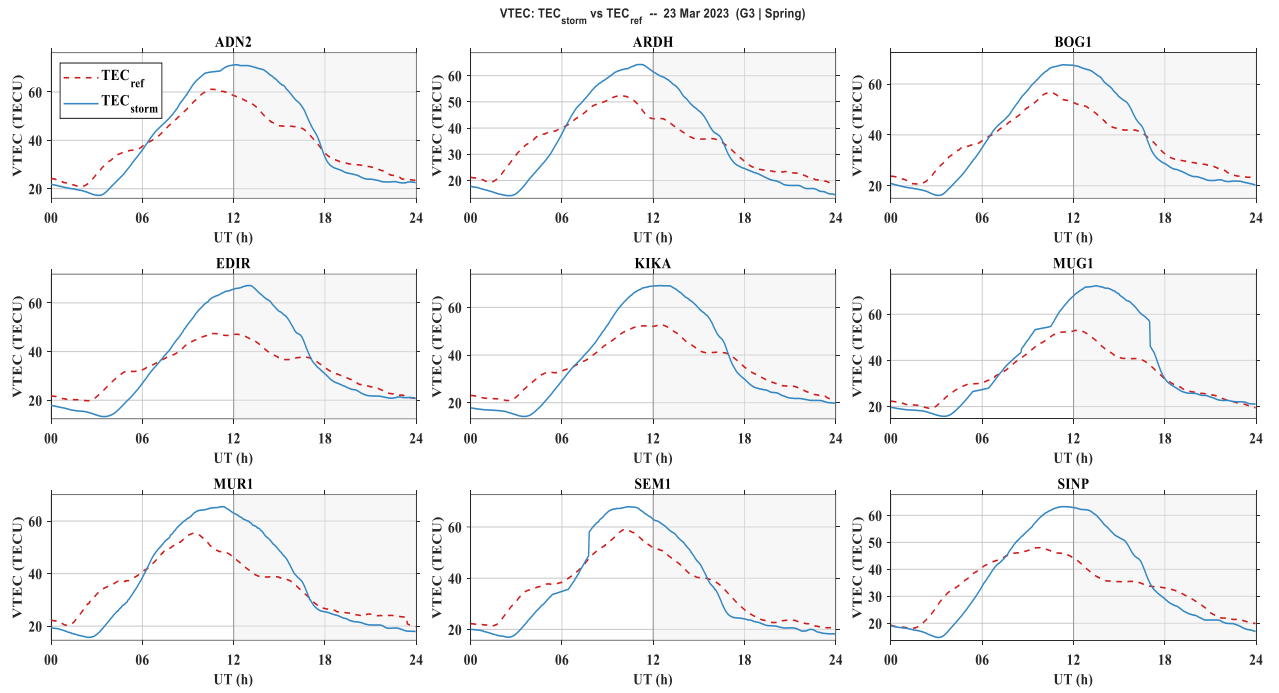
**Figure S8.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 17 August 2022 geomagnetic storm (G2,  $Kp_{max} = 6.6$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



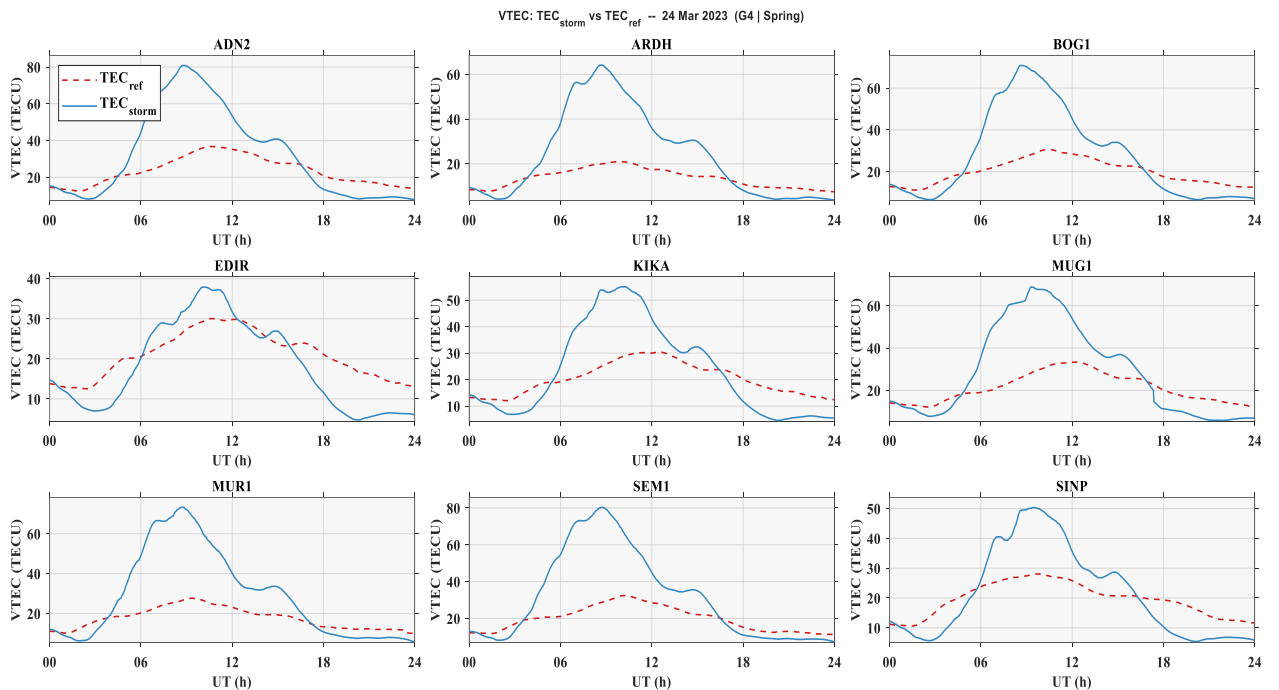
**Figure S9.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 04 September 2022 geomagnetic storm (G2,  $Kp_{max} = 6.3$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



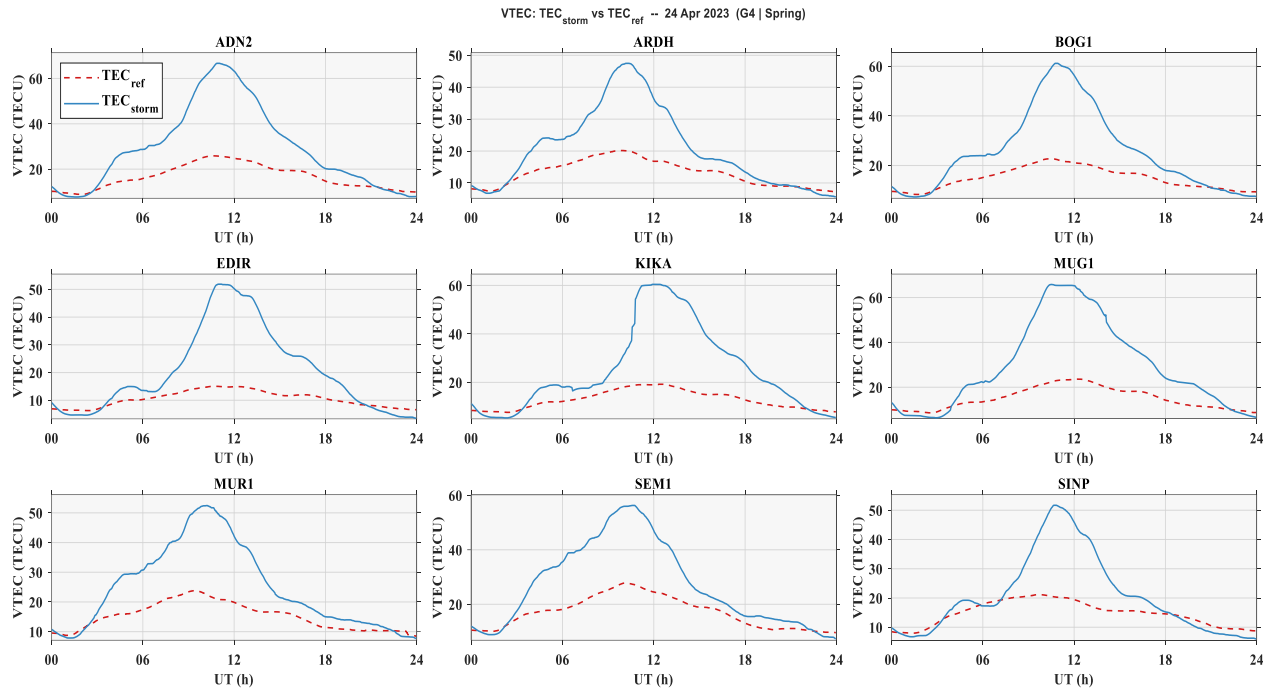
**Figure S10.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 27 February 2023 geomagnetic storm (G2,  $Kp_{max} = 6.6$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



**Figure S11.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 23 March 2023 geomagnetic storm (G3,  $Kp_{max} = 7.0$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



**Figure S12.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 24 March 2023 geomagnetic storm (G4,  $Kp_{max} = 8.0$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.



**Figure S13.** Comparison of storm-time IONOLAB-TEC ( $TEC_{storm}$ , solid blue) and scaled quiet-day reference IONOLAB-TEC ( $TEC_{ref}$ , dashed red) for the nine GNSS stations during the 24 April 2023 geomagnetic storm (G4,  $Kp_{max} = 8.0$ ). The grey shading indicates the post-onset period. Vertical grey line marks the storm onset.