

The Mexican Early Warning System for Space Weather

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Abstract. Early Warning of Space Weather phenomena is one of the most important products produced by Mexican Space Weather Service (SCiESMEX). The aim is to deliver a verified warning to Mexican National Center for Disaster Prevention (CENAPRED) as well as to general public in near-real time automatically. First, the international public warning (or alert) is produced by Space Weather Prediction Center of National Oceanic and Atmospheric Administration, U.S.A. Further, the alert is received by SCiESMEX system, decoded, translated in Spanish and put in the context of local current conditions. The alerts are transformed and validated in agreement to Mexican policies of civil protection and CENAPRED protocols. The automatic system segments the information and delivers the corresponding web- page-alerts, emails, twits, facebook messages and SMS. The latency of the alert is 5 minutes. The code is running since January of 2015 without major interruptions.

Keywords. Sun: activity, Sun: solar-terrestrial relations, solar system: general

1. Introduction

A complex infrastructure of radio communications and energy generation and distribution has been developed in Mexico during the last decades. The transmission system of the National Electricity Company (in Spanish CFE, Comisión Federal de Electricidad) has a capacity of 163,571.7 megavolts ampere (MVA) in 475 power substations and 57,453 km of transmission lines. Additionally, the CFE has in bailment 24,897 MVA with a length of 1,632 km in transmission lines. The CFE distribution system has a capacity of 54,624 MVA with 1,910 power substations and 500,000 km in high and medium voltage lines. According to CFE data, there were 1,380,589 operating electric transformers in 2015 (CFE, 2015). The national capacity for electricity generation is approximately 54,374.7 megawatts (MW) with 1,081 generation units divided between five regions: Northwest (15%), North (17%), West (27%), Central (16%), and Southeast (24%). At the same time, the Mexican Oil Company (in Spanish PEMEX) has 4,100 km of pipelines for gas transportation in order to move 7,000 million of cubic feet of gas per day. The Ministry of Communications and Transportation (SCT) and the Federal Institute of Telecommunications (IFT) are responsible for the quality of radio communications. The study of the use of the electromagnetic spectrum in Mexico performed by SCT (CFT, 2013) showed that there were more than 30 different users operating between 30 MHz and 300 GHz including the following: fixed and mobile services of radio communications for voice and data, maritime, aeronautic in route, mobile by satellite, broadcast, amateur radio, astronomy, Space Weather, aeronautic radio navigation, meteorology, radio localization, space operations, vehicle radio localization, media broadcast,

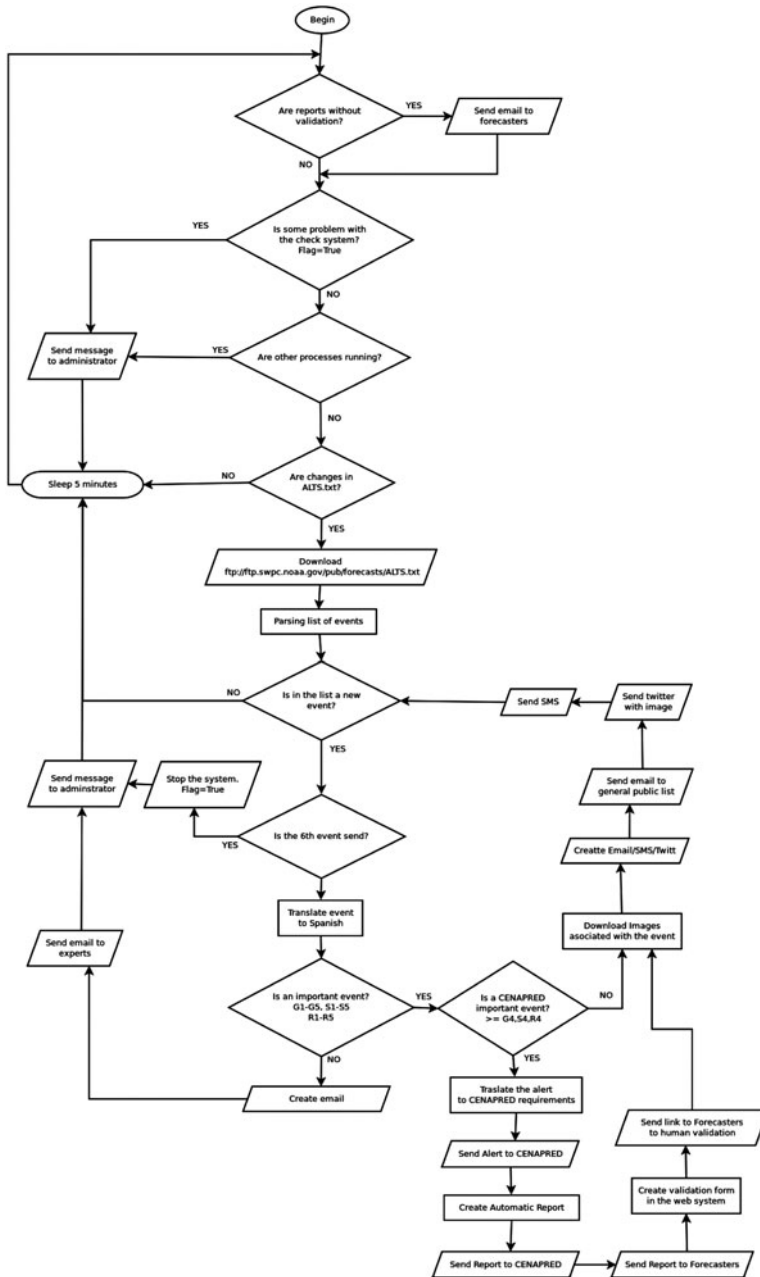


Figure 1. Flow chart of the Mexican Early Warning System developed by SCiESMEX - LANCE.

media links, AM and FM radio, mobile no geostationary, digital broadcast, GPS, horary signals and pattern frequencies for calibration, national system for public security, internet, satellite, tv satellite, point-to-point microwave, radio broadcast by satellite, governmental satellite services, and armed forces radio communications services. There are 62,996 registered dealers operating between 30 MHz and 3 GHz, mainly focused in the range of (148-173) MHz. The Bank of Mexico is the institution that supervises the



Figure 2. Outputs of the Mexican Early Warning System: Top-left, Webpage (<http://www.sciesmex.unam.mx>); top-right, email (sciesmex@geofisica.unam.mx), bottom-left, Facebook (<http://www.facebook.com/sciesmex>); and bottom-right Twitter (<http://www.twitter.com/sciesmex>).

electronic bank transactions. Mexico has become very dependent on radiocommunications. For instance, according 2015 statistics, there were about 16 million credit cards (Banco de Mexico, 2015), 53.9 million internet users, and 38.4 millions of mobile users (58% uses smartphones).

It is important to mention that Mexico is situated at low- and mid-latitudes, which are generally considered to be less vulnerable to Space Weather (SW) effects than the regions of high or equatorial latitudes. However, it has been shown (Cid *et al.* 2014, Yizengaw *et al.* 2013) that SW influence at similar geomagnetic latitudes can be drastic. The impact of solar flares on the ionosphere at mid-latitudes as well as the solar radio burst effects (Balch *et al.* 2004a, 2004b) may serve as example. This clearly indicates the importance of monitoring SW events over Mexico.

In this work, we present the near-real time Mexican Early Warning System developed by Mexican Space Weather Service (SCiESMEX). The alerts are obtained from the international public warnings produced by Space Weather Prediction Center of National Oceanic and Atmospheric Administration, U.S.A. (SWPC, NOAA), and adapted automatically. Then the warning messages are sent by email, social media (Facebook and Twitter), SCiESMEX webpage, and SMS network.

2. Flowchart

Figure 1 illustrates the flowchart of the system. The input for the code are the SW warning messages from SWPC. The system downloads the alerts each 5 minutes and parses the contents, in case of new alert was released. Further, the message is

automatically translated into Spanish. The following step is to check if the particular alert is important to general public. The NOAA scales for SW (G1-G5, S1-S5, or R1-R5) are used for reference. If negative, a warning email is generated and is sent only to the group of SW experts. Otherwise, the alert is important for National Center to Prevent Natural Hazards (CENAPRED in Spanish). In this case the information is sent directly to CENAPRED and a brief note for general public is prepared. The messages are sent via Facebook, Twitter, Email, SMS and SCiESMEX webpage. For safety purposes, if there are more than 5 messages within a 5 minute period, the automated sending system is paused until human check is performed.

3. Conclusion

Figure 2 presents an example of results produced by the warning system for four platforms: Webpage (<http://www.sciesmex.unam.mx>), email (sciesmex@geofisica.unam.mx), Facebook (<http://www.facebook.com/sciesmex>), and Twitter (<http://www.twitter.com/sciesmex>).

The System of Early Warning of Space Weather phenomena in Mexico has been operational without interruption since the end of 2014. The direct connection to Twitter and Facebook helps to increase significantly the number of warning recipients. This is an important issue as the objectives of SCiESMEX as a part of National SW Laboratory (LANCE) include the informing the general public about the current SW state over Mexico. The project is under development and we are currently working on second step human validation, automatic report generation, a double check for downloaded file from SWPC, extensive stress tests, and ISO 9001 Certification.

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