Prediction probability of GPS S4 scintillation data over the Brazilian territory

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ABSTRACT

Ionospheric scintillations are rapid variations of phase and amplitude of an electromagnetic signal passing through the Ionosphere. These signal fluctuations are created by random fluctuations of the medium refractive index, caused by inhomogeneities inside the ionosphere. Ionospheric scintillations occur especially in equatorial and polar regions. They appear after sunset and may last a few hours.

Scintillation deteriorates GPS/GNSS signals causing error on positioning and even loss of information. This can have disastrous effect for example on navigation. Therefore the importance of the study of the scintillation.

One parameter that represents the amplitude scintillation strength is the S4 index. S4 is the square root of the intensity variance normalized by the mean.

There is S4 scintillation index recorded data over the Brazilian territory from 1996 to 2015, one and a half solar cycle, for up to 21 stations. The data consists of station ID, date, UT, PRN, S4, elevation, azimuth, Kp and F10.7 cm. Statistics of these data is presented involving dependence on geographical location, local time, season, F 10.7 cm solar flux and Kp. The S4 histograms show the frequency of occurrence of the S4 index amplitude for the different conditions described above.

The purpose of this work is to calculate the probability of S4 bigger than a S4max on a given location, local time and time of the year.

Given an archive of scintillation data, it is reasonable to suppose that under the same conditions of season, local time, geographic location, F10.7 and Kp the scintillation behavior for a different date, will be similar to the given in the archive.

For every day (or local time of a day) of the data on a given location, month, F10.7 and Kp ranges is verified if there was occurrence of S4 > S4max or not. The sum of all these yes days divided by the number of data days multiplied by 100, gives the probability of scintillation indexes S4 > S4max.

For Cachoeira Paulista station near region, F10.7 > 100 and Kp < 3, Figure 1 presents the probability of S4 > 0.3 and 0.7 variations for the months of the year. Figure 2 shows the local time variation for October in the same conditions of Figure 1.

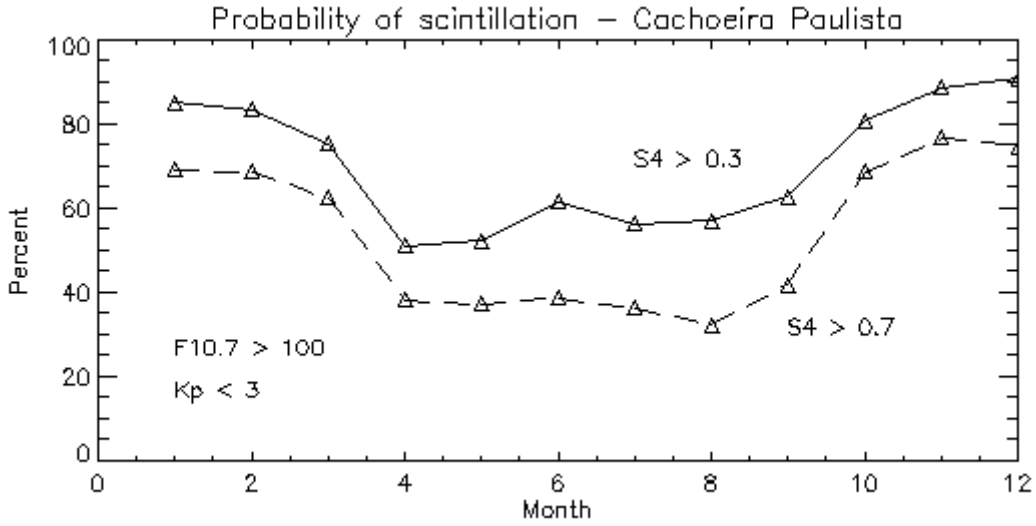

Figure 2. Probability of S4 > 0.3 and 0.7 for region near Cachoeira Paulista station on the condition of F10.7 > 100 and Kp < 3 for a given month.

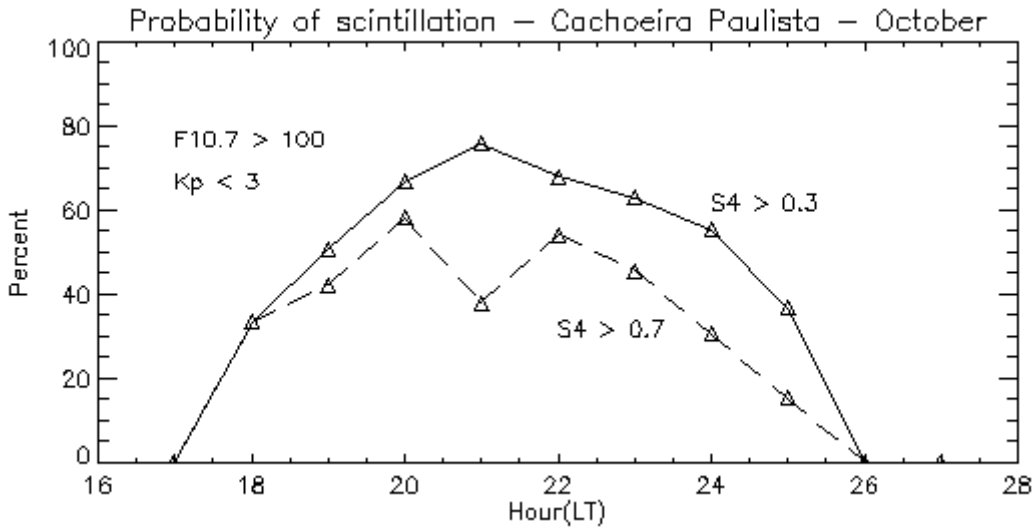

Figure 3. Same as Figure 2 for local time variation in October.

Results for several locations, F10.7 and Kp ranges are presented and analysed.

This work is a step forward for the development of the Brazilian Ionospheric Scintillation Model (BISM) that provides the occurrence probability of scintillation over the Brazilian territory.

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