

Response of the equatorial electrodynamics to geomagnetic pulsations

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Abstract:

The main objective of this poster is to study the signature of the Ultra-Low Frequency (ULF) waves on the equatorial ionosphere during the very strong storm of March 17, 2015. We focused on monitoring the ULF-PC5 type in three different equatorial stations (hint of results). In addition, we analyzed the ionospheric bubble index "IBI" measurements from SWARM satellite, we found (hint of the results).

Our study will contribute to the recent scientific research efforts to demonstrate that: Pc5 waves with a likely driver in the solar wind can penetrate to the equatorial ionosphere and modulate the equatorial electrodynamics.

Introduction:

Geomagnetic ULF (ultra-low-frequency) Pc5 waves (typical periods of about few minutes) are a persistent component of a disturbed magnetosphere. The main source of Pc5 pulsations is the Kelvin-Helmholtz instability (KHI) of the magnetopause engulfed by the solar wind (SW) flow (Yumoto and Saito, 1980; Kivelson and Pu, 1984).

Azimuthally polarized magnetic pulsations with periods of 150-600 sec, Pc5 pulsation, are excited by the surface waves at the magnetopause engulfed by the solar wind flow (Yumoto and Saito 1980; Kivelson and Pu 1984).

The Equatorial Spread-F (ESF) refers to the density irregularities, with a wide spectrum of scale sizes, occurring in the nightside equatorial F region. Among various ESF phenomena, the one with largest scale sizes is localized plasma depletions, referred to as "plasma bubbles". These plasma bubbles generated on the bottomside of the nightside equatorial F region and rise to higher altitudes as a result of nonlinear evolution of the generalized Rayleigh-Taylor and ExB instabilities.

The Bubble Index indicates the plasma irregularity existence. [Jaeheung Park 2013] described the possible cases of the Bubble Index by 3 numbers. The numbers are 0 indicate to Quiet, 1 indicate to Bubble and -1 indicate to Unanalyzable data. For more detailed see [Jaeheung Park 2013].

Data description:

As we see in figure 1 the geomagnetic indices in the first plot of the solar wind speed "Vx" is approximate 450 Km/s and it gets higher in the SSC of the storm to reach to ~ 500 Km/s to reach its maximum at 11:00 UT of 650 Km/s.

And then the auroral electrojets AE and AL&AU indices, their disturbance began at 12:00 UT and it reached its maximum at ~ 13:30UT. The z component of the interplanetary magnetic field "Bz" began to change at 04:00 UT to the north and still north to the end of the day. The Kp index of this day is 8 nT and that is indicator to a severe geomagnetic storm hit the earth on that day. For the SYM H index it is so much like the DST index had a SSC at 4:45 UT and the main phase of the storm to reach its maximum to ~ -200 nT.

The ionospheric bubble index had been measured from 15.42 to 15.81 hr in Mar 17, 2015, in this time the values of IBI are 0 or 1, so CWT applied on the index. The abrupt change in the IBI data appeared so clearly in the spectrum map from 15.55 to 15.61 hr.

For the geomagnetic pulsation of PC5 had been analysed for three station on the geomagnetic equator as shown as table 1, at 04:30 UT in the three stations the SSC began to rise as shown in figure 4 the PC5 began to change also at 04:30 UT. Then we took a small time range from 15.42 to 15.81 UT, KOU, AAE and PHU stations are similar to each other in peaks but different in amplitudes, figure 3 as we see the track of SWARM satellite is near to Africa more. We tried to see common enhancements in both PC5 and IBI.

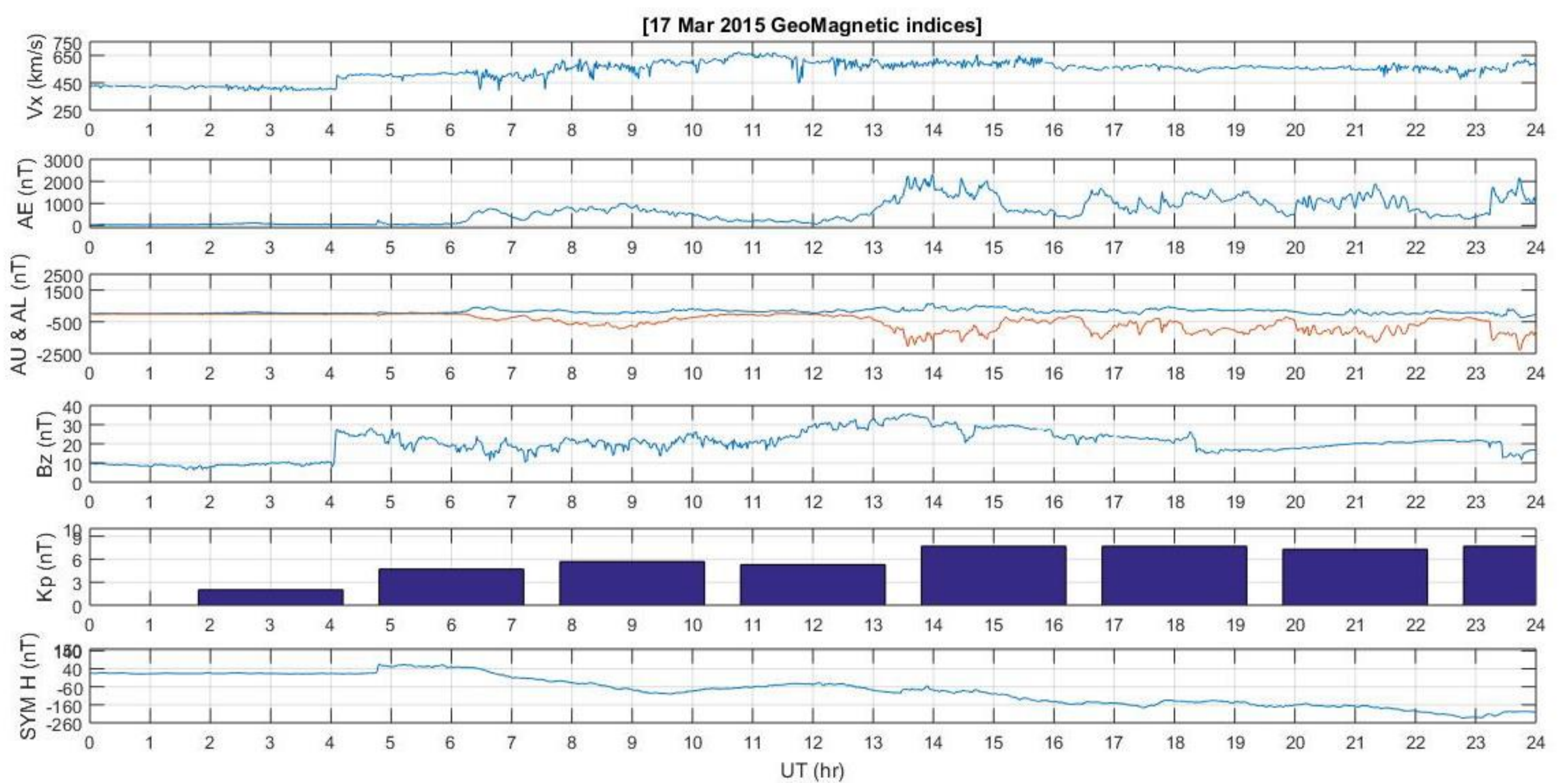


Figure 1. shows the geomagnetic indices of day march 17, 2015. Figure 1 is composed of six panels: from top to bottom the solar wind speed "Vx" in Km/s, auroral electrojets index "AE" AE = (AU - AL) in nT, eastward and westward auroral electrojets index "AU&AL" in nT, the z component of the interplanetary magnetic field "Bz" nT, Kp index is indication of the level of geomagnetic perturbation on planetary scale in nT and the SYM H index is the same to DST index with different resolution in nT.)

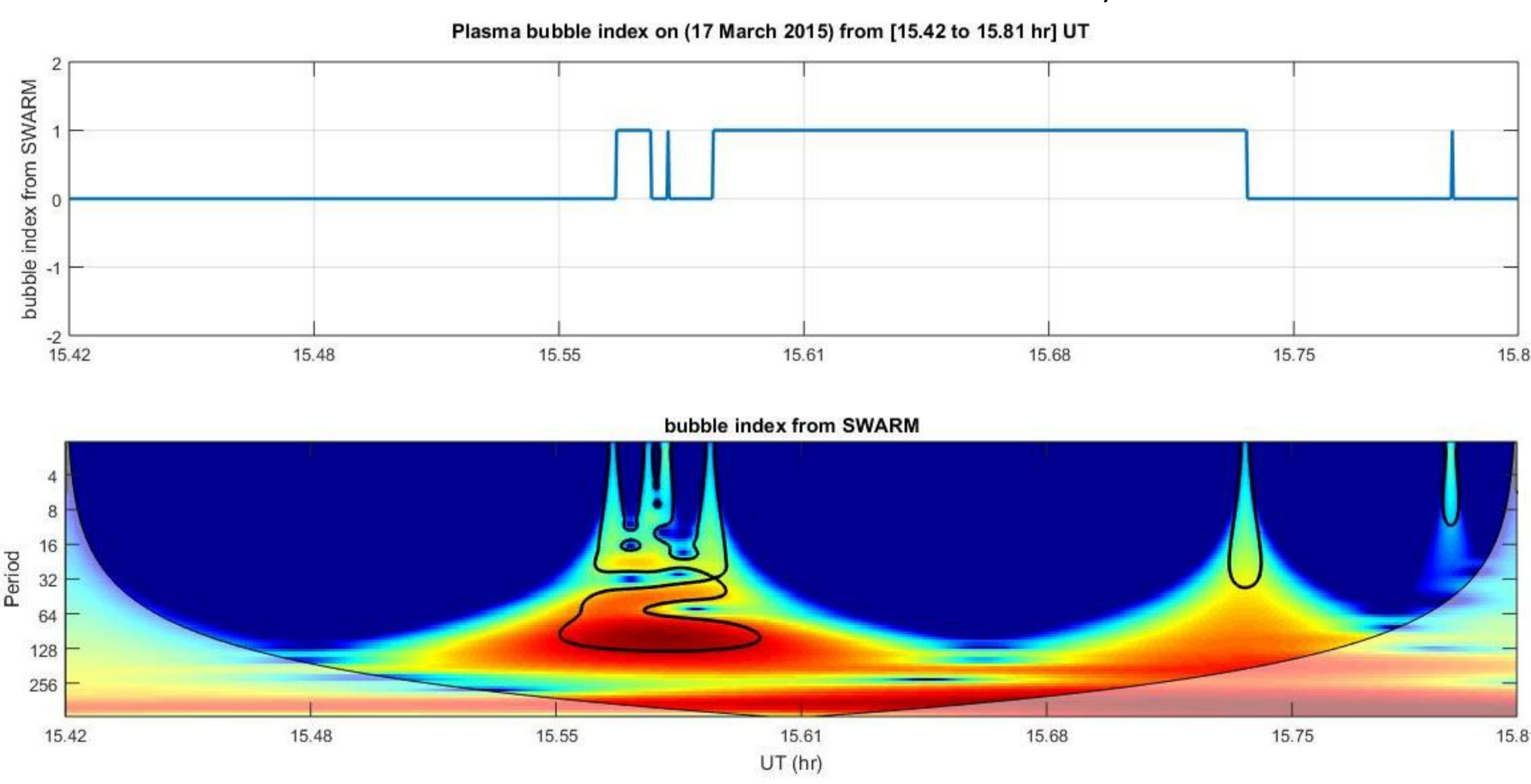


Figure 2. The upper panel shows the plasma bubble index measured by SWARM. The bottom panel shows the continuous wavelet transform for the plasma bubble index, we can notice that, the interested signature during the abrupt change from quiet to bubble time and vice versa at time 15.55 to 15.61 hr UT.

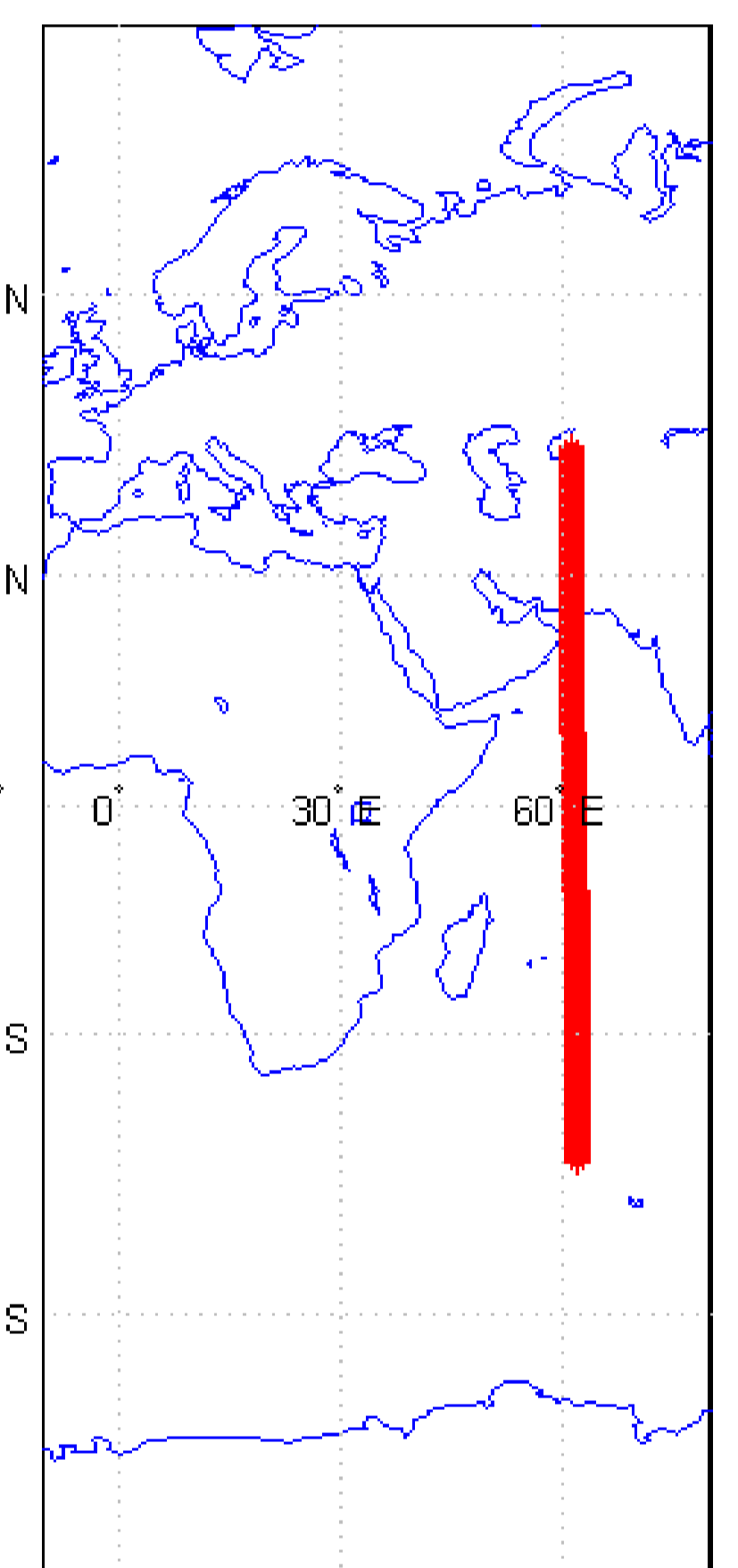


Figure 3. SWARM satellite track

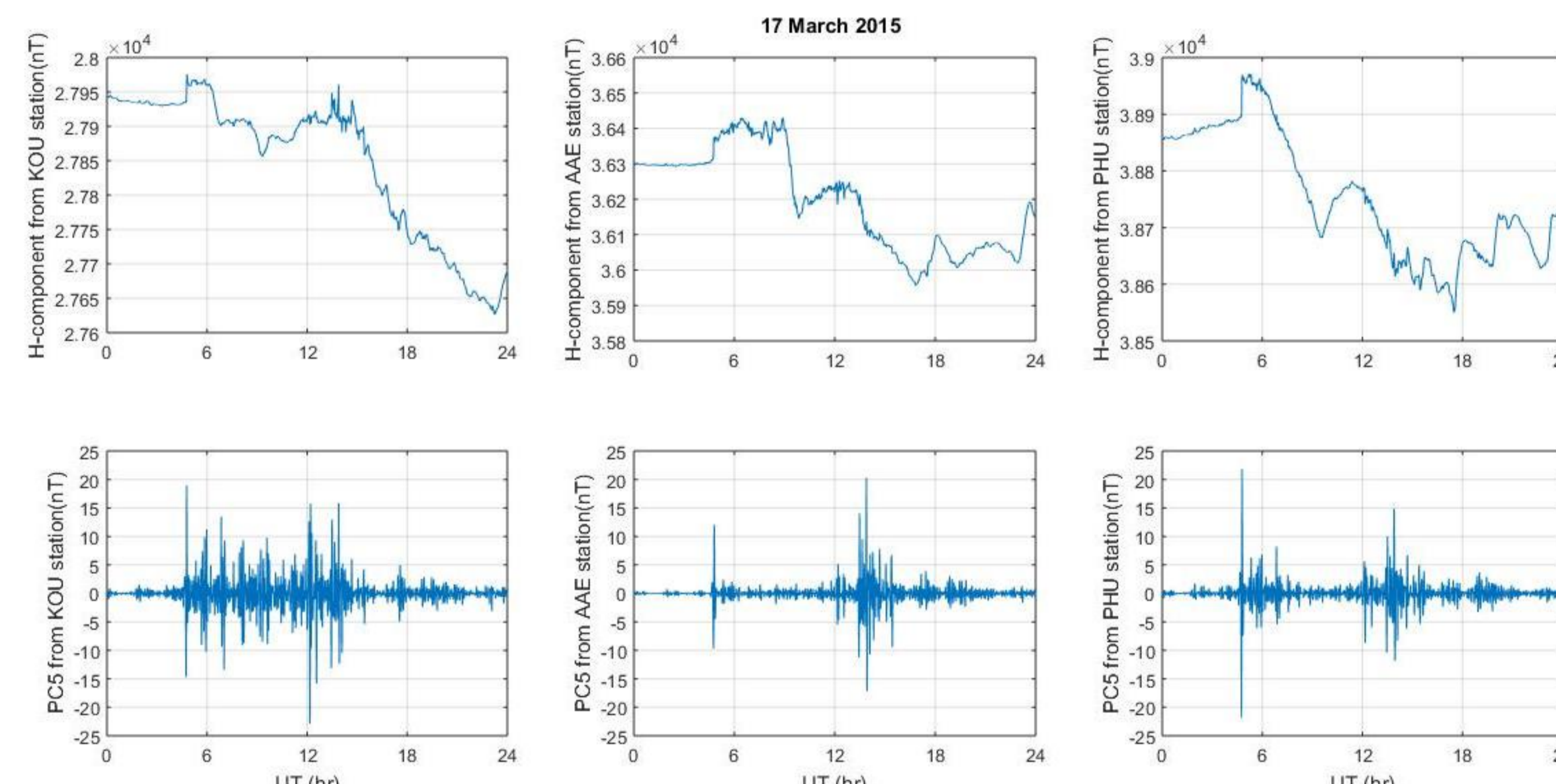


Figure 4. showed here the H-component and PC5 of three stations on the equator at different latitudes, KOU station in America sector, AAE station in Africa sector and PHU station in Asia.

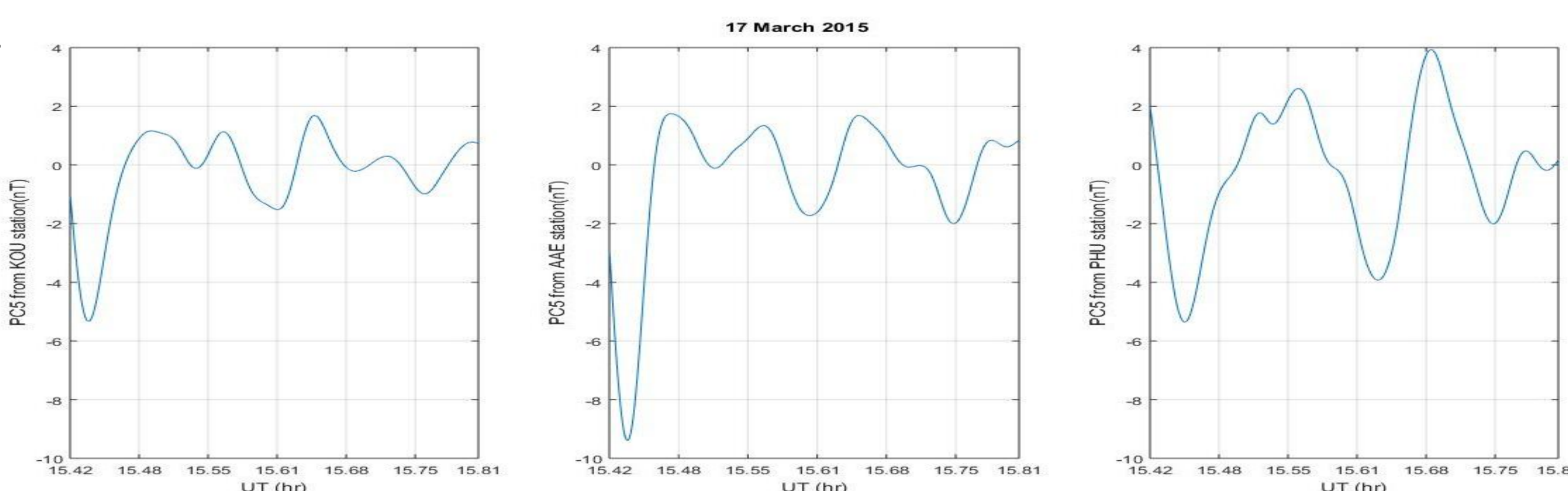


Figure 5. shows the PC5 of the H-component for the three stations of KOU, AAE and PHU for time range of 15.42 to 15.81 hr in Mar. 17

Result and Conclusion:

If we focus on time range of 15.55 to 15.61 UT in IBI, we see clear abrupt change in the CWT analysis very clear. Before we did the CWT on IBI we saw in the data from 15.55 to ~ 15.75 UT there are plasma bubble in that time.

In the PC5 plots in PHU station in Asia the maximum value of it is 4 nT at 15.68 UT and in AAE station in Africa the maximum value was ~ -10 nT.

Acknowledgement:

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References:

- [1] Jaeheung Park, Max Noja, Claudia Stolle, and Hermann Luhr "The Ionospheric Bubble Index deduced from magnetic field and plasma observations onboard Swarm" (2013).
- [2] A. Grinsted, J. C. Moore, and S. Jevrejeva "Application of cross wavelet transform and wavelet coherence to geophysical time series" (2004).

Name of the station of INTERMAGNET network	Geo. Lat	Geo. Long
KOU "Kourou, French Guiana"	5.21	307.27
AAE "Addis Ababa, Ethiopia"	9.0	38.77
PHU "Phuthuy, Vietnam"	21.03	105.95

Table 1. the magnetometers stations used from INTERMAGNET network

