Correlation between St. Patrick`s Day Geomagnetic Storm and Hurricane Nathan, 17 - 19 March 2015

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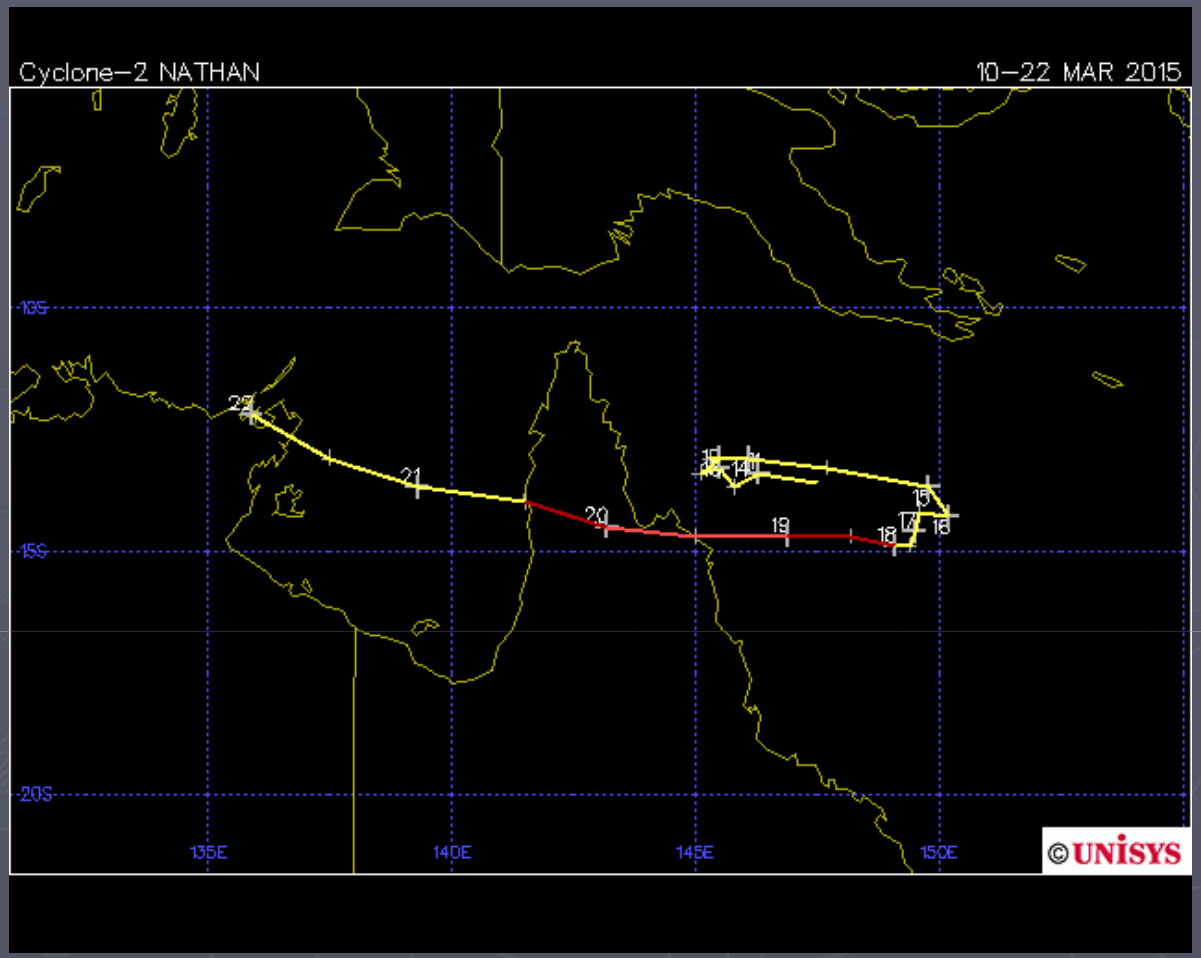

Figure 1. Cyclone-2 NATHAN (10-22 MAR), Storm - Max Wind speed 90 knots; Category: 2

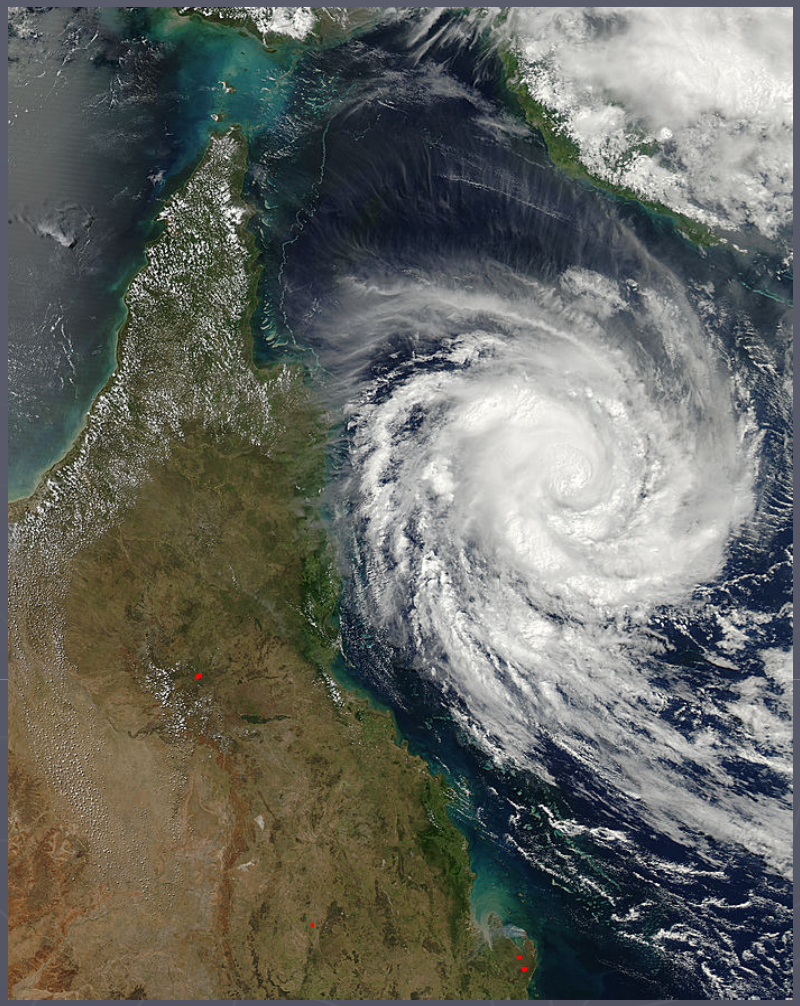

Figure 2. NASA's Aqua satellite captured this visible image of Tropical Cyclone Nathan off the Queensland, Australia coast on March 18, 2015.

Image Credit:

NASA Goddard MODIS Rapid Response Team

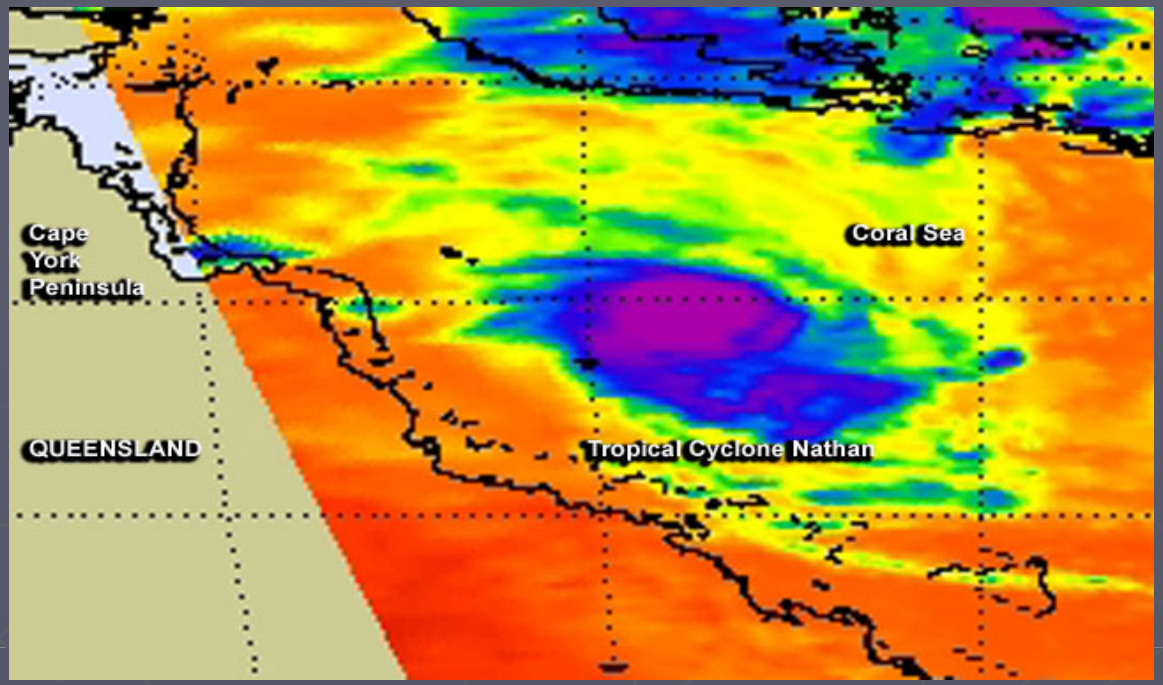

Figure 3. This false-colored image shows infrared temperature data of Tropical Cyclone Nathan's clouds on March 17 at 03:29 UTC, as seen by the AIRS instrument aboard NASA's Aqua satellite.

Image Credit: NASA JPL

The cloud top temperatures around Nathan's center were near -63F/-52C.

Diagram of changes in Dst index indicates the intense geomagnetic storms. On St. Patrick's Day, 17 March 2015, maximum changes in the value of the index of geomagnetic activities were registered [D_{ST}/dt = -228 nT].

- In the analysis of the solar geophysical processes that may influence the development and the dynamics of atmospheric disturbance, such as the hurricane Nathan, the following predictor variables were also included: density [e^+/cm^3], temperature [° K], the speed of protons [km/s], wind speed in the hurricane Nathan (knots) and the indices of the geomagnetic activities K_{GCK}, which are registered in the geomagnetic observatory Grocka (GCK).

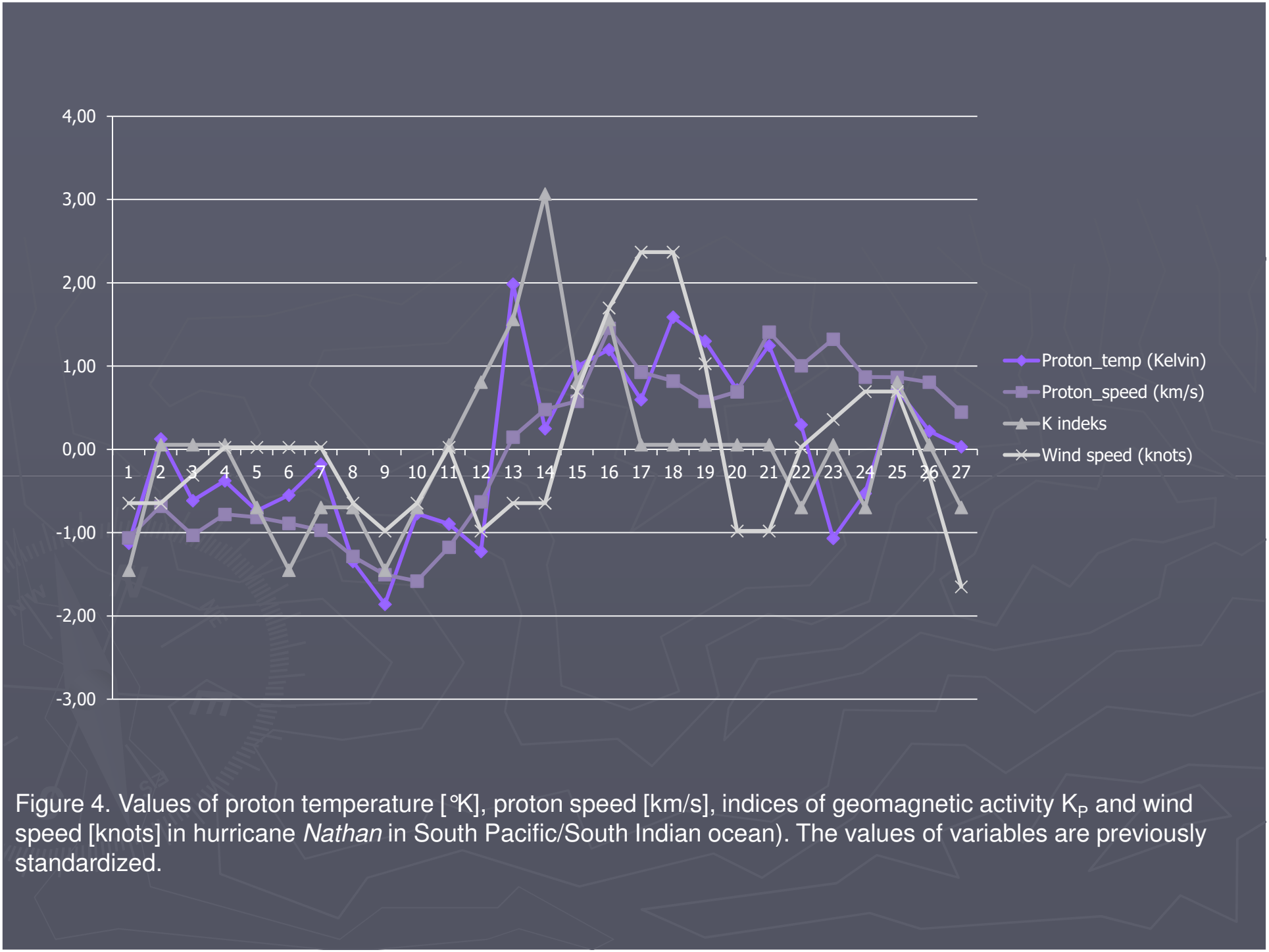

Figure 4. Values of proton temperature [°K], proton speed [km/s], indices of geomagnetic activity K_P and wind speed [knots] in hurricane *Nathan* in South Pacific/South Indian ocean). The values of variables are previously standardized.

- In the first step we analyzed the correlation of predictor variables (proton temperature, proton speed, K indices) with the wind speed in the hurricane Nathan (Table 1). It turned out that the changes in temperature and velocity of the protons show a statistically significant correlation with changes in the wind speed in the hurricane Nathan (bolded values in the Table 2). However, although there is a statistical significance, because calculated coefficient of determination is from 0.17 to 0.18 (i.e. it is less than 20% of changes), it occurs that the correlations have minor practical significance due to the fact that less than 20% of changes of wind speed in the hurricane Nathan can be explained by changes of the mentioned solar activity parameters.
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- In the next step the analysis is done by using a multiple linear regression and the overall impact of predictor variables on changes in the wind speed in the hurricane Nathan is tested (Table 2). However, this approach has not given significant correlations either, considering the fact that the total percentage, with which certain variables influenced the change of wind speed in the hurricane Nathan, is less than 12%.

Table 1 Correlation between indicators of solar activity and the wind speed in the hurricane Nathan

	Proton temp (K)	Proton speed (km/s)	K indices
Wind speed	**0.41**	**0.43**	0.15

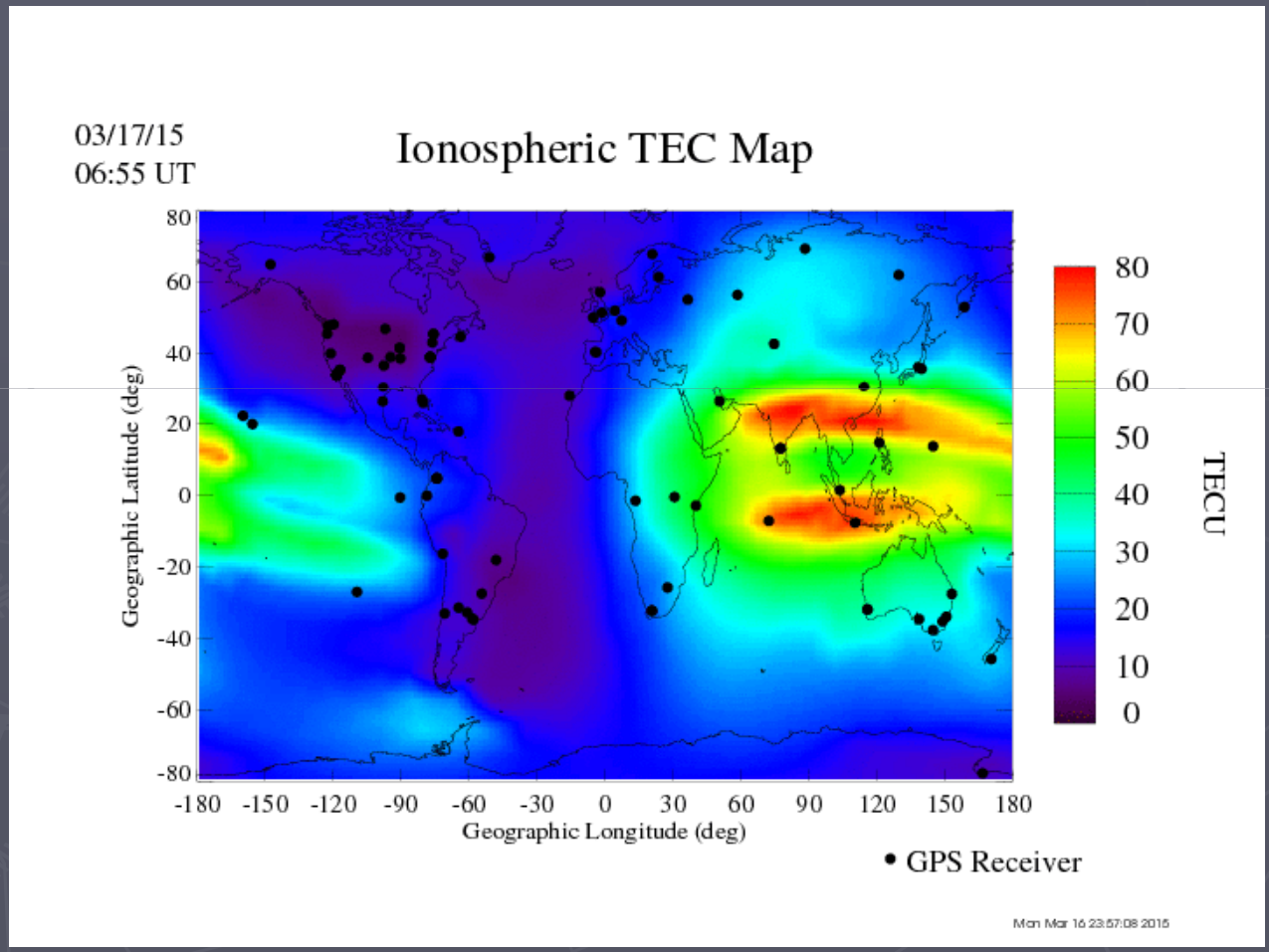
Table 2 Results of linear regression for wind speed in the hurricane Nathan and indicators of solar activity

Predictor variables	F statistic/p level	R2 (%)	Adjusted R2(%)
Proton temp, proton speed, K index	2.161 (p=0.120)	21.9	11.8

- The results of cross-correlation are shown in the Table 3. The increase in the coefficient of correlation occurs when we carry out the phase shift of the values of the solar activity parameters, in the case of the analysis it is the time interval of 3x12 = 36 hours. Then the cross correlation coefficient values increase and they are around 0.45 to 0.46. However, the cross correlation coefficient reaches the maximum values when the wind speed is phase shifted, i.e. when it is 36 hours 'late' in relation to changes in the index of geomagnetic activity [KP and / or KGCK]. Then the correlation coefficient reaches a value of about 0.72, which means that over 50% of changes in the wind speed in the hurricane Nathan can be explained by changes in the geomagnetic activity index KP and / or KGCK.

Table 3 Cross correlation between the wind speed in the hurricane Nathan and indicators of solar activity (the statistically significant values at the confidence level of 95% are bolded).

Lag	Proton temp	Proton speed	K indeks
-7	-0.13	0.21	0.01
-6	-0.20	0.23	-0.14
-5	-0.17	0.25	-0.23
-4	0.05	0.22	-0.22
-3	0.35	0.25	-0.11
-2	**0.45**	0.29	-0.14
-1	0.33	0.36	0.00
0	**0.41**	**0.43**	0.15
1	0.30	**0.46**	0.29
2	0.29	**0.42**	**0.50**
3	**0.43**	0.28	**0.72**
4	0.37	0.08	**0.59**
5	0.09	-0.08	0.37
6	-0.18	-0.23	-0.01
7	-0.34	-0.26	-0.18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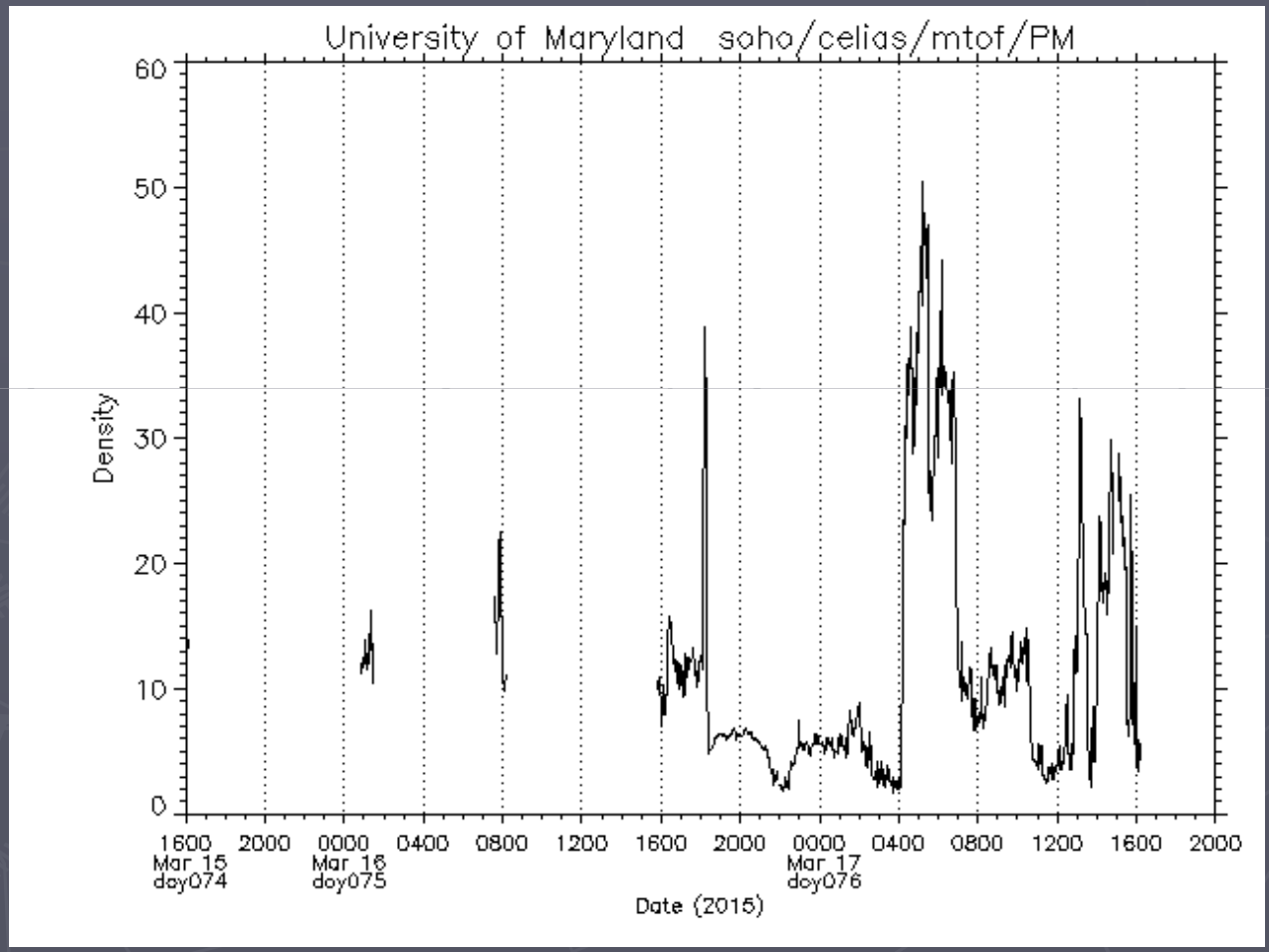
University of Maryland soho/celias/mtof/PM
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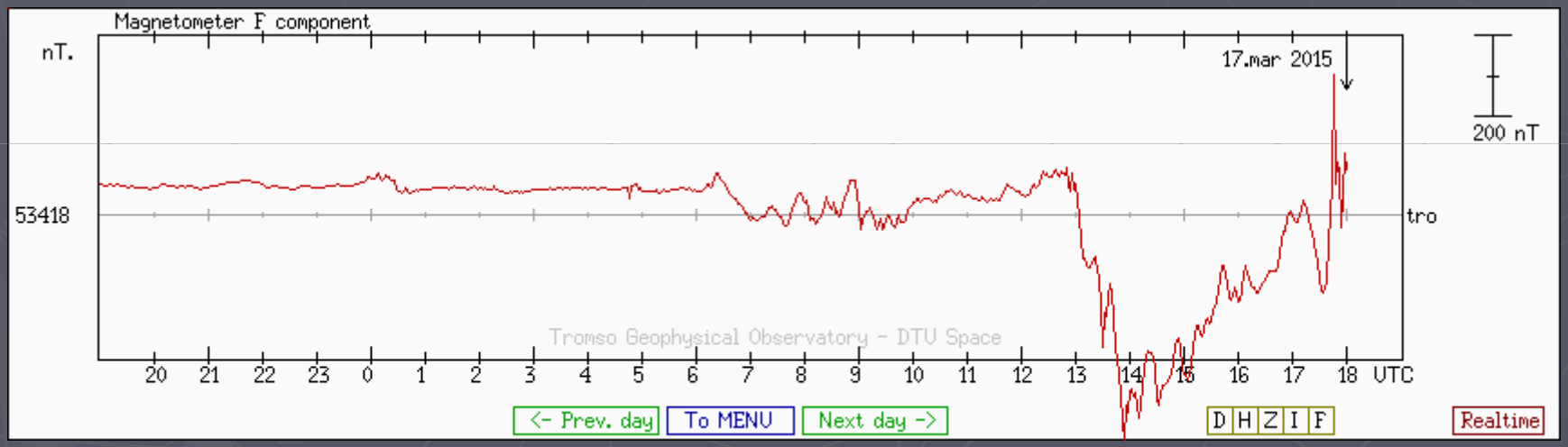
Date (2015)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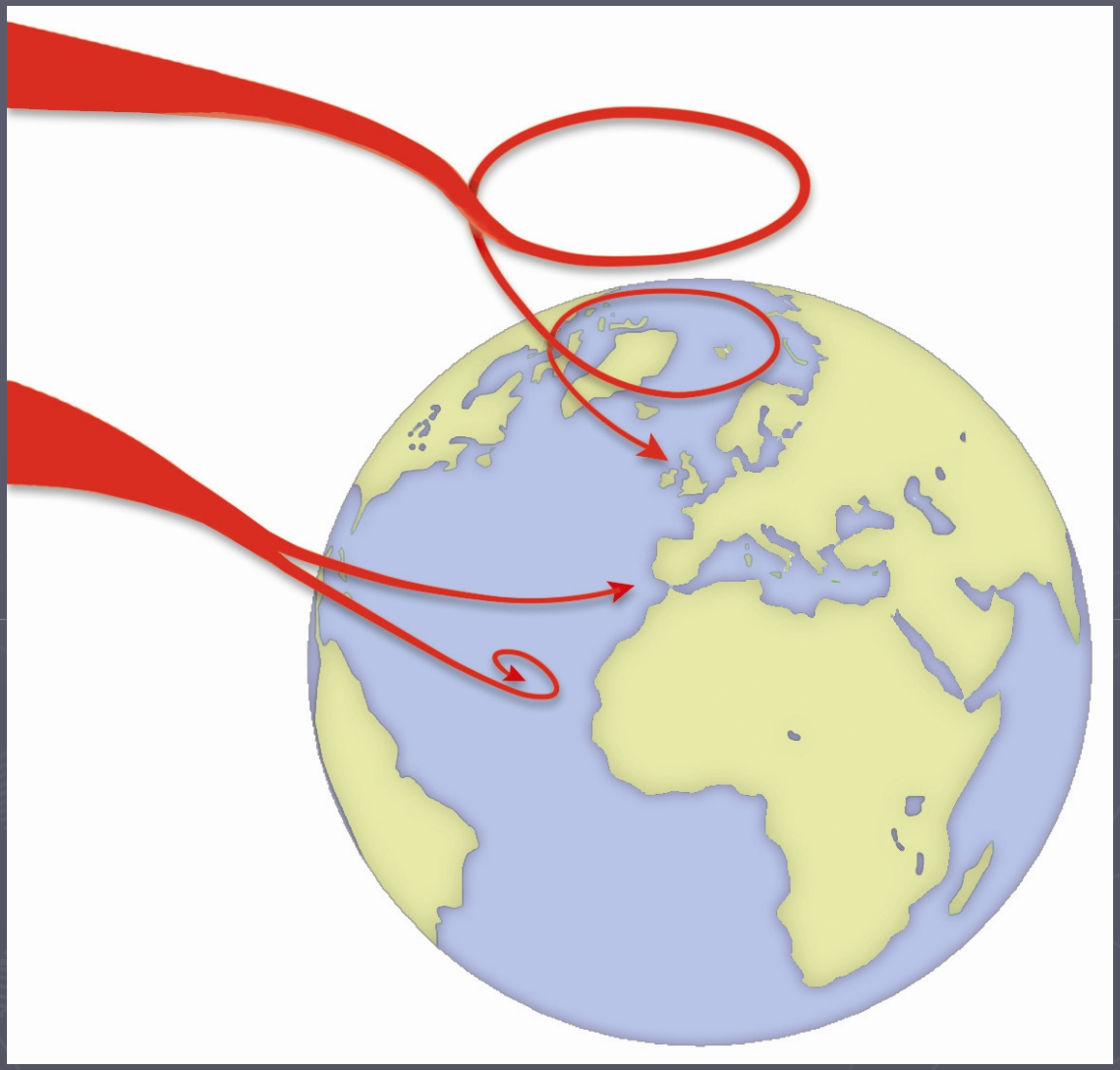

Figure 5. Schematic survey of the way of SW penetration towards topographic surface