22 July 2009 Total Solar Eclipse induced Wave-like-signatures (WLS) in the Lower Ionosphere: inferred using VLF observations

Ajeet Kumar Maurya*, K Venkateshm and Rajesh Singh
Dr. KSK Geomagnetic Research Laboratory, IIG, Allahabad, India

In the present work, we have focused on the generation and detection of solar eclipse caused wave-like-signature (WLS) in the lower ionosphere using VLF navigation signal form NWC (19.2 kHz) VLF transmitter recorded at three low latitude Indian stations Allahabad (Geog. lat., 25.4° N; long. 81.9° E; Geomag. lat. 16.3° N) Varanasi (Geog. lat., 25.3° N; long. 83.0° E; Geomag. lat. 16.03° N) and Nainital (Geog. lat., 29.4° N; long. 79.5° E; Geomag. lat. 20.5° N) located in 100%; 100% and 84 % totality respectively. This work further contributed to the important aspect of generation of wave-like-signature (WLS) in the lower ionosphere during eclipse. The transmitter receiver great circle path (TRGCP) from NWC to observing sites in India intersected totality path and passed through variable ellipse conditions from no eclipse to partial 84% at Nainital and 100% totality at Allahabad and Varanasi. The wavelet analysis shows (Fig. 1) the presence of WLS with period ~16-64 min during nighttime ~04:00–06:00 LT at all the stations. However, during eclipse time we have observed variable WLS signature at different stations. At Allahabad with period ~20-40 min are present after eclipse totality (~6:30-07:20 LT) whereas at Varanasi, nighttime WLS were continued during eclipse duration (up to ~7:20 LT). But no WLS were seen at Nainital during eclipse period despite 84% totality. The presence of WLS during night hours could be interpreted due to nighttime lower ionospheric variability which causes discontinuity/irregularities in lower ionospheric parameters such as temperature, electron density. The WLS during eclipse time have similar features as seen during nighttime and hence could be generated by sudden cutoff of the photo-ionization creating nighttime like conditions in the D region ionosphere and solar eclipse induced gravity waves. But variability in WLS features at different stations suggest that their observations at given station depend on the various factors such as location, day-night conditions, geometry of eclipse, eclipse magnitude, totality duration and TRGCP length, path direction.

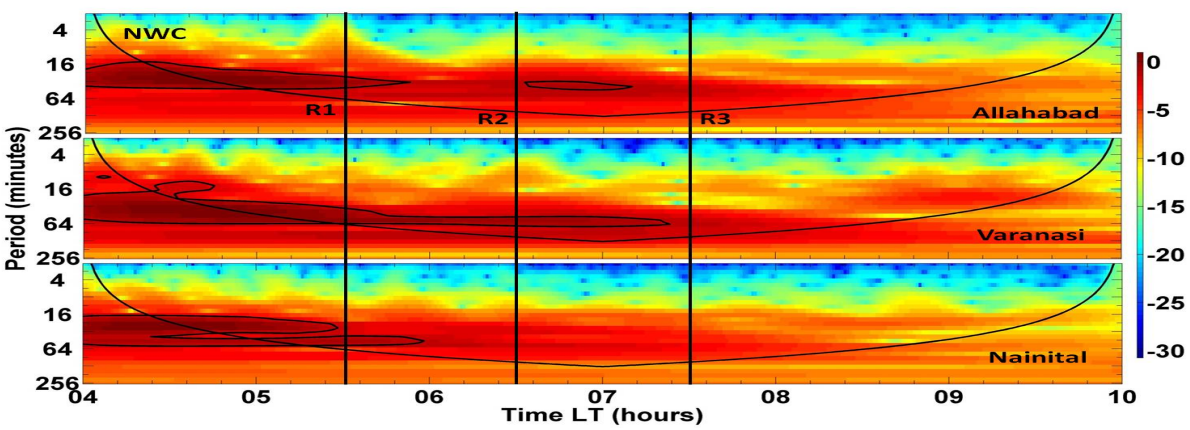

Fig 1: The wavelet spectra of NWC amplitude signal observed at three stations on 22 July 2009 obtained from the Morlet wavelet analysis. The vertical lines R1, R2 and R3, represent the eclipse begins, maximum and end time at receivers. The black thick contour shows 95% confidence line of the period, and the bowel shape contour shows the cone-of-influence, anything below is dubious. Hence, the period lying between two curves is significant.