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Ionospheric Disturbances in Mexican Territory Produced by Objects Entering the Athmosphere from Space

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Abstract

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Keywords: Space Sciences; Atmosphere

1. Introduction

2. Metodology

2.1. Meteors Database

We selected a sample of meteors which were observed in mexican territory from the Geostationary Lightning Mapper (Goodman et al., 2013). Orignally this project was designed to detect ligthning activity in earth's athmosphere, but has been proven that also can detect bolides entering the athmosphere. The detection comes from two satellites called GOES-16 and GOES-17 orbiting the earth in geostationary orbits. We used the interactive database available at `https://neo-bolide.ndc.nasa.gov/#/` to get the events positions presented in this section, as well we obtained data about the bolid trajectory detected and energy released. The sample was chosen following the next criteria:

- The objects were detected inside mexican territory and its surroundings.
- The objects were detected by both satellites GOES 16 and GOES 17 (stereo)
- The detection has been assigned a high confidence ratio.

2.2. GPS data

For the selected sample, we obtained RINEX data from the TlalocNet (Cabral-Cano et al., 2018) and UNAVCO network databases to study potential alterations in the ionospehre due to the presence of the passing meteor at the day the meteor was reported. For each event, we downloaded data from stations that surrounds the place where the event was detected (usually 3 to 5 stations.)The list of the sample meteors is shown in table 1. The events are in chronological order. The reported duration, latitude and longitude correspond to the mean between measurements from satellites GOES-16 and GOES 17; in the same way, the uncertainties correspond to the standard deviation. Also their respective positions are available in figure 1, where each label correspond to the ID (first column) of table 1.

Using the data provided by TlalocNet and UNAVCO, we procceeded to obtain TEC parameters with the GPS_GOPI software, available at `https://seemala.blogspot.com/`. This software takes as input the RINEX data (the navigation file is no strictly neccesary), and the outuput consists in in the vTEC and

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Table 1. List of meteors passing through Mexico. The events are listed in chronological order. The listed duration, latitude and longitude correspond to the mean of the measurements of both GOES satellites. The uncertainties correspond to the respecting mean deviation.

ID	Date of event	Start Time (UT)	Duration (seconds)	Latitude (deg)	Longitude (deg)
01	2019-05-23	16:36:18	0.197 ± 0.0000	24.30 ± 0.000	-101.60 ± 0.849
02	2019-07-18	14:30:30	0.058 ± 0.0000	27.20 ± 0.000	-103.15 ± 0.778
03	2019-08-10	11:18:48	0.199 ± 0.0757	21.50 ± 0.000	-102.50 ± 0.849
04	2019-10-03	07:55:33	0.106 ± 0.0297	25.65 ± 0.071	-96.25 ± 0.778
05	2019-10-09	06:08:11	0.103 ± 0.0078	23.60 ± 0.000	-111.95 ± 0.212
06[1]	2019-10-12	11:12:27	0.006 ± 0.0000	28.8 ± 0.000	-111.3 ± 0.000
07	2019-11-16	09:36:04	0.396 ± 0.0134	20.30 ± 0.000	-100.55 ± 0.919
08	2019-11-17	15:36:01	0.116 ± 0.0035	31.70 ± 0.000	-117.70 ± 1.131
09	2019-11-19	07:57:40	0.097 ± 0.1138	20.00 ± 0.000	-88.40 ± 1.131
10	2019-11-26	13:23:20	0.078 ± 0.0290	23.90 ± 0.000	-108.70 ± 0.849
11	2019-12-04	09:42:54	0.173 ± 0.0028	31.50 ± 0.000	-113.65 ± 0.919
12	2019-12-15	14:50:49	0.127 ± 0.0134	27.70 ± 0.000	-114.10 ± 0.849
13	2019-12-29	16:16:35	0.062 ± 0.0134	29.60 ± 0.000	-116.35 ± 0.919
14	2020-01-03	14:10:17	0.113 ± 0.0085	30.20 ± 0.000	-117.65 ± 0.919
15	2020-01-06	16:39:27	0.118 ± 0.0042	31.40 ± 0.000	-108.20 ± 0.990
16	2020-01-15	15:00:33	0.213 ± 0.1351	19.45 ± 0.071	-95.55 ± 0.919
17	2020-02-12	09:25:40	0.210 ± 0.0226	18.90 ± 0.000	-93.50 ± 0.849
18	2020-03-03	12:33:27	0.062 ± 0.0007	18.25 ± 0.071	-106.35 ± 0.636
19	2020-03-31	19:31:52	0.105 ± 0.0573	28.45 ± 0.071	-112.05 ± 0.636
20	2020-04-08	16:25:28	0.120 ± 0.0926	26.10 ± 0.000	-93.90 ± 0.849
21	2020-04-18	17:43:25	0.139 ± 0.0106	29.00 ± 0.000	-106.55 ± 0.919
22	2020-04-20	16:05:22	0.318 ± 0.1655	28.15 ± 0.071	-97.85 ± 1.061
23	2020-04-25	11:03:09	0.323 ± 0.0813	32.15 ± 0.071	-111.60 ± 1.131
24	2020-04-28	19:31:52	0.105 ± 0.0573	28.45 ± 0.071	-112.05 ± 0.636
25	2020-05-08	10:06:16	0.490 ± 0.0750	21.60 ± 0.000	-92.40 ± 0.849
26	2020-07-15	19:58:28	0.693 ± 0.0495	24.00 ± 0.000	-108.35 ± 0.495
27	2020-08-07	13:29:57	0.163 ± 0.0057	28.80 ± 0.000	-106.05 ± 0.919
28	2020-09-13	16:41:59	0.184 ± 0.0078	28.45 ± 0.071	-113.75 ± 0.919
29	2020-09-30	12:28:11	0.100 ± 0.0078	24.90 ± 0.000	-110.90 ± 0.849
30	2020-11-16	12:28:11	0.100 ± 0.0078	24.90 ± 0.000	-110.90 ± 0.849
31	2020-11-17	12:53:41	0.404 ± 0.0262	23.00 ± 0.000	-102.45 ± 0.919
32	2020-12-19	10:18:14	0.407 ± 0.0110	21.95 ± 0.071	-101.60 ± 0.990
33	2020-12-23	09:43:01	0.148 ± 0.0014	25.75 ± 0.071	-111.25 ± 0.778
34	2020-12-29	15:20:54	0.118 ± 0.0014	16.80 ± 0.000	-102.20 ± 0.707
35	2021-03-31	09:01:17	0.753 ± 0.3083	20.15 ± 0.071	-92.95 ± 0.212

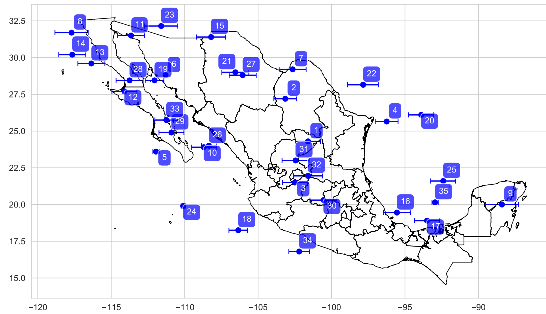

Fig. 1. Positions of events from table 1. The label of each point correspond to the ID (first column) of the referred table.

sTEC measurements for the PRNs of the whole day the event occurred, as well as the averaged TEC as function of time.

3. Ionospheric background and vTEC maps

Ionospheric perturbations also can take place due to space weather and geomagnetic storms. So, in order to discard such events we investigated the space weather in the day each event occured. In figure we present the geomagnetic *Kp* index for the events we consider are the most interesting

4. Frecuency Analysis

5. Discussion

6. Acknowledgments

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