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Solar Flare Effects Observed over Mexico during 30–31 March 2022

Maria A. Sergeeva [1,2,*], Olga A. Maltseva [3], Artem M. Vesnin [4], Donat V. Blagoveshchensky [5], Victor J. Gatica-Acevedo [1], J. Americo Gonzalez-Esparza [1], Aleksandr G. Chernov [6], Isaac D. Orrala-Legorreta [1,7], Angela Melgarejo-Morales [1], Luis Xavier Gonzalez [1,2], Mario Rodriguez-Martinez [8], Ernesto Aguilar-Rodriguez [1], Ernesto Andrade-Mascote [1] and Pablo Villanueva [1]

1 SCiESMEX, LANCE, Instituto de Geofisica, Unidad Michoacan, Universidad Nacional Autonoma de Mexico, Morelia C.P. 58089, Michoacan, Mexico
2 CONACYT, Instituto de Geofisica, Unidad Michoacan, Universidad Nacional Autonoma de Mexico, Morelia C.P. 58089, Michoacan, Mexico
3 Institute for Physics, Southern Federal University, 344090 Rostov-on-Don, Russia
4 Institute of Solar-Terrestrial Physics, Siberian Branch of Russian Academy of Sciences, 664033 Irkutsk, Russia
5 Institute of Radio Engineering and Information and Communications Technologies, Saint-Petersburg State University of Aerospace Instrumentation, 190000 Saint-Petersburg, Russia
6 Sitcomm LLC, 424031 Yoshkar-Ola, Russia
7 Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Coyoacán C.P. 04510, Mexico City, Mexico
8 Escuela Nacional de Estudios Superiores, Unidad Morelia, Universidad Nacional Autonoma de Mexico, Morelia C.P. 58190, Michoacan, Mexico
* Correspondence: maria.a.sergeeva@gmail.com

Abstract: Manifestations of two solar flares of March 2022 were studied over Mexico. The flare effects in the lower ionosphere had a ~3 min delay from the X1.3-flare onset and ~5 min from the M9.6-flare onset. The maximal impact on the HF signal amplitude was ~(14–15) min after the onset of both flares. The X1.3-flare provoked the shortwave fadeout during ~6 min. The effects in the lower ionosphere lasted longer than the flares and the effects at the F2 region and higher altitudes only during the flares. The interpretation of results showed the following. (1) Based on the absorption level estimated with minimum frequency and signal amplitude on ionograms, the major role of X-ray radiation in the electron concentration increase in the lower ionosphere was confirmed. At the same time, the EUV radiation impact on the lower ionosphere cannot be totally discarded. The lower ionosphere recovery began before and lasted after the X1.3-flare end, being more rapid at Eglin than in Mexico. During M9.6-flare, the responses at the two observation points were rather synchronized due to the more similar illumination conditions at the two meridians. (2) According to the dI variations characterizing the F2 region and higher, the M9.6-flare provoked medium-scale and the X1.3-flare provoked both medium- and small-scale ionospheric irregularities. The response duration corresponded to the dI series filtered with (10–20) min windows. The dI curve during the flares was characterized by the И-form and depended more on the active region position and the flare class than on the solar zenith angle. The available data do not allow us to unambiguously identify the reason for the negative dI: the applied filtering procedure or the physical effect. (3) During both flares, the major EUV impact on the lower ionosphere was by the flux at 133.5 nm and on the F2 region and higher altitudes at 25.6 nm. In addition, during the M9.6-flare, EUV 28.4, 30.4 and 121.6 nm spectral bands also played an important role in the F2 response. During the X1.3-flare, the EUV 25.6 nm flux and X-ray flux impacts on the F2 region were of the same level. The weakest impact was caused by the emission in the EUV 28.4 nm spectral band on the absorption in the lower ionosphere during both flares and on the electron density in the F2 region and higher during the X1.3-flare.

Keywords: solar flare; ionosphere; ionospheric sounding; ionosonde; GNSS; slant TEC; Mexico

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